

Pattern of innovation in Indian organized manufacturing firms

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Abstract:

Several theoretical models (Lucas 1988, 1993; Grossman and Helpman 1991) and empirical studies (Griliches, 1984; Mansfield, 1995) have pointed out that spending on innovation is positively associated with economic growth. Literature further illustrates different channels whereby manufacturing firms promotes innovation. In the present paper an attempt has been made to analyze the pattern of innovation in Indian organized manufacturing firms. The study is based on firm level aggregated data of 12222 manufacturing firms extracted from Prowess Database for the period 2000 to 2016.

I. Introduction:

In this era of globalization, technological progress is viewed as an important element in enhancing economic development of a nation (Aggrawal, 2006; Carrol et al, 2001). A plethora of literature has talked about the pattern of innovation in the industrial sectors. High-tech industries are used as synonymous of Research intensive industries due to their more emphasis on Research and development expenditure while low-tech industries are called as supplier dominated industries as spend more on the technology embodied in capital goods. **Pavitt(1984)** classified industries according to the sources, nature and pattern of innovation based on data collected on about 2000 innovating firms in Britain. Industries were classified into supplier dominated industries, specialized supplier, scale intensive industries and science based industries. Industries spending low in house R&D were called as supplier dominated industries. The industries where learning and doing plays an important role were characterized as Scale intensive industries Science based industries are to be found in chemical, electric and electronic sectors. **Grimpe and Sofka (2009)** investigated for the existence of different search patterns i.e. external innovation sources like customers, competitors, suppliers, and universities prevalent among high- and low-

technology industries. Study also found in majority of High and Medium- high Technology industries university knowledge was important search strategy. **Haukens and Knell (2008)** examined the direct and product embodied R&D diffusion of technology between different technology intensive industries in five OECD countries (France, Germany, Norway, Sweden and United States). Results revealed low-technology industries rely more on embodied R&D and the diffusion of the technology is highly dominated by flows into the low-technology sector from high-technology sector.

Heidenreich (2009) found suppliers were the main source of innovation in Low and Medium-Low technology industries (LMT). Fifty one percent of LMT industries spent on machinery, equipment and software as compared to 19 percent in HMT industries.

Based on data drawn for a sample of 753 firms from Taiwanese Technological Innovation Survey **Tsai & Wang (2009)** studied the strategies of low- and medium-technology firms to pursue technological innovation and the role of internal research and development in the utilization of external technological knowledge. Findings of the study indicated internal technology licensing is most popular strategy used by firms to generate technological innovation. About 95% of the firms acquire technology by Internal Technology Licensing. Secondly positive relation was found between firm's efforts in internal R&D and technological partners i.e. suppliers, customers, competitors and research institutes and universities in attaining higher innovation returns. **Kirner et.al (2009)** study made a comparison of innovation performance of German low-technology sector with medium and high-technology sector. The analysis was based on firm level data for 1663 firms drawn from German Manufacturing Survey 2006. The study used **Arora and Nath (2015)** studied the innovative behaviour, sectoral characteristics of innovation and innovation strategies of Indian firms. Results indicated that acquisition of technology through new machines were most frequent mode of innovation adopted by firms. **Pradhan & Puttaswamaiah (2005)** studied the pattern of technology acquisition in the Indian manufacturing for the period 1991 to 2001 by taking four technology indicators i.e. R&D intensity, foreign disembodied technology acquisition, foreign capital goods acquisition and domestic capital goods acquisition. The findings of the study indicated that at the national level disembodied technology acquisition was the most preferred mode of technology attainment followed by in-house R&D expenditure. Further there was fall in the expenditure on the foreign capital goods and domestic capital goods. **Pradhan (2010)** examined the trends and pattern of

R&D expenditure of Indian manufacturing firms and estimated their R&D intensity based on the data drawn from Centre for Monitoring Indian Economy database for the period 1991-2008. Findings of the study indicated that only a small number of firms spend on R&D (8.5 percent of small firms and 16 percent of medium enterprises). There was decline in R&D intensity of firms in 2000s as compared to 1990s.

After going through different perspectives on patterns of innovation among the manufacturing industries, the present study firstly makes an attempt to analyze if particular pattern of innovation exist in the Indian manufacturing.

Section II gives description of sources of data; Section III presents the results and discusses the same. Summary and conclusion are given in Section IV.

II. Database and Variables Used:

II.(A) Database:

Firm level data for the present study on Indian manufacturing industries has been drawn from PROWESS Database provided by Centre for Monitoring Indian Economy (CMIE) 12222 listed manufacturing firms. This database provides information from 1989 onwards but for the present study; the time period is selected from 2000 to 2016 as most of the observations are available during this time period.

II. (B) Variables used:

In order to investigate the pattern of innovation four variables are used as a proxy for innovation expenditure. In the first step, the firm level expenditure on R&D, foreign disembodied technology, foreign embodied technology, and domestic embodied technology were aggregated at the industry level for the period 2000 to 2016.

R&D is taken as the real R&D expenditure performed by an industry. Real R&D expenditure was obtained by deflating the nominal R&D expenditure using GDP deflator (2011-12 as base year). WPI is collected from the Office of Economic Advisor, Govt. of India.

Imported Disembodied Technology is expressed as real expenditure made by firms to acquire technology in disembodied form. Here payments of royalty, technical know-how fees by firms is used a proxy for imported disembodied technology expenditure. Real expenditure on disembodied technology was obtained by deflating the nominal expenditure with GDP deflator (2011-12 as base year).

Imported Embodied Technology is expressed as the real investment done by firms on import of capital goods. Real investment in capital goods import was obtained by deflating the nominal expenditure on capital goods using unit value index of imported capital goods with base 2011-12.

Domestic Embodied Technology is obtained by using the figures of real current year investment in stock of plant and machinery. Current year investment in stock of plant and machinery was arrived at by subtracting last year stock of plant and machinery to this year stock. Real figures were obtained by deflating the nominal values by whole sale price index of machinery and machine tools with base 2011-12.

All the four measures of technology intensity used are taken as average proportion of sales over the time period 2000-2016

III. Results and Discussion:

Table 1 shows the pattern of investment in four different modes of innovation in Indian organized manufacturing sector. These investments are provided in percentage form where the sum of all the four sources of innovation is taken as hundred. Results shows increasing trend of R&D investment and payments made in the form of royalty and technical know-how fees while the investment in the form of embodied technology from domestic as well as imported sources is found to be declining. Thus the pattern of innovation in Indian organized manufacturing sector is shifting from embodied form of innovation towards disembodied form of innovation.

Table 1: pattern of innovation in Indian organized manufacturing sector

Year	R&D	Imported Disembodied Technology	Imported embodied technology	Domestic embodied technology	total innovation expenditure
	1	2	3	4	(1+2+3+4)
2000	3.559	1.470	14.411	80.559	100
2001	3.374	1.482	10.746	84.398	100
2002	3.385	1.548	8.961	86.106	100
2003	3.416	1.566	8.465	86.554	100
2004	3.663	1.732	8.167	86.438	100
2005	7.511	3.628	17.604	71.257	100
2006	7.246	3.522	20.394	68.837	100
2007	7.467	3.540	22.465	66.528	100
2008	7.499	3.648	27.029	61.825	100

2009	6.914	3.553	27.037	62.495	100
2010	6.906	3.549	26.633	62.912	100
2011	7.481	4.133	26.241	62.145	100
2012	7.478	4.266	24.010	64.246	100
2013	8.929	4.609	21.798	64.664	100
2014	9.430	5.005	19.243	66.322	100
2015	9.700	5.601	16.943	67.756	100
2016	10.359	6.6139	16.388	66.639	100

Source: Authors' own calculations based on data drawn from CMIE prowess database.

Table 2 presents the average share of investment in different sources of innovation in Indian organized manufacturing sector over the time period taken for the analysis. It was observed that highest share of investment is in embodied form of innovation from domestic sources (more than 60 percent) followed by imported capital goods which shows investment in domestic and imported capital goods is the preferred mode of innovation as compare to R&D and payments made in the form of royalty ad technical know-how fees.

Summary and Conclusion:

While recognizing the importance of innovation in the manufacturing sector, present study makes an attempt to analyse the pattern of innovation among Indian manufacturing firms. Empirical analysis is based on aggregated data of 12222 listed manufacturing firms drawn from PROWESS Database provided by Centre for Monitoring Indian Economy (CMIE). In order to investigate the pattern of innovation, four variables are used as a proxy for innovation expenditure i.e. firm level expenditure on R&D, foreign disembodied technology, foreign embodied technology, and domestic embodied technology. The result of the analysis revealed that pattern of innovation in Indian organized manufacturing sector is shifting form embodied form of innovation towards disembodied form of innovation.

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