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## Introduction

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India has become one of the fastest growing economies of the world. Her continued surge in economic growth both before and after the recent (2008) global financial crisis has further lent credence to the hypothesis that the economic growth registered by the country is sustainable as it is based more on technological improvements rather than by using more factor inputs such as labour and capital. Recent estimates of total factor productivity growth lend some empirical support to this hypothesis. India has also been receiving sizeable chunks of FDI in R&D by MNCs. There are also press reports of a number of innovations emanating from the country although systematic empirical evidence on this issue is found wanting in the literature.<sup>1</sup> One of the avowed objectives of economic reforms in India since 1991 was to promote competition between firms. Along with the possibility of increased competition, one also sees that the country has become increasingly integrated with the rest of the world although on this count China has a better record than that of India. All these factors may pave the way for India to invest in innovative activities as the firms in India are no longer concerned with domestic competition, but international as well. In the context, the aim of this collection

of papers is to shed some systematic light on varied facets of technological changes and innovations in India's manufacturing establishment.

There are essentially a total of seven papers, which make up this special issue. Of the seven, two are general papers on the nature, extent and the impact on innovative activity in the economy. The subsequent five papers focus on issues related to innovation in five different sectors, two high-technology sectors (namely pharmaceutical and biotechnology), two medium-technology sectors (automotive and steel) and a low-tech sector (textiles). All these five sectors are important for their contribution to employment, exports and GDP as well.

The first paper by Mani takes the reader through the empirical evidence on whether innovative activities in India's economy have increased since the reform process of 1991. A variety of conventional (in the absence of new indicators such as the results of innovation surveys) are analysed and their movements over the last two decades or so chartered to draw some firm conclusions on this front. The conventional indicators considered are the growth in research intensity, patenting, scientific publications and technology balance of payments. The ensuing analysis shows that the growth in innovations is not widespread but concentrated in certain specific sectoral systems of innovation such as in the case of the pharmaceutical industry. But, the most important finding of the paper is the fact that much of the recent surge in innovative activity in the country is indeed contributed by foreign companies operating from the country and such correct conclusion to the original question is that India has now become an important location for innovative activities rather than being more innovative. The paper also identifies two limiting factors to the sustenance of innovations in the country, namely the availability of sufficient quantities of scientists and engineers and specific instruments for overcoming the market failures in the financing of innovations.

One of the important facets of the economic liberalisation policies set into motion since 1991 was to introduce a modicum of foreign competition supplemented in most cases by increases in domestic competition by removing the fetters to international trade. This manifested itself by paring down the customs duties and other quantitative restrictions on international trade. The second paper by Parameswaran investigates the effect of liberalisation of international trade on firms' R&D investment. The paper assumes that intramural R&D is still the most important conduit for introducing innovations. It examines the impact of import competition, export and import of capital goods and disembodied technology on R&D investment. The theoretical predictions on the impact of trade are ambiguous and contingent on many industry- and firm-specific details. This makes an empirical analysis more significant. The paper shows that export, in general, encourages investment in innovation, while R&D promoting effect of capital goods and disembodied technology import is not widespread. On the impact of import competition, the study found that it depends on domestic market structure. It promotes investment in R&D only when the market structure is highly concentrated otherwise it has negative effect. Thus, the paper brings out the conditional nature of trade's impact on R&D investment. This result also supports the recent developments in the growth literature on the relationship between product market competition and innovation.

The first paper had already identified that one of the most innovative industries in India is her pharmaceutical industry. The industry had benefited from a carefully crafted and relatively speaking tightly knit sectoral system of innovation (SSI). The most important component of this SSI was the Indian Patents Act of 1970, which did not recognise product patents, and this allowed Indian pharmaceutical companies to innovate

incrementally and develop cost-effective processes. But, this state of affairs was to change with the TRIPS compliance of Indian Patent Act with product patents now being recognised with effect from 1 January 2005. The important question to ask now is about the effect of this regime change on the quantity and quality of innovative activities in the industry. This is the important question taken up by the paper by Chaudhuri. The world pharmaceutical industry dominated by MNCs has often neglected to research and find remedies for diseases of the poor. It is increasingly being realised that what is required to develop drugs for neglected diseases is a paradigm shift in the system of pharmaceutical innovation, both nationally and globally. Although India has a sizeable domestic research and manufacturing capability in pharmaceuticals, available evidence show that India's drug industry, which is one of the most innovative among the country's manufacturing establishment, has devoted very little R&D efforts to the so-called neglected diseases. In the context, the purpose of the paper is to analyse what has been done and what more can be done to promote R&D for new drugs mainly for neglected diseases. The paper concludes with some thoughts on how public policies may be crafted to make this process self-sustainable.

An important component of the pharmaceutical industry is the biopharma industry. In fact, over three quarters of the country's biotechnology industry is dominated by the biopharma industry. The recent expansion of Indian biotechnology industry backed by strong R&D allocations sets the upward movement of the industry on a new growth trajectory intertwined with innovation and entrepreneurship. This is the theme taken up by Chaturvedi in his paper. He argues that innovation and entrepreneurship is more likely to take off Indian biopharma industry from 'bio-generics' and 'bio-similars' to a higher pedestal where it may develop 'proprietary processes', carving a new niche for the growth of the sector, giving further push to R&D-intensive activities. The issue is how national innovation system, which could provide initial manpower and financial support to the sector, responds to the growing specialisation of the Indian biopharma and help evolve new strategies to sustain the growth in the high-end biopharma sector.

Hitherto, we have viewed innovation as resulting from formal activities such as intramural R&D and the output of it in the form of patents. But, it is also a fact that firms do innovate through a variety of non-R&D but technology-generating activities such as introducing innovations through the acquisition of capital goods and more generally what is referred as Advanced Manufacturing Techniques (AMTs). Parhi's paper analyses the nature and patterns of adoption of AMTs in the Indian auto parts (or components) industry in the light of the policy changes in India and changes in world automotive industry. She empirically investigates the determinants of adoption of AMTs to tease out the parameters of technological change. The process of technology diffusion is dynamic and appears to have been driven by an apparent objective of steering the industry in the direction of an innovation-driven industry. The evolution of the industry in the light of these is discussed and relevant policy implications are spelt out in the paper.

India has sought to build a domestic steel-manufacturing industry as part of its efforts to industrialise. Although the steel industry in India dates back to the early 1990s, it experienced its major growth after the second five-year plan (1956–1957 to 1961–1962). Unlike the colonial period, the growth of the integrated steel plant sector during the period of planned development till 1991–1992 took place mainly at the direction and initiative of the Indian state as per the Industrial Policy Resolution of 1956. This policy reserved the expansion of the integrated steel plant sector (the route of steel making via pig iron making, starting with iron ore as raw material in a single production

establishment) in the public sector. D'Mello's paper examines the adoption of the innovations of the 'centre' by the Indian integrated steel industry (in the 'periphery') and lack of autonomous technological development, despite the potential, during 1970–1990. Imported technology was not subjected to any significant local adaptation and modification; further, there were hardly any autonomous technological innovations. Local ferrous metallurgical R&D, steel plant design and engineering, and the associated capital goods industry were weak and undeveloped, with tenuous linkages among themselves, and with the integrated steel plants. In fact, the paper shows the lack of innovations in the industry during this period. However, after the 1990s, with the liberalisation of India's steel industry, one sees many instances of innovations especially in the energy efficiency. For instance, Tata Iron and Steel Company was recognised as the world's best steel producer by World Steel Dynamics in 2005.

Textiles industry is one of the leading industries in India in terms of its contribution to employment, output and exports. The paper by Roy surveys the technological changes in the industry during the period since the onset of reforms in the country. Although the industry is generally termed as a low-technology one, it does employ high-technology processes and machinery. Liberalisation has certainly resulted in both the importation of second-hand machinery and technological changes in the domestic textile machinery sector. Roy's chronological account of the technological changes in the industry show that with the passing of the Multi Fiber Agreement (MFA) and recovery in the world market, a new phase of modernisation has been ushered in. In this phase, the existence of the Technology Up gradation Fund Scheme (TUFS) and easy import of second-hand machinery played a facilitating role; a long-overdue modernisation in weaving and processing began; relatively integrated mid-level business groups referred to here as the 'semi-composite' sector played a lead role; maturity in domestic machinery capability was a significant factor; finally, the East Asia link and foreign investments are now likely to forge new types of business relationship with implications for technological change.

Thus, this special collection of papers has the real potential of presenting the reader with a fairly deep understanding of the many faceted dimension of the rise of innovations (or the lack of it in some cases) in India's manufacturing establishment. It also presents them with a rich collection of relevant databases and issues for further research. It is hoped that the introduction may whet your appetite for reading through the seven papers in greater depth. We would like to end with the skool to the reader!

#### **Note**

<sup>1</sup>For a detailed count of these see, Business Week, [http://www.businessweek.com/magazine/toc/05\\_34/B3948chinaindia.htm](http://www.businessweek.com/magazine/toc/05_34/B3948chinaindia.htm) (accessed 5 April 2010).