Chapter-VI

CONCLUSION

6.1. Research Findings: Once More

In this dissertation an attempt has been made to study the performance of Indian Chemical sector in the domestic economy as well as in the global market during the post-reform period. At the age of globalization the imposition of uniform patenting practices all over the globe is propagating a switch from process to product patent and protection of trade related intellectual property rights (TRIPs). This places a special challenge to the Chemical sector where the processes were mostly adopted through reverse engineering (by avoiding R&D expenditures) and where forward and backward linkages are not necessarily confined within the geographical boundary of the nation. The post-WTO protectionist measures in terms of TBT (technical barriers to trade) are also targeting this sector in terms of health and environmental safety standards and norms of sustainability. In spite of all these barriers Indian Chemical industry is an important player in the Indian manufacturing sector and especially in the post-reform period its presence in the global market has also become more visible at least in some specific directions of commodity trade. So, the questions that we are trying to answer here are how India is coping with these challenges in the production front and what factors are promoting international competitiveness in India's favor. Chapters I & II set the background of the analysis by describing performance of the sector between 1991 and 2006 in relation to other manufacturing sectors, home and abroad. Chapters III, IV and V constitute the core of the dissertation. The major findings of these chapters are integrated below.
Chapter-III extends an assessment of the overall efficiency, nature of inefficiency, geographical concentration, type of product diversification and pattern of technological heterogeneity for different types of Chemical producing registered factories of India by utilizing disaggregated unit level ASI data for four alternate years starting from 1999-2000 till 2005-06. Here technical efficiency has been taken as a performance measure of the producing units. Technical efficiency is an index which shows ratio of actual production and the potential productive capacity of a firm using the same amount of resources. There are various ways to measure the technical efficiency. This chapter considers the nonparametric Data Envelopment Analysis (DEA) developed from mathematical programming school. The mean VRSTE score for the registered firms for all the four years under consideration turned out to be rather low, ranging between 0.258 and 0.325, with a declining tendency over the years. The very large firms with more than 20 years of experience were found to have better average performance though in terms of absolute score the VRSTE was falling over time. On the other hand a number of very small but young firms showed fast improvement in efficiency score from a very low initial value. So, the high growth in gross value added of the industry over this period is not a very compelling evidence of good performance. To be competitive in the global context the industry has to adopt efficiency enhancing practices.

At the next stage of the analysis the production units were divided into two classes: efficient (with VRSTE score equals unity) and inefficient (those for whom there was scope for further improvement) and it was found that the share of efficient firms is also falling over time, from 2.26% in 2000 to 1.31% in 2006. The analysis of inefficiency
revealed a significant scope of improvement in terms of cutting down of the labor input and irrespective of size the older firms are found to become more inefficient over the years. These observations taken together suggest a fast change in production technology in this industry where the movement is towards more capital intensive processes and newer entrants are placed in a better position to adopt these modern methods compared to the incumbent firms.

The analysis of technology heterogeneity was carried out next and to do that a comparison of VRSTE score obtained on the basis of group frontier and grand frontier was applied. According to the relative concentration of the chemical firms the states were classified as High, Moderate and Low. For High states there was definite evidence of temporally increasing technology divergence whereas for Low states there was sign of technology convergence. At the same time it has been found that in Low states there was relatively greater concentration of Young firms and in High states the production scenario was dominated by the Very old firms. This indicates a possibility that in High states a group of firms might be adopting the modern techniques and getting connected with the global market and those who are failing to do so are performing miserably with their traditional technology, leading to a widening of the technology gap. Of course the possibility of gradual trickling down cannot be ignored at this stage.

Finally, in this chapter an attempt has been made to identify the product lines in which the Indian Chemical sector is concentrating more. Out of 57 varieties of products only 7 varieties of products are explaining more than 50% of total production in High
concentration states. These include manufacturing of basic organic chemicals, manufacturing of allopathic pharmaceutical preparation, manufacturing of fine chemical products including drawing ink, manufacturing of dyes, manufacturing of matches and manufacturing of explosives including firecrackers. For the last three the average technical efficiency score obtained from group frontier is very high with little variation across firms though the differences between the group VRSTE and grand VRSTE are significant indicating strong evidence of technology divergence; for the rest the opposite is the case. So, in Chapter-IV, by using WITS-COMTRADE database, we explore the export performance of Indian Chemical sector to check the relationship, if any, between technology divergence and global connectivity, creating strategic incentive and compulsion for a group of firms to enhance technical efficiency through adoption of appropriate coping strategies.

In terms of a constant market share (CMS) analysis Chapter-IV establishes the significant increase in price competitiveness of Indian Chemical export in the global market between 1991 and 2006. Whether this price competitiveness is leading to greater access to market share was our next question. To explore that possibility an analysis of revealed comparative advantage (RCA) for different sub-group of chemical products was carried out separately for the developed (OECD) and the developing (Non-OECD) world. For all countries taken together, India has high RCA for Organic Chemicals, Dying, Tanning, Coloring and Pharmaceutical Products where the production efficiency was also found to be relatively high. However, the division of the World market into OECD and Non-OECD bloc reveals more interesting facts. RCA in Dying, Tanning & Coloring is
very high in the OECD whereas that in Pharmaceutical Product is very high in Non-OECD. Moreover, in Non-OECD block RCA for Toiletries & Cosmetic Preparations is also greater than unity. Along with RCA the pattern of Multilateral Intra Industry Trade (MIIT) has also been considered simultaneously to check whether India is supplying low-value intermediate products or high-value finished products to the rest of the World. In Chapter-I it has already been noted that though the total volume and value of Chemical export is increasing over time the relative increase in the Unit Value Index (UVI) is getting surpassed by that of the Quantum Index (QI) for export and opposite is the case for Chemical imports. So, it is highly suggestive of concentration in intermediate stage of production in a global economy connected through the chains of sub-contracting and outsourcing.

For Non-OECD countries the MIIT index is high only for Organic Chemicals. For all other product groups where RCA was high the MIIT value is moderate or low, identifying India as a supplier of final products in the developing countries’ market. In contrast, for the OECD bloc MIIT values in Basic Chemicals, Pharmaceutical Products and Toilet Preparations are very high indicating stage dependence and concentration in the lower end of the value chain. This surmise derives further support from the fact that for the latter two product groups India’s RCA values in the OECD market are less than unity. The study of the growth rates of RCA and MIIT in these market segments has shown further that for both Organic and Inorganic Chemicals the OECD market is expanding very fast, for Paints and Dye India is concentrating in relatively more polluting lower value processes and for Perfumes and Toiletries India is gradually
coming up as a supplier of final products, especially in the Non-OECD market. Finally, an analysis of Bilateral Intra Industry Trade (BIIT) revealed that India has very strong bilateral IIT with European Union in products like Organic Chemicals, Paint & Dye and Perfume & Toilet Preparations, with the US and Japan the BIIT is mostly on Inorganic Chemicals, for UK it is on Paints & Dye, for Korea it is the Pharmaceutical Products and for all OECD countries the bilateral trade in plastic products in primary form is increasing rapidly over the years. This pattern has some serious implications in terms of evasion of environmental norms as most of these products have to go through some pollution intensive processes before coming to the final high-value formulation stage.

After assessing the efficiency status of domestic production front and the pattern of participation in the global market, finally in Chapter-V, we have concentrated on the specific Chemical firms of India to study the connectivity between global participation and technology up-gradation by constructing a longitudinal panel of observations collated from the CMIE-PROWESS database. In general it is found that the number of Chemical firms among the top listed companies is rapidly increasing in the post-reform period. Those who have stronger connections with the global market through the export-import chain are investing more on R&D and performing better in this regime. The analysis of panel data indicated a gradual shift towards labor-displacing capital intensive techniques of production. So, the final question that has been raised is related to the combined contribution of all these changes in enhancing total factor productivity of the Indian Chemical sector in the post-reform, post-WTO period. To answer that question applying Malmquist Index an analysis of productivity decomposition has been carried out next.
Three important observations followed: (i) in general, there is no improvement in total factor productivity (TFP) for the industry as a whole; (ii) TFP has improved for the firms undertaking R&D not because of technological improvement but due to the adoption of more efficient techniques of production. Therefore, the R&D is not targeting any fundamental innovation but directed more towards better adaptation of the pre-existing techniques; (iii) TFP of firms participating in exports has gone up mostly due to the availability of improved technology (coming with the sub-contracted processes) and attainment of scale efficiency. So, global connectivity has become very crucial in deciding the future prospect of the industry and to make it sustainable in terms of international norms and standards some specific regulatory policies need to be designed and implemented for effective intervention.

6.2. Policy Implications

The performance of the Chemical sector in India has turned out to be highly dependent on the extent of trade openness and R&D activities. Since the Chemical sector produces a number of basic goods related to food (fertilizer and pesticides), health (pharmaceutical products), etc., the challenge for this century is to innovate with speed and convert the resulting innovations into utilitarian commodities for rapid diffusion in society. The drive is to evolve environmental-friendly and cost effective technologies that ensure conservation of natural resources, optimization of manpower and energy with simultaneous maximization of productivity. In a liberalized globally connected market structure, Chapter-II has already mentioned a good linkage between export participation of the Chemical producing firms of India and firm level profitability as well as total
factor productivity. So, we will talk about those policies which would enhance export and encourage greater global participation of Chemical sector within the purview of TRIPs. The supply-side factors which may induce (push) the domestic firms to participate more in the export market are twofold: one is the stronger presence of the multinational enterprises (MNE) in the domestic market with in-house R&D activities and the other is the spillover effect on the local firms encouraging participation in the global market (Franco & Sasidharan, 2010). The small firms in the Indian drug & pharmaceuticals and paints and varnishes sector experienced productivity growth and the innovations initiated either to survive or to create their own market niches appears to be effective in increasing efficiency. According to the European Chemical Industry Council, “Industrial property rights, including patents, pose no danger to the environment. On the contrary, with effective implementation of TRIPs, patents will foster innovation, including environmentally sound technology and products- and their transfer- and consequently promote the sustainable use of the earth’s resources”. Enhanced IP protection can close off certain revenue options and cause a reorientation of firms’ strategies. The reorientation can affect industry structure and types of competition and this can lead to changes in prices, quality levels and physical availability.

Besides these push factors the export performance may be influenced by a number of demand driven pull factors. In the face of weaker regulatory enforcement in the developing countries, to evade stringent environmental standards, the developed countries may find it more cost-competitive to outsource the polluting production processes to the developing ones. Since quite a few processes involved in the chemical
production are highly polluting in nature this possibility of pollution load shifting cannot be ignored in this context (Chattopadhyay 2005). The products like Paints and Dyes, Basic Chemicals, Plastic in Primary Forms, etc. where India enjoys high MIIT as well as RCA in the OECD market are all related to pollution intensive processes. Another area of growing societal evil and concern is trade of pirated and counterfeit goods. In addition to creating business losses this menace is intimately linked to the issues of non-standard products especially when it relates to items of human or animal consumption and health. Until the present decade the extent of piracy in India's software industry was nearly 70% and that in pharmaceutical industry was no less (Ganguli 2000). So, unregulated expansion of exports may create a lot of caveats which need to be plugged by designing appropriate incentive structures for innovations at par international standard as well as interventionist policies at the national level.

Quite a few recommendations of the Mashelkar Committee (2003) on drug regulatory issues seem very much relevant for the domestic protection of the Chemical sector as a whole. The inadequate infrastructure for storage facilities, testing facilities or the dearth of specially trained inspectors at both Centre and State level are creating weakness in enforcing regulations. That is making the private cost of production much lower than the corresponding social cost and India is enjoying a pseudo competitive advantage in the world market in both pollution-intensive products and pirated counterfeit products. This pattern, if not checked immediately, will increase her vulnerability in the long-run. Finally, the withdrawal of domestic protection in the face of global competition would eventually encourage India to establish her brand name in the World market.
6.3. **Direction of Future Research**

This thesis attempts to analyze the performance of Indian chemical industry in post reform period. Here the performance has been analyzed from two angles. First one is local or domestic performance and another one is global performance. In case of local performance the Technical Efficiency (TE) and the change of Total Factor Productivity (TFP) index has been considered as an indicator. On the other hand the Export and Import Share, Unit Value Index (UVI) and Quantum Index (QI), Revealed Comparative Advantage (RCA) and Intra Industry Trade Index (IIT) such as Multilateral as well as Bilateral have been considered as global performance indicators. All those indicators of global performance are derived from the positive approach of observed relative market dominance. On the other hand the local performance indicators are influenced by the normative approach of deviation from the achievable efficiency. The standard Non-Parametric Data Envelopment Analysis (DEA) has been considered to measure the firm level Technical Efficiency (TE) by using most generalized BCC model and the Malmquist Measure of Productivity Index has been applied to measure the change of TFP at company level. These two techniques are purely based on mathematical programming. Therefore, score (either TE or TFP) generated from these techniques are purely non-statistical. Consequently, in this case the voluntary inefficiency is not distinguishable from pure involuntary inefficiency caused by random shock. The measured value of maximum output from a given input bundle obtained by DEA will depend on the particular set of input-output bundles that define the production technology. Because of the change in the peer group a different sample with the same input bundles producing a different set of output quantities would lead to a different VRSTE score. Given the
sample variation, a specific value of maximum output obtained from a single sample is of limited use. Therefore, one would prefer to have a confidence interval instead. For these one would need the sampling distribution for frontier output. In contrast with standard econometric approach in case of mathematical programming model the statistical properties of the estimator are not well developed. To overcome this difficulty, the Chance-Constrained Programming, Banker's F-Test, Bootstrapping DEA Technique etc. are now being developed as new methodology of Stochastic DEA analysis. To accommodate this intrinsic randomness embedded in the real life there is another way to generate the production frontier by assuming some specific parametric from. Stochastic Frontier Production Function (SFPF) approach is one of the leading techniques in terms of parametric methodology of production frontier estimation. In this approach primarily researchers assume some predefined shape of frontier (such as Cobb-Douglas type, CES type or Trans-log type) and then with the help of maximum likelihood estimation process (MLE) they estimate not only the best envelop frontier but also the score of inefficiency. The basic expression of stochastic frontier is \( Y = f(X, \beta) + v + u \), where an additional random error \( v \) is added to the non-negative random variable \( u \) (representing technical inefficiency) to take care of the effect of such unobserved random shocks including measurement error, if any, on the frontier output. In SFPF approach this non-negative random term is the indicator of the inefficiency. So in future our first attempts will be on the measurement of firm level technical efficiency with assuming stochastic disturbances (that is the TE from Stochastic DEA approach) to find out the confidence interval of technical efficiency and the next attempt will be on the measurement of firm level technical efficiency.
technical efficiency with SFPF approach to observe the differences of TE score of two alternative methods.

Even when a firm is technically efficient that does not mean that the firm is economically efficient. Attaining the technical efficiency ensures only that the firm produces the maximum output which is possible from its given input or the firm using the minimum input quantity to produce its specified output level. But that does not ensure that the firm is operating on its frontier using the efficient input combination. The full economic efficiency lies in scaling the cost minimizing input bundle when the output is exogenously determined and the profit maximizing input output bundle when both are choice variables in case of a business firm. The Allocative Efficiency (cost minimizing input bundle) and the Profitability (profit maximizing input output bundle) which are two yardsticks that make an industry perfect. Initially, the DEA technique was developed for use in a non-market environment where prices are either not available at all or are not reliable, even when they are available (the efficiency of school education, health services, etc.). This may give the impression that when the accurate price data are available then it would be more appropriate to measure the allocative efficiency and profitability instead of measuring the technical efficiency alone. So, in future our tusk will be to undertake appropriate study to measure the allocative efficiency level as well as the profitability profile of Indian chemical industry where the recently developed advanced techniques of the non-parametric data envelopment analysis would be most relevant.