Business Analytics and Cyber Security Management in Organizations

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Chapter 6
Services Trade in Emerging Market Economies

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ABSTRACT

Global trade in services has increased significantly over last three decades. Earlier, the growth was confined primarily to trade among advanced economies. In more recent times, even developing countries – especially, the emerging market economies (EMEs) – have experienced substantial increase in services trade. Services trade still accounts for only a small share of national income in most EMEs. However, one important trend has been the rapid growth of information-intensive services (IISs). This chapter examines the growth and patterns of services exports and imports from and to a number of EMEs. The analysis indicates that the importance of services trade has been growing for most EMEs. Further, among the EMEs, China, India, and Korea are the most dominant players in services exports and imports. For China, both export and import shares have been rising while for India the export share has been consistently rising. This chapter further discusses some of the intuitively plausible explanations for the growth of trade in services in general and in IISs in particular. It also discusses some of the challenges associated with the growth of IISs trade.

INTRODUCTION

In recent decades, the world has experienced a significant increase in services trade. One of the most important aspects of this growth is the manifold increase in the share of emerging market economies (EMEs) in services trade. There are two parallel developments that have contributed to this trend. *First*, as these economies conduct market-oriented reforms and adopt economic liberalization policies, there is an increase in the demand for traditional services such as transportation and travel. *Second*, the unprecedented advances in information and communication technologies (ICT) have not only made certain service items tradable but also, through rapid proliferation, created an opportunity for the developing

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countries to trade those services. In particular, these technological advances have enhanced tradability of information-intensive services (IISs). These are the services that involve creating, processing, and communicating information. Because of ICT, these services do not require physical presence of producers and consumers in the same location, a trait that traditionally characterizes services. The low cost of these technologies seems to be a major driver of the increase in both demand and supply of IISs in developing countries.

The main objective of this paper is to examine the major trends and patterns of services trade in EMEs. A secondary objective is to investigate the importance and growth of trade in IISs in these economies. Although growth of services trade in EMEs could be necessary and beneficial for the overall growth of those countries, it may also create formidable challenges. It is of utmost concerns that the institutional framework to handle some of the challenges associated with services trade is in its nascent state even in the developed countries. As countries increasingly trade in IISs, cybersecurity enters into the realm of national security. The policies and measures to promote trade in these services should recognize this and work towards building a comprehensive framework to address these challenges. This paper discusses some of the challenges created by services trade, particularly IISs trade in EMEs.

Although there has been an emerging literature on services trade, the focus has been primarily on the developed countries. Only a handful of studies examine services trade in EMEs. A lack of reliable data has been a formidable constraint. This, in turn, is related to the issues on how to measure services and what constitute trade in services. However, as international organizations, such as World Trade Organization (WTO) and United Nations Conference on Trade and Development (UNCTAD), have started publishing detailed data on services trade, researchers have also embarked on studying trade in services using empirical data. Thus, a number of articles on this topic have appeared in last two decades or so.

There are several strands of this literature. There are some studies that examine the determinants of international trade and investment in services (e.g., Polese and Verreault 1989; Freund and Weinhold 2002; Grunfeld and Moxnes 2003; Kimura and Lee 2006; Co 2007; Mann and Civril 2008). There are others that focus on gains from trade in services in terms of productivity and growth (e.g. Mattoo et al. 2006; Hoekman and Mattoo 2008; Amity and Wei 2009). Further, some other studies discuss policy issues related to services trade (e.g. Bhagwati 1987; Hoekman 1996; Deardorff 2001; Hoekman et al. 2007; Deardorff and Stern 2008). Francois and Hoekman (2010) give a comprehensive review of these different strands of the literature. To the best of our knowledge, none of these studies provides a comprehensive account of growth and patterns of EMEs trade in services in general and EME trade in IISs in particular.

The rest of the paper is organized as follows. Section 2 presents an overview of trade in services. This section is divided into two subsections. In Subsection 2.1, we discuss the definitional framework for trade in services, as adopted by the General Agreement on Trade in Services (GATS). Subsection 2.2 includes a brief discussion on current trends and patterns of world trade in services. In Section 3, we focus on the EME trade in services in general and IISs in particular. It discusses in details the composition and growth of various IISs. Section 4 discusses some theoretically plausible intuitions behind the rapid growth of trade in services in EMEs. In Section 5, we discuss some of the challenges the EMEs face as the services trade grows. In particular, we discuss certain issues related to cyber security and trade negotiations. Our concluding remarks are included in Section 6.

AN OVERVIEW OF TRADE IN SERVICES

A New Framework for Services Trade

Historically, services that accompany movements of goods and people across borders were perhaps the earliest to be traded across borders. In the past it was almost inconceivable that services could be traded as the production of most services required physical presence of both producers and consumers in the same location.[1] Thus, services were largely considered as non-tradable. Furthermore, in an era when agriculture and then manufacturing were the predominant sectors of the economy, many services were just activities auxiliary to the production of goods and many others were simply not marketed. Consequently, even the General Agreement on Trade and Tariff (GATT), which was the forum for multilateral trade negotiations, was almost silent about services trade.

Several developments in recent decades made countries aware of the importance of services trade. The deregulation of the US airline industry in the late 1970s, increasing presence of American banks and entertainment industries overseas, the formation of the European Common Market (ECM), and, most importantly, ICT advances that made a number of services tradable across borders are some of these developments that contributed to the rise of services trade.[2] The recognition of the importance and viability of services trade among nations led to the General Agreement on Trade in Services (GATS) - a treaty of the World Trade Organization (WTO) negotiated under the Uruguay Round of negotiations - that came into effect on January 1, 1995. In view of the wide array of international transactions that services trade encompass (unlike merchandise trade), the GATS takes a broad view of trade in services. Thus, GATS defines services trade to include four categories of transactions:

1. **Cross-Border Trade:** This category includes services supplied across borders. Examples include electricity, telecommunications, and transportation.
2. **Consumption Abroad:** It includes services supplied in a country to the foreigners. Tourism and education abroad are two examples.
3. **Commercial Presence:** The services supplied in a country by foreign business establishments are included in this category. Examples include restaurant chains, hotel chains etc.
4. **Presence of Natural Persons:** This category includes services supplied in a country by foreign nationals. For example, services provided by visiting entertainers are included in this category.

Recently, the statistical agencies across the world have tried to be consistent with this definition while collecting data on services trade.[3] Note that the range of transactions that this definitional framework classifies into services trade may not be very useful in thinking of services in terms of a unified theoretical model.

Current Trends in Global Services Trade

In this subsection, we discuss the major trends in services trade across the globe as well as in the EMEs. The main sources of data for our analysis are: the *Trade in Commercial Services Trade* database of the World Trade Organization (WTO) and the *World Development Indicators* (WDI) database of the World Bank. The data are publicly available from the websites of these two organizations: http://www.wto.org/ and http://www.worldbank.org/ respectively. We use annual data between 1980 and 2013, mainly

due to the fact that services trade gained some prominence only in the 1980s.[4] Note that the trade data are available more consistently for the EMEs only since the mid-1990s.

Table 1. shows that the share of total private commercial services trade in world GDP was about 3 per cent in 1980 and this ratio increased to about 6 per cent in 2013. In contrast, merchandise trade as a share of world GDP increased from about 19 per cent in 1980 to 25 per cent in 2013. Services trade as a percentage of total trade increased from about 17 per cent to about 20 per cent during this period. It implies that trade in services grew faster than that in goods. While the value of merchandize trade increased about 9 times, the value of services trade increased almost 13 times during this period of over three decades.

A list of 10 leading exporters and 10 leading importers of services in 2013 is presented in Panel A of Table 2. Note that the U.S. is the leader in both exports and imports of services, accounting for about 14 and 10 percent of services exports and imports respectively. Among the EMEs, China and India made it to the list of top 10 exporters of commercial services. These two countries, together account for about 8 per cent of total commercial services trade in the world. The list of 10 leading importers also includes Russia in addition to these two EMEs. One interesting observation about these three EMEs is that while China and Russia are net importers of commercial services, India is a net exporter. As some studies (e.g. Liu et al 2015) show, India gained comparative advantage in information-intensive services vis-à-vis the U.S. and other developed nations around the turn of the twenty-first century. In China and Russia, as the manufacturing sector grew, it created substantial demand for services that seems to have been reflected in large imports of services by these countries.

To highlight the contrasts with services trade, we list 10 leading exporters and 10 leading importers of goods in 2013 in Panel B of Table 2. While China is the largest exporter accounting for about 12 per cent of total exports of goods, the United States is the largest importer accounting for about 12 per cent of total imports in the world. Besides China, Republic of Korea and Russia – two other EMEs – are also in the list of leading exporters of goods. Further, both China and the Republic of Korea appear in the list of leading importers.

TRENDS AND PATTERNS OF SERVICES TRADE IN EMES

We compile a list of 21 EMEs from five different sources: Morgan Stanley Capital International (MSCI), the FTSE Group, Standard and Poor-Dow Jones (S&P-DJ), Banco Bilbao Vizcaya Argentaria (BBVA) Research, and Russell Investments. We use the most recent lists of EMEs prepared by these agencies and

Table 1. World trade in goods and services and GDP, 1980 and 2013

	1980		2013		Average annual growth rate (1980-2013)
	Value in billions of current USD	As percentage of world GDP	Vale in billions of current USD	As percentage of world GDP	
	(1)	(2)	(3)	(4)	(5)
Trade in goods	2,034	18.2%	18,954	24.9%	6.8%
Trade in commercial services	367	3.3%	4,644	6.1%	7.7%
GDP	11,156	100.0%	76,124	100.0%	5.8%

Table 2. Leading exporters and importers of services and goods, 2013

Rank	Exporters	Value in billions of current USD	% share in total world exports	Rank	Importers	Value in billions of current USD	% share in total world imports
Panel A: Trade in Services							
1	United States	662	14.3	1	United States	432	9.8
2	United Kingdom	293	6.3	2	China	329	7.5
3	Germany	286	6.2	3	Germany	317	7.2
4	France	236	5.1	4	France	189	4.3
5	China	205	4.4	5	United Kingdom	174	4.0
6	India	151	3.2	6	Japan	162	3.7
7	Netherlands	147	3.2	7	Singapore	128	2.9
8	Japan	145	3.1	8	Netherlands	127	2.9
9	Spain	145	3.1	9	India	125	2.8
10	Hong Kong, China	133	2.9	10	Russian Federation	123	2.8
Panel B: Trade in Goods							
1	China	2209	11.7	1	United States	2329	12.2
2	United States	1580	8.3	2	China	1950	10.2
3	Germany	1452	7.7	3	Germany	1192	6.3
4	Japan	715	3.8	4	Japan	833	4.4
5	Netherlands	672	3.5	5	France	681	3.6
6	France	581	3.1	6	United Kingdom	656	3.4
7	Korea, Republic of	560	3.0	7	Hong Kong, China	621	3.3
8	United Kingdom	541	2.9	8	Netherlands	590	3.1
9	Hong Kong, China	535	2.8	9	Korea, Republic of	516	2.7
10	Russian Federation	523	2.8	10	Italy	479	2.5

select those countries that appear in multiple lists and for which data are consistently available. These EMEs include: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Republic of Korea, Malaysia, Mexico, Peru, Philippines, Poland, Qatar, Russian Federation, South Africa, Thailand, Turkey, and United Arab Emirates (UAE). In this section, we will analyze service trade data for these 21 EMEs.

Overall Trends and Shares

Table 3 presents the merchandize and services trade shares for these 21 EMEs. In 1980, these EMEs accounted for about 11% of the world merchandize trade (exports *plus* imports). This ratio steadily increased to about 33 per cent or the one-third of the world goods trade by 2013. Thus, the EME share tripled during this period of over three decades. In case of services trade, the share of the EMEs in total trade increased from about 8 per cent in 1980 to about 24 per cent in 2013 that implies a three-fold

Table 3. Goods and services trade shares in EMEs

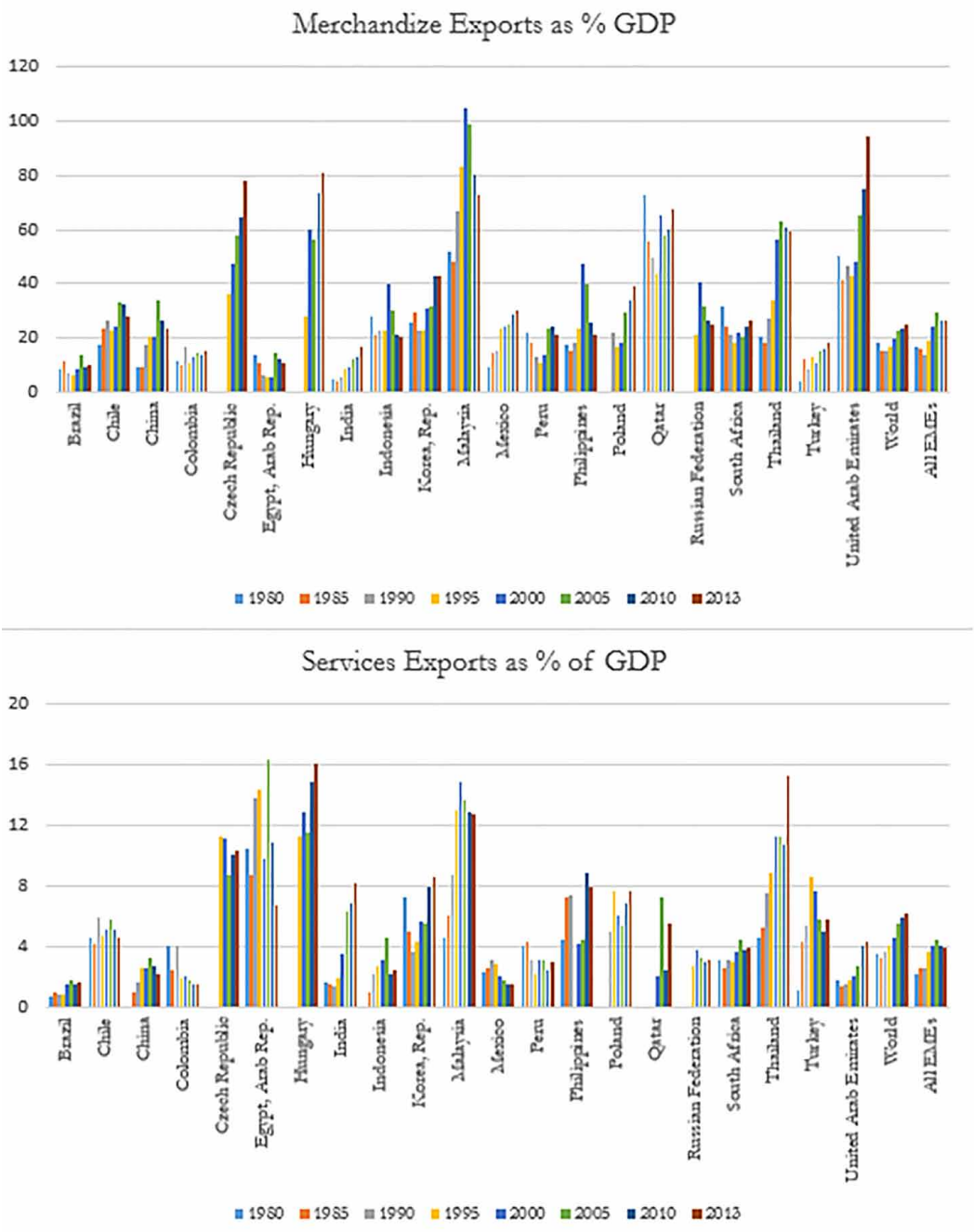
Description	1980			2000			2013		
	Exports	Imports	Total trade	Exports	Imports	Total trade	Exports	Imports	Total trade
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
EMEs share in									
World goods trade	11.1	10.9	11.0	20.3	18.3	19.3	33.6	31.4	32.5
World services trade	7.6	8.6	8.1	14.2	16.8	15.5	20.2	27.0	23.5
EMEs GDP share of									
Goods trade	16.8	16.9	33.7	24.1	22.6	46.8	26.5	24.8	51.3
Services trade	2.2	2.8	5.1	4.0	4.7	8.7	4.0	5.1	9.0

increase. If we examine exports and imports separately, imports by the EMEs increased more than did exports. This seems to indicate that as these economies grew the demand for certain services imports increased at a faster pace. Intuitively, as a country experiences growth in manufacturing sector it creates demand for a number of high-end support services as we will see below. These services are usually produced in developed countries. In terms of GDP share, goods trade was about 34 per cent of total GDP for these EMEs in 1980. This increased to more than 51 per cent in 2013. Increased trade liberalization and growth could be responsible for a large part of this increase in merchandize trade. In contrast, services trade increased from about 5 percent of total GDP of these countries to more than 9 per cent in 2013. The share of services trade is still small relative to the size of these economies. However, there are variations across these countries.

Figure 1 depicts the evolution of GDP shares of exports for both goods and services in all 21 EMEs in 5-yearly intervals from 1980 to 2010 and 2013. In Czech Republic, Hungary, Malaysia, Qatar, Thailand, and UAE, goods exports accounted for more than 50% in most recent years. The share grew and reached the maximum in 2013 in a number of countries: Czech Republic, Hungary, India, Korea, Mexico, Poland, and the UAE. In contrast, Chile, China, Egypt, Thailand achieved their maximum in 2005. Furthermore, the GDP share of goods exports has been falling for Indonesia, Malaysia, Philippines, and Russia since 2000. Overall, the GDP share of merchandize exports has been increasing globally. In contrast, overall merchandize exports share in total GDP for these EMEs reached the peak in 2005 and it has decreased since then. GDP share of services exports has been rising in the most recent decade in Hungary, India, Republic of Korea, Poland, and Thailand. In others including China, the share of services exports has declined during the period of recent global and financial crisis. Note that the GDP share of services exports is much smaller relative to merchandize exports for each of these countries. It exceeded 10% only in Czech Republic, Egypt, Hungary, Malaysia, and Thailand. The merchandize services exports share for the entire world has been persistently increasing since the early 1990s.

In Figure 2, we present the GDP shares of goods and services imports. For five EMEs, namely Czech Republic, Hungary, Malaysia, Thailand, and UAE, the share of goods imports exceeded 50% in most recent years. In contrast, services imports shares are relatively smaller and exceeded 10% for one or more years only in Egypt, Hungary, Malaysia, Qatar, Thailand, and UAE. Chile, Czech Republic, Hungary, India, Republic of Korea, Mexico, Peru, Poland, South Africa, Thailand, Turkey and UAE have witnessed increases in GDP share of goods imports. Similarly, Hungary, India, Korea, Poland, Turkey, and UAE

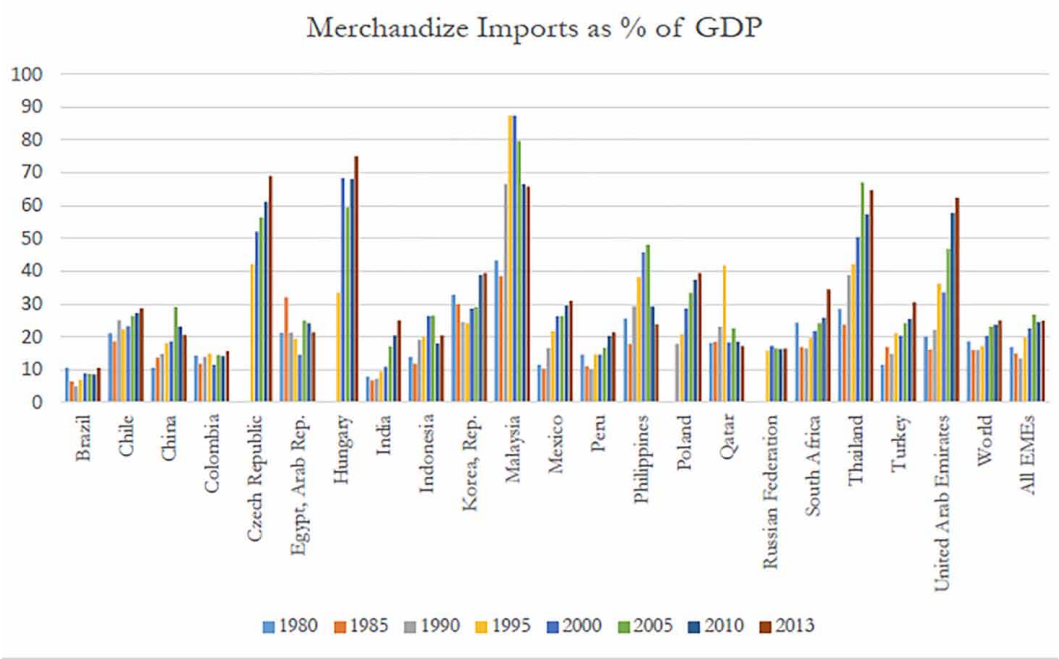
Figure 1. Merchandize and services exports as % of GDP in the EMEs: 1980 - 2013

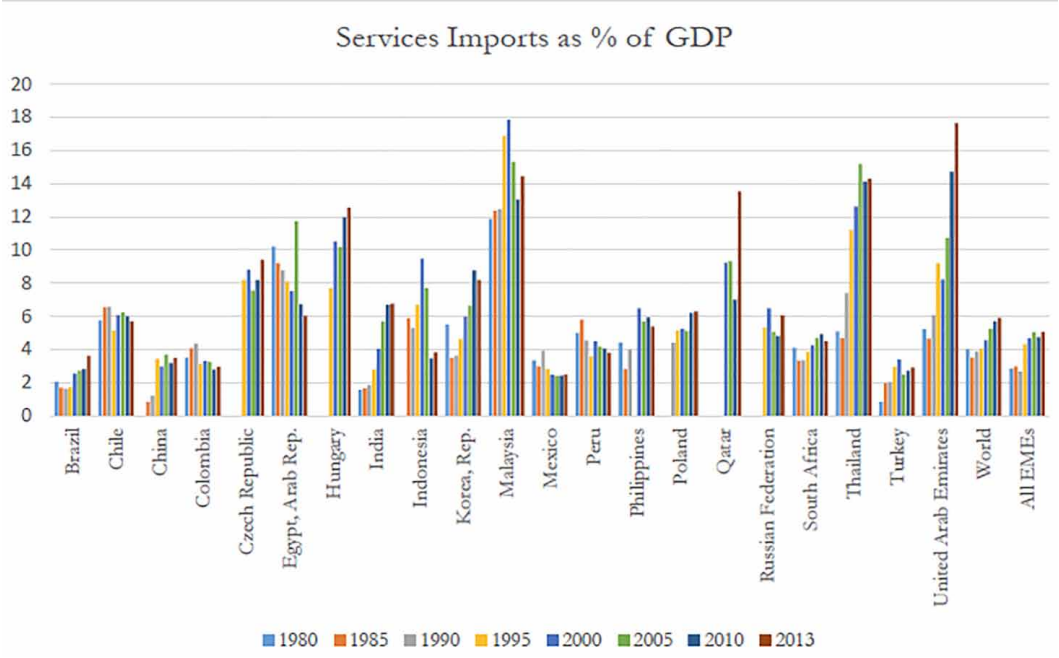


have seen sustained increase in GDP share of services imports. Overall, although the GDP share of services imports has been constantly rising for the world, it has changed little for the EMEs since 2000.

We further examine how the country shares of services exports and imports in total for the EMEs have evolved over time. Figure 3 presents these shares at 5-yearly intervals from 1980 to 2010 and 2013. While the export share has been consistently increasing for China since the mid-1980s, it has been ris-

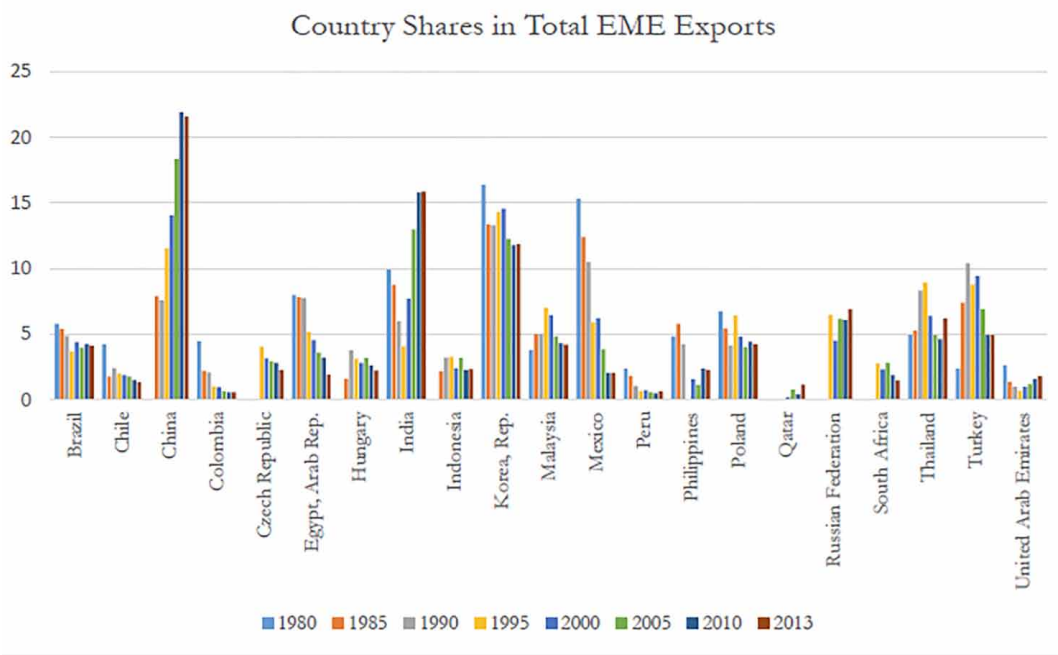
Figure 2. Merchandize and services imports as % of GDP in the EMEs: 1980 - 2013

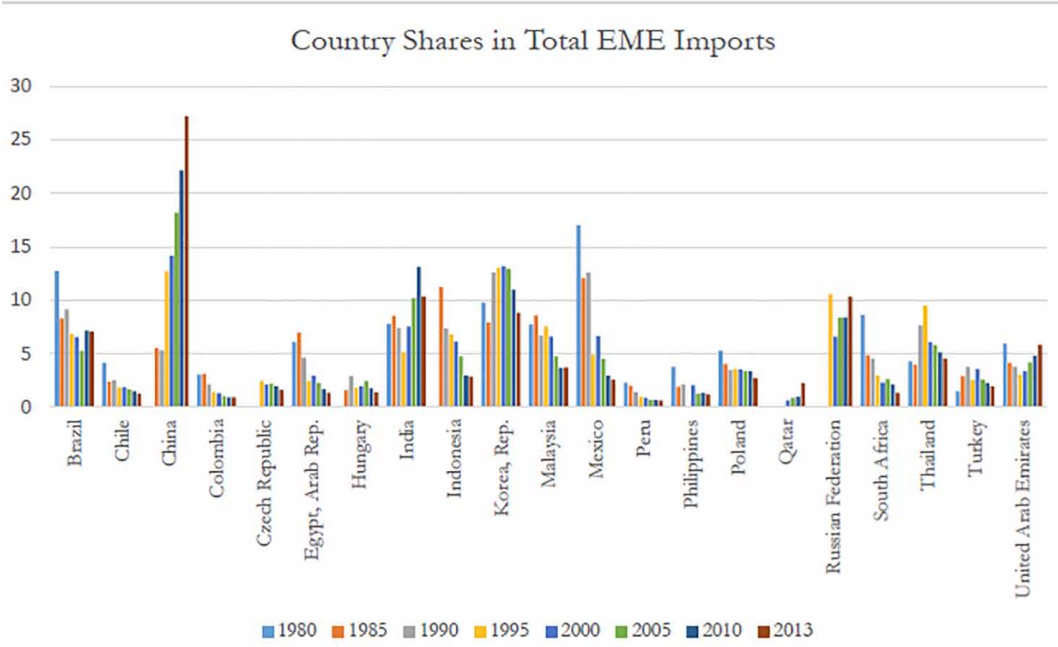




ing for India since the mid-1990s. These two countries together accounted for more than 37 per cent of total services exports from the EMEs in 2013. Although, with about 12 per cent of total EMEs exports, Korea is a relatively large exporter, its share has been declining. For most other EMEs, the shares are relatively small and have been either declining or fluctuating. With more than 25 per cent of total EME service imports, China is the largest importer in 2013 followed by India at the distant second with about

Figure 3. Country shares in total EME exports and imports of services: 1980 – 2013





10 per cent. For some EMEs, such as Chile, Colombia, Czech Republic, Hungary, Peru, and Qatar, both services exports and imports accounted for less than 5 per cent of total EME exports and imports during this time period.

Overall, we can draw a few conclusions about goods and services trade in EMEs. *First*, there has been a steady growth of goods and services trade in EMEs. *Second*, a few of these EMEs (e. g. Czech Repub-

lic, Hungary, Malaysia, Thailand, and UAE) are heavily dependent on merchandize trade as their total trade (exports plus imports) shares in respective GDPs exceeding 100 per cent. However, services trade does not play such a role although its importance has grown for most EMEs. Services trade accounted for more than 25 per cent of GDP only in Hungary, Malaysia, and Thailand. *Third*, among the EMEs, China, India, and Korea are the most dominant players in services exports and imports. For China, both export and import shares have been rising while for India the export share has been consistently rising. However, the fact that the shares of other EMEs have been declining does not necessarily mean that the services exports and imports have been decreasing in those countries. In fact, they have been growing although the growth has been relatively slower than the leading EMEs.

Share and Growth of Information Intensive Services (IISs)

As we discuss above, the unprecedented advances in ICT have contributed to the growth of trade in goods as well as in services. Previous studies (Liu and Nath 2016) show that there has been a disproportionately larger growth of trade in IISs. IISs involve creating, processing, and transmitting information. In the past, transportation and travel – two non-IISs – were the primary service trade items. Some of the IIS categories were either non-existent or were traded in such negligible amounts that the trade values were not reported separately and were clubbed together as other commercial services. However, with the proliferation of ICT, trade in communication (telecommunications) services, financial and insurance services, computer and information services, professional, business, and technical services grew in volume and value. Therefore, in most recent years, data have been reported separately for these categories. However, for some EMEs, these services still account for a negligible share of total services trade.

Table 4. reports the percentage share of IISs in total services exports, imports, and total trade (exports *plus* imports) for five leading EMEs in 2000 and 2013. Exports and imports data on IISs for 2000 are obtained by subtracting corresponding data for 'construction' and 'personal, cultural and recreational services' from 'other commercial services'.[5] As the table indicates, in all five countries, the share of IISs increased for exports and total trade. However, the import shares have slightly declined for China and India. As the service industries grow in these two economies and foreign direct investments (FDI) take place in service producing sectors these declines may be explained by substitution of imports by domestic production of those services. For Brazil and India, IISs accounted for more than half of services

Table 4. Share of information-intensive services in five leading traders of IISs among EMEs: 2000 and 2013

Country	2000			2013		
	Export	Import	Total trade	Export	Import	Total trade
	(1)	(2)	(3)	(4)	(5)	(6)
Brazil	57.4	42.1	47.6	64.5	47.9	53.1
China	31.6	31.4	31.5	50.8	30.8	38.5
India	60.5	38.4	48.7	73.4	37.5	57.1
Republic of Korea	28.7	43.5	36.3	35.6	47.1	41.2
Russian Federation	24.7	27.6	26.5	39.1	33.0	35.1

trade in 2000 and they were joined by China in 2013. Imports of IISs were less than half of total services imports for all five EMEs in 2000 as well as 2013 although these shares increased for three countries: Brazil, Korea, and Russia.

To shed some lights on the exact nature of these IISs, we can take a look at the distribution of services trade by various disaggregate categories for the most recent year. Data are not available by this level of disaggregation for earlier years and therefore we present the export and import shares for each of the five countries for 2013 in Table 5. Other businesses that include a wide range of IISs such as legal, accounting, management consulting, public relations services, advertising, market research and public opinion polling, research and development services, architectural, engineering, and other technical services, accounted for the largest shares in both exports and imports for all five leading EMEs. However, there are variations across countries For example, it accounted for more than 80 percent of exports of IISs in Brazil while it is about 46 per cent in India. In contrast, computer and information services accounted for about 44 per cent of total IISs exports from India. Imports of royalties and license fees account for about one-fifth of IISs imports in China, Korea, and Russia. These are the payments these countries have to make for using trademarks, industrial processes, and software to their trading partner countries. Exports of financial services from Brazil and imports of insurance and financial services to India have large shares in their respective IISs trade.

Overall, EME trade in IISs has been increasing, particularly among the leading nations. Going by the relative importance of various IIS items for different countries, we may infer that these EMEs have comparative advantages in different IISs. In fact, there is some evidence of that in the literature (e.g. see Liu et al 2015). Furthermore, as previous studies (Freund and Weinhold 2002, Liu and Nath 2013 & 2016) indicate, this growth in IISs trade may have been facilitated by increased use of ICT. As countries use ICT as a vehicle of international trade in services, it has substantial implications for cyber security.

Explaining the Rise in Information-Intensive Services Trade in EMEs

We will now present some of the intuitively plausible explanations for the growth of cross-border trade in services in general and IISs in particular in the EMEs. However, we will neither develop any formal theory nor will we empirically confirm or refute any plausible hypothesis.

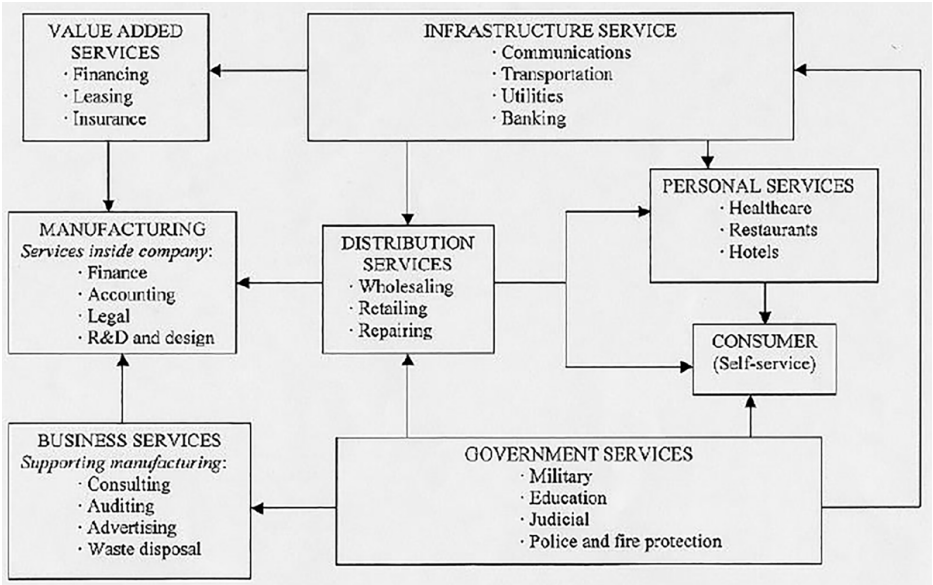
Table 5. Distribution of IIS exports and imports by component items in five leading EMEs in 2013

Component Service Items	Brazil		China		India		Korea		Russia	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Telecommunication services	1.0	0.7	NA	NA	2.0	2.3	1.5	2.1	6.0	6.6
Insurance services	1.9	3.6	3.9	21.9	1.9	12.6	1.6	1.6	2.2	3.5
Financial services	11.5	4.2	3.1	3.7	5.3	11.7	9.0	1.9	6.6	6.2
Computer and information services	1.8	11.5	15.0	5.9	44.4	5.6	2.3	1.3	10.1	7.8
Royalties and license fees	2.4	8.6	0.9	20.8	0.4	8.3	10.2	19.2	2.9	19.8
Other business services	81.3	68.4	77.0	47.1	45.6	59.2	74.4	73.3	71.1	54.1
Audio-visual and related services	0.1	2.9	0.2	0.7	0.5	0.4	1.0	0.7	1.1	2.0

First, the ICT advances since the 1990s – particularly the development and proliferation of the internet mobile phones - have played (and will play) a key role in the growth and expansion of trade in IISs. A growing number of studies have provided evidence of a positive relationship between ICT advances and the growth of trade in goods as well as in services.[6] ICT advances can stimulate trade in IISs through both direct and indirect channels. For example, by lowering the cost of communicating information or transferring data this technology provides a direct channel of influencing such trade. The low cost not only helps with the actual delivery of the service but also with the entry into the market in another country. In contrast, ICT-enabled service innovations such as geographically dispersed production of service components (of which service outsourcing is an example) and assembly provide indirect channels for ICT to affect services trade.[7] Using data for forty EMEs from 1995 to 2010 Liu and Nath (2013) show that Internet subscriptions and Internet hosts have significant positive effects on both exports and imports in EMEs. Although they do not identify the specific channels through which these ICT variables affect trade, the evidence of significant effects itself highlights the importance of ICT for trade. In a follow-up study (Liu & Nath 2016) using cross-country disaggregated data on various services trade items, they show that ICT development has significant positive impacts on exports of other business services and transportation services and the imports of 'insurance services', 'telecommunications services', and 'travel services'. This study also shows that ICT development is more important for growth of services trade in EMEs than in advanced economies.

Second, as the economies grow there is higher demand for services in general and IISs in particular. Besides the growth in demand from consumers with higher per capita income, the range and complexity of economic activities in those economies also create vast demand for a number of IISs. For example, the diagrammatic illustration of Quinn (1992) shows how the size and growth of manufacturing can create demand for a host of services. As Figure 4 shows, manufacturing needs direct support of value-added services like financing, leasing, and insurance; business services like consulting, auditing, and

Figure 4. Interactive role of services (Quinn 1992)

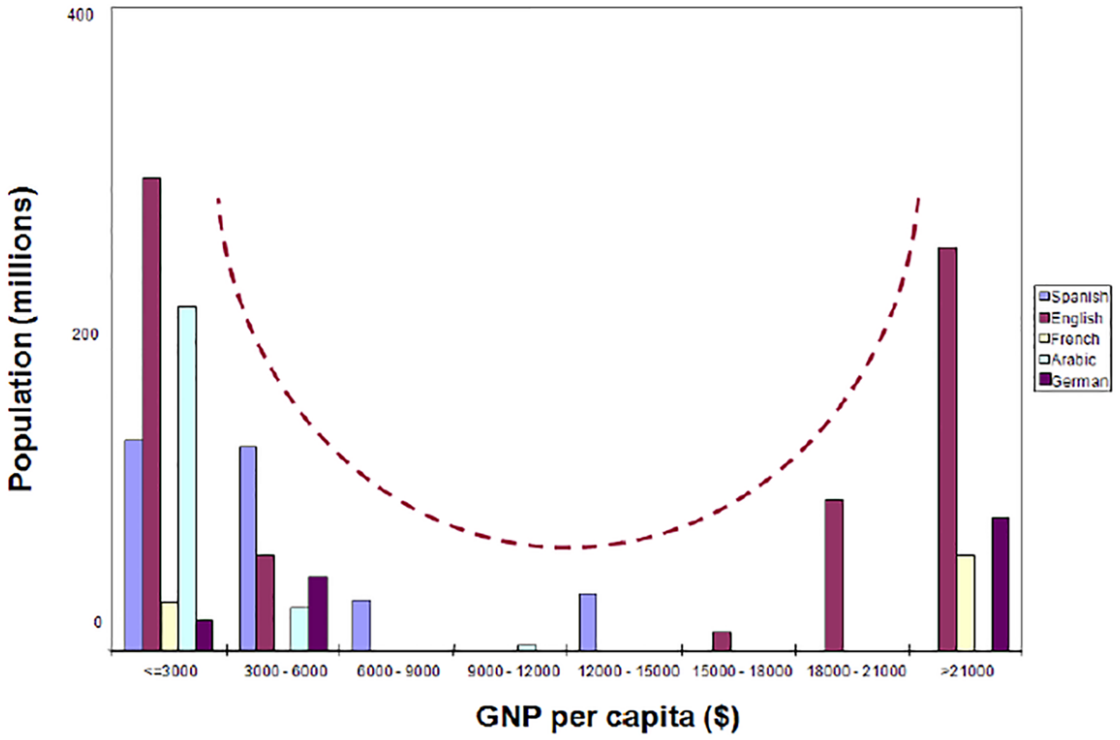


advertising; and distribution services like wholesaling, retailing, and repairing. Then, there is an additional layer of infrastructure services, government services, and personal services behind these support services. Many of these support services, particularly the IISs, can be produced at lower costs in EMEs and traded across borders.

Third, the decades since the early 1990s have witnessed deregulation of service industries and liberalization of foreign trade and investment regimes in many EMEs around the world. Since service industries are heavily regulated, it is often very difficult to attract foreign investment and trade. However, due to the technology-driven enhanced tradability of services, many governments around the world have deregulated a number of IISs primarily to increase competition and gain efficiency. Similarly, bilateral trade agreements and policies to encourage FDI in services also help increase trade in services primarily through affiliated trade.[8] Thus, regulatory reforms and liberalization policies adopted by countries across the world provided further impetus for growth in services trade.

Finally, unlike in merchandise trade, language and culture play an important role in services trade. Apte and Karmarkar (2007) argue that the topography of services trade and outsourcing will be strongly colored by language, culture, and colonial history. In particular, language barriers will essentially direct and define this topography for most consumer services that will be traded across borders. Figure 5 shows the distribution of world population for five major languages by different income groups, measured by GNP per capita. It is clear from the figure that the world English market for services is unique in its size,

Figure 5. Distribution of different language speaking population by income (Modified from Apte and Karmarkar 2007)



geographic distribution and, most importantly, in potential for trade. It also happens to be one of the most open market. Although the distribution of Spanish-speaking population has some similarities, it is less extreme and therefore offers less opportunity for those in poorer countries. Since other major language groups are concentrated in one or a few countries, the potential for offshoring and international trade is rather limited. This might well prove to be a boon for those engaged in services in those countries, since they will not be subject to the intense competition seen due to outsourcing and offshoring in the English and perhaps the Spanish worlds.

There could be additional factors that affect and determine services trade in EMEs. However, the above discussion provides only a partial list of factors that have been suggested in the literature.

CHALLENGES

As trade in services grows in EMEs, these countries also face challenges. If services trade were to become a welfare enhancing economic activity, recognizing these challenges and formulating and implementing appropriate policies are extremely important. These challenges may come from the impediments that get along the way of promoting IISs trade or may come arise due to rapid growth of trade in these services.

First, in order to take full advantage of IISs trade, a country must have well-developed ICT infrastructure and ICT capabilities. However, the EMEs in our sample are at different stages and states of ICT development. Table 6 shows the ranking of these countries in terms of ICT development. Among these 21 countries, while Korea ranks second globally, India ranks 129 in 2013. The ranking is based on a composite ICT development index measured by the International Telecommunication Union (ITU). This index includes three aspects of ICT development: ICT readiness (infrastructure, access), ICT use, and ICT capability. Due to this inequality, all countries may not have been able to realize the full potential of IISs trade. Thus, the countries that are falling behind must invest in all three aspects of ICT development.

Second, increased trade in IIS may make countries vulnerable to cyber-attacks. Thus, issues related to cyber security become extremely important. In particular, trade in certain types of IISs such as financial services, insurance services, are extremely vulnerable to cyber-attacks exposing a large number of consumers in different countries to the risks of identity theft and other associated risks. Many firms in the U.S. and other advanced countries offshore a part of their operations to third-party vendors in EMEs giving access to critical information about the businesses and consumers. This may create a cyber security risk that may well be considered in the realm of national security. Since cyber-crimes are new, some countries do not have the legal and technical framework to handle those crimes. Besides, if there is no uniformity in laws and regulations across countries, it may lead to additional problems.

Third, GATS mandates WTO member governments to progressively liberalize trade in services through successive rounds of negotiations. The negotiations in the Doha Round are being conducted on both bilateral and multilateral tracks. There are four major areas of services negotiations: market access; domestic regulations; GATS rules on emergency safeguard measures, government procurement and subsidies; and implementation of least-developed countries (LDC) modalities. These are all very relevant areas for the growth services trade in EMEs. The GATS preamble includes the aim of increasing the participation of developing countries in services trade. At the Eighth Ministerial Conference in 2011, WTO members adopted a waiver to allow preferential treatment for services and service suppli-

Table 6. Global ranks of the EMEs according to ICT development in 2013

Sl. No.	Country	IDI Rank
1	Brazil	65
2	Chile	56
3	China	86
4	Colombia	77
5	Czech Republic	41
6	Egypt, Arab Republic of	89
7	Hungary	46
8	India	129
9	Indonesia	106
10	Korea, Republic of	2
11	Malaysia	71
12	Mexico	95
13	Peru	105
14	Philippines	103
15	Poland	44
16	Qatar	34
17	Russian Federation	42
18	South Africa	90
19	Thailand	81
20	Turkey	68
21	United Arab Emirates	32

ers from least-developed countries. The 2013 Bali Ministerial Decision has established various steps to encourage WTO members to make use of this waiver. Although the negotiations have made some progress, there are more sticking issues that need to be addressed. The relative underdevelopment of the service sector, presence of heavy regulations or no regulation, obsolete legal framework are some of these issues in developing countries.

Fourth, as we discuss above, services trade is not entirely independent of the cultural contexts of the countries that are involved in trade. With the increase in services trade, there may be an apprehension of cultural invasion and as such certain societies may be resistant to what could be economically viable and profitable opportunities. In particular, since language is such an important factor in services trade that there may be concerns about marginalization of the regional and/or local languages. These concerns may create formidable challenges to the growth of services trade, particularly in developing countries.

In this section, we have discussed only a few challenges. As service trade grows, there will be new problems and challenges. In particular, ICT-enabled service innovations and trade are growing very rapidly posing new challenges and concerns.

CONCLUSION

Global trade in services has increased significantly over last three decades. Earlier, the growth was confined primarily to trade among advanced economies. In more recent times, even developing countries – especially, the emerging market economies (EMEs) – have experienced substantial increase in services trade. Services trade still accounts for only a small share of national income in most EMEs. However, one important trend has been the rapid growth of information-intensive services (IISs). This paper examines the growth and patterns of services exports and imports from and to a number of EMEs. The analysis indicates that the importance of services trade has been growing for most EMEs. Further, among the EMEs, China, India, and Korea are the most dominant players in services exports and imports. For China, both export and import shares have been rising while for India the export share has been consistently rising. This paper further discusses some of the intuitively plausible explanations for the growth of trade in services in general and in IISs in particular. It also discusses some of the challenges associated with the growth of IISs trade.

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ENDNOTES

1. For a discussion on the defining characteristics of services vis-à-vis goods, see Apte et al. (2008). Also, for a discussion on the characteristics of services that affect their tradability, see Lennon (2009)
2. See Apte and Nath (2013) for a brief but comprehensive discussion of these developments
3. For a discussion on the efforts made by the Bureau of Economic Analysis (BEA), see Koncz-Bruner and Flatness (2010).
4. For some detailed analysis in the following section, we use shorter sample periods, depending on the data availability.
5. For detailed description of various service trade items, see Appendix 1.
6. Freund and Weinhold (2002) use bilateral trade data between the U.S. and 31 other countries to show that the Internet penetration in foreign countries has a positive impact on services trade. Freund and Weinhold (2004) further show that use of the Internet also contributes positively to the growth of merchandise trade. They argue that the Internet stimulates exports by lowering the costs of entering the market. However, using data for a sample of 98 countries that include both developed and developing countries, Clarke and Wallsten (2006) find that Internet penetration has a significant positive effect only on exports from developing to the developed countries and not on exports to developing or from developed to other developed and developing countries.
7. These innovations are a major part of the fundamental changes in services, collectively known as service industrialization. For a discussion, see Karmarkar (2010)
8. Mann and Civril (2008) provide evidence in support of this.

APPENDIX

Definitions and Coverage of Services Trade

Transportation services covers sea, air and other including land, internal waterway, space and pipeline transport services that are performed by residents of one economy for those of another, and that involve the carriage of passengers, the movement of goods (freight), rentals (charters) of carriers with crew, and related supporting and auxiliary services

Travel includes goods and services acquired by personal travelers, for health, education or other purposes, and by business travelers. Unlike other services, travel is not a specific type of service, but an assortment of goods and services consumed by travelers. The most common goods and services covered are lodging, food and beverages, entertainment and transportation (within the economy visited), gifts and souvenirs.

Other commercial services correspond to the following components defined in'Balance of Payments Manual 5 (BPM5):

(i) *communications services* includes telecommunications, postal and courier services. Telecommunications services encompasses the transmission of sound, images or other information by telephone, telex, telegram, radio and television cable and broadcasting, satellite, electronic mail, facsimile services etc., including business network services, teleconferencing and support services. It does not include the value of the information transported. Also included are cellular telephone services, Internet backbone services and on-line access services, including provision of access to the Internet;

(ii) *construction* covers work performed on construction projects and installation by employees of an enterprise in locations outside the territory of the enterprise (the one- year rule to determine residency is to be applied flexibly). In addition goods used by construction companies for their projects are included which implies that the "true" services component tends to be overestimated;

(iii) *insurance services* covers the provision of various types of insurance to non-residents by resident insurance enterprises, and vice versa, for example, freight insurance, direct insurance (e.g. life) and reinsurance;

(iv) *financial services* covers financial intermediation and auxiliary services provided by banks, stock exchanges, factoring enterprises, credit card enterprises, and other enterprises;

(v) *computer and information services* is subdivided into computer services (hardware and software related services and data processing services), news agency services (provision of news, photographs, and feature articles to the media), and other information provision services (database services and web search portals);

(vi) *royalties and license fees,* covering payments and receipts for the use of intangible non-financial assets and proprietary rights, such as patents, copyrights, trademarks, industrial processes, and franchises;

(vii) *other business services*, comprising trade-related services, operational leasing (rentals), and miscellaneous business, professional and technical services such as legal, accounting, management consulting, public relations services, advertising, market research and public opinion polling, research and development services, architectural, engineering, and other technical services, agricultural, mining and on-site processing; and

(viii) *personal, cultural,* and *recreational services* is subdivided into two categories, (i) audiovisual services and (ii) other cultural and recreational services. The first component includes services and fees

related to the production of motion pictures, radio and television programs, and musical recordings. Other personal, cultural, and recreational services includes services such as those associated with museums, libraries, archives, and other cultural, sporting, and recreational activities.

13 Climate change and Indian agriculture

Impacts on crop yield

Raju Mandal and Hiranya K. Nath

1 Introduction

There has been indisputable evidence of changes in temperature, precipitation, and extreme weather events. However, there is less of a consensus as to what causes these climatic changes. Since agriculture depends critically on the climatic factors, it is expected that such changes in the climate would have impacts on different aspects of agriculture. The anticipated drastic changes in temperature and rainfall patterns around the globe over the next century are likely to exacerbate the impact on agricultural productivity. Furthermore, people adapt their agricultural practices and cropping patterns in response to the evolving weather patterns. These adaptations too have an impact on agriculture. Thus, there are direct as well as indirect impacts of climate change. The study of the impacts of climate change on agriculture is extremely important particularly in the context of developing countries where a sizable portion of the population relies on agriculture for life and livelihood.

Agriculture plays a vital role in the Indian economy. Together with fishery and forestry, it accounts for about 18 per cent of its gross domestic product (GDP). Over 58 per cent of the rural households depend primarily on agriculture for their livelihood. Thus, it is extremely important to know the impacts of changes in weather conditions and the climate on agricultural productivity and growth. It is in this context that this chapter reviews the extant literature on climatic impacts on agriculture focusing on the studies that have been conducted on India. The empirical evidence on the effects of climate change on agriculture has been mixed. Applying nonparametric median regression technique to state-level time series data on average yield of rice and wheat, and on temperature and rainfall, the present study further investigates the impacts of changes in these climate variables on the yields of these two crops. The results indicate that rising temperature has a significant negative impact while rising rainfall variability has a significant positive impact on the average rice yield. Furthermore, increasing temperature variability over the crop year appears to have a significant positive impact on wheat yield.

organize and discuss these empirical studies according to the methodological strands to which they belong. In section 4, we report and discuss the results from our own estimate of climatic impacts on agriculture using state-level data. The final section includes our concluding remarks.

2 The impacts of climate change on agriculture: empirical evidence from across the globe

There is a substantial empirical literature on how climate changes impact agriculture using data on various crops from different parts of the world. The initial studies mostly focused on developed countries (e.g., Kaiser et al., 1993; Mendelsohn et al., 1994; Adams et al., 1998; Lewandrowski and Schimmelpfennig, 1999). However, some of the relatively recent studies examine climatic impacts on agriculture in developing countries as well (e.g., Sanghi and Mendelsohn, 2008; Moula, 2009; Deressa and Hassan, 2009; Sarker et al., 2012; Poudel and Kotani, 2013). This section reviews this literature that investigates the climate change impacts on agriculture drawing empirical evidence from both developed and developing countries. It especially focuses on the nature of impacts and its geographical characterization.

The empirical literature demonstrates that there have been considerable variations in the impacts of climate change on crop yield across regions and crops. These variations are primarily due to differences in the current levels of climatic conditions across geographical regions and also because of the fact that different crops have varied sensitivities to climatic conditions. An increase in temperature, for example, can have both positive and negative impact on crop yields depending on the latitude of a region and the temperature sensitivity of a particular crop. In the middle and high latitudes, increased temperatures lengthen growing seasons and expand crop producing areas pole-ward, thereby benefiting countries in these regions (Rosenzweig and Hillel, 1995). Further, as Parry et al. (1999) show, climate change increases yields in high and mid-latitudes and decrease yields at lower latitudes. Rosenzweig and Iglesias (1994) further note that for a 4°C warming and assuming CO_2fertilization effect, yields in mid and high latitude countries (e.g., the northern United States and Canada) may increase, but yields in low latitude countries (e.g., Brazil) decline. Magrin et al. (2005) in a study on Argentina find a positive impact of climate change on crop yields. Overall, the biophysical effects of climate change on agricultural production will be positive in some agricultural systems and regions, and negative in others, and these effects will also vary through time (Parry et al., 2004).

However, several other studies find temperature to have a negative impact on crop yields. This is mainly because an increase in temperature leads to higher respiration rates, speeding up of seed formation, and, consequently, to lower biomass production resulting in lower yields (Adams et al., 1998). This negative effect of temperature rise is especially pronounced in semi-tropical and tropical conditions because many crops are already at their tolerance limits of temperature in those regions (Jayaraman, 2011). Ortiz et al. (2008) present evidence

in support of this for wheat in certain zones of the Indo-Gangetic plains where optimal temperatures already exist. Even in high latitudes, temperature increases beyond 1–3°C would result in lower yields. Increase in precipitation, on the other hand, may benefit semi-arid and other water-short areas by increasing soil moisture while it may aggravate problems in regions with excessive water (Adams et al., 1998). Some of these results are also validated by Rosenzweig and Parry (1994) who find that while some countries in the temperate zone would benefit from climate change, many countries in the tropical and subtropical zones would be vulnerable to its adverse impacts.

The positive impacts of climate change as documented in some studies are mainly associated with the augmentation of CO_2 concentration and partly due to moderate temperatures in high altitudes. An increase in CO_2 concentration in the atmosphere enhances water use efficiency and net photosynthesis rate by crops thereby contributing to crop yield. Luo et al. (2003) present evidence of increase in wheat yield under all scenarios of CO_2 levels in South Australia. Climate change may indirectly affect crop production via changes in the incidence and distribution of pests and pathogens, increased rates of soil erosion and degradation, and increased tropospheric ozone levels due to rising temperatures and water run-off (Adams, 1986; Adams et al., 1998).

Attavanich and McCarl (2014) study the effects of increases in CO_2 concentration and projected climate change on the mean and variance of U.S. yield for corn, sorghum, soybeans, winter wheat and cotton. In general, an increase in CO_2 concentration leads to higher mean yields for these crops. Furthermore, increases in climate variability decreases mean crop yields and increases their variance. The effect of CO_2fertilization is generally found to be outweighing the effect of climate change on mean crop yields in many regions resulting in an increase in the yields of these crops.

Al-Bakri et al. (2010) in their study on Jordan find the responses of wheat and barley to be different under different climate change scenarios. For both crops, there is a positive relationship between a change in rainfall and a change in expected yield. An increase in air temperature is expected to reduce yield of barley. In contrast, an increase in temperature is likely to increase wheat yield in most cases.

For South Africa, Benhin (2008) reports that a 1 per cent increase in temperature leads to about US$80.00 increase in net crop revenue while a 1 mm/month fall in precipitation leads to US$2.00 fall with significant seasonal differences in impacts. Using selected climate scenarios, the study predicts that crop net revenues are expected to fall by as much as 90 per cent by 2100 with small-scale farmers being most affected.

Researchers have also examined the effects of changes in temperature and rainfall variability on crop yield. Variability is measured either by temporal variations in these climate variables or by extreme (maximum and minimum) temperature or rainfall measures. For example, Cabas et al. (2010) note that average crop yield increases with warmer temperatures and a longer growing season which is only partially offset by the decreases due to a rise in the variability of temperature

and rainfall in Southwestern Ontario, Canada. The positive impact of a longer growing season offsets the negative effect of greater heat and rainfall variability resulting in higher average yields in the future.

Sarker et al. (2012) in a study on climate change impact on yields of different varieties of rice in Bangladesh find that maximum temperature and rainfall have positive impact on *Aus* yield while maximum temperature and rainfall have positive impact and minimum temperature has negative impact on *Aman* yield. In contrast, they find that maximum temperature has a negative impact and minimum temperature has a positive impact on *Boro* yield.

Welch et al. (2010) find that minimum temperature has negative and maximum temperature has positive impacts on rice yields in Asia. The negative impact could be explained by increased respiration losses during vegetative phase and reduced grain-filling duration and endosperm cell size during ripening phase. Chen et al. (2004) while examining the impacts of annual average climate conditions on major agricultural crops across the United States find the effects to differ by crop. More rainfall causes corn yield levels to rise while decreasing yield variance. Temperature has the reverse effects. For sorghum, higher temperatures reduce yields and yield variability. More rainfall increases sorghum yields and yield variability.

Knox et al. (2012) assess the projected impacts of climate change on the yield of eight major crops in Africa and South Asia using a systematic review and meta-analysis of data from 52 original publications. They show that the projected mean change in yield of all crops is –8 per cent by the 2050s in both regions. Across Africa, estimated mean yield changes are found to be of the magnitudes of –17 per cent(wheat), –5 per cent per cent (maize), –15 per cent(sorghum) and –10 per cent(millet) and across South Asia of –16 per cent(maize) and –11 per cent(sorghum). However, no mean change in yield is detected for rice.

Mendelsohn et al. (1994) in their pioneering study note that higher winter and summer temperatures are harmful for crops while higher fall temperatures and higher winter and spring rainfall are beneficial for crops. Additionally, higher summer or fall rainfall is found to be harmful. Furthermore, they find evidence of non-linear impacts of climatic factors.

According to Mendelsohn (2007), the estimated global combined impacts of temperature and precipitation changes vary from a loss of 0.05 per cent to a gain of 0.9 per cent of agricultural GDP. The greenhouse effect is responsible for between 2.6 per cent and 5.4 per cent of the increase in agricultural production between 1960 and 2000. Most of this impact is due to the beneficial impacts of carbon fertilization. Consistent with the findings discussed above, climate change has also made some small contributions, generally helping mid and high latitude countries and slightly damaging low latitude countries. The percentage gains from warming, however, have been larger in developed countries (3–6 per cent) compared to developing countries (0.4–2 per cent).

A study on the climate sensitivity of Brazilian and Indian agriculture by Sanghi and Mendelsohn (2008) reports that temperature has a more powerful effect

net revenue may fall 12 per cent in India and 20 per cent in Brazil without carbon fertilization. Given a broader range of possible climates, global warming could cause annual damages in Brazil between 1 per cent and 39 per cent and between 4 per cent and 26 per cent in India by the end of the next century, although some of these effects may be potentially offset by carbon fertilization.

Seo et al. (2005) find that while warming is harmful, increases in rainfall are beneficial for agriculture in Sri Lanka. The expected benefit ranges from 11 per cent to 122 per cent of the current net revenue. In contrast, the loss due to increases in the temperature ranges from 18 per cent to 50 per cent of the current agricultural productivity.

Isik and Devadoss (2006) examine the impact of climate change on crop yield and yield variability for wheat, barley, potato, and sugar beet yields in the state of Idaho in the United States. Their results show that climate change has modest effects on the mean crop yields, but it significantly reduces the variance and covariance for most of the crops considered. Precipitation has a negative impact on the mean yield of wheat, barley, potato and sugar beets. Temperature has a positive impact on the mean yield of wheat, sugar beets and potato while it has a negative impact on the mean yield of barley and potato. Furthermore, increases in the rainfall and temperature tend to reduce the variability of wheat yields and barley. The effect of precipitation on potato yield variability is positive. The precipitation has a negative impact and the temperature has a positive impact on variance of sugar beet yields.

Poudel and Kotani (2013) examine the impact of climatic variations on yield and its variability for rice and wheat in central region of Nepal. An increase in the variance of both temperature and rainfall has adverse effects on crop production. But a change in the mean level of temperature and rainfall induces heterogeneous impacts depending on growing seasons, altitudes and types of crops grown. Moreover, climate variations induce greater impacts on rice yields while they do not seem to have much of an effect on wheat yields.

Deschenes and Greenstone (2007) predict that climate change will lead to a 4 per cent increase in annual agricultural profits in the United States. Moreover, the estimates of the effect of climate change on the value of agricultural land range from −18 per cent to 29 per cent.

Schlenker and Roberts (2009) find evidence of a non-linear impact of temperature rise on the crop yields in the United States. According to them, yields increase up to a particular level of temperature beyond which the same decline. More specifically, yields increase with temperature up to 29° C for corn, 30° C for soybeans, and 32° C for cotton but temperatures above these thresholds are very harmful.

Schlenker and Lobell (2010) investigate the impact of climate change on five

Overall, the empirical evidence on climatic impacts on agriculture has been mixed. There are wide variations in the impacts of climate change on agriculture across different regions and crop varieties.

3 The impacts of climate change on Indian agriculture

Against the backdrop of a huge population size along with changes in land use patterns, the Indian economy is faced with the enormous challenge of food and nutrition security. The challenge has been exacerbated due to ongoing global climate change that has the potential of adversely affecting the agricultural sector of the country where majority of the population depends on it for their life and livelihood and who, being poor, have the limited capacity to adapt to the adverse effects.

There are several recent studies that investigate climatic impacts on agriculture in India. The results reported in these studies that use different methodologies and datasets on a variety of crops are mixed. This section reviews this literature.

Most studies examining the impacts of climate change on Indian agriculture use crop simulation models. Several of them find evidence of a negative impact of climate change on crop yields. Soora et al. (2013) while examining regional vulnerabilities of rice yields to climate change in India find that rice yield would decline in all three climate change scenarios that they consider. Irrigated rice yields are projected to decline by 4 per cent by 2020, 7 per cent by 2050 and 10 per cent by 2080. Rainfed rice yields, on the other hand, are likely to decline by 6 per cent by 2020, and marginally (<2.5 per cent) by 2050 and 2080 under the projected climate change scenarios. They also find evidence of spatial variation in the magnitude of climate change impacts. Singh et al. (2017) projects an overall reduction in productivity of rice crop in all main rice producing states in India. Due to an increase in temperature the crop will mature early and yield will decrease in the future decades. Likewise, the study by Aggarwal et al. (2010) on the Upper Ganga Basin reveals that climate change is likely to adversely affect rice and wheat yields. Irrigated rice yield is likely to decline up to 23 per cent in several parts of the study region and the yield loss is projected to be higher in the high rainfall zones where rainfall is projected to increase further. Climate change is also likely to adversely affect the wheat yields in nine out of eleven districts under consideration. The projected increase in CO_2 will not be enough to compensate for the adverse effects of temperature rise. Furthermore, a study by Mishra et al. (2013) shows a decrease in the rice and wheat yields in the upper and middle Indian Ganga Basin (IGB) during 2011–2040. The results for lower IGB, however, are somewhat contradictory. In the upper IGB the projected rate of change in rice yield ranges from −5.9 to −43.2 per cent while in the lower IGB it ranges between +1.2 and −22.6 per cent. Similarly, the projected rate of change in wheat yield varies from −6.1 to −20.9 per cent in the upper IGB as compared to 5.4 to −1.7 per cent in the lower IGB.

heterogeneity in the impacts of climatic variables across the yield distributions. The direction of the climatic impacts on rice yields is found to be highly dependent on the agro-climatic zones. In most agro-climatic zones kharif rice yield is found to increase with an increase in average temperature. Moreover, the monsoon-dependent kharif rice is more sensitive to temperature and precipitation, while the winter season rabi rice is largely resilient to changes in the levels of climate variable. Mandal and Nath (2017) conduct a similar study for Assam and show that there is substantial heterogeneity in the impacts of changes in temperature and rainfall across seasonal rice varieties (autumn, winter and summer), agro-climatic zones and the distribution of rice yield.

Applying the Ricardian approach to farm-level data, Kumar (2011) examines the impact of climate change on farm level net revenue in India. The estimated climate response function is found to be non-linear. The temperature coefficients are larger in magnitude than the precipitation coefficients indicating relatively higher sensitivity of crop growth to temperature changes. Higher precipitation is beneficial in winter and autumn seasons but harmful during spring and summer. With a 2°C increase in temperature along with 7 per cent increase in precipitation, the results from the study indicate an annual decline of 3 per cent in farm level net revenue. The estimates of climatic impacts with India-specific climate change scenarios along with regional distributions of the impacts reveal that with the exception of the eastern states of Bihar and West Bengal and the inland region of Karnataka, climate change is likely to have an adverse impact on agriculture in the rest of the country. Likewise, in a separate study Kumar and Parikh (2001) report that under the climate change scenario of a +2°C temperature and +7 per cent rainfall change the total farm net revenue would decline by about 8.4 per cent. The negative impacts of temperature change more than compensate for the small positive impacts due to precipitation change.

Using data from nine rice-producing states Auffhammer et al. (2006) show that rainfall has a positive impact on rice harvest while minimum temperature has a negative impact. They further note that the simultaneous reductions in atmospheric brown clouds and greenhouse gases (GHGs) would have complementary positive impacts on rice harvests. Rao et al. (2014) find a negative impact of rising minimum temperature on kharif paddy yields in India. As per their estimates, the decline in kharif paddy yield ranges between 411 and 859 kg per hectare for every 1°C rise in minimum temperature across regions. Gupta et al. (2012) observe that rainfall increases rice yield at a decreasing rate whereas maximum temperature reduces it at an increasing rate. The net effect will depend on the relative strength of these two effects. In case of pearl millet and sorghum also, rainfall increases yield at a decreasing rate.

Using the Just-Pope stochastic production function framework, Gupta et al. (2013) further examine the impact of climate change on mean and variability of yield of rice and millets in India. The study shows that an increase in temperature decreases yield and its variability of rice and sorghum. But variability of temperature increases the variability of their yields. In contrast, an increase in rainfall increases their mean yield and reduces their variability. Variability of rainfall has

positive and negative impacts respectively on average yield and its variability in case of rice. For sorghum, rainfall variability reduces mean yield but increases its variability. In case of pearl millets, an increase in temperature decreases mean yield but increases its variability. Variability of temperature raises variability of its yield. An increase in rainfall increases its yield but reduces its variability. Variability of rainfall reduces mean yield but increases its variability for pearl millets.

Krishnamurthy (2012) studies the impact of climate change across yield distributions of rice and wheat in India using quantile regression technique. The results indicate significant reduction in wheat yields of up to 12 per cent in all regions and at most quantiles under scenarios with a reasonable temperature increase. The reductions are found to be larger at upper quantiles. However, in case of rice there is a very modest (up to 2 per cent) increase in yield at the intermediate quantiles and a modest reduction in yield (up to 3 per cent) at upper and lower quantiles. There are significant regional differences in impacts at different quantiles.

From the above discussion it is clear that there is mixed evidence of climatic impacts on agricultural productivity and growth in India. While some studies provide evidence of positive impacts others present that of negative impacts. The heterogeneity in terms crops, topography, existing and projected agro-climatic conditions, and agronomic characteristics across different regions plays a very important role in generating these mixed results.

4 Climatic impacts on rice and wheat yield in India: further evidence from state-level data

In this section, we examine the impacts of climate variables (i.e., temperature and rainfall) on the average yield of rice and wheat, the two most important staple food crops of the country, using state-level time series data.[1] We consider annual average temperature and total rainfall during a crop year (July to June) as our main climate variables. Additionally, we include annual temperature variability (as measured by the standard deviation of monthly temperature) and annual rainfall variability (as measured by the standard deviation of monthly rainfall). To see the impact of these climate variables on average yield of rice and wheat we use median regression. For robustness of the results, we also apply pooled least square (PLS) technique.[2]

Table 13.1 presents our regression results of climate change impacts on rice and wheat yield across the states of India. Our results indicate that an increase in average temperature reduces rice yield. This is consistent with the findings of several previous studies. However, rainfall variability has a positive impact on rice yield indicating that more variations in rainfall over the crop year are beneficial to this crop. When we use PLS method, average temperature is found to have a negative impact on rice yield. Thus, the result with respect to the impact of rising temperature on rice yield is robust to the use of different estimation techniques. As for wheat yield, temperature variability has a significant positive impact on its yield and this result is also robust. It implies that a higher variability in temperature over the crop year is good for wheat yield. Average temperature has a negative effect on wheat yield but it is statistically significant only when we use PLS to

Table 13.1 Regression results (Sample Period: 1968–2001)

Explanatory variables	*Rice yield*		*Wheat yield*	
	Median regression	*Pooled regression*	*Median regression*	*Pooled regression*
	(1)	*(2)*	*(3)*	*(4)*
Constant	2755.83***	3932.85***	779.87	1834.83**
	(688.47)	(734.14)	(1132.00)	(758.33)
Trend	26.95***	27.93***	24.95***	29.50***
	(0.97)	(1.69)	(1.33)	(2.50)
Average Temperature	−43.74*	−91.48***	−37.29	−82.57***
	(24.22)	(28.06)	(37.78)	(26.09)
Total rainfall	−0.07	0.09	0.02	0.08
	(0.07)	(0.18)	(0.17)	(0.25)
Temperature variability	26.96	38.72	127.98***	180.06**
	(34.90)	(55.09)	(47.74)	(73.83)
Rainfall variability	1.54***	−0.02	0.71	−1.07
	(0.58)	(1.58)	(1.39)	(2.25)
Pseudo-R^2/R^2	0.60	0.69	0.58	0.65
No. of states	23	23	21	21
No. of observations	765	765	659	659

Note: The standard errors are in parentheses: ***significant at the 1% level; **significant at the 5% level; *significant at the 10% level.

estimate the regression model.[3] The reasons for the findings with regard to the impact of rainfall and temperature variability are not readily comprehensible. For a better understanding of these results further agronomic research will be helpful.

Note that these results are indicative at the best. We have used aggregate data and it would be desirable to use more disaggregate data. Further, we would like to include other inputs such as fertilizer, irrigation etc. that are important for yields. However, relevant data are not consistently available.

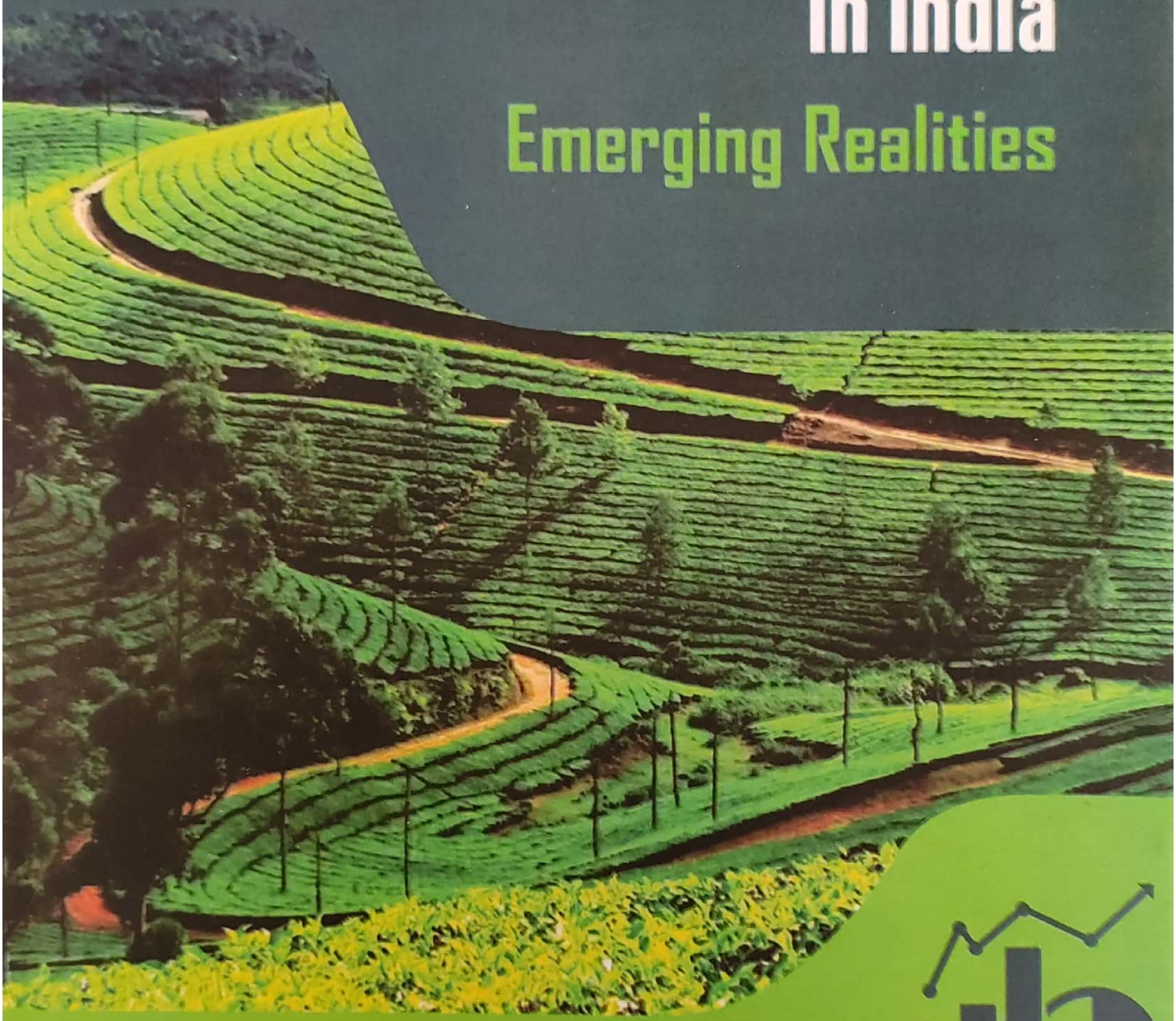
5 Conclusions

The empirical evidence on the effects of climate change on agriculture has been mixed: while some studies find evidence of adverse impacts others report evidence of positive effects. Applying nonparametric median regression technique to state-level time series data on average yield of rice and wheat and on temperature and rainfall from 1968 to 2001, the present study further investigates the impacts of changes in these climate variables on rice and wheat yields in India. The results indicate that rising temperature has a significant negative impact and rising rainfall variability has a significant positive impact on the average rice yield. Furthermore, an increase in temperature variability over the crop year appears to have a significant positive impact on wheat yield.

The studies discussed above show that different aspects of climate change (i.e., changes in temperature, rainfall, CO_2) may have differential effects on agriculture in India. Furthermore, the impacts are conditional on so many confounding factors: type of crops, topography, existing agro-climatic conditions, agronomic characteristics, available technology, and peoples' coping strategies. It seems to suggest that aggregate studies covering a large geographic region may gloss over these heterogeneities that are so critical for investigating climatic impacts. Therefore, it is imperative that researchers conduct more micro-level region-specific studies so that coping strategies and policies can be customized according to these specificities. Since collection, storage, and dissemination of data have become much easier now than before due to the unprecedented advances in the information and communication technologies (ICTs), researchers may take advantage of the enormous information to investigate climatic impacts. In fact, using real time data they may constantly update such analysis and may provide useful information to those who are involved in innovation and designing strategies and policies to cope with the adverse impacts of climate change.

Hill Economies and Sustainable Development in India

Emerging Realities



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5

Food Insecurity in India

A Comparative Study of Hills and Plains

Raju Mandal and *Pallabi Dhar*

Introduction

Achieving and maintaining food security for the growing populations is a major challenge faced by the countries today. This has become more challenging because of the fact that food security requires not only availability of a sufficient physical quantity of food but it has to be accessible to people, nutritious in contents and stable over time. According to FAO (2009), food security is said to exist when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs for an active and healthy life.

Technological improvements have led to enormous increase in the production of food items in a country like India over the years. This, along with trade liberalization, has enabled the country to increase availability of physical quantity of food. Nonetheless, it has not been accessible to millions of households which is quite evident from the fact that more than a third of its population is estimated to be absolutely poor, and as many as half of its children have suffered from malnourishment over the last three decades (Upadhyay and Palanivel, 2011). According to Radhakrishna (2005), the achievement of macro foodgrain security at the national level did not percolate down to households as a result of which the level of chronic food insecurity in India is still high. On the other hand, use of excessive chemicals in cultivation and adulteration of food items have severely damaged their nutritional contents. In the process of intensive use of both natural and chemical factors for producing rice and wheat the Green Revolution has led to serious environmental problems such as reduction in soil fertility, imbalance in nutrient contents of soil, depletion of groundwater etc. (Bhushan, 2018), which has the potential

to adversely affect not only production but also their nutritional quality. Besides, the stability of food supply is under serious threat due to the already evident and anticipated adverse impact of climate changes on food production (Sarma and Mandal, 2018). All this coupled with a huge and growing population, and changes in land use pattern across the country pose enormous risk of food insecurity in the India in the days to come.

The objective of this chapter is to measure the incidence and depth of food insecurity, and also its inequality among the households of India with a special focus on its hill *vis-à-vis* plain States and union territories using suitable aggregated measures. It also examines the differentials in the incidence of food insecurity between the hills and plains. It further tries to identify the factors that affect household level food insecurity in the said area. The available literature in this regard has mainly focused on food security in India (Dev and Sharma, 2010; Kumar *et al.*, 2012; Brahmanand *et al.*, 2013; Ittyerah, 2013; Singh, 2014), and a few others have studied food insecurity on a regional basis (Agarwal *et al.*, 2009; Chinnakali *et al.*, 2014; Mukherjee, 2016). To the best of our knowledge Sarma and Mandal (2018) have studied the extent of food insecurity at the household level. However, any study on the incidence, depth and inequality of food insecurity at the household level and with a special focus on hills *vs.* plains of India is yet to comeby. This study has been taken up to fill this gap to some extent. This will provide important insights about the status of food insecurity in the hills and plains of the country. Given the fact that the geographical and socio-economic factors in the hills are quite distinct from the plains, it calls for special attention as far as the policy actions with regard to food insecurity in these areas are concerned.

The chapter is organized in six sections. Section two outlines data and methodology used. Section three discusses the status of food insecurity in the hills and plains of India. Section four outlines the regression model. Section five covers analysis of regression results and their discussion whereas section six deals with concluding remarks.

Data and Methodology

Study Area and Data Source

This study is based on secondary data compiled from the second round of India Human Development Survey (IHDS-II) for the year 2011-12. The IHDS is a nationally representative survey conducted jointly by the University of Maryland and the National Council of Applied Economic research. The data set covers a sample of 42,152 households spread across

33 States and union territories, 384 districts, 1420 villages and 1042 urban blocks. The IHDS-II provides data on a large number of dimensions and variables. The data were thoroughly cleaned and a few variables relevant for the present chapter were taken into account while a few others were created from the data set. This way we end up with total observations of 39,644 for our analysis. To make a comparative study of hills and plain we have considered 11 States as hills following Pandey and Dasgupta (2014). They are Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya and Assam.

Methodology

Identification of Food Insecure Households

To measure the magnitude of food insecurity we have used some aggregated measures of food insecurity[1]. The first step towards obtaining an aggregated measure of food insecurity is to identify the households that are food insecure. For this we have defined indicator of food insecurity and food insecurity lines as follows.

It is not only the quantity of food available and accessible but also its quality in the form of nutritional contents that are important from food security point of view. Hence, as argued by Nanda Kumar *et al.* (2010) the issue of food security is not so much about availability of food grains but the composition of the overall food basket[2]. Therefore, keeping in view nutritional requirements the food insecure households are identified as follows. The report of the Expert Group (Rangarajan) to the Planning Commission (Government of India, 2014) has outlined the normative requirements of expenditures on food comprising calories, proteins and fats.[3] We have taken this recommended expenditure (per capita per month) on calories, proteins and fats as the cut-off for separating the food insecure households from others. Thus, following Government of India (2014) the national food insecurity lines have been defined as monthly per capita food expenditure (calorie + protein + fat) of Rs. 554 in rural areas and Rs. 656 in urban areas. These food insecurity lines are then adjusted by price indices to estimate State specific food insecurity lines (separately for rural and urban areas) so as to capture spatial differentials in the price level (see Appendix-I). A household whose per capita monthly expenditures on calories, proteins and fats are below this benchmark are considered to be food insecure. The national and State specific food insecurity lines are shown in Table 5.1.

State&UTs	Food Insecurity Line (Rs.)	
	Rural	Urban
Andhra Pradesh	588.05	639.14
Arunachal Pradesh	656.03	691.41
Assam	573.75	662.12
Bihar	553.59	573.15
Chhattisgarh	519.69	573.34
Delhi	850.64	717.12
Goa	684.29	685.41
Gujarat	628.57	702.65
Haryana	642.81	712.56
Himachal Pradesh	607.92	658.14
Jammu & Kashmir	595.31	654.25
Jharkhand	515.25	593.09
Karnataka	555.95	640.28
Kerala	600.75	631.14
Madhya Pradesh	536.73	624.89
Maharashtra	614.61	727.51
Manipur	675.51	728.16
Meghalaya	633.04	710.72
Mizoram	701.64	794.44
Nagaland	700.95	753.34
Odisha	499.52	561.99
Punjab	642.62	689.70
Rajasthan	590.46	655.60
Sikkim	641.92	719.25
Tamil Nadu	616.66	643.58
Tripura	533.21	641.80
Uttar Pradesh	507.16	619.89
Uttarakhand	578.48	656.52
West Bengal	532.40	640.00
Puducherry	644.11	644.49
Andaman & Nicobar Islands	749.48	838.16
Chandigarh	742.75	690.60
Dadra & Nagar Haveli	574.74	718.39
Daman & Diu	684.29	669.02
Lakshadweep	756.77	680.10
All India	554.00	656.00

Source: Authors' Calculation from IHDS-II, 2011-12.

Measuring Food Insecurity

Once the food insecure households are identified aggregated measures of food insecurity have been obtained using three different indices, viz., head count ratio (HCR), food insecurity gap index (FIGI) and squared food insecurity gap index (SFIGI)[4]. They are calculated as follows:

$$\text{HCR} = \frac{N_{FI}}{N} \times 100 \qquad \cdots (1)$$

$$\text{FIGI} = \frac{1}{N} \times \sum_{i=1}^{N} \left(\frac{G_i}{L} \right) \qquad \cdots (2)$$

$$\text{SFIGI} = \frac{1}{N} \times \sum_{i=1}^{N} \left(\frac{G_i}{L} \right)^2 \qquad \cdots (3)$$

Where, N refers to total population, N_{FI} stands for number of food insecure households, L for food insecurity line, and G for food insecurity gap which is the gap between L and actual per capita monthly expenditure on calorie, proteins and fats as mentioned in section II.2.1. Moreover, the food insecurity gaps G for the food secure households are assumed to be 0.

The HCR measures the incidence of food insecurity. While it is easy to calculate and interpret it cannot capture depth and inequality among the households as far as food insecurity is concerned. On the other hand, although FIGI is sensitive to the depth of food insecurity meaning it captures how far the food insecure households are from the food insecurity line, it does not take care of inequality among these households with respect to the same. However, the SFIGI is sensitive to inequality among the food insecure households which implies that if the distribution of the per capita monthly expenditure on food is changed by transferring some amount from one food insecure household to another then the value of the index changes[5]. Hence, these three measures of food insecurity have been used to examine the incidence and depth of food insecurity and its inequality among the households.

Food Insecurity in India: Hills *vs.* Plains

The extent of food insecurity in the hills and plains of India are presented in Table 5.2 and Table 5.3 respectively. As seen from Table 5.2, among the hill States the incidence, depth and inequality of food insecurity is highest in Meghalaya. On the other hand, the same is lowest in Tripura. As seen from the table there is large scale variations in these measures among the states. Similarly, there is large scale variations in the incidence, depth and inequality of food insecurity among the plain states and union territories of India with Goa having the lowest and Chhattisgarh highest figures (Table 5.3).

Table 5.2: Extent of Food Insecurity in the Hills of India

States	*HCR (in %)*	*FIGI*	*SFIGI*
Jammu & Kashmir	4.59	0.009	0.095
Himachal Pradesh	22.10	0.049	0.220
Uttarakhand	43.21	0.123	0.351
Sikkim	8.33	0.001	0.038
Arunachal Pradesh	19.30	0.036	0.189
Nagaland	5.56	0.008	0.092
Manipur	26.19	0.025	0.158
Mizoram	21.43	0.030	0.173
Tripura	0.00	0.000	0.000
Meghalaya	63.21	0.201	0.448
Assam	33.02	0.069	0.262

Source: Authors' Calculation from IHDS-II, 2011-12.

Table 5.3: Extent of Food Insecurity in the Plains of India

States/UTs	*HCR*	*FIGI*	*SFIGI*
Punjab	13.63	0.022	0.148
Haryana	23.11	0.050	0.223
Rajasthan	24.26	0.059	0.242
Uttar Pradesh	31.51	0.080	0.282
Bihar	45.44	0.114	0.337
Jharkhand	44.51	0.124	0.353
Odisha	54.25	0.144	0.379
Chhattisgarh	67.72	0.226	0.476
Madhya Pradesh	39.30	0.112	0.335
Gujarat	20.39	0.044	0.210
Daman & Diu	10.17	0.012	0.108
Dadra & Nagar Haveli	38.46	0.115	0.340
Andhra Pradesh	20.75	0.041	0.204
Goa	0.00	0.000	0.000
West Bengal	26.67	0.057	0.238
Maharastra	38.60	0.096	0.309
Karnataka	21.41	0.045	0.213
Kerala	21.85	0.051	0.225
Tamil Nadu	41.92	0.125	0.354
Puducherry	4.92	0.007	0.081

Source: Authors' Calculation from IHDS-II, 2011-12.

We further examine whether the incidence of food insecurity in the hills is statistically different from that in the plains. For this we have used proportion-test. The test results are shown in Table 5.4. The null hypothesis (H_0) that there is no difference in the proportion of food insecure households between the hills and plains has been rejected and the alternative hypothesis (H_a) that the former has a lower proportion of food

insecure households than the later has been accepted at 1 per cent level of significance. Thus, we can say that food insecurity is lower in the hills than in the plains of India.

Table 5.4: Two-sample Test of Proportions (of food insecure households)

Variable	*Mean*	*Std. Err.*	*z*	*P>|z|*
Plains	.2870668	.002333		
Hills	.1920457	.0058391		
Proportion difference (Plains-Hills)	.0950211	.0062879		
	under Ho:	.0070222	13.53	0.000
Ha: diff < 0			Ha: diff > 0	
Pr (Z < z) = 1.0000			Pr (Z > z) = 0.0000	

The Model

To examine the determinants of food insecurity, a binary logistic regression model is used. The model is—

$$FI_i = \frac{1}{1+e^{-(\beta' X_i' + u_i)}}$$

$$= \frac{1}{1+e^{-Z}} \qquad \ldots (1)$$

Where,

$$Z = \beta_0 + \beta_1 Hill_i + \beta_2 Urban_i + \beta_3 Poor_i + \beta_4 HS_i + \beta_5 Remit_i + \beta_6 Cultivation_i + \beta_7 PCI_i + \beta_8 DR_i + \beta_9 EAF + \beta_{10} OBC_i + \beta_{11} SC_i + \beta_{12} ST_i + \beta_{13} OC_i + u_i \qquad \ldots (2)$$

Here the dependent variable FI_i indicates food insecurity status of the ith household which takes value 1 if a household is food insecure and 0 otherwise. The definitions, measurement and summary statistics of the explanatory variables are shown in Table 5.5.

Results and Discussion

The results of the binary logistic regression of food insecurity are shown in Table 5.6. It is to be noted that the odds ratio are reported here rather than the coefficient, and the results are interpreted accordingly.[6]

Table 5.5: Definition and Summary Statistics of the Explanatory Variables

Non-categorical Variables	*Definition*	*Unit*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
HS	No. of household members	Number	4.85	2.32	1	33
PCI	Per capita income	Rupees	29,402	53,996	–2,89,008	41,61,000
DR	Dependency ratio	%	76.10	74.42	0	80
EAF	Highest education of adult female member	Years	5.65	5.27	0	16

Categorical Variables	*Definition*	*% age*
Hill	= 1 if a household belongs to a hill state, 0 otherwise	11%
Remit	= 1 if a household receives remittance, 0 otherwise	13.28%
Poor	= 1 for poor households, 0 otherwise	16.42%
Urban	= 1 for households living in urban areas, 0 otherwise	34.57%
OBC	= 1 for households belonging to OBC category, 0 otherwise	40.46%
SC	= 1 for households belonging to SC category, 0 otherwise	21.21%
ST	= 1 for households belonging to ST category, 0 otherwise	8.64%
OC	= 1 for households belonging to other category (excluding general caste), 0 otherwise	1.35%
Cultivation	= 1 if the main occupation of a household is cultivation, 0 otherwise	24.40%

Source: Authors' Calculation from IHDS-II, 2011-12.

Table 5.6: Results of the Binary Logistic Regression

Explanatory Variables	*Odds Ratio*	*Std. Err.*	*z*	*P>z*
Hill	0.74	0.04	–6.00	0.00
Urban	1.04	0.04	1.16	0.25
Poor	12.66	0.47	68.03	0.00
HS	1.20	0.01	29.03	0.00
Remit	0.92	0.04	–1.99	0.05
Cultivation	0.80	0.03	–6.45	0.00
PCI	0.99	0.00	–27.00	0.00
DR	1.16	0.02	8.09	0.00
EAF	0.99	0.00	–3.21	0.00
OBC	1.47	0.05	10.37	0.00
SC	1.65	0.07	11.85	0.00
ST	2.13	0.12	13.77	0.00
OC	1.10	0.14	0.73	0.46
Constant	0.11	0.01	–40.03	0.00
Pseudo R squared	0.2887			
LR $\chi^2(15)$	13625.85			
Prob > χ^2	0.00			
Observations	39644			

The odds ratio of *Hill* has turned out to be less than one. This implies that the probability of being food insecure is less in the hill areas than the plains. More precisely, the probability of being food insecure in the hilly areas is 26 per cent lower than the plains.

The odds ratio of *Urban* has turned out to be greater than one. This implies that the probability of being food insecure is more in the urban areas than in the rural areas. The odds of food insecurity for an urban household are 1.04 times that of his rural counterpart. The reason for rural households being less food insecure is that they are mostly engaged in cultivation as subsistence farmers, and hence they have better availability of food items in the villages.

The odds ratio of *Poor* is found to be as high as 12.66. This implies that the probability of food insecurity for the poor households is higher than others. Food insecurity of a poor household is 12.66 times of a non-poor household. This is quite intuitive. The poor do not have enough resources to purchase the required amount of food items for their household which raises their probability of being food insecure.

HS is found to have a positive impact on food insecurity. This implies that the probability of food insecurity increases with increase in the size of households. Larger sized households have more mouths to feed and hence have lesser availability of food consumption per capita. An increase in household size by one member causes the probability of food insecurity to increase by 20 per cent.

The odds ratio for *Remit* has turned out to be 0.92. This implies that remittances into a household reduce its likelihood to be food insecure. More precisely, the households receiving remittances are 8 per cent less likely to be food insecure than others. This is because receipt of remittances enhances liquidity and hence the household can spend more on food.

The odds ratio of *Cultivation* is found to be 0.80. This implies that the households whose main occupation is cultivation are less likely to be food insecure than others. This is quite intuitive. The cultivator households in India are primarily subsistence farmers, and hence allocate a considerable amount of farm produce on household consumption.

PCI is found to have a negative impact on the probability of household level food insecurity. This implies that an increase in per capita income of the households by one rupee reduces its probability of food insecurity by 99 per cent. This is quite expected because an increase in per capita income capacitates a household to access a higher amount of food items for its members.

DR, showing the number of young and adult dependents as a percentage of number of economically active members in the households, is found to increase the probability of food insecurity. The odds ratio of this variable is 1.16 which implies that an increase in dependency ratio by 1 per cent increases the probability of food insecurity by 16 per cent.

EAF is found to have a negative impact on food insecurity with odds ratio of 0.99. This means an increase in the years of schooling of adult female members reduces the probability of food insecurity by 1 per cent. The female adult household members in India take the responsibility of preparing and distributing food in the household. Hence, as their level of education increases they become more aware about the importance of nutritious contents of food. Thus, with improvements in their education expenditure by the households on food items containing calorie, proteins and fats also increases, thereby reducing food insecurity.

As far as the differences in food insecurity among social groups are concerned it is found that compared to general caste, food insecurity is more among Other Backward Classes (*OBC*), Scheduled Castes (*SC*) and Schedule Tribes (*ST*). Moreover, the differences in the magnitudes of odd ratios for *OBC*, *SC* and *ST* indicate existence of sharp differences in the probability of food insecurity among them.

Conclusion

This chapter examined the incidence, depth and inequality of food insecurity at the household level in the hills and plains of India. The study reveals that around 29 per cent of the households in the plains of India are food insecure compared to around 19 per cent in the hills and this difference is found to be statistically significant. Further, there is prevalence of large scale disparity in food insecurity within the hill and plain areas of the country.

This chapter further identifies the factors affecting household level food insecurity in India.

Food insecurity in India is found to be affected, among other things, by poverty, per capita income, and education of female adults and main occupation of the household. While per capita income and education of female adults reduce the probability of being food insecure, poverty has the reverse impact. The households with cultivation as the main occupation are relatively less food insecure. Similarly, as far as the major social groups are concerned people belonging to general caste are less food insecure followed by OBC, SC and ST. While government policy needs

to make concerted efforts to ensure food security across the country, special focus may be given on the regions and communities suffering from higher incidence of food insecurity, which may help reduce regional and inter-community disparities in this regard.

Appendix-I

Estimation of national and State-specific Food Insecurity Lines

The report of the Expert Group (Rangarajan) to the Planning Commission (Government of India, 2014) has outlined the normative requirements of expenditures on food comprising calories, proteins and fats. This recommended expenditures (per capita per month) amount on calories, proteins and fats are used as the benchmark for measuring food insecurity in this chapter. Thus, the national food insecurity lines have been defined as the monthly per capita food expenditure (calorie+protein+fat) of Rs. 554 in rural areas and Rs. 656 in urban areas. These national food insecurity lines are then adjusted as follows to estimate state specific food insecurity lines (separately for rural and urban areas) so as to capture spatial variations in the price level.

The ratio of price index of a state to the national average is worked out as follows. Suppose, the price index of Assam is P_A and that of India is P_I. The poverty line of Assam (PL_A) can be thought of as the national poverty line (PL_I) adjusted by the ratio of price index of Assam to price index of India. Thus,

$$PL_A = PL_I . \frac{P_A}{P_I} \qquad \text{... (A.1)}$$

$$\frac{P_A}{P_I} = \frac{PL_A}{PL_I} \qquad \text{... (A.2)}$$

Thus the ratios of state-specific poverty lines to the national poverty line give the price ratios for different states. From equation A.1 it is seen that multiplication of the national poverty line by the state specific price ratio yields the state specific poverty lines. The same way, state-specific food insecurity line is calculated by multiplying the national food insecurity line by the respective state specific price ratio, where the price ratio is obtained by dividing the state specific poverty line by the national poverty line, as shown by equation A.2.

Notes

1. Here we have taken the idea from the literature on poverty measurement.
2. A change in the consumption patterns from cereals to high value food is observed in both rural and urban areas of India.
3. This Expert Group was constituted in June 2012 by the Planning Commission under the Chairmanship of Dr. C. Rangarajan to suggest a methodology for measurement of poverty in India. It has re-computed the average requirements of calories, fats and proteins on the basis of the 2010, Indian Council of Medical Research norms (Government of India, 2014).
4. These are analogous to head count ratio, poverty gap index and squared poverty gap index in the literature on poverty measurement.
5. In the context of poverty measurement this is known as 'Pigou-Dalton Transfer Principle'. According to this principle, if some income is transferred from a not-so poor to a relatively poorer individual then social welfare must increase and *vice versa*.
6. This is because there is a direct relationship between the two. Odds ratios greater than 1 and less than 1 imply positive and negative coefficients respectively. Therefore, our analysis is carried out in terms of odds ratio as it is easier to interpret the impact of the explanatory variables in terms of odds ratio.

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Neo-natal Mortality and Role of Maternal Education in Assam, India

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Introduction

The future productivity and growth of a nation depends critically on the health of its children. Hence, main public health interventions during the last two decades have focussed on reduction in infant and child mortality. As a result, the number of deaths among children below five years of age has decreased drastically (Singh et al, 2013). However, under-five mortality still remains a cause of concern because the annual rate of decline has been only 2.1 per cent compared to 4.4 per cent per year required to achieve the Millennium Development Goal-4 (Singh et al, 2013; Rajaratnam et al, 2010; Murray et al, 2007). One important contributor to infant and child mortality is the neo-natal mortality. Neo-natal deaths comprise about 40 per cent of all under-five deaths worldwide (Liu et al, 2012). The condition in the developing countries is more depressing as around 98 per cent of the neonatal deaths worldwide occur in these countries (Ahman and Zupan, 2007; Oestergaard et al, 2011).

Notwithstanding the fact that neo-natal mortality rate (NNMR) in India has declined, its share in the overall infant mortality rate and child mortality rate has increased over the years. As per sample registration system (SRS) data, 66 per cent infant deaths occurred during the neo-natal period in 1990 which increased to 70 per cent in 2010. Likewise, the share of neonatal deaths to the under-five deaths has increased from 45 per cent in 1990 to 54 per cent in 2010 (Rajaratnam et al, 2010). The situation is more discouraging in many less developed states including Assam. The NNMR in Assam is found to be consistently higher than that of the country as a whole. As per available evidence, the NNMR in Assam was 51, 45 and 46 neonatal deaths per 1000 live births compared to all India figures of 49, 43 and 39 during 1992-93, 1998-99 and 2005-06 respectively. Moreover, the rate of reduction of NNMR in Assam during 1992-93 to 2005-06 was only 9.80 per cent which is much lower than the reduction of 20.40 per cent at the national level. It is obvious that exceptionally high level of neo-natal mortality in Assam imposes huge cost in the form of loss of productivity, diversion of scarce medical and health resources, and pain and suffering (Smucker et al, 1980).

Although there are many studies that have examined factors affecting neo-natal mortality in different parts of the world, the issue seems to be under-studied in India (Singh et al, 2013) and unstudied in Assam. It is in this context that the present paper seeks to examine the determinants of NNMR in Assam using primary data. More

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