

Annual Report

2015-16

Report of projects and papers completed, papers published, and external academic and policy advice given during the year

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Contents

1. Research papers completed	1
2. Completed Research projects	7
3. New Initiatives	8
4. Publications during 2015-16	10
5. Seminars/Conferences/Workshops attended (2015-16)	11
6. External involvement in academic and policy Advice	13
7. Personnel Associated with the Unit	14
8. Contact Address	14

1. Research papers completed

1.1 Diffusion of Broadband in India, Trends, Determinants and Policy Challenges

Abstract: The diffusion of Internet especially through broadband is expected to have strong economic impacts. Research studies on the economic impact of broadband falls into five areas (Katz, 2012), namely contribution to economic growth (“positive externalities”), contribution to productivity gains, contribution to employment and output of broadband deployment (‘countercyclical effect’), creation of consumer surplus and improvement of firm efficiencies. Of these five, the most important one is its contribution to economic growth. The most widely cited study in this area by Qiang, Rossotto and Kimura (2009), who established through a cross-country regression model involving 120 low and middle-income economies over the period, 1980 through 2002 that a 10 per cent increase in the diffusion of broadband leads to a 1.38 increase in GDP of these countries. Although broadband has implications for virtually everything that one does, it has very strong implications for the spread of education, improving the quality of governance through the spread of e-governance and improve also the quantity of retailing through the spread of e-commerce.

An interesting aspect of India’s economic liberalization efforts set into motion in 1991 was that it has now a very modern and state-of-the art telecommunications services sector. The sector is almost entirely driven by mobile phones as the ratio of mobile phones to fixed phone now (April 30, 2015) stands at 37. India has now close to a billion mobile phones and the density of mobile phones is now touching almost 77 per 100 people. There has also been considerable decline in the rural-urban divide in the availability of mobile phones and this has largely been achieved through significant reduction in the average price of voice communication. India has now one of the cheapest telecom services anywhere in the world. It is hypothesised that the country has achieved the high diffusion of mobile phones through promoting competition in provision of communications services. The Herfindhal index (H-index) has never exceeded 0.16 over the period 1998 through 2014. However this significant improvement in the availability of mobile phones have not been matched in the availability of broadband services in the country. The broadband, despite policy support, has diffused very slowly: as on March 31, 2015 there are only 99.20 million broadband subscribers in the country and a lion’s share of these are mobile internet subscribers (Telecom Regulatory Authority of India, 2015). Unlike many other countries, diffusion of wired broadband in India has been very slow, partly due to poor

landline infrastructure in the country. Though the National Telecom Policy (NTP) 2012 envisioned broadband-on-demand by 2015, this is far from reality. Further, it is assumed that majority of these subscribers are in urban areas and there are frequent complaints about the price and quality of broadband connections. Both mobile and broadband are distributed mostly by the same providers but the concentration in the provision of broadband is higher than in mobile services with the H-Index for the former working out to 0.19. Broadband provisioning can be modelled using two-sided market theories. Broadband service providers act as a platform to connect content and application service providers on one side and the users on the other side. There are strong cross-side network externalities between these two sets of users that can enable diffusion of broadband services. An example is the Over-the-Top (OTT) services such as those enabling communication (Skype, Viber etc), social networking (Facebook, Twitter, LinkedIn) and messaging (WhatsApp) over the Internet are now being increasingly used and the increased demand for those from young population is bound to increase the diffusion of broadband in the country. In the context, the present study attempts to answer the following five questions:

- What is the rate of diffusion of broadband Internet in India and also the trends in it over time?
- How do content and application services (e.g. OTT services) affect diffusion of broadband?
- What are the factors that determine the observed trends in the diffusion of broadband and the trends in its diffusion across urban and rural areas and across the states in the country?
- What are the specific policy challenges to increase the rate of diffusion of broadband especially in the rural areas of the country?
- Should some broadband services (e.g. m-Government services) be considered in the realms of public good and hence the required policy prescriptions for quality provisioning of the same?

The paper is structured into three sections. Section 1 analyses the trends in the diffusion of broadband Internet and also the trends in it across the states in the country. Section 2 will identify the factors that determine the diffusion of broadband and specifically the content and application services that affect its diffusion. Section 3 concludes the paper by delving on the policy challenges to increase diffusion.

1.2 Market Leadership in India's Pharmaceutical Industry: The Case of CIPLA Limited

Abstract : Over the last three decades, Indian pharmaceutical firms have accumulated considerable technological capability in manufacturing generic versions of off-patented drugs (Chaudhuri, 2005). In 2014, the firms accounted for about 10 per cent of the global pharmaceutical industry in volume and 1.4 per cent in value terms. The growing leadership position of the industry is also evident from a number of indicators such as significant increases in the number of Abbreviated New Drug Applications (ANDA) granted to Indian pharmaceutical firms in the United States (US), significant increases in exports, research and development (R&D) intensity, and also in the number of patents granted to pharmaceutical inventors from India at the United States Patent and Trademark Office (USPTO). The industry consists of about five thousand Indian and foreign firms although the industry is largely dominated by domestic enterprises.

Within India's rather small manufacturing, the pharmaceutical industry occupies an important place. In fact, based on indicators such as value added, exports, trade balance, R&D and patents, it is one of India's leading manufacturing industries. In short, India's pharmaceutical industry can justifiably qualify itself to be a market leader.

This case study is about the market leadership of CIPLA Limited, a domestic pharmaceutical firm. The firm was established almost eight decades ago by a knowledge-intensive entrepreneur, is the largest company among the Indian pharmaceutical firms and has made a name for itself as a producer of inexpensive generic drugs. CIPLA is also one of the most innovative firms in the Indian industrial establishment having a large number of US patents to its credit.

In this paper we analysed the case of CIPLA as a market leader in India's pharmaceutical industry, which itself, as we argued, is a leader in India's manufacturing industry. CIPLA met all the three conditions of market leadership: market dominance, global reach and innovation. It must, however, be pointed out that there are other companies which can also claim to be leaders in the industry including Ranbaxy, Dr Reddy's Laboratory, and Sun Pharma. But CIPLA has had a significantly longer history and has enjoyed better success in serving both domestic and foreign markets. It has been a trailblazer for pioneering low cost, lifesaving drugs and is therefore highly respected in India. We sought to explain the source of leadership in terms of firm level and sector level factors. Knowledge-intensive entrepreneurship was a key factor. The firm has a very good vision and a corporate strategy focused on being a provider of low cost, lifesaving drugs both domestically and abroad. CIPLA has also taken advantage of three sector level factors, namely the patent regime, technology

contributions from PRIs and the higher education sector. In a number of ways, the sources of CIPLA's leadership is similar to those discussed in the Tata Motors case. An important factor that is common to both these firms is the knowledge-intensive entrepreneurship behind their respective foundations. Although the founding entrepreneurs wield overall control, the management of both the companies is in professional hands. In both cases, the contribution of both sectoral and country-level factors have been important.

1.3 Innovation without performing formal R&D, Three cases from India's manufacturing industry

Abstract: The general belief is that innovations of any of the five types are introduced by intramural R&D done by the firms. Further there is also another empirical finding that persistent innovators tend to rely on R&D while non persistent innovators may mostly resort to other innovation activities. The other innovation activities include a host of non-R&D routes such as acquisition of machinery, training, purchase of extra mural R&D etc. Based, on the innovation surveys done in a variety of developing countries including that of India, the predominant innovation activity is acquisition of machinery, equipment and software, with 64 per cent of countries having the highest shares of firms engaging in this activity. Only in three developing countries, Indonesia, Mexico and Panama that this route is lower than 50 per cent. In short this finding, places on the table an important finding that innovating firms in developing countries introduces innovations through a variety of activities other than in-house R&D. In the context, the purpose of the present study is to discuss the case of three manufacturing firms from India belonging to three different types of industries in terms of their technological intensity, low, medium and high technology manufacturing industries. The three firms are very innovative in the sense and account for a substantial portion of either the national or the regional market for the product that is their main line of activity. However the firms have reached their respective exalted positions not by investing in formal R&D. The precise route through which they have reached their positions, the source of information on innovative activity are distilled in our present study. The study thus, although, based on a small number of cases have the possibility of suggesting policy instruments for hastening innovative activity by small and medium enterprises in developing countries which performs innovations of an incremental variety.

The study is structured into four sections. In section 2, we provide a discussion of the conceptual framework employed in analyzing the three cases. Section 3 surveys discernible trends in innovative activity in India, first by relying on conventional innovation indicators and subsequently by analyzing the new indicators thrown up by

the first national innovation survey conducted in India. Section 4 discusses the insights from the three cases. Section 5 sums up our main findings and distils out important policy conclusions. The conceptual framework used in the study is the tried and tested innovation survey framework introduced by OECD and Eurostat in its latest 2005 version of the so called Oslo Manual.

The study begins by mapping the general background to the case studies. The background consists of two dimensions. The first one is the recent economic performance of India with the country being one of the fastest growing economies in the world. The second one is the fact that India has become one of the fastest growing economies in the world. Her growth performance during the period since 2005-06 is one of the highest compared to her own growth performance in the past and when compared to other large economies such as China. But her GERD to GDP ratio and even her BERD to Manufacturing Value Added ratio has not shown much increase although the share of BERD within the GERD has increased to almost a third. Results from the national innovation survey shows that 35.6 per cent of the firms surveyed are innovation-active firms and about 18 per cent of them are innovative firms. Majority of these innovative firms have introduced their innovations, whether in product, process, marketing or organizational through routes other than in-house R&D. In short this raises the importance of understanding the non-R&D routes to innovation and that is what the following case studies are seeking to unravel.

In order to understand the role of non-R&D routes to innovation, we chose three cases from India's fledgling manufacturing sector. A *five* pronged criteria was used to select the specific cases. The five criteria are: (i) the firm in question must have introduced either product, process, organizational or marketing innovations on a continuous basis and must have established themselves as an undisputed market leader in their respective industrial sector so that when one refers to them as an innovative firm, that should not be open for any disputation; (ii) the firm should have introduced its claimed innovations through the non-R&D route; and (iii) the firm should have been in existence for at least 15 years so that their innovation performance is not really an aberration; (iv) they should represent different types of sectors in terms of their technological content of their main product line. In other words, they should be belonging to low, medium and high technology sector. Our three cases met all the three criteria; and (v) the external environment obtaining to the selected firms (for example the ease of doing business) should roughly be the same so that the effect of the external environment on their innovative behaviour should be similar

India has a positively skewed distribution of firms with large number of small and medium firms and a small number of large firms. None of the small and medium firms do any R&D, which is by and large concentrated in large firms. So innovating through

non R&D routes is an important one for majority of the firms- confirmed by the three cases that we have chosen and also by the larger national innovation survey conducted from the three year period beginning 2007-08. The three cases show that the firms have used training as the main non R&D route, acquisition of capital goods is not the major route- this is a counter intuitive one. When knowledge intensity of production increases, firms are prone to doing formal R&D unless like one of our cases (Verdant) has access to sophisticated knowledge base residing in institutions and customers. The cases highlight the importance of encouraging firms to subject their technicians to training in latest knowledge in their respective technological domains. Innovation policies must therefore incorporate this important aspect of encouraging training which at the moment is lacking. The case studies does not deemphasize the role of intra mural R&D but highlight the importance of sequencing R&D. Firms which are at the bottom of technological ladder needs to give far more importance to periodic training of their technicians. Another important result, thrown up by our examination of the cases is the role played by the professionally trained founding entrepreneur. She or he is an important source of innovation and is also instrumental in giving the firm a sense of technological direction.

2. Completed research projects

2.1 Teaching Text on Economics of Innovation, Selected Topics

(Sponsor of the project: UN ESCAP-APCTT)

Abstract: This manual describes the process of adopting a National Innovation System (NIS) framework, and evolves strategies to strengthen the process of creating and diffusing new technologies and innovation within a nation state's economy. While innovation can be created without research, the increasing globalization has not reduced the importance of NIS framework in national economy. The framework maps out the institutions and incentive system that support technological change within a nation. Particular attention is paid to the interaction between the different actors or elements that constitute an NIS. The process of adoption of the NIS framework for identifying systemic failures that hamper the generation of innovation and its diffusion, and then correcting them so that innovative activity is promoted in a sustainable manner entails a series of five logical steps. The five steps are defining the core of the NIS, gathering data on innovative activity at the core, diagnosing health of the NIS by employing a variety of tried and tested innovation indicators, designing policy instruments to promote generation and diffusion of innovation, and finally evaluating the effectiveness of these policy instruments and making required corrections for optimizing their effectiveness. The manual would be very useful for policy makers working within the government ministries and institutions that support technological change, as well as to researchers in and students of the economics and policy regimes of technological change.

3. New Initiatives

3.1 One size does not fit all, An analysis of the importance of industry-specific policies for growing high technology industries in India

Abstract: The purpose of the study is to analyse the growth of high technology manufacturing industries in India. Our hypothesis is that whichever mode is employed, each high technology industry requires a specific policy that is crucial for its sustained growth. In short, one size rarely fit all. Let us consider two different high technology manufacturing industries, namely aerospace and pharmaceutical. For the aerospace industry the most important instrument for its promotion will be public technology procurement, which manifests itself in the form of an offset policy. Such a policy assures a certain amount of demand for the new product, which encourages the manufacturers to be venturesome. On the contrary, for the pharmaceutical industry, the most important policy is the one on patents as patents are extremely important for chemical industries in general and pharma in particular¹. However a policy for financing R&D and policies on increasing the quantity and quality of science and engineering human resource is important for both the industries. We refer to the former set of specific policies as vertical policies (VP) and the latter set as horizontal policies (HP). The study proposes to verify the hypothesis of the crucial importance of VP by taking three successful cases and one unsuccessful case from India's manufacturing industry. The three successful cases are aerospace, pharmaceutical and automotive industries, and the one unsuccessful case is the telecommunications equipment industry.

3.2 Emerging medium high technology industries in emerging Asia, The case of Automotive Industry (joint with Professor Patarapong Intarakumnerd, National Graduate Institute for Policy Studies, Tokyo, Japan)

Abstract: Asia is becoming the centre for manufacturing in general and high technology manufacturing industry in particular. One of the fastest growing manufacturing industry in Asia is the automotive industry. The study analyses the growth of this industry across a

diverse set of emerging Asian countries such as China, India, Thailand, Indonesia and Vietnam.

3.3 The growth diffusion of platform economy in India (Joint with Martin Kenney, University of California, Riverside)

Abstract: Through highly efficient matching of different users and/or harnessing large ecosystems of complementary technologies products or services, companies with platform business models have grown dramatically across the globe over the last decade. A recent survey has identified 176 platform companies worldwide with a market valuation of US\$1 billion or more. India has apparently 8 platform companies, some of which have become household names, such as *Flipkart*, *Snapdeal* or *Olacabs*. The purpose of the study is understand the composition of these new and emerging type of industry which is the most obvious manifestation of the so called new economy and its effect on overall economic growth, employment creation and innovation.

4. Publications during 2015-16

Journal Articles

Mani, Sunil and V.Sridhar (2015), 'Diffusion of broadband internet in India', *Economic and Political Weekly*, Vo.50, No: 51, pp. 54-62.

Chapters in Books

Mani, Sunil (2015) 'India' in *UNESCO Science Report 2015*, Paris: UNESCO, pp. 599-619.

Book review

Mani, Sunil (2015), 'Development through manufacturing' Review of "Pathways to industrialization in the Twenty-first century: New challenges and emerging paradigms" *Economic and Political Weekly*, Vol 50, No: 45, pp. 29-32

Other Publications

Mani, Sunil (2015), ' India a hub for frugal innovations', *Mathrubhumi Yearbook Plus 2016*, pp. 288-292.

5. Seminars/Conferences/Workshops attended (2015-16)

Seminars presented at CDS

- Sunil Mani and V. Sridhar, International Institute of Information, Technology, Bangalore, *Diffusion of Broadband in India - Trends, Determinants and Challenges*, (20 August, 2015)

Seminar papers presented outside CDS

- Presented a paper on "Dimensions of India's Innovation Performance" at the Department of Technology Management, Delft University of Technology, April 1, 2015
- Presented a paper on "Performing innovation but through the non-R&D route" at the workshop on 'Industrial development along the global supply chain: organizational evidences from Asia' , Institute of Developing Economies(IDE)-Japan External Trade Organization (JETRO), Bangkok, Thailand, November 29, 2015
- Taught a course on "India in the global economy" for the Masters' programme in Public Policy at the National Graduate Institute for Policy Studies, Tokyo, Japan during February 7 through March 31, 2016
- Participated in the first advisory meeting of the new think tank on innovation studies as a honorary advisor, Forbes Marshal, Pune, October 1, 2015
- Presented a paper on 'Proximate and distant implications of TRIPS compliance on India's innovative activity' at the International Workshop on the Impact of the TRIPS Agreement on key sectors and its continuing relevance in the context of Regional and Bilateral Trading Agreements' , Centre for WTO Studies, Indian Institute of Foreign Studies, New Delhi, October 26-27, 2015

- Mani, S., and Sridhar, V. Diffusion of broadband in India: Trends, determinants and challenges. Second Regional International Telecommunications Society (ITS) Conference, New Delhi, 13-15 December 2015.
- EC-248: Innovation and Technology Policy (10 lectures of 1 hour 30 minutes each) to the students of Post Graduate Diploma in Management (PGDM) at Indian Institute of Management Calcutta, Kolkata, from December 16, 2015 through January 16, 2016

6. External involvement in academic and policy Advice

- Visiting Professor, National Graduate Institute for Policy Studies, Tokyo, Japan
- Honorary Visiting Professor, University of Toulouse Jean Jaures, Toulouse France
- Part Time Visiting Faculty, Indian Institute of Management Calcutta, Kolkata.
- Member, Editorial Advisory Board, Research Policy (Elsevier)
- Member, Editorial Board, International Journal of Technology and Globalization (Inderscience)
- Member, Editorial Board, International Journal of Technological Learning, Innovation and Development (Indescience)
- Member, Editorial Board, International Journal of Development and Social Research
- Member, Governing Board, International Centre for Free and Open Source Software
- External Referee to: Research Policy, Technovation, Economic and Political Weekly, Higher Education for the Future.
- Contributor to *World Science Report 2015*, UNESCO

7. Personnel Associated with the Unit

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