INFORMATION TECHNOLOGY EXPORTS AND REGIONAL DEVELOPMENT IN THE LEADING STATES: A SHIFT-SHARE ANALYSIS OF INDIA

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India has adopted a balanced growth strategy driven by its large internal market, which entails making a major commitment to the endogenous development model. Previously, the country's development plans were built around the supply-side and import substitution approach. In the early 1980s, the economy of India experienced structural changes, as the gross domestic product growth rate steadily increased, and then in the early 1990s, the country leapfrogged into a development policy centred on information technology, which led to the development of a globally competitive information technology (IT) sector. IT has helped states in India to develop through intersectoral linkages with several services and the multiplier effect. This makes it interesting to review the impact of growth of IT on development in states where IT development is prominent. As states have not been equal beneficiaries, a shift-share analysis was carried out to arrive at these imbalances for the period 2004/05-2008/09 and 2009/10-2013/14. The results of a shift in the share show that regional variations in software exports can largely be attributed to a regional component. In addition, the results of ordinary least squares estimation point out that existing infrastructure is overstressed, namely that there is excessive pressure on teledensity, a shortage of power and a large population, which is making it difficult for regions to sustain a high level of specialization.

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JEL classification: L69, R10, R11, R15.

Keywords: Information technology, leading states, regional imbalance, shift-share, Granger causality.

I. INTRODUCTION

The major theoretical concepts and planning applications from the mid-twentieth century originated from Rostow (1960), who dealt with a five-stage model of economic development, Perroux (1950), who pioneered the growth pole theory, and Hirschman (1958), who focused on balanced verses unbalanced growth, and in the 1970's, the East Asia export promotion model. About that time, the neoclassical growth theory emphasized that growth and development were largely a function of labour and capital factor price differentials, that is, comparative advantage among countries and/or regions. Later, Solow (1959) showed that factor price differentials account for only about 50 per cent of the variance in economic growth, while the other 50 per cent was because of technological change. However, in the mid-1980s, the "New Growth Theory", as it is now called, focused on endogenous factors, that is, local conditions, such as leadership, labour force characteristics, innovation patterns and institutional capacity. Throughout that time, supply side or hard infrastructure, including social overhead investment in human capital (education and training), was the primary focus.

Contrary to those prevailing models, India implemented a different course of action. It adopted a balanced growth strategy driven by the country's large internal market. In contemporary terms, this was a very large commitment to an endogenous model for its development strategy. For the first 40 years, the five-year development plans were built around a largely supply-side and import substitution approach. During that period, the economy went through changes with the gross domestic product (GDP) growth rate steadily increasing from an average of 3.5 per cent per year during the first three decades of planning (1950 to 1980) to 5.4 per cent during the 1980s.

The reforms in the 1990 have led to positive growth results. The country's GDP increased from 5.7 per cent during the 1990s to slightly little less than 8 per cent during the 2000s. Its average annual rate of real per capita income growth also increased from about 1.3 per cent in the 1960s and 1970s to about 3.6 per cent in the 1990s and 5.9 per cent in the 2000s (India, Planning Commission, 2013).

During the early 1990s, India leapfrogged in a significant way into IT-oriented economic development (although the origins of this industry can be traced to the mid-1980s). It developed a globally competitive information technology (IT) services

industry, which has continued to grow. The generic term "information technology" sector broadly consists of three segments: (a) IT software: software customization, such as coding and testing, IT consulting, system integration, network infrastructure management and product development; (b) business process management, which covers back office jobs, starting from low-end functions, such as call centres and routine data processing, to more knowledge-intensive applications related to, for example, engineering design, multimedia and graphics, medical and legal transcriptions, insurance claim processing and inventory management; and (c) IT hardware, such as assembling of computers and peripherals.

The key verticals of the IT industry, namely banking, financial services and insurance, telecom, government, manufacturing, education and health care, are driving growth across sectors. Research studies by Arora and Athreye (2002), Kumar (2005) and Chatterji (2013) reviewed the potential of the IT industry as a tool for development. IT has been instrumental in supporting the development of different states in India, but not all states in the country have benefited from it. As IT is directly related to trade and communication and indirectly related to a number of sectors, including among them, transportation, banking and insurance, the development of the IT sector clearly leads to the development of related sectors, such as travel, tourism, real-estate, education and e-governance. This, in turn, benefits the local community and business through the generation of additional economic opportunities, jobs and incomes. Therefore, the present study is aimed at studying the impact of the growth of the IT sector on the regional development in different states. Using a shift-share analysis for two periods, 2004/05 to 2008/09 and 2009/10 to 2013/14, for the top ten IT-exporting states, and with the results of the shift-share analysis using the ordinary least squares method, the study looks into the imbalances stemming from the impact of IT and the causes behind them. Thus, this study provides a picture of regional development in these areas. The results of shift-share analysis show that regional variations in software exports were largely due to the regional component. The examination of industry mix shows that in such states as Karnataka, Tamil Nadu and Uttar Pradesh, an increase in export earnings occurred because of a favourable industry mix. The results on ordinary least square estimation indicates that the existing infrastructure is overstressed, namely that there is excessive pressure on teledensity and a shortage of power and that the high population makes it difficult for regions to sustain a high level of specialization.

In the remainder of this study, section II consists of a literature review, section III provides a discussion on the approach to the study, section IV deals with the methodology and section V covers the database. Empirical results and analysis is dealt with in section VI and section VII contains a discussion on the policy implications. Section VIII concludes the paper.

II. REVIEW OF LITERATURE

The literature review deals with studies that have improved the shift-share analysis theoretically and some with empirical applications. Estaban-Marquillas (1972), Arcelus (1984), and Casler (1989) dealt with theoretical improvement of the shift-share analysis. Haynes and Dinc (1997), Liu, Yao and Zhang (1999), and Randall (1973) dealt with empirical application of shift-share analysis.

Estaban-Marquillas (1972) introduced a new concept of the allocation effect to better understand the competitive effect under shift-share analysis. Arcelus (1984) introduced the concept of allocation effect to accommodate the degree of specialization in a region. Casler (1989) tried to deflect the criticism of shift-share analysis by developing a labour demand model within regions, which is consistent with the theory behind the model. Using the concept of unbalanced growth and certain assumptions, he found that his model was adapted to correspond to shift-share formulation, which, in turn, made the assumptions underlying shift-share analysis obvious and clarified the economic interpretations and analysis of the shift-share effects. He also showed that by slightly modifying the model, the linkage effect between various industries and regions and the national economy could be specified. Using theoretical arguments, he arrived at the conclusion that "arguments against definitions within theory are far more tenuous where these definitions aid in achieving stated research goals". Continuing with the theoretical arguments, he managed to come up with the formation of models from which both spatial and a spatial economics can be integrated and the balanced growth framework or linkage framework can be predicted.

Haynes and Dinc (1997) studied the growth in output and looked into the change in productivity on employment while extending the analysis of shift-share analysis. The authors tried to separate the effects of changes in output and productivity by modifying the Rigby-Anderson extension. Here the contribution of labour and capital to productivity growth were separated for analysing the regional economic performance. They assessed whether the observed changes in employment were because of changes in output or in productivity by using twenty manufacturing sectors at the two-digit level, in twelve states of the United States of America. The results showed that in both, the regions changed during the investigation period because of output growth, new investment in physical capital and improvement in technology. The authors are of the view that the crucial role of labour productivity in employment change cannot be ignored.

Randall (1973), in his empirical study based on the shift-share model analysis on employment change in West Central Scotland for the period 1959-1968, found that if the differential decline could be attributed to one or two establishments that was

manufacturing a distinctive product or targeting a particular market, the negative differential component reflected general factors applicable to most firms in the region. With access to disaggregated data one could have attributed this to structural factors. The author highlighted that another important criticism of shift-share analysis was its failure to take into account intersectoral linkages within the regional economy. A negative differential component can be attributed to linkages to declining specific industries and therefore was a concealed structural effect. However, in the absence of regional input-output data, testing those arguments was difficult. Finally, the author pointed out that despite those limitations, the usefulness of the technique should not be discredited. From the policymaking point of view, it was necessary to provide valid generalizations that could form the basis of policy measures.

Liu, Yao and Zhang (1999) carried out an empirical study on economic growth and structural changes in employment and investment in China. The authors analyses the impact of the multitier and multistage development strategy of former Chinese leader Deng Xiaoping on economic growth in Chinese regions in terms of GDP, employment and investment for a ten-year period covering 1985-1994 using a basic shift-share model. The two objectives of the strategy of Deng was to create a few rapidly growing centres, which would serve as a model for the rest of the country to follow. The authors made use of the Randall (1973) concept of net relative change, the difference between actual change and the national component, which is regarded as an index of relative performance of regions.

After reviewing literature on industry clusters, it appears that the importance of industrial "clustering" in space has long been recognized by regional scientists and economists, such as Marshall and Marshall (1920), Hoover (1948), Isard, (1956), Porter (1998), Lundequist and Power (2002), Stimson, Stough and Roberts (2006). The influential book *Competitive Advantage of Nations,* which was written by Michael Porter in 1990, is considered to have triggered the current intense policy interest in industry clusters. Perhaps the reason why this discussion on clustering resonates so strongly with policymakers is that it echoes much of the literature that preceded it and it analyses the linkages between business organization, strategy, and location (with the help of the diamond model) in a lucid manner.

Much of the recent debate recognizes industry clusters as an agglomeration of competing and collaborating industries in a region involving strong interplay between firms and their stakeholders, willingness of the members to share and nurture key technologies and business knowledge, which drives innovation based on locally embedded collective skills of the people and policy interventions. Reviews have also indicated that the proximity of firms and institutions in one location leads to better coordination and trust. Authors have emphasized that knowledge-based elements are the key determinants of the strength of a cluster. The higher the degree of knowledge

integration among firms leads to increased competitiveness among member firms globally and the greater economic performance of the industrial clusters. Although governments play a crucial role in the initial development of an industry, the ongoing inflow of talent, technology and capital have an accelerated effect on the development of industrial clusters. In addition, because industry clusters are built around core export-oriented firms, they bring new wealth into the region and help drive the region's economic growth.

In a review of the IT industries in India, studies by Basrur and Chawla (1999) pointed out that in the 1980's advanced countries were experiencing a "software crisis" in terms of demand for software services rising more rapidly than its supply. This triggered the globalization of production. During that time, India made a successful entry into the global software industry based on its comparatively low cost of professional technical manpower. The extensive use of English as a second language gave India a further competitive advantage in trading its software services with the advanced industrial economies. Initially, the majority of the firms in the country's software industry acted as body shoppers, but gradually in the 1990s a few pioneering Indian firms, such as Tata Consultancy Services, were able to leverage their technical and project management skills to successfully complete turnkey projects for large corporations.

During the 1990s, based on inputs from the industry body, the National Association of Software and Services, which was founded in 1988, the government began to support the industry proactively. First, the establishment in 1990 of the software technology parks provided high speed data communication facilities and financial incentives to firms to provide offshore services. Second, the economic reforms of 1991 induced a major shift in economic policies, including the devaluation of the Indian rupee, trade liberalization and openness to foreign investment. Tariffs and other taxes that had been plaguing the industry were reduced. In addition, in the 1990s IBM returned to India, which sent a positive signal to other global majors that the country's IT industry was set to be a significant player. Third, the telecom sector was deregulated in the mid-1990s, which facilitated participation from the private sector and multinational corporations. A subsequent review of policies has encouraged the rapid adoption of new technologies, allowing the industry to reap the benefits of free market competition, improved service quality and declining tariffs. Along with this, several new IT firms were started. During that decade, TCS, Infosys, and Wipro also emerged as market leaders (KPMG and CII, 2012).

In mid-1990s the IT enabled services/business process outsourcing/business process management industry emerged in India. The industry initially specialized in voice-led work. However, many of business process management services that could be performed remotely, such as customer care, payment services, administration,

human resources, finance and content development, were developed and continued to expand.

Indian business process management players have quickly broadened and deepened the services they offer, which range from data entry and medical transcription to niche areas and expert knowledge services, such as those in legal, pharmaceutical marketing, research (equity and financial) and analytics and drafting patent documents, in order to remain the world's premier destination for backoffice services.

The business process management industry has had as a social impact, as noted by, for example, Business World and the BPO Industry Report, in terms of its large-scale employment of the educated workforce (graduates and undergraduates) from all areas of concentration. A job in a business process outsourcing does not require an illustrious academic record and professional qualifications, but instead more weight is placed on soft skills, such as language proficiency, adaptability and learning ability. Women recruits also constitute 40 per cent of its workforce. The industries' most visible social impact has been its multiplier effects or spillover effects in terms of jobs created for other industries, such as human resources services, catering, transport, telecom equipment, real estate, IT services and office equipment. The business process outsourcing industry has economically empowered young adults and their high disposable income has led to an increase in the demand for costly consumer durables. The industry has created a burgeoning demand for real estate for office and housing space. This in turn has increased demand for, among others, real estate consultants, architects, builders, engineers, security agencies and landscaping professionals. The business process outsourcing has fueled demand for small vehicles, such as cars and vans, as well as for drivers. These vehicles are plying 24/7/365. The industry has also boosted the airline industry with movement of business process outsourcing professionals initially for business purposes and later for leisure. This has indirectly given a boost to the tourism industry. A large expatriate population is now living in such cities as Bangalore, Chennai, Delhi and Mumbai.

The industry has surged ahead and grown by leaps and bounds starting in 2000. The firms in India offering IT services[1] have evolved from providing application development and maintenance to emerge as full-service players that provide testing services, infrastructure services, consulting and system integration. Within those operations, IT outsourcing has grown rapidly in the following segments: remote

[1] Indian IT services are categorized into: (a) project based: IT consulting, systems integration; custom application development; network consulting and integration; and software testing; (b) outsourcing: application management; information system outsourcing; service oriented architecture (SOA) and web services; and (c) support and training.

infrastructure management; application management; and testing and service oriented architecture (NASSCOM, 2010). The industry's vertical market mix[2] is well balanced across several mature and emerging sectors. In 2013 mature outsourcing verticals-banking financial services and insurance, telecom and manufacturing contributed more than 75 per cent of the country's exports in terms of value (NASSCOM, 2013). To sustain its growth and take it to the next level, the country's IT business process management companies have recalibrated their strategies and shifted their focus from cost competitiveness (current linear model) to providing increased value in terms of domain expertise and being more efficient by adopting a non-linear growth model. The levers of this model are: intellectual property; cloud computing; platform business process outsourcing; non-linear pricing models; delivery accelerators; branding; and mergers and acquisitions. Notably, however, the effect of some of the levers are disruptive, such as cloud products and mergers and acquisition, and other could be incremental, such as pricing models and branding (KPMG and CII, 2012).

In addition, a review of studies on IT clusters in India by Van Dijk (2003), Vijayabasker and Krishnaswamy (2004), Ramachandran and Ray (2005), Sawhney (2006), Kumar (2005), Chandrasekhar (2005), Basant (2006), Balatchandirane (2007), Khomiakova (2007) and Chatterji (2013) shows that there has been a concerted effort to study the IT industry in India through the prism of regional cluster development. The researchers analysed IT clusters around the following key metropolitan regions: Mumbai, Bangalore, Hyderabad, Chennai, Kolkata, Delhi, Gurgaon, Noida and Pune. They asserted that globalization was behind the impressive growth of the IT sector and the expansion of the sector put it in a favourable light among the administrative and political elite of India. They point out that success of the sector has been supported by a combination of factors, including among them, the large pool of science, mathematics and engineering graduates, software firms having ISO 9000, six sigma, SEI[3] CMM,[4] SEI CMMI, PCMM[5]

[2] Vertical wise breakup for the year 2013 BFSI (41 per cent); telecom (18 per cent); manufacturing (16 per cent); retail (10 per cent); health care (5 per cent); travel and transport (3 per cent); construction and utilities (2 per cent); media, publishing and entertainment (2 per cent); and others (2 per cent).

[3] SEI CMM: Software Engineering Institute, Capability Maturity Model of the United States (SEI-CMM) certification at level 5.

[4] The purpose of Capability Maturity Model Integration (CMMI) is to guide organizations in their efforts to improve processes and enhance their ability to manage the development, acquisition, and maintenance of products and services. CMMI places proven practices into a structure and helps organizations assess their maturity and process area capabilities, establish priorities for improvement and implement these improvements.

[5] People CMM or PCMM is a process targeted at managing and developing an organization's workforce. The maturity framework of CMM for software. The aim of PCMM is to radically improve the ability of software organizations to attract, develop, motivate, organize and retain the personnel needed to continuously improve an organization's staff to develop effective teams and successfully manage the human resources of an organization.

certification, an early bird advantage, diaspora, expertise, entrepreneurial dynamism and government support. The formation of IT clusters and the benefits in the form of locational economies have not only made the IT industry globally competitive but it also has had a positive impact on the local economy in the form of large tax collection and job creation in diverse sectors, such as transportation, hospitality and consumer durables, and in spinoffs, such as hardware, electrical products, instrumentation, embedded systems, new start-ups and the biotechnology industry. The expanding IT sector has resulted in an increase in demand for office space, premium residential townships, hotels, shopping malls, educational institutions and specialty hospitals. The sector has been a crucial driving force behind the spatial expansion of major cities in India. Furthermore, as metropolitan areas are attracting IT investments and jobs are being created, pressure is being put on infrastructure, real estate costs are escalating, new socioeconomic conflicts are brewing with local residents over land and livelihood issues and demand for IT professionals is increasing. These are among the challenges the IT industry must deal with to gain momentum for further growth. Although the states of India are operating within the same national level macroeconomic environment, there are substantial variations in regional economic development outcomes. This can be attributed to differences among civil society and local- and state-level political and economic cultures and institutions.

III. APPROACH TO THE STUDY

The IT business process management sector has registered tremendous growth over the past 15 years, achieving an iconic status around the world and a reputation for its reliable and cost-effective delivery of services. India is recognized as the outsourcing destination of choice in the world. The major developed markets are sourcing IT business processing management services from India to improve their competitive edge. Indian IT companies have set up more than 600 delivery centres around the world and are providing services in more than 200 cities across 78 countries. As a proportion of national GDP, the sector revenue has increased from 1.2 per cent in fiscal year 1997/98 to nearly 9.5 per cent in fiscal year 2014/15. Its IT business process management revenue is projected to reach $150 billion, with $98 billion from exports and $48 billion from the domestic market. Exports account for a 67 per cent share of the revenue. E-commerce is driving the rapid growth of the domestic IT business process management sector. The domestic market is expected to get a further boost from the Government's focus on "Digital India" and "Make in India". India continues to maintain a leadership position in the global sourcing arena, accounting for almost 55 per cent of the global sourcing market size in 2015, as compared to 52 per cent in 2012 (NASSCOM, 2015).

The total employment associated with IT software and services was estimated to be 3.5 million in 2015. The indirect and induced employment attributed by the sector is estimated at about 10 million. Indirect employment is generated in several ancillary industries, such as those related to telecom, power, construction, transportation, corporate real estate, residential townships, shopping malls, specialty hospitals, catering, security and housekeeping. Induced employment is being driven by consumption expenditure of employees on food, clothing, recreation, and consumer durables including automobiles, health and other services.

The Indian IT business process management industry has emerged as one of the most dynamic sectors in the economic development of India and is responsible for the global recognition of India as a "soft" power. In addition to fueling the economy, the IT business process management industry has been influencing the lives of the people through active direct and indirect contributions to various socioeconomic parameters, such as employment, standard of living and diversity. The IT industry in India is centred on a few clusters to reap the benefits of agglomeration economies. The clusters in Bangalore, Mumbai, Delhi along with its suburbs, Noida and Gurgaon, Hyderabad, Chennai, Pune and Kolkata have helped to spur the emergence of a globally competitive IT industry. Other cities, such as Thiruvananthapuram and Ahmedabad, are in the process of becoming up as popular locations for clusters (Khomiakova, 2007). The spillover of the software industry for balanced regional development hinges on the availability of skilled labour, high speed data communication links and built-up floor space. Research studies, such as that of Surie (2005), point out that the success of the software industry depends on whether the benefits of IT are accessible to a wider population. To bridge the digital divide and to support the diffusion of IT to improve productivity, the state has to play a more proactive role. These observations have prompted the authors of this study to investigate the extent to which the IT sector is contributing to regional development in the ten states and the extent of imbalances, if any. To examine the above, the shift-share method was used. This method is a popular tool for analysing regional growth or decline over time. It has been widely used since the 1960s to assess a region's overall performance relative to other regions by focusing on output, employment and investment by industry sector. The method was introduced in Dunn (1960) and Ashby (1968) and has been extensively discussed in Casler (1989) and Randall (1973). A recent discussion and application of the method is found in Stimson, Stough and Roberts (2006) and Liu, Yao and Zhang (1999). In addition, to analyse the causes behind the states strength/weakness, the study uses an endogenous growth model solved by using the ordinary least squares method. Added to this, the present study also tries to analyse the extent to which per capita income of a state and its IT exports are causing one another in three main states mainly Karnataka, Andhra Pradesh and Tamil Nadu by using the Granger causality test.

IV. METHODOLOGY

The study mainly uses two methods: a shift-share analysis; and econometrics – ordinary least squares estimation and Granger causality test.

Method I: Shift-share analysis

The shift-share method is a technique that uses a sectoral decomposition to examine the regional growth/decline. The method makes it possible to assess the overall performance of a region relative to others. In addition, the method also allows for an assessment of the relative importance of an industry sector in the region and helps to identify industrial sectoral problems in a region. Particularly, this method is used to demonstrate how the industry structure could affect regional and local economies and thereby help in reviewing regional trends and advising policymakers on targets to industries.

The variable decomposed using this method could be, for example, income, employment, value added and number of establishments (Haynes and Dinc, 1997). Thus, the shift-share model decomposes, for example, regional growth/decline of GDP, investment, and employment into three components while measuring them. These relate to:

- National share:[6] by national share, the measure tries to explain that portion of the GDP/exports/employment, change attributable to national trends
- Industry mix:[7] by industry share, the measure tries to explain that portion of the GDP/exports/employment, change attributable to industrial composition or mix of the region, and
- Regional shift:[8] that portion of the GDP/exports/employment, change that is related to the regional advantage or competitiveness in the region is considered as the regional shift component.

[6] Measures the change (growth or decline) in total GDP/exports/employment of an industry at the national level.

[7] Measures the industry composition of the region, namely to what extent the region specializes in industries that are growing rapidly or slowly nationally.

[8] Measures the change in a particular regional industry's GDP/exports/employment, namely growth or decline in a regional industry because locational advantages and disadvantages.

Literature reviews that supported the earlier models using shift-share analysis were those of Perloff and Wingol (1961) and Dunn (1960). The former is said to have focused on total regional employment, which had only two components. These relate to total shift and differential shift. The total shift is expressed as:

$$TS \equiv \sum i\ ei,\ t - \sum i\ ei,\ t - 1\ (\frac{Et}{Et-1}) \tag{1}$$

and the differential shift is expressed as

$$DS \equiv \sum i\ ei,\ t - 1\ \left(\frac{ei,\ t}{ei,\ t-1} - \frac{Ei,\ t}{Ei,\ t-1}\right) \tag{2}$$

Here while *e* refers to the regional employment, *E* refers to national employment. The subscript i refers to the industry. The subscripts t-1 and t refer to the initial and end periods considered in a study. Dunn (1960) captured the proportionality effect by introducing differential rates of growth in individual industries within the shift-share model. This is said to be equivalent to the industry composition or mix effect, referred earlier. Ashby (1968) introduced a three component model of regional change. These three components were national share (NS), industry mix (IM) and regional shift (RS).

In the present study the variables IT exports[9] are to be decomposed. Thus, the model for IT exports is as follows:

Expressing the above symbolically we have the following equations:

$$\Delta xi \equiv xi,\ t - xi,\ t - 1 \equiv NSi + IMi + RSi \tag{3}$$

Here

$$NSi \equiv xi,\ t - 1\ (\frac{Xt}{Xt-1} - 1) \tag{4}$$

$$IMi \equiv xi,\ t - 1\ \left(\frac{Xi,\ t}{Xi,\ t-1} - \frac{Xt}{Xt-1}\right) \tag{5}$$

$$RSi \equiv xi,\ t - 1\ \left(\frac{Xi,\ t}{Xi,\ t-1} - \frac{Xi,\ t}{Xi,\ t-1}\right) \tag{6}$$

Thus, the symbol Δ refers to change and x_i refers to IT exports in different regions. X_i refers to IT exports at the national level, namely total Software of Technology Parks of India (STPI) exports, and X refers to total of all India non-factor services (NFS) exports. Subscript *i* refers to IT exports and the subscript *t* and *t-1* refers to the end and base period, respectively. NS refers to the national share, IM refers to the industry mix and RS refers to the regional share.

[9] As data pertaining to the IT sector alone are available only for exports, the study analyses the IT exports under a shift-share analysis.

Now following Randall (1973), the above equation 1 could be written as

$$\Delta xi - NSi \equiv IMi + RSi \quad (7)$$

Here the left hand side is the difference between the actual change and the national component. If the national component is deducted from the actual, the net result is the net relative change of exports over the base period. Thus, this equation is called the net relative change (NRC).

Method II: Econometrics – ordinary least squares

An endogenous growth model is attempted in econometrics by using ordinary least squares estimation. As the shift-share analysis only identifies the region or country as factors responsible for growth, the study was intended to go deeper to find out the specific regional factors responsible for the regional influences in the growth of IT. The growth or decline that takes place in different regions could be the result of favourable or unfavourable external environment or regional endogenous factors, such as the locational advantages and disadvantages. However, to measure endogenous growth, there is no universally available variable. Review says that the regional shift (RS) component derived from the shift-share analysis can serve as a reasonable proxy to act as a dependent variable in a model of endogenous growth. The model is thus developed to identify the endogenous factors leading to spatial variation in the performance of the software sector across leading states in India.

Considering the regional shift component as the dependent variable, an ordinary least squares regression is being run by using five independent variables, namely enrolment in higher education, population, location quotient, electricity consumption and teledensity. Here it is hypothesized that the five independent variables are the determinants of endogenous growth that may account for spatial variations in IT performance across Indian states. In other words, it could be said that these independent variables in the model are assumed to serve as potential regional endogenous factors that might influence software export sector performance. Explaining the influence of these potential factors it is seen that the success of the software industry depends on the following.

First, the existence of skilled workers. It is often proposed that regional growth is enhanced in certain regions by the existence of skilled workers, the availability of employment opportunities, opportunities for a wide range of skills and the existence of higher income jobs. The IT sector is no exception to this. However, it also calls for

highly skilled personnel. Therefore, the variable, state-wise enrolment[10] in higher education, was incorporated in the model to assess those effects.

Second, population is used as a dynamic measure of the size of the region.

Third, the study investigates the nature of the software industry structure in the 10 states and the effect of the industry's specialization on the region's endogenous growth. An appropriate measure to this effect could be the location quotient, which is used to measure the concentration of a particular industry in a defined area. Location quotient (LQ) is defined as a ratio of percentage share of a particular sector, say real estate, ownership of dwellings and business services (REODBS)[11] in terms of services sector of the state, to the percentage share of REODBS at the national level, to the services sector at the national level. LQ of greater than one means that the state has a larger share of that industry. Precisely LQ explains the localization of a particular industry in a given state. This can be expressed as follows:

$$LQ = \frac{\textit{State REODBS output}}{\textit{State Service GDP}} \; X \; \frac{\textit{India's Service GDP}}{\textit{India's REODBS output}}$$

Fourth, teledensity and broadband penetration/connections are used to incorporate the potential effect of teledensity on the regions' endogenous growth.

Fifth, one of the prerequisites to attract the IT sector to different regions is the availability of uninterrupted electric power. Availability of electricity is considered as a factor influencing endogenous growth of the software sector. Instead of using total available electricity, state-wise per capita electricity consumed is used as one of the variables, as it clearly indicates the actual availability.

Thus, the competitiveness of a region, namely the regional shift (RS) component is hypothesized to be dependent upon availability of teledensity, the regions enrolment in higher education, the extent of electricity consumption, population of the region and the degree of specialization, namely location quotient.

[10] The number of skilled persons available would be an ideal variable. Since this is available for census years only, data from the Ministry of Human Resource Development of India on enrolment in higher education are being used as a proxy.

[11] The aim of this study is to look into the IT sector independently. However, as the IT sector data are subsumed under REODBS, the study is forced to consider REODBS data. Although it is known that (REODBS) data are a combination of all three. These data are considered because state-wise disaggregated data on computer services were not available. Added to this, these combined industries are interrelated.

The linear model for ordinary least squares estimation is expressed as follows:

$$Y = C + aX_1 + bX_2 + cX_3 + dX_4 + eX_5 + \varepsilon$$

With reference to the variables, the above equation could be expressed as:

$$RS_i = EHE_i + POP_i + LQ_i + EC_i + TD_i + \varepsilon$$

Here $Y(RS_i)$ is the regional shift component derived from the shift-share analysis of growth in IT exports, $X_1(EHE_i)$ refers to enrolment in higher education, $X_2(POP_i)$ refers to population, $X_3(LQ_i)$ refers to location quotient, $X_4(EC_i)$ refers to electricity consumption, $X_5(TD_i)$ refers to teledensity, ε is the error term and a, b, c, d and e are coefficient of the variables. A direct relationship between dependent variable and the independent variables is assumed and a regression is run to produce the results in the next chapter.

Method II: Econometrics – Granger causality test

As regional development is closely related to positive higher growth in per capita income of that region, a causal relationship between regions' per capita income and IT exports is studied to determine how IT exports have contributed towards the development of IT hubs and improved the standard of living of the population in the region. To test the bi-directional causality between two variables the standard Granger causality test (Granger, 1969) was used in the present study. The theory of causation states that if the past values of variable Y improve the forecast of variable X, then it can be said that variable Y Granger causes variable X and vice versa. The Granger causality model is given as below:

$$X_t = \alpha_0 + \alpha_1 X_{t-k} + \ldots\ldots\ldots + \alpha_n X_{t-n} + \beta_1 Y_{t-1} + \ldots\ldots\ldots + \beta_n Y_{t-n} \quad (1)$$

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \ldots\ldots\ldots + \alpha_n Y_{t-n} + \beta_1 X_{t-1} + \ldots\ldots\ldots + \beta_n X_{t-n} \quad (2)$$

Here X_t and Y_t are all possible pairs of (XY) series. The null hypothesis H_0 for equation (1) is $\delta_l = 0$ for all l's against the alternative hypothesis H_1: $\delta_l \neq 0$ for some l's. Similarly, for equation (2) H_0: $\theta_l = 0$ for all l's against H_1: $\theta_l \neq 0$ for some l's. Thus, it can be stated that the Granger causality test is to see how many lags of Y_t are jointly significant in an equation of X_t and vice versa. To test the joint significance of coefficients F-test is applied.

The Granger test is sensitive to the lag length selection hence the robustness of result of the test is subject to optimal lag selection. Akaike information criterion (Akaike, 1974) is commonly used for lag length selection of optimal lag structure. To avoid the probability of spurious regression, the Granger causality test is applied

only on stationary series. To test the presence of unit root in a series Augmented Dickey-Fuller Test is commonly used (Dickey and Fuller, 1979). The Granger causality test is valid only if the variables in question are not co-integrated (Engle and Granger, 1987). Hence, it is important to check the stationarity of each of the variables and the co-integrating relation between the concerned variables before Granger causality test is performed.

Thus, to understand the interrelationships between the different components of the endogenous growth model, causality testing is undertaken. Aiming to see whether the state's change in per capita income are the result of changes in IT exports and changes in the real estate, ownership dwellings and other business services sector, it is assumed that the null hypothesis to be tested as change in a state's IT exports does not influence the change in per capita income of the respective state. To test it bi-directionally entails looking to ascertain if change in IT exports causes the change in state's per capita income or change in state's per capita income causes change in IT exports of the state.[12] Similarly, by considering the null hypothesis to be tested as change in GDP of REODBS sector of state do not influence the change in per capita income of the respective state and testing it bi-directionally whether change in GDP of REODBS sector of state causes change in state's per capita income or change in state's per capita income causes change in GDP of REODBS sector of state is determined.

V. DATABASE[13]

Information technology export data under the title "State-wise Software Exports made by registered units through STPI for last three years in Rupees Crore" are published in STPI annual reports. STPI annual reports for 2006/07, 2007/08, and 2009/10 have been used. Higher education data were procured from the 2008/09 annual report. Following the change in the format of data dissemination in the annual reports of the Ministry of Human Resource Development of India after 2008/09, Indiastat.com data were used for the years 2008/09, 2009/10, 2010/11 and 2012/13 on "state-wise enrolment of students in higher education", which compiles the data from the reports of the ministry. State-wise data on teledensity per thousand population for the years 2006/07 to 2010/11 were collected from *Infrastructure Statistics 2013* and data for the year 2012 from *Infrastructure Statistics 2014*. Instead

[12] Only the top three southern states, Karnataka, Andhra Pradesh and Tamil Nadu, have been done because of a time constraint. It could be extended to other states in later work.

[13] Database has been kept brief to reduce the bulk of the paper. It could be given to interested readers on request.

of making use of state-wise per capita electricity consumption, state-wise data under access "Industrial Electricity Consumption" (gigawatt hour) for the years 2005/06 to 2009/10 from *Infrastructure Statistics 2013*. Data for the 2011/12 are taken from *Infrastructure Statistics 2013*. Sector wise GDP[14] data are collected from the state GDP series published by the Central Statistical Organization, India. All India GDP data sector wise are collected from the site of Ministry of Statistics and Programme Implementation of India. The 1993/94 and 1999/00 series data for those states are adjusted for 2004/05 prices and the whole data set of the states as well as central data used are for 2004/05 prices.

VI. EMPIRICAL RESULTS AND ANALYSIS

The results of the shift-share analysis were arrived at by fitting the data into the models/formulas and calculations of different components of the model using excel sheets. These were then tabulated as different tables. Ordinary least squares estimation was carried out for the two different periods using four different models for each period in Excel. A Granger causality test between change in IT exports and change in per capita income of state and vice versa and change in per capita income of state and change in GDP of the REODBS sector and vice versa was done in EViews. Only two lags are used for arriving at the results.

Results of the shift-share analysis on information technology exports by states 2004/05 and 2008/09

In the shift-share analysis of IT export revenue of ten states in India for 2004/05 and 2008/09, it can be seen in table 1A that overall total STPI exports increased by 122 per cent and total non-factor service exports increased by 99.9 per cent.[15] During this period, except for Delhi, which recorded a negative actual change, in absolute terms, software export revenue for other states had increased. Software export revenue witnessed a relative decline, namely a negative net relative change (NRC) in Delhi, Haryana and Punjab. This decline was mainly influenced by the regional component, with industry mix constituting a negative contribution.

[14] Although specific IT sector data were not accessible, a Granger causality test with the data on REODBS was undertaken, as this includes the share of the IT industry. It was not possible to get the state-wise breakup of such data.

[15] The results do not reflect to what extent NFS exports have increased. However, since such information is calculated. It has been mentioned.

The reasons for the negative net relative change in the results for the three states, Delhi, Haryana and Punjab, are obviously seen in the findings of NASSCOM and a study carried out by NASSCOM and A T Kearney (2008), which pointed out that as far as Delhi is concerned, industry participants perceive the government to be bureaucratic with little focus on the IT business process management. An example of the Government's apathy is that policy drafted in 2000 has not been updated. Delhi needs to address problems of power, water shortage, local connectivity and crime to attract the IT business process management industry.

Furthermore, the same report states that in Haryana, Gurgaon has experienced growth as an IT business process management[16] hub because of its proximity to Delhi and seven operational special economic zones. The report has seen an outsourcing boom in the business process management segment on account of the good English speaking skills of its people. This boom has led to the mushrooming of malls, restaurants and entertainment facilities. The growth of the IT industry is restricted because of frequent power shortages, lack of local connectivity and a high crime rate, which lead to high operational costs. Although real estate space is available, the government needs to develop commercial space to allow plug and play facilities.

In Punjab, the report of NASSCOM and A T Kearney (2008) points out that the state needs to enhance the visibility of locations, such as Ludhiana and Mohali, by investing in engineering and technical education, and improving English language proficiency. In Punjab transport connectivity whether it is local, national and international is poor and needs to be improved in order to attract the IT business process management industry. Both commercial and residential complexes need to be developed in the space available.

During this period, software exports from the IT-dominated states of Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu increased by large amount even though they began from a high base in 2004/05. States, such as Gujarat and Kerala recorded a large increase in net relative change because their exports in the base year were low.

[16] NASSCOM has rebranded the information technology enabled services/business process outsourcing to business process management in 2012.

Table 1A. Shift-share analysis of Software Technology Parks of India's IT export growth by regions, 2004/05 to 2008/09

States	IT growth		Share in net relative change (%)	
	Actual	Net relative change	Industry mix	Regional shift
Andhra Pradesh	197.9	97.9	22.9	77.1
Delhi	-43.0	-142.9	-15.7	115.7
Gujarat	438.2	338.3	06.6	93.4
Haryana	65.4	-34.5	-64.9	164.9
Karnataka	102.4	02.4	923.8	-823.8
Kerala	430.0	330.0	06.8	93.2
Maharashtra	191.3	91.3	24.5	75.5
Punjab	46.0	-53.9	-41.5	141.5
Tamil Nadu	108.6	8.6	259.6	-159.6
Uttar Pradesh	113.0	13.0	171.8	-71.8
India	122.3	22.4	100.0	0.0

Further observing table 1A columns 4 and 5, regional variations in software exports were largely due to the regional component. An examination of the industry mix shows that in such states as Karnataka, Tamil Nadu and Uttar Pradesh export earnings increased because of a favourable industry mix, namely the industry structure in those states supported the IT industry. In Karnataka and Tamil Nadu, the IT sector is concentrated in Bengaluru and Chennai, both leading IT hubs in the country. STPI[17] (in Bangalore, Mangalore, Mysore and Hubli, Chennai, Coimbatore, Madurai, Trichy, Pondicherry and Tirunelveli), special economic zones[18] (Karnataka has 17 IT-information technology services special economic zones and Tamil Nadu 16 such zones), IT parks and state policies all played an important role in promoting the industry. The deregulation of the telecom sector helped both states to have the best telecom infrastructure by ensuring high bandwidth connectivity to global destinations. The presence of other industries, such as aerospace, telecommunication, machine tools, engineering, electronics and banking helped to provide domain expertise to the

[17] India, Ministry of Information and Information Technology, Software Technology Parks of India Several Annual Reports (New Delhi). Available from www.stpi.in.

[18] Available from sezindia.nic.in.

IT sector. Both states offered good physical and social infrastructure, which was the prime factor behind the recruitment of talented professionals both domestically and from multinationals. Excessive concentration of IT business process management companies in those locations has led to traffic congestion, rising real estate and labour costs, a shortage of hotel rooms and high attrition.

Further observing table 1A column 4, it can be noted that the positive net relative change for Karnataka, Tamil Nadu and Uttar Pradesh may be attributed to a favourable industry mix. This can be explained by the results of the NASSCOM and A T Kearney study, which points out that IT business process outsourcing firms were of the view that the government of Karnataka had not supported the growth of the IT sector sufficiently and is riding on the boom that started a decade ago. The same report mentioned that the government of Tamil Nadu support for IT business process management development in Chennai had lessened with more attention being focused on other locations in the state, namely Coimbatore, Madurai and Trichy.

As far as IT in Uttar Pradesh is concerned, the report indicated that the state government strived to leverage central government policies relating to e-governance, wide area networks, high speed telecom links and central agencies, such as those of STPI and special economic zones to build software technology parks and IT enabled services special economic zones. For Uttar Pradesh to emulate the success of Noida in other tier II and tier III cities, the local government needs to (i) develop the Lucknow-Kanpur corridor[19] on the lines of Noida-Greater Noida; (ii) improve connectivity, the social and living environment and recreational facilities, (iii) provide commercial and residential space and (iv) change the negative perception of careers in the business process management industry.

For the second period 2009/10 to 2013/14 the shift-share analysis presented in table 1B shows that the actual increase in IT export revenue was negative in seven out of the ten states and the net relative change was negative for all the states. These variations are due to the industry mix, which is quite obvious from the change in structure from STPI to special economic zones which is explained below. The possible reason for the decline in IT exports from STPI units as pointed out in their annual

[19] Uttar Pradesh Infrastructure & Industrial Development Principal Secretary Surya Pratap Singh, who is also the chairman and chief executive officer of the Lucknow Industrial Development Authority recently approved the Draft Master Plan 2031 of an integrated industrial township on the Lucknow-Kanpur highway, spanning 30,000 hectares during a recent board meeting. He also said: "There is tremendous potential of developing Lucknow-Kanpur industrial corridor on the lines of Noida and Greater Noida, as robust transport infrastructure is already present in the area. However, we have to hasten the process of development in view of rapidly growing urbanization and aspirations of people of the state capital". The comments are available from www.travelnewsdigest.in.

reports[20] was that the fiscal benefit of STPI scheme was withdrawn on 31 March 2011. This imposed a tax burden on the IT business process management sector, adversely affecting their growth. With the passing of the Special Economic Zone Act in 2005, firms moved from STPI to special economic zones. The large IT companies made new investments in special economic zones and also shifted their existing IT business process management business to the zones. This has resulted in a decline in the membership of STPI which has adversely effected their export performance.

Table 1B. Shift-share analysis of Software Technology Parks of India's export growth by regions, 2009/10 to 2013/14

States	IT growth		Share in net relative change (%)	
	Actual	Net relative change	Industry mix	Regional shift
Andhra Pradesh	-2.2	-50.8	99.8	00.2
Delhi	-54.4	-102.9	49.2	50.8
Gujarat	02.6	-46.0	110.2	-10.2
Haryana	-8.8	-57.4	88.3	11.7
Karnataka	13.8	-34.8	145.7	-45.7
Kerala	00.3	-48.3	104.9	-4.9
Maharashtra	-10.7	-59.3	85.4	14.6
Punjab	-27.4	-76.0	66.6	33.4
Tamil Nadu	-16.5	-65.1	77.8	22.2
Uttar Pradesh	-7.1	-55.7	90.9	09.1
India	-2.1	-50.6	100.0	00.0

Results of the ordinary least squares estimation

Consider that the regional shift component as the dependent variable, ordinary least squares is run by using five independent variables, namely teledensity (TD), enrolment in higher education (EHE), industrial electricity consumption (IEC), population (POP), and location quotient (LQ). These independent variables in the model are assumed to serve as potential regional endogenous factors that might influence software export sector performance. It is hypothesized that the

[20] STPI annual reports 2009/10, 2010/11, 2011/12, 2012/13.

competitiveness of a region, namely the regional shift (RS) component is dependent upon availability of teledensity, the region's enrolment in higher education figures, the extent of industrial electricity consumption, population of the region and the degree of specialization, i.e. location quotient.

The four models for the first period 2004/05 and 2008/09 are as follows:

Model 1 – Data used for EHE, LQ, POP, IEC and TD are averages during the period 2004/05 and 2008/2009. For two states, Maharashtra and Tamil Nadu, teledensity are for the corresponding capitals/cities, Mumbai and Chennai.

Model 2 – Data used for EHE, LQ, POP, IEC and TD are the average during the period 2004/05 and 2008/09. Unlike model 1, here teledensity data are for all states, cities are not considered.

Model 3 and *Model 4* – Data used for EHE, LQ, POP, IEC and TD are for any random year and teledensity data are for all states.

The results in table 2 show that in three out of the four models, the results are significant. One explanatory variable, enrolment in higher education is significant and positively related to the dependent variable. However, the other four explanatory variables, namely population, location quotient, industrial electricity consumption and teledensity show significant results with a negative relationship with the dependent variable.

In observing table 2, it appears that in all the models in the first period – 2004/05 to 2008/09, location quotient, namely regional specialization, was significant (at a level of 5 per cent), but was negative. A unit increase in the location quotient decreased the regional competitiveness by more than 270 units, clearly indicating that regional specialization had reached a saturation level in the prominent IT hubs, such as Bengaluru, Chennai and Hyderabad. Excessive concentration of IT business process companies in those locations had led to traffic congestion, rising real estate and labour costs, a shortage of hotel rooms and high attrition. This had also been supported by Pais and others (2006) who found that because of a heavy concentration of IT clusters in a particular region, demand for hotels and restaurants had increased, leading to high hotel occupancy rates and average room rates. This reflected the lack of local policy measures relating to, for example, transport infrastructure, land availability and real estate construction.

Table 2. Results of ordinary least squares using regional shift as a dependent variable, 2004/05 to 2008/09

Model	Intercept	EHE	LQ	POP	IEC	TD
Model 1	313.81**	7.07***	-260.61**	-5.53**	-0.90*	-1.85**
Adjusted R^2	0.73					
F	5.90					
Model 2	196.51	3.62*	-163.26	-2.68	-0.68	-1.14
Adjusted R^2	0.29					
F	1.75					
Model 3	322.45**	5.91**	-233.81**	-5.32**	-1.55*	-2.37**
Adjusted R^2	0.65					
F	4.46					
Model 4	387.57**	6.82**	-277.56**	-6.08**	-1.88*	-2.68**
Adjusted R^2	0.66					
F	4.63					

Notes: Significance codes *** 0.01, ** 0.05, * 0.1.
EHE, enrolment in higher education; LQ, location quotient; POP, population; IEC, industrial electricity consumption; TD, teledensity.

In the case of enrolment in higher education, the models showed that the variable was significant at the 1 per cent or 5 per cent levels. A unit increase in enrolment in higher education was said to increase regional competitiveness by a minimum of 5.91 units. The easy availability of skilled labour related to the IT sector is very evident from the results. This is also substantiated with data brought out in the IT review chapter, which indicated that the ten states accounted for about 80 per cent of the country's authorized Engineering and Technology and Masters in Computer Applications degree granting institutions and sanctioned intake.

The variable population, although significant at a 5 per cent level, is negative, indicating that a unit increase in population reduces competitiveness by at least 6.1 units. The negative effects of excessive population are very much reflected here.

The industrial electricity consumption variable is significant at 10 per cent and is negative, implying a unit increase in it resulting in a decrease in regional competitiveness by a minimum of 1.9 units. The results bring about a clear picture of the supply-demand mismatch of electricity, the mismatch between electricity requirement and electricity availability. Lack of availability of electricity to the required

level is indicated and any increase in demand for electricity beyond this level would affect the regional competitiveness. Teledensity is significant at the 5 per cent level and negative, indicating a unit increase in teledensity would lead to a decrease in local competitiveness by 2.7 units. This is obvious from the fact that telecommunication (fiber optic communication) has now become a basic need, therefore its effective coverage through efficient infrastructure need not be overemphasized. According to the Telecom Regulatory Authority of India (TRAI, 2011), an increase in demand for communication infrastructure (adequate bandwidth at affordable prices) can be attributed to increased Internet usage, e-commerce, e-governance, e-banking, e-entertainment, e-health, convergence of information, communication and entertainment sectors, voice, video and data traffic, among others. The government's initiative aimed at bridging the digital divide and improving broadband connectivity through its ambitious National Optical Fiber Network project aiming at extending broadband access to the country's 250,000 gram panchayats by 2016 is expected to further increase demand for communication infrastructure.[21] This requires each state and local government to be proactive in the provision of communication infrastructure, which includes giving permission, among other things, for right of way,[22] and the erection of towers, and mobile virtual network operators. All these factors clearly indicate the extraordinary demand in this sector, which is implied in the result.

The Telecom Regulatory Authority of India (TRAI) also has mentioned that in order to avoid any inconvenience caused by repeated digging, the central and state roadways authority may consider laying ducts and conduits while roads are being built to facilitate the laying of other cables when required. However, cities in India are to a greater extent unplanned wherein the systematic laying of electric cables, fiber optic cables, and water and gas pipelines is a rare phenomenon. The lack of coordination between those sectors often leads to congestion, which ultimately results in diseconomies. The results also highlight this.

Overall, it could be said that, except for enrolment in higher education, the variables have shown an inverse relationship which contradicts the hypothesis of a positive relationship, clearly indicating the diseconomies related to those variables. The results point out that the existing infrastructure is overstressed, caused by excessive pressure on teledensity, a shortage of power and the high population, making it difficult for regions to sustain a high level of specialization.

[21] Available from www.indian infrastructure.com.

[22] Right of way permission is granted to licensed telecom operators and registered infrastructure providers for laying telecom cables and ducts under, over, along, across, in or upon a property vested in or under the control or management of a local authority or of any person including public authority, public corporation and autonomous body.

For the second period 2009/10 and 2013/14, there are four other models, which are as follows:

Model 1 – Data used for EHE, LQ, POP, IEC and TD are the average during the period 2009/10 and 2013/14. For one state, Maharashtra teledensity data are for the corresponding capital/city, Mumbai.

Model 2 – Data used for EHE, LQ, POP, IEC and TD are the average during the period 2009/10 and 2013/14. In this model teledensity data are for the states, no city is considered.

Model 3 – Data used for EHE, LQ, POP, IEC and TD are for a single year. For one state, Maharashtra, teledensity data are for the corresponding capital city, Mumbai.

Model 4 – Data used for EHE, LQ, POP, IEC and TD are for a single year. In this model, teledensity data are for all states.

In table 3 it can be seen that the regression/ordinary least squares results in all the models in the second period – 2009/10 to 2013/14 – showing the variable location quotient, an industry concentration significant at the 5 per cent or 10 per cent levels. Regional competitiveness would increase by a minimum of 132 units for every one unit increase in location quotient. This clearly indicates that reducing the concentration beyond the optimum level would surely help in improving the results. The fact in the second period is the decrease in STPI membership. The decline in exports from STPI registered units since 2009/10 is because of the decline in membership in STPI. The reason behind this is that the fiscal benefit of an income tax exemption (10A) of the STPI scheme ended on 31 March 2011. The withdrawal of such tax holidays has resulted in increased taxes payments and surcharges required from the IT and IT enabled services. This has adversely affected the growth of the sector. Although the Special Economic Zone Act was passed in 2005, as per the STPI annual report, the movement of firms to special economic zones was said to be in 2009 in order to take advantage of incentives associated with special economic zones. Larger IT companies initiated new investments in special economic zones and also shifted their existing IT and IT enabled services business to those zones. This has resulted in a decline in membership of STPI, which has affected their overall export performance. Nevertheless, the change has had its own advantage in that the decline in STPI membership of IT firms led to a reduction in congestion in those locations, resulting in optimal utilization of existing resources. Thus, the significant location quotient gave a positive result.

Table 3. Results of ordinary least squares using regional shift as a dependent variable, 2009/10 and 2013/14

Model	Intercept	EHE	LQ	POP	IEC	TD
Model 1	-60.42	-1.95095	131.9975*	-0.885695	0.679031	-0.78907
Adjusted R^2	0.19					
F	1.44					
Model 2	-65.37	-3.26658*	160.5587**	1.882268	0.77609	-1.17819
Adjusted R^2	0.16					
F	1.34					
Model 3	-57.37	-2.34407*	136.669*	1.228093	0.646763	-1.08226
Adjusted R^2	0.32					
F	1.44					
Model 4	-42.70	-2.61429*	143.8488*	1.301374	0.499578	-1.31423
Adjusted R^2	0.20					
F	1.45					

Notes: Significance codes: ***0.01, **0.05, *0.1.
EHE, enrolment in higher education; LQ, location quotient; POP, population; IEC, industrial electricity consumption; TD, teledensity.

In the case of enrolment in higher education three out of the four models show the variable to be significant, at the 10 per cent level, and negative. A unit increase in enrolment in higher education is said to decrease regional competitiveness by a minimum of 3.27 units. The considerable increase in engineering colleges and lucrative jobs/white collar jobs in IT and IT enabled services firms and the opportunities to move to the United States and Europe have prompted a number of students, especially those from the southern states, to attain graduate or post-graduate degrees in software engineering. This has led to a large supply of human resources in this sector. The results also support this fact.

Results of Granger causality

The results of the Granger causality in table 4 indicate that in the three states reviewed, per capita income of the state does not influence IT exports of that state. However, with regard to IT exports influencing the per capita income, there are no significant results for the states Andhra Pradesh and Tamil Nadu, but for Karnataka, the results are significant, indicating that IT exports of Karnataka influence the per capita income of the state. The supportive facts behind this seems to be that the

Bengaluru cluster has played a vital role in innovation and upgrading value as contemplated by Porter (1998). This has been possible because the most sophisticated buyers are part of this cluster. It has been shown that the growth of many research firms and academic institutions over a long period has led to the formation of an educated, cosmopolitan population in Bengaluru with a stronger influence on policy framing than in other Indian cities. Bengaluru has a history of proactive planning and consultative and participatory policymaking in the form of implementation of the Panchayati Raj Act, the Nagarpalika Act and the Bengaluru Agenda Task Force and the establishment of the Karnataka Lokayukta Institution, which strengthened the ability of local bodies to determine local development priorities, influence the direction of funding allocation, increased targeting of services to local needs and desires and increased transparency. Participatory models increase the citizens' direct involvement in the deliberation, formulation, implementation and monitoring of public policy. The Bengaluru IT cluster has been nurtured by active venture capitalists and some degree of interfirm cooperation, largely outside the purview of large bureaucratic firms and financial institutions. All this has made it more attractive and easier for foreign customers to source from different vendors. However, in the case of Andhra Pradesh and Tamil Nadu, the initiatives of the respective state led to the development of the IT business process management industry. Policy initiatives and e-governance initiatives are behind the emergence of the Hyderabad and Chennai IT hubs in India.

In the case of causality between GDP of REODBS and per capita income of the states in Andhra Pradesh and Tamil Nadu, some significance is evident whereas it is totally insignificant in the case of Karnataka in which neither REODBS influence per capita income of Karnataka nor per capita income of Karnataka influence GDP of REODBS sector (table 5).

In the case of Andhra Pradesh, GDP of REODBS does not influence per capita income, but per capita income influences GDP of REODBS. In the case of Tamil Nadu, GDP of REODBS and per capita income are influenced by one another. Andhra Pradesh and Tamil Nadu have adopted a low-key IT policy that strongly focuses on social and regional equity and extends incentives to women and backward caste entrepreneurs to set up IT centres in small towns. This has led to brain drain from the two states, Andhra Pradesh and Tamil Nadu, resulting in an increase in remittances and investment in real estate, which could be a valid reason for REODBS to influence the per capita income of the state.

Table 4. Results of the pairwise Granger causality tests

Particulars		**Karnataka**		
Tests:		Pairwise Granger causality tests		
Sample/lags: 2				
Null hypothesis:	Obs	F-statistic	Prob.	
DITEXPORT does not Granger cause DPCI	13	2.98754	0.1074	**Significant**
DPCI does not Granger cause DITEXPORT		0.53687	0.6042	**Not significant**
Particulars		**Andhra Pradesh**		
Tests:		Pairwise Granger causality tests		
Sample/lags: 2				
Null hypothesis:	Obs	F-statistic	Prob.	
DITEXPORT does not Granger cause DPCI	13	0.5779	0.5829	**Not significant**
DPCI does not Granger cause DITEXPORT		2.52567	0.1412	**Not significant**
Particulars		**Tamil Nadu**		
Tests:		Pairwise Granger causality tests		
Sample/lags: 2				
Null Hypothesis:	Obs	F-Statistic	Prob.	
DITEXPORT does not Granger cause DPCI	17	0.94702	0.4151	**Not significant**
DPCI does not Granger cause DITEXPORT		5.1344	0.0245	**Not significant**

Table 5. Results of the pairwise Granger causality tests

Particulars		**Karnataka**		
Tests:		Pairwise Granger causality tests		
Sample/lags: 2				
Null hypothesis:	Obs	F-statistic	Prob.	
DREALESTATE does not Granger cause DPCI	13	0.69554	0.5266	**Not significant**
DPCI does not Granger cause DREALESTATE		0.41204	0.6756	**Not significant**
Particulars		**Andhra Pradesh**		
Tests:		Pairwise Granger causality tests		
Sample/lags: 2				
Null hypothesis:	Obs	F-statistic	Prob.	
DREALESTATE does not Granger cause DPCI	14	0.35091	0.5656	**Not significant**
DPCI does not Granger cause DREALESTATE		16.9085	0.0017	**Significant**
Particulars		**Tamil Nadu**		
Tests:		Pairwise Granger causality tests		
Sample/lags: 2				
Null hypothesis:	Obs	F-statistic	Prob.	
DREALESTATE does not Granger cause DPCI	17	3.40485	0.0674	**Significant**
DPCI does not Granger cause DREALESTATE		7.40399	0.008	**Significant**

VII. POLICY IMPLICATIONS

For the IT sector to develop fully, there must be demand for IT both nationally and internationally. The IT sector in India is more an export-oriented sector. The disproportionality in growth between the export and domestic segments needs to be corrected. In the last couple of years, e-commerce has been driving the rapid growth of the IT business process management domestic industry. Almost all industries leverage the benefits of IT. Synergies are prevalent with banking, financial services

and insurance, manufacturing, retail, telecommunication, health care and government, all of which constitute the key business verticals of the industry. This integration needs to be further strengthened for IT to act as a powerful facilitator and catalyst of growth. This would help to generate employment opportunities and contribute towards the development of the region where it is located.

VIII. CONCLUSION

Thus, it could be seen that the results of the shift-share analysis of IT export revenue of ten states in India for the period 2004/05 showed that software exports trended higher from the IT-dominated regions, namely Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu. Other states, such as Gujarat and Kerala were depicted to have experienced a large increase in net relative change, mainly because their exports in the base year were low.

Regional variations in software exports were largely due to the regional component (regional shift). The examination of the industry mix shows that in some states, including Karnataka, Tamil Nadu and Uttar Pradesh, an increase in export earnings occurred on the back of a favourable industry mix. In Karnataka and Tamil Nadu, the IT parks and state policies, among other aspects, played an important role in promoting the industry. The deregulation of the telecom sector helped both states to have the best telecom infrastructure, which ensured high bandwidth connectivity to global destinations. The presence of other industries, such as aerospace, telecommunication, machine tools, engineering, electronics and banking helped to provide domain expertise to the IT sector. In addition, both states offered good physical and social infrastructure, which was the prime driver for attracting talent both domestically and from multinational corporations. Excessive concentration of IT business process management companies in these locations led to traffic congestion, rising real estate and labour cost, a shortage of hotel rooms and high attrition. The analysis also indicated that the positive net relative change for Karnataka, Tamil Nadu and Uttar Pradesh was due to a favourable industry mix.

The results of ordinary least squares estimation showed that in three out of the four models the results were significant. One explanatory variable, enrolment in higher education was significant and positively related to the dependent variable. However, the other four explanatory variables, namely population, location quotient, industrial electricity consumption and teledensity, showed significant results with a negative relationship with the dependent variable. Location quotient, namely regional specialization although significant (at a 5 per cent level) was negative. In the case of enrolment in higher education, all the models showed the variable to be significant. The easy availability of skilled labour related to the IT sector was shown to be very

obvious from the results. The negative effects of an excessive population were reflected here. The industrial electricity consumption variable was significant and negative, bringing about a clear picture of a supply-demand mismatch of electricity. Lack of availability of electricity to the required level was indicated and any increase in demand for electricity beyond this level would very likely affect the regional competitiveness.

The cases which indicated that teledensity was significant and negative showed the problems in unplanned cities in India in which the systematic laying of electric cables, fiber optic cables, and water and gas pipelines is a rare phenomenon. There are situations in which there is lack of coordination between these sectors congestion often occurs, which ultimately results in diseconomies. The results also highlight this. Overall, it can be said that except for enrolment in higher education, all other variables had an inverse relationship, which contradicted the authors' hypothesis of a positive relationship, clearly indicating the diseconomies related to those variables. The results pointed out that the existing infrastructure was overstressed as there was excessive pressure on teledensity, a shortage of power and high population making it difficult for regions to sustain a high level of specialization.

The Granger causality test pointed out that Karnataka showed significant results, indicating that IT exports of Karnataka influenced the per capita income of the state. In the case of Andhra Pradesh, per capita income influenced the GDP of REODBS and for Tamil Nadu, both GDP of REODBS and per capita income were influenced by one another.

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