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Role of IT- ITES in Economic Development of Asia

Issues of Growth, Sustainability and Governance

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This book is dedicated
to our teachers

Foreword

Information and communications technology (ICT) has an important role in the world since we are now in the information age era. The last two-three decades have witnessed a structural shift of the world economy due to the incredible acceleration in the share of the service sector in the gross domestic products of the countries and regions. Service has emerged as the dominant sector and the main driver of GDP growth mainly attributable to the spectacular progress of the information technology (IT) sector. The lack of appropriate information at the right time will result in low productivity, low-quality research works and waste of time to pursue information and even to do research which actually others had done or in other countries. Digital computer and networking have changed our economy concept to the economy with no boundary in time and space because of ICT. It brings a lot of advantages for economic development enabling millions of transactions to happen in an easy and fast way. The Information Technology-Enabled Services (ITES) has become an emblem of success, a liberalization agenda in India and an ongoing process of globalization. The ITES has contributed substantially to the rapid economic growth and cultural transformations that have taken place. The study has generated a significant data on a wide range of topics, which include work culture and management practices in ITES providing companies.

The book focuses on the contribution of IT and ITES in shaping the current and future global economic scenario, with special focus on Asia, taking into account the three broad macroeconomic dimensions—growth, sustainability and governance mechanism. The chapters are divided into two sections: The first one explains the role of IT-ITES upon economic and financial indicators, and the second one is about the role of IT-ITES upon environment, health, education and employment. The development of information and communications technology (ICT) is a significant step toward empowering individuals and reducing poverty in the countries of Asia and the Pacific. Telecommunication, a vibrant economic sector in its own right, is also increasingly seen as a facilitator of economic development, bringing essential services, such as health, education and government, to previously excluded populations. Asia has greatly benefitted from the worldwide mobile telephony boom of the last few decades. Jobs have been created in manufacturing and services across the region, and income generated for operators, manufacturers, service providers, content developers and governments. Recently, debates and discussions have centered on the issue of long-run sustainability of the outsourcing industry in India as these companies are facing continuous challenges in terms of international competition, salary inflation, health hazards, scarcity of talent, attrition of employees, security concerns, global slowdown and many other technology-related issues. Growing demand for outsourcing worldwide may also induce firms to employ less competent personnel for short-term profits, and this may result in a decline in quality of services offered and may also lead to problems in maintaining secrecy of data records. The journey of software and services industry in the new knowledge economy and the reaping of the young talents in the form of demographic dividend in the emerging nations mainly those of Asia—India, China and Vietnam—have proceeded in a highly accelerated pace, but its long-run sustainability and governance issue have been under scanner in recent times. I hope the title will attract readers from all aspects it covered and will add significant value to the existing literature.

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Preface

The last two decades have witnessed a structural shift in the world economy due to tremendous acceleration in the share of service sector in gross domestic products of countries. This is mainly attributable to the spectacular progress of the IT sector. Tradability, technology and transportability—the three T's—govern the productivity growth in modern service today. But recently, debates and discussions have centered on the issue of long-run sustainability of the outsourcing industry in India as these companies are facing continuous challenges in terms of international competition, salary inflation, health hazards, scarcity of talent, attrition of employees, security concerns, global slowdown and many technology-related issues. Growing demand for outsourcing worldwide may also induce firms to employ less competent personnel for short-term profits, and this may result in a decline in quality of services offered and may also lead to problems in maintaining secrecy of data records. Further, dependence upon technology-induced services of the information technology (IT) and Information Technology-Enabled Services (ITES) industries leads to increase in the magnitude of labor supply in the economies, especially whose GDP is largely attributable to IT-related activities. Hence, there is a trade-off between IT sector's progress and unemployment. The journey of software and services industry in the new knowledge economy and reaping of young talents in the form of demographic dividend in the emerging nations mainly those of Asia—India, China and Vietnam—have proceeded at a highly accelerated pace, but its long-run sustainability and governance issue have been under scanner in recent times. The book, thus, focuses on the contribution of IT and ITES in shaping the current and future global economic scenario, with special focus on Asia, covering the issues of their growth, sustainability and governance mechanism.

After spending a long interval from submission of the book proposal to submission of the final materials, it is a great pleasure for the editors as well as contributors that book is now published. The volume will provide immense knowledge base to academicians, particularly researchers, postgraduate students and political scientists. Additionally, it will provide thought-provoking ideas to social scientists, policy makers, multi-nationals and government officials.

In carrying out the entire project for a long duration, the cooperations and supports of different organizations and academicians cannot be forgotten. We first acknowledge the relentless support and cooperation of Springer Nature, the publisher, for their efforts from processing the project to acceptance. Second, we are highly indebted to the contributing authors for their valuable research articles and maintaining patience for the long time from chapter proposal submission to final chapter submission. Finally, we are indebted to our family members for their sacrifice and for sharing our stress. Although all care has been taken, nonetheless we as editors remain responsible for any error that still remains in the book.

Kolkata, India — Soumyen Sikdar
Midnapore, India — Ramesh Chandra Das
Kolkata, India — Rajib Bhattacharyya

Introduction

The world is entering into a new era of Industrial Revolution with the exponential increase in the digital and information and communications technology (ICT), greater access to knowledge and rapid enhancement of processing and storage capabilities. This form of restructuring is not confined to any particular set of technologies; rather, its foundation is laid on a gradual shift to a new ecosystem built on the infrastructure of the digital revolution. In this context the role of the governments, businesses, the technical community, citizens and consumers—all stakeholders are of crucial importance in building trust and confidence in global networks.

Over the last two decades, the world economy has been passing through its various phases of experience of globalization, liberalization and privatization along with breathtaking changes in information and communications technology (ICT), deregulation of financial markets, cross-border mergers and acquisitions (M&As), increasing role of investors willing to invest abroad. They have contributed to unprecedented growth and prosperity on the one hand and have resulted in greater instability, volatility and repercussions on the other. In advanced developed nations' services has been the key driver of economic growth. But in recent times, even in the developing world and in emerging countries, services have contributed to the largest share of GDP; and growth of productivity in services has surpassed that of industry and agriculture. This is largely explained by rapid development of modern, commercial services—business processing, finance, insurance and communications. Tradability, technology and transportability—the three T's—govern the productivity growth in the modern service today. In terms of contribution to GDP, service is the largest sector in the world, accounting for more than 70% of global output. Modern impersonal services are transportable and tradable and can be moved across borders over the digital Internet, stored electronically and scaled into giant global businesses.

The initial wave of IT, ITES and business process outsourcing (BPO) began in the second half of 1990s in response to a tight US labor market caused by the 'dot-com' boom and by the 'year 2000 (Y2K)' crisis. This created a tremendous upsurge in demand for computer personnel and software programmers, to create and correct legacy software, that was not available in the USA. India's emergence as a technology 'powerhouse' made her a frontrunner, enabling US companies to meet this challenge. Since then, it has become an increasingly attractive proposition for companies and organizations in industrialized countries to take advantage of a new practice called offshore outsourcing which entails substantial cost reduction, given the high remuneration of skilled labor in these countries. Today, India is a prominent sourcing destination across the world, accounting for approximately 55% market share of the US$ 173–178 billion global services sourcing business in 2016–17. India acquired a share of around 38% in the overall business process management (BPM) sourcing market. As India possesses the largest demographic dividend, it provides highly qualified talent pool of technical graduates at very cheap cost. According to the Department of Industrial Policy and Promotion (DIPP), this sector has attracted 37% of total private equity and venture investments in the country (ranking 3rd in India's total FDI share). India's IT industry contributed around 7.7% to the country's GDP. IT industry employs nearly 3.9 million people in India of which more than 170,000 were added in FY17. Indian IT exports are projected to grow at 8.1% in 2020–21.

But recently, debates and discussions have centered on the issue of long-run sustainability of the outsourcing industry in India as these companies are facing continuous challenges in terms of international competition, salary inflation, health hazards, scarcity of talent, attrition of employees, security concerns, global slowdown and many technology-related issues. Growing demand for outsourcing in India may also induce firms to employ less competent personnel for short-term profits, and this may result in a decline in quality of services offered and may also lead to problems in maintaining secrecy of data records.

According to the recent Global Services Location Index (GSLI) Report, there has been a gradual transformation of the whole system toward automation, which has a tendency to destroy low-skilled jobs and focus on high-skilled ones. Though automation is still at infancy, it threatens millions of low-skilled repetitive jobs in both developed and developing nations. So in order to overcome the challenges and to sustain competitive edge, it is required to improve the supply of quality human capital, and for this, creating world-class infrastructure and bridging the digital divide and strict regulatory framework and governance are essential.

In view of the above perspective, the present book tries to touch upon a large spectrum of issues which may be considered as important as well as critical in the sphere of IT and ITES in transforming world economic development, with special focus on Asian economy, taking into account different dimensions of their growth, sustainability and governance mechanism. There are twenty-four chapters which are captured in two broad parts. Part I covers the topics on role of IT-ITES upon economic and financial indicators (Chaps. 1–11), and Part II covers the discussions on role of IT-ITES upon environment, health, education and employment (Chaps. 12–24). Brief outlines of the chapters are presented below.

Chapter 1 intends to investigate the impact of development of IT industry on economic development in Asian countries. It also tries to establish a strong forward linkage of IT sector with education industry, particularly in the field of tertiary education and also services-oriented industries like banking.

Chapter 2 portrays the importance of investment in information and technology worldwide. The main purpose of this study is to identify the effects of IT investment on the performance of banking sector. In order to evaluate the relationship between these variables, co-integration and panel causality analysis are conducted.

Chapter 3 attempts to show there exists a significant long-run as well as short-run relationship between output of IT sector and export of IT sector, and also output of IT sector and export of software services, whereas there exists no long-run and short-run relationship between growth of output of IT sector and growth of export of IT sector, and also growth of output of IT sector and growth of export of software services.

Chapter 4 examines the relative contribution of banking correspondent (BC) model to accelerate financial inclusion in Asian countries with special reference to India. Empirical evidences suggest that South Asian countries excel in the implementation of branchless banking services: largest number of banking correspondents in Bangladesh and eight e-service providers in India.

Chapter 5 tries to isolate the effect of some of the external factors like exchange rate, world GDP, foreign price and oil price on software exports from India. This has been done using VAR analysis and utilizing quarterly data from RBI, US Bureau of Labor Statistics, US EIA and IMF, ranging from 2000Q1 to 2017Q3. It also finds that elasticities of software export–GDP ratio to world GDP and foreign price turn out to be negligible and insignificant.

Chapter 6 has applied advanced econometric tool dynamic panel generalized method of moments and found that information and communications technology has a strong positive impact on foreign direct investment during 2002–2012 for selected developing economies of the world.

Chapter 7 tries to analyze the role of software services export in India's economic growth and employment scenario using time series analysis. It also throws light on the continuous challenges of competitiveness faced in the globalized and modern world, especially from China and the new outsourcing policies of USA.

Chapter 8 depicts the role of e-governance in urban areas of West Bengal in India. It argues that one of the significant aspects of sustainable urbanization is e-governance. Moreover the pape emphasizes that effectiveness of 'smart governance' in this globalized world is not only contingent on public participation but also on degree of information diffusion by the urban local bodies through internet.

Chapter 9 explores the possible job creation effect of innovation activity on a panel of twenty-two major technology products exporting Asian economies between 1996 and 2015. The study finds that countries having a high degree of economic acceleration encountered a trade-off between technological progress and employment generation.

Chapter 10 is an attempt to investigate the dynamic interrelationships among ICT expansion, FDI inflow and economic growth across Asia-Pacific developing nations over the period of 2001–2016. We employ panel data regression technique for execution of the objective of this study using the database provided by World

Development Indicators of World Bank and World Telecommunication Indicators of International Telecommunication Union.

Chapter 11 analyzes the impact of growth of different segments of the information technology (IT) and IT-enabled Services (ITeS) sector on the overall growth of the service (tertiary) sector in India using a time series framework in between the periods 2000 and 2017. It also estimates another model comparing the extent of the impact of the IT and ITeS sector growth and the non-IT and ITeS sector growth on the overall GDP growth of India.

Chapter 12 has shown that trade liberalization, in the form of non-IT-type capital inflow from capital-exporting nation (Global North) to capital-importing nation (Global South), when augmented with environmental restrictions, claims the rise of dirty industry in South at the cost of environment-friendly IT industry. It also supports the arguments of pollution haven hypothesis (PHH) over factor endowment hypothesis (FEH) with the help of general equilibrium (GE) trade model.

Chapter 13 investigates the impact of mobile phone penetration on health outcome; it has used panel co-integration technique suggested by Pedroni (1999). In addition to this, to estimate the long-run relationship, it used fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) approaches.

Chapter 14 focuses exclusively on health-related problems with respect to social sustainability aspect of IT-ITES workers. The basic aim is to identify and assess major health-related problems of IT professionals and build up a comparative framework to examine whether the morbidity and severity of health problems (both physical and mental) are more acute in the case of IT-ITES employees as compared to non-IT workers in terms of a primary survey.

Chapter 15 explores how advanced information and communications technologies (ICTs) could promote human capital development with special reference to India in South Asian Region (SAR). The research methodology chosen is principally descriptive along with corroborating country-specific empirical testing using Granger causality and simple ordinary least squares estimations for India.

Chapter 16 is a modest attempt to examine the potentials of ICT in the pursuit of sustainable agricultural development and to review the present state of ICT and its effect on Indian agricultural sector with respect to digitalization vision of GOI and e-agriculture initiative. The study is based on time series data (2000–2017) related to Indian agricultural production and productivity.

Chapter 17 is aimed at investigating the relationship between economic complexity representing knowledge and skill-based production and agricultural employment in South Korea over the period 1970–2011. Johansen co-integration test is employed in the empirical part of the study. It concludes that the increase of economic complexity reduces agricultural employment.

Chapter 18 concentrates on the impact of IT and IT-enabled platforms on self-employment status in developing countries. It tries to explain the contradiction that on the one hand, fast diffusion of information and communications technology in the society makes self-employment more dynamic at market place in terms of accessibility and transaction cost; but, on the other hand, the past trend shows significant decline in self-employment rate in many countries.

Chapter 19 is devoted to discuss the emergence of sharing economy and role of IT and ITES therein with special reference to India. Crowdsourcing can be referred to as the process of funding from a group of people through online medium. It shows that the use and growth prospects of the economy are high after implementation of information technology but few factors draw the economy back to its base.

Chapter 20 constructs a theoretical framework to assess the likely impact on labor employed in manufacturing along the lines of formal and informal sector. In particular, it examines the outcomes for formal and informal labor and their wages in light of an increasing use of automation in the formal manufacturing sector.

Chapter 21 is based on an evaluation of the existing home loan evaluation process of a private bank in India and at the same time proposes a rule base model using knowledge-based system with respect to the home loan evaluation of a bank.

Chapter 22 discusses different aspects of IT and ITES upon Indian education sector. Using econometric tools, it observed a significant role of IT and ITES upon influencing educational developments of the country.

Chapter 23 proposes to demonstrate the role of business process outsourcing (BPO) in the rapid development of modern, commercial service sector in a developing country like India, thereby focusing on its concept, evolution and growth, impact on the economy, and various issues of its sustainability in the developing nations of Asia, together with the challenges faced by them as against the developed ones.

Chapter 24 has identified the role of governments' various stages of data transfer for improving data insurance supply. The outcomes of this chapter are based on the in-depth interview of IT professionals in the industry and academic sphere. The results show that government focus is mainly required at data encryption stage.

The essence of the studies that this book covers reestablished the positive roles of IT and ITES upon different economic and social indicators in different countries of Asia but the studies put reservations upon the sustainability of such a boom in the IT industry. Specifically, the health, employment and governance issues related to the IT sector are pointed out by the authors as areas that need special attention. Hence, it is prescribed that sustainable IT policy for long run should be taken up by different countries' governments that will not only save the IT sector of that particular country but will have an impact at the global level as well.

Contents

Editors and Contributors

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Abbreviations

AC	Air Conditioner
ADF Test	Augmented Dickey–Fuller Test
ADF	Augmented Dickey–Fuller
ADF	Augmented Dickey–Fuller Unit Root Test
AI	Artificial Intelligence
AIC	Akaike Information Criterion
ANOVA	Analysis of Variance
APE	Asymmetric Productivity Effect
AR	Autoregression
AR(1)	Autoregressive of Order 1
AR(2)	Autoregressive of Order 2
ARDL	Autoregressive Distributed Lag
AREAER	Annual Report on Exchange Arrangements and Exchange Restrictions
ARMA	Autoregressive Moving Average
ARMAX	Autoregressive Moving Average with Exogenous Inputs
ASE	Agricultural Sector Employment
ASPA	American Society for Public Administration
AT	Analytics
ATM	Automated Teller Machine
BBVA	Banco Bilbao Vizcaya Argentaria
BC	Banking Correspondent
BoP	Balance of Payments
BOSS	Burnout Stress Syndrome
BP	Billed Person
BP	Breusch–Pagan
BPM	Business Process Management
BPO	Balance of Payments
BPO	Business Process Outsourcing
CAGR	Compound Annual Growth Rate

CC	Common Criteria
CCM	Constant Coefficient Model
CD	Compact Disk
CGAP	Consultative Group to Assist the Poor
CII	Critical Information Infrastructure
CMIE	Centre for Monitoring Indian Economy
COMPLEX	Economic Complexity
CPI	Consumer Price Index
CPI-IW	Consumer Price Index-Industrial Worker
CR	Current Ratio
CRISDUM	Crisis Dummy
CRS	Constant Returns to Scale
CS	Customer Service
CTD	Cumulative Trauma Disorder
DBS	Digital Business Services
DCF	Domestic Capital Formation
DFS	Digital Financial Services
DGDP	Differenced data of Gross Domestic Product
DHPC	Dumitrescu–Hurlin Panel Causality Analysis
DICT	Differenced data of Information and Communication Technology
DOI	Digital Opportunity Initiative
DOLS	Distributed Online System
DOLS	Dynamic Ordinary Least Squares
DSL	Digital Subscriber Line
EBE	Employment Benefit Expenditure
EC	Electronic Communications
ECS	Energy and Utilities, Communication and Services
EOU	Export-Oriented Unit
ER	Efficiency Ratio
EU	European Union
EXCHRVL	Exchange Rate Variability
EXR	Real Effective Exchange Rate
F&A	Finance and Accounting
FAS	Financial Access Survey
FBS	Fixed Broadband Subscriptions
FCA	Financial Conduct Advisory
FDI	Foreign Direct Investment
FEH	Factor Endowment Hypothesis
FEM	Fixed Effect Model
FINDEV	Financial Development
Findex	Financial Index
FMOLS	Fully Modified Ordinary Least Squares
FPE	Final Prediction Error
FSI	Financial Services and Insurance
FTS	Fixed Telephone Subscriptions

FY	Financial Year
GATS	General Agreement on Trade in Services
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GE	General Equilibrium
GMM	Generalized Method of Moments
GoI	Government of India
GOV	Governance
GP	Gross Profit
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HDFC	Housing Development and Finance Corporation
HDI	Human Development Index
HOS	Heckscher–Ohlin–Samuelson
HQ	Hannan–Quinn Information Criterion
HR	Human Resources
HTE	High-Technology Exports
I(0)	Integrated of Order Zero
I(1)	Integrated of Order One
ICICI	Industrial Credit and Investment Corporation of India
ICT	Information and Communications Technology
ICT	Information, Communication And Technology
ICTs	Information and Communications Technologies
IIT	Indian Institute of Technology
ILOSTAT	International Labour Organization Statistics
IMF	International Monetary Fund
INFVL	Inflation Variability
INTU	Internet Use
IoT	Internet of Things
IP	Internet Protocol
IPI	Investment Promotion Intermediaries
IPR	Intellectual Property Rights
IPS	Im–Pesaran–Shin
IRF	Impulse Response Function
IS	Industry Solution
ISDN	Integrated Services Digital Network
IT	Information Technology
ITA	Information Technology Agreement
ITC	International Trade Centre
ITES	Information and Technology-Enabled Services
ITES	Information Technology Enabled Service
ITeS	IT-enabled services
ITI	Industrial Training Institute
IT-ITES	Information Technology and Information Technology-Enabled Services

ITU	International Telecommunication Union
IWE	International Wage Gap Effect
IWL	Industrial Wages
JC	Johansen Co-integration Test
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KAOPEN	Capital account Openness
KYC	Know Your Customer
LIBOR	London Interbank Offered Rate
LLC	Levin, Lin and Chu
LLC	Levin–Lin and Chu
LPO	Legal Process Outsourcing
LR	Modified LR Statistics
LSH	Life Sciences and Healthcare
LUS	Life Underwriting System
MARBLE	Managing and Recommending Business Loan Evaluation
MARS	Multivariate Adaptive Regression Spline
MCS	Mobile Cellular Subscriptions
ME	Marketing Expenditure
MFG	Manufacturing
MFI	Micro Finance Institution
MG	Mean Group
MMP	Mission Mode Project
MMS	Multimedia Message Service
MNC	Multi-national Company
MNO	Mobile Network Operator
MOSPI	Ministry of Statistics and Programme Implementation
MSD	Musculoskeletal Disorder
NASSCOM	National Association of Software and Services Companies
NBP	Non-billed Person
NCP	New Computer Policy
NCR	National Capital Region
NEER	Nominal Effective Exchange Rate
NeGP	National e-Governance Plan
NFDII	Foreign Direct Investment, Net Inflows
NGO	Non-governmental Organization
NIC	National Informatics Centre
NISD	Network and Information Security Directive
O	Output of the IT Industry in India
OE	Operating Expenditure
OECD	Organisation for Economic Co-operation and Development
OG	The Growth of Output of the IT Industry in India
OGD	Open Government Data
OI	Operating Income
OLS	Ordinary Least Squares
OP	Operating Profit

OPENNESS	Trade Openness
OR	Operating Ratio
OTC	Over-the-Counter Transaction
P.S.U.	Public Sector Unit
PC	Pedroni Panel Co-integration Analysis
PCGDPGR	GDP Per Capita Growth Rate
PHH	Pollution Haven Hypothesis
PIN	Personal Identification Number
PIPEDA	Personal Information Protection and Electronic Documents Act
POLSTAB	Political Stability and Absence of Violence/Terrorism
PP Test	Phillips and Perron Test
PP	Phillips–Perron Unit Root Test
PP	Phillips and Perron
PSTN	Public Switched Telephone Network
QCA	Qualitative Comparative Analysis
R&D	Research and Development
RBI	Reserve Bank of India
RCL	Retail, Consumer Packaged Goods and Logistics
RDCGE	Recursive-Dynamic Computable General Equilibrium
REER	Real Effective Exchange Rate
REM	Random Effects Model
S	Export of Software Services
S&F	Sales and Fulfillment
S&P	Sourcing and Procurement
S.D	Standard Deviation
SAARC	South Asian Association for Regional Cooperation
SAR	South Asian Region
SBI	State Bank of India
SDGs	Sustainable Development Goals
SE	Selling Expenditure
SFM	Specific Factor Model
SG	The Growth of Export of Software Services for IT Industry in India
SIC	Schwarz Information Criterion
SIM	Subscriber Identification Module
SMAC	Social, Mobility, Analytics and Cloud
SME	Small and Medium Enterprises
SMS	Short Message Service
STP	Software Technology Park
SWANs	State Wide Area Networks
TCP	Transmission Control Protocol
TCS	Tata Consultancy Services
TNCs	Transnational Corporations
TP	Technological Progress
TR	Total Revenue
TRD	Volume of Trade

TV	Television
UK	United Kingdom
ULBs	Urban Local Bodies
UN	United Nations
UNDP	United Nations Development Programme
USA	United States of America
USB	Universal Serial Bus
VAR	Vector Autoregression
VAR	Vector Autoregression Mechanism
VAR	Vector Autoregressive Method
VD	Variance Decomposition
VECM	Vector Error Correction Mechanism
VoIP	Voice Over IP
WCR	Working Capital Ratio
WDI	World Development Indicators
WG	Within Group
WHO	World Health Organization
WiMAX	Worldwide Interoperability for Microwave Access
WLL	Wireless Local Loop
WTI	World Telecommunication Indicators
WTO	World Trade Organization
X	Export of IT Industry in India
XG	The Growth of Export of IT Industry in India
ZAP	Zoomcar Associate Program

Part I
Role of IT-ITES Upon Economic and Financial Indicators

Chapter 1
Economic Development and Importance of IT Industry—An Appraisal with Reference to Asian Countries

Debashis Mazumdar and Mainak Bhattacharjee

1.1 Introduction

Information technology is one of the striking outcomes of the pursuit of science and its technological application of the last few decades. Apart from the enable ready access to various kinds of information, IT has ushered in major revolution in business ecosystem and thereby in the economy of a country as well. One primordial and most emergent feature of such technological revolution is the reorganization of productive activities towards the substitution of labour by capital. In particular, the intrusion of IT has enabled the displacement of semi-skilled and low-skilled labour through the agglomeration of production stages and thereof induces the annihilation of the less productive labour on the one hand and the creation of niche for high–skilled labour on the other. This reorganization of production is perceived to accentuate the production efficiency and, in such way, enhance the growth potential of an economy. However, a potential downside of such technological reorganization which is specifically for less developed countries and developing ones too is the fate of higher unemployment. This is because the less developed countries are featured by the relative abundance of semi-skilled and poorly skilled workers and relative of paucity of high-skilled one, contrary to the case of developed nations. Now given this the introduction of information technology in the redesigning, the production may translate into higher unemployment in the economy that in turn will go against the interest of economic development in the less developed nations. Moreover, in competitive regime, the seamless adoption of information technology will essentially let the small marginal

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enterprise to be swallowed by their big shot counterpart (given, the small enterprises are largely constrained their financial might in adoption of any technological progress) which in turn will eventually yield to impede the competition and thereof create monopoly in production. The backlash of such dynamics cannot be but the concentration of economy in the hands of handful number of big enterprises and so much so, the concentration of income and wealth. Thus, a drive to technological transition riding on the back of information technology may drive the less developed countries into further underdevelopment.

It is in the backdrop of the above narrative; the chapter endeavours to address the prospect of the less developed nations in face of the changing technological ecosystem propelled by the advent information technology and consider its plausible implications on the economic development of these nations, especially in regard to distributive justice.

1.2 Literature Review

There are umpteen literatures available on the investigation of the changes introduced by information technology (IT) in the working ecosystem and its far-flung impact on the real economy.

Strassmann (1985) takes its prime focus on how electronic technology is changing the methods of the workplace and examines the changes from the perspectives of the individual, the organization and society as it heads towards enhancing productivity, encouraging economic growth and eventually bringing about an improvement in life at workplace.

Weill (1992) envisages early adopters of strategic IT have enviable success, but the comparative advantage starts getting dried up once the technology becomes common. In addition, the context of the firm was emphasis in the study. Moreover, it has been that conversion effectiveness, which gauges the quality of the firm-wide management and commitment to IT, turned out to be a significant moderator between strategic IT investment and firm performance.

Wilson (1995) reviews the empirical evidence on the contribution of IT investments to economic growth and discusses the need for further research to explain the chain of causation linking the cumulative effects of IT expenditures on vertical and horizontal market structures within specific industries and the factors which influence or mediate the direction and magnitude of these effects. Two hypotheses are discussed as polar explanations for why IT capital productivity increased significantly after such a long period of stagnant and, in some industries negative, growth prior to 1987.

Wong (1994) probes consequence of IT investment on total factor productivity in the Singaporean economy by estimating an economy-wide Cobb–Douglas production function that separates capital stock into an IT component and a non-IT component. Output of the production function is measured by real GDP, while labour, the other input in the production function, is measured by total employment adjusted for average work hours per week.

Mahmood and Mann (2000) examine the impact of information technology (IT) investment on organizational performance has been found to be problematic. Moreover, attempt has been made to bring forth the importance of IT investment by investigating relationships between sets of IT investment measures and organizational performance measures. The results reveal positive and significant relationships between certain of the IT investment measures and organizational performance measures used in the study, indicating that organizations with greater levels of IT investment also had higher performance, as measured by return on investment, return on sales, sales per employee, sales by total assets and market value to book value.

Pohjola (2002) did not find any statistically significant correlation between ICT investment and economic growth in the case of 43 countries from 1985 to 1999. This is attributable to the poor accessibility and availability of communications technology and technology-based products in many developing countries.

Matteucci et al. (2005) demonstrate empirical testimony to the contribution of information and communications technology (ICT), to international productivity performance. It first uses an international industry data set and a growth accounting framework, to show that ICT has typically had a lower impact on productivity in Europe than in the USA, although there is considerable variation within Europe. The paper also analyses the European situation in greater depth by examining microeconomic data from Germany, Italy and the UK. While direct comparisons between the national findings are difficult, the results suggest that the UK experience with ICT has been closer to the USA than other European countries.

Papaioannou and Sophia (2007) and Yousefi (2011) used a panel generalized method of moments (GMM) and a fixed effect model for 42 developing and developed countries over the period (1993–2001). These studies indicate that ICT investments boost growth only in developed countries. This apart, it has also been alluded that developing countries should undertake appropriate measures to benefit from the positive role of ICT in driving economic growth such as liberalizing the trade regime, improving human capital and adopting favourable government policies.

Lee et al. (2012) contemplate the connection between economic growth and telecommunication infrastructure investments such as landline telephony and mobile phones in the SSA region. Based on applied linear GMM estimator on data from 44 Sub-Saharan countries over the period 1975–2006, the study confirms that mobile phone expansion is an important determinant of the rate of economic growth in Sub-Saharan Africa.

Sassi and Mohamed (2013) indicate a positive and statistically significant impact of ICT diffusion measured by three indicators, namely mobile phone, fixed-line telephone and Internet, on economic growth between 1960 and 2009.

Pradhan et al. (2015) investigated the nature of causal relationships between ICT infrastructure, financial development and economic growth in 21 Asian countries over the period 2001–2012. They concluded that both ICT infrastructure and financial development matter in the determination of the long-run economic growth of Asian countries.

Albiman and Zunaidah (2016) examined the long-run impact of ICT on economic growth in the SSA region for a 27-year period (1990–2014). They found that ICT proxies, such as fixed telephone lines, mobile phones and Internet, have a positive and statistically significant direct linear impact on economic growth. However, when they considered a nonlinear effect analysis, they found that mass penetration of ICT proxies seems to slow economic growth in the SSA region.

Aghaei and Mahdieh (2017) using dynamic and static panel data approaches within a framework of a growth model project that every 1% increase in ICT investment led to 0.52% economic growth in the Organisation of Islamic Cooperation (OIC) countries over the time period of 1990–2014.

Sepehrdoust (2018) conducted an empirical study using a panel generalized method of moments (GMM) growth model to investigate the impact of ICT and financial development on the economic growth of petroleum exporting countries (OPEC) during the period 2002–2015. The results showed that 1% increases in the financial development index and ICT variables increased economic growth by 0.048 and 0.050%, respectively.

Bahrini and Qaffas (2019) attempt to study the impact of information and communications technology (ICT) on the economic growth of selected developing countries in the Middle East and North Africa (MENA) region and the Sub-Saharan Africa (SSA) region by using a panel generalized method of moment (GMM) growth model over the period 2007–2016. The study envisages that except fixed telephone, other information and communications technologies such as mobile phone, Internet usage and broadband adoption are the main drivers of economic growth in MENA and SSA developing countries over the recent period 2007–2016. Besides, the findings affirm the superiority of MENA countries over SSA countries in the areas of Internet usage and broadband adoption. From a policy perspective, the results suggest that authorities in MENA and SSA countries should increase investments in ICT infrastructure. To benefit from the ICT drivers of economic growth, policymakers should enact several important policies that permit the development of financial sectors, provide a more convenient regulatory and institutional environment, increase economy openness, prioritize the allocation of resources to the development of ICT infrastructure and contain the negative effects of inflation and government consumption.

1.3 Objective

The chapter aims at investigating into the theoretical underpinning of the linkage between information-technology-led technological progress and economic growth (a necessary component of economic development) in the light of the standard Solovian framework (Solow 1956). This apart, the chapter seeks to examine the empirical evidence of the potential nexus between economic development and IT-driven technological advancement over the period: 2000–2018 in reference to some selected Asian countries.

1.4 Data and Methodology

The paper is based on the secondary collected from World Bank and UNDP on the variables, namely human development index (HDI), fixed broadband subscriptions per 100 people, secure Internet servers and Internet users as percentage population. The time period referred to in this paper spans over the period from 2000 to 2017. Coming to significance of the aforementioned variables, we have HDI as the indicator of economic development and the rest are considered to indicate the penetration of IT and ITES.

The empirical testimony for the connection between economic development and spread of IT has been examined using Persionian Chisquare test and to this end, the countries have been classified in two ways—one on the basis of HDI (UDDP) on the hand and the other, on the basis of all three indicators of IT penetration (using cluster analysis vide k-means approach). Besides, panel data regression with fixed-effect specification has been employed to address the matter of the causal effect that the penetration of information technology might have on the degree of economic development.

1.5 The Baseline Model

The model is based on the aggregative view of a closed economy with a composite production sector as described by the following production function linearly homogenous obeying constant returns to scale and satisfying Inada conditions:

$$Y = F(AK, (1 - u)L) \tag{1.1}$$

Here, u stands for the unemployment rate which is considered as influence by the technological parameter A, which in turn figures along with K to indicate the capital augmenting technological change as what is consistent with the IT-driven technological advancement. The influence of such technological transition is prone to displacement of labour in overall sense, so that the unemployment rate can be expressed as

$$u = u(A), u' > 0 \tag{1.2}$$

Besides, the technology has been assumed to be time variant and hence grows the constant rate 'η', which implies that:

$$\frac{\dot{A}}{A} = \eta \tag{1.3}$$

Moreover, labour force has been assumed to be constant and the capital stock is supposed to depreciate at the constant rate δ. This apart, aggregate saving is proportional to aggregate output with σ being average propensity to savings.

Now, define $\hat{k}$ as the capital stock per unit of labour employed, so that, $\hat{k} \equiv \frac{AK}{(1-u)L}$.

Thus, we have the evolution of the modified per capita capital stock over time as expressed below:

$$\dot{\hat{k}} = \sigma f\left(\hat{k}\right) - (\delta - (1 + \theta\eta)\hat{k}, \tag{1.4}$$

where $\theta = Au'/(1-u)$.

Now, the term θ can be approximated with the technological elasticity of unemployment, denoted by ε and hence we have the modified equation to the change in $\hat{k}$ as:

$$\dot{\hat{k}} = \sigma f\left(\hat{k}\right) - (\delta - (1 + \varepsilon\eta)\hat{k} \tag{1.4$'$}$$

Assuming Inada condition, we get the unique solution of $\hat{k} = 0$ as the steady-state value of $\hat{k}$ as:

$$\overline{\hat{k}} = g(\sigma, \delta, \varepsilon, \eta), \tag{1.5}$$

which is stable equilibrium, given diminishing marginal productivity of each factor.

1.5.1 *Impact of Rate of Technical Progress on Per Capita Real Income and Economic Growth*

Now, we shall examine the consequence of technological progress-driven better application of information technology, which in the light of the above baseline model can be carried by working out the comparative static exercise with respect to 'η'.

Hence differentiating (1.4′) totally holding everything constant except $\hat{k}$ and η, we have

$$\frac{\mathrm{d}\hat{k}}{\hat{k}} = \left[\frac{\varepsilon}{\sigma f'\left(\hat{k}\right) - (\delta - (1 + \varepsilon\eta))}\right]\mathrm{d}\eta \tag{1.6}$$

Now given denominator in (1.6) is positive so to yield a stable equilibrium at steady state, the sign of the left-hand side depends solely on the sign of unemployment elasticity of technological progress. In general, if technological change is geared at enhancing the productivity of capital relative to labour, then $\varepsilon > 0$ and thereof, the modified per capita at the steady state will decrease; otherwise, there will be a rise in $\hat{k}$. Thus, there can be two steady-state equilibria corresponding to whether $\varepsilon > 0$ or $\varepsilon < 0$ and this elucidates significantly of how degree of economic development may matter for the impact of IT-led technical advancement. To be specific, a state of low economic development can be thought of being featured by low $\hat{k}$ and similarly, a $\hat{k}$ indicates high level of economic development. This particular case can be addressed by assuming a certain value of $\hat{k}$ (say, $\overline{\hat{k}^*}$) such that a value of $\overline{\hat{k}} < \overline{\hat{k}^*}$ will be associated by $\varepsilon > 0$ and while $\varepsilon < 0$, otherwise.

At this backdrop it has been sought to investigate into the impact of IT-led technological on per capita real economy and economic growth, in what follows.

Given,

$$y = f\left(\hat{k}\right)(1-u), \tag{1.7}$$

the aforesaid impact can be enumerated by taking the derivative of (1.7) with respect to η as:

$$\frac{\mathrm{d}y}{\mathrm{d}\eta} = f'(\cdot)(1-u)\frac{\mathrm{d}\overline{\hat{k}}}{\mathrm{d}\eta} \tag{1.8}$$

Now, the impact of increase in the rate of technological progress on per capita real income is positive or negative according as

Proposition 1 *An increase in rate of technological progress leads to rise (fall) in modified per capita capital stock and hence per capita real income if the modified steady state per capita capital stock remains greater (lesser) than the critical value to begin with.*

Therefore, the growth rate of aggregate output can be illustrated as:

$$g = \frac{\dot{Y}}{Y} = \frac{\dot{y}}{y} = (-)\left[\frac{u'A}{1-u}\right]\eta \approx (-)\varepsilon\eta \tag{1.9}$$

As evident from (1.9), the growth rate depends on—(a) unemployment elasticity of technological progress and (b) the rate of technological progress. Now, given, the relation between the unemployment elasticity of technological progress and the degree of economic developed, as already indicated, with respect to modified per capita capital stock, what stands out quite reasonably is that for less developed or developing countries (those having $\overline{\hat{k}} < \overline{\hat{k}^*}$) will experience negative growth and is declining with increase in the rate of such technological progress. On the flip side, the developed countries (those having $\overline{\hat{k}} > \overline{\hat{k}^*}$) will experience rising growth rate with deepening up of such technological progress. Thus, we have the following proposition.

Proposition 2 *IT-led technological progress may not be beneficial for the less developed countries; so far, economic growth is concerned since such technological innovation will be unemployment augmenting due to lack of the availability of capital. Thus, IT-led technological lift may militate against the economic development of these less developed countries.*

1.6 Empirical Analysis

We shall now examine if the proposed nexus between penetration of IT and degree of economic development has sound empirical basis. In this endeavour, we attempt to assess if there is any two-way association between the economic development and each of the indicators of the dissemination of IT, as specified in the methodology.

Table 1.1 reveals that there is significant association between economic development and all three indicators of the penetration of information technology. Moreover, it also comes forth that amongst of all three indicators, density of Internet usage has strongest association with economic development followed by the other two.

Next, we shall appraise the statistical significance of causal effect of expansion of IT in terms of its capacity and usage on degree of economic development over the sample 40 Asian countries and over time.

As evident from Table 1.2 all three factors are significantly impactful on economic development. However, a striking observation is that the coefficient of dummy 1(=1/0, according as the first country is in the low level of economic development or not) is significant and negative which essentially signifies the level of economic development falters after controlling the influence of the factor indicating the expansion of information technology is however low. This in turn makes it clear that the fallout of expansion of information technology on economic development is rather pessimistic for the countries lying at the bottom of ladder as opposed to those in the relatively upper portion ladder.

Table 1.1 Information technology versus economic development

Indicators of IT penetration	Measure of association (Persionian chi-square)
Fixed broadband subscriptions per 100 people	81.76**
Secured Internet servers as percentage of population	99.24**
Internet users as percentage population	121.33***

Source Authors' computation based on World Bank Data (2019)
***(**)Significant at 1%(5%)

Table 1.2 Causal effect of the dissemination of IT on economic development

Model: $\mathrm{Ln}(\mathrm{HDI}_{i,t}/\mathrm{HDI}_{i,t-1}) = \beta_0 + \beta_1 \mathrm{intuse}_{i,t} + \beta_2 \mathrm{fbs}_{i,t} + \beta_3 \mathrm{sisv}_{i,t} + \mathrm{error}_{i,t}$	
Independent variables	Coefficient
Intercept	−0.2331*** (0.0012)
Internet users as percentage population (intuse)	0.3471*** (0.0001)
Fixed broadband subscriptions per 100 people (fbs)	0.5410*** (0.0023)
Secured Internet servers as percentage of population (sisv)	0.1274** (0.0015)
D_1	(−)0.1529*** (0.0031)
D_2	0.0124** (0.0048)

Source Authors' computation based on World Bank Data (2019)
***(**)Significant at 1%(5%). Figures in parenthesis indicate standard errors

1.7 Conclusion

The study concludes with a significant implication of the technological innovation mediated through information technology on the economic development. It posits that the impact of such technological progress that mainly enables the swallowing of labour by capital will be adverse for less developed and developing countries in terms of both per capita real income and economic growth rate, however will be favourable to developed countries. This in turn has further connotation with respect to inequality in income distribution in less developing countries, which will henceforth be intensified with the expansion information technology due to the large-scale displacement of labour and consequentially, the falling share of workers in national income. The reason is that the countries on the lower portion of the ladder of economic development lack skilled workforce that can potentially compliment the capital in the newer technological set-up. Thus, the expansion of IT in the form of technological advancement is rather inimical for the economic development in the less developed and developing nations.

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Chapter 2
The Role of IT Investment on the Bank Performance: A Cointegration and Causality Analysis for Asian Countries

Hasan Dinçer and Serhat Yüksel

2.1 Introduction

Competition increased significantly almost in all industries mainly due to the effects of the globalization. In such an environment, companies aimed to implement new strategies to increase their competitive power. Technological investment is generally accepted as one of the most important strategies to achieve this objective. It mainly refers to the making investment for using, producing, and disseminating information to improve technological capacity of the companies (Saberi et al. 2018a, b). With the help of this condition, companies can get opportunity to be one step ahead of the competition.

There is also high competition in banking industry especially in the previous years. The main reason is that large-scale banks have started to operate in most countries. This situation has a negative influence on the performance of the small-scale local banks. Therefore, banks give much importance upon to the technological improvement. In other words, banks aim to make investment in information technology to provide better services to the customers. If customers are satisfied with the services of the banks, these banks are preferred more. Hence, it is obvious that this issue contributes profitability of the banks (Sedunov 2017).

Asia is also very significant continent in the world because of some different aspects. Firstly, it is the largest continent and it has the highest population in the world according to World Bank. Another important point is that Asia also plays a very key role with respect to the economic issues. For example, import and export amount of the goods has an increasing trend. On the other side, there is an important development in financial system. For instance, the ratio of the insurance and financial

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services in service exports has an increasing trend. Parallel to these conditions, there is also an increase in ICT service exports and research and development expenditures.

This study examines the effects of IT investment on the performance of banking industry. Within this framework, all Asian countries, which have necessary data, are evaluated. In the analysis process, PC and DHPC analysis are considered. Being the first study that focuses on Asian countries with respect to the relationship between IT investment and banking performance can be accepted as the main novelty of this study. Because Asia is a growing continent in the world and there are some important countries in this continent, such as China, and it is believed that this study provides significant recommendations to contribute the improvement of this continent. Another important novelty of this study is that both PC and DHPC are used in the analysis process. Therefore, it becomes possible to understand the power of the relationship by considering these two different approaches.

This study has six different parts. This part indicates some general information about technology investment and competition in banking industry. In the next part, literature review is conducted regarding the importance of technological investment. Moreover, the third part indicates some quantitative information for Asia. After that, PC and DHPC analysis are explained in the fourth part. On the other hand, the fifth part includes the evaluation on Asian countries. In addition to them, in the conclusion part, recommendations are given related to the analysis results.

2.2 Literature Review

Technology investment issue has been discussed in many aspects in the literature. Some of these studies addressed the importance of technological investment on the effectiveness in the manufacturing process. Bai and Sarkis (2017) made a study to improve green flexibility in manufacturing systems. They underlined the significance of advanced manufacturing technology selection in this purpose. Saberi et al. (2018a, b), Cheng et al. (2018), and Chen et al. (2017) also concluded that implementing the appropriate technology is crucial to increase efficiency and have more successful supply chain management.

In addition to these studies, technology investment was also examined regarding the relationship with customer satisfaction. In this framework, Tsou and Hsu (2017) focused on the self-service technology. They reached the conclusion that the popularity of this technology increased especially in the last years. In this context, with the help of mobile banking, telephone banking and automated teller machines, customers can perform their operations much easily. This situation has a key role to increase customer satisfaction. Additionally, Navimipour and Soltani (2016), Dye and Yang (2016), Huang et al. (2015), and Mohamad et al. (2017) also stated that technology investment is a must to have better customer relationship management.

On the other side, the role of the technologic investment on the financial performance of the companies was defined in many different studies. Yeniyurt et al. (2019) tried to understand the relationship between the IT innovativeness and business performance. It is concluded that there is a positive relationship between these variables. Additionally, Sato et al. (2017), Chae et al. (2018), Grant and Yeo (2018), and Lee et al. (2015) made also similar studies for this topic in tourism and energy industries. They mainly concluded that IT investment has an essential role in the financial performance of the companies. It was also underlined by many researchers, such as Xia et al. (2015), Stores et al. (2018), and Ning and Wang (2018).

Furthermore, the effects of the technological investment on the bank performance were also evaluated by many different researchers. Some studies stated that technological investment in banking industry improves loan process. For instance, Han et al. (2019) focused on the relationship between the cost of bank loans and technology level. They reached a conclusion that IT investment has a positive impact on the cost of loan process. Similar to this study, Kim et al. (2017), Chu (2016), and Nguyen (2016) also defined that technological investment minimizes paper operations which contributes cost reduction. Also, Simper et al. (2019), Han et al. (2019), Mirzaei and Moore (2019), and Chedrawi et al. (2019) concluded that loan process in the banks can be more effective with the technological improvement.

Similar to bank loan operations, the power of the technological investment on the bank profitability was also examined by many different researchers. As an example, Sathye and Sathye (2017) focused on Indian banking industry. By using data envelopment analysis, it is identified that technological investment in automated teller machines has a powerful impact on the profitability of the banking industry. The main reason is that it decreases the labor costs of these banks. Gupta et al. (2018) also made a study for Indian banking industry by using stochastic frontier analysis. They also underlined the necessity of the IT investment to increase the profitability of the banking sector. Chen and Lin (2015), Mahboub (2018), Panetta et al. (2017), Weiss and Obi (2016), and Akbari et al. (2019) also reached the conclusion that there is a strong positive relationship between technology investment and bank performance.

It is understood that technology investment was considered in different purposes by the researchers. Some studies stated the importance of technological investment on the effectiveness in the manufacturing process. Similarly, the effects of IT investment on customer satisfaction and financial performance were also demonstrated by some researchers. Also, the power of the technological investment on the bank profitability was also examined by many different researchers. It can be seen that there is a need for a new study which examines the effects of IT investment on bank performance by using a different methodology, such as PCA and DHPC tests.

2.3 Quantitative Information About Asian Countries

Asia is the largest continent in the world. There are about 55 different countries in this continent. In addition to these issues, Asia has the highest population in comparison with the others. China and India are the countries in Asia in which there are more than 1.3 billion people. Moreover, China is accepted as the significant economic power

Table 2.1 Asian countries that have the highest GDP in 2018

Countries	GDP (million USD)
China	25,313,268
India	10,401,440
Japan	5,632,475
Russia	4,179,597
Indonesia	3,495,920
Turkey	2,314,398
South Korea	2,139,681
Saudi Arabia	1,856,946
Iran	1,652,888
Thailand	1,323,209

Source World Bank

in the world especially in recent years. Table 2.1 gives information about 10 Asian countries that have the highest GDP.

Table 2.1 indicates that China has the highest GDP in Asia. In addition, India, Japan, and Russia have also high GDP in this continent. Moreover, Russia, Indonesia, and Turkey are other important countries of Asia with respect to the economic aspect. On the other side, Table 2.2 summarizes some financial information in Asia. First of all, it can be seen that there is a significant increase in the total value of the stocks traded (% of GDP) for the years between 2000 and 2017. Similar to this situation, the ratio of the insurance and financial services in service exports has an increasing trend. On the other side, Table 2.3 explains the technological conditions of Asia. It is obvious that there is an increase in ICT service exports and research and development expenditures. In contrast, it is understood that high-technology exports have a decreasing trend.

2.4 Methodology

2.4.1 PC Analysis

PC analysis aims to identify the long run relationship among different factors. The main benefit of this approach is that it is appropriate to use it in panel data. There are seven different tests under this cointegration analysis. If the probability values of at least four different tests are lower than 0.05, there is a relationship among the variables. Otherwise, it is accepted that there is not a relationship between these variables (Pedroni 2004). PC analysis was used in the literature for different issues, such as energy finance (Dogan and Seker 2016; Inglesi-Lotz 2016), tourism performance (Seetaram et al. 2016; Ozturk 2016), banking (Dinçer et al. 2019d), and health expenditure (Dinçer and Yüksel 2018).

Table 2.2 Some financial information about Asia

Indicator name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Stocks traded, total value (% of GDP)	168	108	120	111	88	65	89	101	236	128	124
Insurance and financial services (% of service exports, BoP)	6.7	5.7	6.1	6.1	5.9	5.9	6.3	7	7	7.7	7.8
Domestic credit to private sector (% of GDP)	126	124	135	132	130	132	134	138	145	148	148
Domestic credit in financial sector	182	182	201	195	194	197	193	199	209	225	192

Source World Bank

Table 2.3 Some technological information about Asia

Indicator Name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ICT service exports (% of service exports, BoP)	2.9	3.1	3.5	3.8	3.9	4.3	4.5	4.7	5.4	6.0	6.4
High-technology exports (% of manufactured exports)	27.2	25.9	27.4	26.2	24.3	24.8	25.1	24.2	24.5	24.7	25.5
Research and development expenditure (% of GDP)	2.4	2.4	2.3	2.4	2.4	2.5	2.3	2.5	2.4	2.5	2.5

Source World Bank

2.4.2 DHPC Analysis

DHPC analysis is considered to examine causality analysis between different variables. Similar to PC analysis, it can also be used for panel data analysis. Equation 2.1 summarizes the details of this analysis (Dumitrescu and Hurlin 2012).

$$Y_{i,t} = a_i + \sum_{k=1}^{K} Y_i^k Y_{i,t-k} + \sum_{k=1}^{K} B_i^k X_{i,t-k} + \varepsilon_{i,t} \tag{2.1}$$

In the literature, DHPC analysis was considered by Yüksel (2017), Erdal and Göçer (2015) and Dinçer et al. (2019b) for research and development investment, Aydin and Malcioglu (2016), Dinçer et al. (2019a, c), Furuoka (2015), and Dinçer et al. (2018) for financial development and Dogan et al. (2017) and Dinçer et al. (2017) for energy consumption.

2.5 An Application on Asian Countries

2.5.1 Data, Scope, and Variables

In this study, annual data of the variables for the period between 2000 and 2016 is examined. With respect to the IT investment, the variables of high-technology exports (HTE) (% of total manufactured exports) and research and development expenditure (% of GDP) for IT investment are used. In addition to this aspect, the variable of credit provided by financial sector (% of GDP) is considered regarding the performance of the banking sector. In the analysis process, it is aimed to evaluate all Asian countries. However, only eight different countries (China, Cyprus, Israel, Japan, Kazakhstan, Singapore, Thailand, and Turkey) are taken into consideration because of data availability problem.

2.5.2 Unit Root Test Results

Firstly, stationary analysis is applied. In this context, Levin, Lin, and Chu (LLC) panel unit root test is performed, and analysis results are given on Table 2.4.

Table 2.4 explains that the variables of "R&D Expenditure" and "Bank Credit" have unit root because the level value is greater than 0.05. Hence, the first differences are taken for these variables to become stationary. Nonetheless, the variable of "HTE" is stationary on its level value.

Table 2.4 LLC results

Variables	Level value (probability)	First difference (probability)
HTE	0.0000	-
R&D expenditure	0.1091	0.0001
Bank credit	0.0963	0.0117

Source Authors' Calculations

Table 2.5 PC results

Relationship type	Test name	Probability values
HTE and bank credit	Panel v-statistic	0.0020
	Panel rho-statistic	0.0000
	Panel PP-statistic	0.0000
	Panel ADF-statistic	0.0095
	Group rho-statistic	0.0018
	Group PP-statistic	0.0020
	Group ADF-statistic	0.0001
R&D expenditure and bank credit	Panel v-statistic	0.1781
	Panel rho-statistic	0.0015
	Panel PP-statistic	0.0022
	Panel ADF-statistic	0.5867
	Group rho-statistic	0.0026
	Group PP-statistic	0.0000
	Group ADF-statistic	0.1795

Source Authors' Calculations

2.5.3 PC Test Results

After stationary analysis, PC analysis is performed to understand the relationship. The evaluation results are summarized in Table 2.5.

Table 2.5 states that there is a relationship between HTE and bank credit. The main reason is that probability values of all tests are lower than 0.05. In addition to this issue, it is also understood that there is a relationship between R&D expenditure and bank credit because 4 of 7 tests have the probability values lower than 0.05. This situation explains that IT investment has a long-term relationship between bank performance.

Table 2.6 DHPC analysis results

The way of the relationship	Lag	Probability values	Results
HTE → bank credit	1	0.6304	There is no causality analysis
	2	0.9158	
	3	0.4429	
R&D expenditure → bank credit	1	0.0031	There is no causality analysis
	2	0.3663	
	3	0.9555	

Source Authors' Calculations

2.5.4 DHPC Test Results

DHPC test is performed in addition to the PC analysis. Table 2.6 summarizes the analysis results.

Table 2.6 demonstrates that HTE is not the main cause of bank credit due to the higher values than 0.05. Similar to this result, it is also concluded that there is no causality relationship from R&D expenditure to the bank credit. It is concluded that technological investment is not the main cause of the bank performance. Hence, it is obvious that Asian banks should consider many different factors at the same time to increase the effectiveness in the banking industry. For example, employing qualified personnel and conducting a study to meet customer expectations can be given example for this situation.

2.6 Conclusion

This study aims to identify the effects of IT investment on the performance of banking sector. In this context, eight different Asian countries, which have necessary data, are evaluated. As a result of PC analysis, it is determined that there is a relationship between HTE and bank credit. Similar to this conclusion, it is also defined that there is a relationship between R&D expenditure and bank credit as well. This situation gives information that IT investment has a long-term relationship between bank performance for Asian countries. In addition to them, HTE and R&D expenditures are not the main cause of bank credit according to DHPC results. It is seen that technological investment is not the main cause of the bank performance.

The results of this study mainly demonstrate that technological investment is very significant for the countries to have more effective banking industry. Thus, making any investment to improve technology has a contribution to the effectiveness of the banking system. The main reason is that with the help of technological development, banks can provide better services to the customers so that they can be preferred more by these customers. This situation has a positive contribution to the economic improvement of the countries.

Another important result of this study is that there is not a causality relationship between IT investment and banking performance although there is a cointegration relationship. This issue explains that IT investment may not be enough to improve the effectiveness of the banking industry. In other words, Asian countries should consider some other crucial factors in addition to the technologic development in order to increase the performance of the banking industry. In this framework, personnel quality, meeting customer expectations, and macroeconomic conditions of the country can be considered for this purpose.

In the future studies, new approaches can be used in the analysis process to understand the relationship between technologic development and banking industry. For instance, multivariate adoptive regression splines (MARS) approach and fuzzy logic can be considered to compare the results with this study. In addition to this issue, different variables can also be taken into consideration which may have an effect on banking performance and technologic investment. Moreover, different regions can be evaluated to make a comparison with Asian countries.

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Chapter 3
Is There Any Relationship Between Output Growth and Export Growth in Indian Information Technology Industry After Liberalization?

Dipyaman Pal and Chandrima Chakraborty

3.1 Introduction

Information technology (IT) industry is one of the important sector in India. It plays a vital role in increasing the output of a country. Nowadays, for young generation, IT industry is the most wannabe industry. There are different emerging branches of the IT industry which employed both highly skilled youth in hardware and software sectors. On the other hand, in the ITES-BPO industry generates employment for the people with less technical and formal education. Hence IT Industry can create the employment opportunities for both highly skilled and formally graduated people. According to Kumar and Joseph (2005) apart from creating jobs software industry has provided opportunities for expanding the local base of entrepreneurship is the other notable impact on employment. There are two major components in the Indian IT industry, IT services and BPO. According to NASSCOM, the share of IT in India's GDP has increased from 0.4% in 1991–92 to 9.4% in 2015–16. The annual average growth rate of IT sector in India between 1991 and 2014 is around 29% where as the annual average growth rate of total industrial sector for this period is around 6%.

In terms of foreign direct investment, the rank of the IT sector is third among the all industries in India and for this reason, the revenue in this sector has reached impetus. After the liberalization, the export of IT industry became a competitive, productive, and rapidly growing economy. Moreover, India has the capacity to attract a vast share of IT-ITES demand for off shore services and therefore continues to enhance India's export led growth. IT sector in India is very much dependent upon its export and

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due to this, it has been successful to promote the rank of India among the leading exporters in the world trade.

IT industry in India has contributed about 77% of the industry's total revenue due to its exports dominance. Due to this export dominance, there is a massive employment generation in the country. Over more than hundred countries around the world, India has exported its IT services but most of the export service from India is to the USA market which accounts for 62% of total software exports. One of the main line of thinking for this export led growth is that it assumes that the international market is much wider than the domestic market. With time, the IT exports have shown an increasing growing trend. The IT sector exports both the software products and also the research and development and software products. The main cause behind this export of IT services is that India is rich in human capital therefore the cost of skilled Indian workforce is reasonably low compared to the other developed nations. So for this reasons, Indian IT services are highly cost efficient. The export of the IT sector has grown for more than 20 years. In 1990s the growth rate in the export sector was much as compared to that in 2000s because when it started from a low base it grew more rather than being matured. The annual average growth rate of export of IT sector during 1991–2014 is around 39%. Among the export of IT sector , the export of software services contribution is almost 83% and the annual average growth rate of software services of IT sector during 1991–2014 is around 36%.

In addition, the growth of the IT sector leads to a larger portion of the growth of the IT exports may be due to government encouragement, logical expertise, research and development, etc.

Some studies on IT sector in India relating to growth, region, gender and socio-cultural norms are due to Sen (1995), Heeks (1996), Jorgenson and Stiroh (1999), Vijaybhaskar et al. (2001), Varma and Sasikumar (2004), Nagala (2005), Kumar and Joseph (2005), Srinivasan (2005), Kumari and Reddy (2009), Joshi (2009), Mitra (2009), Hussin (2012), Vijayasri (2013), Dubey and Garg (2014), Vij and Batra (2014), Kanchan (2016), Thanga (2016) among others.

But the perusal of the literature on IT sector in India suggests that there is dearth in the studies for measuring the long-run relationship between growth of IT sector and the growth of IT export.

So in the present paper the main objectives are as follows:

- Is there any long-run or short-run relationship between output of IT sector and export of IT sector or output of IT sector and export of software services of India?
- Whether there exists any long-run convergence between growth of output of IT sector and growth of export of IT sector or growth of output of IT sector and growth of export of software services?
- Whether there exist any short-run fluctuations between growth of output of IT sector and growth of export of IT sector or growth of output of IT sector and growth of export of software services?

The rest of the paper unfolds as follows. Section 3.2 describes the methodology and data sources. Section 3.3 provides the empirical results and Section 3.4 represents the conclusion.

3.2 Materials and Methods

3.2.1 Methodology

The unit root property of the different series have been checked employing Augmented Dickey-Fuller (ADF) Test and Phillips and Perron (PP) Test. Then, vector error correction mechanism (VECM) or vector autoregression (VAR) mechanism has been used for finding out the long-run convergence or short-run fluctuations between the series. As the methodology of Augmented Dickey-Fuller (ADF) Test, Phillips and Perron (PP) Test, vector error correction mechanism (VECM) and vector autoregression (VAR) are very well known, so it is needless to discuss these methodologies in details.

3.2.2 Data Sources

All the annual data have been collected from the Open Government Data (OGD) Platform India (link: https://data.gov.in) and website from Ministry of Statistics and Programme Implementation (Link: https://mospi.nic.in). The variables included are output of the IT industry in India (O), export of IT industry in India (X), export of software services (S), the growth of output of the IT industry in India (OG), the growth of export of software services for IT industry in India (SG)and the growth of export of IT industry in India (XG). The sample period is from 1991 to 2014.

3.3 Results and Discussion

All the results are presented in Tables 3.1, 3.2 and 3.3.

The results of unit root analysis and VECM analysis for output, export of software services, and export of IT industry in India are presented in Tables 3.1 and 3.2. From the results of analysis, it can be seen that when the level of the series are considered, output of the IT sector, export of the IT sector, and export of software services are found to be $I(1)$ series implying that all the three series are non-stationary at level but stationary at first difference. So from these results, it can be concluded that one can apply the co-integration analysis among the series to find out the long-run movement among the series. In this paper, the vector error correction mechanism (VECM) has been used to find out the long-run as well as the short-run fluctuations among (i) output of IT sector and export of IT sector and (ii) output of IT sector and export of software services. It is found that there exists a strong long-run as well as short-run relationship between output of IT sector and export of IT sector. A significant negative co-integrating vector among output of IT sector and export of IT sector implies that these two series are converging series in the long-run and the speed of convergence

Table 3.1 Results of unit root test

Variables	Augmented Dickey-Fuller (ADF)				Phillips and Perron (PP)			
	Level		First diffrerence		Level		First diffrerence	
	t-statistic	Prob.[a]	*t*-statistic	Prob.[a]	*t*-statistic	Prob.[a]	*t*-statistic	Prob.[a]
O	−0.71869	0.8219	−3.5117	0.0209**	−0.53868	0.8653	−4.97036	0.0007*
OG	−5.89084	0.0001*			−14.1789	0*		
X	−0.71455	0.9999	−2.96022	0.0592***	−0.761453	0.985	−3.71753	0.0116**
XG	−3.53602	0.0166**			−3.5362	0.0166**		
S	−0.81659	0.8399	−3.94569	0.0071*	−0.63423	0.7634	−3.40423	0.0254**
SG	−3.65642	0.0128**			−3.63423	0.0134**		

[a]MacKinnon (1996) one-sided p-values
*Significant at 1%, **Significant at 5%, ***Significant at 10%
Source: Authors

Table 3.2 Results of vector error correction mechanism (VECM)

Cointegrating Eq:	CointEq1		Cointegrating Eq:	CointEq1	
O(−1)	1		O(−1)	1	
X(−1)	−1.70852*		S(−1)	−1.31901*	
	(−0.0766)			(−0.22038)	
	[−22.3047]			[−5.98524]	
C	407.6132		C	−564.077	
Error correction:	D(O)	D(X)	Error correction:	D(O)	D(S)
CointEq1	−0.17334*	−0.33376*	CointEq1	−0.21809*	−0.17923*
	(0.053122)	(0.02746)		(0.0851)	(0.07199)
	[−3.26307]	[−12.1543]		[−2.56273]	[−2.48958]
D(O(−1))	0.281405*	0.750558*	D(O(−1))	0.023227	−0.04978
	(0.053586)	(0.079391)		(−0.54672)	(−0.21263)
	[5.251465]	[9.453943]		[0.04248]	[−0.23409]
D(O(−2))	1.242027*	0.468226	D(O(−2))	1.323927*	−0.87771*
	(0.37584)	(0.51119)		(−0.4849)	(−0.18859)
	[3.30467]	[0.915953]		[2.73029]	[−4.65413]
D(X(−1))	0.581146*	0.442386*	D(S(−1))	1.268648	1.08508*
	(0.09369)	(0.055782)		(−1.02525)	(−0.39874)
	[6.20286]	[7.930623]		[1.23741]	[2.72130]
D(X(−2))	1.322005	0.435678*	D(S(−2))	1.612247**	0.877069*
	(−1.71407)	(0.18603)		(−0.87642)	(−0.34085)
	[0.77127]	[2.341977]		[1.83958]	[2.57315]
C	186.6929	202.6581***	C	215.8172*	126.9916*
	(−241.625)	(−124.9)		(−95.0062)	(−36.9496)
	[0.77266]	[1.62257]		[2.27161]	[3.43689]
R-squared	0.790902	0.921636	R-squared	0.785633	0.925244
Adj. R-squared	0.721202	0.895514	Adj. R-squared	0.714178	0.900325
F-statistic	11.34732	35.28276	F-statistic	10.99472	37.1305
Wald F-statistic	959.4622*	928.4535*	Wald F-statistic	616.7836*	592.0093*
Probability	0	0	Probability	0	0

Standard errors in ( ) and t-statistics in [ ]; *Significant at 1%, **Significant at 5%, ***Significant at 10%
Source: Authors

is 1.7. Now, from the results of short-run fluctuations, it can also be concluded that fluctuations in output of current year is influenced by the fluctuations in previous two periods output and fluctuation in the previous periods export. Similarly, fluctuations in current year's export is influenced by the fluctuations in previous periods output and fluctuation in the previous two periods export. Now, if we consider the relationship between output of IT sector and export of software services, it can be concluded that there exists a strong long-run relationship between these two series. A significant negative co-integrating vector among output of IT sector and export of software services implies that these two series are converging series in the long-run and the speed of convergence is 1.3. From the results of short run fluctuations, it can also be concluded that fluctuations in output of current year is influenced by the fluctuations in previous two periods lag of output and also fluctuation in the previous two periods lag of export of software services. Whereas fluctuations in current year's export of software services is influenced by the fluctuations in previous two periods' export of software services and fluctuation in the previous two periods lags of output. The result of Wald test also represents the same conclusion. The Wald F-statistics in both cases is positive and statistically significant implying that there exists a strong short-run relationship between the output of IT sector and export of IT sector and also between the output of IT sector and export of software services.

Table 3.3 Results of vector auto regression (VAR)

	OG	XG		OG	SG
OG(−1)	0.476785	48.75544	OG(−1)	0.15264	0.193632
	(−0.41721)	(−57.4984)		(−0.32932)	(−0.38457)
	[1.14279]	[0.84794]		[0.46350]	[0.50351]
OG(−2)	−0.32993	12.56042	OG(−2)	−0.21589	−0.00083
	(−0.34505)	(−47.5537)		(−0.28886)	(−0.33732)
	[−0.95618]	[0.26413]		[−0.74736]	[−0.00246]
XG(−1)	−0.0006	0.088208	SG(−1)	0.269227	0.439553
	(−0.00318)	(−0.43887)		(−0.29243)	(−0.34149)
	[−0.18898]	[0.20099]		[0.92064]	[1.28716]
XG(−2)	0.003017	0.070158	SG(−2)	0.201112	0.007047
	(−0.00208)	(−0.2873)		(−0.19892)	(−0.23229)
	[1.44712]	[0.24419]		[1.01104]	[0.03034]
C	0.142822**	10.92537	C	0.132359***	0.119265
	(−0.07857)	(−10.8277)		(−0.07811)	(−0.09121)
	[1.81784]	[1.00902]		[1.69451]	[1.30753]
R-squared	0.295663	0.283753	*R*-squared	0.310919	0.339687
Adj. *R*-squared	0.119578	0.104691	Adj. *R*-squared	0.138648	0.174609
F-statistic	1.679097	1.584667	*F*-statistic	1.80483	2.057734
Wald *F*-statistic	2.32704	2.472383	Wald *F*-statistic	2.42856	1.85674
Probability	0.1262	0.1374	Probability	0.1322	0.1847

Source: Authors

The results of unit root analysis and VAR analysis for growth of output, growth of export of software services and growth of export of IT industry in India are presented in Tables 3.1 and 3.3.

Standard errors in ( ) and t-statistics in [ ]; *Significant at 1%, **Significant at 5%, ***Significant at 10%

Now when we consider the relationship between i) growth of output of IT sector and growth of export of IT sector and ii) growth of output of IT sector and growth of Export of software services, we find that growth of output of IT sector, growth of export of IT sector and growth of Export of software services follows $I(0)$ series which implies that all these series are stationary at level (see Table 3.1). By analyzing these results, one can conclude that as all these series are stationary at level then there is no scope to analyze the long run relationship between these series. In this paper we have used the Vector Auto Regression (VAR) mechanism to find out the short run fluctuations between (i) growth of output of IT sector and growth of export of IT sector and (ii) growth of output of IT sector and growth of Export of software services. From the results of Table 3.3 it can be concluded that fluctuations in growth of output of current year is not significantly influenced by the fluctuations in previous two periods lag of growth of output. Again current year's fluctuation in growth of output is also significantly unaffected by the fluctuation in the previous two periods lag of growth of export of IT sector. On the other hand current year's growth of export of IT sector is not significantly influenced by the fluctuations in previous two periods lag of growth of export of IT sector also by the two period's lag of growth of output. Now if we consider the relation between growth of output of IT sector and growth of Export of software services we can found that the current year's fluctuation in growth of output is not affected by the fluctuation in the previous two periods lag of growth of output of IT sector and also by the growth of export of software services. Again current year's growth of export of software services is not significantly influenced by the fluctuations in previous two periods lag of growth of export of software services and also by the two period's lag of growth of output. The result of Wald test also represents the same conclusion. The Wald F-statistics in both cases is statistically insignificant implying that there exists no short run relationship between the output of IT sector and export of IT sector and also between the output of IT sector and Export of software services.

Thus, the major findings of the present paper is that there exists a significant long-run as well as short-run relationship between (i) output of IT sector and export of IT sector and (ii) output of IT sector and export of software services. Whereas there exists no long-run and short-run relationship between (i) growth of output of IT sector and growth of export of IT sector and (ii) growth of output of IT sector and growth of export of software services.

3.4 Conclusion

The present study estimates the long-run as well as the short-run relationship between (i) output of IT sector and export of IT sector and (ii) output of IT sector and export of software services and also for the (i) growth of output of IT sector and growth of export of IT sector and (ii) growth of output of IT sector and growth of export of software services in case of Indian IT industry for the period 1991–2014. The present study also tried to estimate whether there exists any long-run convergence between output or growth of output of IT sector and export or growth of export of IT sector as well as output or growth of output of IT sector and export of software or growth of export of software services or not. Before doing the long-run analysis, unit root property of the different series has been checked by using Augmented Dickey-Fuller (ADF) Test and Phillips and Perron (PP) Test. The major findings of the present paper is that there exists a significant long-run as well as short-run relationship between (i) output of IT sector and export of IT sector and (ii) output of IT sector and export of software services. Also there exists a long-run converging relationship between the (i) output of IT sector and export of IT sector and (ii) output of IT sector and export of software services. On the other hand, there exists no long-run and short-run relationship between (i) growth of output of IT sector and growth of export of IT sector and (ii) growth of output of IT sector and growth of Export of software services.

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Chapter 4
Trend of IT Enabled Banking Correspondence Services and Its Determinants: Evidences from South Asian Countries

Amar Nath Das and Arindam Laha

4.1 Introduction

In recent years, advancement of information and communication technology makes a dramatical change in service sector, especially banking and financial service industry. In this context outsourcing of financial services through third-party model provides a greater presence of financial institutions in the market. Banking correspondents (BC) are those non-financial entities through whom banks offer basic financial services to far-off unbanked areas (Qazi 2019). It is a complementary access channel to formal financial system (Cámara et al. 2015).

These entities include a broad range of service providers such as individual owner of local kirana stores, medicine shop, retired teachers, retired government employee, retired bank employees, ex-service men, agents of small savings scheme, post offices, non-governmental organisation, self-help group, MFIs, cooperative society, etc. With this model, banks try to reach low income clientele through cost-efficient manner. Apart from providing basic financial services (account opening, collection of small value deposit, withdrawal, fund transfer), banking correspondents helps to identify prospective borrower, facilitate them to process loan application, verification and submission of required documents, follow-up recovery, sale of micro-insurance, recovery of credit, develop awareness about savings and investment among low-income customer segment, promoting, nurturing and monitoring of self-help groups (Abrol 2018).

On the basis of the degree of involvement, banking correspondent can be classified into pure and hybrid models. In pure model, BC acts as a branchless channel that

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generates direct physical access points of the formal financial system. The outlets of BCs undertake various activity through different technologies like smart card technology, mobile phone technology, kiosk banking technology. Most of the cases, BCs are needed to open a current account (i.e. settlement account) and keep it pre-funded with respective bank. Technically, when customer comes to deposit money at BC's outlet, BC collets the money and customer's account will be credited and BC's account will be debited with the same amount. At the time of customer's withdrawal, the reverse mechanism is followed. The cash management between BC's settlement account and customer bank account is done through information and communication technology.

On the other hand, hybrid model is an indirect access point to formal financial system. Proliferation of mobile phones has developed a new class of money transfer service providers to reach unbanked segment of population. This model offers financial services (e-money products) on behalf of non-bank electronic money issuers. At the same time, another class of BC offer mobile based money transfer and payment services on behalf of non-bank electronic money issuers as an outcome of bank's outsource agreements.

In this context, Mobile money act as a digital medium of exchange and store of value using mobile money accounts, facilitated by a mobile network operator, independent of the traditional banking network. The transaction of mobile money refers to a financial payment or transfer (including bill payments, merchant payments and international remittances) to a third-party using balances on a mobile money account via a mobile phone (IMF 2018).

In this backdrop, attempts have been made in this paper to examine regional variations in the access to formal financial services through BC model in South Asia[1] and its socio-economic infrastructure determinants. For convenience, the paper has been divided into six sections. The next section analysed the conceptual framework on various forms of IT-enabled banking services. Section 4.3 reviews the transition from traditional to IT -enabled banking services in south Asian countries. Section 4.4 considers the data and methodological aspects relating to the outreach of financial services through BC model and its determinants. In Sect. 4.5, empirical evidences on alternative channels in promoting branchless financial services through BCs among south Asian countries have been made. Also, the effect of various socio-economic and infrastructure indictors on the mobile money usage are identified. The concluding remarks are presented in Sect. 4.6.

[1]South Asia of the eight sub-Himalayan countries like Bangladesh, India, Sri Lanka, Pakistan, Nepal, Bhutan, Maldives and Afghanistan in the southern region of the Asian continent. South Asia belongs to over one-fifth of the world's population, and thereby considered as the most populous and the most densely populated geographical region in the world. The South Asian Association for Regional Cooperation (SAARC) is an economic cooperation organization in the region which was established in 1985.

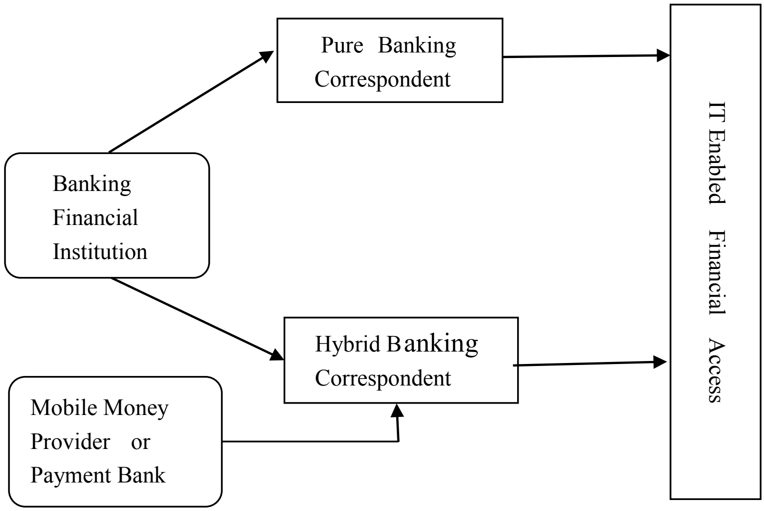

Fig. 4.1 Banking Correspondent model in promoting IT-enabled financial access. Source: Authors own presentation

4.2 IT-Enabled Banking Services: A Conceptual Framework

Financial inclusion, as a means of universal financial access, is taken place when an individual have an access to a transaction account.[2] With this account, an individual can send payments, receive deposits and store money either in an electronic format or physical format (World Bank 2017). Bank can realise universal financial access through direct branch banking, pure BC or through hybrid BC (i.e. mobile money services provided by bank in collaboration with mobile money provider). Another source of access to a transaction account is having a registered mobile money account provided by mobile money service provider. Even if an unregistered mobile money user can also have an access to a transaction account through mobile money agent outlet by way of over the counter transaction.

As per the classification of BC model (Fig. 4.1), pure BC is a channel by which bank could eliminate establishment cost of a new branch. Rather appointment of BCs could reduce recurring cost by maintaining more flexible cost structure. On behalf of bank, BCs act as a direct interface between bank and customer. On the other hand, hybrid model of BCs are pre-existing retail agent network channel offers financial services on behalf of registered mobile network operator. There is an agreement between banks and mobile network operators about guaranteeing indirect or potential

[2]Globally, about 1.7 billion adults are without an account at a formal financial institution or through a mobile money provider. China and India share large number of global unbanked population. China is a home to 225 million adults without an account, followed by India (190 million), Pakistan (100 million) and Indonesia (95 million) (World Bank 2017).

access to formal financial services. In this form of BC, mobile money incurs low entry cost with widely distributable area in compared to bank. Mobile money users could buy airtime, receive money, pay for goods and wide variety of services and make deposits and withdrawals[3] (Boadu and Birago 2013). In this context, indirect access denotes either transfer of fund from mobile money account to bank accounts or manages bank account through mobile money application. Payment bank is another form of hybrid BC introduced by Reserve Bank of India for promoting digital and cashless banking. Services like accept demand deposits, international and domestic remittance, fund transfer, bill payments, etc., (except lending activities) are offered via mobile phones by authorised non-banking financial institutions. Hybrid BC is a way of formalizing people' finance through a mobile platform service. Nowadays, both the BC models are put to use as instruments of IT-enabled financial access for unbanked population.

4.3 Transition to IT-Enabled Banking Services: Experiences from South Asia

The eight countries of south Asia belong to a highly diverse landscape for financial inclusion each with a unique modern history of financial systems development (CGAP 2014). It is generally accepted fact that organised financial sector was emerged in this region with the Cooperative Credit Societies Act of 1904. But cooperative system was failure throughout south Asia (World Bank 2006). Seven decades later, Grameen Bank, BRAC and SEWA Bank were played a pioneering role in this transformation process in early 1970s (World Bank 2006). At the time of microfinance revolution in 1970, some of other measures taken by the governments in south Asian countries were nationalization of private banks, endorsing branch regulations, introducing interest rate ceilings on credit to low-income households and dispersion of priority sectors lending at subsidized rates, etc. (Sangmi 2013). In recent past, a

[3]Technically, mobile money is a similar concept of a bank account where fund value is stored in a secure electronic account linked to a mobile phone or a wallet number against the receipt of equivalent fund by the operator. It is an application where a tiny piece of software embedded on a mobile SIM card or over a network. A subscriber having a feature phone or smart phone can send mobile money to the recipient's mobile money account or bank account. Recipient gets a code and instruction on how to realise the money. Recipient can collect physical cash equivalent to this digital value from mobile money retail agent outlet after providing user's identification code or withdrew from bank branch. The mobile money user can buy electronic value directly from retail agent outlet. A mobile money account is protected by financial regulation of respective countries. Every transaction is secured by a secret personal identification number (PIN). That is why user's fund is kept safe even if mobile phone or SIM card is lost or stolen. In this way, money can travel across the globe through a text message. There are two types of mobile money user: first, those who make mobile money transaction from their own mobile handset; secondly, those who are not mobile handset owner; they may transfer money through mobile money retail agent outlet as over the counter transaction (OTC) by paying affordable charges. In OTC model, mobile money agents use their own account for transferring customer fund.

noticeable transition has been taken place in the landscape of financial development in south Asia. A journey started in twentieth century with social banking has been landed over on a platform of branchless banking network in twenty-first century.

In 1970s, the reality was that formal financial institutions were not been successful in reaching to low-income group segment of the society. Grameen Bank in Bangladesh had experimented peer monitoring and group-based approaches of lending. This approach developed microfinance revolution and established the fact that poor are bankable and finance could be utilised for benefit of the poor. Financial inclusion has now been emerged as a global agenda. In order to remove distance barriers and high set-up cost for traditional bank branches in remote areas, banking industry now adopted some innovative measures such as ATM banking, e-banking and business correspondent banking. Internet and mobile phone have opened up a new era of banking which paved a way to offer affordable formal financial services to unbanked population. In India, non-bank entities had been permitted access to the digital payment space in 2006 (e.g., wallet365.com was the first e wallet introduced in 2006). In August, 2015 Reserve Bank of India gave licences to eleven non-bank entities to launch payment banks, which directly provides retail electronic payment services. Over the time, companies like, Paytm Payment Bank, Fino Payment Bank, Aditya Birla Payment Bank and others have launched these services. Payment bank initiative required a platform to serve innumerable unbanked population characterised by high volumes of small value transaction. Mobile network operators (MNO) business models are appropriately align to this attribute. It paved them a way to entered in this domain. At present India's most prominent payment banks MNOs are Airtel Payment Bank, Jio Payment Bank.

In Afghanistan, M-Paisa was the first mobile money service launched by Roshan (a telecom operator) in collaboration with Vodafone Group in November 2008. In Pakistan, Easy paisa mobile financial service was launched by Telenor Pakistan and Tameer Microfinance Bank in October, 2009. In Nepal, Mobile banking was first launch in the name of "Mobile Khata" by a leading commercial bank, namely Laxmi Bank Limited in late 2012. At the same year, eZ Cash mobile financial service was launched by the Central Bank of Sri Lanka. All these initiatives[4] help to change conventional concept of banking and widen the boundaries of financial inclusion. At present, out of 1.8 billion inhabitants in South Asia, 1.3 billion live in India. Almost, 70% of adult population in this region have an account with a financial institutions or mobile money providers (World Bank 2017).

[4]Mobile money is now available in 90 countries, including three quarters of low- and lower-middle-income countries (GSMA 2018). For example, in Kenya, mobile financial services are mainly offered by mobile network operators like M-PESA. Actually, they are non-bank electronic money issuers. Customers' mobile money accounts need not to be linked to an account at a financial institution. Similarly, other significant players are MTN Mobile Money in Ghana, Orange Money in Africa, Paytm in India, bKash in Bangladesh, Mynt in Philippines, Jazz Cash in Pakistan, eZ Cash in Sri Lanka, KHR in Cambodia, GrabPay in most of the south East Asian countries, etc.

4.4 Materials and Methods

The study tried to examine a cross-country evidences on the progress of pure and hybrid BC models among some selected Asian countries based on available secondary data sources. Indicators such as, number of banking correspondent per one lakh adult population and number of banking correspondent per 1000 km^2. for three countries (India, Bangladesh and Pakistan) have been considered as a measure of outreach of IT enabled services by pure banking correspondent with supply side data set available in BBVA research working paper (Cámara et al. 2015). BBVA research group collected data from two different sources. First, countries where official statistics regarding BCs are available; second, for countries without any available official statistics, data has been obtained by conducting own search (BBVA research group) and compile with data which was self-reported by banks and agents. On the other hand, database on Financial Access Survey (IMF) is utilized to identify to usage of mobile money (hybrid BC model). The FAS data is based on administrative data collected by central banks and other financial regulators of respective countries as reported to the IMF. On the usage of mobile money, we have considered four measures such as

- number of mobile money account per one thousand adult population,
- number of mobile money transactions per 1000 adults,
- number of registered mobile money agent outlets per 1000 km^2, and
- number of registered mobile money agent outlets per 100,000 adults.

For the purpose of determining the effect of the socio-economic and infrastructure indictors on the mobile money usage, Panel Data Regression method[5] was used as it helps in dealing with the country specific data (cross sections) spread over time periods. The empirical models can be specified as:

$$\begin{aligned}\text{Mobile\_accounts}_{it} = {} & \alpha + \beta_1\,\text{GDP}_{it} + \beta_2\,\text{Urbanization}_{it} \\ & + \beta_3\,\text{Bank branches}_{it} \\ & + \beta_4\,\text{Mobile subscription} + u_{it}\end{aligned} \tag{4.1}$$

$$\begin{aligned}\text{Mobile\_ transactions}_{it} = {} & \alpha + \beta_1\,\text{GDP}_{it} + \beta_2\,\text{Urbanization}_{it} \\ & + \beta_3\,\text{Bank branches}_{it} \\ & + \beta_4\,\text{Mobile subscription} + u_{it}\end{aligned} \tag{4.2}$$

where $t = 1, 2, 3, \ldots, T$ and $i = 1, 2, 3, \ldots, n$.

In model (4.1) and (4.2), indicators of mobile money usage (Mobile accounts and Mobile transactions) is the dependent variable, α is the intercept term, β are the

[5]Panel data regression analysis avoids the risk of biased results as it can efficiently take care of the heterogeneity of the time series and the cross sections and the panel data regression allows more variability, less collinearity among the variables and more degrees of freedom (Baltagi 2005).

$k \times 1$ vectors of parameters to be estimated, $1 \times k$ number of observations of the independent variables and u_{it} represents the error term. To determine the variables relevant for mobile money usage in a country, we have considered socio-economic and infrastructural variables obtained from World Development Indicators Database (World Bank). We have chosen two socio-economic variables like GDP per capita (constant 2010 US$) and urbanization (% of urban population in the largest city)as well as two infrastructural variables such as commercial bank branches (per 100,000 adults) and mobile cellular subscriptions (per 100 people) for this study. The study hypothesised that all these independent variables may have a positive relationship with mobile money usage.

In the panel data regression framework, three empirical models are available: constant coefficient model (CCM), random effects model (REM) and fixed effect model (FEM). However, it is to be noted that prior to the application of either FEM or REM, it is imperative to know whether the panel data regression framework will be used or the pooled regression; i.e., CCM will be applicable. Therefore, at first, Breusch–Pagan (BP) test was applied to ensure the application of FEM or REM instead of CCM. Secondly, Hausman test was used to ascertain the applicability of either FEM or REM.

4.5 Results and Discussion

4.5.1 Trend of Banking Correspondence Model: South Asian Countries

For the purpose of measuring outreach of formal financial services through pure BC model as highest degree of engagement between unbanked individual and formal financial institution, we focus on two relative indicators as number of pure BC outlets per one lakh adults and per 1000 km^2 in Fig. 4.2a. Only three South Asian countries (India, Bangladesh and Pakistan) are considered due to non-availability of data for other countries in South Asia. The results show that in terms of availability of BC outlets per one lakh adults population, Bangladesh belongs to exceptionally higher outreach category followed at a considerable distance by Pakistan and India. In respect of availability of BC per 1000 km^2. We observed parallel trend maintained by these three countries. In terms of population density,[6] India's (408.4 per km^2) position is next to Bangladesh (1116.6 per km^2) and it is followed by Pakistan (223.1 per km^2). However, number of BCs per one lakh adult population and number of BCs per 1000 km^2 in Pakistan is higher than India by three and half times for first indicator and double for second indicator, respectively. Thus, Pakistan exhibits a satisfactory performance in outreach of formal financial services through pure BC model.

[6] As per World population prospect, 2017.

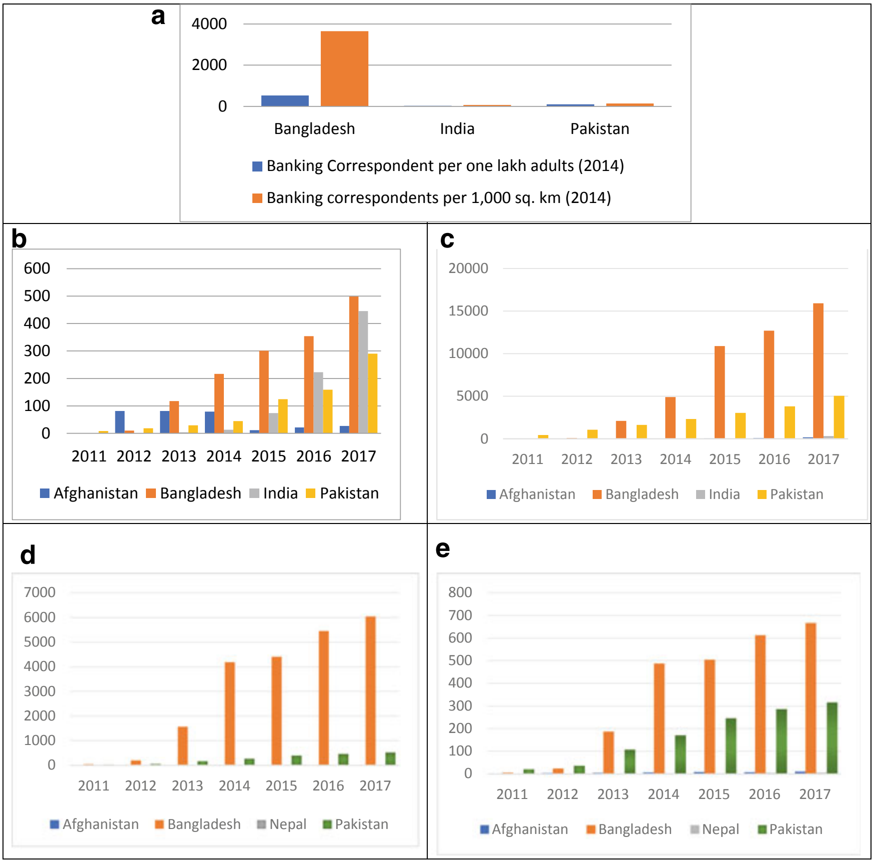

Fig. 4.2 Usage of financial services through BC model in South Asian Countries. **a** Outreach of pure banking correspondent, **b** mobile money accounts: registered per 1000 adults, **c** mobile money transactions: number per 1000 adults, **d** mobile money agent outlets: registered per 1000 km^2, **e** mobile money agent outlets: registered per 100,000 adults. Source: Authors own presentation based on Financial Access Survey database of IMF (2018)

Pure banking correspondent network emerges as a cost-effective channel of outreaching of access to formal financial services. Operating cost of maintaining pure BCs is recovered from customer deposit revenue and borrowings. But in lower income market where customer deposit is scare, pure BC does not work effectively. Since, last decade, this gap is being filled up by mobile money platform. Two-third of the worlds' unbanked population own a mobile device. Mobile money is now available in 90 countries across the world and become a leading money transaction medium of digital economy. For the purpose of service distribution, agents remain the spine of the mobile money industry, as the primary mechanism for digitizing and disbursing cash (GSMA 2017). On the basis of data availability on this hybrid BC model, we have studied growth of mobile money usage in few south Asian countries with four indicators (Fig. 4.2b–e). Registered mobile money account per 1000 adults is a reflection of usage of financial services. In this context, Afghanistan (Fig. 4.2b) shows negative growth for 3 years consecutively since 2013–2015. From 2016, it turns up by 77% positive growth followed by 28% in 2017. In Bangladesh, a massive break through has been taken place right from 2013 and the trend is continuing till 2017. Although, there was a marginal growth in India up to 2014. A quantum jump has been observed from 2015 onwards. Only Pakistan maintains a consistent growth in the account of mobile money registered per 1000 adult.

The usage of financial services can also be measured by frequency of transaction made through a mobile money account (Fig. 4.2c).We have considered this dimension as number of mobile money transaction per 1000 adults. In this context, Bangladesh hold its decent position and the same trend has been maintained by Pakistan and India, as we have seen in pure BC model. Although, since 2013, Afghanistan experienced a marginal positive growth in mobile money transaction in spite of rapid fall down of mobile money account. There is a sharp contrast could be observed if we compare India's position along with other peer countries in terms of registered mobile money account and its usage. Only India is a country where number of registered mobile money account is higher than number of mobile money transaction has been made per 1000 adults. It suggests that adoption of digital financial services (DFS) is still poor in India. During demonetisation[7] period the uptake of DFS and payment banks was augmented by 5% of adults but nearly half (48%) of these did not continued at most after three months. Mobile money active users increase from less than 1% in 2016 to 2% in 2017.[8]

Outreach of formal financial services can be measured by number of mobile money agent outlets registered per 1000 km^2 and per 100,000 adult population. Bangladesh and Pakistan showed (Fig. 4.2d, e) a consistent growth in both parameters. In this respect, Afghanistan has been observed a marginally negative growth (−6.64% in first parameter and −10.21% in second parameter), in the year 2016, rather it maintained a positive growth in both parameters since 2013. There is a downward trend has been observed in Nepal in respect of these two parameters. The growth is slowing down gradually since 2014.

4.5.2 Determinants of Mobile Money Usage

The results of the regression analysis on two linear relationships (as mentioned in the empirical specifications in the methodology section) are presented in Table 4.1. In an unbalanced panel dataset, the results of Breusch–Pagan (BP) test suggest pooled

[7]Demonetisation is a process when existing form of money is pooled from circulation and retired, sometimes replace with new notes or coins (known as remonetisation).On 8 November 2016, Indian Government demonetised all notes having denomination of above Rs. 500 and replaces them with issuance of new currency notes.

[8]Financial Inclusion Insights, wave 5 report fifth annual FII tracker survey, June, 2018.

Table 4.1 The results of the determinants of mobile money usage

Dependent variable	Independent variable	Coefficient (β)	*t*-stat	R^2
Mobile money accounts	GDP per capita	0.4644	3.99^{***}	0.85
	Urbanization	27.8689	5.64^{***}	
	Commercial bank branches	48.7554	3.29^{***}	
	Mobile cellular subscriptions	5.6266	2.84^{**}	
	Constant	−1907.00	-8.18^{***}	
Mobile money transactions	GDP per capita	−7.7926	−1.62	0.72
	Urbanization	267.5971	1.31	
	Commercial bank branches	1142.357	1.87^{**}	
	Mobile cellular subscriptions	337.9839	4.13^{***}	
	Constant	−29,282.66	-3.02^{***}	

Source Author's own calculation
Note *** and **Indicate that the coefficient is significant at the 0.01 and 0.05 level of significance respectively

regression as appropriate. It can be readily seen from the pooled regression result that the regression coefficient (β) of infrastructure variables, viz. commercial bank branches and mobile subscriptions are statistically significant in both the equations. The intuitive explanation of individual relations can be analysed as follows.

It is irrefutable fact that attainment of a higher level of per capita GDP fulfils the basic needs and economic well-being of the society and thereby has a positive impact on secure and convenient usage of mobile money. The coefficient of the variable indicating GDP is found to be positive and statistically significant. It supports the contention that countries with higher per capita income augment the habits of using mobile money account among the people and thereby intensified the process of financial inclusion. The degree of urbanization positively influences the number of registered mobile money account opened. Banking penetration is inevitable in the process of financial inclusion through the development of the secondary and tertiary sectors of the economy. This result is consistent with the study of Sarma and Pais (2008) and Chhikara and Kodan (2011). But these two socio-economic determinants (i.e. GDP and urbanization) do not show any statistically significant result in second equation (mobile money transaction). This implies a higher growth in GDP per capita and urbanization do not influence mobile money transaction. Use of mobile money account in secure and convenient way could increase transaction rate. Lower rate of mobile money transaction in India and Nepal can be explained by legal restrictions like KYC (know your customer) norms, transaction limit, etc.

Another two infrastructural determinants (commercial bank branches and mobile subscriptions) have been emerged as a significant positive influence in determining mobile money usages in both the equations. Subscription of a mobile phone invariably opens up avenues of having a mobile money account and thereby making transaction with it. In other words, the degree of mobile cell subscription influences the opening and usage of mobile money account. In the last couple of years commercial bank has been providing mobile money services in south Asian countries. As the number of commercial bank branches increases the likelihood of using this service is also higher.

4.6 Conclusions

This study sheds some lights on the progress of outsourcing of banking services through branchless BC model across South Asian countries. In addition, determinants of cross-country variation in the use of mobile money services in South Asia are a special interest of the paper. Empirical evidence suggests that pure BC model plays an important role in outsourcing of financial services by mainstream financial institutions. The pervasiveness of non-cash transaction through electronic mode is the outcome of lower level of market entry cost and affordable maintenance cost of having a mobile money account. Countries in South Asia, which are successfully implemented pure BC model, have been maintaining almost same trend in hybrid model also. Higher growth of GDP coupled with urbanization has a positive impact on outreach of financial services through open up mobile money account only (not mobile money transactions). Similarly, commercial bank branches and mobile cellular subscription are other determining factors influencing usage of mobile money transactions. More importantly, South Asia's most thriving mobile ecosystem would be a means of augmenting access to formal financial services and promote greater financial inclusion.

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Chapter 5
India's Software Export and External Factors

Hiranya Lahiri

5.1 Introduction

India's software exports have posted stellar performance over the past two decades. India's Information Technology (IT) industry consists of hardware, training, communications and software, of which, software is a major component of this industry. The software industry has been a major source of foreign earnings for the country. India's software exports find destinations in more than 100 countries of the world, among which USA, UK and EURO are the major destinations. India's software export comprises of almost 40% of India's total service exports.

Customized software development and software consultancy services are the major components of India's software exports. These exports require good technical skills and competencies in which India has an advantage in the world. India focuses primarily in the export of customized products, as it is a high-value but low-volume-based product, and hence, it becomes easier for domestic firms to reap foreign exchange, compared to export of packaged software which is quite the opposite in nature (IIEM 2019).

The reason why India excels in the export of software in the world market is attributable to low cost but high-quality software development, which in turn has been made possible by the availability of trained and qualified software professionals. Lower costs of manpower training and employment due to a large supply of IT-trained-English-educated professionals, as well as availability of cost-effective business infrastructure due to plethora of government initiatives (like development of Software Technology Parks, Export-Oriented Units, tax holidays, subsidies of various kinds, development of ITI/IIT, mushrooming of management/engineering institutes, etc.) have turned out to be advantageous for the development of global

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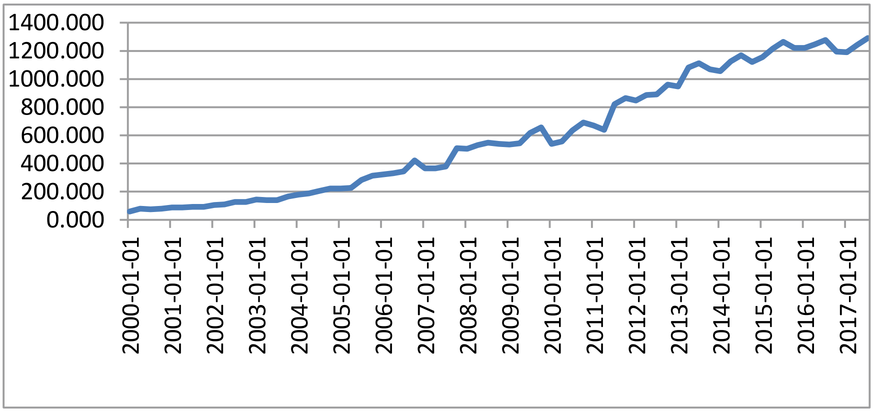

Source: RBI

Fig. 5.1 India's software export (in Rs. billion)

quality software-hubs in India, at a much lower cost than in OECD countries. This explains why India has a comparative advantage in software export.

Software exports can take place through either of the following channels: through packaged channels (like CD/USB ports/courier, etc.) or through communication channels (like mobile communications or Internet). In either case, software professionals can satisfy clients' need by working from any office in India, and sending the desired codes/software through CD/courier, or through communication channel. This is the most popular channel, often referred to as off-site export channel.

On-site export channel or body-shopping channel takes place when software professionals are sent abroad in person to satisfy clients' need. This channel is called on-site as the software is developed by Indian workers of foreign soil, which is on-site. The former is called off-site as the software is developed first on Indian soil and is then exported to the destination country.

Figure 5.1 shows the stupendous rise in software export in India from 2000Q1 to 2017Q3. From fetching meager Rs. 59.05 billion export revenue in 2000Q1, the amount of export revenue fetched by software export in 2017Q3 stands at Rs. 1291.05 billion. As a percent of GDP, the share of software export rose from a scanty 0.85% in 2000Q1 to 6.34% in 2015Q3, and thereafter, it fell marginally to 5.63% by 2017Q3. In fact, the declining trend can be observed from 2013Q3 onwards.

Against this backdrop, the present chapter tries to assess the macroeconomic effects of some of the external factors like exchange rate, foreign price, world GDP and oil price on software export of the country. That is, the aim of the present study is to trace out those macroeconomic factors that have contributed to this phenomenal performance of software export of the nation. The rest of the chapter is arranged as follows. Section 5.2 deals with a brief literature review. Section 5.3 outlines the objectives of the current endeavor and comments on the methodology used. Section 5.4 analyses the major macroeconomic factors that explain India's software export. Section 5.5 compares software export with non-software export in light of these external factors. Finally, Sect. 5.6 concludes the paper.

5.2 Brief Review of Existing Literature

A list of studies in the related area is addressed here. According to Balakrishnan (2006), the competitiveness of India's software industry has been developed in two stages. The first stage was long-term investment in technical education, and science and technology by the policy makers. Subsequently, the second stage was targeting an incipient software industry with recognizably high export potential, via fiscal incentives and the provision of export-promoting infrastructure (like STPs, EOUs, etc.). This has led to high supply of labor at a low cost. Kattuman and Iyer (2001), on the other hand, opine that the burgeoning of software production and export is not attributable to low cost of labor, but is an outcome of 'benign neglect.' The authors also contend that the development of software industry primarily focuses on low-end products with limited development in infrastructure. In tandem, Dossani and Panagariya (2005), opine that the bulk of the work done by the Indian IT industry is in low-value-added and relatively low-skilled products, which is likely a result of protection in the early days. Joseph and Harilal (2001) concludes that to combat some of the negative offshoots of the current export-centric IT scenario and to make software export a durable export item of the country, a proper incentive structure needs to be developed and the supply of technically skilled personnel should be enhanced. Most importantly, the diffusion of IT into other areas of the economy should be accelerated to help in the sustained growth of the sector. Sen (1995) calls for providing greater supply of educational institutes that will maintain the supply of low-cost but skilled professionals, along with expansion of international high-speed datacom facilities. Maintaining track records by Indian IT companies and improving international connectivity are other suggestions given by the author. In contrast, Vaze (2002) contradicts the view that the mushrooming of skilled professionals has helped India transform into a major hub of software export, as the gap between industry requirements and what is taught in the universities/engineering schools continues to exist. Kite (2013) advocates that in order to fully reap the potential of software export, it is pertinent for domestic firms to share secrets of technology, acquired over the years.

Narsimham (1996) notes in his critical analysis of Heek's book on Indian IT industry (1996), that India's software industry burgeoned primarily to cater the needs of foreign demand. Further, he contends that out of top 25 firms producing software, 15 firms earned less than 20% of their income from domestic sales. Patilbandha et al. (2000), however, opine that India's software industry developed due to import substitution strategy. Free trade with technologically advanced economies, especially with the USA, from the initial stages of the birth of India's software industry provided scope for realization of technological and informational externalities.

Few studies go on to assess structure and nature of India's software industry. Chakraborty and Dutta (2002) contend that foreign participation in terms of joint venture or subsidiary organization still remains limited in the Indian software industry. The industry is represented mainly by the private domestic limited companies. Also, a majority of these firms are engaged in contractual programming and designing activities. Though large in number, most of the programming and designing related firms are small in terms of both their size of assets and level of earning. In another paper, Chakraborty and Jayachandran (2001) found evidence that Indian software industry lacks diversification in types of export and relies mainly on software service exports. Tharakan et al. (2005) have used a gravity based model to examine the determinants of software export. They find that both knowledge of the English language and the ability to tap into network connections are important determinants of the Indian exports of software. Distance however has no effect on software export, unlike total exports. However, their study overlooks the impact of other major macroeconomic variables like inflation, world GDP, foreign price and oil price.

Thus, it seems that the erstwhile studies look at structure, nature, constraints and government initiatives in the determination of India's software exports, and largely neglects external factors that determine software export; like exchange rate, foreign price, world GDP and oil price. The objective of this chapter is to fill this lacuna.

5.3 Objectives and Methodology

As pointed out in the previous section, the existing literature does not focus on isolating the macroeconomic factors, particularly those emanating from the demand side, that play a crucial role in determining India's software export. Against this background, the major research questions that this chapter tries to analyze are:

a. What are internal/external macroeconomic variable that affect India's software export?
b. What are internal/external macroeconomic variable that affect India's non-software export?
c. Which of the two exports are more exposed to external shocks?

The appropriate framework to conduct such a study is Vector Autoregression (VAR) analysis. In order to conduct a VAR, the first step is to identify the factors that can plausibly explain India's software export. The second step is to identify the nature of series (that is, whether these various factors are I(0) (level stationary) or I(1) (difference stationary). After identifying the nature of series, all the I(1) variables are first differenced to arrive at I(0) variables, so that VAR can be applied. And, finally, the last step is to conduct the regression exercise where each variable is taken in its stationary form. In this context, it can be mentioned that ARDL framework is another possible methodology to deal with the problem. However, as we are interested in short-run behavior and all the variables used for regression are converted to I(0), we use VAR framework.

5.4 Vulnerability of India's Software Export to Internal and External Factors

Software export depends on a host of factors. Undoubtedly, some of these factors are endogenous factors, while others are exogenous. The first important endogenous variable that affects any export of a nation is undoubtedly its GDP. GDP of a nation affects export through the capital flow channel, which is the major determinant of India's exchange rate. A rise in GDP tends to improve investment opportunities in the host country (as net worth of firms rise, asset quality improves and external finance premium falls, thereby raising return from investment), which therefore lures foreign capital, leading to exchange rate appreciation and crowding out of export. Stronger this channel, higher would be the fall in export, due to a rise in GDP. To illustrate an evidence of this inverse relation in the Indian context, consider the five-year period of high growth rate, from 2003–04 to 2007–08, where average growth was 8.76% and average value of REER was 101.67. However, during the recessionary years of 2011–12 to 2013–14, average growth rate for these three years was 5.3%, while REER posted an average value of 109.83. Thus, in the Indian context, we expect an inverse relation between GDP and exchange rate. As a result, a rise in GDP is likely to reduce software export, through exchange rate appreciation. It must be noted that in the Indian case, the second effect dominates the former effect.

The next endogenous variable that must be factored in is obviously the price level. A rise in the price of the exportable will lead to a decline in foreign demand for domestic goods, leading to an export squeeze. We use CPI-IW instead of other measures of CPI that give more emphasis on rural price level, as majority of software hubs of the country are located in metropolis cities like Bangalore, Hyderabad, Delhi, NCR, Kolkatta, Chennai, etc. Hence, CPI-IW seems to be more appropriate index of price.

Next, we go on to specify the external or exogenous factors, over which India barely has any control, but these factors play an immense role in determining software (and also non-software) exports. The first important variable in such a category is world GDP. A rise in world GDP will lead to an increase in import demand, and India's export supply will rise. In the current context, we however, consider GDPs of only USA, UK and EURO, which are India's major destinations of software export. As per Ministry of Electronics and Information Technology (2016–17) data, 90% of India's software export finds destination in these three areas.

Another important exogenous factor that affects India's export (overall) is oil price. India is crucially dependent on oil import for its domestic production and investment. Moreover, oil is an important intermediate input. India's import is highly oil-inelastic, and a rise in oil price depreciates the currency, and hence is expected to provide a boost to software export.

Lastly, for the purpose of comparison with non-software export, it is instructive to incorporate oil price as an exogenous regressor. If the beta-coefficient of oil price turns out to be positive/negative and significant, it would signify that a rise in oil price tends to propel/crowd out software exports. If, however, it turns out to be insignificant, it would imply that oil price has no possible effect on software export.

Foreign price level is the next important exogenous variable that plays a major role in determining exports of any nation. A rise in foreign price level will raise India's software (and non-software) export supply. However, for the purpose of brevity and due to the fact that 60% of software export reaches destination in USA, and further, that 73% of foreign exchange earnings from software export is comprised of dollar, we proxy world inflation (foreign price) data by US CPI data.

Finally, the last important variable that must be factored in as an exogenous variable is undoubtedly the exchange rate. A rise in exchange rate will propel software (and non-software) exports by making domestic goods cheaper. Therefore, it is immensely important to incorporate exchange rate as a regressor in VAR exercise. In the present context, we consider rupee–dollar nominal exchange rate, instead of NEER, as more than 60% of India's software export lands in USA. Also, almost 73% of currency composition of India's software export is comprised of dollars (as per the Reserve Bank's Annual Survey on Computer Software and Information Technology Enabled Services Exports (2016–17) Report). Following our earlier research, we consider rupee and dollar exchange rate to be an exogenous variable (see Lahiri 2012; Lahiri et al. 2015, 2016 for detailed discussions).

The data on India's software export, GDP, CPI, exchange rate are all obtained from RBI website. World GDP, in this article, is an index, which is obtained by multiplying the GDPs of the areas (data source, IMF) by their software-export shares. Oil price data is procured from US-EIA website. Lastly, US Bureau of Labor Statistics website is the source of US CPI data.

We focus on quarterly data in our analysis, as monthly data for most of these series is absent and availability of annual data is too scarce to conduct a time-series analysis. The sample ranges from 2000Q1 to 2017Q3. The series that we consider are all I(1), barring US CPI which is I(0).

Finally, we are now in a position to run VAR regression and analyze the effects of the afore-mentioned variables on India's software export–GDP ratio. Instead of regressing software export on the various regressors, we use software export–GDP ratio as the explained variable, to nullify the volume (growth) effect on both; software export and GDP, over time. It must be noted that despite considering this ratio, software export–GDP ratio turns out to be I(1) instead of I(0). We run two regressions of software export–GDP ratio, including and excluding GDP as an explanatory variable. This is because, in Model A, where we regress software export–GDP ratio on GDP and other factors, inclusion of GDP as an explanatory variable might lead to some misleading inferences. Thus, in Model B, we omit GDP as an explanatory variable to check if the modified regression alters our conclusion or throws any additional light. However, as GDP is an important explanatory variable, it is necessary to run Model A initially (See Table 5.1 in the Appendix).

From Model A, it can be inferred that GDP barely affects software export–GDP ratio. However, the coefficients of GDP (at lag 1 and 4) are undoubtedly negative (through very close to zero), supporting our conjecture, but are significant at 5% and 10% levels of significance, at lag 1 and 4, respectively. This further prompts us to check Model B, which excludes GDP as an explanatory factor. Domestic price level, as expected impacts software export–GDP ratio adversely, but with some lags. In Model A, CPI impacts software export–GDP ratio adversely with a lag of two periods, but it is significant at 1% level of significance. Though CPI at fourth lag is significant at 5% level, contrary to economic rationale, the coefficient turns out to be positive. This might be an outcome of specification problem or due to seasonal factors. However, in Model B, CPI once again impacts software export–GDP ratio with a two-period lag, but this time the level of significance drops down to 5%. But what is interesting to discern is that the beta coefficients of CPI in the two models are almost identical, −0.0131 and −0.0121, respectively. Hence, we may conclude that a unit rise in CPI reduces software export–GDP ratio by around 0.01 units. Therefore, even though GDP may not be an important explanatory factor, domestic inflation undoubtedly reduces software export–GDP ratio by a significant amount. The detailed results are available with the author on request.

If we turn to the external factors, the results that we get are almost identical between the two models. Focus on the exchange rate first. At 5% and 1% levels of significance, it is suggestive that a one-unit rise in exchange rate would lead to 0.094 units rise in software export–GDP ratio in Model A and 0.11 units rise in software export–GDP ratio in Model B. This result is also along the expected lines. World GDP, on the other hand, has no explanatory power in either of the two models. Same conclusion can be drawn for US CPI, which at 10% level of significance has a beta coefficient (0.001) barely distinct from zero in Model A and is insignificant in Model B.

The real interesting picture is portrayed by oil price in the two models. In Model A, oil price plays no role in determining software export–GDP ratio, but has quite a significant effect (at 5% level of significance) in Model B, where a unit rise in oil price increases software export–GDP ratio by 0.011 units. A priori, it seems that this difference in outcome is plausibly due to specification difference. However, if we delve deep, we find that it is indeed not the case, as oil price affects software export through the possible indirect channel discussed before. If we further probe into the role of oil price as an important determinant of software export–GDP ratio, we can discern that they are indeed positively linked. Let us dive into the details.

We now go on to measure elasticity of software export–GDP ratio to various regressors. This analysis can be conducted by using log-linear forms of Models A and B. The beta-coefficients measure the respective elasticities with respect to the regressors. Moreover, since, the variables are taken at their first-difference level, the beta coefficients can also be interpreted as acceleration or deceleration in growth rate of software export–GDP ratio with respect to change in the growth rate of the exogenous variables. Price elasticity (negative) of software export–GDP ratio hovers between 2.5 and 2.8, while exchange rate elasticity (positive) ranges between 0.5 and 0.8. Oil price elasticity on the other hand is estimated at 0.14 in both the models. Needless to say, even in log-linear models, foreign price and world GDP impose insignificant elasticities (even at 10% level of significance) to software export–GDP ratio, in tandem with Models A and B. Though the Models A and B are not comparable with their log-linear counterparts; since the latter measures acceleration and deceleration in growth rate of software export–GDP ratio due to acceleration and deceleration in the growth in exogenous variables; while the former measures the effects of absolute changes in the regressors, yet, it can be concluded that endogenous variable (CPI) and exogenous variables (exchange rate and oil price) impart considerable influences on software export–GDP ratio, in whichever form of model we consider. Moreover, the significant regressors in Models A and B, and their log-linear counterpart are also the same. However, the magnitudes of rise or fall in software export–GDP ratio are less in comparison with rise or fall in non-software export–GDP ratio, as we shall shortly discern in the next section.

5.5 External Factors and Non-software–Export–GDP Ratio and Comparison with Software Export–GDP Ratio

At this juncture, it might be insightful to compare the effects of the endogenous and external factors on software export–GDP ratio and non-software–exports–GDP ratio, and assess, which of the two is more prone to external shocks. This research question demands slight modification of the baseline models as outlined before. For a better picture on non-software export–GDP ratio, it is important to first decipher the major exportables of India, apart from software exports. The major exportables of the nation are refined petroleum, gems and jewelleries, medicaments and automobiles (as per 2016 data). The list is indicative of the fact that India's exports are highly import-intensive. This once again, justifies the inclusion of oil price as a regressor in the VAR analysis. Moreover, one structural constraint that India faces emanates from the agricultural sector, which is highly dependent on rainfall. Years of drought and excessive rainfall leads to a decline in farm-output, which raises food price. As primary products are used as intermediate goods in the manufacture and export of secondary and tertiary sector-goods, it becomes necessary to include food price as a separate regressor to explain non-software exports of the country. Food price is considered an exogenous variable, unlike CPI, due to the fact that farm output is dependent on rainfall, which is an external factor.

In line with Model A and Model B, we construct Models C and D, respectively, for regression of non-software export–GDP ratio, where we include and exclude GDP as an endogenous variable in VAR analysis. Though significant at 5% level, GDP in Model C is once again having very low explanatory power. Its magnitude is only -0.00055. This justifies the incorporation of Model D in our analysis. CPI has no explanatory power in Model C, but is a significant (at 5% level of significance) regressor in Model D. Unit rise in CPI leads in non-software export–GDP ratio by a significant amount of 0.025. Hence, it would not be incorrect to conclude that CPI is an important endogenous variable that determines non-software exports. Beta-coefficient of food inflation is very similar in magnitude (-0.017 and -0.016) in both the models and is significant at 5% level of significance. Exchange rate too, follows this trait, registering figures at 0.314 and 0.379, respectively. But their levels of significance vary between the two models: 5% in Model C and 1% in Model D. Unit rise in oil price leads to an increase in non-software export–GDP ratio by an amount of 0.055 and 0.058 in the two models at 1% level of significance, indicating a real-balance effect. Also, an increase in foreign price level, proxied by US CPI, propels non-software export–GDP ratio by 0.004 (at 10% level of significance) in Model C only.

Though significant at 5% and 10% levels of significance, respectively, in Models C and D, the magnitude of rise in non-software–GDP ratio due to a rise in world GDP is hardly different from zero (assuming the values 0.00000175 and 0.00000124, respectively, in Models C and D). Thus, we can conclude that world GDP, has very poor explanatory power in explaining non-software export–GDP ratio. One word of caution is that, world GDP in this section has been proxied by GDPs of USA, UK and EURO only, to compare with the regression results of Models A and B (with weights unchanged). Thus, it omits GDPs of other nations (like UAE, China and others), who are other major export partners of India. If we had encapsulated GDPs of all OECD/G-20 countries, we might have witnessed a direct significant relation between world GDP and India's non-software exports–GDP ratio. This result can be interpreted only in the limiting way that the GDPs of these three nations barely affect India's non-software exports.

Hence, from this analysis, we can conclude that most of the external factors; viz exchange rate, oil price, foreign price are significant exogenous factors in explaining non-software export–GDP ratio. From the preceding analysis, we see that foreign price is the only additional important factor that explains non-software export–GDP ratio, which has no explanatory power in software–GDP ratio.

We can further decipher that the external factors have a more pronounced effect on non-software export–GDP ratio than on software export–GDP ratio. As is evident, a unit rise in exchange rate leads to a greater rise in non-software export–GDP ratio than on software export–GDP ratio, almost thrice in magnitude. Hence, with regard to exchange rate, software exports show greater stability than non-software exports. Similarly, oil price rise leads to almost five times improvement in non-software export–GDP ratio due to a unit rise in oil price, compared to software–GDP ratio. Same conclusion can be drawn for changes in foreign price too.

In other words, exchange rate, oil price, foreign price lead to greater changes in non-software export–GDP ratio, and thus, software export–GDP ratio is more stable to external vulnerability. Therefore, it can be concluded that in years of high inflation, or global slump, software export is expected to show lesser variability than non-software export.

5.6 Conclusion and Future Scope of Research

We may therefore, conclude that among the internal factors, CPI, and among the external factors, exchange rate and oil price play the most important roles in determining software export–GDP ratio of India, while world GDP and foreign price barely have any impact. On the other hand, exchange rate, oil price, foreign price and CPI play significant roles in explaining non-software exports of India. Also, elasticities with respect to exchange rate and oil price are significant too. Finally, we conclude that software exports show lesser variability compared to non-software exports.

It must be noted that the factors that have been analyzed in the models are clearly demand-side factors. A major lacuna of this article (due to time and infrastructural constraint) is that it neglects the supply side factors like wage rate, skill, productivity. However, for the incorporation of these factors, it is necessary to conduct sample surveys of firms, and deal with panel data. Since these demand-side factors will remain invariant among firms in such a panel analysis, the regression using the supply-side factors will not be feasible, unless the demand-side factors are ruled out from the analysis. A simultaneous equation model may be carved out dealing with both the supply-side and demand-side factors that vary across firms, whose possibility can be reserved as future research endeavor. For the present context, it suffices to consider only the demand side factors, which is the thrust area of the present paper, and constraint ourselves within the macro-framework, rather than focusing on the micro- (firm-level) framework. The limitation can be treated as a future scope of the study.

Appendix

Table 5.1 Model specification and regression results[a]

Model A		Model B	
	DSOFTWARE−EXPORT/GDP		DSOFTWARE-EXPORT/GDP
DSOFT/GDP (−1)	−0.5666	DSOFT/GDP(−1)	−0.5204
	[−2.82]		[−3.09]
DSOFT/GDP(-2)	−0.0540	DSOFT/GDP(−2)	−0.3453
	[−0.28]		[−2.58]
DSOFT/GDP(−3)	−0.0431	DSOFT/GDP(−3)	−0.2710
	[−0.22]		[−2.06]
DSOFT/GDP(−4)	−0.0695	DCPIGEN(−1)	−0.0033
	[−0.38]		[−0.66]
DGDP(−1)	−0.0002	DCPIGEN(−2)	−0.0121
	[−1.70]		[−2.38]
DGDP(−2)	0.0000	DCPIGEN(−3)	−0.0007
	[−0.43]		[−0.13]
DGDP(−3)	0.0001	DRUPEEDOLLAR	0.1167
	[0.75]		[2.73]
DGDP(−4)	−0.0002	DOILPRICE	0.0111
	[−1.54]		[2.19]
DCPIGEN(−1)	−0.0062	DWORLDGDP	0.0000
	[−1.16]		[-0.46]
DCPIGEN(-2)	-0.0131	USCPI	-0.0001
	[−2.61]		[-0.20]

(continued)

Table 5.1 (continued)

Model A		Model B	
	DSOFTWARE−EXPORT/GDP		DSOFTWARE-EXPORT/GDP
DCPIGEN(-3)	0.0012		
	[0.20]		
DCPIGEN(−4)	0.0102		
	[1.85]		
DRUPEEDOLLAR	0.0938		
	[2.24]		
DOILPRICE	0.0050		
	[0.91]		
DWORLDGDP	0.0000		
	[−0.08]		
USCPI	0.0010		
	[1.26]		
R-squared	0.6029	*R*-squared	0.4618
Adj. *R*-squared	0.4733	Adj. *R*-squared	0.3656

Model C		Model D	
	DNON−SOFTWARE EXPORT/GDP		DNON−SOFTWARE EXPORT/GDP
DNONSOFT/GDP(−1)	−0.3177	DNONSOFT/GDP(−1)	−0.3491
	[−2.75]		[−3.67]
DNONSOFT/GDP(−2)	−0.0956	DNONSOFT/GDP(−2)	−0.2432
	[−0.85]		[−2.36]
DGDP(−1)	−0.0006	DNONSOFT/GDP(−3)	−0.4296

(continued)

Table 5.1 (continued)

Model C		Model D	
	DNON−SOFTWARE EXPORT/GDP		DNON−SOFTWARE EXPORT/GDP
	[−2.50]		[−4.56]
DGDP(−2)	0.0003	DCPIGEN(−1)	−0.0094
	[1.11]		[−0.65]
DCPIGEN(−1)	−0.0080	DCPIGEN(−2)	0.0038
	[−0.47]		[0.24]
DCPIGEN(−2)	0.0144	DCPIGEN(−3)	−0.0245
	[0.87]		[−1.68]
DCPI_FOOD	−0.0179	DCPI_FOOD	−0.0164
	[−1.92]		[−1.90]
DRUPEEDOLLAR	0.3147	DRUPEEDOLLAR	0.3791
	[2.50]		[3.52]
DOILPRICE	0.0550	DOILPRICE	0.0577
	[3.17]		[3.78]
DWORLDGDP	0.0000	DWORLDGDP	0.0000
	[1.67]		[1.34]
USCPI	0.0040	USCPI	0.0013
	[1.40]		[0.55]
R-squared	0.4598	*R*-squared	0.5634
Adj. *R*-squared	0.3537	Adj. *R*-squared	0.4761

[a] *t* statistics at 10%, 5% and 1% level of significance are 1.24, 1.66 and 2.66 respectively
Here, *D* denotes first difference of the variable concerned
Source: Author's Calculations

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Chapter 6
Impact of Information and Communication Technology on Foreign Direct Investment: A Study on Selected Developing Economies

Abhijit Bhattacharya

List of Abbreviations

AR(1)	Autoregressive of Order 1
AR(2)	Autoregressive of Order 2
AREAER	Exchange Arrangements and Exchange Restrictions
CRISDUM	Crisis Dummy
DSL	Digital Subscriber Line
EXCHRVL	Exchange Rate Variability
FBS	Fixed Broadband Subscriptions
FDI	Foreign Direct Investment
FINDEV	Financial Development
FTS	Fixed Telephone Subscriptions
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
GOV	Governance
ICT	Information and Communication Technology
INFVL	Inflation Variability
INTU	Internet Use
IP	Internet Protocol
IPI	Investment Promotion Intermediaries
ISDN	Integrated Services Digital Network
IWL	Industrial Wages
KAOPEN	Capital account Openness
LIBOR	London Interbank Offered Rate
MCS	Mobile Cellular Subscriptions

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NFDII	Foreign Direct Investment, Net Inflows
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
OPENNESS	Trade Openness
PCGDPGR	GDP Per Capita Growth Rate
POLSTAB	Political Stability and Absence of Violence/Terrorism
PSTN	Public Switched Telephone Network
TCP	Transmission Control Protocol
TV	Television
USB	Universal Serial Bus
VoIP	Voice-Over-IP
WG	Within Group
WiMAX	Worldwide Interoperability for Microwave Access
WLL	Wireless Local Loop

6.1 Introduction

In the globalized world, information and communication technology (ICT) has gained huge importance and considered as one of the key drivers of economic growth through its influence on foreign direct investment. The world is reshaping from resource-based economy to knowledge-based economy after rapid growth of ICT. Since developed countries globalized much earlier than developing countries, so it is assumed that development of ICT in the developing economies is lagging behind from the developed economies. ICT can be considered as a sunshade that incorporates any type of communication tool such as radio, TV (television), mobile phones, computer hardware, network hardware, and systems of satellite communications and also various services and appliance with them such as video conferencing and distance learning (Akarowhe 2017). In an alternative way, ICT is taken as a composite variable defined by indicators, such as density of Internet hosts, number of computer machines, number of experts who are skilled in information—communications, telephones (landline and mobile), fax machines, television sets, newspaper subscribers, etc.

Foreign direct investment (FDI) is expected to stimulate the process of growth and development of a country by creating huge employment opportunity, facilitating technology transfer, and thus, enhancing productivity in the post globalization period. So, attracting FDI has become an important objective of the countries. Besides policies, inflows of FDI to a country depend on a number of factors like economic, institutional, political factors, and in the post globalized period, ICT also has considered as an important factor in determining FDI. Developing economies are on the path of development process but are not yet transformed into developed economies.

Developing economies in the world have been building their economies mostly by the infrastructure. Improvement of infrastructure includes import of technology and management expertise, and this requires substantial financial commitments. For this, inward foreign direct investment can be a crucial potential source of capital for developing economies as FDI usually entails import of financial and human capital by the host economy with measurable and positive spill over impacts on host economies productivity levels (Holland and Pain 1998). Besides, FDI has several positive effects on employment, transfer of technology, and consequently, on the development and economic growth of the host country.

World Development Report (2005) cited, "A good investment climate provides opportunities and incentives for firms—from micro-enterprises to multinationals—to invest productively, create jobs, and expand." Various factors such as "policy uncertainty, macroeconomic instability, corruption, cost and access to finance, crime, regulation and tax administration, courts and legal system, electricity, labor regulations, transportation, access to land and telecommunications, affect investment climates" (World Development Report 2005). Whereas, along with other traditional factors, ICT is regarded as an important tool that affects FDI mainly for developed economies.

Improved ICT can spur FDI in a number of ways. A crucial component of ICT is Internet. Internet is likely to have a highly significant impact on productivity over the next few years. According to Wadhwani (2000), among the factors which affect productivity growth, Internet is a crucial factors which should be considered. Internet can improve productivity in several ways. The Internet can able to lower search costs, entry costs. This results greater market competition and productivity can be improved by intensified competition (Choi 2003). The use of Internet can reduce the cost of holding inventories by permitting large suppliers to contact customers directly and thus ignores retailers (DePrince and Ford 1999). Thus, productivity rises (McGukin and Stiroh 1998; Sichel 1999; Temple 2000). At last, Internet usage makes a country comfortable to do business by improving the transparency of the host countries (Choi 2003). It leads the economy more efficient, and in this way, indirectly productivity improved. So, it is obvious that international direct investors may prefer to invest in a country where ICT is well developed. Few recent works have shown ICT diffusion is positively related to FDI (Shirazi et al. 2010; Yazdan and Hossein 2013). Increases in ICT investments have impact on "horizontal FDI" (Heshmati and Addison 2003). Some studies (Addison and Heshmati 2004; Gholami et al. 2006) are focusing the causal relationship between ICT and FDI.

The aim of the present chapter is to examine the relationship between FDI and ICT for developing economies. We have taken 41 developing economies of the world and have tried to find out the impact of ICT on FDI on the selected countries during 2002–2011.

6.2 Review of Some Existing Works

Most of the literature we have found deals with the impact of ICT on FDI are based on developed countries. Since data for developed economies are mostly available as well as there is a strong theoretical justification of positive relationship between ICT and FDI, a large number works have done which are based on developed economies.

Choi (2003) has studied the impact of Internet on the inward FDI volume. Assumption is that by improving productivity, Internet can promote more FDI. Bilateral FDI data from 14 source countries and 53 host countries are taken. Finally, cross-country regressions based on Gravity FDI equation are performed. Ordinary least-squares(OLS) and weighted least-squares (WLS) regressions show that FDI inflows rise by greater than 2% when in a host country , the Internet hosts or users (numbers) rise by 10%.

Gani and Sharma (2003) have done cross-country analysis for the period of 1994 to 1998 and estimated a fixed effects model. The paper wanted to judge the proposition that for high income countries, the level of achievement of technology and diffusion is an assessing factor for inviting foreign direct investment. The result strongly shows that major pull factors of FDI are diffusion of new ICT instruments (such as cell phones and Internet hosts) and also shows that other important determinants are robust economic environment, low cost (per unit), and high degree of openness. To put up reforms which give weight on generation and spreading of ideas and products and to keep a high degree of openness to new investors, mostly ICT was the main policy suggestion for countries which are lagging in terms of attracting foreign investment.

To find out the determinants of FDI, Addison and Heshmati (2004) used a large sample of countries, and result suggests that ICT increases inflows of FDI to developing countries. The reason behind this in poorer countries mainly, ICT drops transaction costs and production costs of international investors and betters their entrance to information on different favorable investment circumstances.

According to Ko (2007), when new Internet users are added, they add value to the value of other users. It is positive network externality. It reduces per user cost of the network since more user shares the cost. Moreover, a larger base of customers and suppliers is formed since extra users are now connected to the network. When increasing number of users augment strain on the subsisting connections, it causes Internet congestion. It is negative network externality. Based on the panel data regressions and the system general method of moments, estimator Ko (2007) empirically finds that negative network externalities create discouragement of inward foreign direct investment in developing countries, whereas positive network externalities invites more FDI in case of developed countries. Further, positive network externality is more effective compared to negative network externality in shortening distance effect of foreign direct investment. The paper also found that Internet development possibly lessen primary intentness of FDI but not likely to the opposite the self-reinforcing procedure of foreign direct investment. Economou (2008) explained How ICT can be used in FDI promotion tool. These are (i) ICT acts as a determinant of FDI, (ii) ICT effects on other FDI determinants (iii) ICT reduces distance effects and (iv) right information and communication technology infrastructure can assist to maximize the absorption of spillovers and linkages that emerges from FDI. Now, ICT can play a key role in investment promotion worldwide. Through fast time management, the information and communication technology has made positive effect on productivity and on foreign direct investment by shortening time gap between demand and production and has made straight and uninterrupted link between producers and consumers.

Fakher (2016) has found the effect of information and communication technology investments on economic development through its impact on foreign direct investment. The paper finds the impact of investments in ICT on FDI in Egypt for the time span 1995–2013. The result shows that there is an insignificant positive relationship between ICT investments and FDI. Additionally, the industrial wages (IWL) and good governance (GOV) may play a crucial role along with the traditional determinants of FDI. According to the author, the findings can be associated to the frailty of the ICT infrastructure of the country. Finally, the paper suggests the requirement of more improvement in the ICT sector in Egypt and also need for rise of investment in ICT.

Technology, based on Internet, has become now a crucial factor for gathering worldwide information. To find out best opportunities and also location, the investors trust on ICT for gathering information. Multilateral investment guarantee agency (MIGA) is a famous cheaper online service. MIGA offers all types of technical assistance for investors, and thus, MIGA is specialized in promoting FDI. For attracting FDI for all countries especially in developing countries, it plays a crucial role. Nowadays, investment promotion intermediaries (IPSs) use the significant and innovation tools are concerned in (i) marketing plan offering, (ii) programs for aftercare, (iii) disseminating information, (iv) internet researching, (v) contacting relevant agencies and (vi) assessing investment promotion campaigns (Fakher 2016).

Lot of studies already have already done on ICT and FDI since post globalization witnessed a huge foreign investment inflows as well as growing importance of ICT. Still in this chapter, we have used advanced econometric tool panel dynamic GMM to examine the determinants of FDI mainly the impact of ICT for selected developing countries.

6.3 Data and Methodology

To find out the impact of ICT on FDI, we have taken 41 developing countries consist of middle income and low income countries during 2002–2011. Our empirical study is based on developing countries because most of the works done only by taking developed economies. There exists a dilemma among the researchers about the actual impact of ICT on FDI for developing economies since developing countries are globalized much latter than developed countries, and for this reason, the proper ICT still not developed in some countries. So, whether the impact of ICT on FDI in developing countries will be positive or negative is a burning question among the researchers.

We have selected countries according to their level of income. World Bank classifies countries into four income levels according to their GNI per capita and also into eight regions. Sampling of countries has been done on the basis of 2006 GNI which is given in the World Development Report (2008). The technique of sampling is both purposive and simple random sampling. Our selected developing countries are Argentina, Angola, Mexico, Malaysia, Brazil, Bolivia, Colombia, Egypt, Libya, Honduras, Panama, Namibia, Venezuela, Indonesia, Russia, Croatia, Uruguay, Oman, South Africa, Thailand, Bulgaria, Romania, Sri Lanka, Ukraine, Turkey, Philippines, Paraguay, Guatemala, Mainland China, Algeria, Maldives, Peru, Armenia, Bhutan, Bangladesh, India, Pakistan, Zimbabwe, Ethiopia, Kenya, and Nepal. Here, Bangladesh, India, Pakistan, Zimbabwe, Ethiopia, Kenya, and Nepal are low income countries, and the rest are middle income countries. To perform the empirical analysis, we have selected the determining variables and time period so as to data availability as well as to focus on the global financial crisis. To find out the determinants of FDI, we have used data for the period 2002–2011.

In the literature, there exists a number of determining variables used by the authors to explain FDI. In the present study we have taken explanatory variables according to the availability of data as well as the importance of variables. Our selected explanatory variables are—(i) Mobile cellular subscriptions (per one hundred people), (ii) Fixed telephone subscriptions (per one hundred people), (iii) Fixed broadband subscriptions (per one hundred people), and iv) Internet use (per one hundred people) considered as ICT indicators, past FDI inflows, financial development, trade openness, capital account openness, GDP per capita growth rate (annual %), political stability and absence of violence/terrorism, global interest rates, exchange rate variability and inflation variability and financial crisis of 2007–08 as other independent variables.

According to the literature, well-developed ICT can increase FDI. So, the four ICT indicators considered in our study may have positive relation with FDI. A country with a history of receiving foreign capital continues to do so in subsequent years. So, we have taken lagged values of FDI as an independent variable. Domestic financial development can influence foreign investment positively. A developed financial sector helps foreign investors to get easy access of financial requirements. Here, domestic credit to private sector as percentage of GDP is considered as the measure of financial development. Foreign investors find its destination to invest where openness (both trade and capital account openness) is higher. According to the literature, trade and capital account openness tend to follow similar pattern. When per capita GDP growth rate increases, purchasing power will increase leading to an increase in market size. When market expands, inflow of FDI rises. Stable political situation and absence of violence or terrorism may invite more FDI. High global interest rate (USD LIBOR) may reduce inflow of FDI. If exchange rate shows more variability, it will hinder inflow of foreign investment. Thus, exchange rate variability should negatively affect FDI. Inflation variability also acts in the same direction like exchange rate variability and negatively affects inflow of FDI. Financial crisis of 2007–08 may reduce the inflows FDI, and so, we can expect a negative relationship between crisis and FDI.

6.3.1 Dependent Variable

Foreign direct investment, net inflows (% of GDP) [NFDII]:

Here, we have considered FDI as net FDI inflows of investment to achieve a long-term management interest (10% or higher) in an enterprise which functioning in a country other than that of the investor. As given in the balance of payments (BOP), it is the total of (a) equity capital, (b) reinvested earnings, (c) other long-term capital, and (d) short-term capital. It is net inflows, i.e., new investment flows minus disinvestment as expressed as percentage of GDP.

6.3.2 Explanatory Variables

Explanatory variables we consider for the study are described in the table below:

Variable	Description of variables	Source of data	Expected sign
ICT Indicators	1. **Mobile cellular subscriptions (per 100 people) [MCS]**: These are public mobile telephone service subscription which gives access to PSTN utilizing cellular technology. MCS takes into account last 3 months prepaid account numbers which are active and also post paid subscription numbers, and the MCS is applicable for all MCS that offers voice communications. Subscriptions (i) via data cards or USB modems, (ii) to public mobile data services, (iii) private trunked mobile radio and others like telepoint, radio paging and telemetry services are excluded	World Bank	+

(continued)

(continued)

Variable	Description of variables	Source of data	Expected sign
	2. Fixed telephone subscriptions (per 100 people) [FTS]: FTS is the summation of (a) number of analogue fixed telephone lines which are active, (b) subscription of voice-over-IP (VoIP), (c) subscription of fixed wireless local loop (WLL), d) ISDN voice-channel equivalents, and (e) fixed public payphones	World Bank	+
	3. **Fixed broadband subscriptions (per 100 people) [FBS]**: It refers to fixed subscriptions to high-speed (downstream speeds = or > 256 kbit/s) access to the public Internet (a TCP/IP connection). It comprises (a) cable modem, (b) fiber-to-the-home/building, (c) DSL, (d) satellite broadband, (e) other fixed (wired)-broadband subscriptions, and (f) terrestrial fixed wireless broadband and is measured disregarding payment method. Subscriptions that have access to data communications (including the Internet) via mobile-cellular networks are excluded. Fixed WiMAX and any other fixed wireless technologies should be included. It incorporates both residential and organizational subscriptions	World Bank	+

(continued)

(continued)

Variable	Description of variables	Source of data	Expected sign
	4. **Internet use (per 100 people) [INTU]**: If access to information increases through greater Internet use, then it is considered as better communication facility and accumulation of knowledge of an economy. In last twelve months who have used the Internet connection from any location are considered as Internet users. Moreover, via computer, digital television, mobile phone, etc., Internet can be used	World Bank	+
Financial development	Financial development [FINDEV]: Developed financial system of a country creates transaction of financial assets easier for both individual and institutions as well, and it brings higher economic growth. As a proxy measure of financial development here, we have taken domestic credit to the private sector as % of gross domestic product. By the financial corporations, domestic credits are given to the private sector. Credit is given in form of a) loans, b) purchases of non-equity securities, c) trade credits, and d) other accounts receivable which creates a repayment claim is considered as proxy measure for domestic financial development. Credit to public enterprises is also included with these claims in some countries	World Bank	+

(continued)

(continued)

Variable	Description of variables	Source of data	Expected sign
Trade openness	Trade openness [OPENNESS] is calculated by the adding total export and total import of a country and expressed as percentage of GDP	World Bank	+
Capital account Openness	A country's degree of capital account openness is measured by the Chinn-Ito index. It is denoted by KAOPEN. The index is based on the dummy variables (binary) which codifies the tabulation of restrictions on cross-border financial transactions reported in IMF's AREAER	https://web.pdx.edu/~ito/Chinn-Ito_website.htm	+
GDP per capita growth rate (annual %)	It is denoted by PCGDPGR and is based on constant local currency. Gross is constructed on constant 2005 United States dollars. GDP per capita is defined by the ratio of gross domestic product (GDP) and population (midyear). By taking summation of gross value added by all resident producers in a country plus any commodity taxes and minus any subsidies not included in the value of the products, we got GDP at purchaser's prices. Without doing any deductions for depreciation of fabricated assets or for exhaustion and degradation of natural resources, the calculation is done	World Bank	+

(continued)

(continued)

Variable	Description of variables	Source of data	Expected sign
Political stability and absence of violence/terrorism	Political stability and absence of violence/terrorism are denoted by POLSTAB. It takes understanding of the likelihood that the government will be destabilized or displaced by unconstitutional or violent means, which includes politically motivated violence and terrorism. This indicator represents governance indicator	World Bank	+
Global interest rates	We have taken 12 months average value of London interbank offered rates (USD LIBOR), all maturities	www.global-rates.com	–
Exchange rate Variability	Exchange rate variability (EXCHRVL) for a year is measured by the standard deviation of last three years exchange rates	Lane, Milesi-Ferretti Database	–
Inflation Variability	Inflation indicates the whole economy's rate of price change and is estimated by annual growth rate of the GDP implicit deflator. The ratio of GDP in current local currency to GDP in constant local currency is a measure of the GDP implicit deflator. Inflation variability (INFVL) for a year is measured by the standard deviation of last three years inflation	World Bank	–
Financial Crisis of 2007–08	The financial crisis which occurred in 2007–08 is termed as the global financial crisis. It is the worst financial crisis since the great depression of the 1930s. Crisis dummy is denoted as CRISDUM. It is considered 1 for the year 2008 and 0 for other years to record the impact of global financial crisis		–

Definitions of variables given in description of variables column are taken from definitions exists in the data source.

6.3.3 Methodology

Dynamic panel model:

As we have taken a time period of ten years, we have used panel liner dynamic model to analyze both short run of ICT on FDI inflows. Following Arelano and Bover (1995) and Blundell and Bond (1998), our basic model is

$$\mathrm{FDI}_{it} = \alpha_i + \gamma \mathrm{FDI}_{i,t-1} + \beta X_{it} + \varepsilon_{it} \tag{6.1}$$

where α_is are the fixed individual effects, FDI is foreign direct investment net inflows, X is a vector containing explanatory variables including (a) Mobile cellular subscriptions (per one hundred people), (b) Fixed telephone subscriptions (per one hundred people), (c) Fixed broadband subscriptions (per one hundred people), and (d) Internet use (per one hundred people) used as ICT indicators, financial development, trade openness, capital account openness, GDP per capita growth rate (annual %), political stability and absence of violence/terrorism, global interest rates, exchange rate variability, inflation variability, and financial crisis of 2007–08. In Eq. (6.1) subscript, i represent country, and time period is denoted by t. The random error term (ε_{it}) follows zero mean, constant value of variance and across time (t) and individuals (i) is uncorrelated. Here (Eq. 6.1) OLS and GLS and within group estimators are inappropriate for both original and first differenced form. Utilizing method of moments, Arellano and Bond (1991) suggested a method which uses all possible instruments. GMM estimators are unbiased like all instrumental variable regressions. Comparing the performance of generalized method of moments (GMM), ordinary least-squares (OLS) and within group (WG) estimators, Arellano and Bond (1991) observed that GMM estimators reveal the smallest bias and variance.

As suggested by Arellano and Bond (1991), firstly the basic model is first differenced, and using instruments, we will obtain the estimators of the panel dynamic model that is called difference GMM estimators. For investigating the validity of the instruments, Arellano and Bond (1991) have suggested Sargan Test of over-identifying restrictions. Here, over-identifying restrictions are valid and are considered as null hypothesis. The result is better when p value of the Statistic (Sargan J) is higher. At estimated parameters, value of the GMM objective function is provided by Sargan J-Statistic. To investigate whether autocorrelation exists or not, Arellano and Bond (1991) have suggested Arellano–Bond test of autocorrelation where null hypothesis is there is no autocorrelation. Tests of AR(1) and AR(2) have performed for the reason. We have transformed the basic model into first differenced form, and then, first differenced lag dependent variable is instrumented with its past levels. We should go for more systematic framework where instruments will be more efficient when we will find the level form instrument is close to the random walk. So, compared to difference GMM, more advanced method system GMM is introduced by Arelano and Bover (1995) and Blundell and Bond (1998) where all possible kinds of instruments are used. Here, in addition to differenced form equation which is used in difference GMM, a level form equation is also added to utilize all types of instruments, and instruments for level form equation will be differenced lag of endogenous variable. In our study, we have used system GMM and taken Roodman's xtabond2 command so to consider endogenity of variables.

When time period (T) is small and cross section (N) is large, then the difference GMM and system GMM methodology are applicable. It is a common belief that if $T < 10$, then GMM provides better result. There is no requirement to use GMM when T is large or N is small.

6.4 Findings of the Empirical Exercise

We have maximum number of 410 observations ($T = 10$ and $N = 41$) for each variable considered in this study. Summary statistics of the dependent and independent variables are presented in Appendix Table 6.2. Average value is the highest for trade openness, and average variability (standard deviation) is highest for mobile cellular telephone. We have also checked correlations among the variables considered in Appendix Table 6.3 which shows that correlation between ICT indicators [FBS and MCS; FTS and FBS; INTU with MCS, FBS and FTS] are greater than 0.5 and also significant. So, we have made different regressions by taking one indicator in one regression model. The four different models are presented here taking four different indicators of ICT separately. Excluding ICT, the other independent variables are not correlated. So, we have presented four models.

To be a good model, the probability of overall fitness (F) should be less than 0.05, the probability of Arellano–Bond test statistic test in the second order should be greater than 0.05, time dummies must be incorporated, and the probability of Hansen test should be greater than 0.05. Number of instruments must not be larger than no of cross sections or groups. In this paper, we have considered all such variables that are purely exogenous excluding FDI and ICT indicators. Because causality may occur in both directions—from ICT to FDI and vice versa, so we have set FDI and ICT indicators into GMM. The two-step robust command is inserted here for appropriateness. We have set small sample in every command since 41 cross sections are not high at all. We have tried a number of regressions taking all the considered variables and their different combinations. In Table 6.1, we have presented four best results those have fulfilled the criterion of a good model. We have considered past two years' lagged FDIs as two of our explanatory variables. We have seen from Table 6.1 that all four models first lag of FDI are highly significant (1%) and positive which indicates that inflow of FDI is a process, and it depends on the past periods. In three models, trade openness and capital account openness are significant and also have expected signs. It is obvious that total openness of a country and FDI inflow are positively related. In all of models, per capita GDP growth rate is positive and

Table 6.1 Result of the Dynamic Panel GMM

Explanetory Variables ⇓	Model No.1	Model No.2	Model No. 3	Model No.4
	Coefficient (*p* value)	Coefficient (*p* value)	Coefficient (*p* value)	Coefficient (*p* value)
NFDIIL1	0.61*** (0.00)	0.51*** (0.00)	0.61*** (0.00)	0.58*** (0.00)
NFDIIL2	−0.16 (0.10)	−0.20** (0.02)	−0.13 (0.34)	−0.21* (0.05)
MCS	0.01** (0.02)	–	–	–
FTS	–	0.15*** (0.00)	–	–
FBS	–	–	0.06 (0.11)	–
INTU	–	–	–	0.03 (0.13)
FINDEV	–	–	–	–
OPENNESS	0.01* (0.08)	0.02 (0.15)	0.02** (0.01)	0.02** (0.04)
KAOPEN	0.30** (0.01)	0.19 (0.31)	0.34*** (0.00)	0.39* (0.05)
PCGDPGR	0.10** (0.01)	0.09** (0.02)	0.09*** (0.00)	0.09* (0.06)
POLSTAB	–	–	–	–
LIBOR	0.16 (0.14)	–	–	–
EXCHRVL	–	–	–	–
INFVL	–	–	–	–
CRISDUM	−0.16 (0.57)	0.31 (0.30)	0.33 (0.26)	0.36 (0.47)
CONST	−0.81 (0.15)	−1.68** (0.02)	−0.53 (0.21)	−0.53 (0.45)
Groups Instruments	41 41	41 41	41 41	41 41
F [13,40]	18.60 (0.00)	16.29 (0.00)	78.39 (0.00)	20.57 (0.00)
Arellano-Bond Test AR(2)	1.25 (0.21)	1.42 (0.16)	0.63 (0.53)	1.38 (0.17)
Hansen Test	20.40 (0.81)	20.08 (0.82)	25.13 (0.57)	31.84 (0.24)

Source Based on the panel GMM regression performed by the author.
Note *** specifies significant at 1% level, ** specifies significant at 5% level and * specifies significant at 10% level

significant. It is natural that a country always tries to find a location for investment where PCGDPGR is high.

The constant term with its negative value is significant at 5% only in one model. We have not seen any impact of financial crisis on FDI inflows in any of the models, and it is expected since literature suggests developing countries are not much affected by the said crisis. Our main ICT variables are separately estimated. We have found that all of the ICT variables have positive impact on FDI. Mobile cellular subscriptions and fixed telephone subscription are significant at 5% and 1% accordingly. It is expected that mobile cellular subscriptions and fixed telephone Subscription have already developed in developing countries in the twenty-first century. Our result shows that fixed broadband subscription and Internet use are not significant. It is normally believed that in the selected countries, broadband and Internet use are not properly developed in our study period. The result also supports the literature that negative network externality in developing countries discourages inflow of FDI. So, to invite more FDI, the countries should take the policy of giving more emphasis on ICT development.

6.5 Concluding Remarks

Nowadays, economies are considered as knowledge -based economy because of rapid growth of ICT. So, the importance of ICT is growing day by day. Literature suggests that improvement of ICT can enhance economic growth through increasing FDI. The present chapter tries to examine the impact of ICT on net FDI inflows for 41 developing countries during 2002–2011. To investigate this, we have taken mobile cellular subscriptions, fixed telephone subscriptions, fixed broadband subscription, and internet use as ICT indicators or main explanatory variable, past FDI inflows, financial development, trade openness, capital account openness, GDP per capita growth rate, political stability and absence of violence/terrorism, global interest rates, exchange rate variability, inflation variability, and financial crisis of 2007–08 as other independent variables. Applying advanced econometric technique, dynamic panel GMM, we have found that impact of mobile cellular subscriptions and fixed telephone subscription on FDI are positive and significant. We can expect that mobile cellular subscriptions and fixed telephone subscriptions have already developed in developing countries in the twenty-first century. Whereas the impact of fixed broadband subscription and Internet use are positive but insignificant. It may be a reason that in the selected countries, broadband and Internet use are not properly developed in the study period and also because of the presence of negative network externality. So, this chapter suggests for development of ICT in the selected countries to attract more FDI. Lastly, it should be mentioned that in general, among other explanatory variables, past FDI, trade openness, capital account openness, and per capital GDP growth rate have expected sign and are significant in determining FDI.

Appendix

Table 6.2 Summary statistics

Variable		Mean	Std. Dev	Min	Max	Observations
NFDII	Overall	3.217083	3.433595	−4.894898	31.24253	$N = 409$
	Between		2.442803	0.1492641	12.92703	$n = 41$
	Within		2.43719	−6.068575	21.53259	$T = 9.97561$
MCS	Overall	57.24029	43.32228	0	182.4305	$N = 410$
	Between		25.64043	3.407321	101.8511	$n = 41$
	Within		35.12627	31.13727	153.4481	T = 10
FBS	Overall	2.503286	3.72203	0.0000469	20.69924	$N = 351$
	Between		2.561709	0.0021607	9.630707	$n = 41$
	Within		2.724574	−7.049953	13.57182	T-bar = 8.56098
FTS	Overall	13.25769	10.08069	0.4435784	43.15017	$N = 410$
	Between		10.00085	0.6582985	42.63655	$n = 41$
	Within		1.950397	6.461049	20.8701	$T = 10$
INTU	Overall	15.31024	13.84342	0.0724023	61	$N = 410$
	Between		10.76925	0.4073801	49.45288	$n = 41$
	Within		8.843959	−6.243758	44.99233	T = 10
OPENNESS	Overall	76.03109	36.24352	22.71487	210.3738	$N = 410$
	Between		35.18438	26.46871	187.9254	$n = 41$
	Within		10.14362	34.96143	127.5501	$T = 10$
KAOPEN	Overall	0.1723591	1.425728	−1.888895	2.389668	$N = 410$
	Between		1.375391	−1.538276	2.389668	$n = 41$
	Within		0.4273478	−2.103664	1.484952	$T = 10$
FINDEV	Overall	41.48327	31.53086	4.330096	160.1249	$N = 400$
	Between		29.99133	10.75541	138.3588	$n = 41$
	Within		10.07473	−0.0543204	85.55324	$T = 9.7561$
PCGDPGR	Overall	3.539543	5.846976	−62.21435	18.4876	$N = 410$
	Between		2.648413	−4.508436	10.02979	n = 41
	Within		5.227559	−55.76618	17.93224	T = 10
EXCHRVOL	Overall	3.27e + 07	3.82e + 08	0	4.75e + 09	N = 410
	Between		2.09e + 08	0	1.34e + 09	$n = 41$
	Within		3.22e + 08	−1.31e + 09	3.45e + 09	$T = 10$
POLSTAB	Overall	−0.572384	0.8420378	−2.81208	1.30769	$N = 410$

(continued)

Table 6.2 (continued)

Variable		Mean	Std. Dev	Min	Max	Observations
	Between		0.8077779	−2.175345	0.9109976	$n = 41$
	Within		0.2662344	−2.066383	0.7465392	$T = 10$
LIBOR	Overall	2.6566	1.583637	0.83	5.325	$N = 410$
	Between		0	2.6566	2.6566	$n = 41$
	Within		1.583637	0.83	5.325	$T = 10$
INFVOL	Overall	5.538109	15.04827	0.1193924	230.7896	$N = 410$
	Between		8.795172	0.7398075	56.84126	$n = 41$
	Within		12.27996	−47.341	179.4864	$T = 10$

Source: Author's calculation

Table 6.3 Correlation matrix

	NFDII	MCS	FBS	FTS	INTU	OPENNESS	KAOPEN	FINDEV	PCGDPGR	EXCHRVOL	POLSTAB	LIBOR	INFVOL	CRISDUM
NFDII	1.0000													
MCS	0.3105	1.0000												
FBS	0.2316	0.6482	1.0000											
FTS	0.3508	0.4425	0.6058	1.0000										
INTU	0.2630	0.7190	0.8107	0.5831	1.0000									
OPENNESS	0.3373	0.2823	0.0584	−0.0275	0.2478	1.0000								
KAOPEN	0.3481	0.1690	0.1930	0.1734	0.2430	0.1359	1.0000							
FINDEV	0.1532	0.1953	0.1929	0.1050	0.2697	0.4124	−0.1655	1.0000						
PCGDPGR	0.2083	−0.0999	−0.0478	0.0817	−0.0636	0.0514	0.0197	−0.0127	1.0000					
EXCHRVOL	−0.1524	−0.1078	−0.1366	−0.1502	−0.1631	−0.0372	0.1133	−0.1550	−0.0312	1.0000				
POLSTAB	0.3913	0.3365	0.2872	0.4200	0.3728	0.4358	0.3328	0.2159	0.0543	−0.2038	1.0000			
LIBOR	0.1934	−0.2209	−0.2154	0.0061	−0.2354	0.0238	0.0591	−0.0582	0.2755	−0.0467	−0.0214	1.0000		
INFVOL	−0.1649	0.0854	−0.0474	0.0015	0.0304	−0.0172	−0.1470	−0.2505	−0.0132	−0.0454	0.0237	−0.1343	1.0000	
CRISDUM	0.0794	0.1213	0.0614	0.0104	0.0246	0.0449	0.0168	0.0016	0.0270	−0.0297	0.0007	0.0897	−0.0691	1.0000

Source: Author's calculation

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Chapter 7
Export of Software Services and Economic Growth Relation in India—A Time Series Approach

Kanchan Datta

7.1 Introduction

Trade deficit is now not only a symptom of disease but becomes a fully fledged disease in the context of the economy of India. Many medicines are prescribed by various doctors to overcome this disease, sometimes devaluation, sometimes national business summit, foreign tours for new negotiations and more loans from international funding agencies, more structural reforms and more openness so and so. But no such initiatives or medicines worked perfectly all right or appropriate to overcome the sustained current account deficit problem. Export of software services is also one kind of medicine which may reduce current account deficit, raise employment and ultimately stimulate economic growth through the channel of remittances. In economic theory, we have the concept of 'export-led growth strategy' which hints that more export means more foreign exchange, more sophisticated technology and managerial skill, efficient allocation of resources more employment and ultimately more income or GDP growth. The openness of an economy is a continuous process overtime which reflects creative innovation and technological progress. It also refers to the integration of the nation's economy with the rest of the world especially through the channels of trade and the movement of capital. To exploit the opportunities provided by the openness of the world economy, all nations are trying to compete with each other. With respect to their comparative advantage or specialization, all are trying to offer their products in the world market. Only trade and no other options are left in the twenty-first century for the growth of the economy. Export of software services is one such invisible product which can reduce current account deficit, increase efficient allocation of scarce resources and foster economic growth. In the literature, we got support from Haberler (1959) who stressed in favor

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of exports for dynamic gains, such as improved availability of foreign capital and technology which otherwise hampered by balance of payments constraints. Similarly, Beckerman (1965) argued growth of export stimulates production efficiency through the channel of improved resource allocation. On the other hand, Vernon (1966) opined that growth of domestic economy is essential initially, this internal growth of domestic economy or GDP growth enhances competitiveness in the global market which eventually eases the way of exports, and hence, causality comes from GDP growth to export growth. Helpman and Krugman (1985) reconcile the idea of Beckerman and Vernon's idea by arguing that the initial growth spurt favored by export expansion through the efficiency and allocation effects reverberates in enhanced international competitiveness, fostering a fresh round of export expansion and paved the way for a virtuous development path.

We know that economic growth is the sustained rise of output. There are three sectors of any economy—primary, secondary and tertiary. Economic development is the summation of economic growth and structural transformation. Thus, one of the indicators of economic development is the structural transformation of the economy that a paradigm shift from agriculture to industry and service sector both from the angle of production and employment. In the liberalized regime, India's economic growth is highly related to the growth of the service sector. Hence, export of services especially net export of software services plays an important role in India's growth episode. Information technology industry in India consists of two major components. (i) Information technology services and (ii) Business process outsourcing (BPO). In the year 1967, India's IT services industry was born in Mumbai. The first software export zone—the precursor to the modern-day IT park—was established in 1973. More than 80% of the country's software exports were from the software export zone of Mumbai in the 1980s. The IT sector has also led to massive employment generation both directly and indirectly in India. The IT industry is making India a dominant player in the global outsourcing sector. However, it continues to face challenges of competitiveness in the globalized and modern world, especially from China and the new out sourcing policies of the USA. However, the recent global financial crises have deeply impacted Indian IT companies as well as global companies. As a result, hiring has dropped sharply, and employees are looking at different sectors like financial services, telecommunications, and manufacturing, which have been growing phenomenally over the last few years. Under these circumstances, it becomes pertinent to investigate the role of service sector for stimulating economic growth of India. Since out of many service exports, software exports capture the significant share. In the liberalized regime, the government of India placed the development of information technology among its top five priorities and formed the Indian national task force on information technology and software development. Most of the economic literature deals with the determinants of export of goods and services, some literature reveals that export of service and GDP growth nexus (Barry and Poonam 2011), whether export causes growth or the reverse. Here, export includes both visible and invisible items. But this paper tries to examine the nexus between export of software services and GDP.

7.2 Motivation and Objectives of the Study

In the contemporary global economy, India is the largest exporter of information and technology. The share of information technology in total export was only 4% in 1998, but it has increased to 25% in 2012 (NASSCOM 2012). The USA accounts roughly 75% of India's information technology or software services exports. The growing structure of this service enables India to form a close tie with both the USA and the European Union (Canton 2012). The most important Indian information technology services are Infosys, Cognizant, Wipro and HCL technologies. If we consider the major information technology hubs in India, we can say that Bangalore, which is known as Silicon Valley of India (NASSCOM 2012), Chandigarh, is also one of the growing international IT services and outsourcing exporters, similarly Hyderabad is known as HITEC city or Cyberabad is a major global IT hub, and the largest bioinformatics hub in India, Pune, Chennai, Kolkata, Gujarat, Mumbai, etc., are also leading Indian and International IT services and outsourcing exporters of India. In India, cheap and skilled software professionals are available in abundance. As a result, software services and the hard products are placed by the companies in the global market in the most competitive rate. This has helped India to become a favorite destination for outsourcing as well. It is expected that this industry is being instrumental in driving the economy of the nation. Many studies have been done in this issue, and most of the studies are related to determinants of software exports. These studies include Grünfeld and Moxnes (2003), Kimura and Lee (2006), Mirza and Nicoletti (2004), Lejour and Verheijden (2007), Kox and Lejour (2005), Lennon (2009) and Head, Mayer and Reis (2009). Under these circumstances, it becomes pertinent to investigate the relation between the export of software services and the economic growth of India by applying some econometric tools. Therefore, an attempt has been taken in this paper to analyze the role of software services export in India's economic growth by applying time series econometric tools.

7.3 Data and Methodology of the Study

Data are collected from World Development Indicators. The data in this study used are GDP growth (annual%), GDP (Current US$), ICT service export (% of Service Export BoP), ICT service export (BoP current US$), industry (including construction) value added (annual % growth), industry (including construction) value added (% GDP), agriculture, forestry and fishing value added (annual % growth), agriculture value added (% of GDP), export of goods and services (% of GDP). For the application of time series techniques, ICT service export (BoP current US$) and GDP (Current US$) data are used. The time period covers year 2000 to 2017. Regarding methodology, time plots of the data, ADF unit root test, Johansen test of Cointegration, vector auto regressive model, impulse response function and variance decomposition, etc., techniques are used in this study.

ADF Unit Root Test

The Augmented Dickey Fuller (ADF) Unit root test can be done by estimating the following equations (Gujarati and Porters 2009)

$$Y_t = \alpha + \beta_t + \rho Y_{t-1} + \sum \lambda j \Delta Y_{t-j} + \epsilon_t \tag{7.1}$$

where $\Delta Y_t = Y_t - Y_{t-1}$.

Now, subtracting Y_{t-1} from both sides, we get

$$Y_t - Y_{t-1} = \alpha + \beta_t + (\rho - 1)Y_{t-1} + \sum_{j=1}^{p} \lambda j \Delta Y_{t-j} \tag{7.2}$$

This is unrestricted regression, and then, we put two restrictions t $=$ 0 and $(\rho - 1) = 0$ and then get the following restricted regression

$$Y_t - Y_{t-1} = \alpha + \sum \lambda j \Delta Y_{t-j} \tag{7.3}$$

Now, we have to apply OLS for both equations (b) and (c) and obtain the residual sum square of both the estimated regression equation. After that, we have to compute a standard F ratio where

$$F = (N - K)(\mathrm{RSS_r} - \ \mathrm{RSS_{ur}})\big/ q(\mathrm{RSS_{ur}}) \tag{7.4}$$

where $\mathrm{RSS_r}$ and $\mathrm{RSS_{ur}}$ are the residual sum square of the restricted and unrestricted regression, N = number of observations, and K is the number of estimated parameter in the unrestricted regression, and q is the number of parameter restrictions. Here, we have to use the distribution tabulated by Dickey and Fuller for hypothesis testing.

Cointegration Test

Capitalizing on the likelihood of a co-movement in their behavior which implies that there is possibility that they trend together toward a stable long run equilibrium, Johansen and Julius (1990) Cointegration test is applied. The objective of this test is to determine if there is existence of long run equilibrium relationship among the variables used in the study. The concept of cointegration creates a link between integrated process and the concept of steady equilibrium. Cointegration occurs when two or more time series variables which themselves may be non-stationary drift together at roughly the same time. This implies that a linear combination of the variable is stationary. The null hypothesis is that the variables are not cointegrated. Based on this, we specify the full information maximum likelihood based on the vector autoregressive equation (VAR) Johansen and Julius (1990), as mathematically stated below:

$$yt = a1\ yt{-}1 + \ldots + ak\ yt\text{-}k + \acute{\o}xt + \mu t \tag{7.5}$$

where: y_t is a k-vector of 'differenced' stationary time series, 'k' being the lag length for the first-order differenced variables, /(1), 'x_t' is a vector of deterministic variables, 'a' is a constant, $\acute{\phi}$ are the coefficients of the deterministic variables, and μ_t is a vector of innovations or error term, and it is known as the adjustment parameters in the vector error correction model, while 't' indicates time dependent. Using this method, we estimated the equation in an unrestricted form and then tested whether we can reject the restriction implied by the residual rank of the cointegration.

Applying the maximal non-zero eigenvalues and the trace test of the maximum likelihood ratio, with reference to the level of significance, the number of cointegration relations could be determined which indicate the existence of long run relationship (Johansen and Julius 1990).

Vector Auto Regression (VAR): is an econometric model used to capture the evolution and the interdependencies between multiple time series, generalizing the univariate AR models. All the variables in a VAR are treated symmetrically by including for each variable an equation explaining its evolution based on its own lags and the lags of all the other variables in the model.

Impulse Response Function: An impulse response function describes the evolution of the variable of interest along a specified time horizon after a shock in a given moment. The key tool to trace the short run effects with an structural VAR is the impulse response function (IRF).

Variance Decomposition: The variance decomposition indicates the amount of information each variable contributes to other variables in the auto regression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. The forecast error variance decomposition shows us how much of the future uncertainty of one time series is due to future shocks into other time series in the system. This involves over time, so the shocks on series may not be important in the short run but very important in the long run.

7.4 Graphical Explanations of the Time Plots of the Variables

The diagram is shown in the appendix. World agriculture value added (annual % growth is fluctuating, though recent growth rate has declined. In case of India, agriculture value added (% of GDP) declines continuously throughout the time period of the study. World industry, value added (% of GDP) has declined sharply specially after 2011, which is the reflection of worldwide recession though the world industry value added (constant 2010 US$) increases, this may be the results of world inflation in 2010. In case of India, the industrial value added (% of GDP) increases up to 2007, and after that, it declines. Similarly, in case of (annual % growth) of Indian industries up to 2006, there is an increasing trend, and then, there is a stochastic trend with a decling tendency. In case of export of goods and services, % of GDP shows an upward trend throughout the time period from 2000 to 2008, and thereafter, a sharp decline in 2009 is visible. Recovery occurs after 2009, but it is confined to a couple of years. From 2013 again, there is a declining trend. GDP growth (annual %) shows a declining trend especially after 2015. World ICT service exports (% of service export, BOP has increased sharply, and world ICT service exports (BOP current US $) increase continuously from 2002 to 2014, and after that, a slight decline is visible. ICT service exports (Bop, Current US$) sharply increases in India except (2008–09), similarly India's ICT service exports (% of service exports, Bop) increase up to 2008, but after that, it declines till 2011, and after that time period, it has an increasing trend. World GDP growth is in a declining trend, world agriculture and industrial growth are also in a declining trend only world ICT service exports are in an increasing trend. However, per capita GDP both world and India is increases with respect to the time horizon of the study. From Indian perspective, it is clear GDP growth has increased up to 2007 after that due to global recession, it has declined sharply, after that with some fluctuations, i.e., ups and downs beyond 2010 to 2014, it has a declining trend (just above 6%). Overall in spite of slow or low growth of the agriculture and industrial sector, there is a slight hope of the growth of GDP due to increasing trend of ICT or software service exports. It is therefore very pertinent to investigate the relation between export of software services and GDP, or in other words, the increasing trend of the service sector can offset the decling trend of the primary and secondary sector to stimulate economic growth?

7.5 Econometric Findings

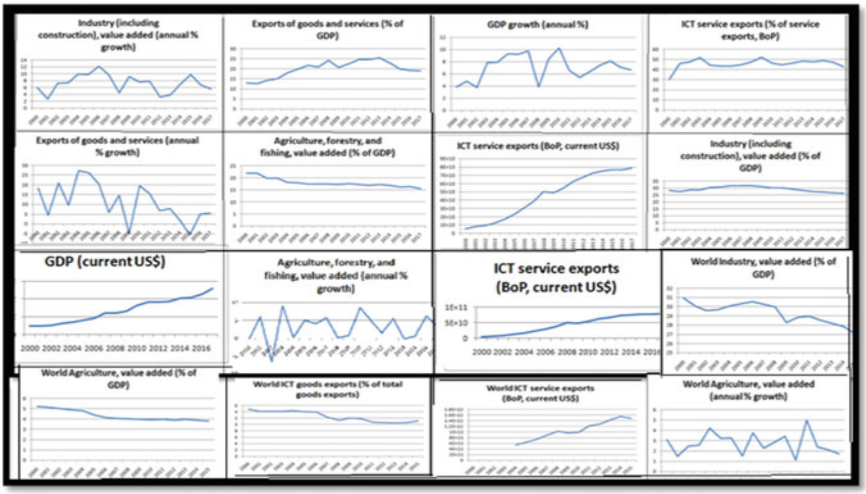
Using the two time series data ICT service exports (BOP current US $) and GDP (Current US$) for the time period year 2000 to 2017, this study finds both the variables are I(1). They are not cointegrated. This implies there is no long run association between the GDP and export of software services. When two series are not cointegrated, we can apply the method vector auto regressive model with certain lag selection criteria. This study finds from the estimation of VAR model that GDP growth causes growth (at lag 1) of the export of ICT services. Hence, the most important thing is to raise our GDP. The impulse response function shows any shocks of GDP moves the ICT growth down words in the first period, but in the next period, it reaches in the stable time path. But the impulse of other variables takes long time to move the dependent variable in the stable time horizon. Similarly, the variance decomposition table shows only 8% variability of GDP growth can be explained by the shocks of export of ICT services, on the other hand, 41% variability of the export of ICT services can be explained by the shocks of D(GDP) or GDP growth. This results further support that it is the change of GDP that plays an important role for the change in the export of software service in the economy of India.

7.6 Summary and Conclusion

In the era of globalization, the world agriculture and industrial value added are in a declining trend. The same flavor is also true for the Indian economy also. But on the other hand, world software services or export of information and communication technology products and services are in the increasing trend. Due to availability of huge skilled or efficient software professionals with low cost, India becomes the home to some of the finest software companies in the world. More than 80% of the revenue from software exports comes from software services (NASSCOM 2012). Besides Indian software companies, a number of multinational giants have also plunged into the Indian IT market. The IT industry accounts for 5% of India's GDP (NASSCOM 2012). This study shows the two variables GDP and export of information and communications technology services are not cointegrated. May be international economic policy specially the policy of the US government regarding the import of software services or our big domestic market plays an invisible role behind these findings. In other words, in India, we should not take the growth of services exports for granted. Despite being generally resilient, the growth of service exports globally and from India slowed in the recent global crisis, suggesting that service exports remain vulnerable to fluctuations in global demand. This study also explores with the increases of income, the nation can able to provide more and skilled or more efficient software professional and also can develop the infrastructure of strengthening the IT sector, which in turn raise our export of software services. Therefore, the government should take policies mainly to raise our GDP, which automatically raise export, employment of our nation since the fruits of rising export of software services is not being utilized effectively for the growth of the nation's income. Hence, government initiatives must be there to raise the agricultural growth, industrial growth (especially through micro and small enterprises) just to obtain the momentum of our GDP growth; otherwise, the benefits of increasing export of software services cannot be able to raise our national income alone.

Appendix

Time Plots of Various Variables Related to This Study



1. **Results of ADF Unit RootTest**

Variable	Exogenous	ADF test statistic	Probability	Decision
GDP	Constant	1.15	0.99	Non-stationary
D (GDP)	Constant	−3.47	0.03	Stationary
ICT	Constant	−0.87	0.77	Non-stationary
D (ICT)	Constant	−3.06	0.05	Stationary

2. **Results of Johansen's test of Cointegration**

UnrRestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.306261	7.833147	15.49471	0.4834
At most 1	0.116542	1.982592	3.841466	0.1591
Tr Trace test indicates no cointegration at the 0.05 level				
*denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

UnrRestricted Cointegration Rank Test (Maximum Eigenvalue))				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical value	Prob.**
None	0.306261	5.850555	14.26460	0.6325
At most 1	0.116542	1.982592	3.841466	0.1591
Max-eigenvalue test indicates no cointegration at the 0.05 level				
*denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

3. **Results of Vector Auto regressive Model estimation**

The model:

$$\mathrm{DGDP}_t = \alpha_1 + \beta_1\mathrm{DGDP}_{t-1} + \beta_2\mathrm{DGDP}_{t-2} + \gamma_1\mathrm{DICT}_{t-1} + 1.705234\mathrm{DICT}_{t-2} + u_1 \tag{7.A}$$

$$\mathrm{DICT}_t = \alpha_2 + \beta_1\mathrm{DICT}_{t-1} + \beta_2\mathrm{DICT}_{t-2} + \gamma_1\mathrm{DGDP}_{t-1} + \gamma_2\mathrm{DGDP}_{t-2} + u_2 \tag{7.B}$$

Results of VAR model estimation:

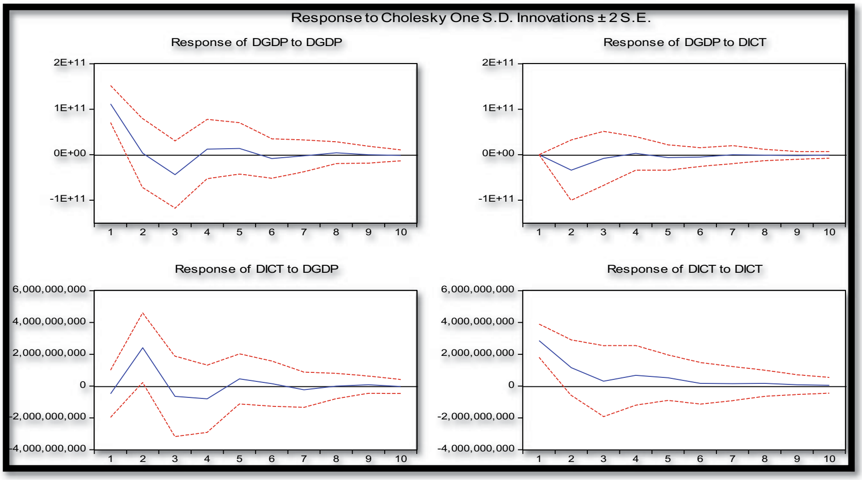
$$\begin{aligned}\mathrm{DGDP}_t &= 2.02E + 11 - 0.021\mathrm{DGDP}_{t-1} - 0.128\mathrm{DGDP}_{t-2} \\ &\quad - 11.88\mathrm{DICT}_{t-1} + 1.705\mathrm{DICT}_{t-2} + u_1\end{aligned} \tag{7.C}$$

R-squared = 0.228751, Adj. Rsquared = −0.079748.

$$\begin{aligned}\mathrm{DICT}_t &= 4.89E + 08 + 0.403\mathrm{DICT}_{t-1} + 0.220\mathrm{DICT}_{t-2} \\ &\quad + 0.023\mathrm{DGDP}^{*}_{t-1} - 0.014\mathrm{DGDP}_{t-2} + u_2\end{aligned} \tag{7.D}$$

R-squared = 0.516518, Adj. Rsquared = 0.323126.
* = significant at 5% level.

4. Results of Impulse Response Functions:



5. Results of Variance Decomposition

Variance Decomposition of D (GDP)				Variance Decomposition of DICT			
P Period	S.E	D (GDP)	D (ICT)	P Period	S.E	D (GDP)	D (ICT)
1	1.12E + 11	100.0000	0.000000	1	2.89E + 09	2.790900	97.20910
2	1.17E + 11	91.55669	8.443311	2	3.94E + 09	38.96567	61.03433
3	1.25E + 11	92.21128	7.788724	3	4.00E + 09	40.35705	59.64295
4	1.25E + 11	92.23840	7.761601	4	4.14E + 09	41.53315	58.46685
5	1.26E + 11	92.08674	7.913262	5	4.19E + 09	41.55707	58.44293
6	1.27E + 11	91.96329	8.036714	6	4.20E + 09	41.56505	58.43495
7	1.27E + 11	91.96650	8.033500	7	4.21E + 09	41.69799	58.30201
8	1.27E + 11	91.97139	8.028614	8	4.21E + 09	41.62987	58.37013
9	1.27E + 11	91.95435	8.045650	9	4.21E + 09	41.63560	58.36440
10	1.27E + 11	91.95365	8.046346	10	4.21E + 09	41.63432	58.36568

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Chapter 8
Understanding the Role of E-Governance in Urban Areas of West Bengal

Joy Karmakar

8.1 Introduction

It is predicted that 91% of the normal increment of world's urban populace will happen in developing nations. Due to this population increase, urban setups accompany various very much distinguished, explicit risks: poor urban and regional planning, absence of coordination and lacking adapting procedures even with social and monetary inconsistencies (UN-Habitat 2012). The test that lies in front of the administrations is to grow reasonably, guaranteeing intergenerational and intra-generational equity (Vernica 2014). This intrinsically implies the national and sub-national government frameworks ought to become resident driven, socially comprehensive and participatory and in particular just. This carries us to that reality that while working for the residents, the administration needs to guarantee what the residents need. Their suppositions ought to be voiced, not through moderator but directly by themselves to the government. Just an immediate collaboration through various modes can guarantee that the correct point of view is thought of and can be examined upon. Scholars argue that e-governance in urban area can be a step forward to the inclusive as well as participatory democracy (Yadav and Tiwari 2014). It is because the old master plan of cities has no relationships with governance structures. Therefore, participation in e-governance is going to be a crucial aspect for its success. In any case, in the writing, Suh (2007) provided details regarding reasons for low e-participation. The main source was if suppositions proposed by residents through government instruments were not appropriately reflected, residents could feel estranged and lose enthusiasm for the adequacy of the approach being referred to. The subsequent reason was culture, resident mindfulness and customary practices. The third reason was the computerized partition which forestalled e-participation. The fourth reason was absence of an

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advancement of resident support utilizing distinctive data courses. In their investigation, Haruta and Radu (2010) announced that in any event, when government considered the assessments of the citizens; support was lower at the local government level than it was at the territorial level. This could be an impression of the obstructions distinguished previously. Citizens in the local government areas may face technical, human and emotional and social barriers. In case of India, low e-participation is the results of lack of computer literacy (6.15%) and low accessibility to Internet and electronic media (12.5%). Besides, the huge heterogeneous populace accompanies an exceptional arrangement of issues and has various requirements. These requirements shift topographically, rely upon race and ethnicity, proficiency level and so on (Vernica 2014). Nonetheless, overwhelming participation in e-governance can fill up the disjunction between the planning, governance systems. It will also influence the aspirations of the bottom half of the urban population (Mahadevia and Joshi 2009). With this argument, paper discusses the new policies and programs formulated for urban e-governance to meet the challenges in India. Moreover, it also sheds light on the role of urban local bodies in the promotion of e-governance as "smart governance".

Organization of this chapter is as follows. In the following section, a brief idea about sustainable urbanization and role of e-governance are discussed. Newly introduced policies and programs to combat the challenges of new governance are highlighted in next section. Fourth section identifies the application of e-governance in the municipal area of West Bengal. Based on above discussion, conclusion is drawn.

A scrutiny of how infrastructure is now grown internationally has developed, however. The "splintering urbanism" approach progressed by Graham and Marvin (2001) has been especially powerful here. It outlined an overall unbundling of foundation systems, especially around the privatization and split responsibility for and correspondence advances, driven to a great extent by a neo-liberal plan of diminished state association in resource proprietorship and the board. As the smart city plan has created, this has been given a clear outline as far as public policy. Under post-industrial "new economy" development systems, the economic competitiveness of urban communities has been to a great extent comprehended through the viewpoint of "urban entrepreneurialism". In this unique situation, endeavors to comprehend the significance of the "digital city" have included the hybridization of urban arrangement between boosting the area and maintenance of innovation firms and representatives, from one viewpoint, and conveying digitized, and subsequently "smart", open administrations (see for example, Hollands 2008; Alizadeh et al. 2014; Wiig 2015). This has prompted an obscuring of the role of public and private actors in strategy development and service delivery, just as making another arrangement of strategy challenges that public discourse has little handle on.

8.2 Methods

To analyze the e-governance situation in West Bengal, mainly secondary data collected from town directory of census of India and concerned municipal Web sites. Using Heek and West framework of e-governance, the paper shades light on the nature of information available in the Web sites, and then, the stage of the e-governance initiative in West Bengal is elaborated.

The three main contributions of e-governance include creating external interactions (e-society); connecting citizens (e-citizens and e-services) and enhancing government processes (e-administration) (Heek 2001). The paper focused on the e-services and citizen participation in e-governance. To get an idea of the e-services, Web sites of the concerned municipal corporation have been checked as well as data available in the Web sites have been verified through secondary literature and interaction with municipal administration. Then, information available on the Web sites is grouped into three categories. Based on available information, I prepared a list to identify the stages of e-services in the respective municipal corporations. Citizens' participation in the Web sites is also calculated based on the number of daily visitors on the concerned Web sites.

8.3 Sustainable Urbanization and E-Governance

E-Governance simply indicates the utilization of Web as a stage for interchanging information, offering various services and negotiating with residents. It also acts as important pillars of government. It gives a sound technique to reinforce governance. It cannot just improve responsibility, straightforwardness and effectiveness of government forms, yet additionally encourage maintainable and comprehensive development. E-governance likewise gives an instrument of direct conveyance of public services to the negligible fragments of the general public in the remotest corners, without interference of intermediaries. The United Nations (UN) and the American Society for Public Administration (ASPA) defined e-government as "utilizing the Internet for delivering government information and services to citizens" (UN 2002). E-government is characterized by the Organization for Economic Cooperation and Development (OECD) (2003) as the utilization of ICTs, and especially the Internet, as an apparatus to accomplish better government. At present, e-government may allude to smaller or more extensive territories: In one, it is characterized as online service conveyance; and in the other, it involves the ability to change public administration utilizing ICTs to present the idea of e-governance. Oakley (2002), e-governance is an innovation interceded forms that are changing both the conveyance of public services and the more extensive connections between residents and government. E-governance permits this change albeit social and political structures could condition the result of the e-governance frameworks. Agenda 2030 and the new sustainable development goals (SDGs) give a ground-breaking outline of the difficulties and chances for cities. Endorsing sustainable cities is presently highlighted in the 2030 Agenda as one of the SDGs—Goal 11: "make cities and human settlements inclusive, safe, resilient and sustainable". Indeed, sustainable development in urban area is basic to accomplishing the vast majority of Agenda 2030. The Sustainable Urbanization Strategy sketches UNDP's reaction to the rapid urbanization of the developing nations and its ramifications for sustainable development. It is composed for interior and outside purposes. Remotely, the methodology is focused at neighborhood and national government and development stakeholders who are liable for urban turn of events. It remains as UNDP's worldwide contribution, sketching out the association's aim, niche and specific regions of spotlight on this issue. Inside, the procedure is expected to outline conversations, to help evaluate urban issues through a multidimensional focal point and to create setting explicit answers for urban improvement challenges for nation programming. Creating compelling, responsible and unambiguous foundations has become a key objective under SDG Goal 16, flagging the criticalness of a functioning public service (UNDP 2016). The urban governance approach centers not just around the spatial limits ("where" governance frameworks are applied), yet in addition on "how" and "by whom", governance and neighborhood development processes are advanced, effective urban governance requires better coordination over the various degrees of government policy making processes. More prominent decentralization and devolution of power utilizing multilevel governance approaches additionally increment responsiveness and effectiveness. Government organizations, specifically line services, and other national stakeholders, public and private, are executing their systems and plans at neighborhood level, where approaches meet individuals. Thus, government's selection of strategies, projects and plans ought to be founded on individuals' interest and facilitated over the various degrees of governance. It is likewise critical to encourage participation among actors that work at the neighborhood level, in view of neighborhood interest. This assists with forestalling the danger of fracture and cover of activities and to fabricate complementarities among stakeholders and coherence between neighborhood procedures and national strategies. Along these lines, new urban governance should be digital era governance. This suggests that public interest must be the main thrust behind urban advancement and the arrangement of data innovations for new urban governance. Built up instruments of e-governance—over all computerized access to data—should keep being created in a "citizen centric" approach to more readily encourage interdepartmental, between organization and cross-sector collaboration (UNDP 2016). In fact, Bhavnani and others (2008) demonstrated that each 10% expansion in the market entrance of cell phones supports gross domestic product (GDP) development by 6 percentage points (Bhavnani et al. 2008). Another estimate suggests that for each 10% expansion in broadband Internet service infiltration in a specific region, business would expand 2–3 percentage points every year (Crandal et al. 2007). Other than employment generation and economic growth, ICT can improve the management of urban organizations' budgetary assets by means of improved inner efficiencies, information security and cost control by encouraging data trade among offices, inside and outside urban areas (Relhan et al. 2016).

Heeks (2001) identified the impact of new data and correspondence innovations and how it can make a critical commitment to the accomplishment of good governance objectives. The paper outlines the three main contributions of e-administration: improving government forms (e-organization); interfacing residents (e-residents and e-administrations) and building outside connections (e-society). Islam (2003) explored the connection between data streams and governance with the target to analyze how the accessibility of data may influence governance. In particular, it looks at (a) how the accessibility of fundamental financial information influences governance and (b) how the legitimate system administering access to data may influence the nature of governance. Akther et al (2007) in their investigation on an e-government venture in developing nations feature that most e-government projects inside developing nations utilize high-innovation intercession though residents are not prepared for this. Corradini et al. (2007) feature that digital personalities, profiles and their administration empower online collaborations and exchanges among individuals, ventures, specialist co-ops and government establishments. Dada (2006) highlighted that there exist wide gaps between the present reality in developing nations and the eventual fate of e-governance frameworks. These gaps could be ordered into three kinds: a hard-delicate gap, inferring a gap between the innovation and the social setting where it is applied; a private–public gap, proposing that what works in the private segment may not work in the public sector; and a country context gap that emerges from the utilization of a similar e-governance frameworks for both the developing and developed nations. Walravens (2012) adds through e-governance decision making can become innovative. Schuurman et al. (2012) characterize e-governance as the way toward gathering a wide range of information and data concerning public management by sensor or sensor systems. New innovations are utilized to fortify the discernment of government by utilizing progressively complete—and all the more promptly accessible and open—data for administrative dynamic procedures and the usage of these choices. Several other scholars noted that there should be four goals of "digital civics[1]" inclusive of fostering social cohesion as mission, promote openness and transparency as vision, work with comprehensive participatory planning as instrument and use ICT as media. Moreover, it has three layers of components consist of (i) Knowledge Platforms, (ii) Ecosystems of Interactions and (iii) Interfaces for Governance (Govela 2016). Platform for knowledge orchestrates data, analytics, visualization and collaboration devices. It gives standard intends to imagine its outcomes and advances participation among its community of users and working clusters. Open data development is a notable case of a platform of knowledge, where information is organized to be unreservedly accessible to everybody without limitations from any system of control (UN 2014). Then again, making

[1]Digital Civics a UN-Habitat initiative intercede citizens' interactions through frameworks of information, ecosystems of interaction, and interfaces for governance. It gives fundamental ideas that can be utilized each as a theoretical structure to perceive the detonating field of smart cities, and as a road guide to help manual the detailing of approaches, projects, and undertakings for residents to connect with their surroundings, and among themselves, through digital tools.

knowledge platforms opens up the additional opportunity for ecosystems of interaction to connect with public in co-creation and agreeable work that sparkles development and business enterprise. They do as such by giving empowering situations where partners can utilize predefined t tool-kits to set shared objectives and to settle clear urban difficulties. These ecosystems of interaction can take numerous structures that run from training and capacity building encounters, online instructive chances, to living labs, open-hardware events, fab labs, masterful programmer spaces and enterprising workshops. Interfaces of governance organize streams of connections, with computerized and community-oriented assets that advance gigantic commitment and synergistic activity. Ben-Attar and Campbell (2014) have noticed a system for youth and ICT-empowered administration. Their exploration shows how versatile stages, the most significant ICT apparatuses that influence youth, can improve their commitment in local government issues and encourage comprehensiveness and responsiveness.

Through crowdsourcing,[2] geo-referencing, and communication networks, youth are driving the path in political cooperation. (Ben-Attar and Campbell 2012). However, various challenges of e-governance have been identified by scholar apart from low literacy and lack of access to ICT. A key challenge detailed in the literature is the propensity of governments to restrain the perspective on ICTs and youth to issues of access and aptitudes. Youngsters are keen on applying their aptitudes to impact social, monetary and political fields. This is something that governments are still delayed to comprehend. Youth-centered ICT programs have underlined aptitudes, access and foundation, with little regard for how these devices can be applied to take care of the issues youth are generally worried about. Another issue is the volume of traffic that mobile platforms specifically have carried vicinity to the resident government relationship. In like manner, there is a lack of municipal capacity as far as staff time, abilities and thoughtfulness regarding measure, oversee and exploit the expanded progression of interchanges (Ben-Attar and Campbell 2014). In this way, e-governance in developing countries can be a significant upgrade for sustainable urbanization.

[2]Crowdsourcing is an online procedure for interfacing on the Web networks and associations in quest for an answer for issue. Crowdsourcing can be practiced through any number of new media apparatuses, including wikis, Web journals, sites, social networking sites (e.g., Facebook, Twitter), versatile mobile applications, mapping programming, etc. Numerous applications empower correspondence, and thus, numerous tools can make crowdsourcing conceivable (Branham 2013). It can possibly be helpful computerized applications to supplement conventional public participation programs for governance. Customary, face-to-face public participation techniques, for example, town corridor gatherings and workshops, accompany their own arrangement of impediments, including logistical issues for holding gatherings that are maximally comprehensive and representing the real factors of companion intimidation, interpersonal dynamics, identity politics, uncommon premiums and facilitator impact over the span of a gathering (Brody 2003; Burby 2003).

8.4 Policies and Programs of Urban E-Governance in India

The National Policy on IT was proclaimed in 2012; centers around use of innovation empowered ways to deal with conquer great formative difficulties in education, well-being, aptitude advancement, monetary incorporation, employment generation and governance and so forth to significantly improve effectiveness no matter how you look at it in the economy. One of the significant objectives of National Policy on IT is to accommodate required conveyance of and affordable access to every single public service in electronic mode (NPIT 2012). Accordingly, the National E-Governance Plan (NeGP) of Government of India intends to make all the government services available to the public in his neighborhood through basic service conveyance outlets and guarantee effectiveness, straightforwardness and unwavering quality of such services at moderate expenses to understand the fundamental needs of the residents. However, E-Sewa is the principal significant activity in the country to utilize data innovation as an instrument to improve services for residents. NeGP has three level structures. The common service centers (CSCs) are the front-end conveyance focuses for a scope of resident administrations. The common man feels enabled when s/he can get assistance in a straightforward way, at a convenient area and at a moderate expense. These focuses additionally give work to the business people running them. The subsequent level is of the normal and bolster framework that can permit data to be shared electronically between various offices of the legislature and with residents. It included the state wide area networks (SWANs), which structure the converged backbone network for information, voice and video all through a state/UT and the state data centers (SDCs) which can give basic secure IT foundation to have state-level e-government applications and information. The third level includes the 27 mission mode projects (MMPs) which will change high need resident administrations from their present manual conveyance into e-conveyance. Each MMP is possessed and initiated by the significant service or office of the national government or by a State government and is called mission mode since it has clear time table, administration level, venture execution group and procedure re-building plans. E-governance in Municipalities is a one of interesting activities of the Government of India conceptualized under the umbrella of the general National E-Governance Plan (NeGP) and the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) planned for improving operational efficiencies inside Urban Local Bodies (ULBs). A portion of the key targets of the Municipalities MMP are improve service conveyance component, achieve better information management and transparency and ensure citizen's involvement in governance, utilize ICT for sustained improvement in efficiency and effectiveness of delivery of municipal service to citizens. During the first phase of project execution, eight civic services have been identified. Services inclusive of (i) Registration and issue of birth and death certificates (ii) Payment of property tax and utility bills (iii) Grievances and suggestions (iv) Building approvals (v) Procurement and monitoring of the projects (vi) Health programs (Licenses and solid waste management) (vii) Accounting system (viii) Personal informational system. At present, the project has been executed in 35 Mission Cities covering 15 states by March 2012. In West Bengal, two cities namely Kolkata and Asansole are incorporated under the program.

However, there are number of projects running successfully as well as provide both win–win situation to government and citizens. Following are some of the projects that run across the various states in India. The Andhra Pradesh government propelled the e-sewa program to offer integrated services to residents of the state. The e-sewa focus is a one stop-search for in excess of 30 government-to-buyer (G2C) and business-to-purchaser (B2C) administrations. From installment of power, water and phone bills to the issue of birth and death certificates, allows and licenses, reservation of transport tickets and receipt of visa applications, the e-sewa focuses to offer a wide scope of services under one rooftop. SETU (meaning "Bridge" in local language) or the Citizen Facilitation Center has been set up by government of Maharashtra in the city of Aurangabad (populace 1 million approx) as a one stop service center for residents who need to visit government offices for certificates, licenses, affidavits, testimonies and other services. The center endeavors, using ICT, to diminish the visit of residents starting with one office then onto the next and forestall the working of touts while giving more prominent straightforwardness, openness and productivity to the procedures in decision making. Key partners are the common public, particularly farmers, workers, small entrepreneurs and students who require certificates and licenses. Different partners are the NGO and government authorities. In the province of Kerala in South India, FRIENDS (Fast, Reliable, Instant, Efficient Network for Disbursement of Services) centers give a one-stop, front-end, IT-empowered installment counter office for the government payments to be made by residents. FRIENDS is a front-end arrangement now, i.e., it is a counter automation instead of a procedure improvement venture, since the back-end computerization is yet to be finished. The counters are prepared to deal with roughly 1000 kinds of payments because of public sector departments/organizations, viz. utility payments for power and water, income taxes, permit expenses, motor vehicle charges, college charges and so forth (Kalsi et al. 2009). In West Bengal, number of e-governance initiative was taken for different aspect includes telemedicine, smart card-based driving license and registration, digitization of land records, municipal GIS, etc., the next section exclusively focused on the municipal e-governance in West Bengal.

8.5 Urbanization and Role of E-Governance in West Bengal

In the current e-administration arrangement of West Bengal, information by means of short message service (SMS) is as of now accessible for various administrations for example emergencies, weather forecasts, well-being-related issues, results of public exams, passport delivery updates and others. The service can be progressively productive when the service is not restricted to SMS. Here, I would focus on the two aspects ,e.g., knowledge platform and ecosystem of interactions of the e-governance in selected Urban Local Bodies (ULBs) in West Bengal. The ULBs include Kolkata Municipal Corporation (KMC), Durgapur Municipal Corporation (DMC), Asansole Municipal Corporation (AMC) and Howrah Municipal Corporation (HMC), Chandannagore Municipal Corporation (CMC), and Bidhannagore Municipal Corporation (BMC) and Siliguri Municipal Corporation (SMC). Selection of these urban local bodies are done based on their corporation status. Since, municipal corporation is large in size both in areal extent and population than municipality, so it has potential of higher revenue generation and ability to facilitate and deliver e-governance. Due to this reason, Municipal corporation has been taken into consideration for the study. Traditionally, West Bengal exhibits lopsided urbanization pattern where maximum share of urban population concentrates in and around the Kolkata Metropolitan Area (KMA) (Dasgupta et al. 1988). But recent emergence of number of census towns has changed this skewed urbanization pattern, urban population is now more spread across the Gangetic plain (Karmakar 2015; Chatterjee 2013). Out of the seven municipal corporations, four municipal corporations are located within the Kolkata Metropolitan Area (KMA), and rests are located in the Asansole and Durgapur Development Area (ADDA) and in the northern part of the state. Table 8.1 shows demographic and administrative details of these municipal corporations.

It is remarkable here to note that BMC is the youngest municipal corporation, while others are being constituted at least five years ago. All the selected municipal corporations have their own Web site, and very few numbers of people visit these Web sites regularly which is apparent from the available visitors figure per day. In fact, frequent visits of the urban local bodies Web site are one of the crucial aspects of the successful e-governance. To maintain higher number of visitors, Web site should be designed in such a way so that it can enhance the user satisfaction. It could be done by improving the usability, accessibility and efficiency of user interaction with websites. For the enhancement of the Web site, the following interconnected components have to be taken into considerations. Flow of the Web site has to be kept in such a manner so that users can notice the items in order of their importance. Scrolling and loading are the next important interconnected components which make sure that users can

Table 8.1 Demographic and administrative details of the municipal corporations

Municipal corporation	Population (2011)	Area in sq. km	Population density	No. of wards	Visitors hit per day in Web site[a]
KMC	4,496,694	185.00	24,306	144	1928
HMC	1,077,075	51.74	20,817	50	NA
BMC	618,358	61.10	10,120	41	329
CMC	166,867	22.10	7550	33	268
DMC	566,517	154.20	3673	43	NA
AMC	563,917	125.23	4503	50	339
SMC	513,239	42	12,219	47	NA

Source Census of India, Town directory, 2011
[a]Computation based on month of May 2019

Table 8.2 Types of information available in municipal corporation Web sites

	Interactive information		Billboard information			
	Online services	Grievances	Administrative	Department	Important links	Others pages
No. of MC	6	4	7	7	5	1

Source Compiled by author based Website data of ULBs in April 2019

complete their primary goal quickly and easily without much scroll down. Last two components include icon and search. Icon has to be made in such a way so that users can easily recognize the meaning of that icon it represents. Search option has to be kept at the top of the Web site so that user can access immediately the items they are looking for. Therefore, to attract more users in e-governance, a user friendly Web site has to be prepared, and municipal corporations are accountable for that.

Information available in the Web sites of each of the municipal corporations is categorized as either billboard information or interactive information. User can utilize interactive information through online, while billboard information can be used for different purposes but not through online. Various citizen services and grievances are the examples of interactive information available in Web sites. Municipal corporations' basic detail, demographic and department details are the examples of billboard information. Table 8.2 shows different types of interactive and billboard information available in each municipal corporation Web sites.

It is evident from Table 8.2 that all the municipal corporations have provided the online services, but presence of grievances in their Web sites is only present at four municipal corporation. It is important to note here that online grievances are one of the important aspects of e-governance. The other important features like quick links and details of the various departments are available. The prime online services facilitate in these municipal corporations are including birth and death registration, building sanction, property tax, trade license, water supply services, heath services, booking facilities, etc. Unlike Siliguri Municipal corporation, rest of the six municipal corporations has online services.

Santos and Heeks (2003) and West (2004) recognize four or five phases of e-government services, which recognize where distinctive government departments are headed for change: (1) "the billboard stage; (2) the partial service delivery stage; (3) the portal stage with fully executable and integrated service delivery; (4) the seamless stage with full integration of e-services across administrative boundaries and (5) the interactive democracy stage." Following are details of the services and their stages as per Heeks and West's framework (Table 8.3).

The above list of various services across the municipal corporation helps us to understand their stages in e-governance. It shows that most of the services available in the municipal corporation are in billboard stage which means municipal corporation is disseminating information, simply by posting information on the Web sites. License and property tax are only in the portal stage. No interactive democracy

Table 8.3 Services in the MC and their stages

Advertisement (BS)	Drainage (BS)	Market (BS)
Assessment collection (PSDS)	Education (BS)	Parking and square (BS)
Birth and death registration (PSDS)	Engineering (BS)	Sewerage and drainage (BS)
Building sanction	Health service (BS)	Social welfare and urban poverty alleviation (BS)
Car parking (BS)	Heritage conservation (BS)	Solid waste (BS)
Bustee service (BS)	KMCP school (BS)	Water supply (BS)
Central records (BS)	Lighting (BS)	Online mutation (BS)
C.H.V.S Dept (BS)	License (PS)	Property tax (PS)

Source Complied and modified by author after Santos and Heeks 2003, West 2004
Note *BS* Billboard Stage; *PSDS* Partial Service Delivery Stage; *PS* Portal Stage; *SS* Seamless Stage; *IDS* Interactive Democracy Stage

stage-based service is available across the municipal corporations. It involves the promotion of Web-based political participation of the various services.

Beyond the online services, it is founded that only few municipal corporations have social media page for direct public interaction. Sometime, these pages are closed group and created by enthusiast local residents. Therefore, very little scope remains for public to interact through such knowledge platforms. It is highlighted by experts that the framework overlooks the issues of absence of education, local language settings and significant applications for poor people (Prasad and Sinha Ray 2012). Moreover, to boost the idea of e-governance, Common Service Center Scheme was launched by installing access points targeting at the “common man”. The so-called Common Service Center Scheme in India is a piece of the National e-Governance Plan Project (NeGP). It is sorted out as a public–private partnership and incorporates a financial plan of 270 billion rupees (~4.25 billion USD). The underlying objective to introduce around 100,000 “tele-centers” is nearly reached today, with the goal that the nation is hypothetically bolstered across the nation. These focuses should offer services in the fields of education, tele-medication, farming and entertainment (Dass and Bhattacherkee 2011). In spite of the fact that the endeavors for actualizing the project have been enormous, it is condemned for its poor interest and affordability among its clients. Therefore, to achieve sustainable urbanization e-governance is a significant aspect. The comparison of the Web sites analyzed suggests that they are in the preparatory stage of e-governance and e-services are in the nascent stage in West Bengal.

8.6 Conclusion

The chapter made an attempt to explore the e-governance situation in all the municipal corporation in the State of West Bengal. It should be noted that the different stages of E-governance incorporated here as conceptual tool to examine the system. The appropriation of e-government practices may not follow a genuine linear progression. Government may build up the segments of e-services at various velocities. It is likewise conceivable that government can seek after different segments of e-government at the same time. The system just gives an exploratory conceptual tool that encourages one comprehend the transformative idea of e-government and their challenges in the state. The framework shows that e-government and its services are in formulation stage. Most significantly, the e-services are in the billboard stage. Apart from services, it also sheds light on the various e-governance policies and plans introduced to cope up with the changing e-governance. It is also apparent that low participation in e-governance remains a major challenge in the state; however, e-government needs to be integrated into the broader public management reform framework. So that it can bring citizens closer to their governments.

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Chapter 9
Technology and Employment: Empirical Evidences in Technology Product Exporting Asian Economies

Krishnendu Maji

9.1 Introduction

The technological progress over the last decade has undergone a very stiff positive transformation. This progress can be categorized into three different stages namely craftsmanship, mechanization and automation (Krishnan 2010). The craftsmanship represents a stage where workers or labor have full control over the entire production process. Although in the present-day scenario craftsmanship is not something which is sufficient enough for technological progress. End-to-end knowledge of the entire production process is not viable today due to the complex nature of the products. As a result, modern-day production process mostly governed by the second stage of technological progress, which is mechanization. Mechanization represents the stage of technological progress where the entire production process is subdivided into a finite number of parts. In this scenario, most workers are involved with a single part of the production. Therefore, this stage can be considered as a stage of specialization. Engineers as a class of labor evolved in this stage of specialization. After the stage of mechanization, as species, we are moving toward the stage of automation in our day-to-day life. The concept of automation is affecting production technology drastically. It has a very ambiguous effect on labor requirement in the production process. Whereas mechanization substitutes labors in the production process, automation replaces them by high-tech machinery. An increasing amount of investments in the field of robotics and artificial intelligence is making unskilled labor almost unemployable.

Therefore, automation in production technology triggers intense debate and headlines. Broadly speaking, there are two major views governing the debate about the employment effect of new technology. In one hand, as a director effect, labor-saving

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innovations create technological unemployment as discussed above. On the other hand, as an indirect effect, technological progress contributes to the creation of new job opportunities by creating new products. Therefore, the net impact of technological progress on job creation is not unambiguous.

There is a number of ways by which innovation can increase employment opportunities. Firstly, under perfectly competitive market conditions, innovation improves the efficiency in the production process, which increases the demand for final goods and services. And as we all know the increase in demand always leads to an increase in employment opportunity. Even under imperfect competition, where the factor market is not perfectly competitive, innovation and automation may increase the level of employment. As we discussed above, new technology makes unskilled labor unemployable. Therefore, the introduction of new technology always leads to a certain degree of attrition, which eventually increases the profitability of firms. Firms eventually redistribute its profit among its skilled labor force, which eventually increases the demand for final goods and services due to higher consumption expenditures by the existing labor force, which indirectly improve the employment opportunities. Secondly, innovation always encourages the creation of new products and services which eventually increase employment. These new products sometimes create a new market which creates new employment opportunities.

As opposed to the scenarios discussed above, in a number of ways, innovation may cause unemployment. Firstly, and most importantly, innovations that create new products may replace or displays an existing mature product from the market (MP3 format replacing music CDs). Such a scenario may create permanent unemployment. Workers displaced due to replacement of the old product by modern products cannot find a demand for their skills. Those labors will drag into long-term unemployment or a sequence of short-term low-paying jobs with periods of unemployment in between. Secondly, technological progress, more specifically automation, substitutes humans by machines, which eventually reduce job opportunity.

As discussed above, economic theory does not have an unambiguous answer regarding the employment effect of innovation. Therefore, there is a need for empirical analyses that can address the issue of the employment impact of technological change. In manufacturing, employment level grew along with productivity for a century or more. But in this era of increasing automation in the industrial sector, it is necessary to reinvestigate the decade-old trend. This paper explores the possible job creation effect of innovation activity on a panel of twenty-two major technology product exporting Asian economies. The concerned study concentrates on a time horizon ranging between 1996 and 2015.

The remainder of the paper is organized as follows: Sect. 9.2 provides an overview of the previous empirical literature on the relationship between innovation and employment; Sect. 9.3 presents the dataset used for this analysis; Sects. 9.4 describes the empirical techniques used for this analysis and presents all the findings. Finally, we conclude in Sect. 9.5.

9.2 Review of Literature

The interrelationship between innovation and employment is a classical debate. Academic research on this issue can be found as early as 1931 (Scheler 1931). As a result, it is quite clear that a large number of studies already have been conducted to test the interrelationship between innovation and employment. Therefore, a complex, multi-stage, and time-consuming process has to be followed to perform a systematic literature review on this area manually. In order to overcome this challenge, text mining techniques and tools are being used to facilitate systematic literature review activities (Feng et al. 2017). More than fifty studies have been analyzed (Abstract and Conclusion) to identify the pattern of result found and the possible explanations given for such results.

Primarily, a frequency-based study has been performed to identify the overall pattern in the literature substance. Not surprisingly, ‘innovation’ and ‘labor’ appeared to be the most frequently used words in the literature other than ‘employment’ and ‘technology’. Words synonyms or antonyms to ‘employment’ (such as job, unemployment) appears among the most frequently used words. Among others, words such as ‘manufacturing’, ‘firm’, ‘skill’, ‘wage’, ‘sector’, ‘growth’, and ‘industry’ appear quite frequently. Words like ‘robots’ also have a rare appearance in the literature. Among the fifty studies used in this analysis, 32 share negative sentiment regarding the relationship between employment and technology. Negative words such as ‘displaced’, ‘problems’, ‘decline’, ‘unskilled’, ‘destruction’, ‘limited’, ‘inequality’, ‘loss’, and ‘conflict’ are being used in the literature quite extensively. Such use of words primarily reflects the negative side of innovation and technological progress, which is unemployment or layoff of unskilled workers. Among positive words ‘innovation’, ‘skill’, ‘significant’, ‘advanced’, ‘important’, ‘benefits’, ‘complementary’, ‘variety’, ‘rapid’ are found to be most frequent in the literature. These words explain how innovation and rapid technological progress can benefit economic growth and complement job creation.

The frequency-based analysis primarily can provide the broad domain of the literature. On the other hand, more sophisticated algorithms on text mining (such as hierarchical clustering and latent semantic analysis, etc.) need to be used in order to find out narrow more specific findings within the existing literature. Using hierarchical clustering technique (based on presence of positive and negative sentiments), it is possible to find out four major observations made in the literature, which represent 16, 10, 7, and 4 research publications or research activities, respectively, in the concerned area. The cluster that contains most number of research publications (see Encarnacion 1974; Pickett and Robson 1977; Henize 1981; Brooks 1983; Rumberger and Levin 1985; Blazejczak 1991; Zimmermann 1991; Alic 1997; Dunne et al. 1997; Hersh 1999; Fung 2006; Samaniego 2006; Malul 2009; Roessner 1985; Frey and Osborne 2017) primarily acknowledges needs for the introduction of new technologies and innovation in the production process for sustainability and efficiency. But, at the same time, these research works accept negative effect of technological progress on employment generation. Other major clusters in the literature (see Rothwell 1981;

Brouwer et al. 1993; Ducatel and Millard 1996; Van Reenen 1997; Klette and Førre 1998; Díaz et al. 2002; Piva and Vivarelli 2004; Bogliacino and Pianta 2010; Cirillo 2017; Roy et al. 2018) are quite optimistic about the job creation. According to this set of research works, labor-friendly innovation can potentially create jobs and increase the productivity of the labor force. The third cluster in the literature (see Paul and Siegel 2001; Kreickemeier 2009; Krishnan 2010; Howell 1985; Ernst 1986; McCurdy 1989; Lordan and Neumark 2017) is primarily talks about level of skill and employability under increasing automation in the production process. As expected, majority of studies in this set of research suggests that low-skilled workers become unemployable under increasing automation. On the other hand, technological progress potentially creates new job opportunities for high-skilled workers. Finally, the last major cluster in the literature (see Mortensen and Pissarides 1998; Gali 1999; Postel-Vinay 2002; Kemeny and Osman 2018) provided an ambiguous conclusion regarding the technology–employment association.

9.3 Data, Variables, and Exploratory Analysis

The study examines a panel of twenty-two major technology products exporting Asian economies with data from the Web site of World Development Indicators (Source: (a) World Bank national accounts data, (b) International Labour Organization, ILOSTAT database, and (c) United Nations, Comtrade database through the WITS platform) for the period 1996–2015. Restriction to only twenty-two countries in the continent is due to constraints in data availability. Finally, the chosen time horizon (1996–2015) primarily determined by the availability of data. At the same time, Asian developing economics has shown rapid technological progress within the given time horizon. The variables used for this analysis include (a) real GDP, (b) employment-to-population ratio in percentage form for 15+ age group (Rate of Employment), and (c) high-technology exports, respectively.

The study used high-technology exports to real GDP ratio as an indicator of technical progress of an economy. Acceleration in this ratio is going to be considered as an improvement in the competitive power of technology products produced in a particular country, which most of the time can be concluded as improvement in the technological level in the production process. Finally, median of first difference of log of real GDP has been used for the computation of average acceleration of economic activity in a particular economy within given time horizon (1996–2015).

In order to explore the data, the correlation coefficient between high-technology exports to real GDP ratio and employment-to-population ratio being plotted against the average acceleration of economic activity within 1996–2015.

As the diagram suggests, there is a negative relation between the two variables. The diagram also suggests that countries having a high degree of economic acceleration encountered a trade-off between technological progress and employment generation. On the other hand, countries with low levels of economic acceleration found to have a positive association between the two. More interestingly, the upper segment of the diagram suggests a small acceleration in economic activity potentially can worsen technology–employment complementarily drastically in countries with a low level of economic acceleration. But, in order to neutralize the degree of trade-off between technology and employment, countries having a high level of economic acceleration must sacrifice a large chunk of economic growth.

In Fig. 9.1, out of 22 major technology products exporting Asian economies, 21 have been used for analysis. Japan remains excluded from the above diagram because the study considered it as an outlier (having a very low degree of association between technology and employment along with very low level of economic acceleration). Six more countries remain outside of further empirical investigation (Kyrgyzstan, Republic of Korea, Thailand, Jordan, Singapore, and Georgia). All these six countries have very weak association between technology and rate of employment (±0.15). The study concentrates only on a set of Asian countries having a strong association between high-technology exports to real GDP ratio and employment-to-population ratio (either positive or negative).

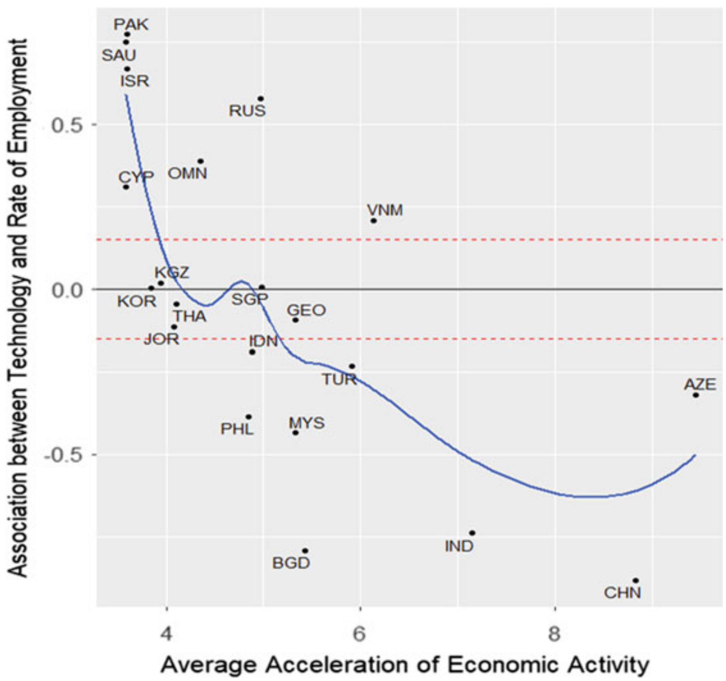

Fig. 9.1 Dependence of ITES-Employment relationship on economic acceleration. *Source* World Bank national accounts data, International Labour Organization, ILOSTAT database, United Nations, Comtrade database through the WITS platform

9.4 Methodology and Results

As explained earlier, primary objective of the study is to analyze the association between employment and technological progress (i.e., responsiveness of employment with respect to change in technology). In this context, two sets of countries are being analyzed separately: Set I: countries having positive correlation between technology and the rate of employment (Pakistan, Israel, Saudi Arabia, Russia Federation, Oman, Cyprus, and Vietnam) and Set II: countries having negative correlation between technology and the rate of employment (Indonesia, Philippines, Turkey, Malaysia, Bangladesh, India, China, and Azerbaijan).

Other than technological progress, economic growth also can affect the employment level. In most macroeconomic models, economic growth and growth in employment level are considered to be synonyms. But such a scenario is possible only if there is perfect competition in all the markets (both, product as well as factor markets), which is not true in reality. Most often, employment growth lags behind the growth of GDP—the scenario best described as 'jobless growth'.

The model used in this study to assess the relationship between level of employment and technological growth is a first-order auto-regressive model described below:

$$\mathrm{EMP}_{it} = \alpha_{it} + \beta_{it}^{1}\mathrm{TECH} + \beta_{it}^{2}\mathrm{GDP}_{it}^{g} + \rho_{it}\mathrm{EMP}_{it-1} + \delta_i t + u_{it}$$

where $i = 1, 2 \ldots, N$ is the country index, $t = 1, 2, \ldots, T$ is the time index and u_{it} a random disturbance term of mean 0. EMP stands for rate of employment, TECH stands for high-technology exports to real GDP ratio (an indicator of level of technology), t stands for individual trend, and GDP^{g} stands for growth rate of GDP represented by the following formula:

$$\mathrm{GDP}_{it}^{g} = \log\left(\frac{\mathrm{GDP}_{it}}{\mathrm{GDP}_{it-1}}\right)$$

where GDP_{it} represents level of real GDP at period t for ith country.

Therefore, the model specification is a dynamic one as it incorporates the lag values of the dependent variable as an explanatory variable.

A number of assumptions can be made regarding the parameters, errors, and the exogeneity of the regressors of this model. The most common one is parameter homogeneity (or pooled linear regression), which means that $\alpha_{it} = \alpha \forall i \,\&\, t$, $\beta_{it}^{k} = \beta^{k} \forall i \,\&\, t$, $\delta_i = \delta$ and $\rho_{it} = \rho \forall i \,\&\, t$.

The error term has two separate components under the assumption of individual heterogeneity: (a) the individual-specific component (μ_i) that does not change over time and (unobserved effects model) (b) the idiosyncratic error or innovation (ϵ_{it}): well-behaved (generally, normally distributed, mutually uncorrelated, and stationary) and independent from both the regressors and the individual error component. That is, $u_{it} = \mu_i + \epsilon_{it}$. Now, under a fixed effect model, this individual component is correlated to regressors, and therefore, $\alpha_{it} = \alpha_i \forall t$. On the other hand, in the random effect model, individual-specific component is uncorrelated with the regressors.

The present study utilizes a dynamic mean group estimation technique as prescribed by Pesaran and Smith (1995). Pooling, aggregating, averaging group estimates, and cross-section regression are the most widely used estimation techniques for paned data. All the four procedures provide unbiased estimates of coefficient means in the static scenario if the coefficients vary randomly. On the other hand, as shown by Pesaran and Smith (1995), in the dynamic case, when the coefficients differ across groups, pooling and aggregating can give inconsistent and potentially highly misleading estimates of the coefficients. They consider the mean group (MG) estimator in dynamic models. A simple MG method uses less restrictive parametric assumptions relative to other estimation techniques. More importantly, unlike aggregated or pooled regressions, it provides consistent estimates of both coefficients and standard errors. As in the original paper, this study also includes individual trends in the model specification. The estimated regression results corresponding to two sets of countries are given in Table 9.1.

As Table 9.1 suggests the intercept and lagged dependent variable turns out to be significant in both the regression equations, along with that, the sigh and the magnitude of both the estimated coefficients found to be almost identical for both set of countries. Both the regression equations fit the data very strongly. Other than these similarities, estimated results in two regression equations differ in certain aspect. Firstly, coefficient corresponding to acceleration of economic activity (i.e., growth rate of GDP) found to be significant and positive only for those countries that have positive correlation between technological growth and the rate of employment. For the other set of countries (having negative correlation between technological growth and the rate of employment), the acceleration of economic activity has no significant

Table 9.1 Regression result (dynamic mean groups)

	Set I: Countries having positive correlation	Set II: Countries having negative correlation
Intercept	20.85 (<0.1)	19.89 (<0.01)
Technology	0.13 (>0.1)	−0.77 (<0.05)
Growth rate of GDP	0.11 (<0.05)	0.02 (>0.1)
Lag of rate of employment	0.66 (<0.01)	0.67 (<0.01)
Trend	0.1 (<0.1)	0.02 (>0.1)
Goodness of fit (R^2)	0.997	0.997

Note: *P*-values corresponding to coefficients are in the parentheses impact on employment generation. Secondly, the coefficient corresponding to indicator of technological progress found to be significant and negative corresponding to countries having negative correlation between technological growth and the rate of employment. For the other sets of countries, the coefficient remains insignificant.

Therefore, the above results suggest that Asian countries which show relatively high degree of economic acceleration in the given time horizon adapt production technologies which are primarily labor displacing, and economic acceleration does not contribute to creation of jobs. In contrast to that, economic acceleration in Asian countries which shows relatively low degree of economic acceleration in the same time horizon contributes significantly to creation of employment opportunities. Finally, micro-level country-specific estimates of parameters are given Table 9.2.

As shown in Table 9.2, firstly, for most countries (Set I and Set II taken together), coefficient corresponding to the acceleration of economic activity found to be positive (Except: Oman, Vietnam, Indonesia and Philippines). Secondly, major chunk of countries belonging to Set II has negative coefficient corresponding to indicator of technological progress (Except: Malaysia and Indonesia). Finally, most countries belonging to Set I have positive coefficient corresponding to indicator of technological progress (Except: Israel, Russia Federation, and Saudi Arabia). Although too much conclusion should not be made out of Table 9.1, statistical significance of country-specific estimated parameters is not available from the estimation technique.

The entire study primarily is limited by the availability of data (especially the time dimension). On the other hand, criticism regarding the regression equation may come

Table 9.2 Country-specific estimated parameters

Set	Country	Intercept	Technology	Growth rate of GDP	Lag of rate of employment	Trend
Set I	Israel	11.82	**−0.23**	0.22	0.76	0.17
	Oman	4.47	0.40	**−0.005**	0.89	0.24
	Pakistan	−0.14	4.15	0.16	0.99	−0.04
	Russia Federation	36.66	**−0.25**	0.16	0.29	0.35
	Saudi Arabia	1.03	**−4.40**	0.05	0.96	0.08
	Vietnam	83.39	0.13	**−0.08**	−0.10	−0.07
	Cyprus	8.68	1.14	0.27	0.84	−0.02
Set II	Azerbaijan	24.72	−0.94	0.02	0.55	0.20
	Bangladesh	37.86	−2.44	0.17	0.31	−0.07
	China	34.44	−0.20	0.02	0.54	−0.15
	Indonesia	17.92	**0.03**	**−0.02**	0.71	0.01
	India	11.85	−2.49	0.01	0.80	0.004
	Malaysia	−1.23	**0.002**	0.007	1.01	0.05
	Philippines	32.76	−0.04	**−0.05**	0.47	0.002
	Turkey	0.83	−0.10	0.03	0.95	0.10

from the incorporation of the lag of the dependent variable as the explanatory variable (Reed and Zhu 2017). Reed and Zhu (2017) have shown the hazards associated with this practice. Finally, the study should be extended to countries belonging to other continents to get a more general understanding regarding the relationship between technological progress and job creation.

9.5 Conclusions

Primarily, the exploratory analysis in the study suggests that countries having a high degree of economic acceleration encountered a trade-off between technological progress and employment generation. On the other hand, countries with low levels of economic acceleration found to have a positive association between the two.

Finally, empirical model used in the study suggests following findings:

(a) Acceleration of economic activity significantly and positively affects employment generation for those countries that have positive correlation between technological progress and the rate of employment (also having relatively low degree of economic acceleration in 1996–2015).
(b) Asian countries which show relatively high degree of economic acceleration in the given time horizon adapt production technologies which are primarily labor displacing, and economic acceleration does not contribute to creation of jobs.

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Chapter 10
FDI, ICT and Economic Growth in Developing Countries: An Empirical Analysis

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10.1 Introduction

Inflows of foreign direct investment (FDI) are well recognized as one of the efficient channels for transferring the advanced technologies and fostering economic growth in developing nations. A group of some mainstream economists under the school of New Theory of Economic Growth considers FDI inflow as a driver of the engine of growth of the economy. They think that inflows of FDI affect not only the per capita economic output but also the rate of economic growth. Bringing this background into the current phase of globalization, it would be observed that advancement of technology through the means of FDI inflows having a vital role in the economic growth process is deeply fuelled by the promotion of information and communication technology (ICT) particularly in developing countries. It is a fact that during last three decades, globalization has performed with its high-speed engine particularly in developing world as reflected in terms of chunk amount of FDI flows, volume of trade, etc., and ICT has also entered into the process with its long and wide wings as a complementary matter. However, with the versatile views several studies document manly two kinds of empirical outcomes; firstly, the huge amount of FDI inflows is nothing but a results of a parallel upgradation of ICT base in developing nations, and another side says that the observed development of ICT in developing

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economies is a complementary results of a big size of FDI inflows from developed world. So, in order to find out the dynamic impacts of FDI on economic growth the present scenario should incorporate ICT as one of the most important drivers of digitalization in developing countries.

The improvement of ICT has made the globalization as a truth mainly in developing economies. Moreover, ICT enables the respective nations to extract their potentiality in economic sphere in terms of the expansion in productivity and competitiveness, and it can also augment the economic efficiency through spreading the flow of relevant information across various sectors, communities, producers, consumers as well as policy planners within and between nations. Through the channel of growing global linkages ICT directly affects FDI inflows significantly, and it also might be considered as a determinant of FDI inflows[1] and economic growth. According to the theoretical view in economics, knowledge developed from international economic activity is important for all nations; in particular for those lagging behind the developed ones. For instance, ICT puts forth a direct impact on two important determinants of economic activities, such as innovation and entrepreneurship.

The newly developedinformation-based economy during last two and half decades is associated with the development of ICTs, which are anticipated to raise efficiency and foster economic growth (Dimelisa and Papaioannou 2010). Through all of these outcomes, inflows of FDI enable the hosting country to achieve a better growth trajectory (Lee 2013).[2] Moreover, FDI inflows, especially from the developed to the developing nations may be act as a stimulus to the ICT investment, as the improvement in ICT eases the process of the advancement of technology and skill formation in the latter countries. Therefore, FDI inflow can expand use the use of ICT and ICT expansion may stimulate FDI inflow, and that is why hypothetically both FDI and ICT should have their positive multiplier effects on economic performances of the country. It is also worth to be noted that progress of ICT and FDI inflow both have numerous beneficial influences on the developing trends of the society.

Based upon these underlying theoretical views, to the best of analytical knowledge gathered, as of now a few empirical research works have been conducted by researchers and policymakers for examining the influence of ICT on the expansion of economic activities in several countries. Findings of the existing studies are not unambiguous particularly in developing economies. Moreover, there are a couple of studies exploring impacts of FDI on economic performances where ICT is also taken into account in mostly in the cases of developed countries. The results of the existing

[1]The finding of the study of Gani and Sharma (2003) reveals that ICT and the transmission of the new instruments of ICT, i.e., internet hosts, mobile phones, etc., are playing as important ‘pull’ factors for the volume of FDI inflows. Gholami et al. (2006) have identified that in the developed countries there is a causal relationship between ICT and FDI inflows, i.e., rise in the investment for the expansion of ICT investment will increase the FDI inflow.

[2]FDI inflow and GDP growth linkage can be sketched from early neoclassical theories of growth. According to them, FDI inflow raises capital stock of the hosting nations and promotes economic growth. It is also revealed from the new theories of economic growth that inflow of FDI enables a nation to achieve a better trajectory of economic growth not only in short-run but also in long-run. This achievement can be realized through technological improvement in the production process.

studies based on the developed countries substantiate some positive influences of FDI inflows and ICT on economic growth. However, for the developing nations there is no unambiguous result on the relationships. Furthermore, the number of studies investigating the impacts of FDI and ICT on economic output is relatively sparse and country-specific for both developed and developing nations.

Therefore, there is a necessity to look at the dynamic impacts of FDI inflows and evolution ICT on gross domestic product (GDP) across a group developing nations which experience a considerable amount of FDI inflows to those countries. Against this background, the present study attempts to conduct an empirically investigation to provide an insight into the impacts of the inflows of FDI and expansion of ICT on economic expansion measured by GDP growth in selected 36 developing nations during the era of digitalization. The remainder of the chapter is organized as follows. The next section carefully documents the brief review of available, related and existing literature followed by the discussions on data sources and methodological issues used in this empirical study. Empirical results are well described thereafter, and the final section concludes the study.

10.2 Review of Literature

With the vast background of theoretical and empirical literature analysing the economic impacts of FDI inflows, the choice of studies incorporate both FDI and ICT together in order to look into their significances in economic growth during the recent past is really a difficult issue particularly in developing countries. Reviewing the studies which are carried out to examine the effects of FDI inflows on economic performances, different types of findings have been observed. The outcomes of Hejazi and Safarian (1999) reveal that FDI inflow is an important way for technology dissemination across the OECD countries. Invoking both panel data regression and time series regression techniques, and by using the data collected from some OECD and non-OECD countries during the period from 1970 to 1990, De Mello (1999) showed that the effects of capital inflows for direct investment on economic growth depend on the complementarity or substitutability between domestic and foreign capital across the hosting nations. By using panel data set of 24 Chinese provinces over the period of 1985–1996, Barthelemy and Demurger (2000) found a significant direct influence of the inflow of foreign capital on the expansion of economic activities, i.e. on economic growth. Likewise, Alfaro (2003) identified that rise in the inflow of FDI does not raise the GDP of the hosting country unambiguously. More specifically this study has found that rise in FDI inflow has a negative influence on the growth of the primary sector and a positive influence on the growth of the manufacturing sector.

Using the data from 66 developing nations, Makki and Somwaru (2004) pointed out a positive influence of FDI inflow and exports on economic growth. Using the data set collected from some selected East and Southeast Asian nations, Hsiao and Hsiao (2006) recommended a unidirectional direct and indirect influence of FDI inflow on the GDP through exports. Sharma (2013) referred that FDI inflows perform as an amplifier for the growth of the economy and subsequently promote employment and output through entering different external investment activities in host economies. Sahoo et al. (2014) reviewed the consideration of the classical economists referring that FDI inflow is a driver of economic growth having a positive influence on per capita income. Kida (2014) examined the dynamic inter-linkage between FDI inflow and economic growth within Solow and endogenous growth models, results imply that a direct influence of FDI inflow on economic growth in both developing and developed countries. Sârbu (2015) documented that countries experience better economic growth while receiving better FDI inflow.

During last twenty years, a considerable number of research works are conducted to examine the influence of ICT on the growth of the productivity (Brynjolfsson and Hitt 1996; Timmer and Van Ark 2005; Chun and Nadiri 2008), and also on the expansion of economic activities and growth (Jorgenson and Stiroh 1995; Mansell and Wehn 1998; Pohjola 2001; Papaioannou and Dimelis 2007; Ishida 2015; Erumban and Das 2016). Findings of most of those studies reveal the direct relationship between the expansion of ICT and economic growth of the respective nation. However, observing the findings of these studies it can be identified that there is a sharp disparity between developed and middle- or low-income countries while we focus on the effects of the advancement of ICT on economic growth. According to the findings of these studies, advancement of ICT influences economic growth positively and significantly across the developed countries. However, the expansion of ICT base through the rise in investment in this sphere has no significant influence on economic growth for the middle countries and poor income countries across the world (Pilat and Lee 2001). However, Kraemer and Dedrick (1994) conducted a study by using the data set of 12 Asia Pacific nations and found a quite different result, i.e. there is a positive and significant correlation between growths in investment in information technology and GDP.

Most of the studies discuss these two above-mentioned factors (FDI and ICT) separately mainly in country-specific cases. However, a single analysis gathering a group of countries in order to find out economic impacts of FDI and ICT is really rare as of now. This background encourages conducting the present study.

10.3 Data and Methodology

The study builds up a balance panel of selected 36 developing countries[3] across the world from 2001 to 2017. All regions of the world are equally treated in order to choose countries for empirical illustrations with the consideration of the latest formula of the World Bank classifications of countries as per their per capita income

[3] Argentina, Azerbaijan, Bangladesh, Brazil, Cambodia, China, Colombia, Costa Rica, Dominican Republic, Egypt, Ethiopia, Ghana, India, Indonesia, Iran, Kazakhstan, Lebanon, Malaysia, Mexico, Morocco, Mozambique, Myanmar, Nigeria, Pakistan, Panama, Peru, Philippines, Romania, Russia, Serbia, South Africa, Thailand, Turkmenistan, Ukraine, Uzbekistan and Vietnam.

level. Finally, the countries are selected as per their performances in receiving of FDI inflows during current period. Besides FDI, ICT and GDP, the study employs some other variables to control them in regression analysis like gross domestic capital formation (DFC), volume of trade (TRD) measured by export plus import and real effective exchange rate (EXR) as a standard measure of foreign exchange rate. Data on all variables except ICT are collected from World Development Indicators (WDI) of the World Bank (2018). International Telecommunication Union (2018) provides the World Telecommunication Indicators (WTI) database, from which the data on ICT as per standard measure is collected for those countries over the same period.

In this study, the estimation of generalized method of moments (GMM) as prescribed by Arellano and Bond (1991) is employed within a dynamic panel structure in order to control the endogeneity issues. The regression models with panel data are more competent for controlling the individual level heterogeneity by gathering more information as compared to time series and cross-sectional data. To conduct the dynamic panel regression analysis, first the study uses Levin et al. (2002) and Im et al. (2003) proposed panel unit root test in order to examine the stochastic features of variables. Equation (10.1) presents the augmented Dickey–Fuller (ADF) specified panel unit root test.

$$\Delta y_{it} = \rho y_{i,t-1} + \sum_{j=1}^{P_i} \eta_{ij} \Delta y_{i,t-1} + X'_{it}\delta + \varepsilon_{it} \tag{10.1}$$

Levin et al. (2002) test allows the intercept including residual variances and the dynamic trends with autocorrelation order; however, it requires the auto-generated time series data with general sample size and the coefficient of autocorrelation (ρ). The individually varying lag order is chosen by t-statistic of η_{ij} by considering the highest lag and thereafter ρ would be estimated from the regression equation of Δy_{it} on $\Delta y_{i,t-j}$ and X_{it}. However, the general criterion of ρ is the major limitation of the Levin et al. (2002) test. But Im et al. (2003) test captures the different ρ for every cross-sectional unit within a heterogeneous panel.

The GMM estimation technique as referred by Arellano and Bond (1991) is extensively used in dynamic panel models with fixed effect, where the fixed effects are eliminated first by taking first-differenced form of the equation, and thereafter, the model estimates instrumental variables, and the study applies the same. Sargan (1958) test results validate the instruments. The dynamic panel equation with one-period lag is presented by Eq. (10.2).

$$y_{it} = \alpha_i + \theta_t + \beta y_{i,t-1} + x'_{it}\eta + \varepsilon_{it} \tag{10.2}$$

where α_i, θ_t and x_{it} denote the fixed effect, the time dummy and the vector of $(k - 1) \times 1$ exogenous variables, respectively, and $\varepsilon_{it} \sim N(0, \sigma^2)$ represents the random disturbances. In most frequent cases with this type of panel data framework, the fixed effect model is more suitable than the random effect model. For elimination of the unobserved cross-sectional specific effects, the first-differenced form of (10.2) is taken as presented in Eq. (10.3).

$$\Delta y_{it} = \Delta\theta_t + \beta\Delta y_{i,t-1} + \Delta x'_{it}\eta + \Delta\varepsilon_{it} \tag{10.3}$$

The lagged difference form of the dependent variable might be correlated with the differenced form of the error term. To eradicate this kind of endogeneity problem in Eq. (10.3), lag instruments as recommended by moment conditions have to be used. The different form of components of endogenous independent variables also should be handled carefully. The GMM estimation process also absorbs the specifications for instruments, choice of weighting matrix and also the determination of estimator.

In order to examine the impacts of FDI and ICT on GDP empirically in selected developing countries over the period of 2001–2017, Eq. (10.4) is to be specifically estimated in a dynamic panel framework.

$$\Delta \text{GDP}_{it} = \beta_1\Delta \text{GDP}_{it-1} + \beta_2\Delta x'_{1it} + \beta_3\Delta x'_{2it} + \Delta\varepsilon_{it} \tag{10.4}$$

In Eq. (10.4), x'_{1it} indicates a component matrix of FDI and ICT; x'_{2it} denotes the component matrix of control variables such as DFC, TRD and EXR, and ε_{it} is nothing but the error term. The main focus of the study goes to FDI and ICT to observe their influences on GDP, and that is why Eq. (10.4) is to be estimated first by excluding x'_{2it}, and thereafter each control variable has to be incorporated in sequence to check the robustness of outcomes.

10.4 Empirical Findings

To investigate the impacts of FDI and ICT on GDP empirically in the selected developing countries, first the study performs panel unit root tests as developed by Levin et al. (2002) and Im et al. (2003). The unit root test statistics of the specified panel variables are calculated by using the particular rules. Akaike (1969) information criterion (AIC) specifies the lag lengths of variables. All estimated equations for panel unit root incorporate both individual effects and linear trends as exogenous variables. Table 10.1 states panel unit root tests outcomes of all panel variables as taken into account for this study. Both Levin et al. (2002) and Im et al. (2003) panel unit root tests results indicate that variables are non-stationary at levels; however, they are found to be stationary at their first differences.

Table 10.2 specifies the estimated results of the dynamic panel regression model pointing out the exploration of the influences of FDI and ICT on GDP incorporating a few control variables like DFC, TRD and EXR. Model 1 shows the initial regression model followed by sequential inclusions of all control variables as mentioned above accounted by Model 2, 3 and 4, respectively. Ultimately, Model 5 ends the estimation process by checking the robustness through incorporating all major and control variables simultaneously in a single regression model. The GMM estimation technique in first difference equation as referred by Arellano and Bond (1991) is

Table 10.1 Result of panel unit root tests

Series	Levin et al. (2002) test		Im et al. (2003) test	
	Level	First difference	Level	First difference
FDI	1.22	−4.82**	−1.05	−5.31*
ICT	1.09	−4.97**	−1.11	−5.07*
GDP	−0.98	−4.73**	−1.02	−5.92*
DFC	−1.87	−5.01**	−1.14	−5.58*
TRD	−1.69	−5.19**	−1.57	−6.01*
EXR	−2.01	−5.66**	−1.43	−5.94*

Source Estimations of authors using WDI and WTI databases
Note **denotes the level of significance at 5% level

Table 10.2 Results of dynamic panel GMM estimations

Dependent variable: ΔGDP (*it*)					
Method: panel GMM					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5
ΔGDP (*it* − 1)	0.2133*** (0.00)	0.2002*** (0.00)	0.1822*** (0.00)	0.1991*** (0.00)	0.1772*** (0.00)
ΔFDI (*it*)	0.0622*** (0.00)	0.0411** (0.02)	0.0579** (0.03)	0.0733** (0.01)	0.0399** (0.02)
ΔICT (*it*)	0.0917*** (0.00)	0.0807*** (0.00)	0.0612** (0.01)	0.0955*** (0.00)	0.0511** (0.01)
ΔDCF (*it*)		0.1003*** (0.00)			0.0822*** (0.00)
ΔTRD (*it*)			0.0698** (0.01)		0.0712** (0.01)
ΔEXR (*it*)				−0.0691** (0.02)	−0.0255** (0.03)
Observations	576	576	576	576	576
No of instruments	12	10	11	11	13
Arellano-Bond test for AR (2)	0.31	0.32	0.26	0.29	0.27
Sargan test *p*-value	0.22	0.28	0.33	0.31	0.26
Hansen test *p*-value	0.29	0.31	0.28	0.37	0.33
Wald test *p*-value	0.00	0.00	0.00	0.00	0.00

Source Estimations of authors using WDI and WTI databases
*Note*** and *** denote the level of significance at 5% and 1% levels respectively, *p*-values are in parentheses

used in order to control the unobserved heterogeneities raised in the estimated model. The existence of lag dependent variable as an explanatory variable in the proposed regression equation indicates the basic dynamism of the model. The Arellano-Bond specified second-order autocorrelation (AR (2)) text validates the accurate specification of the model. The *p* values of Sargan (1958), Hansen (1982) and Wald tests ensure that instruments are exogenous. It also favours the estimation process that the observed instruments numbers are lower than the total numbers of cross-sectional units in specified models.

Outcomes of the core empirical illustrations make known that both FDI and ICT have positive and significant impacts on GDP at their first-differenced forms. However, the degree of the influence of ICT on GDP in the observed developing countries is remarkably lower than that of FDI in terms of coefficient value and significance level both, and this judgement is robust as per all specified models, as Table 10.2 shows. Findings also imply that DFC and TRD positively and significantly cause GDP. However, economic growth (GDP) is negatively influenced by EXR in developing economies.

10.5 Concluding Remarks

The study empirically scrutinizes the dynamic impacts of FDI inflows and progress of ICT base on economic output (GDP) in developing countries across the globe over the period of 2017–2017. The technique of GMM estimation is applied in a framework of dynamic panel consisting of 36 developing economies selected on the basis of their position in the share of acquiring global FDI inflows. The results of two-step robust difference—GMM estimation imply that both FDI and ICT have positive and significant causal impacts of GDP, beside the lag impact of GDP itself. Moreover, the study also observes that the gross domestic capital formation and volume of trade are also causing GDP positively, and real effective exchange rate negatively impacts the output of those countries. So, to make a simple conclusion, it might be referred that both FDI and ICT are found to be pertinent macroeconomic factor having positive and significant multiplier effect on economic output.

The study depicts that enhancement of globalization has been a vital factor of economic growth reflected in terms of current trends in FDI inflows and promotion of ICT. In this regard, Dreher (2006) might be a prominent support of the arguments as made by the study i.e. globalization encourages economic growth through reducing the restrictions on capital flows and trade and also creating employment opportunities. An advanced ICT base helps transnational corporations (TNCs) in order to utilize the advantage of low cost of labour, effortless access to home and external markets, and also easy communications facilities; and in this context, the findings of the study is also consistent with the results of Gajjala (2006). Finally, by following the propositions of Stanley et al. (2018), the study could recommend that in order to promote the economic growth, developing nations should pay some additional attentions on the promotion of ICT and also their performances in receiving

FDI inflows to make them smoother, and in this regard, ICT could play a crucial role even with its significant impacts of FDI (Sinha et al. 2019), besides having its major influences on human capital formation, research and development activities, digitalization as well as advanced infrastructure development as per current needs.

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Chapter 11
Viewing IT and ITeS as the New Opportunity in the Changing Developmental Paradigms of the Indian Economy

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The two areas that are changing … are information technology and medical technology. Those are the things that the world will be very different 20 years from now than it is today.
—Bill Gates

11.1 Introduction

From alpine to elephant, we are heavily dependent on information technology which has brought about a kind of revolution in our daily lives. The story dates back to the year 1967 when the Tata Group together with Burroughs started its intellectual journey with the birth of Tata Consultancy Services (TCS) and thus marked the beginning of India's IT industry. In 1973, SEEPZ, the first software export zone began, accounting for almost 80% of India's software exports in the seventies and eighties. In 1974, Burroughs recognised that India had comparative advantage in terms of cheap labour availability and decided to send Indian engineers to the USA to work in Burroughs' clients' offices. Thus, it started the export of Indian programmers for the completion of assignments in the USA which became renowned as the concept of "body shipping". One of the major breakthroughs came when IBM was asked to leave India because it did not want to hand over the ownership of its subsidiaries—a classic case of the infant industry argument to protect the IT industry (Basu 2008). In leaps and bounds, software exports became popular and by 1981 India's export

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revenue earnings stood at US$4 million, shared by 21 firms, out of which TCS only accounted for 63% (Heeks 2002) to US$154 billion in 2017–18. With late Rajiv Gandhi's mission and vision, the former Honbl'e Prime Minister of India, New Computer Policy (NCP) was rolled in 1984 which was followed by the National Informatics Centre (NIC) coming into existence and paving the way for cultivating the concept of "Digital India".

Coming to the export trends within the IT and ITeS segment, IT services is the one showing the fastest growth and has generated export revenue of US$69.3 billion in 2017–18 as compared to US$66.0 billion in year 2016–17. Coupled with this, we have the domestic sector performing exceedingly well with growth rate y-o-y being 8.7% in 2017 and being mainly driven by IT services which occupy 40.5% of domestic IT sector in terms of revenue generation. The BPO/ITeS segment has almost hit the 9.23% export growth rate mark between 2016–17 and 2017–18 (see Table 11.1). The rapid growth of the IT industry in India has created a large number of jobs, thus changing the socio-economic fabric of a large number of families given 5% of the employees come from the economically backward sections of the society (Bhattacharyya 2015). At present, being the fifth-largest country in the world, the level of employment in the IT services and BPO/ITeS sector is growing at almost 4%, i.e. a total of roughly 3.96 million in 2017–18 from 3.86 in 2016–17 (refer to Table 11.1)—a great achievement indeed. But a worrisome factor as pointed out by HFS Research (2016), there can be a drastic fall of around 33%, i.e. 6.4 million in the level of "low skilled" positions in the IT sector by 2021 on account of automation.

India became one of the first countries from the third world to export IT and IT enabled services contrary to manufactured goods—a rare success story from a developing country perspective. The industry grew substantially after 1984 when the number of firms increased from 35 to 700 by 1990 and subsequently to 8347 as of 2018. This was possible mainly because the government, after a period of hostility to the private IT sector, changed its position and announced several incentives for IT and ITeS exports by drastically reducing import bound tariffs from 60% in the nineties to 10% in recent times (as social welfare surcharge in place of the 3% import cess) for products under the Information Technology Agreement (ITA-1) of WTO. Off-shoring has played an immense role in India's software development (Sharma and Sharma 2011). Though USA is the major exporter of IT and ITeS, India has also made its presence felt in other external markets like UK, Singapore, Germany, Hong Kong and Australia. This is one of the major reasons behind India bouncing back from the depression which hit the USA in the last few years of the last decade.

Finally, after the onslaught of the global depression, the gradual recovery of USA, UK and other import destinations again led to the increased external demand for Indian IT and ITeS. It needs to be noted that India mostly concentrates on the export of computer software services and ITeS, but the growth of hardware components in the new millennium has been good but not that great in comparison to the other segments of IT and ITeS. The revenue of the IT industry is projected to grow by 8% from US$143 billion in FY 2016 to almost US$154 billion in FY 2018. India being the biggest BPM destination in the world today contributes to 38% of the services exports and fascinatingly, the e-commerce sector, in particular, has been growing at a

Table 11.1 Recent figures of revenue in Indian IT-ITES industry (in USD billion)

Year/Description	**2013–14**	**2014–15**	**2015–16**	**2016–17**	**2017–18 (Estimated)**	**CAGR % (2013–18)**
Exports (ˆ)	87.3	97.8	107.8	117.0	126.0	10.49
Domestic	19.0	21.0	21.7	24.0	25.0	5.42
Total	106.3	118.8	129.5	141.0	151.0	9.55
Year/Segment	**2013–14**	**2014–15**	**2015–16**	**2016–17**	**2017–18 (Estimated)**	**CAGR % (2013–18)**
IT service	49.2	55.3	61.0	66.0	69.3	10.07
ITES-BPO	20.4	22.5	24.4	26.0	28.4	9.19
Software products, engineering services, R&D	17.7	20.0	22.4	25.0	28.3	13.09
Total IT-ITES	87.3	97.8	107.8	117.0	126.0	10.32
Employment generation						
Year/Segment	**2013–14**	**2014–15**	**2015–16**	**2016–17**	**Leading IT_BPO exporters**[a]	
IT services exports	1.610	1.74	1.846	1.921	Tata Consultancy Services Ltd. Infosys Ltd. Wipro Ltd. HCL Technologies Ltd. Mahindra IT & Business Services MphasiS Ltd. iGate Larsen & Toubro Infotech Ltd. etc.	
BPO exports	0.989	1.03	1.086	1.152		
Domestic market	0.699	0.745	0.758	0.790		
Total employment	3.267	3.485	3.690	3.863		

Source Compiled from NASSCOM Report (2017, 2018) and Singh (2015)
[a]Rankings can change as companies like Accenture, HP, Capgemini, IBM and others having their headquarters located outside India have not reported their revenue figures
ˆThe leading export destinations of IT and ITES from India are—USA (62%), UK (16%), Europe (excluding Europe; 11%); Asia (9%) and Rest of the World (2%)

CAGR of almost 15%. Coming to some of the recent facts, the IT and ITeS sector in India is a source of employment for practically 3.7 million employees in about 1500 outsourcing firms. With nearly 4700 start-up ventures and 600 offshore development firms, India is currently ranked as the third-largest tech-start-up hub with operations spread across 78 countries in the world (NASSCOM 2017). Of late, the major IT companies are targeting emerging places like New Town and Rajarhat in Kolkata, Gachibowli in Hyderabad, Hinjewadi in Pune, Gurgaon and Greater Noida in Delhi, to name a few. With so many IT hubs coming up across, these states in India explain the importance of IT sector in the overall growth position of the country.

In an attempt to explain the magnitude of ICT growth (i.e. by separately considering the different components of IT and ITeS) and its impact on the overall growth of the Indian economy, we propose a theoretical model and then try to justify the results empirically. The impact of ICT growth on the different sectors of the Indian economy, viz. agriculture, manufacturing and services can be analysed separately; but in this paper, we consider only the overall growth and to what extent overall growth can be explained by the IT and ITeS sector's growth. The following section reviews the selected literature on this broad topic, followed by reviewing the performance of the IT and ITeS sector with respect to its exports growth and level of employment generation. The methodological part entirely rests on the synthesis of the theoretical and the empirical model. The paper comes to a close with a comment on the e-governance issue and the sustainability of the IT sector growth in this regard.

11.2 Motivations from Existing Literature and Research Gaps

11.2.1 Review of Select Literature

Over the last two and a half decades, India has become one of the pioneers in the amphitheatre of Information Technology (IT) and Information Technology-enabled services (ITeS). The theme of the existing studies reported in this section is suggestive of the dynamism with which the service sector has expanded so far. We will review the different dimensions associated with the closest proximity of growth of IT and ITeS with the focus on India and try to provide an outline of what the present study looks to reveal.

To begin with, we have endeavoured to link up trade, growth and the penetration of IT and ITeS in this regard. Studies which started portraying information and communication technology (ICT) as an engine of economic growth dates back to the study by Jorgenson and Stiroh (1999). In a similar context, studies like Stiroh (2002), Pohjola (2001) looked at the liaison between return on investments in ICT and improvements in economic performance. In a similar study, Lal (2007) took up the case of five developing nations—India, Costa Rica, Jamaica, Malaysia and Nigeria and that which corroborated what Pohjola (2001) proposed. For the Indian situation, with the ICT revolution, Mitra (2008), Joshi (2009), Dasgupta and Singh (2005) to the very recent ones like Erumban and Das (2016) commented on how ICT can act as an engine of growth in India. Among some other issues, moving on to employment generation, a report by UNCTAD (2010) stressed on the role telecommunication services play in the creation of productive jobs (Nayyar 2012). Studies in this context, in India, are few and far between given the lack of availability of data. But recently, labour productivity in the service sector have been looked at by papers like Jain and Ninan (2010), Krishna et al. (2016) among which, Krishna et al. (2016) address these issues following the KLEMS growth framework.

Thereafter, we move our focus on overall growth and how exports and domestic growth in the IT sector have impacted the overall growth. In this paper, for the first model we basically try to estimate a modified polynomial recombinant growth function in line with Singh (2008), one where we can decompose (following Weitzman 1998; Lemma, p. 338) the IT and ITeS sector growth in terms of its different components, viz. ITeS-BPO, IT services, engineering services, software products and R&D and hardware and electronics and try to look at the impact of this on the overall service sector growth; whereas in the second model, we try and decompose the overall growth of the Indian economy in terms of IT and ITeS sector growth and non-IT and ITeS sector growth in a time series set-up. In this context, for India, a developing economy, the causal relationship between ICT revolution and overall growth behaves very differently from developed ones (see O'Mahony and Vecchi 2005; Jorgenson et al. 2003; Strauss and Samkharadze 2011) as pointed out by Niebel (2018) because of lack of R&D expenditures. Also, recent studies stemming out of such growth exercises have focused on the impact of different price and non-price-based factors on the level of exports and growth of exports of IT and ITeS (see Tharakan et al. 2005; Banga and Kumar 2011; Gupta et al. 2015).

11.2.2 Research Gap

The first research gap that we have identified relates to the choice of a proper estimable growth model for India. The paper, as already pointed out, makes an attempt to decompose the service sector growth rate using a modified recombinant growth rate function (refer to the section on empirical methodology for details). Second, the literature on empirical studies capturing the growth of IT and ITeS sector and its impact on the overall economic growth in the Indian context is not very well developed. This has motivated us to fill in the research gap by broadly incorporating not only the IT and ITeS sectors but also the non-IT and ITeS ones. Moreover, in the Indian context, comparing IT and ITeS sector growth with the non-IT and ITeS ones over a period of time using an "ARMAX" model (refer to the data and methodology section) is something novel. Thus, the research question that we try to look at is to what extent has the ICT revolution influenced the tertiary sector growth and hence the overall GDP growth of India in the post-liberalisation era.

11.3 Empirical Methodology—Findings and Discussions Thereof

11.3.1 The Model

We introduce here an implicit production function based on Mukherjee (2017) where standard assumptions are applicable

$$Y = Y(K_{\mathrm{e}}, K_{\mathrm{i}}, K_{\mathrm{s}}, K_{\mathrm{h}}, K_{\mathrm{e}}^{\mathrm{e}}, K_{\mathrm{i}}^{\mathrm{e}}, K_{\mathrm{s}}^{\mathrm{e}}, K_{\mathrm{h}}^{\mathrm{e}}, \mathrm{NIT}, L) \tag{11.1}$$

where Y stands for the net worth of output in the service (tertiary) sector, K_{oe}, K_{oi}, K_{os}, K_{oh} stand for the output generation within the domestic sector from the different components in the IT and ITeS sector, namely ITeS-BPO (K_{oe}), IT services (K_{oi}), engineering services, software products and R&D (K_{os}), and hardware and electronics (K_{oh}), respectively. Similarly, $K^{\mathrm{e}}{}_{\mathrm{oe}}$, $K^{\mathrm{e}}{}_{\mathrm{oi}}$, $K^{\mathrm{e}}{}_{\mathrm{os}}$, $K^{\mathrm{e}}{}_{\mathrm{oh}}$ stand for the level of exports under the different heads in the IT and ITeS sector, viz. ITeS-BPO ($K^{\mathrm{e}}{}_{\mathrm{oe}}$), IT services ($K^{\mathrm{e}}{}_{\mathrm{oi}}$), engineering services, software products and R&D ($K^{\mathrm{e}}{}_{\mathrm{os}}$), and hardware and electronics ($K^{\mathrm{e}}{}_{\mathrm{oh}}$), respectively. $\mathrm{NIT}_{\mathrm{o}}$ stands for the output of the other tertiary sub-sectors except IT and ITeS and L_{o} stands for the aggregate employment in the service sector. For convenience, the notations as mentioned above, without the subscript "$_{\mathrm{o}}$" stands for the money value of output generated under the different components and money value of labour services. Here, it needs to be noted that under the component of software products, engineering services and R&D, in India, we have the R&D on IT and ITeS factor clubbed in.

Totally differentiating Eq. (11.1), with respect to time t and then dividing throughout by Y, we have:

$$\frac{1}{Y}\left(\frac{\partial Y}{\partial t}\right) = \frac{1}{Y}\sum_j \left(\frac{\partial Y}{\partial K_{\mathrm{o}j}}\right)\left(\frac{\partial K_{\mathrm{o}j}}{\partial t}\right) + \frac{1}{Y}\sum_j \left(\frac{\partial Y}{\partial K_{\mathrm{o}j}^{\mathrm{e}}}\right)\left(\frac{\partial K_{\mathrm{o}j}^{\mathrm{e}}}{\partial t}\right)$$
$$+ \frac{1}{Y}\left(\frac{\partial Y}{\partial \mathrm{NIT}_{\mathrm{o}}}\right)\left(\frac{\partial \mathrm{NIT}_{\mathrm{o}}}{\partial t}\right) + \frac{1}{Y}\left(\frac{\partial Y}{\partial L_{\mathrm{o}}}\right)\left(\frac{\partial L_{\mathrm{o}}}{\partial t}\right)$$

This implies that in period t,

$$y_t = \sum_j \left(\frac{K_{\mathrm{o}jt} \times \mathrm{MP}_{K_{jt}}}{Y_t}\right)\bar{k}_{jt} + \sum_j \left(\frac{K_{\mathrm{o}jt}^{\mathrm{e}} \times \mathrm{MP}_{K_{jt}^{\mathrm{e}}}}{Y_t}\right)\bar{k}_{jt}^{\mathrm{e}}$$
$$+ \left(\frac{\mathrm{NIT}_{\mathrm{o}t} \times \mathrm{MP}_{\mathrm{NIT}_{\mathrm{o}t}}}{Y_t}\right)\bar{n}_t + \left(\frac{L_{\mathrm{o}t} \times \mathrm{MP}_{L_{\mathrm{o}t}}}{Y_t}\right)\bar{l}_t$$
$$\text{or,}\quad y_t = \sum_j \left(\frac{K_{jt}}{Y_t}\right)\bar{k}_{jt} + \sum_j \left(\frac{K_{jt}^{\mathrm{e}}}{Y_t}\right)\bar{k}_{jt}^{\mathrm{e}} + \left(\frac{\mathrm{NIT}_t}{Y_t}\right)\bar{n}_t + \left(\frac{L_t}{Y_t}\right)\bar{l}_t \tag{11.2}$$

$$\text{or,}\ \ y_t = \sum_j w_{K_{jt}} \overline{k}_{jt} + \sum_j w_{K^{\text{e}}_{jt}} \overline{k}^{\text{e}}_{jt} + \left(w_{\text{NIT}_t} \overline{n}_t\right) + \left(w_{Lt} \overline{l}_t\right) \tag{11.2a}$$

$$\text{or,}\ \ y_t = \sum_j k_{jt} + \sum_j k^{\text{e}}_{jt} + n_t + l_t \tag{11.2b}$$

$$\text{where,}\ \ k_{jt} = \left(w_{K_{jt}} \overline{k}_{jt}\right);\ k^{\text{e}}_{jt} = \left(w_{K^{\text{e}}_{jt}} \overline{k}^{\text{e}}_{jt}\right);\ n_t = \left(w_{\text{NIT}_t} \overline{n}_t\right);\ l_t = \left(w_{L_t} \overline{l}_t\right).$$

Here, $y = \left(\frac{\frac{\partial Y}{\partial t}}{Y}\right)$ = rate of growth of net worth of output of the service sector, $\overline{k}_{jt} = \frac{\left(\frac{\partial K_j}{\partial t}\right)}{K_j}$ is the rate of growth in the revenue of the IT-ITeS sector in terms of domestic use, $\overline{k}^{\text{e}}_{jt} = \frac{\left(\frac{\partial K^{\text{e}}_j}{\partial t}\right)}{K^{\text{e}}_j}$ is the rate of growth in the revenue of the IT-ITeS sector in terms of exports, $\overline{l} = \left(\frac{\frac{\partial L_{\text{o}}}{\partial t}}{L_{\text{o}}}\right)$ = rate of growth of employment in the service sector, $\overline{n} = \left(\frac{\frac{\partial \text{NIT}_{\text{o}}}{\partial t}}{\text{NIT}_{\text{o}}}\right)$ = rate of growth of the major tertiary sub-sectors other than IT and ITeS, w_{NIT} stands for the share of major tertiary sub-sectors except IT and ITeS clubbed under one head and w_{L} stands for the labour share in the net worth of output of the service sector. $\left(\frac{\partial Y}{\partial K_{\text{o}j}}\right)$ is the marginal productivity of *j*th component in terms of domestic use, $\left(\frac{\partial Y}{\partial K^{\text{e}}_{\text{o}j}}\right)$ is the marginal productivity of *j*th component in terms of domestic use, $\left(\frac{\partial Y}{\partial \text{NIT}_{\text{o}}}\right)$ is the marginal productivity of the major tertiary sub-sectors except IT and ITeS and $\left(\frac{\partial Y}{\partial L_{\text{o}}}\right)$ is the marginal productivity of labour. Also, w_{K_j} and $\overline{k}_j$ stand for the *j*th component's domestic revenue share and growth rate in total net worth of output of the service sector respectively while $w_{K^{\text{e}}_j}$ and $\overline{k}^{\text{e}}_j$ stand for the *j*th component's export revenue share in total net worth of output of the service sector and export growth rate, respectively. Here, *j*th component denotes—ITeS-BPO (K_{e}), IT services (K_{i}), engineering services, software products and R&D services (K_{s}) and hardware and electronics (K_{h}) and t stands for the time period concerned. The shares of revenue or net worth of the different components add up to one under the constant returns to scale assumption and from Euler's product exhaustion theorem, i.e.

$$\sum_j w_{K_j} + \sum_j w_{K^{\text{e}}_j} + w_{\text{NIT}} + w_{\text{L}} = 1$$

This is the first model that we have estimated where we try to break up the overall growth of the service sector in terms of growth of its different components, namely, IT and ITeS sector, major tertiary sub-sectors other than IT and ITeS and employment generation. In addition to this, we estimate another model where overall growth of the Indian economy can be decomposed into two components, i.e. the growth of the IT and ITeS sector and the growth of the non-IT and ITeS sectors (this includes the growth of all other tertiary sub-sectors other than IT and ITeS, the manufacturing and the agricultural sectors) following the recombinant growth model of Weitzman (1998). The model is as follows

$$(g_t - g_{t-1}) = \alpha(I_t - I_{t-1}) + \beta(\mathrm{NI}_t - \mathrm{NI}_{t-1}) \tag{11.3}$$

This is a polynomial recombinant expansion where on the right-hand side, the first term measures the growth of the IT and ITeS sector while the second term measures the growth of the non-IT and ITeS component.

11.3.2 Data and Methodology

The chapter uses annual data under the various heads from 1992 to 2017. The data on the GDP growth rate of India and the different sectoral growth rates have been compiled from the Planning Commission and the NITI Aayog database. The growth, revenue generation within the domestic economy and from exports across the different components of the IT and ITeS sector have been compiled from the NASSCOM reports of the various years and also from the company-wise details for these concerned heads available at the Centre for Monitoring Indian Economy (CMIE) Prowess database for the period under consideration. In addition to these data sources, the Handbook of Statistics on the Indian Economy database of the Reserve Bank of India and the National Account Statistics database of various years under the Ministry of Statistics and Programme Implementation (MOSPI), Government of India have been also referred to compile the growth rates of the other tertiary sub-sectors[1] other than the IT and ITeS sector. The data on the average daily wage rate in the service sector has been accessed from the database at www.indiastat.com for the period under consideration after suitable interpolation and extrapolation to fill in the missing data points.

Coming to the estimation of the growth rate of the non-IT and ITeS sector for the period under consideration in Eq. (11.3), we take the geometric mean of the growth rates of the primary sector, secondary sector and all the other major tertiary sub-sectors (the data for which are available as is mentioned (see Footnote 1)) in every year. It needs to be noted that in Eq. (11.2), we apply the same technique for calculating the growth rate of NIT, i.e. geometric mean of the growth rates of the

[1]Some of the major tertiary sub-sectors that have flourished over the two and a half decades of economic reforms and included in our analysis are: (i) trade and tourism services, (ii) transport-related services, (iii) real estate services, (iv) select business services which include IT-ITeS services, consultancy services, R&D services, media services, healthcare services, banking, insurance and other financial services, education and telecom services.

The spectacular growth rate in the service sector in the past actually was driven by the exceptional growth performance of two sub-sectors: Communication (with an annual growth of almost 25%) and banking and insurance (where GDP grows at an annual rate of around 15%). Now, IT-ITeS is fast catching up and making its presence felt in the tertiarization of the economy.

major tertiary sub-sectors (see Footnote 1) that we have considered except IT and ITeS.

For estimating Eqs. (11.2b) and (11.3) which are basically growth equations, firstly, we check for the stationarity of the variables concerned by performing the unit root tests. The estimable equation under the unit root test is given by:

$$\Delta y_t = \mu + \rho t + \tau y_{t-1} + \sum_{j=1}^{k} \varphi_j \Delta y_{t-j} + e_t$$

where μ is the constant, ρ is the coefficient on the time trend and j is the order of lag of the autoregressive (AR) process and Δy_{t-j} captures the autoregressive moving average (ARMA) effects (Dickey and Fuller 1979, 1981). The test procedure is performed under the null hypothesis of $\tau = 0$ against the alternative hypothesis of $\tau < 0$. If the null hypothesis is rejected, it can be concluded that there is no unit root and the data are stationary. Following the unit root tests, we specify an ARMAX time series model where the dependent variable is expressed in terms of a linear combination of independent variables, as well as a standard ARMA disturbance/error process. Given the theoretical model we have, the ARMAX model scores well over the ARMA model in general because of its ability to incorporate exogenous explanatory variables for prediction in addition to the AR and MA terms (see Chen et al. 2004). As a general rule, an ARMAX (p AR terms, q MA terms, b exogenous terms) model is represented by,

$$y_t = \sum_{i=1}^{p} \varphi_i y_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} + \sum_{k=1}^{b} \eta_k x_{t-k} + \varepsilon_t \tag{11.4}$$

This model specification in Eq. (11.4) can be re-written to make it is consistent with our model specifications in Eqs. (11.2b) and (11.3).

$$\Delta y_t = \sum_{i=1}^{p} \varphi_i' \Delta y_{t-i} + \sum_{j=1}^{q} \theta_j' \Delta \varepsilon_{t-j} + \sum_{k=1}^{b} \eta_i' \Delta x_{t-k} + \Delta \varepsilon_t \tag{11.5}$$

The ARMAX model applied in Eq. (11.5) is an extension of the very popular Box–Jenkins autoregressive moving average (ARMA) model but with the inclusion of explanatory exogenous variables (Lim et al. 2009).

11.3.3 Results and Interpretations

Before starting off with the unit root tests, the heteroskedasticity needs to be looked at. The Chi-Square value of 1.33 lies within the confidence interval and the results conclusively confirm the absence of heteroskedasticity which is very much consistent with the assumptions of standard white noise disturbances. This is followed by checking of the stationarity of the concerned time series variables used in our model using the augmented Dickey–Fuller (ADF) tests as reported in Table 11.2. For robustness and consistency of the unit root results, we have also used the Phillips and Perron's (PP) test with trend and intercept. This PP statistic can be viewed as

Table 11.2 Unit root results of the level values of the basic variables

Variables	Level of stationarity	Test statistic (ADF)	Test statistic (PP)	Probability value	Order of integration
Model 1					
Y	First difference	−7.12	−5.58	0.00*	I(1)
K_e	First difference	−5.41	−6.61	0.00*	I(1)
K_i	First difference	−6.23	−7.01	0.00*	I(1)
K_s	First difference	−5.26	−4.98	0.00*	I(1)
K_h	First difference	−5.69	−5.50	0.00*	I(1)
$K^e{}_e$	First difference	−6.16	−5.78	0.00*	I(1)
$K^e{}_i$	First difference	−4.34	−6.57	0.00*	I(1)
$K^e{}_s$	First difference	−6.27	−5.55	0.00*	I(1)
$K^e{}_h$	First difference	−6.33	−7.64	0.00*	I(1)
NIT	First difference	−4.99	−5.01	0.00*	I(1)
L[a]	First difference	−6.72	−6.88	0.00*	I(1)
Model 2					
g	First difference	−6.38	−6.12	0.00*	I(1)
I	First difference	−5.26	−5.99	0.00*	I(1)
NI	First difference	−4.96	−5.22	0.00*	I(1)

Notes *Denotes significance at 95% level and as obtained from Stata 12

[a]L (total money value or net worth of employment generation) has been derived as the total employment in millions in the service sector multiplied by the average daily wage rate in the service sector

Source: Authors' Calculations

Table 11.3 Results of the ARMAX estimation of the growth function (variables are at their differenced level)

Variables	Coefficient	Standard error	*t* value	$P > \|t\|$
Model 1				
Wald chi_square = 3294.80; Prob > chi^2 = 0.00				
k_e	1.55	0.28	5.54	0.00*
k_i	0.95	0.19	5.01	0.00*
k_s	0.66	0.15	4.41	0.00*
k_h	0.34	0.09	3.37	0.00*
$k^e{}_e$	0.89	0.41	2.17	0.04*
$k^e{}_i$	0.77	0.29	2.66	0.02*
$k^e{}_s$	0.55	0.23	2.39	0.03*
$k^e{}_h$	0.14	0.06	2.33	0.03*
n	0.86	0.34	2.53	0.01*
l	0.29	0.07	4.14	0.00*
Model 2				
Wald chi_square = 1294.80; Prob > chi^2 = 0.00				
I	1.02	0.14	7.28	0.00*
NI	0.88	0.09	9.78	0.00*

Notes *Denotes significance at 95% level and as obtained from Stata 12
Source: Authors' Calculations

a Dickey–Fuller test statistic that has been nonparametrically corrected for serial correlation by using Newey–West heteroskedasticity and autocorrelation-consistent covariance matrix estimator (see Phillips and Perron 1988). The results under both ADF and PP tests are consistent (see Table 11.2).

Given the unit root results in Table 11.2, the level values of the concerned variables are integrated of order 1 indicating that their first differenced values[2] will be stationary. This, in turn, implies that the growth variables are stationary at their level, and the ARMAX models in Eqs. (11.2b) and (11.3) can be estimated. The mean VIF value turns out to be 2.9, which is well within the specified limits and there is no serious problem of multicollinearity (see for details on the limits of VIF, Akinwande et al. 2015).

The results of the ARMAX model given in Table 11.3 have been carried out by maximising the Gaussian likelihood function of the following form following Doornik and Ooms (2003),

[2]Going by the AIC: Akaike information criteria, SIC: Schwartcz information criterion, HQ: Hannan–Quinn, RMSE: Root mean square error and MAE: Mean absolute error criterion the optimal lag length turned out to be 1 in line with the autoregressive and moving average terms and thus, tackling the problem of autocorrelation.

$$\log L(\varphi, \theta, \eta, \sigma^2) = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\log|\Omega| - \frac{1}{2}\varepsilon'\Omega^{-1}\varepsilon$$

where $y = (y_1, y_2, \ldots, y_T)'$, $\varepsilon = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_T)'$ and Ω is the symmetric Toeplitz covariance matrix drawn from the ARMA process.

The variables used in Model 1 as presented in the first column in Table 11.3 are the growth rates of the different components weighted by their respective shares as shown in Eq. (11.2b). The weights keep on changing over the years given their respective share in the total output of the service sector. The Wald Chi-Square statistic in Table 11.3 tests for the overall goodness of fit, i.e. whether predictors in the model are significant enough or not? For both the models, the overall goodness of fit is highly significant as indicated by the probability values.

The results under Model 1 in Table 11.3 noticeably justify that there is a positive and significant impact of the different components of the IT and ITeS sector growth in terms of domestic use and exports on the service sector growth. First, the performance of the ITeS-BPO segment both in terms of domestic use and exports has been that: with 1% unit increase in the growth of ITeS-BPO, the magnitude of increase in overall service sector growth is 1.55% points based on data over the concerned period. This is followed by the performance of the IT services and the engineering, software and R&D segments. The focus should be on ITeS-BPO and IT services segment for driving the IT and ITeS sector growth. These results are consistent with what we see in Table 11.1. As already been mentioned, though significant, but there is a very negligible influence of the hardware and electronics segment on the overall service sector growth. It must be pointed out, that the combined growth rate of all the other tertiary sub-sectors are influential in driving the service sector growth in India but from the policy intervention point of view, this component cannot bring out much out from this analysis. Because here we have considered the combined growth of the major tertiary sub-sectors, there exists heterogeneity in terms of how these sub-sectors influence the overall service sector growth, and hence, we put up a disclaimer that one should be careful while using this coefficient (0.86) of mean growth rate across the non-IT and ITeS tertiary sub-sectors for the purpose of policy prescriptions.

Coming to the results reported under Model 2 in Table 11.3, the overall IT and ITeS growth has kind of overpowered the non-IT and ITeS sectors in driving the overall economic growth. This gets validated through the facts because the share of IT and ITeS sector in the overall GDP of India has been constantly increasing in the new millennium with the figure standing at 9.4% in 2016–17. In a nutshell, the results in Table 11.3 are a reflection of India's dominant expedition into the global software and ITeS exports market. The domestic growth has also been phenomenal but even amidst such a performance; there is a cause of worry in the hardware and electronics production, which has slowed down.

So much so, in what continues, we discuss the impacts on employment generation. It is true that India is earning a huge amount of revenue from the exports of IT and ITeS. The problem is if this does not trickle down to the deprived and poor sections of the society and is confined only to the rich, then such growth cannot be treated as an inclusive broad-based growth. Unfortunately, India's case is exactly this and we discuss in detail about this in the closing section.

11.4 Concluding Remarks and Suggestions Thereof

In what follows, India has become one of the fastest growing economies in the world over the last two and a half decades aided by the performance of the economic reforms. One of the striking aspects of India's recent growth has been the dynamism of the tertiary/services sector, particularly, information technology (IT) and IT-enabled services (ITeS), financing, insurance, telecommunications, real estate, etc., and while in contrast, manufacturing has been less robust. The contribution of tertiary sector was particularly striking in the 1990s and beyond, which not only saw rapid growth, but also a high contribution—over in India's GDP. This growth trajectory has been termed "excess growth of services", or "services-led" industrialisation, even a "services revolution". It is to be noted here that while agriculture and manufacturing sectors have experienced phases of deceleration, stagnation and growth, the tertiary sector has shown more or less a uniform growth trend during the period 1950–51 to 2016–17.

Services exports have been a dynamic element of India's trade and globalisation in recent years. WTO data show that India's services exports grew from US$16.8 billion in 2001 to US$155.6 billion—which constitutes 7.5% of the GDP—in 2014, making the country the eighth largest services exporter in the world. The overall openness of the economy reflected by total trade including services as a percentage of GDP shows a higher degree of openness at 50% in 2014–15 compared to 38% in 2004–05, particularly, because of the availability of a large pool of highly skilled, low cost, and educated workers in the country.

Despite this sector's contribution being the highest in India's GDP, the most pertinent question that crops up in this connection is: why is it that poverty is not declining in India or, if it is declining, its space is abysmally slow among the vast majority of the Indian population.

For poverty reduction, the approach towards using information technology by the government has to be focused on key areas (in terms of improving governance, public service delivery) where information technology can make a perceptible difference to the lives of the poor. Effective use of information technology could help in better targeting of the deprived under the various programmes of poverty alleviation being implemented, like—Gyandoot Project in Dhar district of Madhya Pradesh, catering to the everyday needs of the masses including those lying below the poverty line (Marshall et al. 2003). Thus, a "rebalancing" of economic growth towards the manufacturing industry and greater domestic reorientation with prudent governance seems essential at the present stage, in order to make it more employment-oriented and inclusive. While the traditional sectors like agriculture and manufacturing cannot be ignored, the new opportunities driven by IT and ITeS, cannot be missed.

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Part II
Role of IT-ITES Upon Environment, Health, Education and Employment

Chapter 12
IT Industry, Environmental Regulations and International Trade-A Two-Sided General Equilibrium Approach

Tonmoy Chatterjee

12.1 Introduction

Information technology (IT) industry, nowadays, has gained a great deal of attention among researchers, so far global trade and development in services are concerned. IT sector has a remarkable potential for accelerating economic growth of any nation through the channel of trade in services. In particular, the recent and enduring rapid innovations in IT makes it a dynamic sector that is a pretty and alternative participant as a potential engine to economic growth,[1] much as the automobile industry was targeted by the Japanese after World War II (Singh 2015). In fact, the IT industry can be described as the augmentation of so-called hardware, services and infrastructure to embrace production, manipulation, storage and dissemination of information across nations (Singh and Kaur 2017).

Nations are broadly related to each other through the understanding of international trade. Trade policies in most developing economies are generally moderate and bring about opening prospects on the quantity or quality of goods and services (Bhagwati 1984; Sampson and Snape 1985). Moreover, it can be noted that, according to General Agreement on Trade in Services (GATS), trade in services may occur through the following four modes and namely (i) cross-border supply; (ii) consumption abroad; (iii) commercial presence and (iv) presence of natural persons (Chanda 2001). Arguments in favour of economic liberalization and free trade sometimes create a space of conflicting arguments in developing nations by postulating the gains from such trade in terms of 'pollution haven'.

[1] If we consider the incidence of India, we find that the total revenue generated by the IT and business process management industry in India in the year 2013–14, a total of 106.3 billion US dollars of revenue was created by the Indian IT industry, due to the huge response of outsourcing from international companies.

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The relationship between trade and environment is a complex and highly debated issue. Addressing this relationship is fundamental in order to achieve sustainable development. The Commission Communication on Trade and Environment, adopted in 1996, underlined that a mutually supportive relationship between trade and environment can occur but is in no way automatic. In fact, trade liberalization and trade policy have positive and negative impacts on the environment. But what is the impact of trade liberalization on the environment is a matter of debate. Two conflicting hypotheses have emerged from the debate. First one is the pollution haven hypothesis (PHH). This hypothesis suggests that the developed countries impose tougher environmental policies than do the developing countries, which result in the distortion of existing patterns of comparative advantage. So the polluting industries shift operations from the developed to the developing countries; developing countries thus become 'pollution havens'. It has been correctly evidenced that free trade in developing countries encouraging dirty industries to migrate from developed economies owing to offset their environmental tax and standard (Copeland and Taylor 1994). Therefore, it creates doubt among policymakers by questioning, whether free trade policy can unambiguously expand global production structure by employing resources? In fact, the production structure may suffer from an adverse impact due to scale, technique and composition effects owing to changes in the level of pollution mainly due to the presence of PHH (Grossman and Krueger 1993).

Thereby, several questions, thus, arise while structuring suitable trade and environment-related policies; one, whether developing nations become 'pollution haven' due to the migration of dirty manufacturing industries owing to the economic liberalization? Second, does economic liberalization always pushes environmental bad? If the answer is yes, we have to depart from the array of international trade and who knows in this process the developing nations may lose huge gains from trade. However, if the answer is no, then we must try to find out some alternative goods and services for which developing countries can be benefitted from the angel of both gains from trade and environmental degradation. To answer the above-mentioned questions, here, we consider IT-based goods and services as an identical instance. In fact, IT-based services are surrounded by BPO and ITES[2] (Singh 2015) activities and all of them are environmental-friendly. From the trade point of view, it has been evidenced that only in India exports of IT-related services continue to be decisive to its IT-BPO sector and generate revenue of US$ 100 billion (Singh 2002, 2015). For that reason, a proper integration among IT industry, environment, and trade becomes essential to propose fair and acceptable policy measures to realize proper gains from trade. As per our knowledge, perhaps, this is the first theoretical study which accumulates IT industry within the basket of trade and environment and tries to find out the most acceptable trade policy measure among the alternatives owing to technological progress arguments.

[2]BPO and ITES included the followings: customer Interaction Services, Business Process Management, Back Office Operations, Accounting Services, Insurance Claims Processing, Medical Transcription, Legal Databases and Services, Digital Content, Online Education, Data Management and Data Analytics, Data Digitization or GIS, HR Services, Web Site Services, etc.

The rest of the chapter is organized as follows: the second section of the chapter considers a two-sided general equilibrium (GE) framework. Section three allocates the arguments behind the vanishing industries as a consequence of capital flows. The same section also confers about the size of the IT industry in both North and South under different trade policy paradigm. Section 12.4 concludes.

12.2 The Benchmark Model

To outline a compatible framework in order to categories the presence of both IT and non-IT-based industries within an arena of asymmetric environmental regulations across the economies, here, we assume the representative of both South and North and apply GE on both economies simultaneously.[3] It is to be noted that, the North is the net exporter of capital and the South is the net importer the same. Hence, at autarky, the South has a higher rental rate and the North has a lower rental rate. In fact, the presence of asymmetric environmental regulations between the North and South may encourage the process of international capital mobility. Moreover, following Marjit and Kar (2013) we assume that both South and North are small enough to affect commodity/service prices. More precisely, we assume domestic as well as foreign economies as small open economy to create proper background for GE based on HOS structure (Jones 1965, 1971).

12.2.1 Production Process in the South

Let us start with the South which is a small open economy and producing three goods: a non-IT environment-friendly good (X) that uses labour (L) and Non-IT-type Capital (K); a Non-IT pollution-intensive good (Y) produced by traditional manufacturing sector, using L and K, and finally, an IT environment-friendly good (Z) produced by the IT sector, combining IT-type Capital (N) with L. Goods X and Z are exported, whereas Y is imported by South. The markets are perfectly competitive and production technology exhibits constant returns to scale. Given the world prices of the final goods, the zero-profit conditions are described as[4]:

[3] Here, we take one representative from each group, i.e. from South and North. We further assume North representative as the Foreign country and Southern representative as the domestic economy.

[4] The following notations are used in this model: X_i = product produced by the ith sector, $i = X, Y, Z$; P_X* = world price of commodity X; P_X = domestic price of commodity X, we assume $P_X = P_X*$; P_Y* = world price of good Y; P_Y = domestic price of commodity Y, we assume $P_Y = P_Y*$; P_Z = domestic price of good Z; P_Z^* = world price of good Z, we assume $P_Z = P_Z^*$; L = fixed number of workers in the economy; N_D = domestic IT-type capital stock of the economy; N_F = foreign IT-type capital stock of the economy; N = economy's aggregate IT-type capital stock ($N = N_D + N_F$); K_D = domestic non-IT-type capital stock of the economy; K_F = foreign non-IT-type capital stock of the economy; K = economy's aggregate non-IT-type capital stock($K = K_D + K_F$); a_{ji} = quantity

$$a_{LX}W + a_{KX}r = P_X \tag{12.1}$$

$$a_{LY}W + a_{KY}r = P_Y \tag{12.2}$$

$$a_{LZ}W + a_{NZ}R = P_Z \tag{12.3}$$

Factor price flexibility, on the other hand, ensures full employment of all factors:

$$a_{LX}X + a_{LY}Y + a_{LZ}Z = L \tag{12.4}$$

$$a_{KX}X + a_{KY}Y = K_{\mathrm{d}} + K_{\mathrm{f}} = K \tag{12.5}$$

$$a_{NZ}Z = N_{\mathrm{d}} + N_{\mathrm{f}} = N \tag{12.6}$$

Of course, we have the input choice conditions described by the input coefficients, a_{ij}s. It is to be noted that, these six equations are sufficient to determine the six variables—three input prices and three output levels. However, being a variant of the specific factor model (SFM), factor endowments do have a perceptible influence on factor prices unlike in a HOS model.

12.2.2 Production Process in the North

Now we look forward to the production base of the foreign country. The North which is also by assumption a small open economy and producing the same three goods, namely, X, Y and Z like the South. Moreover, similar to that of Southern firms, the Northern firms are also using the same inputs to produce corresponding commodities. However, in North goods X and Y are exported whereas Z is imported. Assuming a variant of SFM (Jones 1971; Beladi and Marjit 1992) for the North, we basically try to replicate the production structure of the South in the North. Due to the assumption of small open economy, prices of all the products are internationally given. Production functions exhibit constant returns to scale with diminishing marginal productivity to each input. Hence, for given world prices of the final goods and services, the product market equilibrium conditions are illustrated as[5]:

$$a_{LX}W^* + a_{KX}r^* = P_X^* \tag{12.7}$$

of the jth factor for producing one unit of output in the ith sector, $j = L, K, N$ and $i = X, Y, Z$; θ_{ji} = distributive share of the jth input in the ith sector; λ_{ji} = proportion of the jth factor used in the production of the ith sector; W = competitive wage rate; r = rate of return to non-IT-type capital; R = rate of return to IT-type capital; $\hat{}$ = proportional change.

[5]To understand the theoretical notations, follow Footnote no. 4. The following equations with * mark illustrate production structures at the North.

$$a_{LY}W^* + a_{KY}r^* = P_Y^* \tag{12.8}$$

$$a_{LZ}W^* + a_{NZ}R^* = P_Z^* \tag{12.9}$$

Factor price flexibility describes full employment of all inputs:

$$a_{LX}X^* + a_{LY}Y^* + a_{LZ}Z^* = L^* \tag{12.10}$$

$$a_{KX}X^* + a_{KY}Y^* = K^* \tag{12.11}$$

$$a_{NZ}Z^* = N^* \tag{12.12}$$

It can be noted that these six equations (Equations from 12.7 to 12.12) are sufficient to determine the six variables—three input prices and three output levels.

12.3 Productivity, IT Industry and International Capital Mobility

In this section, we analyse the effects of trade liberalization policies in the form of (i) international mobility of non-IT-type capital from North to South, and (ii) international mobility of IT-type capital from North to South on the transformation of production baskets of each nation. Here, we first derive the level of productivity changes carried out by each sector of both South and North at autarky. Next, we proceed to check the transformation of production baskets under alternative trade policy regimes.

12.3.1 Autarky

Technological progress (TP) across sectors in South and North is crucial in order to capture the reformation of production baskets. To outline the presence of TP in terms of productivity changes across sectors in both free trade and autarky, here we start with symmetrical changes in the level of productivity across sectors and countries. Hence, productivity changes for X, Y and Z in South and North are described as follows:

Using Eqs. (12.1), (12.2) and (12.3):

$$\theta_{LX}\widehat{W} + \theta_{KX}\hat{r} = \alpha \tag{12.1$'$}$$

$$\theta_{LY}\widehat{W} + \theta_{KY}\hat{r} = \beta \tag{12.2$'$}$$

$$\theta_{LZ}\widehat{W} + \theta_{NZ}\hat{R} = \gamma \tag{12.3$'$}$$

Similarly, differentiation of Eqs. (12.7)–(12.9):

$$\theta_{LX}\widehat{W}^{*} + \theta_{KX}\hat{r}^{*} = \alpha \tag{12.7$'$}$$

$$\theta_{LY}\widehat{W}^{*} + \theta_{KY}\hat{r}^{*} = \beta \tag{12.8$'$}$$

$$\theta_{LZ}\widehat{W}^{*} + \theta_{NZ}\widehat{R}^{*} = \gamma \tag{12.9$'$}$$

Here, we assume the productivity parameters of sectors X, Y and$Z$ endure TP by $\alpha > 0$, $\beta > 0$ and $\gamma > 0$, respectively, in both economies.

12.3.2 Asymmetric Technological Progress, Environmental Regulations and IT Industry

Strict environmental regulations (Ω) are quite common in North, and it creates the main dividend for the inflow of non-IT-type Capital from the North to the South. Hence, constraint augmented productivity of non-IT pollution-intensive good (Y) producing sector generates the asymmetry in the level of change in productivity in both countries. To capture this, here we reconsider Eqs. (12.2) and (12.8) and after some manipulations we get:

$$\theta_{LY}\widehat{W} + \theta_{KY}\hat{r} = \beta_1(\Omega) \tag{12.2$''$}$$

Similarly, differentiation of (12.7–12.9)

$$\theta_{LY}\widehat{W}^{*} + \theta_{KY}\hat{r}^{*} = \beta_2(\Omega) \tag{12.8$''$}$$

It is illustrated above that imposition of environmental regulation creates productivity disorder for the same sector across nations, and it insists us to state the following Axiom for further theoretical progress.

Axiom 12.1 *The imposition of different order environmental regulations in different economic regions, for instance, differently imposed in North and South, generates asymmetric change in the productivity of sector Y in both countries, that is,* $\beta_1 \neq \beta_2$ *as* $\Omega_{\text{North}} \neq \Omega_{\text{South}}$ *and* $\beta_1' < 0$, $\beta_2' < 0$. *However, same order imposition of environmental regulations across countries leads to* $\beta_1 = \beta_2$ *as* $\Omega_{\text{North}} = \Omega_{\text{South}}$ *and* $\beta_1' = \beta_2' = \beta'$.

Axiom 12.2 *Existence of strict environmental regulations in North encourage pollution-intensive good-producing sector to invest in South and hence its effective productivity* ($\beta_2(\Omega)$) *fall in North, and at the same time, the effective productivity* ($\beta_1(\Omega)$) *enhances in South, i.e.* $\beta_1(\Omega) > \beta_2(\Omega)$; $\beta_1(\Omega) > 0$, $\beta_2(\Omega) > 0$; $\beta_1'(\Omega) < 0$, $\beta_2'(\Omega) < 0$.

12.3.3 Open Economy

In this section, we shall try to track the main element behind the inflow of foreign capital from North to South. Moreover, we shall also try to focus on the impact of international capital mobility (both in terms of IT-type and non-IT-type) on the production structure of both nations. We look into the above-mentioned points one by one for both types of capital (i.e. K, N). First, we start with the inflow of foreign K, and secondly, we allocate the same for foreign N.

12.3.3.1 Case 1: Mobility of International *K* and Asymmetric Productivity in *Y*

From Eqs. (12.1′) and (12.2″) for the South, we get,

$$\widehat{W} = (1/|\Delta|)\{\alpha\theta_{KY} - \beta_1(\Omega)\theta_{KX}\} \tag{12.13}$$

$$\hat{r} = (1/|\Delta|)\{\beta_1(\Omega)\theta_{LX} - \alpha\theta_{LY}\} \tag{12.14}$$

Similarly, for North, using Eqs. (12.7′) and (12.8″) one can obtain,

$$\widehat{W}^* = (1/|\Delta|)\{\alpha\theta_{KY} - \beta_2(\Omega)\theta_{KX}\} \tag{12.15}$$

$$\hat{r}^* = (1/|\Delta|)\{\beta_2(\Omega)\theta_{LX} - \alpha\theta_{LY}\} \tag{12.16}$$

Now Eqs. (12.14) and (12.16) lead to us

$$\hat{r} - \hat{r}^* = (1/|\Delta|)\theta_{LX}[\beta_1(\Omega) - \beta_2(\Omega)] \tag{12.17}$$

Using Axiom (12.1) and Axiom (12.2) from expression (12.17), we get $r - r^* < 0$. It entails us that foreign capital of non-IT-type (K) flows from North to South. In standard SFM with three sectors-three-factors framework, availability of non-IT-type capital in the two countries differs, that is, $K^* > K$, and hence, it implies $r > r^*$. Thus, to hold $r > r^*$, in our SFM with stability and uniqueness in commodity prices under free trade, it is necessary that the productivity gap remains asymmetric.

Remarks 12.1 *For $\alpha_1 = \alpha_2 = \alpha$, $\gamma_1 = \gamma_2 = \gamma$ and $\beta_1(\Omega) > \beta_2(\Omega)$, foreign part of non-IT-type capital flows from the North to the South.*

Note, in the South, it is usually assumed that the domestic return to non-IT-type capital (r) is greater than its international counterpart (r^*), i.e. $r > r^*$. From Eqs. (12.1′) and (12.2″), we can get a fall in r and an increase in $W(\widehat{W} > 0)$ due to the inflow of foreign non-IT-type capital. At the same time, in the North, it is usually realized that the domestic return to non-IT-type capital (r) is lower than its southern counterpart (r), i.e. $r^* < r$. From Eqs. (12.7′) and (12.8″), we can get an increase in r and a reduction in $W(\widehat{W} < 0)$ due to the outflow of foreign non-IT-type capital. Economic intuitions of these movements of input returns are crucial to propose further policy prescription. Strict environmental regulations restrict Northern Y producing firms to invest more in North, and hence, the North realizes the outflow of K. In fact, inflow of K in South creates upward pressure on W in both sectors X and Y. Again, Eq. (12.5) tells us that, other things remaining same, non-IT pollution-intensive good-producing sector of South expands (i.e. $\widehat{Y} > 0$) as $\widehat{K} > 0$. Expansion of Y needs more labour (along with K for maintaining K/L ratio), and hence, W will increase more in the non-IT manufacturing sector in South and higher W with higher probability of getting job may attract more labour to move from X to Y. Hence, sector Y gains more importance in South (i.e. $\widehat{Y} > 0$) and almost vanished (i.e. $\widehat{Y}^* > 0$) in the North, while the non-IT environment-friendly goods-producing sector expand (i.e. $\widehat{X}^* > 0$) in the North and almost mislay its significance in the South (i.e. $\widehat{X} > 0$). It is to be noted, that fall in r leads to a reduction in R (i.e. $\widehat{R} < 0$) (from the relation (12.3′)). Relation (12.6) tells us that under the present regime of international mobility non-IT-type capital sector Z has not gained much significance (i.e. $\widehat{Z} < 0$) in the production structure of the South as $\widehat{N} = 0$ and $\hat{a}_{NZ} > 0$. However, Eq. (12.9′) entails that in the North an increase in r^* leads to a rise in R^* (i.e. $\widehat{R}^* > 0$) and relation (12.12) reveals that under the above-mentioned regime sector Z has gained much significance (i.e. $\widehat{Z}^* > 0$) in the production structure of the North as $\hat{a}_{NZ} < 0$.

Proposition 12.1 *In short, finite movement of K from the North to the South enhancing the prospects of non-IT bad goods manufacturing industry in South, while creating immense scope for environment-friendly IT Industry in the North.*

12.3.3.2 Case 2: Mobility of International *K* and Asymmetric Productivities in *Y* and *X*

Reconsideration of relations (12.1) and (12.7) and after some manipulations, we obtain:

$$\theta_{LX}\widehat{W} + \theta_{KX}\hat{r} = \alpha_1 \tag{12.1″}$$

$$\text{and, } \theta_{LX}\widehat{W}^{*} + \theta_{KX}\hat{r}^{*} = \alpha_2 \qquad (12.7'')$$

It is illustrated above that imposition of environmental regulation along with preexist productivity disorder between sectors X of both nations generates some extended outcome from our model, and thereby, we need the following Axioms for further analytical perspective.

Axiom 12.3 *Existence of different order environmental regulations along with different order technological progress in non-IT export sector in different economic regions, for instance, differently allocated in North and South, generate asymmetric change in the productivity of sectors X and Y in both countries, that is,* $\alpha_1 \neq \alpha_2$ *and* $\beta_1 \neq \beta_2$ *as* $\alpha_1 > 0, \alpha_2 > 0, \beta_1 > 0, \beta_2 > 0, \gamma_1 = \gamma_2 = \gamma$ *and* $\beta_1' < 0$, $\beta_2' < 0$. *However, same order imposition of environmental regulations across countries leads to* $\alpha_1 = \alpha_2 = \alpha$, $\beta_1 = \beta_2 = \beta$ *as* $\Omega_{\text{North}} = \Omega_{\text{South}}$ *and* $\beta_1' = \beta_2' = \beta'$.

Axiom 12.4 *Prevailing the presence of* Axiom 12.2, *the South-based non-IT export industry accrue high productivity* (α_1) *compared to its Northern counterpart, i.e.* $\alpha_1 > \alpha_2, \beta_1(\Omega) > \beta_2(\Omega); \beta_1(\Omega) > 0, \beta_2(\Omega) > 0; \beta_1'(\Omega) < 0, \beta_2'(\Omega) < 0$.

For South, Eqs. (12.1″) and (12.2″) tell us,

$$\widehat{W} = (1/|\Delta|)\{\alpha_1\theta_{KY} - \beta_1(\Omega)\theta_{KX}\} \qquad (12.13')$$

$$\hat{r} = (1/|\Delta|)\{\beta_1(\Omega)\theta_{LX} - \alpha_1\theta_{LY}\} \qquad (12.14')$$

Again, for North, Eqs. (12.7″) and (12.8″) give us,

$$\widehat{W}^{*} = (1/|\Delta|)\{\alpha_2\theta_{KY} - \beta_2(\Omega)\theta_{KX}\} \qquad (12.15')$$

$$\hat{r}^{*} = (1/|\Delta|)\{\beta_2(\Omega)\theta_{LX} - \alpha_2\theta_{LY}\} \qquad (12.16')$$

Similar to case 1, Eqs. (12.14′) and (12.16′) demonstrate the following relation,

$$\hat{r} - \hat{r}^{*} = (1/|\Delta|)\theta_{LX}[\beta_1(\Omega) - \beta_2(\Omega)] + (1/|\Delta|)\theta_{LY}[\alpha_2 - \alpha_1] \qquad (12.17')$$

Using Axioms (12.1–12.4), relation (12.17′) offers $r - r^{*} < 0$. It describes the argument behind the mobility of foreign capital of non-IT type (K) from North to South. To make the economic intuition about the sign carrying out by the relation (12.19), we are considering the following lemma.

Lemma 12.1 *International wage-income gap and environmental regulations disorder between the North and the South are synonymous with due pursuance of* Axioms 12.1 and 12.2.

Proof of Lemma Using relations (12.13) and (12.15)

$$(\widehat{W}^* - \widehat{W}) = (1/|\Delta|)\{\alpha\theta_{KY} - \beta_2(\Omega)\theta_{KX} - \alpha\theta_{KY} + \beta_1(\Omega)\theta_{KX}\}$$

Rearrangements of the above expression

$$(\widehat{W}^* - \widehat{W}) = (1/|\Delta|)\{\beta_1(\Omega)\theta_{KX} - \beta_2(\Omega)\theta_{KX}\} \tag{12.18}$$

Using the Lemma 12.1 along with Axioms (12.1–12.4) accumulate the drive towards international mobility of K from the North to South owing to the overwhelming impacts of asymmetric productivity effect (APE) of non-IT export industries over the International Wage-Gap Effects (IWE).

Remarks 12.2 *For $\gamma_1 = \gamma_2 = \gamma$ and $\alpha_1 > \alpha_2$, $\beta_1(\Omega) > \beta_2(\Omega)$, foreign part of non-IT-type capital flows from the North to the South, iff, $\theta_{LX}[\beta_1(\Omega) - \beta_2(\Omega)] < \theta_{LY}[\alpha_2 - \alpha_1]$.*

Exposure of sectoral distribution owing to the inflow of K almost remains same in the South and the North. Here, again we are initiating with $r > r^*$ in the South. From Eqs. (12.1″) and (12.2″), we find a reduction in r and a rise in $W(\widehat{W} > 0)$ due to the inflow of $K(\widehat{K}_{\mathrm{F}} > 0)$. However, in the North, we are initiating with $r^* < r$. Using expressions (12.7″) and (12.8″), we get an increase in r and a reduction in $W(\widehat{W} < 0)$ due to the outflow of $K(\widehat{K} < 0)$. It can be noted that either by using similar kind of arguments which have been used earlier in case 1 or simply by stating the Rybczynski type effect, we can postulate that in the South Y expands (i.e. $\widehat{Y} > 0$) and X contract (i.e. $\widehat{X} < 0$) and in the North exact opposite crop up (i.e. $\widehat{Y}^* < 0$ and i.e. $\widehat{X}^* > 0$). Moreover, the impact of the inflow (to South) and outflow (from North) of K remain almost unchanged like Case 1 in both economies. In short, Eqs. (12.6) and (12.12) reveal the expansion of IT industry (i.e. $\widehat{Z}^* > 0$) in the North and contraction of South-based IT industry (i.e. $\widehat{Z} < 0$).

Proposition 12.2 *Finite movement of K from the North to the South augmented with productivity asymmetry between non-IT export industry makes it ornamental for the non-IT bad goods manufacturing industry in South, while creating enormous capacity for environment-friendly IT Industry in the North.*

12.3.3.3 Case 3: Mobility of International *N* and Asymmetric Productivities in *Y* and *Z*

To obtain the impact of finite movements of foreign IT-type capital on the sectoral distribution of both the South and the North, here we once again adopt Eqs. (12.3) and (12.9) and after proper handling:

$$\theta_{LZ}\widehat{W} + \theta_{NZ}\widehat{R} = \gamma_1 \quad (12.3'')$$

$$\theta_{LZ}\widehat{W}^* + \theta_{NZ}\widehat{R}^* = \gamma_2 \quad (12.9'')$$

Note, the above expressions tell us that imposition of environmental regulations augmented with productivity disorder between sectors Z of both countries breed some unmitigated conclusion from our benchmark model, and in this manner, we require the following Axioms for further critical perception.

Axiom 12.5 *Existence of different order environmental regulations along with different order technological progress in IT industry in different economic regions, for instance, differently allocated in North and South, generate asymmetric change in productivity of sectors Z and Y in both countries, that is,* $\gamma_1 \neq \gamma_2$ *and* $\beta_1 \neq \beta_2$ *as* $\gamma_1 > 0, \gamma_2 > 0, \beta_1 > 0, \beta_2 > 0, \alpha_1 = \alpha_2 = \alpha$ *and* $\beta_1' < 0, \beta_2' < 0$. *However, same order annoyance of environmental regulations across countries leads to* $\gamma_1 = \gamma_2 = \gamma$, $\beta_1 = \beta_2 = \beta$ *as* $\Omega_{\text{North}} = \Omega_{\text{South}}$ *and* $\beta_1' = \beta_2' = \beta'$.

Axiom 12.6 *To be had the presence of* Axiom 12.2*, the Northern IT industry accumulate high productivity* (γ_2)*compared to its Northern counterpart* (γ_1)*, i.e.* $\gamma_1 < \gamma_2, \beta_1(\Omega) > \beta_2(\Omega); \beta_1(\Omega) > 0, \beta_2(\Omega) > 0; \beta_1'(\Omega) < 0, \beta_2'(\Omega) < 0$.

For the South, using Eq. (12.13), from relation (12.3″) we get,

$$\widehat{R} = (\gamma_1/\theta_{NZ}) - (\theta_{LZ}/\theta_{NZ})\widehat{W} \quad (12.19)$$

Similarly, for the North, Eqs. (12.15) and (12.9″) give us,

$$\widehat{R}^* = (\gamma/\theta_{NZ}) - (\theta_{LZ}/\theta_{NZ})\widehat{W}^* \quad (12.20)$$

If $\alpha_1 = \alpha_2 = \alpha$, then Eqs. (12.19) and (12.20) display the following relation,

$$\widehat{R} - \widehat{R}^* = (\theta_{LZ}/\theta_{KZ})(\widehat{W}^* - \widehat{W}) + (1/\theta_{KZ})(\gamma_1 - \gamma_2) \quad (12.21)$$

To make the matter more suitable for the international trade in terms of finite changes in trade policies, here we craft Axiom 12.6 as more plausible in nature. Using Axioms (12.1, 12.2, 12.5 and 12.6), from expression (12.21), we acquire $R - R^* < 0$. It affirms that foreign capital of IT-type (N) flows from North to South. Like the earlier cases, here we reconsider the critical posture of standard SFM with 3×3 framework to categorically justify the availability of IT-type capital in both countries be different, that is, $N^* > N$, and hence, it implies $R > R^*$. It describes the argument behind the mobility of foreign capital of IT-type (N) from North to South. To compose the compatible economic argument regarding the sign carrying out by the relation (12.21), we are taking into consideration the Lemma 12.1. Trailing the Lemma 12.1 along with Axioms (12.1, 12.2, 12.5 and 12.6) accumulate the drive towards international mobility of N from the North to South owing to the overwhelming impacts of asymmetric productivity effect (APE) of IT industries over the International Wage-Gap Effects (IWE).

Remarks 12.3 *For* $\alpha_1 = \alpha_2 = \alpha$ *and* $\gamma_2 > \gamma_1$, $\beta_1(\Omega) > \beta_2(\Omega)$, *foreign part of IT-type capital flows from the North to the South, iff,* $\theta_{LZ}(\widehat{W}^* - \widehat{W}) < (\gamma_1 - \gamma_2)$.

In the South, it is usually assumed that the domestic return to IT-type capital (R) is greater than its international counterpart (R^*), i.e. $R > R^*$. Note, Eq. (12.3′) describes an increase in $W(\widehat{W} > 0)$ following a reduction in $R(\widehat{R} < 0)$ due to the inflow of foreign IT type capital. At the same time, in the North, it is comprehended that the domestic return to IT-type capital (R^*) is lower than its southern counterpart (R), i.e. $R^* < R$. From Eqs. (12.7′) and (12.8″), we can get an increase in $r(\hat{r} < 0)$ and a reduction in $W(\widehat{W} < 0)$ owing to the outflow of foreign IT-type capital. Economic perceptions of these movements of factor returns are critical to put forward for further policy implication. Indeed, an inflow of N to South creates an upward pressure on W in both sectors X and Y. Now if the W increases more or with higher pace at X compared to Y, labour with high frequency will move to sector X and thereby, it expands and non-IT pollution-intensive bad-producing sector may try survive (i.e. $\widehat{X} > 0$, $\widehat{Y} < 0$) owing to factor intensity condition. Again, Eq. (12.6) describes us that, other things remaining same, environment-friendly IT sector of South expands (i.e. $\widehat{Z} > 0$) as $\widehat{N} > 0$. Hence, sector Y vanishes from the world, i.e. $\widehat{Y} < 0$ and $\widehat{Y}^* < 0$. Sector Y is losing its significance in the South also as environment-friendly IT and non-IT sectors can absorb all the labour (released from sector Y) to reach full-employment situation. Relation (12.6) tells us that under the present regime of international mobility IT-type capital sector Z has gained much significance (i.e. $\widehat{Z} > 0$) in the production structure of the South as $\widehat{N} > 0$ and $\hat{a}_{NZ} > 0$. However, relation (12.12) reveals that under the above-mentioned regime, though the sector Z has failed to maintain (i.e. $\widehat{Z}^* < 0$) its production capacity in North; however, its demand remain same, and hence, the Northern IT sector may propose for outsourcing to meet up their demand.

Proposition 12.3 *Finite movement of N from the North to the South augmented with productivity asymmetry between IT industry leads to an expansion of the IT industry in South, while remaining enormous capacity for environment-friendly IT Industry in the North via the outsourcing path.*

12.4 Concluding Remarks

In the present chapter, we have considered the possibilities of finite changes of trade policies in terms of regime switch from autarky to open economy for two distinctive small open economies (namely, the South and the North). The effects of such a regime change on the sectoral distribution of the said North and South in the presence of technological progress and environmental regulations have been discussed here. Moreover, we have examined here the impact of perfect international capital mobility in terms of both IT-type capital and non-IT-type capital on the assumed South and North. For this purpose, we have employed a three-sector GE model for both North and South with special emphasis on IT-based industries. In such a setup, we have found that inflow of 'bad goods'-producing sector-specific capital from the North to the South emphasize importance of bads' market in the South while the same sector becomes almost vanished in the North owing to the existence of strict environmental acts or regulations in North. Moreover, such trade policy may harm the potentiality of IT industry in the South at the cost of larger pollution-related activities. On the other side of the coin, that is, in North, the IT-based industries expand with potentiality of making an opportunity in the path of sustainable development. Further imposition of productivity restriction in terms of asymmetric technological progress between the environment-friendly non-IT sectors of North and South generates almost similar kind of outcomes in the South and North. However, finite movement of IT sector specific capital from the North to the South augmented with productivity asymmetry between IT industry leads to an expansion of the IT industry in South, while same trade policy claiming colossal capacity for environment-friendly IT Industry in the North by means of the outsourcing.

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Chapter 13
Mobile Phone Penetration and Health Outcome: Panel Evidence from 25 Selected Asian Countries

Ujjal Protim Dutta, Hemant Gupta, and Partha Pratim Sengupta

13.1 Introduction

Health is considered as one of the vital components of human development. World Health Organization (2001) has observed that poor health is an impediment to the development of an economy. If life expectancy at birth increases by 10%, then the economic outcome rate will increase by 0.35% annually. The economic growth rate of the developed and developing countries differs by almost 50% due to factors such as life expectancy and poor health. The quality of the population's health and distribution of basic health services across the social spectrum of a country are the preconditions for the economic as well as social development. Health, along with other factors contribute to higher standards of living, thereby increasing people's ability and output. Health is of prime importance and it is the foundation that facilitates human development and socioeconomic development.

Healthcare systems across the world are confronted with challenges due to round the clock demands from patients, delivery of required aids and treatments. These challenges require innovations that have the potential to address the problems of increasing cost and lack of awareness. Like the Millennium Development Goals, the Sustainable Development Goals have emphasized on health outcome by formulating goals such as Goal 2 (zero hunger), Goal 3 (good health and well-being) and Goal 6

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(clean water and sanitation). Due to the awareness created by SDGs, the UNICEF, WHO and other international agencies invested in health outcome estimation by conducting research in national mortality survey across the countries (Murray 2015). 'Health outcome' indicates the factors of healthcare system which may influence the lives of people in any nation (Dutta et al. 2019). In this light, the usage of mobile phone has the potential to strengthen the public health programs in developing world. The improved access to health and the efficient healthcare system due to the mobile technologies will help the developing countries to save their scarce resources, which in turn would positively impact the development of the countries. As noted by WHO (2011) "The use of mobile and wireless technologies to support the achievement of health objectives (m-Health) has the potential to transform the face of health service delivery across the globe." According to Lupton (2012), "m-Health encompasses any use of mobile technology to address healthcare challenges such as access, quality, affordability, matching of resources, and behavioral norms (through) the exchange of information."

With seven billion mobile phone users in 2016, mobile phone technology has been considered as a fast growing information and communication technology in human history (Castells et al. 2009). As pointed out by Jeffrey Sachs (2008): "Mobile phones and wireless Internet end isolation, and will, therefore, prove to be the most transformative technology of economic development of our time." In developing countries, the number of people having mobile phone subscriptions has grown from 1200 million in 2005 to 5400 million in 2014 (ITU 2015). It is considered as the only ICT-based sector, wherein developing nations are rapidly progressing. The unprecedented growth of mobile phone exceeds other infrastructural facilities such as road, electricity and Internet in many low-income and middle-income nations (WHO 2011). The rapid catching up of mobile technology in developing countries has caused a great deal of positive interest regarding its possible impacts on the health sector. It can potentially revolutionize the way the health services and information are managed, accessed and delivered. According to many researchers, poor and rural populations might receive a large share of benefits from mobile technology (Donner 2004, 2008; Rangaswamy and Nair 2010). In their efforts to attain health-related Sustainable Development Goals (SDGs), the governments of low-income as well as middle-income nations have realized the importance of m-health for strengthening the health services (ITU 2015).

In the recent years, e-health, that is, health on the Internet, has been widely researched and deliberated upon, especially about the value of the information available on this platform (Adams and Berg 2004) as well as the redefining roles of experts and the doctor-patient relationship (Henwood et al. 2003). However, the scope and role of wireless technology and mobile phone have been relatively unexplored in the Asian context. Given the rapidly increasing penetration and proliferation of mobile phones, it is reasonable to question whether it could further leverage health sector development. This is the key question that this study tries to evaluate. Setting the backdrop of the study, the second section reviews existing literature with respect to socioeconomic development, health and child mortality. Subsequently, the next section addresses the methodological concerns. To address the objective of the study, panel cointegration technique suggested by Pedroni (1999) has been used in case of selected Asian countries from 2000 to 2014. In addition to this, the panel regression model was estimated with the help of FMOLS and DOLS techniques. The fourth section elaborates on the results and provides an analysis of the outcomes. Thereafter, the last section briefly sums up the findings of the study and discusses the policy implications.

13.2 Diffusion of Mobile Telephony and Health: Reviewing the Value of Communication

13.2.1 Mobile Phone and Socioeconomic Development

In general, new forms of technological advancements are considered to be drivers for all the countries, especially for developing countries, in eradicating problems relating to illiteracy and poverty as well as to assist in improving the living standards (Obijiofor 2009). There are wide ranging viewpoints as various studies investigate diverse facets of the impact of technology on socioeconomic issues. Many studies, like Rodríguez and Wilson (2000), have found that the new forms of technology may improve economic performance yet the relation between ICT and uniform socioeconomic improvement is debatable. The vast range of viewpoints regarding technology and the ways in which they either encourage or impede the transformation of economies has been explored in multiple contexts, like Africa (Hudson 2013; Sissouma 2000), Southeast Asia (Mirandilla 2007) and India (Pitroda 1993).

More specifically, many research attempts have explored the relationship of mobile phone penetration with the development of a nation (Donner 2008). These studies mainly illustrated the benefits of mobile phone in the context of social as well as economic development. For instance, Hardy (1980) explains the importance of telephones in the socioeconomic development of a nation. Madon (2004) examines the e-governance application (m-governance) on development, which is an emerging concept in the recent literature (Smith et al. 2011). Similarly, Aker and Mbiti (2010) have elaborated the benefit of mobile phone for entrepreneurs to grab the market opportunities utilizing social networking platforms. A number of studies have exemplified the efficiency of the mobile phone as a catalyst for empowering the communities and for societal development (Manyozo 2012; Dreze and Sen 1999).

13.2.2 Mobile Phone and Health

As health is one of primary importance, governments across the globe are concerned with making advancements and utilizing technology in the sphere of health care to maximize its potential. The cost of accessing and utilizing healthcare services is increasing and the growing expectations from the patients have forced the entire healthcare industry to strive for new developments. In general, studies related to the connection between mobile phones and health have mainly concentrated on the role of the mobile phone in enhancing direct healthcare intervention (Kaplan 2006). This direct intervention has proven effective as mobile technology not only increases a person's access to information but also disseminates it in a much simpler manner (Wilson and Lankton 2004). Several studies have considered voice and text function of the mobiles as revolutionary as it provides better access to health-related information and helps in improving efficiency within the healthcare system (Chib 2010). Due to some of the useful functional properties such as text messaging, flexible payment plans and low communication cost, the mobile phone becomes an attractive healthcare intervention in the developing world (Kaplan 2006). With improving data-processing and storage facilities, mobile phone networks support easy transmission and analysis of data in various forms, which includes numerical, graphic and video files. According to Lacal (2003) and Mechael (2006) due to the advanced progress made in health-related applications, the mobile phone can deliver instantaneous response, and this proves to be immensely helpful for the decentralized healthcare system. Many research papers have highlighted the possibility of the mobile phone to provide health-related information and mobilize attendance in health programs, particularly in developing countries. An empirical study concerning mobile phone and health in Egypt found that mobile phone contributes overall family well-being by improving access to routine health services (Mechael 2006). In line with this, many studies have found that mobile phones have eased the communication mediums for aged people, which makes it easy for them to contact their family or doctors (Agar 2013; Haddon 2004; Ling 2004).

Previously, the healthcare system suffered from the lack of innovation and on-demand supply of services. The high cost of medical services was another major issue for the patients. Consequently, the researchers relied on the advancement of mobile technology for the improvement of health services. In this context, the health service providers mainly depended on mobile phone technology to improve the clinical outcome. For instance, Shet and de Costa (2011) experimented upon the impact of the mobile phone on health outcome by text, i.e., short message service (SMS) to clients or patient on clinical outcomes. In developing countries, mobile phone penetration has the potential to change the scenario of the primary healthcare system. Nowadays, mobile phone is utilized not only to track human right abusers or for monitoring thieves but also for developing humanitarian programs (Bott and Young 2012). For primary healthcare system in developing nations, the local volunteers or members of the non-governmental organization (NGOs) are collecting information locally in their mobile phone and it is forwarded to a centralized system to improve the healthcare system. These kinds of humanitarian programs motivate and empower the local health administration and community with relevant data and services. Mobile phone plays a key role in developing healthcare services due to its transmission value and clear communication exchange (Medhi et al. 2012). This has been seen in countries like Uganda, where the healthcare workers were able to save almost 24% of their expenditure by using mobile phone for collection of data and storage (Rashid and Elder 2009). Consequently, the experts from the medical science believe that the mobile phone utilization can revolutionize the healthcare system in the developing nations of Asia (VWC 2009).

13.2.3 Mobile Phone and Child Mortality

With the low cost and high efficiency, mobile phone permits the exchange and conveyance of information across geographical or temporal barriers (Shade et al. 2012). The importance of mobile phone in providing health-related information has been underscored in existing research. For example, in Uganda, a radio-based project aiming to provide health care to pregnant women was successful in reducing mortality rate among the expectant mothers (Musoke 2001). Later, it was replaced by a mobile phone due to its more functional properties (Noordam et al. 2011). According to Brownlee (2012), with the establishment of mobile birth notification system ‘mobile for health’ in Bangladesh, about 89% of the child-births are taking place in the hospitals.

By notifying the target population by text messages of different health campaigns and disease eradication programs, mobile phone has increased the likelihood of safe-guarding mothers and babies from several sicknesses. This medium has also proved crucial for disseminating vital information about precautionary steps in controlling or preventing the spread of any disease. Fedha (2014) found that mobile phone has significantly reduced the chances of missing any clinical appointments among the expectant women, which considerably lessens the risks of infant deaths.

13.3 Methodological Issues

The study attempts to evaluate the effect of mobile phone penetration on health outcome while controlling for other variables which are related to better health status. Cross-country data of the chosen Asian nations for the period of 2000–2014 has been used to serve the purpose of the study. To comprehend the impact of the mobile phone on health outcome, the following model was employed;

$$\begin{aligned} \mathrm{HO}_{i,t} = {} & \alpha_i + \beta_1 \ln(\mathrm{Mobile})_{i,t} + \beta_2 \ln(\mathrm{Health\ Exp})_{i,t} + \beta_3 \ln(\mathrm{Female})_{i,t} \\ & + \beta_4 \ln(\mathrm{Urban\ Pop})_{i,t} + \beta_5 \ln(Y)_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{13.1}$$

where

Mobile	Mobile phone subscription;
$\mathrm{HO}_{i,t}$	Infant mortality rate (IMR) has been taken as a proxy for health outcome for country i;
Health $\mathrm{Exp}_{i,t}$	Expenditure on health care;

$\text{Female}_{i,t}$	Educational attainment of female;
$\text{Urban Pop}_{i,t}$	Population inhabiting urban areas (measure of urbanization);
$y_{i,t}$	GDP per capita;
$\varepsilon_{i,t}$	Disturbance term.

β_1, the coefficient of mobile phone penetration, shows the impact of mobile phone penetration on health outcome. As we assumed that higher the mobile phone penetration, the better will be the health outcome (lower is the infant mortality rate), this coefficient is likely to have a negative sign.

The study expects a positive relationship between the health expenditure and health outcome as expenditure on health is likely to improve the infrastructure which will make medical facilities available to a large section of the population at an affordable cost. The existing literature shows that investment in the heath sector has significant impact on the economy as poor health can be a financial burden and a major cause of the gap between developed and developing nations (Karim 2016; Anyanwu and Erhijakpor 2009). Due to the realization of the importance of public health, the issue has been researched upon from various viewpoints, especially the close link between health outcome and health expenditure. This relationship has been explored by a number of researchers in the context of the developing countries like Nixon and Ulmann (2006) and Crémieux et al. (1999), but research in the Asian context has been sporadic.

Urbanization affects an economy in two opposing ways. On one hand, it leads to better and easier access to healthcare services, proper sanitation and employment, while on the other, it leads to the problems of over-crowding, crime, stress and pollution which impact the health status negatively (Godfrey and Julien 2005). Thus, in the study, the impact of urbanization on health outcome in case of Asian countries can be either positive or negative. The general assumption is that the level of female education is expected to improve health-related outcome as it implies informed decisions at the household level and healthier lifestyles. Awareness about health and better disposable income will lead to judicious utilization of health services and consequentially improve the overall health outcome.

13.3.1 Data

The annual data of 25 Asian nations during the years 2000–2014 was compiled for undertaking the study. The data was retrieved from World Development Indicator. The variables used are—health outcome proxied by IMR, mobile phone subscription rate, per capita GDP, government expenditure on health, female education and urban population (as a proxy for the urbanization). The detailed description of chosen variables is elucidated in Table 13.1.

Table 13.1 Details of variables

Variables	Symbols	Details	Data sources
Health outcome	HO	It refers to the number of infant deaths (before completing 1 year) in a year per 1000 live births	WDI, World Bank
Mobile phone penetration	Mobile	It refers to mobile subscription per 100 people	WDI, World Bank
Expenditure on health care	HE	Present per capita expenditure on health (in current USD)	WDI, World Bank
Educational attainment of female	FEDU	Female students at primary level (including enrolments in public as well as private institutions) as % of total pupils	WDI, World Bank
Urbanization	UP	Percentage of population inhabiting in urbanized areas as compared to the total population	WDI, World Bank
GDP per capita	GDPPC	It is the gross domestic product divided by midyear population	WDI, World Bank

Source: Authors'

13.3.2 Cross-Section Dependence Test

While undertaking panel data analysis, it is mandatory to consider the occurrence of cross-section dependency in the dataset employed in the paper. To fulfill this objective, we have applied four commonly used tests, which are—Breusch–Pagan Lagrange Multiplier (LM) (1980), Pesaran cross-sectional dependence (CD) (2004), Pesaran scaled LM (2004), and Baltagi, Feng and Kao bias-corrected scaled Lagrange multiplier (LM) (2012). The null hypothesis of no cross-section dependence has been assumed in all the mentioned tests.

13.3.3 Panel Unit Root

For detecting the stationary properties of the chosen variables, the study used Levin-Lin and Chu(LLC) (2002) as well as Im-Pesaran-Shin(IPS) (2003) unit root tests. These panel unit root tests are an extension of the augmented Dickey-Fuller(ADF)unit root test for time series modeling. LLC test can be viewed as pooled ADF test when lags are considered. In addition to this, LLC test presumes homogeneity of the autoregressive (AR) coefficients across the panel. Though all the panel unit root tests are based on the restrictive postulation of individual cross-sectional independency, IPS panel unit root test relaxes the assumption of individual cross-sectional independency and panel homogeneity. The panel LLC and IPS unit root tests are based on the following panel ADF regression equation:

$$\Delta y_{i,t} = \alpha_i + \rho y_{i,t-1} + \sum_{j=1}^{p_i} \alpha_j \Delta y_{i,t-j} + \varepsilon_{i,t} \tag{13.2}$$

where $i = 1, 2, \ldots, N$ units and $t = 1, 2, \ldots, T$ time periods, p_i = number of lags in the ADF regression and $\varepsilon_{i,t}$ = error terms.

Both the tests are based on the null hypothesis of H_0: $\rho = 0$. However, distinction between the tests is evident when the alternative hypothesis is considered, as LLC test assumed H_1: $\rho_i < 1$ for all i and IPS test assumed of H_1: $\rho_i < 1$ for atleat one i.

13.3.4 Pedroni's Cointegration Technique

Pedroni's Cointegration technique has been applied to understand the existence of a long-run association among the variables under consideration. The following regression model was estimated to carry out the cointegration analysis;

$$y_{i,t} = \alpha_i + \delta_i t + \beta_1 X_{1,i,t} + \beta_2 X_{2,i,t} + \cdots + \beta_n X_{n,i,t} + \varepsilon_{i,t} \tag{13.3}$$

In the above equation, $i = 1, \ldots., N$, represent the number of countries in the panel. Similarly, $t = 1, \ldots, T$, indicate the number of years included in the panel. Individual panel member-specific effect is denoted by α_i. The specification of the estimated residual is as given below:

$$\varepsilon_{i,t} = \rho_i \varepsilon_{i,t-1} + \mu_{i,t} \tag{13.4}$$

The seven test statistics provided by Pedroni, to test the cointegration, are grouped into two. The first group is referred to as 'within dimension' and it comprises of four statistics. On the other hand, the second group is known as 'between dimension' and it comprises of three test statistics. Both groups are based on the null hypothesis of no cointegration. However, distinction between the groups is evident when the alternative hypothesis is considered, as within dimension statistics assumed $H_1 : \rho_i < 1$ for all i and between dimension statistics assumed H_1: $\rho_i < 1$ for atleat one i. Pedroni (1999) permits heterogeneity across individual panel member, and hence it is considered as an improvement over conventional cointegration tests (Pakistan energy yearbook, 2013).

13.3.5 *Fully Modified Ordinary Least Square(FMOLS) and Dynamic Ordinary Least Square(DOLS) Techniques*

The study has estimated the panel regression model with the help of FMOLS and DOLS techniques. These tests are conducted after checking the stationary properties of the variables. To execute these estimators, we have taken into consideration the given fixed effect (FE) panel regression model:

$$\text{Health Outcome}_{i,t} = \alpha_i + x_{i,t}\beta + u_{i,t} \tag{13.5}$$

In the above equation, $i = 1, \ldots., N$, represent the number of countries in the panel. Similarly, $t = 1, \ldots, T$, indicate the number of years included in the panel. Individual panel member-specific effect is denoted by α_i. $\text{Health Outcome}_{i,t}$ is a matrix of (1, 1) dimension. β is a vector of parameter, with (k, 1) dimension. Here, $x_{i,t}$ is a vector of explanatory variables with (k, 1) dimension. The presumption is that $x_{i,t}$ are integrated of order 1 for all panel members i, where,

$$x_{i,t} = x_{i,t-1} + \varepsilon_{i,t}$$

The modified version of standard OLS, in the form of FMOLS, is given as;

$$\hat{\beta}_{FM} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}(X_{i,t} - \overline{X}_i)^2\right)^{-1} \sum_{i=1}^{N}\left(\sum_{t=1}^{T}(X_{i,t} - \overline{X}_i)\widehat{\text{Health outcome}^{*}_{i,t} * \text{come}}^{*}_{i,t} - T\hat{\delta}_{\varepsilon u}\right) \tag{13.6}$$

Kao and Chiang (1999) have extended DOLSDynamic Ordinary Least Squares estimators to panel analysis. This estimator in the present panel study is obtained by estimating the given regression model:

$$\text{Health Outcome}_{i,t} = \alpha_i + x_{i,t}\beta + \sum_{k=-p_1}^{p_2} \delta_k \Delta\text{Health Outcome}_{i,t-k} + \sum_{k=-q_1}^{q_2} \lambda_{ik}\Delta x_{i,t-k} + u_{i,t} \tag{13.7}$$

In the above equation, $i = 1, \ldots., N$, represent the number of countries in the panel. Similarly, $t = 1, \ldots, T$, indicate the number of years included in the panel. Individual panel member-specific effect is denoted by α_i. The coefficient of a lead or lagged value of first differenced explanatory variables is denoted by the term λ_{ik} while $u_{i,t}$ is the disturbance terms.

In case of finite sample, Kao and Chiang (1999) observed that this least squared technique outperforms standard OLS and FMOLS in terms of unbiased estimation. Further, the advantage of this estimator is that it helps to control the problem of endogeneity by augmenting the above equation with lead and lagged difference of mobile phone penetration and other independent variables (Saikkonen 1992).

13.4 Analysis of Results

13.4.1 Cross-Section Dependency and Panel Unit Root Tests Results

The study has conducted LLC and IPS unit root test after looking at the cross-section dependency properties of the variables under consideration. So, to check for the existence of cross-section dependency in the panel data set before applying the panel unit root tests is a mandatory step. So, to check the cross-sectional dependency of the variables, Breusch–Pagan Lagrange Multiplier (LM) (1980), Pesaran scaled LM (2004), Pesaran cross-sectional dependence (CD) (2004) and Baltagi, Feng and Kao bias-corrected scaled Lagrange multiplier (LM) (2012) tests were used. Table 13.2 reports the outcomes of all the four abovementioned tests. The outcomes show that the whole test statistic rejects the null hypothesis of no cross-section dependence at one percent level of significance. Therefore, the results of the cross-section dependency test indicated the presence of cross-section dependence.

After cross-sectional dependency tests, the study applied LLC (2002) and IPS (2003) unit root tests to determine the order of integration. Table 13.3 presents the outcomes of these tests at level and first difference. The outcomes of the tests imply that the chosen variables are non-stationary at their levels and stationary at their first

Table 13.2 Outcome of cross-section dependence test

Variables	Breusch–Pagan LM	Pesaran scaled LM	Bias-corrected scaled LM	Pesaran CD
Health outcome	4228.502*	160.3084*	159.4876*	64.8958*
Mobile phone penetration	4130.651*	156.3857*	155.4928*	64.1928*
Health expenditure	4018.698*	151.8152*	150.9223*	63.3341*
Female education	1204.515*	36.9266*	36.0338*	2.7546*
Urbanization	4439.512*	168.9949*	168.1020*	37.4235*
GDP	4079.692*	154.3053*	153.4124*	63.6860*

Note *, ** and *** signifies the rejection of null hypothesis at 1, 5 and 10% levels of significance
Source: Authors'

Table 13.3 LLC and IPS tests outcomes

Variables	Test	Level	First difference
Health outcome	LLC	−1.159	−5.892*
	IPS	2.706	−4.471*
Mobile phone penetration	LLC	0.925	−7.727*
	IPS	5.113	−5.584*
Health expenditure	LLC	1.597***	−10.260*
	IPS	0.409	−4.880*
Female education	LLC	0.537	−6.647*
	IPS	1.492	−1.564**
GDP per capita	LLC	2.235	−8.810*
	IPS	2.696	−2.517*
Urbanization	LLC	4.847	−5.840*
	IPS	6.749	−6.929*

Note *, ** and *** signify rejection of having unit root at 1,5 and 10% level of significance
Source: Authors'

difference. Thus, it is deduced that all the series are integrated of order one, i.e., I (1).

13.4.2 Cointegration Test Results

The outcomes of Pedroni cointegration test are presented in Table 13.4. As far as within dimension approach is concerned, except panel p-statistics, all the test statistics rejected the null hypothesis of no cointegration at 1% significance level. Similarly, in the case of between dimension approach, the null hypothesis of no cointegration

Table 13.4 Outcome of cointegration test

		Statistics	Probability
Within dimension	Panel v-statistic	5.849	0.000*
	Panel ρ-statistic	6.047	1.000
	Panel t-statistic: (non-parametric)	−7.444	0.000*
	Panel t-statistic (ADF): (parametric)	−4.536	0.000*
Between dimension	Group ρ–statistic	7.539	1.000
	Group t-statistic: (non-parametric)	−12.984	0.000*
	Group t-statistic (ADF): (parametric)	−6.418	0.000*

Note *Denote rejection of null hypothesis of no cointegration at 1% significance level
Source: Authors'

is rejected at 1% significance level except the group p-statistics. Five test statistics rejected the null hypothesis of no cointegration (Table 13.4). Thus, from the outcome, it can be deduced that the estimated equation is stationary in more than one direction and it implies that the variables of health outcome, mobile phone penetration, health expenditure, female education, income as well as urbanization are moved together in the long run.

13.4.3 Outcomes of FMOLS and DOLS

As a cointegrating relationship was found amongst the chosen variables, it is convenient to estimate the mobile phone penetration retention coefficient by utilizing FMOLS and dynamic OLS panel estimators. Pooled and grouped versions of both the estimators have been applied to serve the purpose of the study. Table 13.5 presents the outcomes of fully modified OLS and dynamic OLS estimators. It is evident from the outcomes that mobile phone penetration has the potential to improve the health outcome of the countries selected for the study as its coefficients are negative [−0.0179 (pooled version of FMOLS) and −0.0359 (grouped version of FMOLS)] and statistically significant at 1% significance level. Likewise, mobile phone penetration also has significant effect on health outcome as far as DOLS estimator is concerned. Mobile phone penetration coefficients have negative sign (−0.0434 and −0.0299) and are significant at 1 and 5% level of significance (Table 13.5). This reveals that mobile phone is closely linked to the health outcome, which implies that sound telecommunication policies will have greater impact on the health outcome in Asian countries. Along with mobile phone, the study has also found significant effect of health expenditure, income and urbanization on health outcome in the pooled

Table 13.5 FMOLS and OLS test

Variable	FMOLS		DOLS	
	Pooled	Grouped	Pooled	Grouped
Mobile phone penetration	−0.0179* (0.0011)	−0.0359* (0.0093)	−0.0434* (0.0139)	−0.0299** (0.0139)
Health expenditure	−0.1674* (0.0043)	−0.0095 (0.0234)	−0.0496 (0.0499)	−0.0172 (0.0184)
Female Education	0.4434* (0.0294)	2.2618* (0.8530)	0.6338 (0.4365)	2.0751 (1.2675)
GDP per capita	−0.0836* (0.0048)	0.0183 (0.0400)	−0.1203** (0.0573)	−0.0060 (0.0195)
Urbanization	−0.6321* (0.0119	−3.4947* (0.4994)	−0.5347*** (0.3235)	−3.5510* (0.8838)

Note *, ** and ***signify levels of significance at 1, 5 and 10%, respectively. Standard error is indicated by the numbers in the parenthesis
Source: Authors'

version of FMOLS model. Likewise, the coefficients of income (which was proxied by GDP per capita) and urbanization are also found significant in the case of pooled version of DOLS.

Health expenditure is one of the areas that the government directly invests in and is one of the factors that contribute to the health outcome in both qualitative and quantitative manner. This expenditure improves infrastructure and makes health care affordable for a major section of the population, thereby, reducing mortality. This is supported by a number of studies like Gupta et al. (2003), Anand and Ravallion (1993) and Turner (1991). The results of the study point out that urbanization tends to improve the health outcome as urbanization would also mean better and easier access to health-related services, sanitation and safe potable water. Urbanization is one of the important variables that impacts health outcome as urbanization entails better access to mobile phone technology (McDade and Adair 2001; Eckert and Kohler 2014) that would help in dissemination and collection of information. Further, income (proxied by GDP per capita) is directly related to better health status as more disposable income would imply that people can afford nutritious food, better health facilities, timely medical interventions and, more importantly, this would entail in investments like better education, housing and other amenities which enhance the quality of life. Some of the studies that explore this relationship and reinforce the results are Ecob and Smith (1999) and Ettner (1996).

13.5 Conclusion

Mobile phones are likely to offer an opportunity to strengthen healthcare services in developing countries. These services are specifically more successful in regions where access to basic healthcare services is challenging due to undeveloped infrastructural conditions and geographical hurdles. The present paper attempted to assess the effect of the mobile phone on health outcome. To realize the objective, Pedroni's (1999) panel cointegration test was used in addition to FMOLS and DOLS estimators on a panel dataset of 25 Asian nations from 2000 to 2015. The results of the study show that mobile phone is one of the important factors that reduce IMR. Additionally, in case of FMOLS results, the other determinants such as health expenditure, income (proxied by GDP per capita) and urbanization have a statistically significant effect on health outcomes. While in case of DOLS, GDP per capita and urbanization have a significant effect on the same.

Given the improvement in health outcomes due to mobile phone penetration indicated by the results of our study, the policymakers should contemplate on how to initiate it systematically for ensuring that its potential is realized to the maximum. This offers a newer way of dealing with future challenges in healthcare industry as it provides an unique source of information as well as communication across various age-groups. Realizing the significance of mobile phones and its potential in facilitating data collection and information exchange, it is vital to invest in the infrastructural development and expansion of mobile service providers so that it encompasses the entire nation, bringing the distant and rural areas that do not have easy access to healthcare facilities into its purview. In the future, mobile phones may play a more significant role as it has the ability to bring about social changes through proper dissemination of knowledge. Moreover, health expenditure was found to be a key factor which influences the health outcome, so an increase in the public expenditure will further lead to improvement in health status. The increase in funds for health care purpose has to be appropriately and efficiently used to address key health areas primarily. Further, policies must be formulated and executed keeping in mind the income level of the people so that they can spend more on health-related services and goods. The process of urbanization has to be accompanied with proper investment in the areas of water supply, sanitation, human resource and health-related facilities. Therefore, an improvement in health status needs a holistic approach among various sectors of an economy, like, health, urban planning and others.

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Chapter 14
Challenges of Health Sustainability in IT-ITES Industry in India

Rajib Bhattacharyya

14.1 Introduction

Computers have become the epitome of modern life with its ever increasing use being observed in every aspect of day-to-day operation. Information is available in few seconds with the click of a mouse in the world of internet and rapidly developing information and communication technology. India has been the pioneer in the world of IT and ITES and also one of the major destination offshoring service providers at present. This has ushered in a new genre of occupational health problems, which are slowly taking its roots among the information technology (IT) professional. This has also an adverse impact on the efficiency and productivity through increments in health-related expenditure. The health-related problems of the IT and ITES employees may be broadly classified under two main heads: (i) physical health problems—cumulative trauma disorders (CTD), back, neck and shoulder problems or musculoskeletal disorder (MSD), vision-related problems and radiation issues, etc., (ii) psychosocial and mental health problems—high stress level, burn-out stress syndrome (BOSS), anxiety, sleeping disturbances, depression, etc. Key factors which are responsible for these mental health problems are—workload (both excessive and insufficient work); lack of participation and control in the workplace; monotonous or unpleasant tasks; role ambiguity or conflict; lack of recognition at work; inequity; poor interpersonal relationships; poor working conditions; poor leadership and communication; conflicting home and work demands.

The relation between occupational health and well-being at work and its impacts on individuals, organizations and societies has been widely recognized. It has significant effect on the productivity of workers, and hence, one of the most important challenges facing the IT-ITES sector is the promotion of both physical and mental health for ensuring health sustainability in the long run. Good mental health enables people

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to realize their full potential, cope with the normal stresses of life, work productively and contribute to their communities (World Federation for Mental Health 2017).

14.2 Literature Review

A list of select studies has been reviewed for justifying the rationale for the present study. Kumari et al. (2014) examines the nature of job stress in software companies in Bangalore, India (a Case Study of HCL) and finds that 98 out 100 feel stressed about daily physically, mentally or emotionally. Nayak (2014) in his study aims to find out the level of anxiety and mental health of software and mechanical professionals. It tries to identify the key factors responsible for producing anxiety amongst professionals, which limit their job functionality and overall efficiency. Aveline and Kumar (2018) observed that employees who are having more experience are considered to have health issues such as stress, depression, eyes and backbone problems when compared to the freshers or new joinees. An extensive review by Kesavachandran et al. (2006) explores the relation between the work organization, psychosocial well-being and health disorders of workers in ITES. They stressed on risk factors associated with work-related musculoskeletal disorders, as well as those associated with the psychosocial aspects of work. A perceived connection has been found between information and communication technology (ICT) use and mental symptoms among young adults in a qualitative study by Thomée et al. (2010). In this study, they tried to explore possible explanations for associations between high ICT use and symptoms of depression, sleep disorders and stress among young adults. In another in-depth study by Vaid (2009), we observe a detailed survey on the lives of unmarried youth in the BPO sector in Gurgaon. It argues that ambitious performance targets, strict deadlines and close monitoring may not be sustainable in the long run and suggests BPOs need to consider measures that would alleviate some of this stress. A recent study conducted by Sharma (2005) in VV Giri National Labour Institute, Noida, India, on a case study of call centers, found that women (between 20 and 30 years age group) constituted about 38% of the work force sampled. Sudhashree et al. (2005) throws light on the issues and concerns of health among call center employees. They apprehends that long hours of work, permanent night shifts, incredibly high work targets, loss of identity are the dark clouds which threaten to mar the sunshine call centre industry in India. Geeta (2006) found that the burn out stress syndrome (BOSS) is commonly observed among young people working in call centers. The symptoms of this syndrome include chronic fatigue, insomnia and complete alteration of the 24 h biological rhythm of the body, leading to sickness absenteeism. A health survey conducted by Choudhary et al. (2003) on professionals working in software development, showed neck and shoulder problems in 31%, wrist and hand pain in 15%, tiredness at the end of the day in 26% and exhaustion in 12%. Sobratty and Korumtolle (2005) showed a high prevalence of visual problems (59.5%) among computer professionals. The study conducted on computer professionals by Parekh et al. (2006) showed that the symptoms of health problems rises with increased duration of computer use and with use of improper furniture. The symptoms were also more in spectacle-wearers, compared to non-spectacle users. The survey by Halford and Cohen (2003) reveals symptoms of pain in neck, shoulder and hand wrist in the case of call center workers of Brazil. Hafner et al. (2015) in the summary report of Britain's one of the healthiest company, tried to examine the relationship between health and well-being of staff and productivity. They have identified three key factors job and work environment, personal factors and health and physical risks. Using regression modeling techniques, they tried to establish associations between these factors and productivity loss in the workplace.

14.3 Objective of the Study and Methodology

The basic aim is to identify and assess the major health-related problems of the IT professionals and build up a comparative framework to examine whether the morbidity and severity of the health problems (both physical and mental) is more acute in the case of IT-ITES employees as compared to the non-IT workers in terms of a primary survey. The study tries to explore whether there exists any interdependence between morbidity from the diseases, on the one hand and age, sex, marital status, nature of jobs, duration of work per day, work experience, on the other. This is being done in terms of Chi-square test for independence for categorical variables. After that an attempt has been made to estimate the significance of the explanatory variables using Binary Logistic Regression Model. This primary survey has been done either by personal oral investigation or by sending questionnaires by mail across four major cities of India, viz. Delhi, Kolkata, Mumbai and Hyderabad. The study design is cross-sectional, and the sampling design used is stratified/purposive sampling. The study period was from October 2016 to July 2017. The IT and non-IT professional workings in different sectors were identified, and representative sample was taken to compute the sample size which has been limited to 300 due to time and resource constraint. In doing this study, two Statistical Computer Packages 'STATA' and E-views have been used.

14.4 Structure of the Primary Survey

This primary survey has been done across four major cities of India, viz. Delhi, Kolkata, Mumbai and Hyderabad. The sample size is 300 (150 IT + 150 non-IT). The ratio of total male and total female respondents is 166:134. Out of 166 male respondents, 79 were from IT and 87 from non-IT. Similarly, out of 134 females , 71 were from IT and 63 from non-IT. The inclusion criteria for subjects to be considered for study were.

(i) Firstly, the subjects should be working in the current job for the past six months.

(ii) Secondly, he or she should be working on the computer for at least 3 h/day or at least 15 h a week.

The primary service providers in **InformationTechnology (IT)** are grouped into four categories: (1) call centre (2) BPO (3) customer care (C-Care) (4) others (software developer/programmer/system engineer). The **non-IT sector** Comprises of the following seven categories: (i) banking (ii) insurance (iii) trade and commerce (iv)transport (railway/air) (v) communication (telephone/radio/ TV.) (vi) health care (vii) others (Public Sector Units or PSU).

14.5 Major Attributes of IT and Non-IT Sectors

Table 14.1 shows that the average age of the male is higher than their female counterparts for all the four sub-categories within the IT sector. In the non-IT category, except for insurance and trade & Commerce, the mean age of males exceeds those of the females for all other workplaces. Most interestingly, the mean age differences between males and females are quite significant. In the IT sector, the percentage of unmarried are the highest (85) for both the call centre and BPO. Within the non-IT sector, the percentage of married are the most for others (PSU) and Banking, while the percentage of unmarried are the highest for the insurance category (85). But in aggregate, the percentage of married (51) to unmarried (49) does not differ much. If we concentrate on the duration of work across various sub-categories, we will find that within the IT the mean duration of work is the highest for the customer care (9.7 h) followed by others (9.5 h) and call centre (8.65 h). But the mean duration of work is more for female than for male for each of the categories within the IT (except call-centre). But contrastingly, the mean duration of work for males is higher compared to the females in each of the category within the non-IT. In the non-IT category, the mean duration of work is the highest for insurance and trade & Commerce (both 8.65 h) followed by others (PSU), and it is the lowest for health care. If we go to the detailed analysis, we observe that except in insurance and health care, the years worked by both males and females are significantly higher in non-IT than in IT sector. Again marked difference has been found in the mean years worked between males and females in the Banking sub-category. For Banking, it is the males whose mean years worked is much higher than the females, while in Trade & Commerce, it is just the other way round.

Table 14.1 Variation between IT and non-IT employees on major attributes

IT	Workplace	Sex	Obs	Mean age	Married (m)/Single (s)	Sex-wise Av. duration (per day)	Average duration of work (per day)	Mean years of work
	Call-centre	M	10	24.2	m = 6 (15) s = 34 (85)	8.9	8.7	2.6
		F	30	23.2		8.6		2.7
	BPO	M	18	28.2	m = 6 (15) s = 34 (85)	8.3	8.5	4
		F	22	25.3		8.6		2.8
	Customer care	M	5	27	m = 4 (40) s = 6 (60)	9.4	9.7	3.4
		F	5	24.2		10		3.2
	Others (software developer, etc.)	M	46	33.3	m = 31(51.67) s = 29 (48.33)	9.4	9.5	4.3
		F	14	29		9.6		3.6
Non-IT	Banking	M	19	54.6	m = 28 (93.33) s = 2 (6.67)	8	7.8	31.6
		F	11	45.6		7.4		21.8
	Insurance	M	13	23.5	m = 3 (15) s = 17 (85)	8.7	8.7	1.4
		F	7	26.4		8.6		2.6
	Trade & Commerce	M	10	41.7	m = 15 (75) s = 5 (25)	8.9	8.7	16.2
		F	10	46.7		8.5		21.3
	Transport	M	10	34.9	m = 15 (75) s = 5 (25)	8	7.9	10
		F	10	33.2		7.8		9.2
	Communication	M	20	46.1	m = 26 (86.67) s = 4 (13.33)	7.8	7.7	20.3
		F	10	39.5		7.6		16.3
	Health care	M	8	32.1	m = 9 (45) s = 11 (55)	8	7.3	2
		F	12	31.7		6.8		2.2
	Others (PSU)	M	7	43	m = 10 (100) s = 0 (0)	8.6	8.4	17.7
		F	3	37.7		8		14.7

Source Field Survey
Note The figures in brackets denotes the percentages

Chart 14.1 Major categories of health problems

Health disorders			
CTD	MSD	Vision	Psychological & Mental
Pain in forearm	Pain in neck	Watering of eyes	Exhaustion
Pain in wrist	Pain in shoulder	Pain in eye	Chronic fatigue
Finger pain	Pain in lower back	Burning/itching	Anxiety
		Redness of eye	Sleep disturbances
		Blurring of vision	Depression
			Stress

14.6 Comparison of Major Health Disorders Between the IT and Non-IT Sector

Now let us try to focus on the magnitude and nature of the health problems in the IT sector and then compare it with non-IT to see the extent of these health hazards there. The health disorders can be broadly categorized as per Chart 14.1.

14.7 Magnitude of Computer-Related Health Problems in IT-ITES

Male employees have psychological and mental problems more than those of females. For both males and females, the major cause of problem in the call centre is the stress related burn out stress syndrome (BOSS)—the symptoms of this syndrome include chronic fatigue, insomnia and complete alteration of 24 h biological rhythm of the body, leading to sickness and absenteeism. In the BPO case, females experience CTD, MSD and vision problems much more than the men, but the psychological and mental problems are much more prominent for male than female. In the customer care, all male and female employees have MSD (100) which is the highest among all sectors. For category ‘others’, male have more of each of the health problems than female. Among all the four health problems, call centre employees experience more CTD than other type of workers; MSD is the highest for customer care; vision problems are maximum for Call-centre; but there is not much difference in mental problems across types of jobs (except for BPO). The magnitude of health problems does not vary significantly across sex, except in mental problems, but they vary significantly across type of jobs performed (Table 14.2).

Table 14.2 Magnitude of health problems in the IT-ITES and non-IT-ITES sector

	Types of health problems in IT-ITES and non-IT-ITES					
			CTDs	MSD	Vision	Mental
IT-ITES	sex: M = 79 F = 71 Total = 150	Male	53 (67)	64 (81)	60 (76)	72 (91)
		Female	48 (68)	59 (82)	55 (77)	59 (83)
		Total	101 (67)	122 (81)	115 (77)	131 (87)
	Type of work- 1. Call centre employee (n = 40; M = 10; F = 30)	Male	07 (70)	08 (80)	09 (90)	09 (90)
		Female	23 (77)	25 (83)	25 (83)	27 (90)
		Total	**30 (75)**	33 (83)	**34 (85)**	**36 (90)**
	2. BPO (data processing/back office jobs) (n = 40; M = 18; F = 22)	Male	9 (50)	13 (72)	11 (61)	15 (83)
		Female	14 (64)	18 (82)	18 (82)	17 (77)
		Total	23 (58)	31 (78)	29 (73)	32 (80)
	3. Customer care employees (n = 10; M = 05; F = 05)	Male	04 (80)	**05 (100)**	04 (80)	05 (100)
		Female	03 (60)	**05 (100)**	04 (80)	04 (80)
		Total	07 (70)	**10 (100)**	08 (80)	**09 (90)**
	4. Others (software developer/ programmer/system engineer) (n = 60; M = 46; F = 14)	Male	33 (72)	38 (83)	36 (78)	43 (93)
		Female	08 (57)	11 (79)	08 (57)	11 (79)
		Total	41 (68)	49 (82)	44 (73)	**54 (90)**
Non-IT-ITES	Sex: M = 87 F = 63 Total = 150	Male	39 (45)	52 (60)	36 (41)	44 (51)
		Female	30 (48)	42 (67)	29 (46)	36 (57)
		Total	69 (46)	94 (63)	65 (43)	80 (53)
	Type of work 1. Banking(n = 30; M = 19; F = 11)	Male	08 (42)	14 (74)	05 (26)	10 (53)
		Female	07 (64)	07 (64)	03 (27)	07 (64)
		Total	15 (50)	21 (70)	08 (27)	17 (57)
	2. Insurance (n = 20; M = 13; F = 07)	Male	09 (69)	09 (69)	08 (62)	11 (85)
		Female	03 (43)	05 (71)	05 (71)	05 (71)
		Total	12 (60)	14 (70)	**13 (65)**	16 (80)
	3. Trade & Commerce (n = 20; M = 10; F = 10)	Male	02 (20)	05 (50)	03 (30)	04 (40)
		Female	01 (10)	05 (50)	03 (30)	03 (30)
		Total	03 (15)	10 (50)	06 (30)	07 (35)
	4. Transport (n = 20; M = 10; F = 10)	Male	07 (70)	06 (60)	06 (60)	06 (60)
		Female	04 (40)	05 (50)	04 (40)	05 (50)
		Total	11 (55)	11 (55)	10 (50)	11 (55)
	5. Communication (n = 30; M = 20; F = 10)	Male	07 (35)	08 (40)	07 (35)	04 (20)
		Female	08 (80)	07 (70)	07 (70)	06 (60)
		Total	15 (50)	15 (50)	14 (47)	10 (33)

(continued)

Table 14.2 (continued)

	Types of health problems in IT-ITES and non-IT-ITES					
			CTDs	MSD	Vision	Mental
	6. Health care (n = 20; M = 08; F = 12)	Male	06 (75)	08 (100)	06 (75)	08 (100)
		Female	07 (58)	12 (100)	07 (58)	10 (83)
		Total	**13 (65)**	**20 (100)**	**13 (65)**	**18 (90)**
	7. Others (PSU) (n = 10; M = 07; F = 03)	Male	0 (0)	02 (29)	01 (14)	01 (14)
		Female	0 (0)	01 (33)	0 (0)	0 (0)
		Total	0 (0)	03 (30)	01 (10)	01 (10)

Source Field Survey
Note The figures in brackets denotes the percentages

14.8 Magnitude of Computer-Related Health Problem by Sex and Type of Work in Non-IT

In the non-IT category, MSD has been the major problem for both males (60) and females (67) and the overall is 63. But this is much lower as compared to the IT (81). Moreover, the MSD for males (81) and females (82) in IT is much higher as compared to non-IT. Mental and psychological problems are significantly lower in non-IT (53) as compared to IT (87). Among all workplaces CTD, MSD and mental are recorded to be the highest for healthcare sector. Vision problems are the maximum for both the healthcare and insurance segment (Table 14.2). One probable reason for the healthcare segment to exhibit the highest percentage of all the four health problems is that data for the health care has been collected solely from private diagnostic centers where the work pressure, targets to be achieved, working hours, etc., may be responsible for this result. In case of each of the four health problems, the percentage of female affected exceeds those of male percentage. The overall level of morbidity from the four diseases in non-IT is much less than that of IT. So, if proper measures are not taken , the morbidity from these diseases in IT can reach such an alarming stage that it will be difficult to get steady supply of skilled personnel to maintain the quality and efficiency of the work.

14.9 Empirical Analysis

We apply Chi-square test for Independence for Categorical Variables. This test is used to check whether row and column categories are independent or not.

Hypothesis
H_0: the row and column categories are independent.
H_a: The row and column categories are not independent.

$$\chi^2 = \sum \left[(f_o - f_e) / f_e \right]$$

where,

f_o observed cell frequency
f_e expected cell frequency.

The formula shows that larger the squared differences are relative to their respective expected frequencies, the larger will be the value of sample χ^2. Therefore, the larger value of Sample χ^2 leads to the rejection of the independent hypothesis (Table 14.3).

a. High value of Chi-square between categories (IT or non-IT) and the four diseases shows morbidity from a four diseases depends on the category of the job—IT or non-IT.
b. Low value of Chi-square between sex and diseases shows morbidity from a four diseases does not depend on sex.
c. High value of Chi-square between workplace of the employee and the four diseases shows that the morbidity from a four diseases depends on the workplace of the employee.
d. If we find the Chi-square values between age (in years) and the four diseases, we find that they are significantly high i.e. it leads to the rejection of the null

Table 14.3 Chi-square (χ^2) values

Relation between categorical variables	Chi-square (χ^2) value	*P*-Value
Category (IT & non-IT) and CTD	Pearson chi2(1) = 13.9005	*Pr* = 0.000
Category (IT & non IT) and MSD	Pearson chi2(1) = 14.0081	*Pr* = 0.000
Category (IT & non IT) and vision	Pearson chi2(1) = 34.7222	*Pr* = 0.000
Category (IT &non IT) and mental	Pearson chi2(1) = 41.5517	*Pr* = 0.000
Sex and CTD	Pearson chi2(1) = 0.2346	*Pr* = 0.628
Sex and MSD	Pearson chi2(1) = 1.1182	*Pr* = 0.290
Sex and Vision	Pearson chi2(1) = 0.7283	*Pr* = 0.393
Sex and Mental	Pearson chi2(1) = 0.0367	*Pr* = 0.848
Workplace and CTD	Pearson chi2(10) = 38.5181	*Pr* = 0.000
Workplace and MSD	Pearson chi2(10) = 41.2415	*Pr* = 0.000
Workplace and vision	Pearson chi2(10) = 54.4097	*Pr* = 0.000
Workplace and mental	Pearson chi2(10) = 80.8190	*Pr* = 0.000
Age and CTD	Pearson chi2(40) = 51.5550	*Pr* = 0.104
Age and MSD	Pearson chi2(40) = 50.8909	*Pr* = 0.116
Age and vision	Pearson chi2(40) = 49.9291	*Pr* = 0.135
Age and mental	Pearson chi2(40) = 76.2343	*Pr* = 0.000

Source: Primary survey of the author

hypothesis that they are independent. Hence, it shows that the morbidity from the four diseases depends on the age of the employees.

14.9.1 Estimation Using Binary Logistic Regression Model

From the above empirical analysis, we may say that morbidity from any of the four disease (CTD, MSD, Vision, Mental) is supposed to depend on age in years of the employee and the category (IT or non-IT) to which he or she belongs. Here, we specify the following linear probability model (Table 14.4):

$$y = \beta_0 \div \beta_1 X_1 + \beta_2 X_2 + \in \tag{14.1}$$

$$y = \begin{cases} 1 \text{ if morbidity exists} \\ 0 \text{ if morbidity does not exist} \end{cases}$$

$$X_1 = \text{age in years (Age\_ yrs)}$$
$$X_2 = \text{category}(\text{IT} = 1;\ \text{Non-IT} = 0)$$

Both explanatory variables are highly significant. Both, age in years and category (IT = 1; non-IT = 0), have a positive effect on the probability of morbidity of any disease, as expected. They are also jointly highly significant

$$\text{LR stat} = 21.10,\ P = 0.000026\,(< 0.001).$$

So, the estimated logistic model (logs of odd ratio) is given by

$$\text{Ln}\left(\frac{\overbrace{p}}{1 - \overbrace{p}}\right) = 1.462034 + 0.021048 X_1 + 1.934636 X_2,$$

Table 14.4 Results of binary logistic regression

Variable	Coefficient	Std. error	z-Statistic	Prob
C	1.462034	0.672314	2.174628	0.0297
AGE_YRS	0.021048	0.016008	-0.065487	0.0078
CATEGORY (IT = 1; Non-IT = 0)	1.934636	0.534904	3.616794	0.0003
McFadden R-squared = 0.099624				
LR statistic = 21.10197;				
Prob. (LR statistic) = 0.000026				

Detail is given in the appendix
Source: Primary survey of the author

where $\mathrm{Ln}\left(\frac{\widehat{p}}{1-\widehat{p}}\right)$ = the log of the odds ratio (i.e. the ratio of success to failures).

So, with higher age an employee's likelihood of morbidity from any of the four diseases (CTD, MSD, Vision, Mental) increases. Similarly, a change of category from non-IT to IT increases odds of morbidity from diseases.

14.9.2 Major Findings of the Primary Health Survey on IT and Non-IT Employees

1. The age distribution among the IT employees shows that the mean age is minimum for both males and females in the call centre and maximum for both males and females in case of others (comprising of software developers and persons in the higher job profile with more years of experience). In the non-IT category, the mean age in our sample has been found to be the lowest for both males and female in the insurance sector, whereas it is highest in the banking sector.
2. In the IT sector, 68.67% of the total employees are unmarried, while 70.67% of the total employees in the non-IT are married. In the IT sector, the percentage of unmarried are the highest (85%) for both the call centre and BPO. Within the non-IT sector, the percentage of married are the most for others (PSU) and Banking, while the percentage of unmarried are the highest for the insurance category (85%).
3. The mean duration of work in the IT (9 h) is much higher than that of non-IT (7.99 h). Within the IT, the mean duration of work is highest for customer care and lowest for BPO. In the non-IT category, the mean duration of work is the highest for insurance and trade & commerce (both 8.65 h), and it is the lowest for health care (7.3 h).
4. The mean years worked for both males and females are significantly lower in the IT in comparison with the non-IT. The work experience is minimum for call centre and maximum for category others in the IT sector. In the non-IT, there is a marked difference between the workplace with maximum work experience (Banking) and minimum work experience (health care) for both males and females.
5. The presence of each of the four diseases is much higher for IT than non-IT. In the IT, the maximum presence has been for psychological and mental problems, followed by MSD disease. For the non-IT also, the biggest problem is the MSD, but its percentage of presence is much lower than that of IT. 97.33% of the employees in the IT has one or more of the identified health-related problems. Eighty percent employees in the non-IT are exposed to at least one of the four health disorders. So, the morbidity or health hazards are relatively more severe in the IT as compared to non-IT.

6. Among all the four health problems in IT, call centre employees experience more CTD than other type of workers; MSD is the highest for customer care; vision problems are maximum for Call centre; but there is not much difference in mental problems across types of jobs (except for BPO). In the customer care, all male and female employees have MSD (100%)—which is the highest among all sectors.
7. In the IT sector, the magnitude of health problems does not vary significantly across sex, except in mental problems, but they vary significantly across type of jobs performed.
8. In the non-IT category, MSD has been the major problem for both males (60%) and females (67%) and the overall is 63%. But, this is much lower as compared to the IT (81%). Moreover, the MSD for males (81%) and females (82%) in IT are much higher as compared to non-IT.
9. Mental and psychological problems are significantly lower in non-IT (53%) as compared to IT (87%).
10. Among all workplaces CTD, MSD and mental are recorded to be the highest for healthcare sector. Vision problems are the maximum for both the healthcare and insurance segment.
11. Our primary survey reveals that the problem health hazards are not seriously taken care-off by the IT companies following the recommendations of WHO (2005), except in case of some large well-established reputed organizations.
12. The estimation by means of binary logistic regression model reveals that with higher age, an employee's likelihood of morbidity from any of the four diseases (CTD, MSD, Vision, Mental) increases. Similarly, a change of category from non-IT to IT increases odds of morbidity from diseases.

14.10 Conclusion

The present work demonstrates the morbidity and severity of health hazards of the ITES-BPO employees as compared to the non-IT sector. 97.33% of the employees in the IT has one or more of the identified health-related problems, as compared to 80% in case if that in non-IT. Unless these problems are treated with urgency, the social cost of our export success will swamp its benefits. The overall level of morbidity from the four diseases (CTD, MSD, vision problem and psychological and mental problem) in IT is much severe than that of non-IT. So, if proper measures are not taken , the morbidity from these diseases in IT can reach such an alarming stage that it will be difficult to get steady supply of skilled personnel to maintain the quality and efficiency of the work. A mental health policy for the workplace can be developed separately, or as part of a broader health and safety policy (as per the recommendations of WHO 2005). Employer, employee and nongovernmental organizations have an important role in working with governments to improve the mental health of employees. These partners should advocate for the development of policies and strategies that promote the mental health and physical of employees and prevent and treat mental health problems equally with other health disorders. But our primary survey reveals that the problem health hazards are not seriously taken care-off by the IT companies following the recommendations of WHO, except in case of some large well-established reputed organizations.

Appendix

Dependent Variable: MOR_DIS				
Method: ML—Binary Logit (Quadratic hill climbing)				
Date: 05/15/19 Time: 20:59				
Sample: 1300				
Included observations: 299				
Convergence achieved after 4 iterations				
Covariance matrix computed using second derivatives				
Variable	Coefficient	Std. error	z-Statistic	Prob
C	1.462034	0.672314	2.174628	0.0297
AGE_YRS	0.021048	0.016008	−0.065487	0.0078
CATEGORY	1.934636	0.534904	3.616794	0.0003
McFadden R-squared	0.099624	Mean dependent var		0.886288
S.D. dependent var	0.317994	S.E. of regression		0.308566
Akaike info criterion	0.657906	Sum squared resid		28.18309
Schwarz criterion	0.695034	Log likelihood		−95.35698
Hannan-Quinn criter	0.672767	Deviance		190.7140
Restr. deviance	211.8159	Restr. log likelihood		−105.9080
LR statistic	21.10197	Avg. log likelihood		−0.318920
Prob(LR statistic)	0.000026			
Obs with Dep = 0	34	Total obs		299
Obs with Dep = 1	265			

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Chapter 15
Network Society—Towards a *Holistic Approach* to Human Development in Asia

Megha Jain, Aishwarya Nagpal, and Sunita Gupta

15.1 Introduction

In the twenty-first century, the existing literature supports the growing eminence of 'network society' as a key to human capital development (Asongu and Tchamyou 2017; Kuada 2015). This *new society* is comprised of *networks* which often reflects the global society since networks don't have confined boundaries. In the saga of humanity, this era is expressed as 'the Information Age'—a distinguished phase of rising digital knowledge to facilitate access to, and administration of information (Mason 1986; Castells 2010). In fact, IT and ITeS are considered to be the most powerful tools as per the World Bank's 'knowledge economy index' to exercise impact on human capital development due to its ability of penetration. Rather, ICT is viewed to exert desired effects due to its possible ripple effects across innovative capacity and income levels. In this area, one of the remarkable feats includes the

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digital opportunity initiative[1] (DOI) as was announced at the G-8 Okinawa Summit in the year 2000 that aims to ascertain the ICT roles in enhancing social equity and cultivating sustainable economic development.

Earlier in the 1990s, technological advancement used to account for a mere fifty percent of the mortality decline. However, today's landscape of such revolution is far more precipitous in comparison to the past, notably in the technology domains like memory storage, telecom costs, processor power (Moore's law), and bandwidth (Gilder's law). Still, there are vast north–south gaps that separate within south and north too. The same is generally termed as 'digital divide'. The incidences of 'digital divide' with a special reference to South Asian Region (SAR) already exist in the form of disparities within the cultures that need careful examination in terms of differing modes of distribution of resources and also technological ownership patterns of developing nations' societies.

In general, the concepts of 'societies'/'cultures'/'human development' are highly debated and largely remains misperceived. Still, GDP is considered to be the most popular proxy to depict and measure the magnitude of economic advancement by most of the nations. It is often said that the challenge lies in not only to manage the asset volume portfolio but also the constitution of the portfolio to require different types of capital like institutions, governance; in short the *Social* intangible capital. Human Development Index (HDI[2]) is a composite qualitative indicator that depicts the level of social and economic development (well-being) of a country, coined by UNDP[3] in 1990.

India is considered to be the Asian powerhouse on most of the key macrofundamentals (GDP growth, urbanization, job creation, etc.). Still, human capital development issues prove to be the paradox of plenty. There are a few studies that correlate information technology investments with economic growth via shifting jobs from intermediary skill to high skill jobs (by building the human capital). While technology has essentially witnessed to a subsequent proliferation in the capital intensity, yet overall it has not squeezed aggregate employment[4] in Indian manufacturing industries. Rather network society could contribute to economic growth through different mediums[5] like production and investment mediums. Production medium shall definitely be benefiting the factor productivity growth (labor) through rapid technological change. Several quantitative research reports on westernized nations' dataset have

[1]a public–private partnership of Accenture, the Markle Foundation, and the United Nations Development Programme (UNDP).

[2]It primarily comprises three broad indices—education index, income index, and life expectancy index.

[3]United Nations Development Programme.

[4]From *Destruction or Polarization: Estimating the Impact of Technology on Jobs in Indian Manufacturing* by Vashisht (2017).

[5]From *Information and communication technology and economic growth in India* by Erumban and Das (2016).

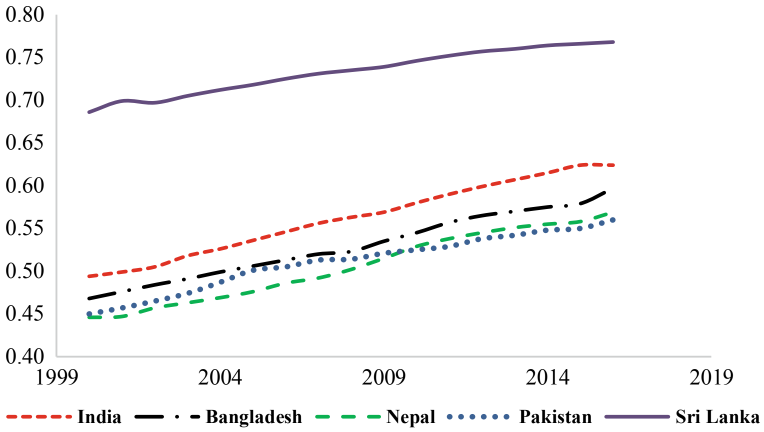

Fig. 15.1 Human development index time trends for South Asian region. *Source* Authors' representation using UNDP human development reports and reviews on qualitative indicators (Available at https://data.un.org/. Accessed on: 21st May 2019)

proved the existence of correlation (if not causation) between technology usage and worker's skill-set.[6]

From Fig. 15.1, it can be observed that HDI of all selected South Asian nations is indicating an upward sloping trend between the year 2000 and 2016. Sri Lanka and India top the region with higher HDI values.

Theoretical Framework

Today, the pace and presence of ICT are indispensable in all the fields of human activities. ICT development has generated a major change in the world map (Castells 2000). Parallelly, the involvement of technology to improve not just growth and efficiency but human well-being too is discussed on the broader platforms of both developing and developed nations. Even the World Economic Forum (WEF) recognizes the ICT role as a crucial enabler in order to ensure sustainable and balanced socio-economic development. ICT is also taken as an imperative component for desirable regional harmonization in the formation of larger competitive markets. ICT is proved to be instrumental in impacting various realms including the intangible (human) capital creation. The Internet usage is suitably detailed to encourage and protect human rights in democratic control.

Areas like education, human development, and health have adopted the urge of emancipation and shall continue to discover the new advanced usage of digital knowledge as a key catalyst of behavioral transformations, e.g., telemedicine investments (Rosser et al. 2009). By means of ICT, both domestically and globally, human capital is progressively producing a sense of experience that is beyond the constraints of geographical space. It is only via ICT that people have multi-fold revelation to

[6]From *Information technology, workplace organization, and the demand for skilled labor: Firm-level* evidence by Bresnahan et al. (2002).

outward influences that have profound effects on identity and culture (Appadurai 1996; Greig 2002). In the words of Castells (2000), people are enjoying *timeless time* (the ability to operate real-time across nations) without interruption with convenience and without absolute difference between digital and physical proficiencies.

From above, it is apparent that the digital technology used for human capital creation still remains debatable and challenging. Such inadequacies could be addressed by appropriate digital tools in a cordial involvement of community and MNCs both throughout the transformation process.

ICT, Human Development, and the Digital Divide

All said and done, the digital sub-divide of south-north actually hampers the perceived potential dividends associated with IT and ITeS. The same still remains unavailable for people in the world (Shields 2003). However, the same cannot outweigh the ones that are truly impacted by the IT and ITeS advancement via virtual networks. Today, the digital divide is extremely appropriate to those who understand and hence value the elemental role of ICT (Guillen and Suárez 2005).

One has to be exceptionally conscious to deal with the distributional inequalities to use and access among groups and nations while taking into account the effect of ICT on human capital as these could exert grave consequences on human capital creation. IT and ITeS could harness and nurture human capital development via information access and greater possibilities of communication. The very objective of growth is to broaden people's alternatives by the expansion of existing knowledge of ICT (Haq 1995; Dreze and Sen 1989; Hill 2007). It is in this context, the current study explores the possible prime interlinkage between human development and Internet of things (IoT), proxied by mobile usage, Internet penetration, and technological readiness along with co-existing simultaneous sub-linkages with other macroeconomic factors like population growth and density and urbanization and its growth.

From Fig. 15.2, it can be noticed that the human development index and ICT indicators (mobile usage and Internet penetration) have the pertinent rising trend, more pronounced after the year 2008 for India over the period 2000–2016. The same hints toward the probable association among them. Notably, the mobile usage time trend indicates a much early and substantial increase all throughout as compared to the Internet penetration rate.

In light of the above, this article identifies the roles of the network society (ICT enabled) in human capital development, especially in South Asia. The rest of the chapter is structured as follows. Section 15.2 presents the existing literature review on correlates of HDI like ICT, technological readiness, urbanization, population density, etc. Section 15.3 mentions the prime rationale and underlying objective of the chapter. Section 15.4 includes the descriptive qualitative analysis and details of the data sources and selection. Section 15.5 entails the empirical research methodology adopted in the chapter in order to establish the possible linkages between HDI and ICT tools. Section 15.6 encloses the key results of the empirical analysis, followed by conclusion and key policy implications in Sect. 15.7.

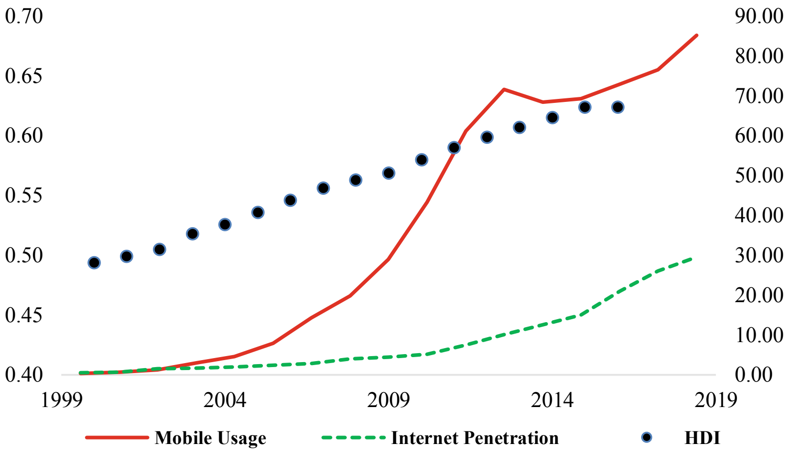

Fig. 15.2 HDI and ICT time trends. *Source* Authors' depiction using data sourced from ITU World Telecommunication/ICT Indicators and UNDP databases. HDI is plotted on the primary axis, whereas mobile usage and Internet penetration on the secondary axis

15.2 Literature Review

In light of the above background, the current chapter digs deeper to investigate the existing strand of literature that associate ICT with human development. There is scarcity of studies that assess empirically the impact of ICT investments on human development. Majority of the studies have explored the effect of ICT on economic development so far. And whatever nominal that has been conducted is mostly confined to developed nations with a lot more such untapped areas to be directed in the context of developing nations.

Many global institutions like World Bank, International Telecommunication Union (ITU), and International Monetary Fund (IMF) have pinpointed ICT as a powerful catalyst in the development process of emerging economies. As per a recent report by UNDP, the increasing role of ICT infrastructure in empowering human capital growth is at the priority agenda list of many ICT practitioners, policy think-tanks, and government bodies.

It is worth discussing the theoretical background before the existing literature to link HDI and ICT. The contemporary theories of growth apprehend the role of IT and ITeS within the ambit of excluded goods, private goods. In fact, as per Solow (1994), creation of intellectual property rights (patents) and also different forms of compensation for technology could also be counted a private good. While the secluded kinds of IT (like monopolistic power and patents) are expressed in certain versions of economic growth and expansion, yet most of the versions especially enunciating from monopoly are found to be temporary (Uzawa 1965). As per Romer (1990), technological advancement could be both concurrently endogenous and exogenous. In the process, some of the IT and ITeS features may prompt technology to turn out to be a public good (or service) over a period of time. The author also confirms that the technological paybacks by different nations are heterogeneous due to the presence of intercountry technological spillovers. Obviously, the same would cause disequilibrium in the processes of human and economic development to produce intercountry alterations in economic development (Verspagen 1992).

Outcomes emanating from ICT depict the importance to determine inclusive and sustainable growth from commercial and national outlooks. It is due to the fact that these are influenced by further progress in ICT. Therefore, the vital factor that emerges from here to make relevance for ICT improvement is human capital development (depicted by individual's knowledge, expertise and skills) as per Coleman (1988). It is also proposed that ICT should not be recognized as a silver bullet of holistic growth in the absence of substantial empirical studies (Mpogele et al. 2008).

A part of existing literature entails the potential outcomes of ICT specifically in the area of inclusive growth, remarkably, in terms of: enhancing financial inclusion levels (Singh 2012; Kirui et al. 2013); social change and developmental effects (Islam and Meade 2012; Mir and Dangerfield 2013); extenuation of urban–rural sub-divide (Chan and Jia 2011; Qiang et al. 2011); women empowerment (Ojo et al. 2013; Maurer 2008); better reach to health care amenities by the low economic strata of the society (Kliner et al. 2013); and opening up of potential business avenues, especially for SMEs (Ssozi and Asongu 2015; Ondiege 2010; Mishra and Bisht 2013).

Mostly, all the studies in this field have probed the influence of ICT investments on economic growth (Jalava and Pohjola 2002; Daveri 2002; Stiroh 2002). In general, the findings reflect the positive stimulus of ICT penetration on economic expansion in different settings across developed countries (Kim et al. 2008; Oulton 2002; Wang 1999; Colecchia and Schreyer 2002). Unfortunately, there are a fewer studies that explore such an association in the context of developing nations (Ngwenyama et al. 2006).

Bankole et al. (2011) study the relationship between four components of ICT infrastructure (hardware, software, telecommunication and internal spending) and three facets of human development (education, health, per capita GDP and school enrollment rates) in 51 nations classified into high-income, middle-income, and low-income countries based upon their respective presence in the area of ICT across the globe over the period 1994 to 2003, deploying three SLS regression techniques. The study confirms the substantial impact of ICT investments on the standard of living, level of education and health in the sample of considered country set; however, the impact is found to be varying across different classification of the nations.

Asongu and Roux (2017) explore the linkage between ICT and human development using a sample of 49 nations by employing instrumental variable Tobit regression in sub-Saharan Africa (SSA) over the period 2000–2012. The study confers it by incorporating different aspects of human development such as income levels, resource-wealth, religious dominations, legal origins, etc. The key finding of the study suggests that increasing ICT penetration will enhance inclusive human development and hence will push SSA in its quest to attain sustainable development goals (SDGs).

15.3 Objective and Rationale of the Study

The study aims to provide a comprehensive overview of the role of ICT to raise human development, in the backdrop of the impact of technological disruptions on reaching individuals. Trend analysis exhibits a much rapid growth in mobile telecommunication services, hence proffering the opportunities this strand of ICT development has for speeding up human capital growth through mobile financial services. The study is an attempt to present *novel evidence* regarding the role of ICT (considered as the *digital financial services*), mobile rollout, and Internet usage in advancing human/intangible capital of South Asian Region. It also investigates numerous factors influencing the pace of human development like urbanization, technological readiness, etc. in the economy. Through this chapter, the authors principally attempt to ascertain the role of advanced IT and ITeS (ICT tools) to promote human capital development in the context of South Asia in specific. This shall further enable to look into conceivable choices to such IT tools to foster human development in the region. The two prime notions that are examined in this chapter are human development and the role of ICT.

15.4 Qualitative Analysis and Data Sources and Selection

15.4.1 Descriptive (Qualitative) Analysis

The current section conducts the preliminary analysis to understand the basic features of data behavior and validity of the sample considered with respect to the existing interlinkages and causality relationships.

Some of the pertinent interpretations from above tabulated values (from Table 15.1) are listed below for the variables that we intend to study empirically in the next section:

- Table 15.1 results indicate that dependent variable, HDI, varies from 0.45 to 0.77 with an average value of 0.57.
- The distribution of the sample around mean values seems to vary widely. The same is supported by their average and measure of dispersion values in Table 15.1.
- Among the explanatory variables, mobile usage, Internet penetration, urbanization growth, technological readiness index indicators depict the wide range of variations for the selected South Asian nations over the period from 2000 to 2016.

Table 15.1 Summary statistics of selected variables

Variables	Obs	Mean	Std. dev	Min	Max
HDI	85	0.57	0.09	0.45	0.77
Mobile_sqrt	85	5.35	3.40	0.21	11.14
Internet_square	84	119.44	212.68	0.01	1027.27
FixedBroad	65	0.79	0.95	0.00	4.29
Pop_Growth	85	1.39	0.48	0.54	2.28
UrbanPop_G	85	2.76	1.19	0.47	5.99
TRI	50	2.87	0.35	2.21	3.46
Life_Expectancy	85	68.04	3.79	62.39	75.28
School_Enrollment	70	105.23	16.63	73.83	145.13

Source Author's own computation on Stata 13 for selected variables for South Asian nations from the year 2000 to 2016, conducted on database extracted from UNDP, ITU indicators, WDI (the World Bank) and WEF (World Bank)

15.4.2 Cross-Correlation

This section precisely helps in understanding the degree of endogeneity existing among the selected variables. Additionally, this section helps in identifying the level of criticality of the factors for the tested variable dependence.

Table 15.2 Correlation matrix

Variables	HDI	Mobile_sqrt	Internet_sq	UrbanPop_G	Pop_G	FixedBroad	TRI
HDI	1						
Mobile_sqrt	**0.5642*****	1					
	0.0000						
Internet_sq	**0.5035*****	0.6461	1				
	0.0000	0.0000					
UrbanPop_G	**−0.8791*****	−0.3166	−0.2938	1			
	0.0000	0.0016	0.0067				
Pop_Growth	**−0.7513*****	−0.36	−0.1697	0.6292	1		
	0.0000	0.0007	0.0220	0.0000			
FixedBroad	**0.4606*****	0.7209	0.7813	−0.1712	−0.2176	1	
	0.0001	0.0000	0.0000	0.1728	0.0817		
TRI	**0.6757*****	0.4867	0.3056	−0.7096	−0.1116	0.3808	1
	0.0000	0.0003	0.0309	0.0000	0.4404	0.0064	

Source Authors' testing results using Stata 13 on correlation exercise on studied variables where '***' is 1% significance, '**' is 5% significance and '*' is 10% significance

Table 15.2 displays the correlation testing outcomes on the variables taken into account for the purpose of the study. Pertinent observations that emerge out of Table 15.2 results are:

1. Human Development Index (HDI) is found to have a positive strong and significant relationship with mobile user subscriptions (ICT indicator), Internet penetration (ITU indicator), fixed broadband subscriptions (teleinfrastructure indicator), and technological readiness index (IT and ITeS indicator).
2. Due to a mixed country set in the South Asian region, urban population growth and population growth (macroeconomic demographic indicators) are found to negatively impact the human capital development in the selected South Asian nations.
3. Other components of dependent variable (HDI)tested in Models (1) to (3) such as school enrollment (primary), per capita GDP, and birth life expectancy are not presented in the tabulated results in Table 15.2 since these variables are found to have weak association as compared to HDI directly for the selected group of nations over the period from the year 2000 to 2016.

15.4.3 Data Sources and Sample Selection

The data for macroeconomic demographic indicators is obtained from World Development Indicators, World Bank. International Telecommunication Union's ICT statistics have been utilized to gather data on mobile cellular subscriptions and Internet usage.

HDI data is collected from UNDP Human Development reports and reviews on qualitative indicators. Technological Readiness Development Index (TRI) database is taken from the World Economic Forum (WEF), the World Bank Global Competitiveness database (TCdata360).

The sample is purposively considered to be of selected South Asian (developing) nations in order to examine any pertinent distinction on the association among the studied variables due to differences in the stage of development that is unique for this region only. The period considered for the study is from *2000 to 2016* so as to investigate the recent reversals (if any) for developing nations for human development with positive impact due to ICT wider usage.

15.5 Research Methodology

In order to conduct an empirical examination of the linkage among the variables, the study has applied *fixed-effects panel modeling* (*FE Model*) technique on the selected country set. Fixed-effects model eliminates the probable impact of time-invariant attributes so as to evaluate the net impact of the explanatory variables on the key (left-hand side) outcome variable. Each firm is distinct; therefore, the firm's error term and the constant (that captures discrete properties) must not be associated with the remaining. In case the error terms are linked, fixed-effects model may not give the true, correct, and realistic inferences, and the only option left is to probably use random-effects modeling. This is the key reasoning behind the Hausman[7] specification test (current empirical estimation results mentioned in the explanation section below). Additionally, cross-sectional dependence problem is automatically taken care with usage of micro (short)-panel (a large number of entities with fewer years).

Econometric Model Specification

$$Y_{it} = \beta_1 X_{it} + \alpha_i + \mu_{it} \quad \text{(Common FE Model Regression Equation)}$$

where, $\alpha_i (i = 1, \ldots, n)$ captures the individual firm-level traits via unknown intercepts of each firm, Y_{it} represents the dependent variable (DV) over time (t) and entity/firm (i); $X_{it}s$ is the list of independent variables (IVs) used in the model; β_1 is the regression coefficient of the respective IV and μ_{it} is the error term. Thus, it is often suggested to use panel fixed-effects modeling wherever firms' individual characteristics are to be kept intact.

In order to capture the holistic view, the authors have extended the model specifications with different dependent variables. Therefore, the current chapter tests the impact of ICT indicators on HDI and other components of HDI like per capita GDP, school enrollment, life expectancy in the empirical analysis results tabulated in Table 15.3.

Variables Used in the Econometric Model

Dependent Variable(s): Human Development Index (HDI) represents the social-cum-economic growth indicator to estimate the magnitude of influence due to improvement in the standard of living and per capita income level of the people staying in the selected developing nations group. Alternatively, HDI includes a decent standard of living (given by GNI per capita), knowledge (given by expected years of schooling) and long and healthy life (with a holistic mix of qualitative and quantitative growth parameters).

The net school enrollment rate is the ratio of children of official school age who are enrolled in school to the population of the corresponding official school age.

Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

Independent Variable(s): The key independent variables are Information and Communication Technology (ICT) indicators, i.e., mobile phone penetration, fixed broadband usage, and Internet usage per 100 inhabitants denoted by $X_{it.}$ In the current chapter, square transformations of Internet penetration and square root transformations of mobile usage are considered so as to eliminate the non-normality characteristic of the data. Further, square root transformation works well for data with

[7]Due to the poor properties of Hausman test empirically, it often fails to provide practical results in general.

Table 15.3 FE regression results

Selected South Asian nations panel results						
Dependent variable	Per Cap GDP	Life_Expec	Sch_Enro_Rate	HDI	HDI	HDI
Control variables	(1)	(2)	(3)	(4)	(5)	(6)
Mobile_Sqrt	(1.7906) 2.4323**	(0.0580) 0.5921***	(0.3474) 0.5416*	(0.0011) 0.0111***	(0.0011) 0.0089***	(0.0012) 0.0089***
Internet_Sq	(0.1021) 1.1962***	(0.0004) 0.0001*	(0.0023) 0.0047**	(0.0008) 0.0001**	(0.0007) 0.0005*	(0.0008) 0.0001*
Population growth	(1.9968) −1.7751	(0.5419) −1.0119**	(0.8130) −0.1348	(0.0119) −0.0319***	(0.0096) −0.0343***	
Urban population growth						(0.0068) −0.0216***
Fixed Broad Band_sq					(0.0044) 0.0168***	(0.0045) 0.0133***
TRI	(1.0738) 4.6442***	(0.4163) 1.0008*	(1.1218) 6.8692**	(0.0181) 0.0139**	(0.0077) 0.0171**	(0.0079) 0.0181**
Constant	(2.9147) 5.9697**	(0.9813) 8.7967**	(1.2570) 7.6914**	(0.0405) 0.5822***	(0.0189) 0.6007***	(0.0221) 0.6183
R-square	0.7011	0.5775	0.6214	0.5741	53.4211	0.8333
F-stats	74.14	76.46	72.98	87.85	96.43	91.21
Probability	0	0	0	0	0	0
Rho	0.9843	0.9846	0.9692	0.9949	0.9926	0.9886
No of obs	50	50	44	50	50	50
No of groups	5	5	5	5	5	5

Source Author's regression results based on FE modeling using STATA 13 testing
signifies 1%, **5% and *10% level of significance ($p < 0.01$, **$p < 0.05$, *$p < 0.1$)
Standard errors in parentheses

non-constant variance and also when the testing variable is 'a count of something', for instance, in the current study, mobile-cellular telephone subscriptions is expressed as 'per 100 inhabitants'. Also, square transformation of Internet penetration has been taken to reduce the left skewness of the data.

The technological readiness index pillar of GCI encapsulates this competence via components on the latest techniques availability, technology absorption at firm-level, tech transfer, and FDI. The index takes into account the innovation capacity as well.

The annual population growth rate for year t is the exponential rate of growth of mid-year population from year '$t-1$' to 't', expressed as a percentage. The population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.

15.6 Empirical Analysis and Results

Table 15.3 includes the panel regression results of empirical testing on selected South Asian nations dataset over the period from the year 2000 to 2016 as per trailing regression equation:

$$\begin{aligned}
\mathrm{HDI_{it}} &= \alpha + \beta_1\left(\mathrm{Mobile_\ sqrt_{it}}\right) + \beta_2(\mathrm{Internet_\ sq_{it}}) \\
&\quad + \beta_3\left(\mathrm{Pop_\ growth_{it}}\right) + \beta_4\left(\mathrm{UrbanPop_\ G_{it}}\right) \\
&\quad + \beta_5(\mathrm{FixedBroad_{it}}) + \beta_6(\mathrm{TRI}_{it}) + \varepsilon_{it} \\
\mathrm{Per_\ Cap_\ GDP}_{it} &= \alpha + \beta_1\left(\mathrm{Mobile_\ sqrt}_{it}\right) + \beta_2(\mathrm{Internet_\ sq}_{it}) \\
&\quad + \beta_3\left(\mathrm{Pop_\ growth}_{it}\right) + \beta_4\left(\mathrm{UrbanPop_\ G}_{it}\right) \\
&\quad + \beta_5(\mathrm{FixedBroad}_{it}) + \beta_6(\mathrm{TRI}_{it}) + \varepsilon_{it} \\
\mathrm{School_\ Enrol}_{it} &= \alpha + \beta_1\left(\mathrm{Mobile_\ sqrt}_{it}\right) + \beta_2(\mathrm{Internet_\ sq}_{it}) \\
&\quad + \beta_3\left(\mathrm{Pop_\ growth}_{it}\right) + \beta_4(\mathrm{UrbanPop_}G_{it}) \\
&\quad + \beta_5(\mathrm{FixedBroad}_{it}) + \beta_6(\mathrm{TRI}_{it}) + \varepsilon_{it} \\
\mathrm{Life_\ Expect}_{it} &= \alpha + \beta_1\left(\mathrm{Mobile_\ sqrt}_{it}\right) + \beta_2(\mathrm{Internet_\ sq}_{it}) \\
&\quad + \beta_3\left(\mathrm{Pop_\ growth}_{it}\right) + \beta_4(\mathrm{UrbanPop_}G_{it}) \\
&\quad + \beta_5(\mathrm{FixedBroad}_{it}) + \beta_6(\mathrm{TRI_{it}}) + \varepsilon_{it}
\end{aligned}$$

We have run several different specifications of the regression equations; however, the significant key results are listed here in Table 15.3. To correct the panel's heteroscedasticity drawback, the robust standard error estimates are considered. Although FE panel modeling takes care of the multicollinearity problem, it is advisable to check the multicollinearity (VIF < 10) for the variables of key interest. Table 15.3 encapsulates the key findings of the empirical regression analysis. To conduct the regression on the selected panel dataset, we have utilized STATA 13.0 MP for regression coefficients computation.

Although *R*-square is found to be as low as nine percent in some of the initial basic regression models listed in Table 15.3, the same is reasonable with the large heterogeneous panel of firms considered in the sample. The F statistics and the DW test statistics have turned out to be highly significant. The specification tests under regression diagnostics (post-estimation testing), especially testing for heteroscedasticity (hettest and szroeter) and serial correlation (xtserial), are found to confirm the presence of strong homoscedasticity for DV (dependent variable) series and no auto serial correlation among IV (independent variable) series.

From Table 15.3, the following pertinent observations could be noted:

- All ICT infrastructure indicators, fixed broadband, and mobile subscriptions, and Internet penetration are found to impact positively and significantly all the key dependent variable, HDI, and its components like net school enrollment rate, birth life expectancy and per capita GDP (Models 1–6). The same corroborates with existing studies that have propagated that IT and ITeS have a crucial role to determine the prospective human capital development, especially in the context of developing nations (Hettiarachchi 2006; Bankole et al. 2011).

- Population growth, annual (in %) and urban population growth (in %) are found to impact HDI significantly and negatively (Models 4–6). Instead, these demographic macroeconomic variables for selected developing South Asian nations are adversely influencing rather hampering the path of creation of skilled manpower (resources) in these nations (Hettiarachchi 2006).
- Another global competitiveness indicator, technological readiness, is found to impact the coefficient of HDI (and other dependent variables tested) positively and significantly (Models 1–6). This indicates that the adaptation and availability of basic infrastructure in the selected group of developing nations are mandatory pre-conditions for having a positive contribution of technological advancement in the human capital creation of these countries.

15.7 Conclusion and Policy Implications

Undoubtedly so far, ICT tools have proved crucial and advantageous for the regions like South Asia. Historical pieces of evidence have vested in high hopes of the relevance of such technologies. Despite prevailing usage of the same are not essentially determined toward human capital development. Formulating different notions to explore the influence of ICT investments on human capital creation delivers a contemporary outline to comprehend how nations could best invest in IT and ITeS for advancement. The empirical analysis has exhibited the distinguishing effect of IT investments on human capital development in developing economies. By selecting only the highly significant results ($p < 0.01$, 0.05), key inferences relevant to the selected South Asian countries of this chapter are revealed. The prime detection from the current chapter indicates that the ICT investments are of substantial relevance to impact the (increased level) standard of living and also the education level across the globe.

There is an urgent need to change the entire paradoxical thinking about ICT in order to ensure effective use of ICT in human capital creation in SAR. The same shall include the complete transformation from rethinking of fruitful government policies, integration of ICT policies with broader economic and social goals, and of course, active participation of residents.

In developing nations (as per empirical analysis results in Sect. 15.6), the importance of ICT investment can't be denied on the level of education and standard of living. For developing nations like South Asia, the outcome of IT and ITeS investments on human capital creation are more obvious. Measures like health and education in the HDI are possibly more suitable for these nations. Most of the current shreds of evidence indicate that these nations are still attempting to enrich elementary education (primary school enrolments and literacy rates), and health (birth life expectancy). These nations will consequently undertake conscientious investments in manpower and skill enhancement in their IT financing policies so as to fully exploit the effect of investments in the domain of human capital creation.

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Chapter 16
Role of ICT in Sustainable Agricultural Development—The Case of India

Amit Chatterjee

16.1 Introduction

Agriculture is the only source of energy provider and basic input provider to all other economic spheres not only literally in terms of calories but also in form of labour, raw material and economic market for finished goods. The relationship of agriculture with mankind can be traced back since the inception of homo sapiens-right from the paradigm of hunting animals to the present modern era of digitized farming. Overtime, agriculture has developed across the globe differently-since climatic conditions, nature of soil and vegetation and geographical location account for the differentiating role in the agriculture. Today, there has been a general consensus of transferring the role of agriculture from non-economic to economically profitable, environmentally friendly and more importantly sustainable agricultural development. As an answer to most of the major macroeconomic issues such as economic development, food and nutritional security, poverty, unemployment, economic and regional inequalities, BoP (Balance of Payments) disequilibrium, etc., agriculture sector has immense untapped potentials-especially in India's case. This is quite evident from the unprecedented shift in terms of sectoral contribution to India's GDP from agriculture to service sector during the post-reform period. As per the Economic Survey 2017–18, Indian agricultural sector employs close to 50% of total workforce; nevertheless, it accounts only for 17–18% of total GDP. Besides the economic cause that agriculture is subject to scarcity and supply-side bottlenecks, the low productivity of Indian agricultural sector can be largely attributed to use of primitive techniques, poor technical know-how, improper dissemination of information, low responsiveness to adopt modern inputs and more importantly shallow outreach of R&D (Research and Development) institutions. Thus, given the dependence on monsoon, the backwardness and

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underperformance of the agricultural sector can be majorly linked to underplay role of ICT.

This chapter is a modest attempt to explore the potentials of ICT in the pursuit of sustainable agricultural development and to review the present state of ICT and its effect on Indian agricultural sector with respect to digitalization vision of GOI (Government of India) and e-agriculture initiative. The study is based on the time series data (1990–2017) related to Indian agricultural production and productivity. In the last five years, India has been experiencing a harmonic growth rate of smart phones consumption, which has further being accentuated by the war of the airwaves with the introduction of brand Jio in telecommunication. The variables identified are fixed telephone, fixed Internet, mobile communication, percentage of Internet facilities, agricultural credit, economic complexity and rail facilities. The chapter attempts to explore the impact of these variables on the dependent variable agriculture output in India.

The main hypothesis of this study is that *growth of India's agricultural output has been sporadic in the post-reform era, but in last decade there has been a positive impact due to ICT infrastructures.*

The empirical estimation for this study has been considered with the utmost precaution by incorporating regression models. In order to avoid ambiguity and potential bias in the estimation, all variables have been converted into the natural logarithm. The rest of the chapter is organized as follows. Section 16.2 deals with the literature part of the study. Section 16.3 deals with the empirical estimation and econometric procedure and also discusses the results. Section 16.4 concludes the findings.

16.2 Literature Review and Research Gap

There exists no dearth of literature in the field of evaluating the role of ICT and economic development conducted on countries at different development levels. But when it comes for the case of India and particularly India's agricultural sector, there is a lacuna of empirical researches. Presented below is a glimpse of existing literature related to the role of ICT in agricultural and overall economic growth.

Deichmann et al. (2016) in a policy research working paper of World Development Report Team conducted a comprehensive study on the role of ICT and its contribution in transforming agricultural sector in the developing countries. The study lays a general analysis based upon World Bank Flagship Report. One of the major findings of the study suggests that nevertheless mobile phones penetration has deepened while the Internet access remains shallow. The study also stresses upon the need of parallel investments in the complementary physical infrastructure and literacy to derive full-fledged benefits associated with digital technological advancements.

Hwang and Shin (2017) laid a comprehensive study on the role of ICT specific technological change in Korea's economic growth for the period 2000–2030 considering 2013 as a base year. The study has been segmented into two parts—the role of

ICT in the past and expected future contributions to the economic growth. In the first part, the study verifies a significant role of ICT on economic growth through growth accounting framework. In the latter part, they have employed Recursive-Dynamic Computable General Equilibrium (RDCEG) model to suggest policy measures required for sustainable economic growth. One of the major findings of the study is that during the period 2000–12 approximately 40% of Korean economic growth can be attributed to the role of ICT. Secondly, the ICT leads to virtuous circulation in terms of ICT-producing industries (in terms of product innovation by intermediate inputs) and ICT-using industries (in terms of process innovation by ICT capital stocks).

Haftu (2019) studied the impact of mobile phone and Internet on the per capita income of sub-Saharan Africa for the period 2006–15. The study deployed the two-step difference GMM (Generalized Method of Moments) on the panel data of 40 countries and revealed that a 10% increase in mobile phone penetration led to a 1.2% increase in per capita GDP. The study further found no significant impact of Internet on GDP during the study period, which might be accrued to low ICT skill of Internet users and relatively immature state of technology among others.

Arvin and Pradhan (2014) have worked upon the panel data set of G-20 countries (19 member countries and the European Union) pertaining to broadband penetration, degree of urbanisation, FDI (Foreign Direct Investment) and economic growth during the period of 1998–2011. Using Granger Causality Model, their research concludes the short-run bidirectional causality between broadband penetration and economic growth.

Czernich et al. (2011) studied the effect of broadband penetration upon per capita economic growth of OECD countries using Instrumental Variable Model during the period 1996–2007. Their results indicate higher per capita GDP from 2.7–3.9% in the post-introduction period of broadband introduction. Their findings further imply that a 10% increase in the former leads to a rise in per capita economic growth from 0.9–1.5% during the period of study.

Levendis and Lee (2013) analysed the impact of tele-density on economic growth using the panel data of 29 Asian economies during the period of 1981–2006. They deployed the two-step difference GMM and worked upon two different models—one considering telecom as strictly exogenous and other one as strictly endogenous. The study reveals a robust positive impact of tele-density oneconomicgrowth, which becomes even stronger with the further level of telephone penetration.

The glimpses of the remaining available literature related to the role of ICT in sustainable agricultural and economic growth have been tabulated below.

Authors	Time period	Context	Topics considered	Technique used	Findings
Vu (2017)	2004–14	ASEAN economies	ICT diffusion and production	Revealed comparative advantage	ICT leads to the higher diffusion of production
Gruber and Koutroumpis (2011)	1990–2007	192 countries	Mobile communication and economic growth	3 SLS technique	Positive and significant relation between mobile communication and economic growth
Jung et al. (2013)	1994–2007	South Korea	ICT, industrial productivity and economic growth in Korea	Panel ARDL	ICT directly impacts the industrial productivity
Erumban and Das (2016)	1985–2011	India	ICT and economic growth	TFPG model	ICT increases economic growth
Pradhan et al. (2018)	2001–12	G-20	ICT and economic growth	VECM model	ICT, labour force participation, CPI, fixed capital formation and economic growth are well co-integrated
Hofman et al. (2016)	1990–2013	Latin America	ICT and economic growth	TFP model	ICT leads to economic growth
McArthur and McCord (2017)	1961–2001	Developing countries	Agriculture inputs and economic growth	Log-linear model and instrumental variable model	Agriculture inputs and economic growth are positively correlated
Chavula (2014)	2000–2011	34 African economies	ICT and agriculture	Fixed and random effect models	Mobile phones have no significant and telephone lines remain significant for agriculture growth

(continued)

(continued)

Authors	Time period	Context	Topics considered	Technique used	Findings
Lee et al. (2012)	1975–2006	44 SSA economies	Telecommunications and economic growth	Panel GMM	Mobile phone connection is the significant determinant for economic growth
Pradhan et al. (2017)	1961–2012	N-11 economies	ICT-Finance-growth nexus	VAR model	Causal relation among all variables in short run and long run
Lio and Liu (2006)	1995–2000	81 economies	ICT and agricultural productivity	OLS model	ICT has positive impact upon the agricultural productivity
Fountas et al. (2005)	1998–2003	UK, Denmark and U.S.A	ICT in precision agriculture	Survey model	ICT helps in making precision agriculture
Egyir et al. (2011)	2001–2010	Ghana	ICT-based market information services and agriculture markets	Threshold autoregressive model	ICT-based services lead to the increase in agriculture production
Koutroumpis (2009)	2002–2007	22 OECD economies	Economic impact of broadband on growth	Structural econometric modelling	Broadband impacts growth positively
Ding et al. (2008)	1986–2002	29 Chinese regions	Telecom infrastructure and regional income	System GMM	Positive and significant relation between telecom infrastructure and regional income

Source Author's own compilation of previous studies. The overall compilation of earlier literature shows the relation between information infrastructure, economic growth, agriculture productivity, broadband penetration rate and industrial productivity over different economic contexts

16.3 Empirical Estimation and Results Analyses

As can be inferred from the literature review that there exists a lacuna of empirical researches made in evaluating contribution of ICT in India's agricultural sector; thus, this study is a modest attempt to fill-up this white space in the research. Secondly, an attempt has been made to include the information and communication technological advancements made in physical infrastructures such as railways and broadband penetration along with greater accessibility to agricultural credit due to advancements in banking and information disseminating technologies. This study analyses the relation among the agriculture output, agriculture credit and several ICT infrastructures for India over the time period from 1990 to 2017. In this study, the main outcome variable is the agriculture output. Agriculture credit is the main independent variable. Other control variables are rail facility, economic complexity and ICT infrastructures. By considering this, our empirical equation is described as follows,

$$\begin{aligned} \mathrm{AGOUT}_t = \alpha &+ \beta_1\mathrm{AG}_t + \beta_2\mathrm{FT}_t + \beta_3\mathrm{FI}_t + \beta_4\mathrm{MC}_t \\ &+ \beta_5\mathrm{PIU}_t + \beta_6\mathrm{EC}_t + \beta_7\mathrm{RAIL}_t + e_t \end{aligned} \tag{16.1}$$

In the above empirical equation, AGOUT_t is the agriculture output for the time period t. α is the constant in the equation. Here t refers to the time period 1990 to 2017. AG_t, FI_t, MC_t, PIU_t, EC_t and RAIL_t refer to the agriculture credit, fixed telephone, fixed Internet, mobile communication, percentage of Internet facilities, economic complexity and rail facilities of the study for time period t. e_t is the error term of the above equation. Data for the study are considered from the various secondary sources. Agriculture output data are considered from the World Development Indicators database of World Bank. In our study, agriculture output refers to the total agriculture final production in India over the period from 1990 to 2017. Agriculturecredit data are taken from Government of India database from Ministry of Agriculture. Agriculture credit data refer to the financial assistance given to the agriculture over the year. Fixed telephone and fixed Internet are the main ICT infrastructures considered for the analysis. Mobile communication refers to the availability of mobile phones to the individuals. Economic complexity database is taken from the Fraser Institute database. Economic complexity refers to the difficult conditions of economy, which is based on the scores of the economy. Rail facilities imply the rail density of the economy in terms of kilometres and data for this are taken from the World Development Indicators database of World Bank.

Table 16.1 presents simple regression analysis with the agriculture output being the main outcome variable. Models from I to IV study the basic regression analysis of agriculture output, credit and ICT infrastructure in various contexts. Model I considers the relation by deleting the aspect of secure Internet servers. Model II considers the empirical analysis without taking into account the percentage of individual Internet usage. Model III looks into the full-fledged model, and Model IV looks into the aspect of agriculture credit and output by deleting the aspects of both fixed telephone and secure Internet users.

Table 16.1 Baseline regression

Agriculture output	I	II	III	IV
Agriculture credit	−0.178* (0.082)	−0.204* (0.080)	−0.183* (0.087)	−0.199* (0.089)
Fixed telephone	0.058* (0.025)	0.052** (0.026)	0.056** (0.027)	
Fixed Internet	0.196* (0.053)	0.123* (0.046)	0.179** (0.092)	0.185* (0.057)
Mobile communication	0.131*** (0.074)	0.124*** (0.077)	0.130*** (0.078)	0.207* (0.075)
Percentage of individual Internet usage	−0.917** (0.311)		−0.709 (0.708)	−0.987* (0.337)
Secure Internet users		−0.397* (0.140)	−0.097 (0.094)	
Economic complexity	−1.532* (0.586)	−1.125*** (0.679)	−1.432** (0.807)	0.818 (0.620)
Rail facilities	−0.036 (0.037)	−0.021 (0.023)	−0.035 (0.033)	−0.054 (0.053)
Model	OLS	OLS	OLS	OLS
R^2	0.646	0.638	0.645	0.560
Adjusted R^2	0.545	0.534	0.523	0.460

Source Authors' own estimation. All variables are converted into natural log. Standard errors are reported in the parentheses below the coefficients. (*), (**), (***) denote the estimates that are significantly different from zero at 1%, 5% and 10% levels of significance, respectively

As per the empirical result, we notice that coefficients of agriculture credit are negative and significant. It states that increase in agriculture credit leads to the decline in the output due to the rapid corruption and channelizing agriculture credit for some other purposes. Our empirical results further reveal that improvements in ICT infrastructure lead to the increase in agriculture productivity over the year. As evident from the empirical analysis, every 1% increase in telephone lines and Internet services leads to the 0.052–0.058% and 0.123–0.196% increase in agriculture output respectively. Furthermore, our results show that every 1% increase in mobile phone communications impacts agriculture productivity positively from 0.124–0.207% increase in the agriculture output annually. However, we find no noticeable impact of rail density upon the agriculture sector output. In addition to this, we find the negative and significant association between economic complexity and agriculture output annually. It otherwise states that economic hardness negates the agriculture output during this period (see models I to III, Table 16.1).

16.4 Stationarity Check and Cointegration Test

We now proceed towards checking stationarity property and further to check long run cointegration among the concerned variables. The unit root empirical results for various variables have been tabulated below. The unit root tests are drawn based upon the level and first difference analyses. For both, we apply the trend as well as trend-intercept. With respect to agriculture, we find that it is non-stationary at level, but, stationary at the first difference (Table 16.2). Similarly, for fixed Internet services, it is also non-stationary at the level but exhibit stationary at the first difference. Likewise, all the remaining variables such as telephone, economic complexity and mobile communication exhibit stationarity at 1st difference. Thus, basis upon the unit root test results, it can inferred that all the variables exhibit stationary at first difference, thereby indicating the level of stability in the model.

After examining the stationarity properties through unit root test, we now further take up to test the long run cointegration among the variables.

Table 16.3 presents empirical analyses of cointegration for all the six variables. The results are interpreted in the following manner.

1. All the variables have cointegration in the long run.
2. The result is more imminent from both, no trend and with trend analyses.
3. Considering the aspects of at most 5, we notice that all variables are highly cointegrated during this period. It states that agriculture output has robust cointegration relation with the fixed telephone, fixed Internet, mobile communication, and Internet access and rail infrastructures.
4. Other empirical results show that the variables are well cointegrated over the period of time in cases of at most 1–4.
5. The results further show that agriculture output is highly cointegrated with the improvements in rail and other physical infrastructures over the years.

Table 16.2 ADF unit root test results

Variables	Level		1st difference	
	Trend	Trend and intercept	Trend	Trend and intercept
Agriculture	0.043	0.183	0.000	0.000
Fixed Internet	0.789	0.748	0.000	0.002
Fixed telephone	0.021	0.977	0.525	0.097
Mobile communication	0.010	0.329	0.068	0.021
Rail	0.298	0.724	0.000	0.001
Percentage of individual Internet	0.999	0.472	0.005	0.001
Economic complexity	0.223	0.475	0.010	0.003

Notes Author's own estimation. All variables are converted into natural log. The values given in the trend as well as trend and intercept indicate the probability value. From probability value, we can get to know the stationary level

Table 16.3 Cointegration test results

AG FT FI MC PIU RAIL		AG FT FI MC PIU RAIL	
Johansen cointegration test			
No of cointegration	No trend	No of cointegration	With trend
None	0.984* (0.000)	None	0.984* (0.000)
At most 1	0.904* (0.000)	At most 1	0.905* (0.000)
At most 2	0.848* (0.000)	At most 2	0.849* (0.000)
At most 3	0.538* (0.001)	At most 3	0.678* (0.000)
At most 4	0.415* (0.020)	At most 4	0.537* (0.000)
At most 5	0.024* (0.023)	At most 5	0.380* (0.011)

Notes Author's own estimation. All variables are converted into natural log. Eigen values are given. Probability values are given in the parentheses under the values of Eigen values. (*), (**) and (***) denote the estimates that are significantly different from zero at 1%, 5% and 10% levels of significance, respectively

16.5 Quantile Regression

Having checked the stationarity and cointegration properties, we now present the quantile regression results different quantiles such as 25th, 50th and 75th. As indicated in Table 16.4, agriculture output is the main outcome variable and most of the infrastructures like ICT and rail facilities are considered as the control variables.

We can notice that at all quantiles there exist negative and significant association between agriculture credit and output. It implies that the increase in agriculture support system has rather led to the underutilization in terms of corruption and diverting of credit for others, resulting in the declining output. With respect to ICT infrastructure, Internet connection has the positive robust impact upon the agriculture output compared to the fixed telephone line. The claim has got its empirical support from the positive and significant association between the mobile connection and agriculture. Farmers' accessibility to the mobileand Internet connections has led to the positive and significant effect upon the agriculture output. However, we notice the opposite impact of negative and significant association between percentage of individual Internet usage and agriculture output. It states that Internet accessibility to the farmers is still less and information disseminating through theagriculture portal is not reaching farmers in proper time. Our empirical results show that rise in difficult economic conditions does hamper the agriculture output negatively during this time period.

Table 16.4 Quantile regression result

Agriculture output	I	II	III
Agriculture credit	−0.143** (0.075)	−0.171** (0.092)	−0.176* (0.044)
Fixed telephone	0.030 (0.032)	0.029 (0.040)	0.019 (0.023)
Fixed Internet	0.137* (0.063)	0.179* (0.068)	0.291* (0.077)
Mobile communication	0.144** (0.074)	0.143*** (0.090)	0.153** (0.079)
Percentage of individual Internet usage	−0.759* (0.357)	−0.950* (0.343)	−1.485* (0.459)
Economic complexity	−1.901*** (0.680)	−0.942 (0.827)	−0.563 (0.514)
Rail facilities	−0.050 (0.056)	−0.016 (0.016)	−0.015 (0.013)
Quantiles	25th	50th	75th
Pseudo R^2	0.439	0.572	0.475

Sources Authors' own estimation. All variables are converted into natural log. Standard errors are reported in the parentheses below the coefficients. (*), (**) and (***) denote the estimates that are significantly different from zero at 1%, 5% and 10% levels of significance, respectively

16.6 Fully Modified OLS (FMOLS)

Table 16.5 indicates the fully modified OLS for the above model. To overcome the problem of endogeneity, FMOLS is utilized here. The above two models take care of FMOLS with and without constants, respectively. Our empirical results suggest that coefficients of agricultural credits are negative and significant at 1% level of significance. It shows that increase in the agriculture credit leads to the decline in agriculture output, which leads to the corruption. Our empirical results further show that ICT infrastructures like telephone andInternet exhibit positive and significant impact upon the agriculture output. Coefficients of fixed Internet and mobile communication are found to be impacting agriculture output differently (see models I and II, Table 16.3). Rail facilities are found to have no significant impact upon the agriculture output. It shows that transportation facilities like rail density are not uniformly distributed across the Indian states. However, we find the noticeable impacts of economic complexity upon the agriculture output. Our empirical results show that every 1% increase in economic complexity leads to the decline in 1.175–1.253% decline in the agricultureoutput.

Interaction Model of OLS and FMOLS

Table 16.6 presents the case of interaction effect. In order to make our analysis more robust, we multiply both fixed Internet and mobile communications to find out the joint impact upon the agricultureoutput. By considering this interaction model, we

Table 16.5 Fully modified OLS (FMOLS) result

Agriculture output	I	II
Agriculture credit	−0.193* (0.061)	−0.253* (0.074)
Fixed telephone	0.054* (0.020)	1.109 (0.859)
Fixed Internet	0.223* (0.030)	0.168* (0.060)
Mobile communication	0.131* (0.058)	0.077 (0.066)
Percentage of individual Internet usage	−1.042* (0.232)	−0.526 (0.464)
Economic complexity	−1.253* (0.496)	−1.175* (0.477)
Rail facilities	−0.034 (0.033)	−0.054 (0.053)
Constant		−7.213 (5.954)
R^2	0.620	0.639
Adjusted R^2	0.506	0.506

Sources Authors' own estimation. All variables are converted into natural log. Standard errors are reported in the parentheses below the coefficients. (*), (**) and (***) denote the estimates that are significantly different from zero at 1%, 5% and 10% levels of significance, respectively

apply OLS and FMOLS results with agriculture output. More importantly, we find the positive and significant association between mobile and Internet facilities upon the agriculture output. Our empirical results suggest that every 1% increase in the interaction effect leads to 0.359–0.821% increase in the agriculture output annually (See models I to III, Table 16.4). Another important findings of the economic complexity reveals that the increase in economic difficulty in terms of rising inflation, financial constraints and several other macroeconomic imbalances impact the agriculture output negatively (see columns I to III, Table 16.4). Transport facilities like rail are found to be impacting least upon the agriculture output due to the unequal access across the country (see models I and III, Table 16.4).

16.7 Conclusion

This study empirically evaluates the relation between agriculture output and ICT infrastructures over the time period 1990–2017. Our study mainly shows that agriculture sectoral growth is primarily dependent upon the infrastructures and economic conditions. Our study reveals that improvements in mobile phone availability and Internet facilities especially pronounce positive impacts upon the agriculture growth.

Table 16.6 Interaction model of OLS and FMOLS

Agriculture output	I	II	III
Agriculture credit	−0.162** (0.089)	−0.191* (0.082)	−0.307* (0.083)
Fixed telephone	0.080* (0.024)	0.071* (0.023)	2.134* (0.840)
Fixed Internet * Mobile communication	0.695* (0.179)	0.821* (0.165)	0.359*** (0.210)
Percentage of individual Internet usage	−0.524** (0.296)	−0.682* (0.273)	0.122 (0.108)
Economic complexity	−1.881* (0.693)	−1.699* (0.665)	−1.287* (0.547)
Rail facilities	0.095 (0.063)	0.123** (0.060)	−0.031 (0.032)
Method	OLS	FMOLS	FMOLS with constant
Constant			−14.215* (5.820)
R^2	0.565	0.524	0.609
Adjusted R^2	0.467	0.411	0.492

Sources Authors' own estimation. All variables are converted into natural log. Standard errors are reported in the parentheses below the coefficients. (*), (**) and (***) denote the estimates that are significantly different from zero at 1%, 5% and 10% levels of significance, respectively

But we notice the worrying trend of diversion of agriculture credit toward the non-agriculture works. Our empirical results across models state that the increase in agriculture credit has rather led to more negative growth of agriculture output. In developing economy like India, agriculture is a highly volatile sector subject to the economic conditions. Economic complexities have its say on the agriculture sector output, as revealed by the empirical results. Furthermore, we find the positive impacts of ICT infrastructure upon agriculture output. However, our empirical results suggest that there still needs improvements in rail transport in terms of transporting agriculture goods.

Being a volatile economic sector, agriculture sector is more prone to various economic crises. In India, agriculture is quite volatile to the monsoon rainfall. For the time being, this study exclusively considers the impacts of ICT infrastructures upon the agri-output. As a part of policy suggestions, the study argues that ICT infrastructure sector needs to be doubled by keeping special emphasis upon the agriculture sector. Rail sectors need to be widened in terms of agriculture goods transportation, which must ensure the smooth flow of agriculture output across the economy. Furthermore, the study proposes that corruption needs to be checked, while disbursing the agriculture finances for the farmers. Despite many initiatives taken by government in terms of farmer loans waiving and easy accessibility of loans by banks with minimum interest, our country is still reeling under the problems of farmer suicides and the declining agricultureoutput.

This study although is limited in terms of scope, still it gives rise to some of the future possibility in terms of widening and interlinking the research between infrastructure and agriculture sectors in the upcoming years.

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Chapter 17
The Effect of Knowledge and Skill-Based Production on Agricultural Employment: An Empirical Analysis in the Sample of South Korea

Muhlis Can and Buhari Doğan

17.1 Introduction

Structural reform is one of the most important topics of contemporary economics since the reform to be carried out in the field of economy has a vital role for the efforts of countries to grow. Therefore, developing countries try to implement structural reforms in order to reduce the development gap with developed countries and promote new policies for the manufacturing industry (Andreoni 2011). Structural transformation is closely related to orientation from the agricultural sector towards more productive sectors. Specifically, one of the most crucial obstacles to structural transformation is the specialization of the country in the primary product group, which has low productivity (McMillan et al. 2014). For example, Singapore and Pakistan export 133 kinds of products. However, in terms of income, Singapore is 38 times richer than Pakistan because of the "Knowledge" differences (Hausmann et al. 2011). Technological change is ensured by the accumulation of this "knowledge" factor (Kogler et al. 2013).

In the early stages of development, countries are dependent on the sectors in which the primary product group is involved, while the dependency on these sectors decreases with the structural transformation (Srinivasan 2013). When the relationship between the success of structural change and growth is considered in the literature, it can be said that the first group that comes to mind is East Asian economies. The countries that have achieved this success are Japan, South Korea, Singapore, Hong Kong, China and Taiwan, respectively (Shrestha 2013). In this country group, thanks to the reforms carried out, the production factors have been directed from the

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low-paid and low-productivity agricultural sector to high-paying and high-efficiency manufacturing industry (Nabi 2010). Among the East Asian countries, South Korea is one of the most remarkable countries that achieved to reach success thanks to structural reforms (Felipe et al. 2010b; Jankowska 2012). The structural change in this country began with the five-year development plans laid down in the 1960s. Thanks to qualified human capital, the country has started to produce high value-added, technological products in many different sectors (Jankowska 2012). In this way, South Korea's dependence on agriculture has decreased, and rapid and sustainable growth has been achieved (Felipe et al. 2013). It can be concluded that industrialization may have a negative effect on the agricultural sector including employment (Akram 2013). Structural transformation is evaluated in the context of the contribution of agriculture, manufacturing and services sector to employment and growth (Srinivasan 2013). More specifically, directing the production factors in the agricultural sector to other sectors reveals the success of the structural transformation.

The aim of this study is to examine the effect of economic complexity representing knowledge and skill-based production on agricultural employment in the sample of South Korea over the period 1970–2011. According to our best knowledge, this is the first study that investigates the effects of economic complexity on agricultural employment in the literature. In the study, first of all, a theoretical background about the concept of economic complexity will be given. Afterwards, the literature about economic complexity will be examined. In the next section, we present the empirical findings and discussion. In the final section, policy recommendations will be presented in light of the findings.

17.2 Theoretical Background

The concept of production is divided into two approaches in the literature. According to the first approach, the production consists of a combination of machinery, raw materials, and labour force. On the other approach, "knowledge" is at the forefront of the emergence of products. For example, a tooth paste is just a product filled to a tube or is there a different set of "knowledge" in it? When it is taken into account, toothpaste contains a number of chemicals that will keep the teeth healthy and protected. The amount of substance to be used in content is related to knowledge. This shows the importance of knowledge even in the case of simple products (Hausmann et al. 2011). Each product which is manufactured in the any given country requires different capabilities such as knowledge and skills (Hausmann and Hidalgo 2010). From this point of view, it is possible to say that the more level of knowledge and skill that countries have, the more the countries able to manufacture diversified and sophisticated (knowledge and skill intensive) products (Can and Dogan 2017; Can and Gozgor 2018; Hidalgo and Haussmann 2009). For example, each of the letters U, N, I, V, E, R, S, I, T, Y represents an input (knowledge and skill). From these letters, we can derive the words of IT, SIT, REV, VER, SITE, UNIVERS and UNIVERSITY. Among those words, short words represent products that require less knowledge and skills, while long words represent more sophisticated products which require more knowledge and skills. If there is no “S” input (knowledge, skill) in the country, then the country will not be able to derive the UNIVERSITY word. For the manufacturing of certain products, very different various knowledge and skills have to be combined. If an individual is to be considered as a byte, a hundred different individuals must come together for a product that requires a hundred bytes (Hausmann et al. 2011).

The existence of individuals, firms and organizations with different knowledge and skills in a country indicate the structure of a complex production (economic complexity) in that country. In this context, economic complexity can be defined as the whole of the knowledge and skills used in production (Minondo and Requena-Silvente 2013). The economic complexity can be measured with the index developed by Hausmann et al. (2011).[1] The high-level index value is an indication that the current level of knowledge and skills is quite good in a given country. Moreover, a high-level index value also indicates that the manufacturing sector uses very different knowledge and skills. However, the low index value will indicate that a given country is specializing in products that do not require knowledge and skills (Sweet and Maggio 2015). If countries specialize in products that require more complex products (need more knowledge and skills qualifications), it will be easier for them to manufacture other products that require relevant qualifications. However, if the current level of knowledge and skill is low in a given country, the possibility of manufacturing sophisticated products will be low (Minondo 2011). For example, adding shorts to a production basket for a country that produces t-shirts is much easier to add mobile phones. If the country is already able to produce mobile phones, it is possible to add smartphones to the production basket (Felipe et al. 2010a). In other words, if the range of the products requires similar infrastructures, similar physical factors, similar organizations, it is possible to say that when the country produces one of these products (in the range) will produce the other/others more easily (Hidalgo et al. 2007).

Technology-intensive and sophisticated manufacturing is very important for a given country in terms of future economic growth since such products have high-income elasticity. In addition, these products lead to an increase in demand. Therefore, countries that produce more complex (sophisticated) products grow faster than in other countries. Moreover, technology-intensive sophisticated manufacturing increases the tendency of new scientific developments to be transferred to production (Lall 2000). This situation allows the emergence of new complex (sophisticated) products and provides an advantage over other countries.

Increasing the income levels of countries are closely related to reducing their dependency on the agricultural sector. In this context, it is very important to direct the labour force and other resources from agriculture to sectors with high productivity. In this way, the productivity level of the country will increase, and the country will be wealthier (McMillan et al. 2014). As sophisticated (knowledge, skill-intensive-based) production increases, it is expected there will be a shift in the labour force

[1] For detailed information, see Hausmann et al. (2011).

from agriculture to other sectors. From this point of view, considering the heavily sophisticated production of South Korea, employment in the agricultural sector is expected to decrease.

17.3 The Situation of Agricultural Employment and Economic Complexity in the South Korean Economy

In this section, we will discuss employment in the agricultural sector and economic complexity in the context of South Korea. As can be observed from Fig. 17.1, the number of people employed in the agricultural sector is around five million in the early 1970s. In the following years, this number increased slightly, however, in the 1980s, it fell below four million levels. It is clearly detected that this decline follows a certain trend. Especially in the 2000s, the number of people employed in the agricultural sector fell below two million and reach one million in 2010.

When the economic complexity of South Korea is examined, it is clearly seen that it has been following a continuous fluctuating graph until the 1990s. It is observed that the index has been sudden ups and downs from the early 1970s to the middle of the related period. This process has shown a downward trend, especially after the 1980s. However, after the 1990s, the index has followed an increasing trend in general (Fig. 17.2).

At this point, it should be noted to give information about South Korea's ranking of world economic complexity in order to make the picture clearer. Based on the economic complexity index which takes place in the Atlas Media database (2015), South Korea is ranked 23rd in 1970. In 1980, it increased to 18th place in the rank

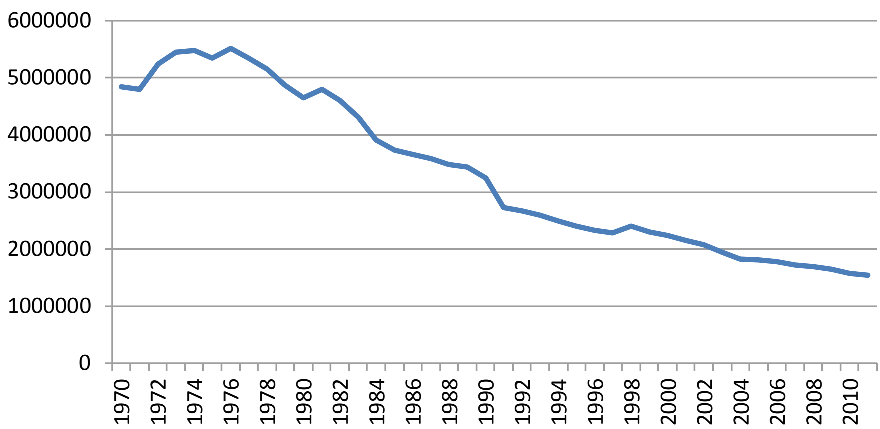

Fig. 17.1 South Korea agriculture sector employment (1970–2011)

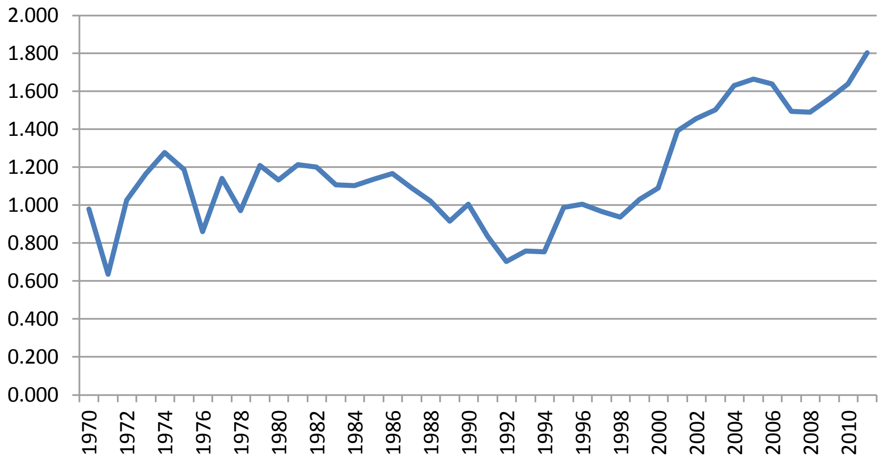

Fig. 17.2 Economic complexity of South Korea (1970–2011)

with 1.13 index value. South Korea's complexity index value was 1.64 in 2006 and 1.80 in 2011, and it was ranked 9th and 5th place in the world ranking, respectively.

When the employment of agriculture and economic complexity are evaluated together, it can be said that agricultural employment decreased as the index value grew. In other words, as the country's structural structure changes with reforms, it can be interpreted that there is a labour movement from the agricultural sector to other sectors.

17.4 The Literature

When the international literature is examined in the context of economic complexity, it is observed that the subject is handled in various ways. For example, Poncet and Waldemar (2013) have tested the effect of economic complexity on economic growth in the case of two hundred cities in China. The empirical results reveal that economic complexity positively affects growth. Hausmann et al. (2011) have tested the effects of economic complexity on economic growth for the periods 1978–1988, 1988–1998 and 1998–2008 in the case of different county groups. The findings provide that economic complexity positively contributes to economic growth. Hartmann et al. (2015) have examined the effect of economic complexity on income inequality over the period 1996–2001 and 2002–2008. The findings demonstrate that economic complexity contributes to decreasing income inequality. Sweet and Maggio (2015) investigate the effects of intellectual property rights on economic complexity in the sample of 94 countries for the period of 1965–2005. Their empirical result concludes that intellectual property rights have a positive effect to economic complexity. Employing the fully modified ordinary least square and Maki Cointegration Test, Can (2016) has explored the effect of economic globalization on economic complexity in the sample of South Korea over the period 1970–2012. The empirical findings show that series are cointegrated and economic globalization is an important determinant of economic complexity. Can and Dogan (2018) have tested the effect of financial development on economic complexity in the sample of Turkey for the period 1970–2013. The result reveals that financial development positively contributes to economic complexity. Daude et al. (2015) have examined the determinants of economic complexity in the sample of 103 countries. It is concluded that financial development, trade openness, foreign direct investment, population, and infrastructure are important determinants of economic complexity. Can and Gozgor (2017) have explored the impact of economic complexity on CO_2 emissions in the case of France over the period 1964–2014. The empirical finding demonstrates that economic complexity decreases CO_2 emissions.

When the literature on economic complexity is observed, it is noticed that the issue has become widespread in international literature. However, we have not found any study examining the relationship between economic complexity and agricultural employment. As McMillan et al. (2014) indicated, the success of the structural transformation of countries is closely related to the directing of the production factors used in agricultural production to other productive sectors. In this context, it is likely that economic complexity may lead to a decline in agricultural employment due to the fact that South Korea has achieved the success of structural reform.

17.5 Data and Methodology

In this study, we test the impact of the economic complexity (COMPLEX) which is the indicator of knowledge and skill-intensive production on agricultural sector employment (AGR) in the case of South Korea for the period of 1970–2011.[2]Considering the technology-intensive production in the growth of South Korea's economy, the effect of growth (GDP) on agricultural employment is undeniable. In other words, as economic growth increases, it is expected that the labour force in the agricultural sector moves other productive sectors. For this reason, it is predicted that the coefficients of both COMPLEX and GDP series will have negative signs. The AGR (number of people) and GDP (Constant 2010, USD) data are taken from the World Development Indicator (WDI) released by the World Bank. COMPLEX data is collected from the Atlas Media database (2015).

Before running the model, AGR and GDP series are taken into logarithmic form. In this respect, the model can be defined as follows.[3]

[2]We select this period because of the data limitation.

[3]This study is based on the studies of Karagöz (2007) and Peker and Göçer (2010). Both studies have tested the effect of foreign direct investments on employmentt/unemployment. In this respect,

$$\mathrm{AGR}_t = \alpha_0 + \alpha_1 \mathrm{COMPLEX}_t + \alpha_2 \mathrm{GDP}_t + \varepsilon_t \quad (1)$$

where t refers to time, AGRshows agricultural employment, COMPLEX reveals economic complexity; GDP mentions economic growth and, ε_t implies error term.

Cointegration analysis was first developed by Engle and Granger (1987). However, the approach is a single-equation analysis. Following this method, Johansen (1988) and Johansen and Juselius (1990) developed a multi-equation analysis. Johansen Cointegration (JC) is performed based on vector autoregressive method (VAR). However, in order to run Johansen Cointegration, the series to be included in the analysis should not be stationary at the level I(1) and they should become stationary I(0) as a result of the different process.

In order to test whether the series is stationary or not, we use augmented Dickey–Fuller (ADF) and Philips–Perron (PP) unit root tests. The hypotheses for both tests;

H_0: There is a unit root, series are not stationary.
H_1: There is no unit root, series are stationary.

The findings of unit root tests are reported in Table 17.1. The obtained results show that the series is not stationary I(1) at the level and they become stationary I(0) as a result of the different process.

For the Johansen Cointegration, it is necessary to determine the appropriate lag length based on the VAR model. The findings are reported in Table 17.2.

As a result of the findings of different information criteria, we decide to use one lag. However, in order to reach the best result, we apply autocorrelation and heteroskedasticity by using one lag. We report the empirical finding in Table 17.3. Although we do not detect the autocorrelation problem in the model, we observe that there is a heteroskedasticity. In order to solve the problem, we run the same model

Table 17.1 ADF and PP unit root tests results

Variables	ADF test statistics	PP test statistics	Critical value (1%)	
			ADF	PP
AGR	−3.543 [0]	−3.543 [0]	−4.198	−4.198
ΔAGR	−4.692*[0]	−4.668*[2]	−4.205	−4.205
COMPLEX	−1.800[0]	−1.724[3]	−4.198	−4.198
ΔCOMPLEX	−8.113*[0]	−7.882*[2]	−4.205	−4.205
GDP	−0.110[0]	0.157[4]	−4.198	−4.198
ΔGDP	−6.229*[0]	−6.295*[5]	−4.205	−4.205

Note Numbers in brackets are lag lengths used in the ADF test (as determined by AIC) to remove serial correlation in the residuals. When using the PP test, numbers in brackets represent Newey–West bandwidth (as determined by Bartlett–Kernel). *, ** and ***, respectively, denote $p < 0.10$, $p < 0.05$, and $p < 0.01$

instead of foreign investments on the right side of the equation, we use economy complexity as an explanatory variable.

Table 17.2 Determination of optimum lag length based on VAR model

Delay	LR	FPE	AIC	SC	HQ
0	NA	0.000	−4.353	−4.223	−4.307
1	277.494*	0.000*	−12.276*	−11.753*	−12.092*
2	6.040	0.000	−11.991	−11.076	−11.668
3	4.972	0.000	−11.688	−10.382	−11.228
4	15.668	0.000	−11.855	−10.157	−11.256

Note LR: Modified LR statistics, FPE: final prediction error, AIC: Akaike information criterion, SC: Schwarz
information criterion and HQ: Hannan–Quinn information criterion

Table 17.3 Assumption results of VAR (1) and VAR (2) models

Lagrange multiplier (LM) autocorrelation test				
VAR estimation	Lag length	LM-test statistics	Prob	Modulus
1	1	4.248	0.894	0.961939
				0.895415
	2	4.454	0.879	0.755335
	3	11.296	0.255	
2	1	4.772	0.853	0.950386
				0.950386
	2	3.312	0.950	0.643261
				0.221762
	3	12.901	0.167	0.221762
				0.146546
White heteroskedasticity test				
VAR estimation	χ^2-test statistics		Prob	
1	48.318		0.082	
2	53.982		0.944	

Note In the autocorrelation test, the H_0 hypothesis is "There is no autocorrelation", in heteroskedasticity test is the H_0 hypothesis is "There is no heteroskedasticity". The optimum lag length is limited as three because of the fact that the series is annual

by using two lags. After employing autocorrelation and heteroskedasticity tests, we observe that there is no autocorrelation and heteroskedasticity.

The Pantula principle has been adopted on the determination of the cointegration vector. According to this principle, the obtained coefficients and probability values of the cointegration Models 2, 3 and 4 are written from top to bottom. Then, the table is read from left to right. This process will continue when we stop in the first time where we accept the null hypothesis (Asteriou and Hall 2007, 327–328).

When Table 17.4 is read from left to right, it is concluded that Model 3 is the appropriate integration vector. According to Model 3, there is at least one co-integration

Table 17.4 Trace statistics according to the Pantula principle

Rank (r)	Model 2	Model 3	Model 4
$(r = 0)$	62.810[0.000] H_0rejected	41.376***[0.001] H_0 rejected	51.243[0.006] H_0 rejected
$(r = 1)$	30.121[0.001] H_0 rejected	12.090[0.152] H_0 accepted	21.824[0.147] H_0accepted
$(r = 2)$	6.165[0.178] H_0 accepted	2.357[0.124] H_0 accepted	9.416[0.156] H_0 accepted

Note The values within [] indicate the probability values, and *** denotes $p < 0.01$

Table 17.5 Weak exogeneity test

Variable	Constraints	Chi-square test	Prob
D(AGR)	$A(1,1) = 0$	18.614	0.000***
D(COMPLEX)	$A(2,1) = 0$	3.03	0.08*
D(GDP)	$A(3,1) = 0$	0.022	0.8814

Note *, ** and ***, respectively, denote $p < 0.10$, $p < 0.05$ and $p < 0.01$

Table 17.6 Error correction model

	D (AGR)	D (COMPLEX)	D (GDP)
Coefficient	−0.276	−0.970	−0.010
Standard error	0.055	0.538	0.067
t-statistics	−4.992***	−1.802*	−0.158

Note *, ** and ***, respectively, denotes $p < 0.10$, $p < 0.05$, and $p < 0.01$

between the series. According to this result, the long term equation can be written as AGR = −0.046*COMPLEX-0.521*GDP and both coefficients are significant. In other words, when GDP and COMPLEX increase, we observe a decrease in agricultural employment.

Before running error correction model, we employ a weak exogeneity test. The empirical findings provide that AGR and COMPLEX are not weak exogeneity variables. After the weak exogeneity test, we apply the error correction model and report in Table 17.6. The results demonstrate that the error correction coefficient belongs to AGR and COMPLEX are both negative and statistically significant.

17.6 Conclusion

In the literature on economics, structural transformation is one of the most frequently emphasized issues. Scholars have mentioned that the countries which achieve the structural transformation will grow more rapidly and converge to the countries with high-income levels. One of the most important policies that should be implemented for this purpose is to direct the labour force in the agricultural sector to other productive sectors. In this study, it is aimed to examine the effect of economic complexity (knowledge and skill-intensive production) on agricultural employment in the sample of South Korea. The empirical findings demonstrate that the increase in economic complexity causes a decrease in agricultural employment. In other words, it can be said that there is a shift from agriculture to other productive sectors as the level of knowledge and skills intensive production of the South Korean economy increases. Developing countries take important lessons from the obtained results. Of course, it is an undeniable fact that the agricultural sector has great importance for countries. However, the agricultural sector will benefit from the spillover effect caused by investment in productive sectors. For example; the manufacturing of a product to be used in the agricultural sector (machinery, medicine, equipment, etc.) in the manufacturing industry or in the chemical industry will have two main important contributions to the economy. Firstly, this will increase productivity in the agricultural sector and will reduce costs in the sector. Secondly, the country will add a new sophisticated product into the production basket. Accordingly, the productivity increase in the agricultural sector of countries is closely related to knowledge and skill-intensive production. In the process of structural reform, it has great importance for policymakers direct the factors of production in agriculture to productive sectors, while supporting the knowledge and skill-intensive production in a synchronous manner. Otherwise, the abandonment of the agricultural sector can leave countries in a dilemma.

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Chapter 18
Information Communication Technology and Self-Employment

Ashu Tiwari, Archana Patro, and Jahnavi Patky

18.1 Introduction

Creating ample employment opportunities has always been a big challenge for the governments all over the world. Therefore to cope up with this issue, governments actively promote opportunities related to self employment. However after the widespread proliferation of ICT, this domain also faced certain challenges. However without understanding the various employment categories, one cannot figure out the real cause of these challenges. Therefore, upon exploring the existing literature we found that there are two broad categories of employment namely, permanent or standard and non-permanent or nonstandard. Though the terminology of labor market differs country-wise, **standard employment** and **nonstandard employment are the frequently refered categories in the existing literature**. The existing literature defines the standard employement is the contractas in which the employees work for a single employer and have a pre-decided retirement date. The retirement age or dismissal conditions also differ as per the government policies and rules of countries. Nonstandard employment are conditional contracts that provides employment for fixed-term or pre-decided period of employment and task-wise or project-wise employment. According to the model of the Institute of Manpower Studies, the standard and non standard employees have different types of flexibility. Permanent employees are the core group and are provided functional flexibility, whereas non-permanent employees are provided numerical and financial flexibility and considered as a peripheral and external part of the organization. Non-permanent category consists of short-term contractors, part-timers, job sharers, agency temporaries, self-employed people, subcontractors, etc. Out of non-standard category self

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employment has emerged as critical one in resolving the problem of unemployment. According to the report of the Labor Bureau, self-employed are those who work in the farm or non-farm arrangements, and they have autonomy over what, when, and how to produce. They can be (a) independent entrepreneur (b) accompanied by a few partners and/or labor under them or (c) helping another person from the same household. The production of their enterprise decides their income.

The advent of online platforms has created additional category within self-employed category. This is known as own account workers. Own account workers are those workers who are independent individual workers. When own account workers use online sites and application to connect to the employer, they are called "sharing economy workers" (Minter 2017). The other terms for sharing economy workers are 'Microworkers,'Clickworkers,' 'Crowdworkers,' 'on-demand workers' (De Stefano 2015; Ross et al. 2010; Todolí-Signes 2017; Webster 2016).

However, in current discussion we are focussing on overall self-employment domain. In this context, De Wit (1993) defined self-employed individuals as, 'the individuals who earn no wage or salary, but derive their income by exercising their profession or business on their account and for their own risk.' The definition of De Wit (1993) clearly states that all sorts of risks would be borne by self employed person themselves. However, despite these embeded caveats in definitions, the studies have never evaluated the impact of emergence of ICT-enabled plateforms on this domain. While, data shows that there is consistent decline in the self employment rate after the massive diffussion of technology-driven spaces. In the past, many research articles have studied the role of information technology in evolutionary market conditions and argued that technology is an essential element of future economic growth. However, we ignored the studies on role of many by-products of the information technology on and self-employment that is also exposed to many new risk factors. For example, see in Fig. 18.1, in the past two to three decades, self-employment has reduced significantly.

This problem is especially significant in developing countries where self-employment is a critical dimension for economic development. For these countries, the adoption of ITenabled plateforms in the domain of self-employment in appropriate manner is essential for further growth of this domain in this fast-changing world. It is in line with the argument given by the evolutionary theory of economic development that argues that in the process of economic change, those who adapt to change, survive and those who do not, are left behind. Away from the primary focus of evolutionary theory that is based on firms' behavior, we are applying it to the self-employment domain and trying to study it in the background of risk aversion. The study extends the evolutionary theory of economic development by adding a new element of risk aversion, and at the same time, it studies the problem of technology adoption in the self employment domain. This theory has rarely been applied to micro-units. Since self-employment is though resource-constrained yet more desired domain in the current state of the economy, this study has greater applicability on policy fronts.

Data Source: World Bank

Fig. 18.1 Downside trending self-employment trend. *Source* World Bank

The remainder of the paper is divided into five sections. Section second surveys and highlights the gap in the literature. Section third discusses the theoretical framework used in this study. Section fourth explains the models, measurement, samples, and data definitions. Section fifth is data estimation and findings. Section sixth concludes this study.

18.2 Literature Review

Most of the work on the subject of self-employment is conducted in Britain after 1970. The reason lies in the sudden surge in numbers of self-employed people during the year 1970 in many of the western countries (De Wit 1993). Therefore plenthora of literature emerged around the subject. In this context, Colombo and Delmastro (2002) found that incubator firms have more productivity than that of their counterparts in Italy. Westhead and Matlay (2006) found that the skills and attributes reportedly associated with the propensity to obtain employment positions in SMEs are not the same as those associated with the propensity to report a favorable attitude toward self-employment or business ownership in Britain. An older study by Winch (1998) in Britain showed that the main reason behind the growth of self-employment domain since 1977 was the strategic choice of firms to choose the flexibility over productivity to gain a competitive advantage in the industry. However, they found that this choice hindered productivity because of lowering training and declining scope of innovation. Baines (2002) found that there were two key contradictory elements in home-based or micro-level self-employment. According to him, some people found greater flexibility and freedom in home-based work, whereas others felt that micro-employment put limit on trainings. He futher added that self employed people found home awkward place for curtailing freedom and flexibility in the UK. Colombo and Grilli (2005) found that experience in technology helped new firms to grow. Kangasharju and Pekkala (2002) argued that firms run by highly educated showed higher growth than the one operated by less educated persons. Ono and Zavodny (2005) discovered that working women in Japan have lower levels of IT use and skills than their male counterparts. It is a difference that generally did occur in the USA. Therefore, studies did highlighted the role of gender difference on the level of computer education. Segal et al. (2002) studied individual characteristics necessary for self-employment. Moulik and Purushotham (1982) discussed the institutional aspect of self-employment. They argued that technical knowledge in the absence of an appropriate policy on international trade could not benefit any self-employed person from value addition in economic activity. De Wit (1993) presented a literature review with the existing models of self-employment such as different entrepreneurial abilities model, choice of wage-employment model, capital requirement model, demand uncertainty model, cost uncertainty model, dynamic model, and influence of taxation model. In these models, the authors tried to point out how changes in exogenous variables impact the number of self employed people (Brock et al. 1986; Lucas 1978; Sheshinski and Dreze 1976; Appelbaum and Katz 1986; Kirzner 2015). McNaughton, Symons, Light, & Parsons (2006) explained how technology could assist a person with disabilities in realizing their dreams in the domain of self-employment (Griffin et al. 2003). Granger et al. (1995) explained that how ‘entrepreneurial pull’ and ‘unemployment push’ dynamics work for self-employment.

Lopez (1984) found that utility and profit-maximizing decisions were not independent. Wellington (2006) presented the relation between self-employment and work–life balance. Fairlie and Meyer (2000) explained the relationship between black and white male, and self-employment rate. It says earlier white males’ self-employability used to be two times higher than that of black males self-employability. Parker (2004) explained the various aspects of self-employment such as income inequality, entrepreneurship, earning age, and paid-employment status in his book. Baines and Gelder(2003) argued that self-employment always provided an opportunity to engage in house routine works which were not found in regular employment status. Goetz et al. (2012) explained that self-employment has a positive impact not only on income but also on the growth of employment and GDP. Yamada (1996) showed that in urban areas, people were self-employed out of choice and were earning competitive salaries. Gollin (2008) showed that aggregate productivity change was more because of the cross-country variation in establishment size and self-employment rates. Douglas and Shepherd (2002) found that self-employment depends upon the career choice and attitudes of a person. They further added that expected utility out of self-employment depends upon independence and degree of risk tolerance. Romero and Martínez-Román (2012) explained that innovation in any self-employed type firm was dependent upon individual characteristics such as motivation and educational background; organizational characteristics such as sector/industry and external environment. Noorderhaven et al. (2004) found that self-employment rate was dependent upon the dissatisfaction from the functioning of democracy and family. Burke et al. (2002) found that there was a difference between male and female characteristics required to make a person possess self-employment inclination. Akyol and Athreya (2011) found that wealth and tendency to become self-employed were not outcomes of credit constraints. This condition persisted even when plenty of credit was available at low-interest rates. Though the existing literature provides a variety of knowledge around factors influencing self-employment tendency, yet the impact of risk aversion on technology adoption has rarely been investigated in the existing literature. Therefore, we have tried to fill this gap.

18.3 Theoretical Framework and Hypothesis Development

Authors have discussed mainly around two theoretical tenets 'entrepreneurial pull' and 'unemployment push,' but the risk aversion component has been missing in the extant literature. Like every other domain, technology-adoption by the people aspiring for self-employment has repercussions of risk aversion. In this chapter, we attempted to know whether risk aversion has any impact on the adoption of technology by self employed people. We took our theoretical framework from Nelson (2009) and Tiwari, Patro, and Shaikh (2019). The latter based their argument on technology adoption and technology-driven economic growth theories and found that risk aversion has a significant impact on the adoption of ICT-enabled plateforms in business domains. Besides it, we also used the element from framework of Evolutionary Theory of Economic Development, which says that at the market place, firms adjust themselves as per the changed economic conditions and emerging factors. Thus, markets achieve a new equilibrium of various conditions. However, in the extant literature, technology adoption in self-employment has never been studied through lenses of risk aversion. This chapter argues that though technology has transformed the lives of masses unequally, and policymakers cannot overlook these changes Therefore, the process of IT adoption needs an investigation to understand the uneven impact of IT-enabled platforms in various sectors. Hypotheses Development: Evolutionary theory of economic development argues that adaptability is vital element of survival in markets. Therefore, if we go by the argument of this theory, self-employed domain exists because it has brought essential changes require to survive in the current system. However, we can't ignore the fact that internal and external factor will impact the domains' propensity to adapt certain change. In the context, we tested the element of risk aversion with the help of following hypotheses. Figure 18.2 presents conceptual framework of our hypotheses. We developed the four hypotheses. First two hypotheses are based on the argument of evolutionary theory whereas other two hypotheses are testing the element of risk aversion on the adoption ICT-plateforms in the domain of self employment;

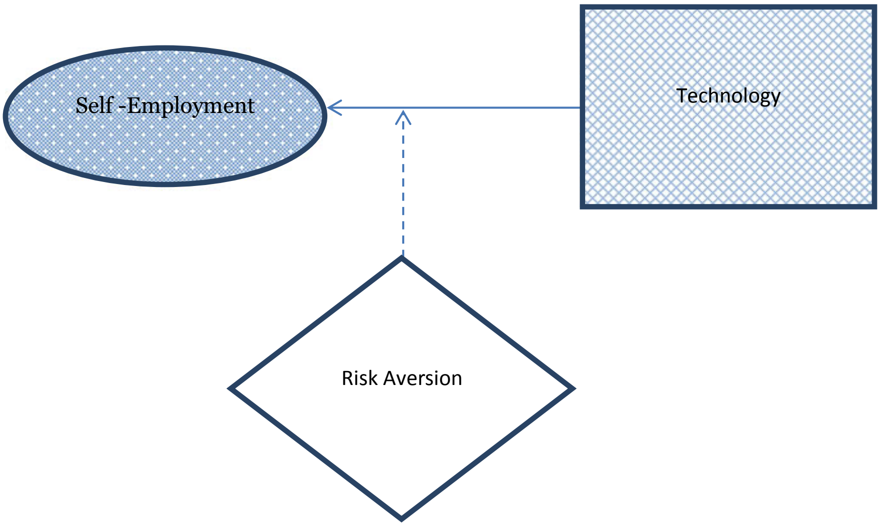

Fig. 18.2 Theoretical framework

$\boldsymbol{H}_1$: Ceteris paribus the IT penetration positively impacts self-employment domain
$\boldsymbol{H}_2$: Ceteris paribus mobile subscription positively impacts self-employment domain.
$\boldsymbol{H}_3$: Ceteris paribus the risk aversion impacts IT adoption by self-employment domain.
$\boldsymbol{H}_4$: Ceteris paribus the risk aversion impacts IT adoption by self-employment domain.

18.3.1 Model and Variable Definition

$$\Delta \boldsymbol{SI}_t = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 * \boldsymbol{Ra} + \boldsymbol{\beta}_2 * \Delta \boldsymbol{P} + \boldsymbol{\beta}_3 * \Delta \boldsymbol{IT} + \boldsymbol{\beta}_4 * \Delta \boldsymbol{IN} + \boldsymbol{\beta}_5 * \boldsymbol{VA}_t + \boldsymbol{\mu}_t + \epsilon_t$$

where

ΔSI_t Stands for self-employment
ΔRa Stands for risk aversion
ΔIT Stands for information technology adoption
ΔIN Represents income growth
VA Voice accountability
ΔP Population growth

We have taken a sample of 75 seventy-five developing countries for our model. Data for self-employment, secondary education, tertiary education, population, gross domestic product, and information communication technology penetration has been taken from the World Bank. The period for our data set is ten years, ranging from 2006 to 2015. Many of these variable series have unit roots, but after the first difference, the problem of unit root is resolved. In our analysis, we used ordinary least square (OLS) for estimating our models. This method is based on the concept of minimizing the error in our model.

18.4 Estimation and Results

In model 1 of Table 18.1, we can see that except for the information technology, all the elements are significant at various levels of significance. GDP growth rate is negative at 5% significance level, the deposit rate is positive and significant at 5% significance level, saving rate is negative at 10% significance level, and voice accountability is also negative at 5% significance level. In model 2 of Table 18.1, the GDP growth rate is negative at 10% significance level, deposit rate is again positive at 10% significance level, saving rate is negative at 1% significance level, population growth rate is negative at 1% significance level, information technology is negative and significant at 5% level of significance, and voice accountability is again negative at 10% significance level. In model 3, the deposit growth rate and GDP growth rates are not found significant. Other than these two terms, rest all terms are found significant at various levels. Saving rate and population growth rates are found significant at 1% significance levels, and information technology and secondary education are found significant at a 1% significance level. In model 4, again, deposit rate and GDP growth rate are not found significant. Other than these two terms, rest all the terms are found significant. In model 5 of Table 18.1, other than the GDP growth rate and deposit rate, all the other terms are significant at 1% significance levels.

In Table 18.2, there are three models; GDP growth rate and deposit growth rate are significant and negative at a 5% significance level. Saving rate and growth rate of cellular mobile subscriptions are not significant. Voice accountability is again negative and significant in model 1 of Table 18.2. In model 2 of Table 18.2, deposit growth rate and GDP growth rates are not found to be significant, whereas the growth rate of saving, population, and an interaction term between technology and tertiary education is found significant 1%, 1%, and 10% significance levels, respectively. Voice accountability, like other models, in this model, is found significant at 10% significance levels. In model 3 of Table 18.2, GDP growth rate and deposit growth rate are not significant, whereas the growth rate of saving, population, and cellular mobile is found significant at 1%, 1%, and 10%, respectively. Other than this, interaction term between cellular mobile and voice accountability is also found significant at 10% and 1% significance levels, respectively.

Thus, coming to our hypotheses, we argued that technology increases self-employment rate, which is not found. In our investigation, we have taken two models to study this aspect, namely IT penetration and cellular mobile subscription. In the

Table 18.1 Self-employment and the impact of technology (OLS)

Independent variable	Model 1	Model 2	Model 3	Model 4	Model 5
GDP growth rate	−0.091	−0.0409	−0.062	−0.066	−0.031
	(0.032)	(0.0989)	(0.1202)	(0.1075)	(0.3714)
Deposit growth rate	0.164	0.080	0.089	−0.002	0.016
	(0.019)	(0.072)	(0.216)	(0.980)	(0.796)
Saving growth rate	−0.0274	−0.171***	−0.091	−0.13***	−0.16***
	(0.065)	(0.000)	(0.0015)	(0.000)	(0.000)
Population growth rate	−2.419***	−3.593***	−2.541***	−2.855***	−4.945***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Information technology Growth rate	−0.037	−4.734	−0.134***	−0.003***	−1.098***
	(0.194)	(0.017)	(0.000)	(0.000)	(0.000)
Tertiary Education		4.734			
		(0.017)			
Secondary enrollment			−0.135***		
			(0.000)		
Secondary enrollment* IT penetration				−0.003***	
				(0.001)	
Tertiary Education* IT penetration					−1.098***
					(0.000)
Voice accountability	−0.028	−0.017	−0.025	−0.021	−0.014
	(0.003)	(0.053)	(0.01)	(0.028)	(0.006)
Summary statistics					
Adj R-Square	0.625	0.659	0.689	0.671	0.737
Cross sections					
Observation	465	291	304	299	280

Note In all the above series, we have removed unit roots before the estimation of regression models. In brackets, there are *p* values

case of IT penetration, in all our models, there is a negative impact of IT -enabled platforms on the domain of self-employment, while, in the case of cellular mobile subscription, there is a positive impact on self-employment status. Therefore, we cannot say anything simply about our hypotheses. Similarly, we expected a positive effect of tertiary education in the case of technology adoption. Again, there are different results in different models which need further understanding of our results.

Table 18.2 Self-employment and the impact of technology (OLS)

Independent variable	Model 1	Model 2	Model 3
GDP growth rate	−0.086	−0.067	−0.067
	(0.038)	0.107	0.107
Deposit growth rate	0.172	0.065	0.065
	(0.015)	(0.398)	(0.398)
Saving growth rate	−0.022	−0.205***	−0.205***
	(0.4488)	(0.000)	(0.000)
Population growth rate	−2.469***	−3.214***	−3.214***
	(0.000)	(0.000)	(0.000)
Information technology growth rate			
Cellular mobile growth rate	0.0007		0.0005*
	(0.467)		(0.074)
Cellular mobile growth rate*tertiary edu		0.0005*	
		(0.074)	
Cellular mobile growth rate*secondary edu			7.92***
			(0.000)
Voice accountability	−0.025	−0.016*	−0.016
	(0.013)	(0.082)	(0.082)
Summary statistics			
Adj R-Square	0.624	0.632	0.632
Cross sections			
Observation	461	274	274

Note In all the above series, we have removed unit roots before the estimation of regression models. In brackets, there are *p* values

18.5 Conclusion

In developing countries, technology can transform the self-employment market provided that the problem of slow diffusion of ICT related platforms is resolved. This is evident from our current analysis that ICT has negatively impacted the self-employment domain. In all the above models, neither secondary nor tertiary education has any role in facilitating technology adoption in self-employment domain. However, another measure of ICT component, i.e., cellular mobile subscription, seems to work differently. Not only, secondary education is positively impacting the usage of mobile in self-employment domain, but also, tertiary education is positively impacting mobile usage in self-employment domain.

Additionally, people educated beyond secondary education are more likely to be self-employed than those who are not. Other than this, in most of our models, the

GDP growth rate is negatively impacting self-employment domain, which essentially means that when the economy grows well, people do not choose to be self-employed. Other variables also differ in sign, such as deposit rate positively impacts self-employment domain. It simply means that a high deposit rate encourages people to invest, which in turn increase credit availability for these small or micro-level self-employment domains. The high growth rate in saving adversely impacts self-employment. This may be due to the fact that self-employed people also constitute a significant proportion of the population who saves. Therefore, it shows that either risk aversion or self-employment opportunities are not as much productive as savings in the market. Voice accountability is another important variable which is negative throughout our models. It may be due to the fact that this is more likely to bring the legal cost to a self-employed person. Since self-employed people have smaller units, it may be difficult for them to afford the legal cost. Thus, if these aspects are substantial, people will not be willing to engage in self-employment activities.

These findings are crucial for policy formulations. Self-employment is an essential economic aspect on employment issues. Therefore, policymakers have active incentive in promoting self-employment opportunities. However, in the absence of credit availability, appropriate arrangements to lower down legal costs, the people are less likely to become self-employed. The limitation of this work is that only developing and emerging markets have been taken into consideration. Therefore, either micro-level or more specific economic definition of countries can bring more specific insights. Other than this, we have also not considered many aspects crucial to promote self-employment such as credit availability, treatment of tax and subsidies, interest rates, inflation, and other similar variables. Besides this, in our present analysis, we did not consider cultural dimensions, whereas countries like India, China, Brazil, Japan, etc., have significant degree of cultural influence in various economic aspects. Therefore, in the future, we can also conduct studies which may bring some insights about the cultural influence in the context of self-employment.

Appendix

See Tables 18.3 and 18.4.

Table 18.3 Descriptive statistics

	Self-employment	Population between 14–65	Saving rate	Deposit rate	Voice accountability	GDP growth rate
Mean	50.80074	62.87287	22.27962	6.6805	36.89036	4.977202
Median	50.8545	63.66207	19.57643	5.707917	37.05422	4.879087
Maximum	93.594	100	72.97112	22.91333	80.76923	34.5
Minimum	0.444	48.03197	−22.1091	0	2.403846	−7.820885
Std. deviation	25.11876	8.926735	12.54517	4.196416	16.62382	3.977709
Skewness	−0.090449	1.032545	0.866057	0.912744	0.063193	1.132248
Kurtosis	2.093858	6.18482	4.901664	3.52426	2.259806	10.99563
JaraqBera	19.21088	324.1726	148.8723	81.16328	12.68686	1553.806
Probability	0.000067	0	0	0	0.001758	0
Observations	540	540	540	540	540	540

Table 18.4 Correlation table

	GDP growth rate	Deposit rate	Saving rate	Voice accountability	Population between 14–65
GDP growth rate	1				
GDP growth rate	0.03839	1			
Saving rate	0.198785	−0.28236	1		
Voice accountability	−0.1005	−0.00782	−0.23366	1	
Population between 14–65	−0.13523	−0.11174	0.3554	0.100786	1

Variables	Definition	Data source
Self-employment	Self-employed workers are those workers who, working on their own account or with one or a few partners or in a cooperative, hold the type of jobs defined as "self-employment jobs," i.e., jobs where the remuneration is directly dependent upon the profits derived from the goods and services produced. Self-employed workers include four sub-categories of employers, own account workers, members of producers' cooperatives, and contributing family workers	World Bank
Deposit rate	Deposit interest rate is the rate paid by commercial or similar banks for demand, time, or savings deposits. The terms and conditions attached to these rates differ by country, however, limiting their comparability	International Monetary Fund, International Financial Statistics, and data files
Saving rate	Gross domestic savings are calculated as GDP less final consumption expenditure (total consumption)	World Bank national accounts data, and OECD National Accounts data files

(continued)

Table 18.4 (continued)

Variables	Definition	Data source
IT penetration	Internet users are individuals who have used the Internet (from any location) in the last three months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV, etc.	World Bank
Cellular mobile subscription	The number of postpaid subscriptions, and the number of active prepaid accounts during the last three months	World Bank
Voice accountability	Voice and accountability capture perceptions of the extent to which country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI	World Bank
GDP	GDP per capita in constant 2010 US dollars	World Bank

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Chapter 19
An Introspective Study on the Emergence of Sharing Economy and the Role of IT & ITES Therein with Special Reference to India

Dipayan Singha and Amit Majumder

19.1 Introduction

Scarcity is a fundamental truth of existence which cannot be avoided as there is never enough of any resource to satisfy the demand of everyone. To curb the problem of scarcity, economics was initiated. Economics is the study of how scarce resources are allocated to make best possible use with a simultaneous projection of the fundamental truth of scarcity. Ever-present situation feels the need of scarcity as the available supply is inadequate against the demand or the purchasing power of the consumer is scanty. This universal phenomenon leads to the definition of economics as the 'science of allocation of scarce resources'. To deal with the problems of unlimited human wants and limited resources, the need for sharing was felt. The term collaborative consumption or sharing economy was first coined in 1978 which provides us with an opportunity to explore new sources of income. Smart use of resources may be justified as an initiative to reduce the problem of scarcity. The concept of borrowing has existed from a long period in our culture; in borrowing, we take and use something that belongs to someone else and return it in specified time. The concept of sharing is an extension to the concept of borrowing in which people with mutual needs come together to fulfil their wants and demands but at a certain amount which benefits both the peers eventually, wherein the lender charges an amount for the goods or services being shared and the borrower gets the benefits of the goods or services without purchasing the product or services. Sharing can be helpful in many aspects like.

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1. **Recycle, Reuse and Repurpose**: Generally, people own cars, properties and gadgets which at one point or the other, becomes an article of less use or no use. With the concept of sharing economy, private owners can offer their vehicles, properties and gadgets to others for a fee. Things that are kept idle with someone can be useful to others.
2. **Decreasing Environmental Effects**: Carbon footprint is increasing day by day due to immense production of goods by artificial means. However, the concept of sharing can be helpful as it reduces the need of new goods and focuses on reusing the existing goods and also helps to curb other means of environmental degradation like air pollution, wastage, sound pollution, etc.
3. **Accessibility to Self-employment Opportunities**: Sharing goods and services nowadays is done only for exchange of money. So, this mechanism helps to obtain self-employment by letting the products or services.
4. **Reduces Negative Impact**: It helps reducing the negative impact of consumption of resources on environment by minimising the unused or waste value of resources and optimises the use of resources. By sharing, underused capital items can be turned into revenue generating assets.
5. **Reduces Capital Expenditure**: It reduces the capital expenditure by offering an easy and convenient access to resources that people want to use but do not want to buy or are not able to buy.
6. **Easy Entry and Exit**: The access to the economy is quick and simple by which an individual can lend its goods or services at a fair price whenever in need and also disrupt it when required.
7. **Secondary Source of Income**: Money being a scarce resource is always demanded by public. No matter how much you earn, you are always in deficit of income. Sharing economy benefits peers to cope up the deficit income or it generates an additional source of income.

However, there are disadvantages of the sharing economy too. These are:

1. **Reduces Large-Scale Business Opportunity**: Opponents of the sharing economy, mostly businesses, find it hard to compete with sharing business as it is way cheaper and cost efficient when compared to regular course of business.
2. **Decrease in Government Revenues**: Sharing economy effects tax collection in large scale as large scale of operations does not take place under one organisation; rather, income is divided among the tiny entrepreneurs who lend their personal assets in exchange of money. India follows a progressive tax structure in which tax increases with increase in income and the taxable income is being distributed among many individuals; the tax collection will eventually decrease. As a result, if an individual's income is less than the income prescribed by government, the individual is not liable to pay tax.
3. **Fraud and scams**: Fraud and scams can arise on behalf of both the parties. Consumers and sellers both can be exploited by each other as both involved in personal assets and monetary transactions. Online buyers of products are exposed to sellers offering inferior quality product, and on the other hand, sellers can also be exploited by consumers with fraudulent intentions.

4. **A New form of Capitalism**: Sharing economy can be referred as 'Access Economy' because it is a online platform for people to access services and products from a peer when needed via an online service providing company, and in the end, these capitalists and middlemen are the ones who benefit the most but not the individuals who offer their services and products through these online platform.
5. **Use of Contract**: Sharing-based companies have often been criticised to enjoy the profits while offloading the risk of their services to the peers (Malhotra and van Alstyne 2014).These companies consider using contracts with allied parties rather than making them employees so that the risk is transferred to the peers.

19.2 Review of Literature

We present here a list of studies available in the literature to substantiate our study. Howells (2006) studied the importance of Internet platforms that are provided by intermediaries who serve as brokers who create a link between seekers and suppliers in exchange of goods and services against money. Belk (2014) opined that sharing economy describes the socio-economic phenomenon of temporary access-based utilisation of consumer goods or services rather than ownership of goods. Web 2.0 enables sharing along with the bidirectional communication and collaboration opportunities to be facilitated mostly via virtual contact. Malhotra and van Alstyne (2014) mention the empowerment of customers as one of the most important ways to encourage sharing which includes train skills, deliver knowledge or to design tools for value creation, because of better-trained freelancers helping them to deliver higher quality and charge more for their work. Sharing-based companies have always enjoyed profits while offloading the risks to the peers.

Cusumano (2015) describes how Internet start-ups form a sharing asset perspective and divided them into four categories like spare time (Task Rabbit, Fiverr) and idle cars to drive (Uber, Lyft), extra rooms (Airbnb, Flipkey) and occasionally used tools and household items (Streetbank, Snap-Goods). There is no specification for shareable product or services; anything can be shared depending on its use. Sach (2015) in his study described that Information Technology allied business model has created the most important dynamic capabilities of a sharing-based company. This approach helps to constantly integrate new technologies with useful resources and make them available to the peers and not deviating too heavily from existing mechanisms.

19.3 Objective of the Study

The study is focused on the evolution of sharing economy and its prospects with information technology; prime focus has been given to areas like:

1. To justify the emergence of sharing economy through the application of IT and ITES.
2. To understand its significance and drawbacks towards economy.
3. To show the sectors in which sharing has growth and potentials.

19.4 Methodology

The study is a deliberate effort to recognise the evolution of sharing economy throughout the globe via collection of secondary data from various articles, research works and Websites. An attempt has been made to evaluate the sharing economy in respect to Indian scenario by the information available in the public domain. The emergence of sharing economy is a recent concept which makes it very difficult to track the developments and restricts the scope of primary database research work. Sharing has grown in different sectors like vacation stays, office space, travel sharing, finance, etc.

19.4.1 Conceptual Framework

Well no economy is clean, every economic system has its pros and cons. The sharing economy has been accepted globally and has gained momentum through the years. The cons of the sharing economy can be diluted via developmental efforts of government. Whatever may be the consequences there, one cannot stop the developmental change and technology will continue to evolve. What if, suddenly people get an opportunity to earn more from the existing cars, houses and manufacturing plants they already own? The answer to the question is quiet obvious; it will lead to extra revenue generation of individuals. That is exactly what is happening to people who are sharing some of the idle time assets to other individuals. It increases the supply side of the economy with the existing resources. Getting better use out of idle resources provides a large boost for economies running short of labour, tightly built urban centres that lack prime space to expand the existing buildings and consumers and other buyers who worry about the prospects of rising prices. This is just the beginning of an new era in which people share things with individuals who are in need but do not want to invest huge amounts in purchasing those goods or services. The emergence of sharing has been triggered by Internet and smart phone technology. The term sharing economy describes the socio-economic phenomenon of temporary, not ownership but access-based utilisation of consumer goods or services (Belk 2014). The number of Internet users in India is expected to reach 500 million by June 2018, as reported by the Internet and Mobile Association of India (IAMAI) and Kantar IMRB. In December 2017, the number of Internet users stood at 481 million, which represents an increase of 11.34% over December 2016 as mentioned in the report titled, ‘Internet in India 2017’. Urban India has an estimated population of 455 million and has reached a remarkable position in which approximately 65% people are using the Internet. Rural India had an estimated population of 918 million according to 2011 census, consisting of only 186 million Internet users which are roughly above 20% of the total rural population. By taking advantage of Internet along with technology and bridging the digital divide that exists between urban and rural India, sharing economy can achieve new heights (Howells 2006). IT user aligned business model innovation to be one of the most important dynamic capabilities of a sharing-based company (Sach 2015).The mechanism of sharing economy can be described by the following flow Table 19.1. It can be observed here the peer sharing concept depends a lot on the IT and ITES. Through IT and ITES, a relationship between the supply of peers and demand of peers can be established.

India is the leading sourcing destination acquiring 55% of the market share in global services sourcing business 2017–18. The fruitfulness of highly qualified technical graduates of computer science or information technology has led to the emergence of a developed market to offer to the world. Indian IT industry contributed 7.7% to the country's GDP and is simultaneously contributing towards employment status to millions of people each year. The industry has noticed gradual increase in every single previous year, and the total market consists of domestic revenue and export revenue. Export market of IT was preferred from the very beginning in India for its low cost, and the market showed continuous increment over the years, as represented in Table 19.1. Indian software product industries have set up over 1000 global delivery centres in more than 80 countries throughout the world. For sharing economy start-ups, the most important area of information technology is Social, Mobility, Analytics and Cloud (SMAC); it helps to digitise the business model according to the needs of the business. As sharing was always a part of the economy but proper recognition of sharing was limited due to availability of information, information technology has bridged the traditional gap via modern technology and SMAC is a major contributor for the development of sharing start-ups.

Table 19.1 Sharing economy and various Indian players operating in this market segment

Area of sharing	Indian players in the market
Vacation stays	Stayzilla, Safron Stays and TripVillas
Room rentals	Nestaway, Ziffy Homes, CoHo, Fella Homes, Grabhouse, GetSetHome and Homigo
Office space	91Springboard, Innov8 and BHIVE Workspace
Transportation	Ola share, Uber pool and Zoomcar Associate Programme, (ZAP)
Finance	LendingClub, Faircent, i2iLending, LenDenClub, Lendbox, etc
Appliances	GuaRented, Rentomojo, Furlenco, Zilok, Neighborgood, Rentsher, etc.
Odd jobs	DriveU, Freelancer, E-Lancer and Taskr
Domestic animal carers	Waggle

Source: Data collected by authors from corporate electronic disclosures and various search engines

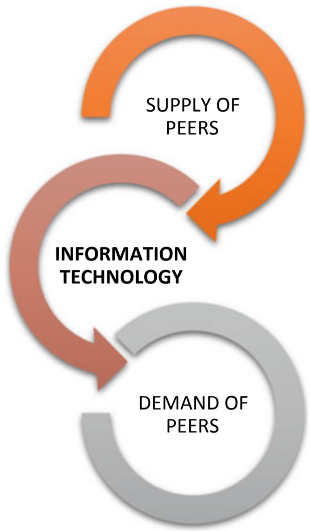
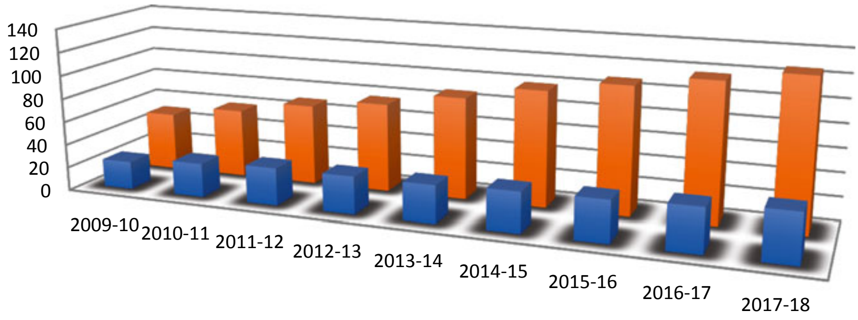


Fig. 19.1 Sharing economy mechanism through information technology and information technology-enabled services. *Source* Authors' created

From Fig. 19.2, it can be observed that Indian IT & ITES had a steady market growth rate over the years both in terms of domestic market and offshore operations. The growth of this industry segment reached to pinnacle in 2017–18 thanks to positive regulatory support and continuous flow of skilled talent workforce. One of the major emergences in IT & ITES-based activities can be observed in terms of growing start-ups in various sharing economy market segments. Start-ups in India are highly supported by information technology industry. Nearly, 5200 start-ups are being backboned by IT industry. The expanding economy along with low cost advantage is the reason for enormous growth of information technology in India. Governmental support has also been an influencing factor in which tax exemption of three years is provided in a block of seven years to start-ups under 'Startup India' along with liberal policies for raising global capital, funding the business and ease of doing business. The Indian government has adopted a friendly infrastructure to digitalise the economy and henceforth enhancing the start-ups by providing them a ready market and easy access to information technology and information technology-enabled services.

Vacation Stays: Letting house property is in practice for a long period, but the use of information technology can trigger the utilisation out of idle property. This opportunity has led to many start-ups who act as middlemen in connecting interested peers. Sharing has pros for individual but is problematic to the economy as well. The hotel owners are compelled to pay licence fees, income tax, safety & regulatory stipulations, etc., whereas many start-ups are exempt from such requirements. These loopholes are to be recognised by the government or local municipality to impose tax or safety measures on a peer-to-peer service. While a business is more concerned about its customers, follows systematic procedures, provides specialised services and



	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
DOMESTIC	24	29	32	32	32	34	35	37	41
EXPORT	50	59	69	76	87	98.5	108	117	126

Fig. 19.2 Market size of IT Industry in India (US$ billions). *Source* www.ibef.org

many more, the sharing concept is restricted to basic services for basic fees. Indian start-ups like Stayzilla, Safron Stays, and TripVillas are pure-play vacation or short-term rental portals that creates a link between peers. These companies with the help of information technology upliftthe sharing economy without which the economy would have been concentrated to a small segment of the market. The tenant can be provided with auxiliaries by the landlord, but these auxiliaries come at an additional price. In extension to these vacation stay services, the much-needed room rental services have also gained popularity via sharing. Companies like Nestaway, Ziffy Homes, CoHo, Fella Homes, Grabhouse, GetSetHome and Homigo allow individual member to rent out a single bed or full room in a fully furnished house against a monthly fee per bed or per room. The tenants are provided with facilities like furniture, Wi-Fi, electricity, gas, water, etc.For availing facilities outside the room, one has to pay additional charges. This rental service provides a finished product which can be used instantly on only one condition of paying a security deposit of 2–3 time the monthly rental. Currently, start-ups are focusing on information technology-enabled services to connect these peers and generate revenue for the company and the landlord with pocket friendly rates for customers.

Shared Economy Office Space: The concept of sharing can be extended to professional workspaces in which the same concept of sharing can be achieved but not room sharing rather sharing offices in the same building. Emergence of start-ups has helped these concepts to achieve new heights by interlinking peers or businesses who are in need of office space and are willing to work in collaborative workspaces which offer a plug & play experience with all required amenities that are readily available. These dealings can be made offline, but information technology enhances the opportunities in connecting the peers. The best use of these collaborative workspaces is made by start-ups, freelancers, small & medium enterprises and even few MNC's. Indian players like 91Springboard, Innov8 and BHIVE Workspace are successfully working in this sector. Owning a whole building may be not necessary, so why not make optimal use by sharing floor spare with required personal. There is a clear Win–Win for both parties.

Shared Economy Transportation: Most of the private cars stays idle but can be optimally utilised by letting for a fee or rent in which a vehicle owner enrols himself on a platform to offer peers a ride from a particular point to an end destination, when that person along with his/her vehicle is available. The additional requirements for these services are GPS mapping technology to provide location detection & routing algorithms and registration in an information technology start-up that provides these services. We cannot consider Ola or Uber as a part of sharing economy, but these services consist of significant part which shares rides with peers travelling in same direction; again, the possibility is made reality by IT services in which software connects the peers in need of a ride. Ola share and Uber pool have been successfully conducting these share rides. Each and every sharing services and products do affect the business sector directly. The motive of business is missing in sharing economy as individuals are in a motive to earn an extra income out of fixed resources. If a company earns profit, it is liable to pay, but individuals having seasonal income may not be liable to pay tax. Zoomcar launched the Zoomcar Associate Programme, (ZAP), a true peer-to-peer car-lending scheme. In the Zap scheme, a person who wishes to buy a new car/upgrade their old car can do so in partnership with Zoomcar. ZAP enables the participants to register their new car on the Zoomcar platform whenever they want and solicit bookings from the customer base of Zoomcar. Zoomcar also installs on-board diagnostic monitoring tools and has an innovative locking mechanism using smart phones, eliminating the need for physical keys.

Shared Economy Finance: Considering all sectors, the need for peer-to-peer lending can be felt. Connecting potential lenders with borrowers through use of information technology services can reduce the cost overheads, and the same benefits can be passed to the users. These loans have no collateral security which makes them unsecured loans. The system follows a free flow of demand and supply mechanism in which equilibrium is achieved at a situation where the lender and the borrower agree on same interest rate. The lender tends to earn a higher rate of interest, while the borrower tends to secure a loan at a lower rate; thus, the system ends up being mutually beneficial for both borrowers and lenders. The system is not fully developed in India as there is no mechanism for reducing the risk. The only way to reduce risk is by mortgaging some valuable asset against the loan. But the commercial banks are also in the same business at huge scale. So, this segment suffers from cons of its own kind. Information technology-enabled services like credit rating of borrowers are to be included in the system to make it more effective and worthy. Some of the prominent names in the space including LendingClub, Faircent, i2iLending, LenDenClub, Lendbox, etc., are operating in the market currently, but these models of lending are exposed to default risks of unknown borrower.

Shared Economy Appliance Rentals: This strategy of letting out common household items like TVs, washing machines, dryers, vacuum cleaners, beds, furniture items, etc., opens up new dimension of renting items which can be used without owning them. Sharing in true sense can unlock a whole new world of opportunities in which no new products are being purchased but the old products are being used. Some companies like GuaRented, Rentomojo, Furlenco, Zilok, Neighborgood, Rentsher, etc., allow people to upload unused items and enable them to rent it out on a digital platform for a small percentage of the rent. The same goes for clothing in which you can borrow or rent wardrobe. Instead of buying costly designer clothes, why not rent them. This enables the interested parties to use the latest fashion without investing huge amounts. Every sharing economy has the limitation of peers, and these peers are the ones who can either create or uplift the economy or can diminish the economy by mishandling or unprotected use of the product. Prominent start-ups in this space include Rent the Runway, Stage 3, StyleBank, Flont, Swishlist, Rent A Closet CandidKnots & HiFlame14 provide clothes on rental both for men & women. , whereas start-ups like Klosetedit, Coutloot, Zapyle, Elanic, Spoylare using a different strategy allow people to buy or sell pre-owned garments and fashion accessories through an online platform.

Shared Economy Odd Jobs: People are so busy these days that they do not have time for odd jobs like cleaning, lawn-mowing, moving in, painting, delivery, handyman work, etc. So, they prefer hiring semiskilled or unskilled personal at low day or hourly rates via an information technology start-up (Manyika et al. 2015). TaskRabbit is one of the oldest in the sharing economy platform which was launched in 2008 and revolutionised the sector. The start-ups in this space connect people who are available for part time work to people who need men for these jobs. The dresses for any special occasion can also be rented from local individuals at minimum cost and then returned. The closest form of job sharing in India is DriveUwhich only offers drivers for hire, while sites like freelancer, E-lancer and Taskr allow freelancers to enrol themselves or bid for projects that are more technical and requires skills like coding, graphic design, tax or business consulting, marketing, etc. These skilled work forces can be self-dependent by doing work of others and get remunerated for completing the job. This helps the job provider by saving the fixed costs involved in buying computers hiring skilled personnel, providing them salary, etc. Urban clap has started its successful journey in India by providing services like AC services, salon at home, appliance repair services, etc. It is a solution for odd jobs with the help of experts via Internet services without heavy investments.

Shared Economy Domestic Animal Carers: Pets become an integral part of the family and are needed to be taken care of when the owners are away on vacation or work. There are start-ups that offer the same services of caretaking the pets when their owners are away on vacation/work. The urge of information technology-enabled services can be felt in this segment also to connect the pet owners with this kind of service providers as in today’s world of technology, it is not possible to physically find these services. Waggle performs the same activities in India for fees. This proves that sharing can fulfil the basic needs on a temporary basis depending on the usage rate.

19.5 Concluding Remarks

Sharing is a short-term procedure in which interested parties come together to meet their temporary demands not by purchasing them but by renting them. Information technology eliminates the information gap between peers by creating a link among them. The first requirement is money which can be borrowed from a peer-to-peer borrowing network at cheap rates. The next move can be domestic animal carriers which is also a part of sharing economy. The third requirement maybe a car which can be borrowed on rent from the locals on a rental basis, and the fixed cost of buying a car can be avoided; the next comes the part of stay. Staring with vacation stays which are again for short time, one does not need to own an house or rent it from a business; rather, the individual is provided with a cheap alternative of sharing with the local landlords who provides home stay at relatively low prices. In the following Table 19.1, various Indian players operating in the sharing economy market segment like vacation stays, room rentals, office space, transportation, finance, appliances, odd jobs and domestic animal carers had been furnished. It can be mentioned that all these sharing economy-based business organisations depend exclusively on both dedicated mobile app based services and computer-based applications.

19.5.1 Limitations of the Study

- The study is an introspective conceptual study conducted on the secondary data available in different Websites and articles. Future study can be conducted by collection of primary data.
- The study is conducted on secondary data so the accuracy and authenticity needs to be validated in real field.
- The introduction of sharing economy with respect to Internet is a recent concept, which has future aspects, and currently, very few authentic information are available.

19.5.2 Epilogue

Sharing economy trends have inspired individuals to involve in the idea of reuse rather than ownership. Purchasing an asset involves huge capital expenditure which may not be useful frequently, so sharing can be a better way to maximise utilisation out of given resources. Share economics has benefited a huge sector by cost savings but also disrupted businesses and reduced governmental revenue. Sharing creates a perfect balance of monetary benefits & usage planning which benefits both the parties. The benefits of sharing are short term and have scope for further improvements, but sharing cannot be coined successful in long run and continuous consumption situations. Sharing in large scale is only possible due to continuous support of IT

Industry which expanded the market area of sharing by connecting peers on a global scale. The most important flaw is trust, unless until trust exists among both the peers the process of sharing cannot be completed. Peers of sharing economy are the makers of this economy as considerable factors like values, ethics, help and support will contribute to a better economy and economic conditions.

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Chapter 20
Automation in Manufacturing: The Effects on Formal and Informal Sectors

Mainak Bhattacharjee and Jayeeta Roy Chowdhury

20.1 Introduction

The world economic structure has been shaped over the last two centuries by three large-scale industrial revolutions, spanning all the way from establishment of industry as the foundation for an economy to technological advancements benefitting mass production. Yet, a fourth revolution is already underway which seeks to change the very face of the industrial landscape. This has been made possible through a continuum of innovations that have yielded automation, artificial intelligence (AI), machine learning and others as critical inputs to the production process. Robotic and digital production of goods and services coupled with AI and machine learning are now prepared to take over routine and repetitive tasks, which makes multitudes of jobs at risk. Many analysts have estimated a significant reduction in the workload, indicating the requirement of restructuring the labour market. According to the Geneva-based World Economic Forum, machines could force 75 million people out of jobs as early as 2022. Foxconn,[1] a leading smartphone manufacturer, for example, has already replaced 60,000 factory workers with robots as of 2016, with more such initiatives in the pipeline. While manufacturing is an obvious destination for the newly crafted cutting-edge technologies like automation, many other sectors like logistics and supply chain, retail, transport, healthcare etc., are also very likely to bear the brunt of these changes. Thus, automation in industries is being greatly

[1]Foxconn replaces "60,000 factory workers with robots"—BBC News Article by Jane Wakefield. Available at https://www.bbc.com/news/technology-36376966.

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feared by many on account of its potential to displace workers and create long-term changes. The pro-automation commentators however point out massive productivity gains along with possibilities of creation of new job opportunities. The onset of the race between technology and manpower thereby throws open a research dimension that has to be explored, complying with the dynamic nature of this revolution.

In the present chapter, we seek to capture the effects of automation in manufacturing on the related labour market, along the lines of formal and informal sectors. Automation is capital-intensive, intensive to highly skilled workers and overall, labour-saving in nature. The rise in automation in industries together with fall in employment in the formal sector is likely to create spill-overs of displaced workers into the informal sector. In other words, the new wave of IT and ITES in production technology will lead to further aggravation of informalization. The expansion of informal sector under the added pressure from the needs to absorb the displaced workforce will certainly have broader implications for income inequality. Our task consists of building a theoretical model that will allow us to ascertain whether the increasing use of IT and ITES with automation in manufacturing will contribute to reduction in wages and employment and hence, a greater divide between the formal and informal sectors or usher in a“creative destruction” that will eventually add new jobs in the economy through productivity gains and cost-saving effect.

20.2 Literature Review

There are mainly two distinct strands of literature as far as the rise of automation and its welfare implications are concerned. One outlines clearly the gains from the technical progress. Such works mention that according to historical evidence, technical progress raises the number of jobs on the balance. It is true that in spite of being uncertainty provoking in nature, automation over decades and centuries has not wiped out the majority of jobs. Automation indeed substitute for labour, as it is typically expected to do, but it also complements skilled labour, raises output in ways that leads to higher demand for labour, and interacts with adjustments in labour supply (Autor 2015). On the other hand, a large number of studies show a grimmer picture of the changes in the labour market that will accompany the increasing use of automation. One can find suggestions of certain economic policies and actions that can cushion these changes, such as correcting the disproportionally high tax burden on labour in relation to other factors, provisions of qualifications through the education and training system required for the digital era, aggregate demand management to create economic conditions that facilitate transition from one job to another and finally, use of suitable competition policy and design of income distribution to ensure that the benefits of industrial automation will not be enjoyed by only few individuals (Tichy 2016). We give a brief account of the research conducted in the context of automation and its implications for employment of the factors below.

Eden and Gaggl (2015) hint at large effects of information and communication technology on the income distribution within labour. They establish that the rise in income share of information and communication technology accounts for half of the decline in labour income share in USA. This decline further consists of a sharp fall in the income share of "routine" labour, i.e. those more prone to automation and a milder increase in that of the non-routine share.

Fuei (2017) examines the susceptibility of jobs to computerization and automation in Singapore and finds that one-quarter of Singaporean employment is at high risk of computerization. This places the country as having one of the lowest proportions of jobs under high risk internationally. Within the high risk category of workers, a significant number of them have non-tertiary educational qualification and tend to be older adults, making them less likely to be re-employed, if they lose their jobs.

Nakamura and Zeira (2018) use a task-based model in which automation leads to a continuous addition of new labour tasks. They assume that all new tasks and automation innovations are adopted and that labour share does not converge to zero in the long run. They find that given such restrictions, unemployment due to automation is expected to converge to zero over time.

Acemoglu and Restrepo (2018a) summarize a framework for studying the implications of automation and artificial intelligence (AI) on the demand for labour and employment. They show that automation creates a displacement effect as machines and AI replace labour in their tasks, but is counteracted by productivity effect resulting from cost-savings generated by automation. The framework also highlights that mismatch between the skill requirements of new technology and the possibility that automation is being introduced at an excessive rate are some constraints and imperfections that slow down the adjustments of the economy and the labour market to automation. They also observe (Acemoglu and Restrepo 2018b) that modelling automation as factor-augmenting technological change has unappealing implications and that it should be correctly modelled as a process of replacing tasks previously performed by labour. This is more realistic because, in contrast to factor-augmenting technological change, the automation of tasks always reduces the labour share and can reduce the equilibrium wage. The authors have also considered the response of technology to demographic change (Acemoglu and Restrepo 2018c). They argue theoretically and document empirically that aging leads to greater industrial automation and to more intensive use and development of robots. The supporting US data shows that indeed the robots substitute for middle-aged workers. A demographic change measured as increase in the ratio of older to middle-aged workers is associated with greater adoption of robots and other automation technologies across countries.

Autor and Salomons (2018) outline the various channels through which automation impacts labour's share of output and empirically estimates the employment and labour share impacts of productivity growth using data on 28 industries for 18 OECD countries since 1970. Their primary observation is that although automation has not been employment-displacing, it has reduced labour's share in value-added. Their estimates highlight that labour share-displacing effects of productivity growth have become more pronounced over time, largely because of a weakening wage response.

Dinlersoz and Wolf (2018) provide evidence based on US Census Bureau's Survey of Manufacturing Technology, which indicates that more automated establishments have lower production labour share and higher capital share, and a smaller fraction of workers in production who receive higher wages. Such establishments also have higher labour productivity and experience larger long-term labour share declines. The relationship between automation and relative factor usage is modelled using CES production function with endogenous technology choice.

Berg et al. (2018) note that "robot" capital is distinct from traditional capital in its degree of substitutability with human labour. They analyse a range of variants that reflect widely different views of how automation may transform the labour market. The main results indicate that automation is good for growth but bad for equality. This is seen in terms of a benchmark model, in which the real wages fall in the short run and eventually rise, but "eventually" can easily take generations.

Zhang (2019) studies how automation affects the skilled–unskilled wage gap and whether robots should be taxed, within a specific-factor framework. This shows that acceleration in automation generates displacement effect and capital-reallocation effect. The interaction between these two effects along with the elasticity of substitution has consequences for the wage gap. Hitherto, a tax on robots will unambiguously narrow down the wage gap.

20.3 Objective

The purpose of this chapter is to examine if an increase in the use of automation triggers informalization in the manufacturing sector and its consequences for wage inequality.

20.4 Basic Model

We consider a closed economy which has two distinct types of manufacturing sectors: a formal manufacturing sector (denoted by X), and an informal manufacturing sector (denoted by Y). Automation technology is generated by an independent sector (Z). Sector Z is dominated by few large firms that can bear the large cost of R&D. Therefore, sector Z enjoys monopoly power over its innovations. This automation-powered technology is adopted only by the formal manufacturing sector (sector X). Automation in sector X can be gauged only through the changes in relative factor intensity.

There are two categories of capital—one is specific to sector Z and the other is competitively allocated between sectors X and Y; i.e. $K = K_Z + \tilde{K}$ where, $K =$ total capital endowment of the economy; $K_Z =$ capital specific to the Z sector; and, $\tilde{K} =$ capital competed by formal and informal manufacturing sectors.

Similarly, labour is also categorized as low-skill labour (L_w) and high-skill labour (L_h). Low-skill labour is competitively allocated between sectors X and Y, while the high-skill labour is specific to sector Z only. Thus, $L = L_w + L_h$ where, L is the total labour endowment in the economy.

The wage of the low-skill labour is institutionally given in the formal manufacturing sector (i.e. in sector X) as $w*$, while that of the low-skill labour in the informal manufacturing sector (i.e. sector Y) is determined by market forces of labour demand and supply. Let the informal wage be denoted by w. The wage of the high-skill labour is also institutionally fixed but at a level higher than $w*$ (say, $\overline{w_h}= 1$).

The rental price of capital is fixed (say, $\overline{r_z}$) for K_Z while that of $\tilde{K}$ is determined from market (say, r).

Production technologies in both X and Y sectors exhibit CRS. Broadly, the production functions of the three sectors are:

$$X = X\left(\tilde{K}, L_w\right)$$

$$Y = Y\left(\tilde{K}, L_w\right)$$

$$Z = Z(K_Z, L_h)$$

With CRS, total factor demands are given by the product of the factor coefficients and the levels of output. The requirement that all factors are fully employed is given by the following equations:

$$a_{L_wX}.X + a_{L_wY}.Y + a_{L_hZ}.Z = L \tag{20.1}$$

$$a_{\tilde{K}X}.X + a_{\tilde{K}Y}.Y + a_{K_ZZ}.Z = K \tag{20.2}$$

where a's are the factor coefficients or the per unit factor requirements in the different sectors.

Let A denote the degree of automation. An increase in A in formal manufacturing augments the capital intensity of production and undermines the labour intensity of production in sector X. In other words, the very nature of automation is to raise the intensity of capital relative to labour in the production process.

So, we can write:

$$a_{\tilde{K}X} = a_{\tilde{K}X}(A); a_{L_wX} = a_{L_wX}(A) \tag{20.3}$$

Thus, $\frac{a_{\tilde{K}X}(A)}{a_{L_wX}(A)}$ = relative capital intensity in sector X.

Let the unit prices of output in the three sectors be P_X, P_Y, P_Z, respectively.

Since, sector Z or the automation-generating sector is monopolistic in nature, it sets its price using a fixed mark-up:

$$P_Z = a_{L_h Z}.(1 + m_z) \tag{20.4}$$

where m_z is the fixed mark-up that covers the fixed cost (containing the cost on capital K_Z) and allows a profit margin.

Since the factor coefficient $a_{L_h Z}$ is taken as constant, the price P_Z is thus constant.

The two manufacturing sectors—formal (X) and informal (Y)—produce commodities that are substitutes economically but not technologically. There is heterogeneity in the production of X and Y sectors in the sense that X-sector produces high-end variety goods while Y-sector produces low-end variety goods. Furthermore, the average costs between the two sectors differ. So, the prices ($P_X$and P_Y) are different. Moreover, invoking the Walras Law, it can be said that if market for one sector clears, then that for the other sector also clears.

In a competitive equilibrium, unit costs must reflect market prices:

$$P_X = a_{\tilde{K}X}.r + a_{L_w X}.w* \tag{20.5}$$

$$P_Y = a_{\tilde{K}Y}.r + a_{L_w Y}.w \tag{20.6}$$

In sector X, the wage cost is given by$w * .(a_{L_w X}.X)$, where $w*$ is fixed and the capital cost is$r.(a_{\tilde{K}X}.X)$. So, the relative wage cost can be written as $\frac{w*.a_{L_w X}(A)}{r.a_{\tilde{K}X}(A)}$. Thus, when the capital intensity rises in the formal sector, the relative wage cost tends to fall and the low-skill labour L_w is released from sector X. This released labour migrates to the informal sector (Y) where now arises an excess supply of low-skill labour. This excess supply is cleared through the wage adjustment in the informal sector which implies that the market determined informal wage w falls. And, the formal–informal wage ratio $\left(\frac{w*}{w}\right)$ increases.

The release of labour from the formal sector is matched by an equal increase in the intake of capital as automation enhances the relative capital intensity. Additional capital required by the formal sector (X) is released by the informal sector (Y) (where the latter is now required to embody more low-skill labour in every unit of production). So, the rental rate on capital remains unchanged. From the price Eqs. (20.5) and (20.6), we find the formal sector price P_X remains unchanged whereas the informal sector price declines P_Y, if we assume the fall in wage w to be sharper than the rise in per unit labour embodiment $a_{L_w Y}$. So, there occurs an increase in the price ratio $\left(\frac{P_X}{P_Y}\right)$. Then, by the price magnification effect, the wage ratio $\left(\frac{w*}{w}\right)$ also rises. That is, we have,

$$\widehat{w*} > \widehat{P_X} > \widehat{P_Y} > \widehat{w}$$

Since $w*$ and P_X remains unchanged, $\widehat{w*} = \widehat{P_X} = 0$.

This implies $0 > \widehat{P_Y} > \widehat{w}$. That is, price of informal sector manufacturing as well as informal sector wage falls, but the informal wage falls more.

Thus, there is a clear indication of wage inequality arising among the low-skill workers due to greater adoption of automation. In particular, the wage inequality intensifies in two stages:

First, the wage gap between formal and informal workers widen due to surplus labour conditions in the informal sector which drives down the informal wage.

And, second, this leads to a fall in the price of informal manufacturing (P_Y) which further accentuates the fall in the informal wage (w) and thus amplifies the prevailing wage inequality between the formal and informal sectors of manufacturing.

Proposition 1 An increase in the use of automation by the formal sector manufacturing causes displacement of formal sector workers which creates pressure on informal manufacturing sector to absorb them. This has the effect of driving down the market-determined wage in the informal sector.

Proposition 2 The higher use of automation entails a social cost in the form of greater inter-sectoral wage inequality.

20.5 Conclusion

Induction of automation as a labour-saving mechanism has notable influence on the labour market related to manufacturing industry. Although generation of automation itself creates job opportunities, understandably such scopes are limited to only highly skilled workers. The full brunt of labour-saving automation is borne by the low-skilled workers. An increase in the use of automation thus releases low-skilled workers from formal manufacturing who thereafter have only one destination, namely the informal manufacturing sector. The added pressure of labour to be absorbed in the informal manufacturing sector drives down the already low informal wage, thus augmenting the wage inequality in the economy. In this way, the inter-sectoral wage gap highlights the welfare cost of automation.

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Chapter 21
Design of Knowledge Base Model for Home Loan: Case Study of a Bank in India

Subhasis Sen and K. Rajagopal

21.1 Introduction

Knowledge-based systems are being developed and deployed globally in wide variety of applications. Knowledge-based system (expert system) is an application of artificial intelligence (AI). AI is a discipline with two major goals, viz. to develop intelligent computer power to supplement power of human brain and to better understand how human beings think, reason and learn. Knowledge base is a vital component of an expert system. It comprises domain, facts and rules of thumb based on experience (Liebowitz 1997). The US recession during 2008–2009 has affected the banks who have failed to understand the numbers since 1930. A study has examined internal factors pertaining to banks and their role in the sound operation of the institutions during 2009. The study explains about how the aspects of the performance related to the institution can be verified using the technology (using decision support technology) specifically for understanding and recognizing the pattern of the data (Moore 2011).

Indian banking system has undergone a total metamorphosis since the introduction of financial sector reforms in 1992. Paytm, India's largest e-payments platform, has partnered with ICICI bank to launch a digital credit facility. The banks are trying to attain international standards and practices. In their pursuit to achieve global standards, public sector banks are facing cut-throat competition from private and

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foreign market players like ICICI, HSBC, Standard Chartered and HDFC owing to low employee productivity, high operational costs and delayed response to change. These problems are mainly targeted to retail banking which covers credit cards, and all other loans. State Bank of India has initiated digital banking programmes like SBI Digi Voucher, SBI Digital Village and other similar such programmes.

Housing sector is recognized as a major vehicle to produce and create wealth, generate employment and earn foreign exchange. Banks are aggressively marketing home loans due to downward movement of interest rates, stable real estate prices, tax concessions by the government, better living and positive mindset of the people towards loan. Government initiatives that are expected to boost the growth of real estate sector are Real Estate Bill, Land Acquisition and Resettlement Bill and Real Estate Investment Trusts. The technological advancement and shortening of the business cycles have boosted the significance of intangible assets, especially knowledge as the critical factor in decision-making for banking industry. On the other hand, as per CMIE Industry Outlook data in India, there has been significant drop in the net worth year-on-year growth of privatized housing finance companies like HDFC, ICICI bank and so on. The year-on-year growth rate of Indian housing market size has been predicted to steadily reduce from 10.3% in 2015–2016 to 6.2% in 2019–2020, whereas a number of households' and housing stock growth indices are showing steady rise of 10.3% from 2012 to 2017 and 10.7% from 2012 to 2017 as per Euromonitor International Research Report 2018. Knowledge-based system is a tool which has got its origin from the artificial intelligence field (Abdullah et al. 2006). Knowledge management provides guidelines to the organizations in terms of how they should extract values from their intellectual assets seeking assistance from both the knowledge and expert systems.

Knowledge building exercise pertaining to an expert system is commonly indicated as knowledge engineering which deals with knowledge elicitation, representation and programming (Duchessi et al. 1988).

Knowledge engineer derives concepts, rules and procedures from experts in knowledge elicitation. In the next step, the engineer interprets knowledge in expert system software. Finally, knowledge engineer develops a system incorporating the changes result from testing. The focus of this research is to study and propose knowledge base prescriptive model for home loan evaluation with respect to a private bank in India. This would enable the financial institutions to expedite home loan process from application to disbursement.

With the steady fall of interest rates and rising property prices in the housing sector, there has been a huge demand for home loans among the citizens especially salaried professionals looking for comfortable living. The banks dealing with home loans in the Indian scenario need to enhance their service quality in order to stay ahead of the competition. There is a need for fast and accurate decision-making in terms of the services rendered to the home-seekers. Keeping the above context in mind, the following objectives have been framed:

1. Study the existing home loan evaluation process of a private bank in India
2. Propose a rule base prescriptive model using knowledge based system with respect to the home loan evaluation.

21.2 Literature Review

The results of a content analysis indicate that there are a large number of studies informing design and development issues related to knowledge-based systems (Santhanam and Elam 1998).

The development of expert systems has enabled banks to apply financial expertise related to problems in specialized fields with respect to loan approval, cross-selling, risk analysis, treasury operations and so on (Chorafas 1987).

The primary job of a loan officer is to decide on the conditions and amount of a loan. As a result, the loan officer has to track the applicant's credit history as well as check previous and current financial status. The nature of the task is repetitive and unstructured. The throughput and accuracy of loans granted can be improved using several credit analysis expert systems (Holsapple et al. 1988). The financial Institutions utilize the knowledge-based system and the neural network systems in order to detect the fraudulent activities related to the credit card, for deriving the credit scoring and also for bond ratings (Tofti and Nikbakht 1993). American Express Bank has introduced Authorizer's Assistant which is designed to evaluate unusual credit requests from cardholders on a real-time basis (Newquist 1987; Piketty 1987). These requests have been evaluated manually with a 15% bad guess rate. With the deployment of Authorizer's Assistant, the rate has dropped significantly to 4%. Even Citibank has developed a rule-based system known as DOLS (Distributed Online System) to process several pension cheques each night.

As per the research findings, it is evident that the expert system application helps in the process of evaluation and interpretation. It also offers the services of making the analysis of the organizational level productivity. This also helps the business managers with minimum understanding of the productivity model who intends to utilize the knowledge-based system for timely identification and correction of the business problems (Rao and Miller 2004).

The research findings by Meyer and Curley (1991) indicate the utilization of the knowledge-based system has grown multi-folded and is being used across a range of industries. There are two complexities that exist in the domain of the expert system, the first one is the knowledge held intact by a very small group of experts. The second dimension of the framework relates to the complexity of the technology. The outcome derived as a result of applying the framework on 50 samples serves as a base for developing hypothesis, time management, budget allocation, staffing and promote organizational participation and exercise organization control. An example of high-knowledge and high-technology system includes Life Underwriting System (LUS) for the insurance applications. New applications are submitted to the expert system, which results in accepts or declines based on medical, financial and other risk factors. Another example of such system is XCON and embodies high levels of both knowledge and technology complexity. The size of the company's product portfolio and the number of components used in the assembly of its products have made XCON a large-scale development effort that is considered by management to be a cornerstone in the firm's ability to deliver customized computer system to every customer.

MARBLE (managing and recommending business loan evaluation) is an expert system that uses decision rules to evaluate commercial loans (Buchanan and Shortliffe 1984). MARBLE has been developed as a model to educate lending officers, loan review committees, audit analysts and students of business applying expert systems to the evaluation of business loans. Syntelligence has an expert system called Loan Advisor that evaluates loan applicants. It is being used by banks globally on an experimental basis. Loan evaluation and advisor expert systems are being developed by several international banks (Shaw and Gentry 1988).

A firm engaged in a cost-plus medical insurance policy can gain better control of expenditures by using a knowledge-based expert system to select a subset of previously paid claims for manual review. The selection process focuses on identifying probable errors in claim payments. Knowledge of medical practices and procedures provides the foundation for detecting errors. Knowledge has been obtained from healthcare professionals and encoded in a rule-based system (Martin and Eckerle 1991).

During 1988 and 1989, a system has been developed to help the South African Navy identify threatening events. The navy has used the system to improve productivity and reduce risk. It is a real-time knowledge-based system with an iterative analysis, design and implementation methodology (Jough et al. 1994).

A research has been aimed to develop a knowledge-based system used for calculating course difficulty and producing appropriate learning strategies for students. The system is based on fuzzy reasoning and attempts to contribute to the personalization of the learning process. The knowledge based system proposed here can yield several benefits for both students and institutions (Novak and OreA ki 2016).

The housing production and finance models implemented by the Housing Development Administration of Turkey (HDAT) and Istanbul Public Housing Corporation (KIPTAS) can be considered as solution to housing problems faced by urban poor in other countries (Gulter and Basti 2014).

21.3 The Role of Knowledge-Based System

An expert system is a computer program that represents and reasons with knowledge of some specialist subject with a view to solve problems or giving advice. Typical tasks of expert system are knowledge acquisition, knowledge representation and application of knowledge. In a study by Zocco (1985), a knowledge -based expert system can enable a bank to have technological edge in loan evaluation. The loan evaluation process is performed by banking officials dealing with computerized system.

Benefits of using such a sophisticated system are credit scoring, automated loan pricing and pre-defined guidelines, application of sensitivity analysis and records of past data. Expert systems technology is derived from the research discipline of artificial intelligence (AI)—a branch of computer science concerned with the design and implementation of programs which area capable of emulating human cognitive skills such as problem-solving, visual perception and language understanding. The conventional architecture of an expert system is shown in Fig. 21.1.

The conventional expert system comprises a knowledge system, an inference engine and a user interface. Inference engine and user interface are software part and does problem processing from users while drawing on available system contents (Holsapple and Whinston 1987). The knowledge system stores application-specific reasoning about a particular domain. Each piece of reasoning knowledge specifies a valid conclusion about a specific situation. The fragmented knowledge is termed as variant of a production rule (Davis et al. 1977). The expert system generally represents the knowledge of an expert through a series of rules. The rule-based system mainly deals with IF conditions and THEN action statements. The knowledge is formulated into operating procedures, codified into routine and rules leading to explicit knowledge and forming a rule-based system (Choo 2000). The set of IF–THEN rules which are used to derive a conclusion is called inference chain. The system moves from condition to condition by interacting with the user. Subset of a rule many a times becomes prime member of the existing rule list or it may become a new rule by itself. The elimination of the rules which are redundant also keeps happening. The experience and domain expertise of the knowledge engineers paves way for designing much better and higher knowledge base efficiently (Christopher et al. 2016).

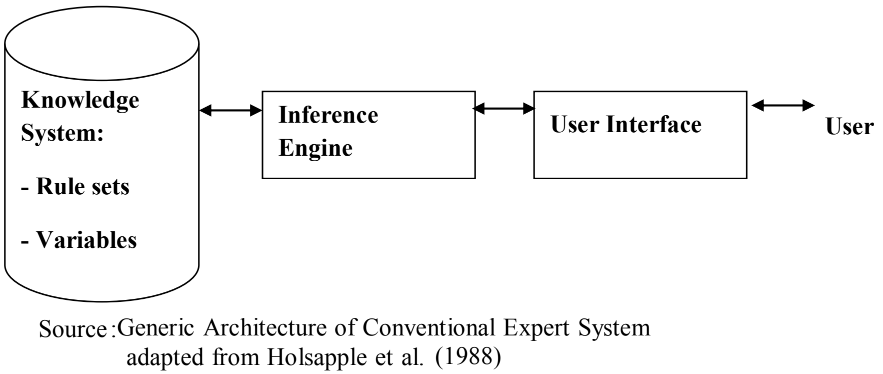

Fig. 21.1 Generic architecture of conventional expert system adapted from Holsapple et al. (1988)

21.4 Methodology

With the help of the knowledge base and the inference engine, the problems are solved through the Knowledge-based systems. The knowledge base refers to the domain specific knowledge and the inference engine holds in it the various functions. The representation of the conditional knowledge is made through the rules and is dependent on the knowledge and its nature (Gottschalk 2016). The study is exploratory in nature and the researchers have made a thorough investigation of the feasibility of a knowledge-based system in home loan evaluation with respect to financial institutions. The qualitative study includes banking operations in relation to home loan sanction to disbursement. In designing the knowledge base model, it has been observed that certain factors aid the managers of banks to take vital decision of a loan approval. The case-based reasoning (CBR) adapted here is a useful knowledge repository for decision-making based on expert opinion for solving new problem (Wang et al. 2008; Choy et al. 2018). Primary data has been collected using in-depth semi-structured interviews (Punch and Oancea 2014) from existing home loan customers, managers, agents and credit processing officers associated with a private bank in India.

21.5 Empirical Results and Discussion

The processing in a rule-based system can react to a dynamic environment.

Existing home loan evaluation Process.

The home loan process mainly operates in two phases—**sanction and disbursement of loan**. **Sanction process** involves the following steps:

- Customer requests for home loan
- Home loan representative visits the client for explanation
- Prospective customer then submits income proof and personal documents
- Validity of documents is checked by credit-processing officers and home loan representative
- Representative then visits or intimates customer about validity of documents given
- Final decision taken on loan sanctioning
- Declaration regarding loan sanctioning along with list of documents required to be submitted by the customer.

21.5.1 Steps to Be Followed with Regard to the Loan Disbursement

- Loan disbursement request from the customer

- Representative visits customer to collect legal documents, loan documents and post-dated cheques for loan repayment duly signed
- Lawyer appointed by bank verifies legal documents
- Site engineer visits property to verify stage of construction
- Legal and technical reports sent to the bank by lawyer and site engineer
- Disbursement cheque for loan issued by bank
- Disbursement cheque delivered by representative.

The applicant or the borrower needs to submit the following documents to the Bank for the Legal and Technical Verification:

- The deeds related to the lease or sale
- Layout plan
- Sanction plan
- Commencement certificate from Municipal Corporation
- NA order which implies the proof of construction being taken place on a non-agricultural land
- Latest 7/12 extract
- Title search report
- Latest agreement
- Registration receipt
- Index-II
- Completion certificate
- No Objection Certificate (NOC) from the builder/society / authority
- Own contribution receipts (OCR)
- Latest tax paid receipts of the applicant.

21.5.2 Knowledge Acquisition Phase

In this phase, transformation of the expertise pertaining to the problem-solving takes place to a program from the knowledge source. It involves observation, interviews, research and introspection. In a survey of 100 existing home loan customers in India, the following major results have been derived (Table 21.1):

Table 21.1 Time taken for home loan processing

	Time taken in days							
	1	2	3	4	5	6	7	More than 7
Number of customers	13	28	25	11	6	3	5	9

Source Data collected from home loan customers

Table 21.2 Automation in home loan process

	Automation required	
	Yes	No
No. of customers in percentage (%)	85	15

Source Data collected from home loan customers

The data shows that there is no specific time frame from loan application to disbursement. It varies from case to case. Delay in the process happens due to non-availability of personal, legal and technical documents on time. In many cases, it has been found lack of proper communication between the loan officer and customer in terms of documentation resulted in delay. Owing to increasing number of home loan applicants, it has been difficult for the bank officials to deliver customer service within 2–3 days. In few cases, loan has been processed in 1 day owing to trustworthiness and credibility of the customer.

Table 21.2 shows majority of the customers are in favour of automation. They are looking for accurate and fast services. Few customers are comfortable with traditional system of home loan evaluation and intend to clarify all their doubts through personal interaction with bank officials.

21.5.3 Knowledge Representation Phase

This phase is defined as the structure of knowledge-based system, and the organization executes declarative and procedural statements obtained from experts in a particular domain. Conventions include rules and frames.

21.5.4 Rule Base Design

The major factors considered by financial institutions for home loan evaluation are the following:

i. Personal verification (PV) of the home loan applicant
ii. Technical verification (TV) of the home loan applicant
iii. Legal verification (LV) of the home loan applicant.

PV includes validity of name, residential address, office address & telephone, mobile, designation through a team of experts appointed as bank agents; validity of documents & eligibility of the application.

TV verifies built-up area as per sanction plan, stage of construction and valuation of property as per market rate.

LV deals with latest agreement, registration receipt, OCR, Index II, NOC from builder, NA order, sanction plan, title search report and completion certificate from government authority.

There are three values assigned against each factor or parameter. They are:

i. PV: Positive–Negative-Partially Positive
ii. TV: Positive–Negative-Partially Positive
iii. LV: Positive–Negative-Partially Positive.

These values are the decision-making elements for granting, denying and pending of home loan. In case of home loan pending, the applicant is intimated about the fact and loan can be granted after further verification and discussion.

The following table shows the goals set for knowledge-base system for home loan evaluation (Table 21.3).

Table 21.3 Few goals for home loan evaluation

Goal No	Goal parameters	Parameter value	Outcome
1	PV	POSITIVE	GRANT HOME LOAN
	TV	POSITIVE	
	LV	POSITIVE	
2	PV	NEGATIVE	DENY HOME LOAN
	TV	NEGATIVE	
	LV	NEGATIVE	
8	PV	POSITIVE	DENY HOME LOAN
	TV	NEGATIVE	
	LV	NEGATIVE	
17	PV	POSITIVE	HOME LOAN PENDING
	TV	POSITIVE	
	LV	PARTIALLY POSITIVE	
24	PV	PARTIALLY POSITIVE	DENY HOME LOAN
	TV	NEGATIVE	
	LV	PARTIALLY POSITIVE	
27	PV	PARTIALLY POSITIVE	HOME LOAN PENDING
	TV	PARTIALLY POSITIVE	
	LV	PARTIALLY POSITIVE	

Source Interviews with home loan managers and agents

Rules are formed based on the above goals. Few instances of rules are given below:

RULE 1: IF PV IS POSITIVE AND TV IS POSITIVE AND LV IS POSITIVE

THEN GOAL 1

RULE 2: IF PV IS NEGATIVE AND TV IS NEGATIVE AND LV IS NEGATIVE

THEN GOAL 2

RULE 8: IF PV ISB POSITIVE AND TV IS NEGATIVE AND LV IS NEGATIVE

THEN GOAL 8

RULE 37: IF BUILT-IP AREA IS NOT AS PER SANCTION PLAN AND STAGE OF CONSTRUCTION > = 90% AND PROPERTY VALUE IS AS PER MARKET VALUE
THEN TV IS PARTIALLY POSITIVE

21.5.5 Discussion

Living aspiration is the key to growth for consumer lending in India. Use of AI in financial space is growing at a great pace and can bring more transparency in the routine process. PV has been the key parameter for home loan sanction as derived from this study. Salaried professionals have enjoyed longer tenure of loan owing to consistency of income over a longer time period as compared to self-employed or business professionals. Growth of mortgages since 2015 is due to leading banks such as HDFC, ICICI, Axis & SBI made the rate of interest fixed for home loans and loan to value ratio has been increased for housing loans by RBI (*Source*:*Consumer Lending in India, Euromonitor International November 2015*). Goals and rules are formulated with expert consent of the managers and home loan agents which would facilitate in decision-making without human intervention. The advantage of knowledge-based system is acquisition and retention of highly satisfied customers by reducing delay in loan evaluation or process and providing quicker and better solution to home buyers.

21.6 Conclusion

The need for knowledge-based systems can be felt in different disciplines like medicine, education, finance and insurance. As it is considered to be a rule base model, benefits of usage include:

i. Transfer of expert knowledge to non-experts. The knowledge is preserved even if an employee of a bank retires or resigns from the organization.

ii. It performs diagnostic as well as prescriptive tasks in providing a solution to home buyer.
iii. The model ensures suitable alternatives to decision-making for both the bankers and home loan applicants.

The study has evaluated home loan process and provided valuable information related to decision-making for the stakeholders associated with home loan, for example, if the applicant wants to know his or her eligibility for loan, the system can able to guide him or her automatically without any human intervention.

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Chapter 22
Role of IT and ITES in the Indian Education Sector

Amit Chatterjee

22.1 Introduction

Knowledge is not only the virtue but an end in itself. Education is the way to acquire knowledge. Through education, human beings acquire newer skills, undergo perception changes, become rational and logical thinkers and are counted as productive labour force. The significant role of human capital in economic growth has been identified by Arrow's learning by doing approach (1962), Mankiw et al. (1992) and other extended works of neoclassical growth models with human capital. Education enhances the quality of human capital, and its spread further catalyses the pace of economic growth and development.

India—once known for '*Vishwa Guru*' status—has witnessed the growth in terms of number of universities from merely 20 in 1947 to 907 March 2019 and colleges from 500 in 1950 to 37,204 February 2017 (as per consolidated list of all universities-UGC dated 31st March 2019). With an annual budgetary allocation of 3.7–4.3% of GDP, the Government of India strives to invest in human capital.

In today's modern era, every nook and corner of our daily lives is affected by the Information and Communication Technology (ICT). Education sector too has been blessed with ICT. The concepts of e-learning, MOOCS, virtual learning, EdTech firms like Byju's and Khan Academy, Internet and mobile penetration, smart classes, satellite classes, cloud learning, have been fancy in the education and learning field during the last two decades. Today, education and learning know no more boundary and are not geographically limited. Streamed online videos and recorded classroom lectures have enabled the learners to learn anything and everything under the sun. Anyone who has a mobile phone and Internet services can access, learn and acquire newer skills. Such technological advancements have not only enhanced the quality

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of human capital and lifelong learning but also have paced up the economic growth for sustainable development.

This chapter is a modest attempt to explore the impact of ICT and IT infrastructures measured by Internet and mobile phone users on enhancing accessibility to education in India during the period from 1990 to 2017. In the last five years, India has experienced a harmonic growth rate of smartphone consumption, which has further being accentuated by the war of the airwaves with the introduction of brand Jio and transmission through optical fibre in telecommunication and Internet. The variables identified are fixed telephone, fixed Internet, mobile communication, secured Internet servers and individual Internet access. The chapter attempts to investigate the impact of these variables on the dependent variable education in India. Education is the explained variable.

The main hypothesis of this study is that growth of India's education sector has been sporadic in the post-reform era but in last decade there has been a positive impact due to IT and ICT infrastructures.

The chapter expands the existing literature in the following ways. First, the chapter establishes a direct link between IT infrastructures and penetration with the access to and level of education attainments in India during the post globalization era, which further extends to economic development. Secondly, the study indicates the immense scope for Internet inclusion and providing economical access to Internet across different states of India for mitigating state-wise disparities in Internet accessibility.

The empirical estimation for this study has been considered with the utmost precaution by incorporating regression models. In order to avoid ambiguity and potential bias in the estimation, all variables have been converted into the natural logarithm. The rest of the chapter is organized as follows. Section 22.2 deals with the literature part of the study. Section 22.3 deals with the empirical estimation and econometric procedure and also discusses the results. Section 22.4 concludes the findings.

22.2 Literature Review and Research Gap

There exists no dearth of literature in the field of evaluating the role of ICT and economic development conducted on countries at different development levels. However, when it comes for India and particularly India's education sector, there is a lacuna of empirical researches. Although it is obvious and macroeconomic studies indicate a direct relationship between IT and economic growth and between education and economic development, there is a gap in terms of analysing economic impacts of penetration, accessibility and usage of educational content. Such a type of research can be counted upon to have an empirically backed research arguing for investing in ICT infrastructures in educational sector.

Presented below is a glimpse of existing literature related to the role of ICT in education sector and further to the overall economic growth.

Authors	Time period	Context	Topics considered	Technique used	Findings
Adonsou (2019)	1993–2015	45 sub-Saharan African countries	Telecommunications infrastructures, economic growth and education	Two-step fixed-effects GMM estimator	In countries that have greater access to education, Internet contributes to economic growth, but mobile phones (with no access to Internet) has bleak contribution to economic growth
Yao (2019)	1990–2008	China	Higher education and productivity	Two-sector general equilibrium model with overlapping generations of households	1% expansion in China's higher education leads to 2.5% detrimental effect on average labour productivity due to crowding effect because of policy distortions
Edquist et al. (2018)	2002–2014	135 countries	Mobile broadband networks for global economic development	Two-stage model	10% increase in mobile broadband adoption leads to a 0.8% increase in GDP
Lobo et al. (2019)	2011–2015	Tennessee, USA	Broadband speed and county unemployment rates	Merging NBM and FCC data	Unemployment rate is 0.26% points lower in counties with high speeds compared to counties with low speeds

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Authors	Time period	Context	Topics considered	Technique used	Findings
Katz and Callorda (2013)	2008–2012	Ecuador	Economic impact of broadband deployment	Two models based on aggregate macroeconomic data	1% increase in penetration, GDP increased by 0.052% annually. Broadband deployment increases average income by 3.67% annually
Asongu et al. (2019)	2004–2014	42 sub-Saharan African countries	Inequality, information technology and inclusive education in sub-Saharan Africa	Generalized method of moments, Gini coefficient, Atkinson index Palma ratio	0.400 and 0.625 are income inequalities to not be exceeded for positive effect of Internet penetration on inclusive education; 0.574, 0.676 and 9.000 are income inequalities beyond which fixed broadband subscriptions would not positively affect inclusive education
Galperin and Ruzzier (2013)	2010	Latin America and Carribean	Price elasticity of demand for broadband	Survey and general analysis of relation	Price reduction of 10% would result in an increase of almost 22% in the penetration rate in LAC
Castellano (2010)	1996–2009	27 EU countries	Determinants of broadband diffusion and supply-side factors	Qualitative comparative analysis (QCA)	High secondary school attainment is a necessary factor for broadband innovator countries

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Authors	Time period	Context	Topics considered	Technique used	Findings
Alfahad (2012)	2012	Kingdom of Saudi Arabia	Effectiveness of using information technology in higher education	Survey model	61.5% of the participants used the electronic device in their course activities 65.8% for blogging, 72% online shopping and 88.6% creating read, send e-mail and instant messages
Kim and Shin (2019)	Korea Innovation Survey 2016' conducted by STEPI	72 logistics firms of South Korea	IT, higher education and R&D	Input-oriented data envelopment analysis with CRS & Kruskal Wallis one-way ANOVA	Higher education institutes and R&D institutes are generally not considered as crucial sources of information for logistics innovation but it could lead to lower innovation efficiency
Al-Rahmi et al. (2019)	2012–2017	Massive open online courses	MOOCs and higher education data	Analysis of descriptive research	The paper stressed on the pivotal role of intention to use, interaction, engagement, motivations and satisfaction in improving the accessibility of MOOCs

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Authors	Time period	Context	Topics considered	Technique used	Findings
Baker et al. (2018)	2018	Australia	Technology in public health higher education	Survey model	96.6% of the students perceive audience response technology as well as streamed and recorded lectures as useful for their learning
Lee et al. (2012)	1975–2006	44 SSA economies	Telecommunications and economic growth	Panel GMM	Mobile phone connection is the significant determinant for economic growth
Czernich et al. (2011)	1996–2007	OECD economies	Broadband infrastructure and economic growth	Instrumental variable model	10% increase in broadband infrastructure leads to 0.9–1.5% increase in economic growth
Arvin and Pradhan (2014)	1998–2011	G-20 economies	Broadband penetration and economic growth	Granger causality model	Short-run bidirectional causality between broadband penetration and economic growth
Levendis and Lee (2013)	1981–2006	29 Asian economies	Telecommunications and economic growth	GMM	Impact of tele-density on economic growth is positive

Source Author's own compilation of previous studies. The overall compilation of earlier literature shows the relation between information infrastructure, economic growth, agriculture productivity, broadband penetration rate and industrial productivity over different economic contexts

22.3 Empirical Estimation and Results Analyses

Before we take up the empirical analysis in terms of quantile and basic regression model, let us have a quick overview of the descriptive statistics of all the variables of our study. In the following table, all the variables have been converted into natural logarithm.

Descriptive statistics

Variable	Mean	S.D	Max	Min
Education	0.422	0.078	0.556	0.311
Fixed telephone	7.360	0.289	7.700	6.705
Fixed Internet	3.935	3.297	7.207	0.000
Mobile phone	6.358	2.346	9.067	0.000
Secure Internet servers	0.377	0.666	2.275	0.000
Individual access to Internet	0.541	0.539	1.549	0.000

Source: Author's own estimation

Mean values of the variables indicate the average percentage change in the concerned parameters during the year 1990–2017. Standard deviation indicates the conventional meaning of resultant change from the actual mean deviation. Maximum and minimum of the variable represent the highest and lowest values of the concerned variables during these periods. In the above table, some of the variables exhibit zero values. It necessarily means that the values of those variables for the concerned year were absent and unreported by the data collection authority. As far as mean variation is concerned, we find that fixed telephone has exhibited the average change of nearly 7% per year in terms of access. It indicates that the distribution and accessibility of fixed telephone line have been increased considerably in recent years. Next to telephone among the infrastructures, mobile phone intensity has seen noticeable change in terms of its average accessibility. The average variations in terms of secured Internet services, accessibility to the Internet services on an individual basis and education have been quite mild. From the maximum point figure, we notice that telephone line and Internet exhibit the greater change in terms of their improvements. Although the education is considered as the explained variable in the further empirical exercise, still we notice from the descriptive statistics that accessibility of education is not uniform and equal across the country. While looking from the minimum point perspectives of Internet, secured Internet servers, individual access to Internet and mobile phone networks, we find that in early 1990s, data for these variables were missing considerably. Hence, these variables exhibit zero values. Other possible reasons could be the low accessibility and new launch of services in few areas, for which data are not readily available.

After discussing the formal descriptive statistics, we look for the empirical analysis in terms of drawing some quantile regressions and basic regression model.

The study analyses the relation among the higher education, fixed telephone, fixed Internet, mobile communication, secured Internet servers and individual access to Internet for India over the time period from 1990 to 2017. By considering this, our empirical equation is described as follows:

$$\mathrm{HIGHEd}_t = \alpha + \beta_1 \mathrm{FT}_t + \beta_2 \mathrm{FI}_t + \beta_3 \mathrm{MC}_t + \beta_4 \mathrm{SIS}_t + \beta_5 \mathrm{IAI}_t + e_t \tag{22.1}$$

In the above empirical equation, HIGHEd_t is the higher education level at the time period t. α is the constant in the equation. Here t refers to the time period from 1990 to 2017. FT_t, FI_t, MC_t, SIS_t, and IAI_t refer to fixed telephone, fixed Internet, mobile communication, secured Internet servers and individual access to Internet for time period t. e_t is the error term of the above equation. Data for the study are considered from various secondary sources. Fixed telephone and fixed Internet are the main ICT infrastructures considered for the analysis. Mobile communication refers to the availability of mobile phones to the individuals.

Empirical model

Education	I	II	III	IV
Fixed telephone	0.022 (0.017)	0.005 (0.005)	0.037 (0.026)	0.081* (0.023)
Fixed Internet	−0.002 (0.001)	−0.001 (0.001)	0.004** (0.002)	0.003* (0.0004)
Mobile communication	0.003* (0.001)	0.005* (0.002)	0.002 (0.002)	−0.000 (0.000)
Secured Internet servers	−0.001 (0.001)	−0.002 (0.002)	0.005 (0.004)	0.009* (0.001)
Individual Internet access	0.137* (0.018)	0.129* (0.023)	0.150* (0.023)	0.129* (0.003)
Constant	0.169 (0.120)	0.278 (0.230)	0.065 (0.063)	−0.228* (0.024)
No of observations	28	28	28	28
R^2	0.899			
Adjusted/pseudo R^2	0.880	0.920	0.930	0.941
Model	Basic OLS	Quantile regression at 25th quantile	Quantile regression at 50th quantile	Quantile regression at 75th quantile

Notes All variables are converted into natural log. Standard errors are given in the parentheses under the values of coefficients. (*), (**) and (***) denote the estimates that are significantly different from zero at 1%, 5% and 10% levels of significance, respectively

In these empirical analyses, education is the explained variable. Fixed telephone and Internet are the main explanatory variables. Rest of the variables are considered as the control variables of the analysis. The main empirical table for the quantile and basic regression is presented as above.

The above empirical table displays some empirical techniques like basic regression and quantile regression models with education being the explained variable. Models I to IV feature basic empirical regression model to quantile regression models at several quantiles. Our empirical estimates suggest that coefficient of fixed telephone is highly positive and significant at the conventional level of significance. It is significant at the higher quantile, which states that development in fixed telephone line especially after 2009 has exhibited positive impact upon the education. Empirically, we notice that every 1% increase in telephone line access leads to 0.081% increase in the education accessibility annually after 2009 (see model IV). Like telephone, we find the noticeable positive and significant impact of Internet service upon education. Especially at the higher quantiles like 50th and 75th, we find that coefficients of fixed Internet are positive and significant at the conventional level of significance. It solely indicates that improvements in Internet services after 2000s have exerted positive impact upon the accessibility of education at large (see models III and IV). However, for mobile communication, we rather find some reverse result of getting significant result at the earlier quantiles, i.e. at 25th. It states that improvements in mobile services after 1995 have impacted education positively. This has also been empirically gained support from the positive and significant association between mobile communication and education at the basic regression level. Most remarkably, we notice that coefficients of individual Internet access have shown positive and significant impact upon education all time across models (see models I to IV). Especially, the basic regression model states that every 1% increase in individual Internet access has impacted education positively by 0.13% annually (see model I). It is even true for all quantile models as well.

22.4 Conclusion

For education in India, information technology infrastructure plays pivotal role in terms of providing easy accessibility of education. Our study is one of the smallest empirical enquiries into this arena stating the relation between education and information technology access in post globalization era. Although our study at various models agrees that information tech infrastructures play notable role, still more space for improvement is needed in terms of uniform and equal accessibility. Especially for the secured Internet servers, it is still a dream for many Indians. For secured Internet services at lower prices, the government at both federal and state levels must initiate plans to establish IT stations and hubs at the rural areas for more Internet access to the poor people at lower prices. Many states, especially in mountains and N-E areas, are still far from reaching good accessible data, for which there exists information inequality and asymmetry in terms of education accessibility across states. Mobile phone density in post globalization era has improved noticeably across states. However, providing safe, fast and cheaper Internet services remains a dream in many inland states as well as inland areas.

Such a mismatch has potentially brought the difference in the quality of education as well as inequality in development pattern. Giving top most priority for the education in the backward states must be the foremost step of government, through which a formal stable growth cycle could be thought of for India in post 2020. Our empirical insight is definitely a miniscule attempt to unravel the potential of information technology upon the education. Still, a lot of scope is there in this field to study further on the potential feasibility of such infrastructure upon the education sector.

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Chapter 23
Significant Role of Infosys BPO Industry in Economic Development of India

Aparna Banerjee

23.1 Introduction

The economic history of outsourcing process could be traced well back during early eighteenth century, at the onset of industrial revolution in developed world, with transfer of manufactured goods to countries of cheap labour force. Later, outsourcing started to reduce cost and regain profits in USA, to control inflation, during 1960s, when US economy hitted with economic stagnation and rising inflation, in terms of heavy job loss. Since then, trend of outsourcing to cheaper locations continued in USA and later started in 1990s in rest of world. After North American Free Trade Agreement (NAFTA) among the USA, Mexico and Canada, outsourcing accelerated along Canadian border, proved to be a significant advantage over America as Canada was best suited to low-cost labour with good English-speaking people, similar to American culture in 2002 (Bowen and Lawler 1992; Cariner 1998).

Initially, in production of auto parts, outsourcing had begun in back office services in cheap cost locations in Europe and Asia of which Asia has proved to be profitable with quality services at cheaper cost, high-end jobs like research and development, product innovations and design.

In 1970s and 1980s, Japanese and American firms Toshiba, Motorola and Texas Instruments moved their production frontier to low-cost locations of Taiwan and Singapore with outsourcing of only manufacturing activities. But, in 1990s, as an impact of liberalization, US companies started their outsourcing offshore facilities, most importantly, in activities of manufacturing, research and designing, information technology (IT) to low-cost locations in India and Philippines (Tom et al. 1997; Wallace et al. 2000).

After flourishing tide of information technology (IT) in the late 1990s and 2000s, outsourcing spread to all IT nations, especially with two Asian giants China and India

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to provide outsourcing services on a large scale to American industries, with opening of top US and European investment banks, starting their offshore outsourcing facilities in low-cost locations like Ireland, Philippines, China, India, Mexico, Australia and Singapore (Johnsi and Nirmala Devi 2004).

However, process in India started during nineteenth century, with outsourcing of services, first, in aviation sector, rapidly followed by IT sector in the late 1990s, with some of notable players in earliest Indian outsourcing market such as Texas Instruments, American Express, Swissair, British Airways and GE offering world class IT software and technology-related services. As a consequence, in wake of globalization of Indian economy, with pooling of investments by MNCs in form of FDI, a new path was also paved by recognition of unemployed mass of English-speaking technologically skilled educated class, which led to profound growth of BPO sector in India (Swadesin and Kalindi 2012).

23.2 Conceptual Framework

The word outsourcing, in economics, literally, means to buy a product or service from outside organization, rather than to produce or provide it within country at least cost advantage at large economies of scale. Outsourcing is composed of two words—"out" and "sourcing". Sourcing refers to act of transferring work, responsibilities and decision rights to someone else defined as an external party. It will be economically futile if any company or any organization will run at a loss solely conducting the administrative task rather than sourcing it to any other organization, costing less in terms of both real (salary) and opportunity (time, attention and effort) costs, which are most important economic determinants in sourcing decision. As no organization is either self-sufficient from demand side, or from supply side with unlimited resources, outsourcing is conducted from cost–benefit analysis, to achieve greater effectiveness at low cost against wastage of valuable resources in pursuit of capabilities, readily purchased from others, external to it (Burgers et al. 2000; Gilmore and Moreland 2000; Houlihan 2001; Prabhakar et al. 1997).

"Business Process Outsourcing" is process of outsourcing in business world with transfer of ownership of a business process by any business organization to a supplier as a contractual service, for business process of company done through any other organization, globally, in order to completely manage, deliver and operate one or more typically IT and ITes business services or functions with sole objective of reduction in cost of services. As a result, it becomes economically beneficial for both outsourcing company and service provider, as it enables outsourcer to reduce costs and increase quality by utilizing their expertise, knowledge skills and competencies of their human resource capital to the optimum in non-core areas of the business services (Gary and Prahalad 2002).

Hence, Business Process Outsourcing can be well defined in words of Mark J. Power as "act of transferring some or all of an organization's recurring internal activities and decision rights to outside providers whether domestic, near shore or offshore as set forth in a contract", for managing corporate change and growth in this new business model (Duening and Click 2005).

The following types of sourcing various economic activities are generally practised across world by business firms such as:

1. Outsourcing service where efficient service provider's expertise is used in handling a particular operation.
2. Insourcing is a unique outsourcing phenomenon where firm makes activity economically more viable by providing this service to other businesses for a revenue consideration after its own interests are satisfactorily attended to.
3. Co-sourcing where host organization or company provides staff or managers to outsourcing organization for better use and utilization of their expertise and skills so that in such a deal, both suppliers and host have onus to supply human resources for success of the outsourced task.
4. Benefit-based relationship where both parties have long-term agreement for outsourced task to share both investments to be made for outsourcing activities and also benefits from its successful implementation (Jones and Jaebeom 1997; Neely et al. 2002; Acey 2002).

Generally, above types of outsourcing of services can be classified into two types, namely technology outsourcing and business process outsourcing. Technology services include e-commerce, networks and software applications and telecommunications website development and hosting. Business process outsourcing includes customer contact, equipment finance, accounting, human resources, logistics procurement, supply chain management and security (NASSCOM Report 2012, https://www.nasscom.org/domestic-itbpo).

23.3 Evolution and Growth of BPO in India

In India, IT and ITes industry can be broadly segmented into IT and ITes software, IT and ITes BPO and Hardware services with BPO market under three functional operations:

1. Business administration (under G&A expense costs) includes GA, finances, HR and payment services.
2. Supply chain management (COGS) includes procurement services, warehousing and inventory services and transportation and logistics services.
3. Sales, marketing and customer care (selling and marketing costs), including diverse services related to customer relation.

A commendable feature of Indian software industry is that its IT and ITES have emerged as key contributor to foreign exchange earnings, in form of revenue generation from 16.7 billion in 2004 to 129.5 billion in 2015–16, with total employment absorption from 0.830 million in 2003–04 to 3.688 million in 2015–16 respectively. This has increased contribution to Indian GDP in form of increased output and employment potential of IT and ITes BPO sector which is currently contributing 9% of India's incremental GDP and per capita GDP contribution of IT–BPO employees over 80 times that of agriculture. IT–BPO industry has created direct employment of 2.2 million and indirect employment of 8 million for the creation of employment for young India. According to the NASSCOM report, by 2020, the IT-BPO industry is expected to account for 10% of India's GDP and 14% of total services sector revenues, with its employment figures between 10 and 20 million, respectively (Joshi 2009; Hussain 2017).

Again, 32% of IT–BPO industry's total workforce, constituted by women in 2014, accounting for 45% of new intake, bridges India's gender divide, with almost 26% of being female chief wage earners and 20% at managerial level or above. By 2020, five million women are expected to join IT–BPO workforce, with Indian IT and ITes likely to grow to about $300 billion by 2020, focusing on areas like e-commerce, software products and IT market (NASSCOM Report 2015, https://www.nasscom.org/domestic-itbpo).

Both global and domestic market attracted major companies in BPO industry like Apple, WNS, Infosys, TCS, Wipro of which Indian market is currently dominated by Genpact, TCS BPO, Wipro BPO, Aegis BPO, WNS Global Services, First source Solutions, IBM Daksh, Aditya Birla Minacs, **Infosys BPO**, Accenture India, HCL BPO, holding major market share of domestic and global business pie (www.businessweek.com). This chapter, therefore, focuses on Infosys BPO because it is only the leading global company, solely engaged in BPO services, to dominate among other giant BPO companies, since its inception, in post millennium years during post globalization period, in the ranking list of top 10 BPO companies, according to the National Association of Software and Service Companies (NASSCOM) Report of 2015. (NASSCOM Report 2015, https://www.nasscom.org/domestic-itbpo). So, the background motivation of this chapter is, therefore, to focus on the case study of the Infosys BPO, in terms of its overall performance in the role of economic development of a developing country, like India, in the context of globalization.

23.4 Impact of BPO on the Indian Economy

There is no doubt that Indian BPO industry is more favourable destination of world, as many countries have outsource units in India acting as major competitors in outsourcing thinking it to be safe and best utilization of their resources. Even developed nations, like USA, have extensive Asian market for outsourcing because of the following main factors acting as the major strengths to many developing nations like that of the Indian BPO sector (Kavitha et al. 2004; Srivastava et al. 2011). To sum up, in terms of economics, from cost-benefit criteria, they are cost competitive, consisting of cost of labour, infrastructure costs and currency exchange rates, labour competitive, consisting of the vast size of the available labour with the largest talent pool of workforce of low cost technically sound, together with possessing greater ability to complete business functions at low wage cost, level of education, domain skills, fluency in English language speaking educated working class and expert in engineering, cultural compatibility to western markets and attrition rates and other factors, comprising of existing business and political risks associated with the country, government favours, attractive flexibility in working hours, geographic location (time difference), tax regime and regulatory considerations such as data security and IPR issues (Hussain and Iqbal 2017) as compared to developed countries.

Another important economic aspect of BPO relates to the moving up of the value chain for the developing economies like India and other countries of Asia. BPO throughout the business world has become both a necessary and sufficient condition in order to survive in this struggle for existence, to get more and more market shares by outsourcing the non-core functions to achieve high-quality results at minimum operational cost along with reduction of manpower quantity just as to satisfy theory of optimization in economic theory (Rucci et al. 1998).

It was in these recessionary times, BPO has offered the recession hit companies in the West a positive way of increasing their profitability and margins, with the welcome of any cost savings objective, so that they can either grow by boosting their revenues or cutting costs or both. During times of economic downturn, it is often the case that companies choose the latter strategy of cutting costs rather than finding it difficult to increase revenues due to the gloomy economic conditions. Hence, the natural, economically right and obvious choice for such an endeavour is the outsourcing of their back office work to companies in developing nations like India and other Asian countries. So, in all the above cases, it is the case that the BPO phenomenon has resulted in net gains for both parties in the exchange, thus, representing a win–win situation for both that outsource their work as clients (developed ones) and for the firms that act as vendors and partners (developing ones) (Joshi 2009), through competitive and comparative advantage, just like a theoretical trade model in economic theory. Here the benefits that accrue to the developing economies such as India and other Asian countries resulted when these economies have played itself out for BPO activities, so as to assure best quality with cost advantage to the developed nations such as Western countries, who have also benefitted, on the other hand, by outsourcing their business operations and back office work by moving up the productivity curve to the former ones.

Finally, the BPO phenomenon has also won in improving the balance of payments of the country like India by adding substantial amount of dollars to its foreign reserves, given the devaluation of Rupee, together with the increase in the competitiveness of the BPO companies. All these above cases, however, indicate shifting of the power to the East, for being a land of mystics to that of powerhouses of manufacturing and services in recent times, as far as competitiveness and efficiency in outsourcing are concerned (Marr and Schiuma 2001; Miciak and Desmanais 2001).

23.5 Issues and Challenges of the BPO Sector

Developed nations like USA have extensive Asian market for outsourcing because of above-mentioned factors. But, as major challenge, BPO sector, in general, needs to face ongoing global economic crisis, like any other sectors of economy. For instance, there has been a twin movement that has manifested itself in way BPO sector of world has been impacted. Perhaps, this is the most complex phenomenon, as the issue to be explained is that, outsourcing, itself, especially, is topic of effect of recession on outsourcing and its effect on the BPO sector in context of both developed (West) and developing nations (East) (Stauss and Mang 1999).

First, there has been a trade-off between many companies of USA and Europe in West who has trimmed their budgets and has reduced their outsourcing exposure significantly, with those who have increased pace of outsourcing. Although, these twin imperatives might seem contradictory and conflicting but there are reasons behind this kind of behaviour. Companies, deciding to curtail outsourcing budgets, have not received assistance from the government, whereas, others, deciding to increase outsourcing, have been supported by government, as a means of cutting costs. Hence, former ones in West have preferred to lay off their employees at home and instead ship jobs overseas for BPO sector in East, as against latter ones, preferring to retain their domestic workforce for their increased pace of outsourcing (Spencer and Spencer 1993).

Secondly, effect of domestic policies on outsourcing phenomenon is another weighing factor that led to greater sufficient circumspection, over outsourcing in home countries, by West, in recession, rather than ship more jobs overseas.

Finally, other than economic factors (recession), political factors, too, such as presidential election year in West or government role of developing nations may also often create greater turbulence, especially, when a presidential election year in USA is generally associated with greater focus on outsourcing. Again, one of major drivers to fabricate to higher degree capacity in outsourcing, generally, has come from government demand as laid down in its national plans that has increased the length and breadth of Indian companies offering in global market (Burns 1995).

23.6 An Overview of Infosys BPO in India

The BPO subsidiary of Infosys Limited, formerly, known as Infosys Technologies Limited, today, being, one of the top among the other BPOs in India, was first incorporated on 3 April, 2002 as “Progeon Limited” and changed to Infosys BPO Limited (“Infosys BPO”), on 29 August, 2006.

The company offers BPO solutions to its global clients by leveraging process, domain and people management expertise, through a scalable, cost-effective and predictable delivery platform by building a deep and wide relationship with their “strategic” acquired clients on whom the company has focussed on over time. It is committed to provide best-in-class services in both horizontal and vertical focus areas. Horizontal (Industry) solutions comprise S&P, various services business platforms such as CS, F&A, AT, LPO, HR, S&F, IS and DBS, and Indian domestic BPO. While vertical (Industry) solutions include financial services and insurance (FSI), manufacturing (MFG), energy and utilities, communication and services (ECS), retail, consumer packaged goods and logistics (RCL) and life sciences and health care (LSH). The total revenue from operations aggregated to Rs. 2940 crore, in 31 March, 2017 from Rs. 2849 crore (by 3.19%) over the previous year, with net profit after tax being 18.78% of revenue in 2017. It started as a 74% and 26% joint venture between Infosys and Citibank Investments, spread its establishments all over world through various acquisitions in the following years. In December 2003, Infosys had acquired Australia-based IT service provider Expert Information Services for $23 million. In 2006, Infosys bought out Citibank's share at a price of Rs. 592 per share, with Citibank's investment at Rs. 0.20 per share. In July 2007, Infosys BPO acquired finance back offices of Royal Philips spread in India, Poland and Thailand for $28 million. In December 2009, Infosys BPO acquired Atlanta-based Mc Camish Systems for about $38 million. In January 2012, Infosys BPO acquired Australia-based Portland Group, providing strategic sourcing and category management services, for about AUD 37 million. In September 2012, Infosys acquired Switzerland-based Lodestone Management Consultants for about $345 million. Infosys BPO (headquarter in Bangalore, operating in Chennai, Gurgaon, Jaipur and Pune in India) has now 87 global software development centres (32 in India) and 69 sales offices (2 in India) operating in Czech Republic, Poland, Mexico, Brazil, USA, China, Philippines, Australia and Costa Rica (www.infosys.com).

23.7 Literature Review

Studies available on existing literature of IT–ITES services can be analysed on various dimensions. For instance, some studies, such as Burgers et al. (2000), Stauss and Mang (1999), Cariner (1998), Rucci et al. (1998), Jones and Jaebeom (1997), Burns (1995) and Bowen and Lawler (1992), mainly reveal the role of this sector from the view point of a customer. They had examined various issues involved in the growth of employee–customer relationship, regarding the nature of the services, the impact of subsequent transaction of satisfaction between the service provider and the customer, with its overall impact on the workers, in general, thereby focussing on several 'intercultural shocks' involved in such "encounters". However, Neely et al. (2002), Spencer (1993) and others had mainly focused on the features of this service, thereby emphasizing on its implications for future research to act as the "models for superior performance". Again, Marr and Schiuma (2001) had considered it as the "Intellectual Capital and Knowledge Assets" for measurement and a prism of management in the "new economy organization" in Bourne, M (ed), Handbook of Performance Measurement, Gee, London. Further elucidate studies of Hussain et al. (2017), Joshi (2009) and very few others, regarding the role of IT–ITES services in the growth of information and tecnology sector with its immense contribution in the economic development in the case studies of India, deserve mention.

Other important studies, such as Acey (2002), Houlihan (2001), Miciak and Desmanais (2001), Gilmore and Moreland (2000), Michell (1998) and Prabhakar et al. (1997), had focused on the history and developmental issues, concerning the growth of the call centres, nature of technology, henceforth, questioning on their "predictivity" of their management services, regarding the maintenance of their service quality, thereby highlighting on various stories of call centres. However, Tom et al. (1997) had examined the role of telecalling in a life of a customer, further, analysing its effect of telephone on customer perception. Moreover, Wallace et al. (2000) recognised the sacrificial role of human resource (HR) strategy in the course of developing and implementing a "customer contact strategy" in call centres.

Besides these, existing literature on BPO either focuses from the generic specific or may be country centric. For instance, Duening et al. (2005), Gary and Prahalad (2002) and others have developed the definitional concept and other essentials of BPO from a theoretical viewpoint, focussing on the implication of its future competence. Again, Kavitha et al. (2004), Srivastava et al. (2011) and others have highlighted the dynamism of the growth of BPO sector, emphasizing both on its positive and negative aspects as an impact on the economic development from the general perspective. While, both Swadesin et al. (2012) and Johnsi et al. (2004) have stressed on the emergence of the growth of BPO in India, but the latter had compared both India and USA in this context, thereby focussing on their overview, trends and future challenges of this sector, both from the viewpoint of a developed as well as that from developing nations.

Apart from these, only data reports of the specific BPO company are found in their respective Annual Reports, together with those of the Confederation of Indian Industry over the years.

The above existing profound literature on IT–ITES services reveals that major attention has been given only to the study of this service and BPO sector, in general, with few literature on BPO, particularly, focussing on the overall growth and performance, and very few (mainly, the Annual Reports) on the specific BPO industry (sector), in the context of both developed and developing countries, specifically, in the context of India. Moreover, our economic literature is enriched with the important studies on IT–ITES services, call centres, BPO sector from the general perspective, focussing on their growth, history and other developmental and functional issues and challenges in their management, with a little or almost no focus on the role of the specific BPO industry (sector), in the economic development from the perspective of its overall performance.

Thus, this chapter searches the above gaps in the extensive profound existing economic literature and primarily focussed on this. Unlike the existing literature (which may have focussed on the study of specific performance, such as financial performance), this chapter deals with the significant role of specific BPO industry in economic development of India, which, so far, has not been dealt in the literature section.

Against the above theoretical backdrop, the above limited existing economic literature has given profound scope to this chapter, therefore, to fill up the above-mentioned gaps in an attempt to trace out the significant role of Infosys BPO industry in the economic development of a developing country, like India, thus, focussing on its overall growth and performance within the business service sector, as an impact of its physical, financial as well as economic performance in the context of economic development, emphasizing on its contribution towards the trade and employment growth of the country.

23.8 Objective of the Study

The main objective of this chapter is, therefore, to analyse the role of Infosys BPO Limited, in terms of its growth performance within the business service sector of India during the period (2006–07 to 2016–17), thereby focussing on its

1. Financial performance, in terms of operating ratio (OR) [i.e. % ratio of operating expenditure (OE) to operating income (OI)], considered as efficiency ratio (ER) of company, with a ratio of 50% to be maximum optimal ER, as a matter of convention (annual report-2017.pdf). So, a lower ER implies its better financial operations or performance.
2. Financial status, in terms of current ratio (CR) or working capital ratio (WCR) [i.e. ratio of its current assets to current liabilities], indicates whether a company has enough short-term assets to cover its short-term debt. A good WCR, usually ranging between 1.2 and 2, indicates a company (CR less than 1) with potential liquidity.
3. Physical performance analysed, in terms of variations in
   (a) Sectoral decomposition of revenues from various economic sectors, in terms of revenue growth by industry
   (b) Geographical distribution of revenues in global scenario, in terms of revenue growth by regions.
4. Role of Infosys BPO in economic development of India, with respect to
   (a) Impact of employee cost on efficiency of its labour utilization. Now, employee cost, consisting of salaries paid to employees in India, includes overseas staff expenses, in terms of billed person (BP) months and non-billed person (NBP) months. Now, employee cost, in terms of % of NBP months, while ratio of BP months to NBP months can be taken as parameter of efficiency of its labour utilization, also known as ER in employment generation. Thus, employee cost assesses its contribution towards employees as well as employment creation. Hence, any decrease in NBP months as compared to BP months may result in improved utilization of its employees, be considered as a proxy variable for greater employment generation within India.

(b) Impact of employee utilization rate, in terms of % of BP months on growth of total revenue (TR), obtained solely from BPO management services, can be measured as a proxy variable for its risk return factor, because a positive risk reward curve is always its desirable objective for its effective management, less severe risks through provision of greater benefits of its outsourcing associated with offshoring, based on its experience and process management skills. In fact, any decline in employee utilization rate, with its negative impact on TR, is considered as its risk factor (Annual Report-2017.pdf). Here TR is considered to assess its solvency, as without growth in sales, it cannot increase its profit and also its market share.

(c) Impact of overall growth performance on profit growth performance (PGP) analysed in terms of profit growth, measured in terms of ratio of its operating profit (OP) to gross profit (GP). Overall growth performance includes:

(i) Productivity performance, in terms of % growth of marketing expenditure (ME) and selling expenditure (SE) in OE.
(ii) Employment growth performance, in terms of % ratio of employment benefit expenditure (EBE) to TR, and
(iii) Economic growth performance, in terms of % of revenues earned from three major economic sectors (FSI, MSG and ECS), being the largest contributor of the revenues.

23.9 Data Source and Methodology

Secondary data from various Annual Reports of Infosys BPO's official website, relating to financial performance and status [Rs. (crores)], physical performance (%), employment expenditure [Rs. (crores)] are collected for the period 2007–17. But employment data on BP months and NBP months are collected for period 2008–09 to 2016–17 due to its non-availability of previous years.

Appropriate econometric and statistical tools such as charts and diagrams (used to study the trend growth of financial performance and status of the company), coefficient of variation (C.V.) (used to study growth of variation in revenues generated from both the various industrial sectors and also from regions across the globe), correlation analysis [correlation coefficient (r)] and multiple regression analysis have been used as methodology. Finally, r and classical linear multiple regression model (CLMRM) are used to study impact of its role in economic development of India during 2007–2017 (Gujrati and Sangeetha 2008).

23.10 Results and Discussion

Role of Infosys BPO in India

Financial Performance of Infosys BPO

Figure 23.1 shows an efficient growth of the company as its OR ranges between above 35–50%, with its maximum optimal efficiency achieved almost 50% during 2011.

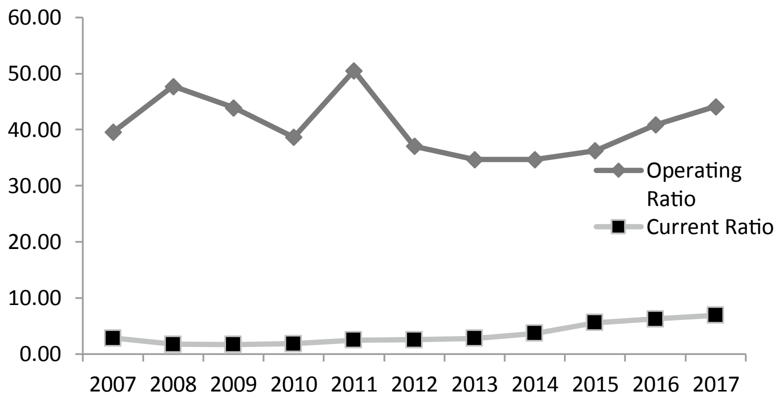
Financial Status of Infosys BPO

Figure 23.1 indicates its potential status in its short-term financial health and also in its operational efficiency position during 2007–17 as its CR, showing a steady rise in its growth trend, ranges between above 1.5 to almost 7.0.

Physical Performance of Infosys BPO

Table 23.1 shows a declining trend in growth of CV of revenues generated from various economic sectors (FSI, MSG, RCL and LSH, and ECS), thus, implying stability in growth of revenues mainly from three major industrial sectors (FSI, MSG and ECS), thereby indicating, a greater % amount of revenues generated from them.

Again, Table 23.1 also shows a declining trend in growth of CV of revenues generated from various global regions [developed countries (America, Europe) and developing countries including India], with a slightly rising trend in recent decades of the said period, because of gradual shift of sources of revenue generation from developed to developing nations, particularly India, owing to its leading contribution in outsourcing across world, almost from 3.9% in 2012 to 44.2% in 2013 and further



Source: Data compiled from Annual reports of the Infosys BPO 2007-2017. Calculations have been done by the author.

Fig. 23.1 Trend in the growth of Operating ratio (OR) and Current ratio (CR). *Source* Data compiled from annual reports of the Infosys BPO 2007–2017. Calculations have been done by the author

Table 23.1 Growth of variation in revenues generated from various economic sectors and regions across globe

Years	Growth of C.V. across economic sectors	Growth of C.V. across global regions
2007	54.71	86.01
2008	65.41	86.36
2009	53.57	78.15
2010	45.53	72.35
2011	42.01	65.92
2012	46.02	60.48
2013	36.41	53.27
2014	42.91	53.58
2015	43.18	57.25
2016	35.62	68.80
2017	37.28	72.98

Source Data compiled from Annual reports of the Infosys BPO 2007–2017. Calculations have been done by the author

to 44.8% in 2017 (www.infosys.com). This also indicates a greater stability in growth of revenues in past than in present, because of its increasing contribution over the years.

Role of Infosys in the Economic Development of India

The impact of employee cost on efficiency of its labour utilization is measured by value of (r) between growth in employee costs and this ER of the company in employment generation, as higher employee costs imply lower efficiency. The value of (r), found to be -0.9879, indicates a very strong negative linear relationship, thus, implying, that the lower the employee costs, in terms of decrease in NBP months as a % of total, the higher is its efficiency.

Next, impact of employee utilization rate on growth of TR is also measured by r between the employee utilization rate and TR of company, as higher risks imply higher return for its positive risk reward curve. The value of r between risk and return factors, found to be 0.663, indicates a positive linear relationship, thus, implying, a positive risk reward curve as desired by the company.

Finally, to study the impact of overall growth performance on profit growth performance (PGP) of the company, the following background on theoretical matter supports the empirical model considered later.

The rapid evolution and unprecedented growth of IT–ITES sector in this era of ICT, as an impact of globalization, no doubt, influences the growth of an economy of a developing country like India, quite differently like any other sector. This is because, the IT–ITeS industry had evolved from a "Lift and Shift" model of moving headcount in and out of India over the years for services at the lowest end of the value chain, to one where Indian players can aggressively bid up for and win large-scale turnaround projects within the services at the highest end of the value chain, thereby leading to greater diversification of existing, so-called traditional service sector to a most value-added service sector, with the consequent emergence of the BPO sector in the country from global outsourcing market, either because of the spatial advantage related to trade advantage, or because of the competitive advantage through cost competitiveness or labour competitiveness, according to market analysis firm Gartner (Confederation of Indian Industry 2010).

BPO, itself, therefore, had played a very important factor behind the economic development of India, through its direct role in creation of a market economy in order to fill up the gap between the West and the East, so as to balance the demand and supply equation between the clients or service providers (foreign countries or West) and the outsourcer (home countries or East), based on the BOT model of deal structuring, from supplier's perspective, while, gradually moving towards "Global Delivery Model" from vendor's perspective. Hence, the higher the growth of BPO–IT–ITES sector, better will be the profit growth of BPO, moreover, through greater diversification towards value-added services, with the consequent creation of dual source of revenue generation both from economic source (industry) as well as from geographic source (global regions), so that higher will be the contribution of IT revenues, in terms of foreign exchange earnings, in the total revenue generation of the country through its direct impact on the balance of payments (BOP) or trade sector of the economy. Again, higher the growth of BPO–IT–ITES sector, greater will be the scope of employment generation, so as to directly affect the employment scenario and indirectly the poverty situation of a country.

Now, with the gradual growth and development of the business service sector, sustainability of any BPO industry, measured in terms of its profit growth, depends, solely, on its marketing and selling strategies (reflected in terms of its productivity performance), its employment growth performance and its economic growth performance (reflected in terms of its revenue generation from the sectoral decomposition of various economic sources). Since it is based on a trade exchange model of economic theory, it is expected that the overall growth performance of any BPO industry, (as a proxy, entirely, for the BPO sector) in terms of the above-mentioned performance, will ultimately provide an economic explanation behind the sustainable growth of the industry, through its various repercussion effects in a macro-sense. Not only that, such a dependence relationship is, also, therefore, expected to be between the overall growth performance of any BPO industry and its profit growth performance (PGP), so as to analyse its direct impact on the trade and employment sectors of the economy. This fact is, hence, captured in the following model, in this chapter so as to measure the extent of dependence between overall growth performance of any BPO industry and its sustainable growth (measured in terms of profit growth performance).

Hence, a Classical Linear Multiple Regression Model analysis (CLMRM) is constructed, with one dependent variable (Y), and more than one independent variable (Xs), in following equation (Table 23.2).

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 X_{5t} + u_t \tag{23.1}$$

Table 23.2 Summary statistics of Multiple Regression Analysis and ANOVA

Variables	Coefficient	Lower 95%	Upper 95%	*t* stat	*P* value	*F*	R^2	Adjusted R^2
Intercept	399.39	154.69	644.09	4.19	0.0085	9.34	0.903	0.8067
Productivity performance	−2.18	−3.613	−0.751	−3.92	0.0111			
Employment performance	−0.27	−1.095	0.545	−0.86	0.43			
FSI	−2.82	−6.516	0.867	−1.97	0.106			
MSG	−2.09	−4.220	0.027	−2.58	0.05			
ECS	−3.61	−5.984	−1.24	−3.91	0.01			

Source Data compiled from annual reports of the Infosys BPO 2007–2017. Calculations have been done by the author

Now, Y denotes PGP of the company, with respect to profit growth, whereas indicators of the overall growth performance as Xs, denote variables X_1 (productivity growth performance), X_2 (employment growth performance), X_3, X_4 and X_5 (economic growth performance) as three major economic sectoral revenues (in %s) generated from FSI, MSG and ECS, respectively.

Here β_0 (intercept) measures mean value of Y, when all Xs are set equal to zero. All other βs [individual partial regression coefficients (slope coefficients)] measure change in mean value of Y per unit change in Xs.

In order to test significance of individual regression coefficients, null hypotheses are constructed below:

$H_0{}^1$: Change in X_1, holding other Xs constant, has no significant influence on PGP respectively.
$H_0{}^2$: Change in X_2, holding other Xs constant, has no significant influence on PGP respectively.
$H_0{}^3$: Change in either X_3 or X_4 or X_5, with respect to the revenues generated from any of the three sectors, holding other Xs constant has no significant influence on PGP respectively.
To test the overall significance of the model,
$H_0{}^4$: Change in overall growth performance has no linear influence on PGP respectively [(H_0: $\beta s = 0$) as against (H_1: $\beta s \neq 0$)].

In case of MRM, from Table 23.2, estimated multiple regression equation is

$$Y_t = 399.39 - 2.18X_{1t} - 0.27X_{2t} - 2.82X_{3t} - 2.09X_{4t} - 3.61X_{5t} \qquad (23.2)$$

Now, $R^2 = 0.9033$ (Table 23.2) implies almost more than 90% of total variation in PGP, as explained jointly by overall growth performance of the company. Moreover, both individual partial slope coefficients of productivity performance and employment performance are found to be negative. This implies that a fall in either of these growth performances, both measured in terms of expenditure, therefore, increases profit performance.

Again, both $\beta^{*}s$ of productivity growth performance and economic growth performance of two major sectors (MSG and ECS), with their rapid growth and greater contribution in the total % of sectoral revenue generation, excepting that of employment growth performance, are highly statistically significant at 5% level of significance as $\beta = 0$ of both of them fall outside their respective confidence intervals. Moreover, productivity growth performance and economic growth performance of MSG and ECS are also highly statistically significant at 5% level of significance, as their computed (absolute) t values are higher than that of critical value or table value $t_{0\cdot 025,5} = 2.5$, respectively. Again, from overall significance of model, its overall growth performance jointly has led to significant rise in PGP as computed F value (9.34) being much higher than given critical value of $F_{0.05,\,5,5} = 5.05$. Further, p values of t of both of them are also very low to reject both H_0s [$H_0{}^1$, $H_0{}^3$] and accept $H_0{}^2$, to arrive at a greater statistical significance of both productivity growth performance and economic growth performance.

23.11 Conclusion and Recommendation

Infosys BPO company has played a very significant role in economic development of India from 2006–07 to 2016–17, through its overall performance, by strengthening its financial position in entire business world in terms of both its profit and its financial performances respectively; being also as major contributor of both geographic as well as economic source of revenue generation, to favour BOP and also through its employment growth performance, it acts as major effective source of job absorber as well, thereby creating ample employment opportunities (both domestic and worldwide), thus, contributing a lot to tackle the unemployment problem of the country. But for a developing country, like India, performance of Infosys BPO will not suffice as only major contributor in this concern. Indian BPO companies, despite, many comparative advantages [both cost as well as locational advantages (reduce tariff barriers, low infrastructure cost, large pool of manpower with cheap labour costs, the unique capability of providing efficient business solution with low costs, favourable government policies, more flexible in terms of culture and working hours and often sharing of the business risks)], occupy top position in nest of this blooming Indian BPO industry, but overlooks above serious issue of unemployment, with rapid and tremendous population growth day by day. Further, greater absorption of women workforce is needed within this sector, through better security provision for betterment of this industry both for socio-economic issues of employment and reduction of gender discrimination.

To retain its glory in this industry in long run, some suggestions are recommended for future of Indian BPO industry.

First, it needs to rebrand itself in terms of value, sustain competitive edge to enhance the power of cost effectiveness as compared to its world competitors to overcome need to drive by technical skills and quality; otherwise there is less hope to stay longer in future.

Secondly, India needs to hold top position in scientific and technology field of BPO through establishment of world class research institutions for new advancement of technology, regarding BPO-specific programs, to encourage greater employment opportunities for BPO industry in rural backward areas.

Thirdly, recent atrocities against women, social crimes, etc., in workplaces of BPO against provision of congenial and safe work environment in present days need serious concern through fair practices, tight security environment, especially for women, necessary for work culture of the BPO industry.

Finally, security issues such as accountability, ethical practices for contracts, data security, privacy and emphasis on customer satisfaction, effective mechanism for information sharing among government, BPO industry and other parties should be implemented and addressed seriously by executives of Indian BPO industry, as, these issues, being key players for success of BPO industry, require greater concern of both public and private sectors, which should not be overlooked in no way, so as to combat threats posed by the world competitors of Indian BPO in the coming days.

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Chapter 24
Data Protection in Market-Driven Network Economies

Ashu Tiwari and Archana Patro

24.1 Introduction

We all have witnessed the change that has taken place in our day-to-day life due to the growth of information communication technology (ICT) enabled platforms. This growth in information communication technology usage across various domains has brought forth embedded risk of data theft, data breach, cyber terrorism, and many more similar nature insurable risks. This is evident from the recent growth in data loss incidences. As per the Identity Theft Resource Center (2016), in the USA, 12.8 million records are exposed related to a data breach. Therefore, discussion on combating the data related crimes has occupied significant attention within the insurance industry as well as on policy formulation front of many big size economies (Kesan 2004; Eling and Schnell 2016). Since the data risk can come in many forms with different motives, therefore many definitions are available in the existing literature refering to the data risk. For example, few authors covered the cyber terrorism perspective of data risk and defined it as a crime that may be politically motivated and premeditated attacks against information, computer systems, computer programs, and data, which result in data disaster or against non-combatant targeted by antisocial groups or clandestine agents (Curran, Concannon, and McKeevers 2007). Halder and Jaishankar (2011) covered the cyber terrorism perspective of data risk and defined it as a offences which are committed against individuals or groups of individuals with a criminal motive to intentionally harm the reputation of the victim or cause physical or mental harm, or loss, to the victim directly or indirectly, using modern telecommunication networks such as internet (networks

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including chat rooms, emails, notice boards and groups) and mobile phones (Bluetooth/SMS/MMS). However our focus in current discussion is not to narrow down our discussion on any specific form of data risk rather we are trying to develop a broad framework to prevent the occurences of such incidences. Since these risks are highly correlated, therefore, the insurance industry is facing a tough task of combating with this complex nature peril. However, in terms of overall data risk, the insurance industry is peculiarly fighting on two fronts; the first is knowledge gap in terms of techniques required in coping up with the systematic hazards emerge out of various forms of data risks. And the second issue is related to small proportion of people buy such risks. Generally, both of these problems threaten the insurance industry (Toregas and Zahn 2014; Kshetri 2018). Therefore, it is vital to keep the discussion alive on both fronts. However, the cyber risk is prominently hovering in the countries in which ICT is extensively being used. Therefore, our discussion surrounds G-7 economies.[1]

Like all other systematic risks, cyber risk also involves a large number of stakeholders. Thus, the challenge cannot be adequately dealt without regulators intervention. Other than this, the role of the regulator is unavoidable, given the vast accessibility and concentration of transaction on online platforms. Therefore, at the international level, similar to other systematic risks, the United Nation has initiated the Global Cyber Law Tracker 2015 to supervise cybercrime-related issues. Besides it, many other international groups such as the World Bank, ITC0F,[2] IPU1F,[3] and ITU2F[4] have developed legal frameworks to improve regional governance for ICT-related risks. United Nation's private-sector advisory council is also trying to facilitate dialog among private companies in developing and developed countries to reduce the risk of using IT-enabled platforms. However, the landscape of insurance markets varies widely in terms of cyber-related risks. Therefore, this study elaborates the frameworks of security arrangement available in G-7 countries on cybersecurity regulation and insurance market development. Following chapter is divided into four parts. The second part of this chapter discusses the literature available on this subject. The third part develops framework and formulates hypothesis. The fourth part of this chapter is about discussion and findings. The fifth part of this chapter summarizes the findings and concludes the study.

24.2 Literature Review

Like most of the other systematic nature risk, data risk is also widely covered in literature (Anderson and Moore 2006; Baer and Parkinson 2007; Talesh 2018; Khalili,

[1]G-7 is group of the world's most economically advanced countries. This includes the UK, the USA, Canada, France, Japan, Germany, and Italy.

[2]International Trade Centre.

[3]International Postal Union.

[4]International Telecommunication Union.

Naghizadeh, and Liu 2018). The overall literature on data risk can broadly be classified into four broad categories; the first group of studies have advocated the role of insurance firms in improving data safety landscape (Bolot and Lelarge 2009), and the second group of studies have highlighted the issues in managing data safety landscape by insurance firms (Shackelford 2012; Bandyopadhyay, Mookerjee, and Rao 2009; Yang and Lui 2014; Laszka and Grossklays 2015; Romanosky 2016; Tiwari, Patro, and Shaikh 2019). The third group of studies have used incentive approach and covered various stakeholders. Finally, fourth group of studies have covered regulatory aspect of data risk management. However, fewer studies covered regulatory aspects (Toregas and Zahn 2014; Camillo 2017). In this regard, Camillo (2017) highlighted the importance of insurers and argued that insurers are de facto regulators. On further exploring the literature, we found that discussion on a collaborative risk management framework is not prominent in the literature (Bohme and Schwartz 2010). Besides these, the landscape of IT-driven insurance varies widely among G-7. As per Forman and Anne (2009), 53% of IT, the landscape of IT-driven insurance varies widely among G-7. As per Forman and Anne (2009), 53% of IT services are consumed by insurance firms alone in the USA and is expected to increase with growth in automated tools for service delivery and online transactions (Groves 2003). Therefore, ICT-related risks are also high in magnitude. As per the Identity Theft Resource Center (2016), in the USA, 12.8 million records are exposed related to a data breach. On the other hand, in the USA, insurance is an essential tool for the stability of insurance markets, whereas insurers are facing the challenge of their vulnerability against the risk of data theft and data breach. Besides their vulnerability in terms of numbers and the average cost per incidence, insurers are facing the challenge of the modeling with small pooling premium. However, in order to reduce risk related to data theft and data breach, US government brought Cybersecurity Information Sharing Act, 2015, Cybersecurity Enhancement Act, 2014, Federal Exchange Data Breach Notification Act 2015, and National Cybersecurity Protection Advancement Act of 2015. In Germany, insurers have developed Trusted German Insurance Cloud and crisis management plan to cope with cybersecurity issues, while German policymakers have promulgated German Cybersecurity Act 2015. In the UK, after the incidences of a massive data breach in 2014, on the one side, the UK policymakers have proposed regulatory reforms such as Network and Information Security Directive (NISD) which translates EU's cybersecurity strategy into binding laws. And, under European data protection, regulation companies in Europe have to pay fines in case of defaulting compliance of data protection rules (Swiss Re 2017).

On the other hand, to promote ICT culture, Financial Conduct Advisory (FCA) has also created innovation hub to experiment to know the regulatory consequences of any innovative product and services without actually incurring any cost to promote the innovation in IT-driven environment (OECD 2017).In Italy, under Kaplan and Haenlein framework, 77% of Italian insurers are using Facebook platforms for various insurance-linked activities, and there are usage-based insurance products[5] in the automotive industry of Italy. Despite the stricter regulations to adopt the IT-driven

[5]https://newsroom.cisco.com/press-release-content?articleId=1808872. 3/11/17.

new paradigm in the insurance industry, the traditional insurers in Italy are leading ahead of USA, UK, and South Africa with its strong automotive sector with about sale of 6.3 million insurance policies based on telemetric at the end of 2016 (Swiss Re 2017). In terms of cyber risk, Italy has one of the most secure legal frameworks for cybersecurity. Data protection authority, as well as judiciary systems, has powers to inspection administer and exercise advisory action. In France, Germany, and the UK, the new concept of peer to peer insurance platform, known as friends insurance, had emerged in 2010.

In France, InsPeer is peer to peer service to share deductibles. These models are the by-products of digital insurance revolution in the industry. As an aggregate, more than 78% of insurance tech participation has been from G-7 economies, in which the USA has the largest 59% in the industry (OECD 2017). As a part of the cybersecurity strategy, France has the provision of regular audits, mandatory adoption of security and detection tools for all the business entities. In France, under Military Programming Act of 2013 for 2014–2019, regulators have a responsibility to create the necessary infrastructure to protect the critical sectors against any cyber threat.

However, early ICT adopters are facing the comparatively higher challenge of cyber risks due to a lack of preparation for such potential threats. For example, in USA, the data and identity theft issues have emerged in recent decade due to a significant increase in a class action lawsuit brought by the consumers against the firms which could not protect customer's privacy against the cyber risk in their core business activities (Groves 2003; Njegomir and Marovic 2012; Franke 2017).

24.3 Method Used for Article Collection

The author has compiled the literature on the subject by following three steps:

1. In the first step, the literature is collected on the broad theme of cyber risk.
2. We retained the articles focussing on regulations and regulations. We removed all other articles from our set.
3. We mainly collected important information from online portals of IT regulators, insurance regulators, and government of all the G-7 countries.

24.4 Theoretical Framework and Hypothesis Development

Regulations are essential for stabilizing inherently unstable markets. In the case of systematic risk, unstable market contingencies are more likely to happen. Therefore, we have taken a framework from regulatory theories to study current problems. In the past, many of the industries were deregulated in order to increase efficiency. However, in the absence of appropriate results, we believe that the regulatory outcome of industry deregulation depends upon the nature of products/services. One of the general objectives of regulations is to reduce the information asymmetries (Darby and Karni 1973; Dulleck and Kerschbamer 2006). However, more often than not, the government could not do so due to high costs at formulation implementation and administration stages of regulation. The regulatory failure to achieve information-efficient markets may cause unstable market equilibrium or sometimes results in complete market failures. In case of uncorrelated risks, information asymmetry can be minimized with private contracts provided there are small number of stakeholders. This type of contractual arrangement is easier to operationalize. However, the situation becomes more challenging when large number of stakeholders are participating under informal arrangements (Hirshleifer and Riley 1979). These parties could not consider collective benefits landed into crisis like situation. Since correlated risks most often transform into crisis over long time horizons, this study has discussed the issue in three-stage regulatory framework namely, Pre-Data Crisis Stage, Underwriting Stage, and Post-Data Crisis stage. In the following paragraphs we have defined these stages. **Pre-Data Crisis Stage**: we have defined this stage as the stage before any crisis takes place. In this stage we covered the actions of two actors namely, insurers, and regulators before the crisis happens. It is also depicted into Fig. 24.1. Since technology is one of the important factors in modern network economy, it has large number of stakeholders. At this stage, regulators role and size of markets are important. **Underwriting Stage**: This stage is important for insurers' point of view. However, pre-crisis activities of insurers and regulators impact the outcome of underwriting stage activities. **Post-Data Crisis stage**: At this stage, role of regulators and insurers is critical. This stage again affects Pre-data crisis stage as well as underwriting stages. With the help of these three stages, we tried to understand the frameworks of cyber risk management that have been used in G-7 economies.

H1: Pre-crisis stage of data crisis, regulations can promote the insurance industry only if insurance industry can align its objectives in any of the three stages, namely pre-underwriting stage objectives, underwriting stage objectives, and post-underwriting stage objectives.

H2: Crisis stage of data crisis, regulations can promote the insurance industry only if insurance industry can align its objectives in any of the three stages, namely pre-underwriting stage objectives, underwriting stage objectives, and post-underwriting stage objectives.

H3: Post-crisis stage of data crisis, regulations can promote the insurance industry only if insurance industry can align its objectives in any of the three stages, namely pre-underwriting stage objectives, underwriting stage objectives, and post-underwriting stage objectives.

24.5 Discussion and Findings for G-7 Economies:

The United States: Data Market: As per Forman and Anne (2009), 53% of IT services are consumed by insurance firms alone in the USA, and it is expected to

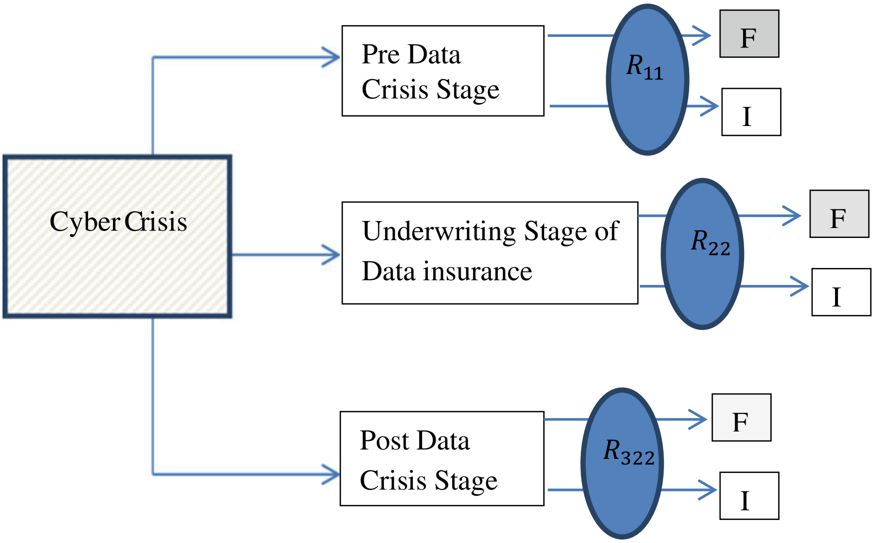


Fig. 24.1 This figure depicts study framework. F denotes firm, I denotes individual, $\boldsymbol{R_1}$, $\boldsymbol{R_2}$ and $\boldsymbol{R_3}$ denote regulation on three stages of crisis management. *Source* Author

increase with growth in automated tools used in the service delivery and online transactions (Groves 2003). Therefore, the magnitude of ICT-related risks is also growing in the USA. As per the Identity Theft Resource Center, in the USA, approximately 12.8 million records are exposed to a data breach. **Insurers in the USA**: insurers in the USA are facing the challenge of their vulnerability against vast statistics on data theft and data breach. Besides the own vulnerability of insurance firms in terms of numbers and the average cost per incidence, insurers are facing the operational challenge, risk of inappropriate modeling, and risk of small pooling premium. **Regulations in the USA**: Though in order to cope with the situation, the USA government brought many new legal frameworks, namely Cybersecurity Information Sharing Act, 2015, Cybersecurity Enhancement Act, 2014, Federal Exchange Data Breach Notification Act, 2015, National Cybersecurity Protection Advancement Act of 2015, Children's Online Privacy Protection Act, 1998, Children's Internet Protection Act, 2000, Computer Fraud and Abuse Act, 1984, and other Computer Abuse Laws, Electronic Communication Privacy Act, 1986, Identity Theft and Assumption Deterrence Act, 1998. Additionally, the USA federal government has also brought the Cybersecurity National Action Plan, National Cyber Incident Response Plan (PPD-41), and commission on enhancing national cybersecurity. The USA has undertaken wider roles in response to cybersecurity. The agencies working toward this problem are the defense department, Justice Department, Department of Homeland Security, Federal Trade Commission, and Department of Health and Human Services. Government has sought to work in coordination with private firms to combat cyber risk and implement Orange Book (TCSEC).

Germany: **Data Protection/Cybersecurity Market in Germany**: According to national digital Association Bitkom, Germany is the world's fifth largest market in terms of ICT usage. The German market for cybersecurity has also grown at cumulative average growth rate of 7.70% for the period 2013–2019.[6] It is also largest software market in Western Europe. This shows the size of cybersecurity markets in years to come. First concern for risk of cyber threats was raised to the national level in Germany in 2006. **Insurers in Germany**: In order to reduce data vulnerability, German insurers have developed Trusted German Insurance Cloud and crisis management plan for cybersecurity crisis. **Regulations in Germany**: German policymakers have promulgated German Cybersecurity Act 2015. Despite some law, in 2018, massive data theft has taken place. Germany has a state-of-the-art cybersecurity arrangements (Camillo 2017; Johnson et al. 2014). They have ISO 270-XX (a family of information security standards) and Evaluation of IT products according to the Common Criteria for Information Technology Security Evaluation (CC), similar to the USA.

The United Kingdom: Data Protection/Cybersecurity Market in the UK: The cybersecurity markets in the UK are around $8 billion dollar annually. This market is one of the most concentrated and competitive markets in the world. A survey conducted by the UK government in 2014 found that 81% of large business corporations and 60% of small size businesses suffered a cyber breach. Thus, the UK market for cybersecurity market and data protection is also going to increase in years to come (Stoddart 2016).[7] **Insurers in UK**: In the UK, picture is significantly different. In the UK, insurers are excluding cyber risk from other risk insurance covers. However, in June 2014, UK government and insurers brought joint scheme "Cyber Essentials scheme". Under this scheme, government tried to make it mandatory for all the firms to adhere to basic technical controls to mitigate Internet-based threats. The insurers have made this "Cyber Essentials scheme" as reference for underwriting cyber insurance policies. **Regulations in the UK**: In the UK, after the incidences of a massive data breach in 2014, on the one side, the U.K. policymakers have proposed regulatory reforms such as Network and Information Security Directive (NISD) which translates EU's cybersecurity strategy into binding laws. Additionally, under European data protection regulation companies in Europe have to pay fines in case of defaulting compliance of data protection regulation (Swiss Re 2017). On the other hand, to promote ICT culture, Financial Conduct Advisory (FCA) has also created innovation hub to experiment to know the regulatory consequences of any innovative product and services without actually incurring any cost to promote the innovation in IT-driven environment (OECD 2017). Additionally, the UK government also promulgated The Regulation of Investigatory Powers Act, Data Protection Act 1998, The Privacy and Electronic Communications (EC Directive) (Amendment) Regulations

[6]https://www.micromarketmonitor.com/market/germany-cyber-security-3119328409.html. 23/07/2019.

[7]https://www.abi.org.uk/products-and-issues/choosing-the-right-insurance/business-insurance/cyber-risk-insurance/. 23/0719.

2011, Directive 95/46/EC (Data Protection Directive), and Compliance with EU Data Protection Directive (EC/95/46) (the Directive).

Italy: Italy is the fourth largest market for ICT and equipment and at the same time has been the biggest target for cyber-related crimes in recent years. The real problem lies in poor awareness about cyber prevention measures. Insurers in Italy: In Italy, under Kaplan and Haenlein framework, 77% of Italian insurers are using Facebook platforms for various insurance-linked activities, there are usage-based insurance products in the automotive industry. **Regulation in Italy**: Despite the stricter regulations to adopt the IT-driven new paradigm in the insurance industry, the traditional insurers in Italy are leading ahead of USA, UK, and South Africa with its strong automotive sector with about sale of 6.3 million insurance policies based on telematics at the end of 2016 (Swiss Re 2017). In terms of cyber risk, Italy has one of the most secure legal frameworks for cybersecurity**.** Data protection authority, as well as judicial authority, has powers to inspection administer and at the same time have powers to exercise advisory action.

France: Like other G-7 members, in France insurer and regulators both are contributing for the safety of cybersecurity landscape. **Insurers in France:** In France, Germany, and the UK, the new concept of peer to peer insurance platform, known as friends insurance, had emerged in 2010. Similarly, in France, InsPeer is peer to peer service to share deductibles. These models are the by-products of digital insurance revolution in the industry. As aggregate, more than 78% insurance tech participation has been from G-7 economies, in which the USA has driven mainly with 59% in the industry (OECD 2017). **Regulations in France:**As a part of cybersecurity strategy, France has the provision of regular audits, mandatory adoption of security, and detection tools for all the business entities. In France, under the Military Programming Act of 2013 for 2014 to 2019, regulators have a responsibility to create the necessary infrastructure to protect the critical sectors against any cyber threat.

Canada: Regulation in Canada: Canada's Centre for Cybersecurity is the authority working on various aspects of cybersecurity. It works for government and issues, advices, trains, and develops frameworks for various aspects of cybersecurity. The Cyber Centre works collaboratively with Canada's academia, private sector, and all levels of Government of Canada are proactively ensuring cybersecurity on all fronts. The government certifies IT products according to the regulatory standards. Apart from these, it also has access to IT products that follow Cyber Centre guidelines for cryptography. Additionally, it has promulgated the Personal Information Protection and Electronic Documents Act, or PIPEDA which provides right to individual to ask for safety of personal information. Canada also has national framework to combat with cyber risk—"The Vision of the National Cybersecurity Strategy". It is a strategy which has three pillars, namely securing government systems, partnering to secure vital cyber systems outside the federal government, and helping Canadians to be secure online. Therefore, we can say that Canada has near to integrated framework to deal with the threat of cybersecurity threat.

Japan: Japan has established critical information infrastructure to safeguard the information space in the country. This includes the enhancement of safety standards and raising awareness, training, and the improving information sharing arrangement among various stakeholders. However, unlike regulatory aspect, Japan has remained focusing on technical aspects of cybersecurity.

Japan's cybersecurity framework works on following basic principles:

1. Being Proactive, not Reactive
2. Acting as a Catalyst, not Just a Passive Player
3. Envisaging Cyber-Physical Space, not Cyberspace Alone
4. Creation of Secured I.o.T Systems.

However, early ICT adopters have been facing the comparatively bigger challenge of cyber risks due to lack of preparation for such potential threats. For example, in USA, the data and identity theft issues have emerged in recent decade due to a significant increase in a class action lawsuit brought by the consumers against the firms which could not protect customer's privacy against the cyber risk in their core business activities (Groves 2003; Njegomir and Marovic 2012; Franke 2017). Therefore, this section has focused on the regulatory framework in response to new risk class. Japan has provisions to improve security-related knowledge time to time so that change may appropriately be assimilated into the critical information infrastructure (CII). Additionally, local governments have responsibilities to cooperate with national strategy measures of CII.

International Landscape: General Data Protection Regulation (GDPR): European countries are the greatest targets of cybercrimes. Therefore, this regulation makes companies disclose any incidence related to a data breach. Failing to report will result in penalties and fines (Drzik 2018). Apart from it, GDPR encourages fair and consent-based usage of personal information. GDPR obliged businesses to respond to all the inquiries made by individuals or authority. Figure 24.2 shows various dimensions of GDPR. Other than GDPR, many authors have covered the numerous aspects of international relations in relation to the cyber risk (Broadhurst 2006; Johnson et al. 2014)

Apart from GDPR, EU brought many other policy instruments to immunize the region from cyber risks such as Computer Emergency Response Teams, Critical information infrastructure Protection, European Union Agency for Network and Information Security, and Common Security and Defence Policy.

Three Components of Cyber Risk: The general trend shows that in the current scenario for cyber insurance risk cover, regulators role is extremely important in order to develop stable cyber insurance markets, and therefore, they are focusing on three critical dimensions (CIRNU, Carmen 2016).

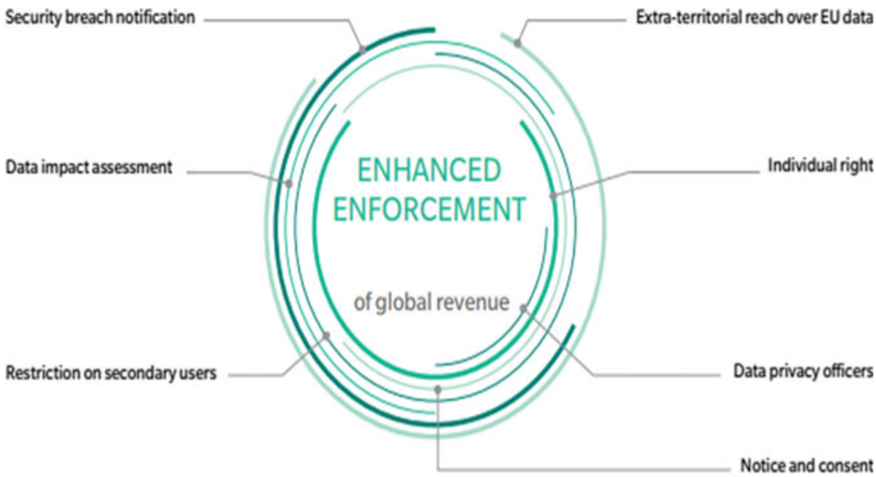
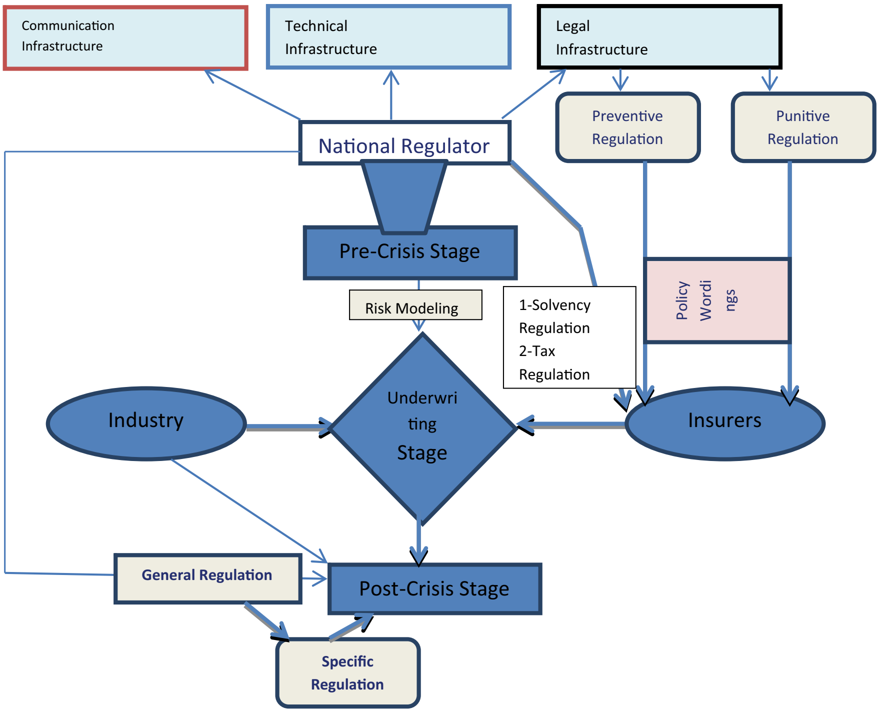


Fig. 24.2 Figure depicts the framework of data regulation. *Source* Fire Eyel Marsh & McLennan Cyber Risk Report 2017 Cyber Threats: A perfect storm about to hit Europe (https://www.marsh.com/us/insights/research/cyber-threats-a-perfect-storm-to-hit-europe.html. 24/07/19)



(A) Cyber Communication Infrastructure: In order to reduce socioeconomic vulnerability of people against cyber risk, consistent awareness is necessary as cyber risk is dynamic. In this context, USA, UK, Japan, and EU have created portals for exchange of information on cyber risks. **(B) Technical Infrastructure**: In order to combat cyber risk, development of remedial software is necessary. Therefore, technical centers will work on developing security software as well as on safety network. **(C) Regulatory Infrastructure**: Regulatory reforms are meant to discourage cybercrime and promote preventive culture among public and business. Since a cyber insurance market is not well developed in all the countries of G-7 economies, the viability of the insurance market is mainly dependent on the country's jurisprudence. In order to realize more benefit of ICT and reduced impact of risk, the European Union has made the combined effort of General Data Protection Regulations.

24.6 Conclusion

Like other extreme nature risks, cyber risk has not received much attention in all G-7 economies. In our analysis, we tried to identify integrated models. However, it is tough to identify cyber insurance separate three-stage regulatory frameworks in G-7 because much information is not available explicitly to develop a model on these lines. Therefore, based on the findings of regulatory arrangements, we presented only one integrated framework shown in Fig. 24.2.

Pre-crisis Stage: At this stage, study finds that it is required to focus on infrastructure development. This study identifies three types of infrastructures, namely communication infrastructure, technical infrastructure, and legal infrastructure that are critical for cybersecurity. Here communication infrastructure is used to emphasize well-developed infrastructure for ICT-related services. Technical infrastructure stands for safety arrangements for ICT-enabled network platforms. And finally, legal infrastructure refers to well-developed cyber laws.

Underwriting Stage: At underwriting stage, there are challenges for insurers as well as insurance regulators such as risk modeling, policy terms and conditions, and claim settlement procedures. For risk modeling, insurers are dependent on mathematical modeling as well as individual risk assessments. However, most of the insurers from USA and UK evaluate cyber risk based on the information provided by the customers via proposal forms. Many of detailed information crucial for underwriting are missing in this whole process as per the standards of ISO/IEC 27002 (Woods et al. 2017).

Post-disaster Stage: At post-disaster stage, not much of regulatory development is observed from the side of regulators or insurers. Some proactive developments are seen in case of EU regulations and Japan regulations (CIRNU, Carmen 2016). The USA has also brought forth the post-disaster regulatory response, for example, National Cyber Incident Response Plan (PPD-41).

The limitation of current work is that we have information that is available in public domain on ICT security checks. Therefore, we cannot argue strongly about limitation of safety arrangements. Therefore in conclusion part, we provided a holistic framework for cybersecurity.

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In the original version of the book, the following correction has been incorporated: The affiliation of Dr. Subhasis Sen has been changed from "SCMHRD, Balaji Institute of Telecom and Management (BITM), Sri Balaji University, Pune, India" to "Balaji Institute of Telecom and Management (BITM), Sri Balaji University, Pune, India". The correction chapter and the book have been updated with the change.

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