# TRADE LIBERALISATION, COMPETITIVENESS AND EXPORT PERFORMANCE: A STUDY OF MACHINE TOOL INDUSTRY IN INDIA

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# TRADE LIBERALISATION, COMPETITIVENESS AND EXPORT PERFORMANCE: A STUDY OF MACHINE TOOL INDUSTRY IN INDIA

*Dissertation Submitted in the partial fulfillment of the requirements for the degree of Master of Philosophy in Applied Economics of the Jawaharlal Nehru University*

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I hereby affirm that the work for this dissertation, **Trade Liberalisation, Competitiveness and Export performance: A Study of Machine Tool Industry in India,** being submitted as part of the requirements of the M.Phil Programme in Applied Economics of the Jawaharlal Nehru University, was carried out entirely by myself. I also affirm that it was not part of any other programme of study and has not been submitted to any other Institution/University for the award of any Degree.

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Certified that this study is the bona fide work of Rijesh.R, carried out under our supervision at the Centre for Development Studies.

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*Dedicated to my family...*

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ABSTRACT OF THE DISSERTATION

# TRADE LIBERALISATION, COMPETITIVENESS AND EXPORT PERFORMANCE: A STUDY OF MACHINE TOOL INDUSTRY IN INDIA

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One of the notable trends in the world economy in recent period is the increasing integration of economies resulting in faster growth in international trade. This has been fostered by trade liberalisation in a number of countries. Though there are divergent arguments on the possible effect of trade liberalisation, particularly in the developing countries, its expected benefit includes higher production efficiency due to increased competitive pressure, increase in the scale efficiency due to expansion in markets technological progress arising from various kinds of learning and greater export performance out of reduction in incentive distortion. However, it has been pointed out that many of these beneficial effects are contingent on the factors specific to the domestic economy.

Indian economy has been moving towards more liberal trade policy regime since mid 1980s, and this got further acceleration since 1991. The declared objective of the trade liberalisation policy was to increase the efficiency and competitiveness of the Indian manufacturing industry. Though a number of studies examined the export performance of the manufacturing industries, these studies were aggregate nature and therefore mask industry specific variation. Against this background, the present study examines the export performance of India's machine tool industry. Machine tool industry is considered to be a strategic industry with the potential to have a significant influence on the overall health of capital goods and the whole manufacturing industry. Generally across the world, machine tools are highly traded commodities because of its nature and diversity. The specific objectives of the present study are (1) To examine the trend and composition of machine tool production and trade (2) To assess the export competitiveness of machine tool industry in the post liberalisation period and (3) To identify the determinants of machine tool export.

The study shows that, though the production of machine tools increased during the post liberalisation period, its instability has also increased. The industry has also diversified its production structure and introduced advanced CNC machines. But the growth performance of capital good industry, a major user industry and machine tools, have shown a diverging trend since reform. With the relaxation of industrial controls and regulation new firms have emerged in the market and the share of public sector companies have declined. The study also shows an improvement in the technology profile of the industry.

India's machine tool trade has expanded during the liberalisation period and there was a massive surge in the imports. There was a noticeable upward trend in machine tool export since the late 1990, which was almost absent in the earlier regime. Further, the destination of machine tool export has changed towards OECD countries. Although these are significant development, the composition of machine tool export reveals India is specializing in low to medium technology intensive products.

Analysis of export competitiveness using market share movements revealed that the exports have remained uncompetitive throughout 1980-2003, but during the last few years the disadvantage is showing a declining trend. In the analysis of the determinants of machine tool export for the period 1980-2005, we considered demand and supply factors. We adopted econometric methodology and used three-stage least square (3SLS) to accommodate two-way relationship between price and quantity. The result showed that demand factors are the significant determinants of machine tool exports. Among them the real exchange rate and world demand are highly significant. In the supply side only skilled labour force are the significant at a lower level. This suggests that the nature of external demand along with a depreciating currency can have a significant impact on machine tool exports.

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## CHAPTER 1

# INTRODUCTION

One of the significant developments in the world economy in recent period has been the increasing interdependence among countries resulting increased volume and variety of trade in goods and services, capital flows and rapid diffusion of technology. A notable feature of this economic integration has been the active participation of developing countries in world trade (UNCTAD, 1998). Developing Asia's exports expanded almost 10-fold from 1984 to 2004 while the world exports grew only fivefold. As a result, developing Asia's share of world exports doubled over the same period and by 2004 had reached 21.3 percent (Asian Development Outlook 2006). The increasing international trade among countries is chiefly attributed to the liberal trade policies adopted by countries all over the world resulting lower barriers to trade[1].

This was in sharp contrast to the earlier regime where most of the countries where following import substitution industrialisation, in which government policies actively encouraged domestic industry to meet fully the domestic demand (Weiss, 2002). Although initially, countries such as Latin American and Asian countries experienced rapid industrialisation and diversification, as time passed the inefficiency of protection soon began as they experienced slow growth. This was in sharp contrast to the experience of some East Asian countcries such as South Korea, Taiwan, Singapore, Hong Kong, Malaysia, Indonesia and Thailand that followed and an outward oriented strategy focusing on export-oriented industrialisation. Since 1965, these countries have recorded some of the highest GDP growth rates in the world, averaging as a group nearly 6 percent per annum and also some of the highest rate of growth of exports, averaging more than 10 percent per annum.

The advocates of liberal trade regime argue that it is the export-oriented strategy, which helped these countries to realise their comparative advantage and thus raise the standard of living. So as a policy prescription, trade liberalisation and outward orientation is generally advocated as a means to overcome the low level of growth. The idea behind liberal trade regime following export orientation is rooted in the basic ideas of international trade which

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[1] The major barriers to trade are tariff, and non-tariff barriers (NTB) consisting of quotas, licenses, technical specification etc. Although the rich countries still protect sensitive sectors such as agriculture and textiles, the average tariff levels have significantly declined and stood around 4 percent in recent period. Tariff levels in developing countries have also been reduced but still remain relatively high, averaging over 20 percent in the low and middle income countries (Thirlwall, 2005)

advocate that free trade is pareto optimal as countries will specialize in production according to comparative advantage which increase welfare gains due to increased production and consumption utilities. Let us discuss some of the important principle ideas and empirical conformity of these arguments in detail.

### 1.1 Trade Liberalisation and export growth performance: Theory and empirical evidence.

There are divergent views among scholars regarding the possible impact of trade liberalisation on competitiveness and export performance. Therefore, we will highlight some of the prominent view of these two schools of thought and also provide some empirical evidence for their claim.

Trade liberalisation according to Krueger, (1998), is the action of making the trade regime less restrictive and consequently reducing the incentive for Import substituted industrialisation. The major elements of trade liberalisation involves (a) the removal of quotas, import licenses and other quantitative restrictions (b) subsequent reduction of the level and dispersion of import tariffs (c) devaluation of national currencies in order to compensate for removal of protection or to remedy over valuation of the exchange rate and (d) removal of export taxes and subsidies[2].

The rationale behind trade liberalisation is that trade among countries is mutually beneficial as it will allow countries to specialize according to their comparative advantage. Under free trade, nation's production frontier and consumption utility will be enlarged compared to the situation under autarky. The shift from domestic market orientation will enhance the efficiency of the manufacturing sectors, as it will increase the pressure to become competitive in the world market. Thus, in order to improve the growth performance it was necessary to reduce trade restriction and focus on export orientation by way of trade liberalisation.

The idea of trade liberalisation and outward orientation was deepened with the publication of Kruger (1978), Bhagwati (1978) and Balassa (1980). These studies tried to pinpoint the high inefficiency of the controlled regime, which jeopardized the growth prospect in several countries. Some of the well-known arguments in favour of trade liberalisation are the following,

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[2] In the literature we can see that trade liberalization is often interpreted narrowly or broadly. In a narrow sense, it is identified as the removal of trade restricting practices like tariff and non- tariff barriers. In a broader context, it includes not only the removal of trade barriers but also the all forms of controls and restrictions that affect economic transaction among countries, including relaxation in capital controls, exchange rate rationalization and minimal government intervention.

a) Static efficiency: This involves reallocation of resources in favour of more efficient production in line with international opportunity cost and prices (Bhagwati, 1988: 36). Here the incentive structure would shape in such a way that there would be no bias against exports and towards home market, and there would hardly be any discrimination among the various products within export and import competing activities. The short run efficiency gain led to improve GDP growth performance and it is once for all level effect.

b) Trade liberalisation will not only increase growth of export in general but even more so to rapid growth of non-traditional exports (Kruger, 1980:288). Exports expand aggregate demand, encourage full employment of resources, and earn revenues to pay for the imports, which enhance consumption and facilitate technological progress.

c) Trade liberalisation leads to better rate of growth of GDP. Kruger (1980) argue that this occurs as a result of improvements in resource allocation, in favour of tradable, particularly exportable, increase in total factor productivity and gains from efficiency in existing industries and development of new efficient industries.

d) Trade liberalisation infuses competition and the wider market choice and cheap input flows can supplement industries to attain competitiveness. It also reduces unproductive activities such as in rent seeking. Trade liberalisation will reduce the monopoly rent appropriated during the import substitution regime, thus reducing the unproductive rent seeking activities, shifting resources to more efficient use (Corden, 1971; Bhagwati and Srinivasan, 1979)

e) Dynamic Efficiency gains: This involves the improved innovation and learning opportunities and better economies of scale. These views originate mainly from the new growth theories, which originated during 1980s. One of the main arguments was that a more open economy would have greater ability to adopt the wide range of innovation taking place around the world resulting increasing its long run growth rate. The other benefits involves better technical change, greater competition with resulting productivity gains as producers are forced to compete internationally, greater awareness of international standards (Weiss, 2002).

f) Lack of government intervention: Another major argument of some of the advocate of trade liberalisation is that government should gradually withdraw from economic transaction, as the market institution is more efficient in resource allocation. The neo liberal economists argue that government intervention involves high cost and often inefficient, oppressive, and waste capital and other resources (Little et al, 1970, Kruger, 1980). In addition, if a country is underdeveloped, the risk of government failure is high and it is better to leave the allocation of resources to the markets.

One of the positive benefits attributed to trade liberalisation is the export-oriented development (Weiss, 2002). To quote Kruger (1980: 92) 'the commitment to an export oriented development strategy implies a fairly liberal and efficient trade regime'. Export promotion strategy denotes the adaptation of a structure of incentives, which does not discriminate against exports in favour of home market (Krueger, 1998). This also involves the use of compensatory export incentives to encourage domestic resources to be re-directed to the exportable sectors (Bhagwati, 1988). Under inward orientation, export sector was often sidelined and severe anti export bias prevailed. The biasness result emerge due to divergence in input cost and world market prices (input tax argument) the unavailability of cheap and quality inputs from abroad and finally the currency appreciation due to the gap in the demand for foreign exchange and exchange rate fixation.

The export sector are advocated as it is believed that (i) they generate a greater capacity utilization; (ii) they take advantage of economies of scale; (iii) they bring about technological progress; (iv) they create employment and increase labour productivity; (v) relaxes the current account pressures for foreign capital goods by increasing the country's external earnings and attracting foreign investment (World Bank, 1993). An export-oriented strategy also enables the domestic manufactures to improve the competitive position in international market. This can result if the lower barriers enable access to cheap inputs, technology diffusion and learning.

As a consequence of these intellectual thinking and the export oriented strategy of East Asian countries many international organisations such as World Bank and IMF began to advocate trade liberalisation as the official policy option for developing countries during the 1980s. The devolution of funds and loans to these countries became subject to several conditions including trade Liberalisation. Finally, the Uruguay round of trade negotiation, concluded in 1995, led to an agreement, which included a radical degree of trade liberalisation.

Although these arguments have strong theoretical backing, many have questioned the universal application of trade liberalisation policies across developing countries. Critics argue that, the argument of free trade, which is based on pure theory of international trade, is static in nature. Most of the assumptions underlying the model are very restrictive and does not hold in a developing country where markets and information is often imperfect[3]. There is also a well-established consensus that the most of the successful export oriented countries from East Asia, have maintained varying degree of import protection for most commodities and government took an active intervened in the market[4]. Moreover, most of them pursued inward looking policies prior to their shift towards greater export orientation in the 1960s (Weiss, 2002).

More structural theorists have questioned the wisdom of relying heavily on external markets, particularly for contemporary Third World economies (Myrdal, 1957). These economies have generally specialize in traditional exports such as primary products and very low wage assembly, which often lie in sectors that offer unattractive demand prospects and limited inter-sectoral linkages (Prebisch, 1964). Meanwhile, a flood of imports from more established foreign firms might prevent the development of new domestic industries. Thus, trade dependence may lead to distortions, which compromise future growth opportunities of these economies (Emmanuel, 1972). The heavy reliance upon trade may leave a nation dangerously vulnerable to market disruption or political pressures, particularly if that trade is concentrated in a small number of products and a small number of trade partners. Modern protectionist also highlights the unfavourable effect of trade liberalisation on balance of payment and terms of trade. Generally, the free trade theorist argue that moving to a more open trade regime will increase the volume of trade thus offsetting the negative impact of unfavourable terms of trade. But if the terms of trade do offset the gains from trade, there is ample argument for raising the protective instruments and government support.

These arguments point out that there are theoretical possibilities were trade liberalisation could have either beneficial or adverse impact on the host economy. Therefore, an assessment of the empirical literature can be useful in understanding the nature of relationship. Not surprisingly, number of empirical works has been carried out which assessed the impact of trade liberalisation on export growth. We will briefly discuss some of this important literature below.

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[3] The other restrictive assumptions are the existence of small and passive firms, constant returns to scale, full employment of resources and the lack of risks in investments, production and trade.

[4] See Krugman (1994) and Rodrik (1995)

### 1.1.1 The empirical evidence

In the empirical literature there is wide disparity of viewpoints among scholars. Generally, most of the studies have found a positive impact of trade liberalisation on export performance but differ regarding the nature of relationship and structure of exports. Michaely *et al* (1991) found strong growth of export immediately in the year of liberalisation, and even more in the later years for 31 countries. The export growth increased as a result of relaxation of import restrictions, which is accompanied by a real devaluation and not by export promotional measures. Weiss (1992) found that Mexico has improved the export performance due to the relaxation of internal demand constrain as a result of trade liberalisation. In the case of Sri Lanka, Jayanthakumaran (1994) shows that liberalisation of trade and industrial policies enabled changes in composition, growth and stability of exports. In a more recent study by Santos-Paulino (2002) showed that for 22 developing countries that have adopted trade liberalisation policies, has raised export growth by nearly 2 percent points compared with the pre liberalisation period.

There are studies, which report insignificant growth performance of export as a result of trade liberalisation. Greenway and Sapsford (1994) found that for eight out of twelve liberalizers there is 'no discernible impact on the export/growth relationship'. In the case of Bolivia, Jenkins (1996) did not find any link between reductions in protection and export performance, as their commodity composition did not change as a result of changed environment. Sharma *et al* (2001) found no link between reductions in protection and export performance in Nepal and attributed this to weak institutions and poor infrastructure facilities. Shafaeddin (2005) showed that majority of African and Latin American countries have faced de-industrialisation with the introduction of trade liberalisation and find it difficult to diversify its product range resulting increasing vulnerability.

The evidence clearly establishes that there is no linear relationship between trade liberalisation and export growth performance. The performance of countries diverges due to result from the nature of investigation, methodology adopted and econometric techniques employed. Moreover, the choice of variable to measure trade liberalisation has also varied across studies. Having said that, we can conclude that there are certain important beneficial impacts of trade liberalisation but its realization is subject to the domestic economic conditions.

In this context, let us discuss trade liberalisation and export orientation in Indian economy.

## 1.2 The Indian Experience: From import substitution to export oriented strategy

India is currently experiencing major changes in its industrialisation and trade strategy. This was in sharp contrast to the earlier regime were government took active participation in the decision-making. The basic premise of the earlier regime was self-sufficiency, minimal dependence and commanding heights of the public sector. Export pessimism was widely prevalent. The trade-policy regime was highly protectionist and regulated through high tariff/non-tariff control on imports. Domestic industry, heavily insulated from international competition, was under strict regulation (Chadha, 1997). The continued pursuit of inward looking policies created large and diversified industrial sector in the country (Lall, 1987). Although initially very successful, the empirical analysis on the performance of the industry has highlighted several weakness of such blanket protection[5]. As an alternative, the scholars advocated a move towards more liberal regime.

A beginning was made towards liberalisation of India's trade regime during the late 1970s, and this liberalisation gained some momentum during the latter half of the 1980s (Chadha, 1997). In order to expand and remove the bias in the export sector, government introduced various export promotion policies and instruments. This was further carried out in the 1990s with the initiation of internal as well as external liberalisation measures where an explicit recognition of looking outward was seen as a rational strategy for economic growth.

Some of the important measures were gradual reduction in tariff and NTBs, relaxation of exchange rate controls, opening up of domestic industry to foreign competition etc. The basic aim of these measures was more integration with rest of the world with an increasing role for exports industries and competitiveness. Apparently, currently Indian economy is more open than earlier regime as can be seen from the measure of openness i.e., trade share in GDP which increased from 14.1 percent in 1980 to 20 percent in 1999 (kalirajan, 2003). The table 1.1 present some important indicators of trade liberalisation namely imported weighted tariffs, effective rate of protection and coverage ratio.

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[5] The import substitution strategy was criticized for resulting in low sectoral growth (Ahluwalia, 1985), high cost industrial structure (Pillai, 1979), technological stagnation and dependence (Chudonovsky, *et al*, 1983, and UNCTAD, 1983), inefficiency, low productivity and lack of innovativeness (Lall 1999).

**Table 1.1 Indicators of Trade Liberalisation (Per cent per annum)**

| | Import Weighted Tariff | | Effective Rate of Protection | | Coverage Ratio (QR) | |
|---|---|---|---|---|---|---|
| | 1988-89 | 1996-97 | 1988-89 | 1996-97 | 1988-89 | 1996-97 |
| Manufactured Goods | 137.1 | 36.5 | 166.1 | 55.1 | 80.2 | 32.5 |
| Food | 125.0 | 49.9 | 233.1 | 48.9 | 98.8 | 82.4 |
| Beverages | 150.0 | 122.0 | 219.4 | 173.9 | 100.0 | 75.0 |
| Tobacco | 150.0 | 52.0 | 137.5 | 60.2 | 100.0 | 100.0 |
| Textiles | 113.0 | 51.9 | 109.8 | 59.2 | 98.1 | 50.8 |
| Footwear | 148.0 | 51.1 | 160.1 | 53.4 | 95.7 | 92.7 |
| Furniture and Wood Products | 108.8 | 34.6 | 119.6 | 38.5 | 84.7 | 26.9 |
| Paper & Paper Products | 154.0 | 30.6 | 172.8 | 29.7 | 83.8 | 42.2 |
| Printing & Publishing | 37.5 | 21.7 | 7.3 | 16.3 | 73.5 | 56.3 |
| Leather & Fur Products | 130.0 | 42.0 | 147.1 | 45.6 | 56.4 | 51.3 |
| Rubber Products | 143.6 | 52.0 | 153.7 | 69.0 | 88.2 | 59.8 |
| Chemicals & Chemical Products | 189.3 | 39.6 | 236.5 | 42.6 | 77.0 | 26.2 |
| Petroleum & Coal products | 104.9 | 31.4 | 127.5 | 79.1 | 81.5 | 27.5 |
| Non-metallic mineral Products | 133.7 | 50.7 | 139.8 | 61.0 | 76.6 | 61.2 |
| Basic metal industries | 163.1 | 31.3 | 127.8 | 41.4 | 81.9 | 59.1 |
| Metal products | 144.4 | 36.6 | 127.8 | 41.4 | 81.9 | 59.1 |
| Non Electrical Machinery | 111.1 | 31.4 | 92.0 | 31.0 | 71.0 | 19.0 |
| Electrical machinery | 124.2 | 38.3 | 116.2 | 42.0 | 72.7 | 24.4 |
| Transport Equipment | 106.1 | 45.5 | 96.4 | 51.0 | 83.0 | 36.2 |

Source: Reproduced from Ahluwalia (2006)

An examination of the table clearly reveals that compared to the late 1980s, the restrictive measures have come down significantly for most of the industries. For instance, the import-weighted tariff has come down to 30 percent in 1996 from 137 percent in 1988. The sharpest fall was in chemical and basic industries. Machinery and equipment also witnessed significant decline. This was the case for most other industries with other measures also. This shows that currently the industry has been experiencing rapid liberalisation which facilitates rapid integration with other economies.

### 1.2.1 Empirical Studies

The impacts of trade liberalisation on Indian industries export performance and competitiveness has been subject to empirical scrutiny by different scholars. The examination of some of these studies reveals that there has been a significant expansion of manufacturing exports since the trade liberalisation period (see Lall, 1999; Tendulkar, 2000; Srinivasan, 2003; and Sinha Roy 2004). But one of the major features of the growth

performance has been the concentration of export basket in few items, mainly resource based and low technology intensive products (Lall, 1999 and Kaushik and Paras, 2000)). It was found that, the export structure remained more or less stagnant during the reform period (Lall, 1999) and uncompetitive in the world market (Tendulkar, 2000 and Srinivasan, 2003). There is evidence of a positive effect of exchange rate depreciation on improving export performance (Srinivasan, 2003) but a recent study by Sinha Roy (2004) highlighted that the superior export performance cannot be attributed to liberalisation per se, as Indian export is significantly influenced by various demand and supply factors. Also, compared to other emerging Asian countries, the competitive performance of Indian export was poor (Marjit and Raychaudhuri 1997; Lall, 1999 and Srinivasan, 2003).

There has been studies that examined the export performance at disaggregate level. The result has been mixed. Marjit and Raychaudhuri (1997) found that compared to 1980s, the export performance of Leather and various textile products did not register growth in early 1990s. The export performance of Indian machinery during the 1980s was also relatively poor as India lost its market share due to the superior performance of East Asian countries. Srinivasan, (2003) also found that the performance of leather products and handicrafts declined steeply during the 90s. But the performance was notable in chemical products, particularly drugs and pharmaceuticals and also textile yarn and in engineering goods.

India was found to have a competitive advantage in the traditional resource intensive industries like processed agricultural and mineral products rather than scale intensive and differentiated products like machinery (Tendulkar, 2000). Shabeer (2002) for the analysis of pharmaceutical product exports from India noted that the growth rate was comparatively lower during the post reform period but exhibited a positive balance of trade. At the disaggregate level, India seem to export value added products like formulation rather than bulk drugs to the advanced country markets. The study, using revealed comparative advantage (RCA) index, also found that India does have a comparative advantage in pharmaceutical products.

This brief review of the empirical studies reveals that the impact of trade liberalisation on the performance on the export performance and competitiveness has been very complex and performance varies across product groups. This highlights the need to have

more sector specific studies which will explain the working of trade liberalisation policies at a disaggregate level as most often aggregate analysis masks the industry specific variation. Sector specific studies will also enable us to identify the comparative advantage of a particular industry in the global market. Although, from a theoretical perspective we can hardly get much information regarding the likely impact of trade liberalisation on specific industries, we can expect that the likely impact of trade liberalisation may vary according to sector specific characteristics. Therefore, the present study assesses the impact of trade liberalisation on competitiveness and export performance of machine tool industry in India. The choice of the industry was guided primarily due to the lack of empirical works in this area, and the significance of machine tool sector in overall industrial performance. Let us briefly discuss some of the main feature of this industry in an economy.

### 1.3 Machine tool Industry

A machine tool is a stationary, power-driven machine used to cut, shape, or form materials such as metal and it consists of wide range of products ranging from simple bench-top lathes to large machining centers. Machine tools are indispensable to the production and repair of the various new machines being introduced in all branches of society. The industry forms the pillar for the competitiveness of the entire manufacturing sector since machine tools produce capital goods, which in turn produce the manufactured goods. Machine tools are also known as mother or master machines because they are used to manufacture both machine tools and other machines i.e., a means of manufacturing the end product. It generates and transmits new technology to user industries, imparts initial solution to technological problem by developing new skills and techniques in response to new demand from the specific customers. Once these are developed, the newly developed techniques are transmitted to the other part of the machinery using sectors of the economy (Rosenberg, 1976). As technological change in machine tool production is more rapid than any other branches of capital good sector, its growth and technological development is crucial for the growth of industry as a whole.

Machine tools are central to almost all-durable goods production. The machinery-producing sector is considered as a leading and core sector because of its high backward linkage effect (Amsden and Kim, 1986). The role of machinery producing and especially machine tools in introducing and diffusing technological change is multi dimensional because almost all the innovation require the capital good sector to produce a new machine tool according to new

specification (Rosenberg, 1976). The domestic machine tool sector is strategic as it supports national security interests as well as national industrial competitiveness (Ashburn 1988, and Nivin, 2000). The industry creates large amount of externalities in the process of industrialisation in terms of its impact on manufacturing, possibility of dynamic returns to scale, influence on product characteristics, production process of other industries, backward and forward linkage etc (Cohen and Zysman, 1987; Westphal and Pack 1986). The quality and cost of engineering products depends on the quality of parent machine tools and their automation levels. Therefore, most of the nations have embarked policies to build self sufficient and efficient machinery sector. The government of India has also laid great stress on developing a strong and viable machine tool sector since the initiation of planning process. The industry was heavily protected by way of restricting new entry and investment and erecting trade barriers. As a result, India was able to produce wide range of machines and catered to the developmental need of the domestic market.

There are number of studies that analyzed the performance of machine tool industry during this period. The table 1.2 provides a brief summary of some important studies of the past and highlights some of the basic issues addressed by them. An examination of these studies reveals that machine tool sector has been active area of research in the past. But most of these studies confined to the period of import substitution and there is no systematic account of the impact of trade liberalisation on competitiveness and export performance of machine tool industry over the years.

**Table 1.2 Selected reviews of major Studies on machine tool industry in India**

| Study | Issues and period of study | Data Source | Methodology | Results |
|---|---|---|---|---|
| Alagh (1971) | Development experience during first three five year plans | Secondary data | Descriptive | Production has increased but confined to simple machines |
| Mathews (1986) | Technological dynamism in India and Japan during 1970s and 1980s. | Secondary data | Descriptive measures | Superior performance of Japan due to intensive trade strategy |
| Srinivasan (1986) | Production and consumption during 1960-80 | Secondary data from ASI, IMTMA and DGTS. | Descriptive measures | Cyclical growth |
| Alam (1998) | Government role in the development of machining centre in India and Korea during 1975-86 | Secondary data | Descriptive measures | Korea outperformed India due to better competitive environment and export orientation. |
| Mehta (1990) | Growth and competitive performance till 1980s | IMTMA and DGTS | Descriptive and Case studies | Low production and export performance. |
| Suvrathan (1991) | Trend in exports and competitiveness during 1962-86. | Secondary data from IMTMA | Descriptive and estimation of ERP/DRC | Low growth of exports and poor competitive performance attributed to price and non-price factors |
| Pillai and Srinivasan (1992) | Age and productivity for the period 1960-80 | Secondary data from ASI | Descriptive and Kendrick method for estimating TFP | Inverse relationship between age and productivity due to low operational efficiency, high dependence on foreign collaboration and product diversification |
| Albin (1992) | Growth and rate of diffusion of CNC machines during 1951-91 | Secondary data from ASI and IMTMA | Descriptive measures including Ray's method for assessing diffusion | Cyclical growth till 1980s. Rapid diffusion of CNC machines since 1985 |
| Desai *et al*, (1999) | Comparative assessment of the performance India and Taiwan during 1970s to mid 1990s | Secondary data from IMTMA, UNIDO and TAMI | Descriptive measures | Indian machines are internationally uncompetitive due to supply side factors |
| Uchikawa (1999) | Impact of reform on structure and export performance since reform | Secondary data from IMTMA and ASI | Descriptive measures | Not much export dynamism and exports suffered from external shocks. |
| Kathuria (2000) | Role of government in fostering international competitiveness during 1990s | Secondary data source from IMTMA | Descriptive measures | Compared to other Asian counterpart competitiveness was poor. Government has significant impact on shaping user producer linkage. |
| Kumar (2004) | Government policy on performance of CNC machines | Secondary data from IMTMA and firm level surveys | Descriptive measures | Significant role as policy decision determine firms ability to use resource and build capability resulting better performance. |

### 1.4 The problem of the Study

The liberalisation process has greatly changed the market scenario of machine tools. The ease of domestic market constrains and the liberal imports of machines have increased the pressure of the industry to be more export oriented and competitive in the world market. This sector has witnessed high import of technology and capital. The liberalized import like the import of specialized machine tools in particular, the import of CNC machine tools has been very significant in recent years. Most of the past studies on machine tool have concentrated on the dynamism of the industry in the pre- reform period or up to mid 1990s. However, there is no study on the changes in the structure of this industry during the post liberalisation phase. A priori, there must have taken place a drastic change in the product composition of the industry due to an infusion of foreign technology and capital.

As discussed earlier, the change in the trade regime is expected to have a positive impact on machine tool export performance. The machine tool industry, where greater scope for specialization exists, can expect to improve its export orientation by following its comparative advantage. As discussed in the theoretical literature, there are mechanisms by which trade liberalisation can improve and foster competitiveness and export performance. One significant factor that most of the previous authors have neglected is identifying the factors determining machine tool exports. As export performance is influenced a variety of factors, an assessment of these factors not only help in understanding the export scenario but also provides some policy insights.

Therefore, the present study strives to fill these research gaps. The study has following three broad objectives.

1.To examine the trend and composition of machine tool production and trade.

2.To assess the export competitiveness of machine tool industry in the post liberalisation period.

3.To identify the determinants of machine tool export.

## 1.5 Data Source and Methodology

The study is primarily based on secondary data collected from variety of sources. The study required data on production, trade and price indicators of machine tools and capital goods and is collected from different sources. We briefly discuss them here. The production and investment data on machine tools are collected from Annual Survey of Industries (ASI), CSO. The ASI classification is based on National industrial classification (NIC), which follows the structure of standard industrial trade classification (SITC) of United Nation (UN.) Since inception, ASI has made major changes in its classification of Industries. Until now, there were four revisions of the series[6]. Manufacture of machine tools comes under 3-digit level under NIC 1970 (357) and NIC 87 (357+392) and at four-digit level under NIC 1998 (2922) and NIC 2004 (2922). Capital good consist of NIC (1998) consist of 29-32 and 34-35. In NIC (1970) it is 35-37. This matching was made according to the concordance table prepared by ASI. We have used the time series data series available in the summary result of ASI database. The data on capital goods and manufacturing sector is also obtained accordingly.

Trade data in India is available according to the Indian Trade Classification (ITC) based on the Harmonised Commodity Description and Coding System (HS). India's foreign trade data is mainly available from three sources, The Directorate General of Commercial Intelligence and Statistics (DGCI&S), Reserve bank of India (RBI) and United Nations Conference on Trade and Development (UNCTAD). Both DGCI&S and UNCTAD provides detailed, disaggregate level data for both import and export. We cannot use RBI database for machine tool industry, as the data is available only at a high level of aggregation.

DGCI&S provides data at a very high level of desegregation. The data series comes under two versions. (1) Foreign Trade Statistics of India (Principal Commodities & Countries) and (2) Monthly Statistics of the Foreign Trade of India -Vol. I (Exports including Re-exports) Vol II (imports). The March issue of the latter provides the financial year data for all the commodities. All these data are available from Centre for monitoring Indian Economy as CD-Rom titled as 'India Trades'. Since 1987, DGCI&S has changed its classification system from Standard International Trade classification (SITC)

[6] These are NIC 70 for 1973-74 to 1988-89, NIC 87 for 1989-90 to 1997-98, NIC 98 for 1998-99 to 2003-04 and NIC 2004 for 2004-05 onwards.

to HS system. UNCTAD is the most comprehensive database covering all the trade flows across the world. The data is available in two versions. (a) Online database (UN COMTRADE) and (b) UNCTAD commodity yearbook. One limitation of this database is that it does not report data for commodities whose share is less than 0.3 percent in total trade. But the online database is highly flexible in the sense that it gives data for different classification like SITC, HS and Broad Economic Categories (BEC) and also up to 6-digit level.

We have followed the broad definition of machine tools adopted by UNCTAD, and according to HS code 1992, it consist from 8456 to 8468. Whereas, according to SITC rev3, the capital goods fall under 71-73. The data on machine tools under SITC Rev3 and HS 1992 is available from 1988 to 2005. To obtain the data prior to that period, we depended on DGCI&S and other published sources. The trade data has been collected after checking it with the concordance provided by Debroy and Santhanam (1993), which provide matching of trade data with industrial data. Also we have used the correspondence table provided by COMTRADE for matching HS codes with SITC codes.

Machine tool data are also available from Indian machine tool manufactures association (IMTMA) Annual reports and other reports. IMTMA provides detailed information of production and trade but it is available online since 2001 only. In order to arrive deflate the series of machine tools and capital goods, we have used the wholesale price series provided by office of economic advisory, Ministry of Commerce & Industry. The series is available from 1962-63 onwards. The R&D data has been collected from Research and Development Statistics, Ministry of Science & Technology, Department of Science and Technology (DST), Government of India.

The Study has used statistical and econometric methodology for the analysis and the detailed accounts of them are given in the respective chapters.

**Chapter Scheme**

The second chapter will provide an overall picture of the industry. It will trace the historical evolution of machine tool industry and examine the growth pattern over the years. This chapter will assess the trend, structure and pattern of machine tool production and trade.

The third chapter will address the issue of trade liberalisation and competitiveness of machine tool industry. A theoretical discussion followed by the empirical verification will be attempted in this chapter.

The fourth chapter deals with the determining factor behind India's machine tool export. Factors that are crucial for the analysis will be selected after reviewing the theoretical and empirical literature. An econometric methodology will be used to determine the relationship.

The fifth chapter summarizes the entire discussion and discusses some policy implications.

CHAPTER 2

# MACHINE TOOL INDUSTRY IN INDIA

In this chapter we will examine the performance of the machine tool industry in India over the years. We begin by a description of what a machine tool industry is and what are its basic characteristics. Following this, a brief note on the evolution of the industry, the production and trade performance at the international level is given. The next section focuses on the development of machine tool industry in India over the years. We will discuss the growth performance of machine tool production in the context of changing policy regime. This is followed by a discussion on the structure, product specialisation and technological development of the industry over the years. We then examine the trade performance of machine tools, especially in the context of trade liberalisation. This is supplemented by a discussion on composition and direction of machine tool trade. The final section concludes the entire discussion and set out the issues analysed in the coming chapters.

## 2.1 Machine tool Industry

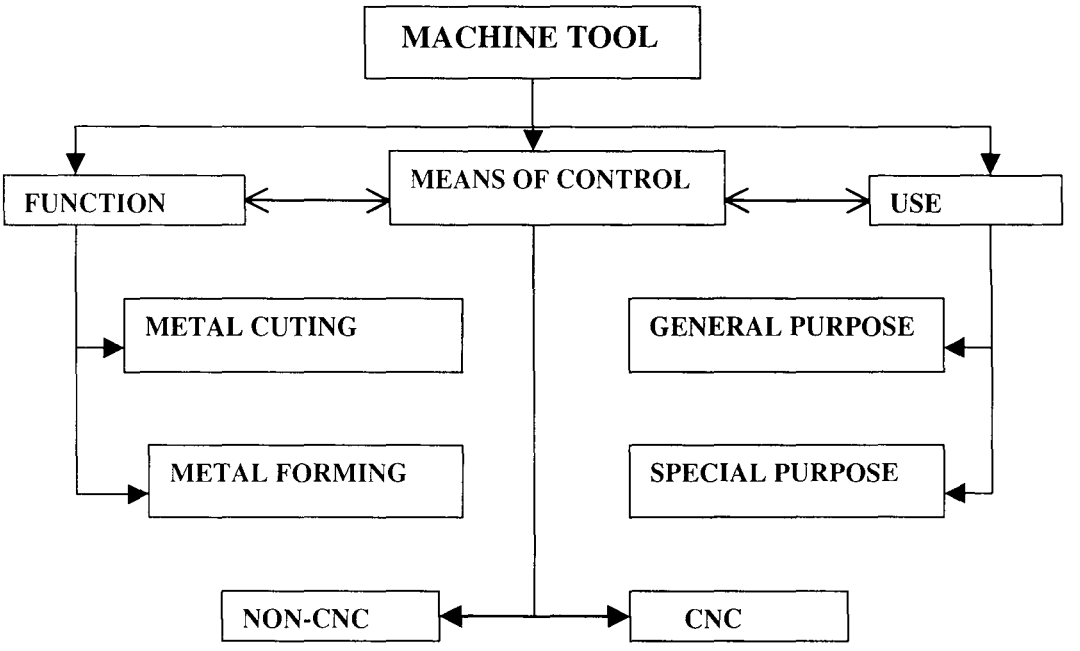
A machine tool is a power-operated tool used for finishing or shaping metal parts, especially parts of other machines. Generally, the term is used to denote tools that cut or drill, press or shear, or otherwise shape hardened materials into specific forms[7]. Machine tool operates by removing material from the work piece. Basic machining operations are: a) turning, the shaping of a piece having a cylindrical or conical external contour; b) facing, the shaping of a flat circular surface; c) milling, the shaping of a flat or contoured surface; d) drilling, the formation of a cylindrical hole in a work piece; e) boring, the finishing of an existing cylindrical hole, as one formed by drilling; f) broaching, the production of a desired contour in a surface; g) threading, the cutting of an external screw thread; and h) tapping, the cutting of an internal screw thread. In addition there are operations such as sawing, grinding, gear cutting, polishing, buffing, and honing. Many machine tools have a name that indicates their principal function, e.g., drill press, broach machine, milling machine, and jig borer.

[7] A detailed discussion on machine tool industry can be found in Columbia Electronic Encyclopaedia, published by Columbia University Press; available online at http://www.bartleby.com/65/ma/machineto.html

### 2.1.1 Type of Machine tools

Machine tool can be classified in terms of function (metal cutting or metal Forming), means of control (conventional or numerical) or use (general purpose). Figure 2.1 show the classification of machine tool according to this criterion.

**Figure 2.1: Classification of machine tool**




A metal cutting machine tool shapes or surfaces a metal work piece by cutting or removing metal in the form of chips. Eg, lathes, drills, milling, turning etc. These consist of around 80 percent of machine tool in use worldwide (Kumar, 2004). A metal forming machines shapes metals without the use of a cutting tool either by pressing, forging, punching, shearing or binding etc. A general-purpose machine tool (GPM) could machine a variety of different shapes, sizes and materials in any sequence in batches or as one off piece, eg, lathes, machining centre, grinders etc. On the contrary, a special purpose machine can machine only specific work piece or family of work piece or perform a specific precision job (Kumar, 2004).

A machine tool can be classified as conventional or computer numerical control machines. An operator essentially controls conventional machines. The skilled machinist manually feeds control information like speed, depth of the cut etc to the machine, does the selection of tool based on his interpretation of the drawings and loads or unloads the

tool work piece manually. If the above operations are done automatically with the help of electronic controls or computers, such machine tools are generally known as computer numerical control (CNC) machine tools. CNC uses program of instruction that is electronically transmitted to the machine to regulate operations. The introduction of numerical controls allowed the combination of several cutting processes into machines with higher flexibility (Arnold, 2001). A metal cutting/metal forming machine tool or a GPM/SPM may be either conventional or computer numerical controlled (see the two-way arrow in chart 1.

### 2.2 Historical evolution of Machine tool industry

It is believed that Lathe, one of the basic machine tool was developed during the early 15th century. During the next few centuries, it was adapted for making screws, cams and patterns. But many historians believe that machine tool manufacturing in a systematic manner originated during the industrial revolution in Great Britain, with the invention of horizontal boring mill by John Wikinson[8]. Following this development, an increasing number of machine tools were developed to serve industries such as clock and instrument making, heavy capital goods for textile and railway equipment producing firms, sewing machines and typewriter production and finally for the mass production of automobiles at the beginning of the twentieth century (Wograt *et al*, 1993).

By the beginning of the 20th century, the automobile industry becomes the major user of machine tools. The trend continued till the 1940s. During the World War II period, aircraft industry become the main driver of innovation and technological change in the industry and led to the development of numerical control (NC) machine tool in 1948 in USA. USA dominated the world market till the late 1970s. Thereafter, Japan began to capture the market with the introduction of low cost, standardised and reliable microprocessor based CNC in the eighties (Kumar, 2004). The period also witnessed the emergence of developing countries meeting the lower end demand of the automobile and general engineering industries. During nineties, technological innovation in this industry was fostered by electronic and consumer good industries (Arnold, 2001). In nutshell, the evolution of the machine tool industry is summarized table 2.1.

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[8] The history of Machine tool development is well documented. The history and the performance of machine tool industry from 1700 to 1910 is described in Steeds (1969). Rosenberg (1963) illustrates the experience of USA. For an overview of the history until around 1980 see Sciberras and Payne (1985).

**Table 2.1 Evolution of Machine tool Industry**

| Era | Country's position | Period | Main user industry |
|---|---|---|---|
| I | British Dominance | Before 1840 | Textile, Locomotive |
| | | 1840-1850 | Firearms |
| II | American Emergence | 1850-1870 | Sewing machine, |
| | | 1870-1900 | Bicycle (Ball bearing, chain), firearms |
| III | American Dominance | 1900-1940 | Automobiles, defence |
| | | 1940-1950 | Aircraft, Defence |
| IV | Japanese and German Dominance | 1950 onwards | Space, Aircraft, Automobile, Defence |
| V | Emergence of developing countries viz, Taiwan, Korea, china etc | 1980 onwards | Automobile, General engineering |
| VI | Japanese and German Dominance | 1990 onwards | Aerospace, Electronics, consumer Goods. |

Source: reproduced from Kumar (2004). The author classification is based on Sciberras and Payne (1985) and Rosenberg (1976)

### 2.2.1 Machine tool Production and Trade at global level

Machine tool production has been concentrated in Europe and U.S for most of the centuries because of the early invention and demand for machinery and equipment in the west. Before the introduction of CNC, the leading dominant market players were USA, West Germany, and former USSR. Since 1980 Japan has emerged as a leading producer and supplier of machine tools, which created competitive pressure for established supplier.

The production structure is highly uneven among countries. More than 80 percent of world output originates from just seven countries (Japan, Germany, US, Italy, China, Switzerland and Taiwan) and there also Germany, Japan, contribute around 40 percent (American Machinist, 1993). Since mid 1970s, Japan share in world output has increased three fold from about 8 percent to 24 percent. The world machine tool production has grown from $13.6 billion in 1976 to $36.2 billion in 2001 at an average growth rate of 4.7 percent. The production reached its peak of $45.3 billion in 1990. Then it declined to $28.3 billion by 1993 due to recession in the world market and disintegration of Soviet Union. The industry recovered from the shock in 1995 and registered $36.2 billion by 2001.

In 2001, the industrialised countries accounted for 84 percent of world output. Western Europe is the largest producer (49 percent) followed by Asia (40percent) and Americas (10 percent). In terms of individual country performance, Japan stood at first ($9.4 billion) followed by Germany ($7.7 billion), Italy ($3.8 billion), USA ($2.9 billion) and

China ($2.6 billion). Japan has retained its top position since 1982 except in 1999, when Germany was at the top (Gardner Publications, 2001). Currently, Japanese (e.g.Mazak, Okuma, Mori Seiki etc) and German (e.g. Thyssen, Trumpf, Gildemeister) machine tool firms dominate the list of largest machine tool manufacturers in the world. China is the world's fourth largest producer and the largest consumer of machine tools (Suresh, 2007).

Machine tool production is gaining importance in developing world. The production share has increased from five percent in 1975 to 17 percent in 2001 and the consumption has increased from 9 percent to 29 percent during the same period. The top thirty-five machine tool producing countries are also the main purchasers, accounting for about 96 percent of consumption (Wograt *et al* 1993). The prominent countries are Brazil, china, South Korea, Taiwan and Singapore. The production, trade and consumption of machine tools at the global level are presented in Table A (1) in the appendix.

### 2.2.2 World Trade in Machine tools



The machine tools are highly traded commodity. There are several reasons for this. One is its complex and specialised nature. Specialisation results in niche production and therefore trade. The machine tools are highly sensitive to cyclical shocks. An adverse shock can reduce the demand for new machines from the user industry. This forces the domestic producers to seek market outside. (Mehtha, 1990). Most of the countries imported large amount of machine tools irrespective of its trade regime. This reflects the significance of high degree of specialization among individual suppliers in the world market (Wograt *et al* 1993). One of the most important product segments for exports consists of metal forming machines.

The pattern of world export is similar to that of world production- a high degree of concentration in a few countries and a rapid growth in Japan's share. Almost half of the machines are produced for export. Two prominent exporters are Germany and Japan, with a combined share of 45 to 50 percent of world export (Gardner publication, 2001). The machine tool export and import are concentrated in three major trading blocks during seventies and eighties. They are Western Europe, Eastern Europe, and North America-Japan. Among the LDCs, only Asian countries have presence in the world market (Wograt *et al* 1993)

In 1975 West Germany followed by US dominated the world export market. This pattern shifted radically by 1986. Germany, although remained at top, experienced a decline in its export share from 32.5 percent to 23 percent whereas the position of US slipped from second

to sixth experiencing a sharp fall from 9.57 percent to 4.09 percent. The end of 1980s witnessed the rise of Japan as leading exporter of machine tools as her share increased from 5 percent to 21 percent, nearly four- fold rise during 1975-86 (Arnold, 2001).

Another significant fact is that during 1975 to 1986, machine tool exports and imports were high for several countries relative to the value of machine tools produced by them. The export was higher for countries like Switzerland, Austria, Belgium and Denmark where the domestic market size is relatively small (Mehtha, 1990). Acknowledging this point, Amsden (1985) noticed that export of machine tool become mandatory for countries with high specialisation pattern and small domestic market size. Countries with low machine tool consumption such as Austria, Switzerland, Belgium, Denmark and Netherland exported around 80 percent of output whereas countries like India, China, Mexico, and South Korea with high import to production ratio tend to have low export coefficient.

**Table 2.2 Exports intensity of top five machine tool Producers in the world**

| Year | Japan | Germany | USA | Italy | Switzerland |
|---|---|---|---|---|---|
| 1990 | 61.5 | 62.3 | 20.1 | 57.9 | 84.9 |
| 1993 | 65.2 | 66.1 | 21.2 | 60.2 | 85.3 |
| 1996 | 66.6 | 68.8 | 24.1 | 60.5 | 86.0 |
| 1999 | 67.1 | 69.2 | 26.2 | 61.8 | 87.2 |
| %Change (1990-99) | 8.8 | 11.1 | 30.3 | 6.7 | 2.7 |

Source: AMT (2000)

As evident from table 2.2, the export intensity remained high for Switzerland, Japan, Germany and Italy. The machine tool import also follows the same pattern. Between 1975 and 1986, US share in world import increased from 8 percent to 19 percent while Germany and USSR remained almost similar position. In 2001, USA, Germany and china accounted for almost 65 percent of machine tool consumption.

### 2.3 Machine tool industry in India

Soon after independence, India adopted an inward oriented development policy that emphasized import substitution, heavy industries, and commanding heights of the public sector. During second five-year plan (1956-61) India chooses to adopt Mahalanobis model of development, which emphasized the development of an indigenous and strong capital good sector, which was expected to provide strong boost for industrialisation.[9] As a result, India began to build a heavy capital good industrial

[9] The model received several criticism and many had suggested alternative models. For example, Raj and Sen (1961) emphasized the role of intermediate sector, which did not get priority in the Mahalanobis model, for the economic growth of the economy. Vakil and Brahmanand (1956) argued that the model did not take into account issues related to resource availability, employment and inflation, and suggested an alternative model.

sector under heavy import substitution strategy. Naturally, the machine tool industry received much attention as the performance of the capital good sector was strongly depended upon its overall development and the nature of linkage.

The machine tool production in India began with the establishment of Hindustan Machine tool (HMT) in 1953 by the government. The industry has grown under the umbrella of protection to achieve national objective of self-reliance. Today, India manufactures almost all the complete range of metal-cutting and metal-forming machine tools. There are significant changes in the development of Indian machine tools, which has to be examined in detail. We next briefly explore some of them.

### 2.3.1 Evolution of Machine tool Industry in India

This section will focus on the evolution of machine tool industry in India since its inception. The discussion is followed by an analysis of machine tool production and consumption over the years. The discussion will also keep track on the evolution of policy towards the development of this industry.

We can identify four different phases in the development of machine tool industry in India[10]. These are explained below.

#### Phase 1: Pre-Independence Development

The machine tool production in India began in 1890, when some workshops in Punjab started production for self-consumption. The British government initiated various promotional measures to encourage domestic machine tool production. This was due to increasing military demand and import crunch at the time of world war. As soon as the war ended these measures were rescinded and government relaxed the protection given to the industry. Overall, the share of machine tool production in total industry remained at 4.5 percent in 1945 (Mathews, 1988).

#### Phase II: Planning era, (1950-66)

The production of machine tools in an organised manner started after independence. In 1953, government established HMT with the technical and financial collaboration (10 percent equity) with Orelkon, Switzerland in Bangalore (Desai *et al*, 1999, Patil, 1985). Government set up three large-scale public sector enterprises during this phase.

[10] The categorization of phases is attributed to Kathuria (2000)

Simultaneously 15-20 medium and large-scale private firms and over hundred small-scale enterprises in private sector emerged. Since the development of capital goods required varieties of machine tools a policy of diversification was followed. As a result large number of firms entered in the manufacture variety machine tools[11].

An examination of Machine tool production during this period reveals that production increased marginally during 1951-55. (See table 2.3) and thereafter increased significantly to Rs 85.2 million in 1961 and Rs. 284.8 million in 1966[12]. This can be the result of explicit policy thrust by the government towards the development of capital good sector. Although the average growth remained high during these two periods, it was low in the second period.

**Table 2.3 Production, consumption and self-sufficiency rate in machine tool Industry (1950-66)**

| Year | Production | Consumption | Self-sufficiency rate (%) |
|---|---|---|---|
| 1950 | 2.86 | 27.76 | 10.30 |
| 1951 | 4.73 | 29.73 | 15.91 |
| 1952 | 4.44 | 26.55 | 16.72 |
| 1953 | 4.41 | 35.68 | 12.36 |
| 1954 | 4.71 | 43.35 | 10.87 |
| 1955 | 6.80 | 59.70 | 11.39 |
| 1956 | 10.80 | 94.50 | 11.43 |
| 1957 | 23.50 | 169.90 | 13.83 |
| 1958 | 34.10 | 178.30 | 19.13 |
| 1959 | 41.60 | 204.90 | 20.30 |
| 1960 | 58.60 | 268.00 | 21.87 |
| 1961 | 85.20 | 327.40 | 26.02 |
| 1962 | 120.10 | 379.40 | 31.37 |
| 1963 | 167.80 | 481.80 | 34.62 |
| 1964 | 209.80 | 553.00 | 37.72 |
| 1965 | 254.80 | 602.70 | 42.04 |
| 1966 | 284.80 | 708.10 | 39.29 |
| Average Annual Growth rate | | | |
| 1950-57 | 40.9 | 32.6 | 6.8 |
| 1957-66 | 30.9 | 19.0 | 9.7 |
| 1950-66 | 36.15 | 24.1 | 10.22 |

Note: Production and Consumption are in Rs. Million at current prices.
Source: Own calculation from the data given in Mathews (1986), Mehtha (1990), and IMTMA publications.

The government followed an open door policy in order to develop and expand the domestic production capacity of the capital good industry from the second plan period onwards. Therefore, various protective instruments were initiated so that the domestic

[11] These machines were mainly general-purpose conventional machines like turret lathes, single & multi spindle automats, gear shapers & Hobbers, boring machines, broaching machines, Hydraulic press and simple special purpose machine tools etc. Most of them were produced under technical assistance from foreign Collaborators like Oerlikon, Louden, Ward, Herbert, Jones & Shipman, etc (Patil, 1985)

[12] The production data is in nominal term. We have not been able to deflate the series as the wholesale price series for machine tool was not available during this period

industry caters to the home market[13]. But this did not completely eliminated imports, as the domestic industries required sophisticated and reliable machinery in the early stage of modernization, which was virtually absent domestically[14]. Naturally, a significant import of capital goods and machine tools took place during this period and as a result the self-sufficiency rate[15] of machine tool remained almost stable during the initial period. As the import substitution progressed, the growth rate increased marginally to 9.7 percent during 1957-66 compared to 6.8 percent during 1950-57 (see table 2.3).

The consumption of machine tools in India, measured by the difference between total absorption (production+ import) and exports has increased from Rs 27.8 million in 1951 to Rs 169.9 million in 1957 and shoot up to 708.1 million in 1966. Although consumption has increased considerably, the average growth was only 19 percent during 1957-66, which was lower than the previous period growth of 33 percent. One of the major reasons behind this growth of domestic consumption of machine tools was the increase in user demand.

**Phase III: Years of Drift (1966 - 1980)**

During this period, the basic characteristics of the industry remained unchanged vis-à-vis the earlier period. The source of technology and firms conduct remained same (Kumar, 2004). HMT played the dual and a critical role of providing leadership in the field of machine tool technology and keeping prices and quality of private sector under check. There was not much competition between private sector firms until the late 1970s. Despite the entry of large small firms, the industry remained oligopolistic where large firms generally tried to monopolise specific type of machine. The top five accounted for 73 percent and top ten 80 percent in 1980 (Wograt, *et al*, 1993).

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[13] This was the basic logic behind the heavy import substitution policies of the government. Government virtually banned the import of those machines that are locally manufactured. The Industrial policy resolution of 1956 established an industrial Licensing committee to act as an arbiter on its capacity. Unless a new licence was issued, the manufacture was obliged to produce only those type and size of machine tools assigned to it. This resulted in 'product monopolies' with each producer producing a different kind of machine tool. This also created an artificial pricing system that suppressed industrial competition and efficiency (Mathews, 1988).

[14] During this period, most of the R&D efforts of firms were directed towards adaptation of technology, localisation of parts and components. The smaller firms basically focussed on copying through reverse engineering and manufacturing crude products (Desai *et al*, 1999).

[15] Self-sufficiency rate is defined as 100% -supply of tools to India (Mathews, 1986). This is equivalent to Domestic market share which is defined as (production-Export/consumption) %.

**Table 2 .4 Production, consumption and self-sufficiency rate in machine tool Industry (1967-1980)**

| Year | Production | Consumption | Self-sufficiency rate (%) |
|---|---|---|---|
| 1967 | 18.6 | 71.4 | 25.0 |
| 1968 | 14.9 | 68.8 | 19.1 |
| 1969 | 18.8 | 40.9 | 39.5 |
| 1970 | 23.7 | 42.3 | 51.0 |
| 1971 | 30.5 | 52.4 | 54.0 |
| 1972 | 29.0 | 50.6 | 54.5 |
| 1973 | 32.6 | 57.8 | 52.2 |
| 1974 | 35.2 | 55.5 | 55.5 |
| 1975 | 38.2 | 65.3 | 51.5 |
| 1976 | 43.6 | 66.6 | 51.3 |
| 1977 | 40.4 | 56.6 | 58.8 |
| 1978 | 42.2 | 56.6 | 57.0 |
| 1979 | 46.9 | 82.8 | 44.4 |
| 1980 | 81.8 | 125.6 | 55.0 |
| Average Annual Growth rate | | | |
| 1967-73 | 11.4 | -1.0 | 19.2 |
| 1973-80 | 16.2 | 14.1 | 1.7 |
| 1967-80 | 14.0 | 7.1 | 9.8 |

Note: production and consumption are in 1993-94 prices.
Source: Own calculation based on data from Mathews (1986), Mehtha (1990), and IMTMA publication.

The industrial sector, particularly the capital good sector experienced stagnation during this period[16]. As machine tool industry is very sensitive to demand shocks, the growth of machine tool production decelerated during 1967-73 (11 percent). This was evident in the consumption figure as well as it recorded only -1.0 percent during this period[17]. During the later phase, the growth of production and consumption recovered to 16 and 14 percent respectively (see table 2.4). Srinivasan (1986) have noted that the machine tool growth during 1960s was chiefly driven by high capital intensity and he noted that there was a gradual shift from general-purpose machines to special and complex machine production.

The period witnessed significant import substitution in this industry and as a result the self-sufficiency rate improved significantly from 25 percent in 1967 to 52 percent in 1973 and remained more or less same thereafter. This was mainly due to the prolonged protective policy of the government that created monopoly situation for the domestic manufactures as domestic producers were offered incentive such as marketing and restriction of import if such products are available domestically. It is argued that the

[16] Industrial stagnation in India is well documented. For a detail account on the various debates see Ahulwalia (1985) and Nayyar (1994).

[17] Although the figures are clearly indicating a recession, Desai *et al* (1999) argue these figures are not representative of the actual situation. According to him, there was considerable shift in market demand from HMT to unregistered small manufacturers during this period, which is not reported by IMTMA figures.

curtailment of imports deprived the industry from copying new models (learning by reverse engineering) and reduced the opportunity for the workers to broaden their skills (Kumar, 2004). In contrast, in the case of Taiwan, Amsden (1985) showed that the production of CNC lathes, assembly of manufacture centre and the skill level of workers accelerated when import of such machines increased.

As the industrial requirement increased over time, the domestic manufactures of machine tools started to diversify their product range. Firms like HMT, with foreign collaboration, attempted to introduce sophisticated machines like NC. But due to lack of demand from user industries this attempt failed to take off. This slowed down the general technological development in the industry. Kumar (2004) noted that high prices, long delivery schedule, low technology, poor after sale service and lack of tooling up was some of the problem of the industry during this period.

**Phase IV Changing market condition and initial liberalisation of industry (1981-1990)**

The industry witnessed some gradual policy changes during 1980s. This was partially due to the acknowledgement of the loss of economic efficiency and high economic cost associated with the prolonged protective policy regime. As a result, the import liberalisation was introduced so that firms can modernize their product structure by importing embodied and disembodied technology from abroad[18]. The protective regime gradually shifted from tariff to quantitative restrictions and there was some expansion in the OGL list (i.e. list of products which require no import license). In the industrial sector, broad banding was introduced in 1984, which enabled the manufacture to produce new models, within their existing licensed capacity with no requirement of an additional industrial licence. Other measures to promote the industries include relaxation of MRTP and FERA guidelines and technology up gradation scheme.

In this scenario, the modernisation of user industries such as automobile, consumer goods and other engineering industries resulted in a shift in demand for advanced machines tools. Most of the demand was met by imports of foreign technology as during 1980-85 the foreign collaboration increased from 370 to more than 1,000 and 60 percent of the agreement was accounted by machining centre and CNCs[19]. In the latter period of the 1980s domestic manufactures started production of CNC machine in order to

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[18] Some of the other promotional measures include the permission to freely import technology, purchase foreign components, and expands capacity for larger entrepreneurs. A detailed note on these policy changes can be seen in Aksoy, (1992) and Panagaria, (2004).

[19] According to Mathews (1988) this indicated the growing technological gap in Indian machine tool industries as the indigenous development of CNC machines was in place for a long time.

compete with foreign products. As a result, the production of CNC increased from Rs 129 million (7 percent of total production) in 1985 to Rs 1375 million (33 percent of total production) in 1990. Most of them were produced with the help of indigenous R&D efforts (Wograt et al 1993).

**Table 2.5 Production, consumption and self-sufficiency rate in machine tool Industry (1981-1990)**

| Year | Production | Consumption | Self-sufficiency (%) |
|---|---|---|---|
| 1981 | 101.9 | 177.0 | 50.8 |
| 1982 | 104.5 | 172.1 | 54.5 |
| 1983 | 106.6 | 175.5 | 54.4 |
| 1984 | 130.1 | 198.6 | 60.0 |
| 1985 | 133.3 | 179.6 | 65.7 |
| 1986 | 132.0 | 164.1 | 70.7 |
| 1987 | 110.7 | 141.7 | 68.0 |
| 1988 | 118.2 | 152.2 | 64.9 |
| 1989 | 143.9 | 182.7 | 68.6 |
| 1990 | 136.5 | 174.6 | 67.6 |
| Average Annual Growth rate | | | |
| 1981-85 | 10.7 | 8.8 | 3.9 |
| 1985-90 | 1.2 | 0.1 | 0.7 |
| 1981-90 | 6.0 | 4.4 | 2.3 |

Note: production and consumption are in 1993-94 prices.
Source: Own calculation based on ASI, DGCI&S and UN COMTRADE *online database.*

The growth of production in real term was comparatively better during the first half of the eighties (see table 2.5). Due to the relaxation of import controls domestic user industries preferred foreign machines and as a result the growth of self-sufficiency was less than unity during the second half of 1980s. The real consumption remained at high level in the first half of eighties although the rate of growth was marginal in the second half.

### Phase V: Post Reform period (1991-2003)

The policy changes initiated during the eighties were considered rather piecemeal as the basic premise of the policy framework remained inward looking throughout the 1980s (kumar 2004). Major changes in trade and industrial policy took place with the introduction of economic reform in 1991, which was initiated in the context of severe balance of payment and fiscal crunch[20]. The new economic policy (NEP) of 1991 did away with the license raj and ended many public monopolies, allowing automatic approval of foreign direct investment in many sectors (Panagariya, 2004). The policy

[20] Literature on India's economic reforms, its rational, impact and implication on different economic and social issues are well documented. See among others, Ahulwalia (1995), Joshi and Little, (1996), Patnaik (1997), Mani and Bhaskar (1998), Goldar and Ranganathan (1999), and Nagraj (2003).

dismantled almost all entry barriers, and gradually brought down tariffs and non- tariff barriers making the economy more outward oriented. The machine tool industry was de-licensed in 1991 followed by removal of import licensing for machine tools and industrial inputs.

As India moved to a more open trading regime the competitive pressures on Indian industry became more intense. The reduction in tariff rates resulted in large inflow of imported machines, which resulted in a decline in market share for leading producers. The reform encouraged firms to reduce their product range, and forced more vertical disintegration (Desai *et al* 1999).

As evident from table 2.6, the machine tool output highly fluctuated during the reform period. The growth rate, which was 9 percent during 1991-96, remained negative during the second period of 1990s. This was mainly on the account of sharp decline in user demand as user industries witnessed recession during this period. The production marginally recovered from 2001 onwards as domestic demand condition improved. This is reflected in the growth of fixed capital formation (see figure 2.2). The trend in the growth of Gross capital formation reveals that, the growth rate fluctuated over the years and have sharply declined and negatively grown since the mid 1990s[21].

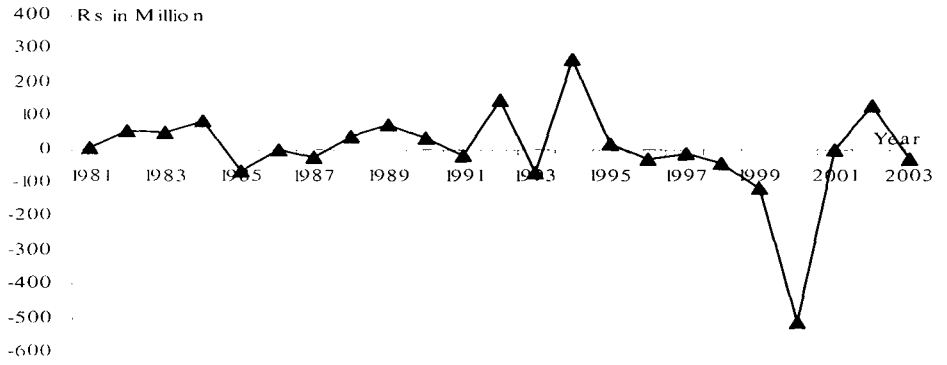
**Table 2.6 Production, consumption and self-sufficiency rate in machine tool Industry (1992-03)**

| Year | Production | Consumption | Self- sufficiency (%) |
|---|---|---|---|
| 1991 | 131.0 | 165.9 | 71.4 |
| 1992 | 147.6 | 164.7 | 79.6 |
| 1993 | 104.4 | 140.3 | 64.7 |
| 1994 | 143.4 | 174.9 | 71.3 |
| 1995 | 216.9 | 278.4 | 69.8 |
| 1996 | 183.0 | 232.9 | 68.9 |
| 1997 | 172.9 | 250.3 | 61.3 |
| 1998 | 126.3 | 171.7 | 61.6 |
| 1999 | 140.4 | 215.1 | 56.0 |
| 2000 | 109.5 | 170.8 | 38.7 |
| 2001 | 74.2 | 99.8 | 32.4 |
| 2002 | 107.4 | 218.2 | 15.8 |
| 2003 | 111.3 | 278.8 | 21.1 |
| Average Annual Growth rate | | | |
| 1991-96 | 8.7 | 7.8 | 0.9 |
| 1996-03 | -3.9 | 12.2 | -12.1 |
| 1991-03 | 1.9 | 10.2 | -6.1 |

Note: production and consumption are in 1993-94 prices.
Source: Own calculation based on ASI, DGCI&S and UN COMTRADE online database

[21] Gross fixed capital formation is defined as new investment in physical assets. It does not include stocks or inventories. It is often considered to be a measure of total absorption of new machine tools or total demand (Mundle and Mukhopadhyay, *1992*).

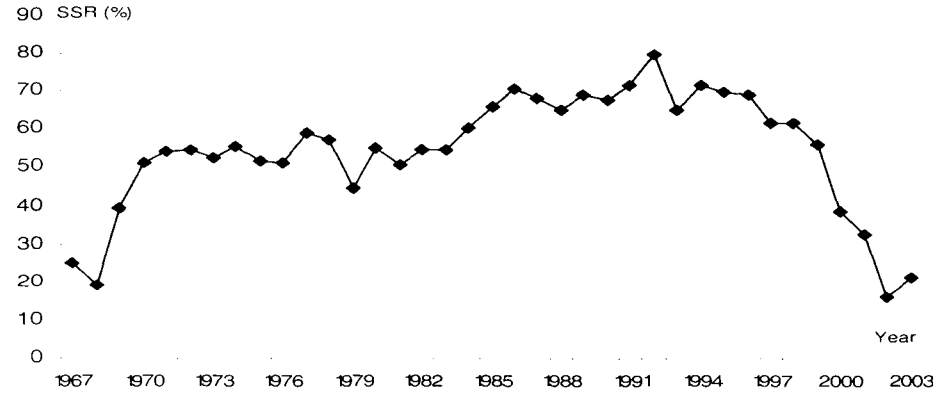
**Figure 2.2 Average Growth rate of fixed capital formation**




Source: computed from ASI.

Not surprisingly, the growth of self-sufficiency remained negative throughout this period and remained at a level, which prevailed during the earlier planning period. A time series data plot of self sufficiency (figure 2.3) shows that the ratio went up till 1974 and thereafter it stabilized around 65 percent till the onset of reforms. The rate began to decline afterward. On the contrary real consumption of machine tools increased from 8 percent during 1991-96 to 12 percent (see table 2.6) and as we can see in the later section most of it was met by rising imports.

**Figure 2.3 Self- Sufficiency Rate in machine tools (1950-2002)**




Source: computed from data provided in table 2.4 to 2.6.

This suggests that, there was a significant change in the market scenario of machine tools since liberalisation. The apparent instability in production and declining self-sufficiency points out that, the domestic industry experienced considerable strain during the changed policy regime. In this context, an examination of real net value addition can

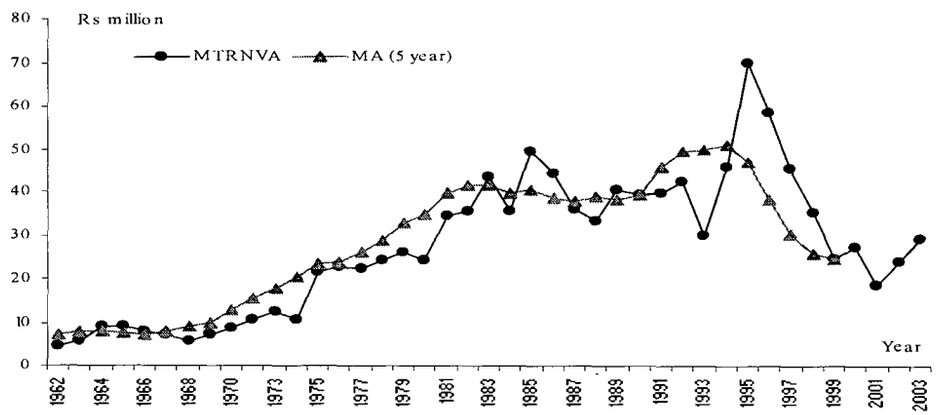
assist in a better understanding of production condition of machine tool manufactures[22]. Thus, in the next section, we examine the trend and growth of real net value added in machine tool industry from 1962 to 2003.

### 2.4 Growth of value added in Machine tool Industry

The value added indicates the actual contribution made by the factors of production or resources from raw material stage to the finished good stage in the manufacturing process. The movement in net value added, when measured in constant prices reflect changes in the volume of work done in the manufacturing process (Maizels, 1971).

Here, we are analysing the growth of value added in machine tools from 1962 to 2003[23]. We have plotted the actual values of real net value added and growth trend by taking five year moving average (see figure 2.4). One general feature evident in the figure is its cyclical nature. The fluctuation in value added become more visible since the 1980s and intensified in the 90s. In order to calculate the growth rate we have divided the series into two periods, 1962-85 and 1985-03. We have taken 1985 as the cut off period as it was during this period the initial wave of liberalisation was initiated in this industry. In terms of exponential growth rate, we can see that machine tool growth performance was relatively better during the pre-liberalisation period (10.3 percent compared to -2.3 percent in the second period, (see table 6)[24]

**Figure 2.4 Machine tool Net Value added (1962-2003) at 1993-94 prices**




Source: computed from ASI, Various issues

[22] Value added by definition is computed by taking the difference deducting total Intermediate input and depreciation from total output.

[23] The wholesale price series of machinery & machine tools is available from 1962 onwards. The different price series were spliced in order to derive price series with a common base year.

[24] Many economic time series are better approximated by an exponential trend, which follows when a series has the same average growth rate from period to period (Wooldridge, 2003)

**Table 2.7 Growth rate of Machine tool value added (1962-2003)**

| Exponential growth rate (EGR) | |
|---|---|
| Period | EGR |
| 1962-85 | 10.3 *** |
| 1985-03 | -2.8 * |
| 1962-2003 | 4.3 *** |
| Average Annual Growth rate (AGR) | |
| Period | AGR |
| 1962-74 | 10.4 |
| 1974-85 | 18.6 |
| 1985-95 | 9.6 |
| 1995-03 | -1.0 |

*** Significant at. 5 % level, *Significant at 10% level

In terms of average growth rate in the sub periods, we can see that real value added actually increased substantially during the second and first period (see table 2.7). The growth rate was negative during the later part of the 1990s. This result confirms our earlier findings that machine tool production has remained unstable during the liberalisation period and growth rate has been dismal.

The investment boom during the early period of 1990s created additional demand for machine tools from user industries, which helped in rising production (Uchikawa, 1999). This declined during the period of industrial recession during the later part of 1990 as investment rate was curtailed by user industries, which adversely affected the value addition in machine tools. The real output decelerated from Rs 58 million in 1996 to 18 million in 2001. Promisingly, there is a sign of marginal improvement in real output in the latter period, as there was an overall development in economic condition and an enhanced growth in the automobile and the auto components sector.

This shows that there were significant changes in the performance of machine tool industry over the years. The industry, once considered to be a classical import substitution industry have seen radical shift in the policy environment in recent time period. As the development of machine tools have significantly contributed to the development of Indian capital good industry of the past, it would be worthwhile to examine the nature of the relationship between machine tool and the capital good industry during recent time period. This is attempted in the next section.

## 2.5 Growth Performance of Machine tool Industry and capital good industry

Capital goods generally refer to machinery and equipment, which enter into capital formation (UNCTAD, 1996)[25]. In an inward oriented economy, the development of capital good industry required expansion of machine tool sector. As the access and choice of machines were limited during that regime, the nature of product improvement in domestic machine tool sector significantly affected the prospects of domestic capital good sector. The development of new machines, design, accuracy, precision and technological advancement had a direct bearing on the growth of capital good sector.

This has been significantly changed in the new policy regime where domestic manufactures have to face not only the emerging competition from new firms but also the import of superior and relatively cheaper machines from abroad. As the choice of domestic capital good industries widens, the relationship between growth in machine tools and capital goods may shift. The existing literature hardly provides any information regarding the nature of relationship between these two at present. Therefore, we will examine the relative growth performance of the two sectors during the period of economic liberalisation.

The analysis is based on net value added of machine tool and capital goods from 1980-2003. In order to assess the relative performance and to examine whether the growth performance has been similar over the years, we have taken the share of machine tool in capital goods and manufacturing value added and calculated the average growth rate for both for two-sub period, namely 1980-91 and 1991-03. We also examined the trend growth rate by calculating 5 year moving average, so that we could control the yearly variation across time.

The table 2.8 shows one of the general features of this industry that can be seen across the world i.e., a very low contribution to total manufacturing value added. The share remained less than one percent throughout the years. The table also shows that the share of machine tools in capital goods sector have significantly declined from 3.7 percent in 1990 to 2.2 percent in 1996 and 0.9 percent in 2002.

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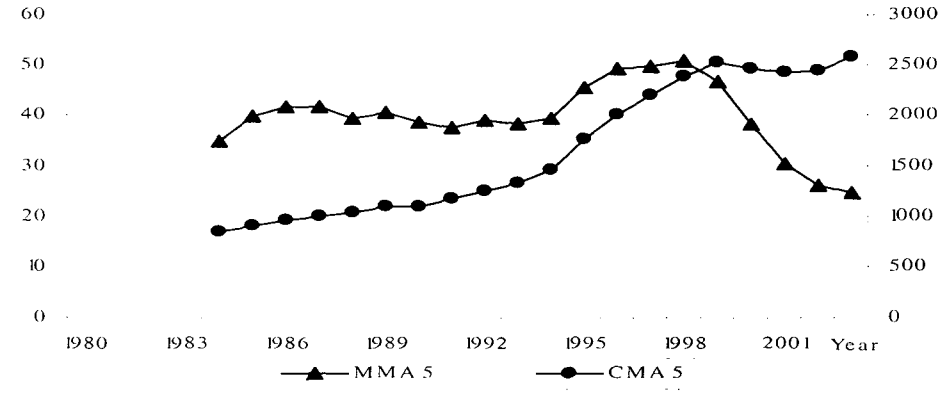
[25] At the two digit level, capital goods refer to the following three sub sectors of the National industrial classification (1970) of India (a) NIC 35- Non electrical Machinery, Machine tools and parts, except electrical machinery, (b) NIC 36- Electrical Machinery, apparatus, appliance, suppliers and parts, (c) NIC 37 Transport equipment and parts. In this study we have included industries producing these goods as capital good sectors. The matching of different NIC classification has been done on the basis of a concordance prepared by ASI.

**Table 2.8 Share of Machine tool value added in total manufacturing value added and Capital good value added (1990-2002)**

| Years | 1990 | 1992 | 1994 | 1996 | 1998 | 2000 | 2002 |
|---|---|---|---|---|---|---|---|
| Manufacturing sector | 0.67 | 0.63 | 0.5 | 0.48 | 0.29 | 0.22 | 0.17 |
| Capital Good Sector | 3.66 | 2.64 | 2.23 | 2.19 | 1.44 | 1.15 | 0.92 |

Source: computed from ASI

**Figure 2.5 Trend in Capital good and Machine tool net value added since 1980-2003**




Note: MMA5= 5 year moving average growth of machine tools, CMA=5 year moving average growth of capital goods
Source: Own calculation based on ASI.

The trend growth rates of both the industries are shown in figure 2.5. We can see that the growth of capital goods have shown an increasing trend since mid 1980s while the machine tool growth rate was relatively low. There is a clear sign of divergence in the growth performance of both from 1998 onwards as the capital goods registered a marginal increase whereas the value added by machine tool has declined sharply.

A comparison of exponential growth rate for these two industries also substantiates the above findings (see table 2.9). It points out that the growth performance of capital goods was superior to that of machine tool sector during the entire period. This analysis shows that the nature of relationship between machine tool industry and capital good industry have shown a pattern of divergence in its growth performance which is more pronounced as the reform measures got further intensified.

**Table 2.9 Growth rate of Capital good and Machine tool value added (1980-2003)**

| Period | 1980-91 | 1991-03 | 1980-03 |
|---|---|---|---|
| Capital Good | 4.96** | 5.52** | 6.5 ** |
| Machine Tool | 2.65* | -6.0** | -1.5 |

Note: the figures are exponential growth rate
** Significant at. 5 % level, *Significant at 10% level

Having examined the performance of machine tool production, let us look at what have been the major changes in the ownership structure and nature of machine tool production in India.

## 2.6 The Structure of the Indian machine tool industry

During 1960 and 1970 there was not much competition among large firms in the industry and HMT acted as a major supplier of machine tools in the market. HMT produced different varieties of machines and manufactured almost 50 percent of organised output. In parallel, small firms like Turn-o-Mat industries, Parmar mechanical works etc also existed and supplied quality machines (Mehta, 1990). Correspondingly numerous skilled craftsmen in various parts of Punjab, Gujarat, and Tamil Nadu, producing different varieties of machine tools in small sheds or workshops catered the demand in domestic market. This unorganised sector constituted a significant portion of machine tool output.

During the mid 1980s the industry witnessed a rise of technocrat's entrepreneurs who were earlier workers of big public sector units like HMT and Praga. The liberalisation of the industry in 1990s attracted entry of fresh firms in the market, most of them being smaller firms. Later, these small firms began to capture the market share of the larger firms as they were able to supply quality products at reasonable prices (Desai, *et al* 1999). In contrast to the earlier experience where firms went for over diversification of their product range, the small firms concentrated on some specific varieties of their product. In recent years some of major feature of the industry has been high vertical disintegration and sourcing more from abroad (Desai, *et al* 1999).

Currently, the industry consists of about 450 manufacturing units of which approximately 33 per cent (150 units) fall under the organized category (IMTMA, 2006). Further, ten major Indian companies constitute almost 70 per cent of the total production (IMTMA, 2006). The industry has an installed capacity of over Rs.10 billion and employs around 65,000 skilled and unskilled personnel's, either directly or indirectly. During 1990s, machine tool production shifted from bigger firms to medium-sized technocrat companies. This led to the introduction of new products especially in NC and CNC machines mainly by technocrats (Exim Bank, 1996).

One of the general features of the industry is its segmented structure and geographical dispersion (Desai, *et al* 1999). Although India's machine tool industry operates throughout the country, major manufacturing clusters are located in Mumbai and Pune in Maharashtra, Batala, Jalandhar, Faridabad and Ludhiana in Punjab, Ahmadabad, Vadodara, Jamnagar, Rajkot and Surendranagar in Gujarat, Coimbatore, Guindy and Chennai in Tamil Nadu, Bangalore in

Karnataka (IMTMA, 2006). Most of the important international players like Makino, DMG, Yamazaki, Haas, Trumpf, Daewoo are present in India either through their marketing agents, technical centers, service centers or assembly centers. Table 2.10 provides information regarding the major firms in the production different types of machine tools in 2004.

**Table 2.10 Major firms producing machine tool in India (2004)**

| CNC Lathes | Machining Centers | Presses | Grinding machines | SPM | Surface Grinders | Vertical Turning Boring | Bending Machine | Gear cutting |
|---|---|---|---|---|---|---|---|---|
| ACE Designers | BFW | ISGEC | Parishudd Machines | Widia | Praga Tools | HMT | Electro Pnuematics | Premier Automobiles Ltd. |
| LMW | ACE Manufacturing | Electro - pneumatics & Hydraulics Ltd. | Micromatic Grinding | BFW | Alex Machine tools | Premier Automobiles Ltd. | Hindustan Hydraulics | HMT |
| HMT | HMT | Hindustan Hydraulics | HMT | HMT | HMT | - | ISGEC | - |
| Jyoti | LMW | Bemco Hydraulics | PMT | MICO | - | - | - | - |

Source: IMTMA, 2006

In the liberalisation era, the impact of policy changes can be better understood by an examination of machine tools market structure[26]. A basic indicator of market structure is the degree of concentration among suppliers. We know that market concentration[27] is a function of number of firms and their respective shares in the total production in the market. By studying the concentration ratio an idea about the market structure that characterizes machine tool industries can be known. In order to understand the state of market concentration we have used the well-known Herfindahl index[28].

Herfindahl index (H) is a measure of the size of the firms in relationship to the industry and indicates the amount of competition among the suppliers. The value of the index is the sum of the squares of the market shares of all the firms in the industry. The index ranges from 0 to 1 moving from a large number of very small firms to a single monopolistic producer. Decrease in the Herfindahl index generally indicates a loss of market power and competition and vice versa.

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[26] By structure we mean the size distribution of firms in the market, Structure is characterized by the number and size distribution of sellers and buyers, market share, concentration, presence or absence of barriers to entry, degree of product differentiation, and degree of vertical integration etc (Scherer & Ross, 1990, Shepherd, 1979).

[27] Since machine tool industry is a heterogeneous industry, a better understanding of the level of concentration requires product wise analysis. As the required data is not available, our analysis is primarily based on aggregate industries. Therefore, any conclusion drawn has to be interpreted with caution.

[28] See George and curry (1983)

The H is measured as follows

$$H = \sum_{i=1}^{n} (s_i^2)$$

Where $s_i$ is the market share of firm $i$ in the market and $n$ is the number of firms[29].

**Table 2.11 Trends in Market Concentration**

| Year | 1991 | 1993 | 1995 | 1997 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|
| H | 0.022 | 0.025 | 0.011 | 0.009 | 0.008 | 0.007 | 0.007 | 0.008 | 0.006 | 0.004 |

Note: H= Herfindahl index
Source: Market Size & Share, CMIE, Various issues, Prowess-CMIE

As shown in table 2.11, the Herfindahl index was 0.02 in 1991, which declined to 0.01 in 1996 and come down to 0.004 in 2005. This suggests that the competition in the industry is increasing over the years. That is the market concentration by some big firms might have reduced since economic reforms.

**Table 2.12 The market share of Hindustan Machine Tool - HMT (1981-2004)**

| Year | 1981 | 1983 | 1985 | 1987 | 1989 | 1991 | 1993 | 1995 | 1997 | 1999 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Market share | 38.64 | 39.47 | 37.12 | 35.71 | 38.92 | 27.41 | 19.7 | 11.44 | 9.69 | 5.91 | 5.52 | 7.45 | 6.3 | 3.9 |

Source: Own calculation based on data available from Albin (1992), IMTMA publication and Industry: Market size & shares, CMIE.

Table 2.13 shows that the market share of HMT has come down rapidly since 1990. HMT dominated the domestic market till the late 1980s as it had a share of more than 35 percent. This has shown a declining trend since then and during 2004, HMT had only 3.9 share of the domestic market. This can be due to the deregulation and restructuring of the industry since 1990s that have attracted many players to the market. Due to increasing competition, HMT and others have experienced a loss in market share.

But this result has to be viewed cautiously as the industry produces large number of different varieties of machines, each of which have its own market niche. As noted by Mehta (1990) one of the typical characteristic of this industry in India and abroad is that at the aggregate level it will indicate considerable competition among firms. For instance, there are large number of firms manufacturing lathes, milling machines,

[29] Scholars have identified several shortcomings of Herfindhal index as a measure of market power. Notably, the share of output in an industry does not really capture the true market size. The index is usually calculated for domestic production but whenever there is high incidence of imports the relevance of the Herfindhal index is limited (Blair, 1972).

grinders etc. But if we disaggregate each of these product, we can see that for certain type of products the level of competition is limited. Although sophisticated machines are entering in the market due to liberal import policy, the domestic firms are still finding niche for their product because each product have its own uniqueness. This can be due to design, precision, flexibility or prices and users requirements.

The discussion on the structure of the industry shows that there have been significant changes since reform. The manufactures are facing competition from internal as well as external market. In this scenario, one of the necessary conditions for firms to be competitive and able to sustain the market share is through product specialisation[30]. As market demand will vary according to the variety of products, it is essential that Indian machine tool manufactures have to narrow down the product range and specialise in certain variety of machines. The next section will have a discussion on the development machine tool specialization.

### 2.7 Product-mix in machine tools

India manufactures almost the complete range of metal-cutting and metal-forming machine tools. Metal cutting accounts for 87 per cent of the total machine tools output in India. Some of the key metal cutting tools includes turning centres, machining centres and grinding centres, which account for nearly two-thirds of the total metal-cutting produce. Metal forming is dominated by presses, which account for 51 per cent share (IMTMA, 2006). Customized in nature, the products from the Indian basket comprise conventional machine tools as well as CNC machines. There are other variants offered by Indian manufacturers too, including special purpose machines, robotics, handling systems, and TPM-friendly machines

As machine tool comes under different types and varieties there are different technologies or design feature for each variety of products and therefore specialization in narrow product lines is needed to enhance productivity and competitiveness. There is wide difference in the kind of product available in the market. The product differs in terms of technology, skill, accuracy, flexibility etc. Lathes for instance, can be of simple technology type or advanced sophisticated CNC type. In developed countries, the firms are more specialized and confine to one family of machine tools such as Turning and Milling, Machining centers, Grinding, Press, Electro discharges.

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[30] There are three different kind of specialisation in machine tools. (1) According to the product manufactured like lathes, boring machines, grinders etc. (2) the size and degree of complexity of products and (3) the demand for product.

As the case with other LDCs, Indian machine tool manufacturing started with the production of simple, conventional machines like lathes, milling machines, drilling machines etc. Most of the demands for sophisticated products were met by large imports from abroad. Gradually Indian machine tool industry began to diversify and introduced variety of machines in the market. She began its indigenous development of CNC machines during 1980s (Mehta, 1990). The reform processes further induced industries to focus on product specialisation.

In order to explore the nature of product specialisation of Indian machine tool industry we have used ranking method[31]. We ranked products according to their share in total production of machine tools. The product category that hold larger share in total machine tool production was assigned rank one and so forth. The period of analysis is 1987 to 2005.

**Table 2.13 Machine tool Product mix (Rank Analysis)**

| Types | 1987 | 1993 | 2002 | 2005 |
|---|---|---|---|---|
| Automatics | 4 | 12 | 9 | 11 |
| Boring Machines | 7 | 11 | 10 | 10 |
| CNC Horizontal machine centres | 12 | 10 | 3 | 2 |
| CNC lathes/turning machines | 10 | 9 | 7 | 8 |
| CNC Special Purpose machines | 11 | 8 | 8 | 12 |
| Drilling machines | 8 | 7 | 6 | 4 |
| Gear cutting machines | 9 | 6 | 1 | 1 |
| Grinding machines | 2 | 5 | 2 | 3 |
| Lathes | 1 | 4 | 4 | 5 |
| Milling machines | 3 | 3 | 12 | 9 |
| Presses | 5 | 2 | 11 | 7 |
| Special purpose machines | 6 | 1 | 5 | 6 |

Source: computed from the data available from Mehta (1990), Uchikawa (1999) and IMTMA, *online database.*

The analysis reveals that during the early period, Indian machine tool manufactures were producing more conventional machines compared to special purpose machines (see table 2.13). For instance, lathe had the largest share followed by grinding machines and milling machines. It was during this period that some efforts were given to manufacture technology intensive products like CNC lathes, turrets etc. Although there was some progress towards moving up the value chain, the product specialisation pattern remained more or the less same during the early 1990s. The manufacturing of simple lathes slipped its position from 1 to 4 whereas special purpose machines become

[31] The analysis was constrained by the availability of necessary data. The analysis was carried out with the help of compiling data from different published sources. The data for 1987 and 1993 is from Mehta (1990), and Uchikawa (1999).The information about detailed product structure of machine tool are available from 2002 onwards from IMTMA online database.

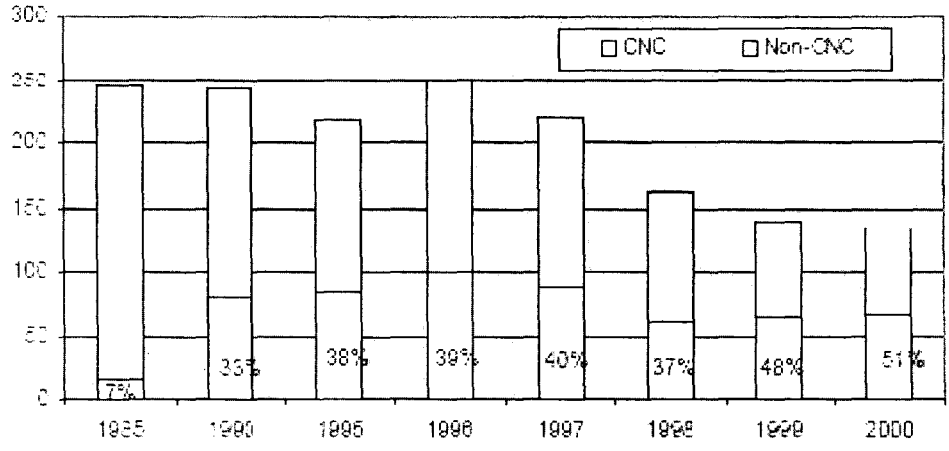
the major product produced by India. Automatics, and boring machines had also experienced a fall in this period. The manufacturing began to shift towards complex product like Gear cutting machines, various CNC variants, drilling machines etc.

The specialisation pattern has shown some distinct changes during the last two periods. The efforts have shifted towards manufacturing low to medium skill and technology intensive products like gear cutting, grinding, drilling machines. Although machine tool output fluctuated around during the latter half of the 1990s, efforts were made to introduce new products. The entry of new firms and the presence of foreign machines in the market might have created an environment where firms were forced to develop new and cheap products in the market. This may was supplemented by the boom in automobile sector which created demand for sophisticated machines like CNC and special or multi purpose machines.

### 2.7.1 Rise of CNC Machines

The Indian industry is gradually moving towards the production of numerical and computer controlled machines since liberalisation of the industry[32]. The figure 2.6 shows that share of CNC, which was around 7 percent during 1985, shot-up during the post liberalisation period. In 2005, it recorded more than 50 percent share in total organised manufacturing of machine tool production. Uchikawa (1999) pointed out that higher domestic demand was the main reason for the simultaneous increase of import and domestic production of CNC. The decline in conventional machines was mainly due to the substitution of CNC machines rather than their import.

**Figure 2.6 Share of CNC Machine tool in production (1985-2000) (Million $)**




Source: Kumar (2004)

[32] See Desai, et al, (1999) and Kumar (2004).

Another notable impact of the reform period has been on the prices of CNC machine tools. The average unit value of machine tool has come down considerably over the years (see table 2.14). The price of CNC lathe has come down from $122 thousand to $42 thousand in 2000. Similarly, machining centre price also declined from $116 thousand to $78 thousand during the same period. The reduced prices of machines is due to hassle free import of material inputs at cheap prices, reduction in the inventory carrying cost and requirement of working capital (Kumar, 2004).

**Table 2.14 Average unit price of CNC machine Tool in international Perspective ($ "000)**

| Year | CNC Lathe | | | Machining Centre | | |
|---|---|---|---|---|---|---|
| | India | Korea | Taiwan | India | Korea | Taiwan |
| 1990 | 122.3 | 61.5 | 50.0 | 226.7 | 116.3 | 59.5 |
| 2000 | 41.5 | 53.2 | 27.3 | 77.8 | 86.3 | 34.5 |

Source: Kumar (2004)

One important factor that might have contributed to the development of special purpose machines at competitive prices is the technological progress achieved by India over the years. The next section will briefly review the development of technology policy and the nature of technological development in machine tool industry.

## 2.8 Technological Development

The technology policy in developing country is chiefly concerned with creation of new product and processes, access to new technology, the adaptation and modification of foreign technology to local condition etc. The technology policy has four main components: import of technology, promotion of in-house R&D, provision of technology infrastructure and supply of skilled personnel (kumar, 2004). The import of technology policy consists of technology licensing, (commonly known as foreign collaboration[33] policy in India) and import of embodied technology (import of capital goods) and foreign direct investment.

India has always recognised the need to develop technology to create capability to expand industry growth. During the period of import substitution, the focus was to develop indigenous technological capability in manufacturing production process. To meet the demand of growing industrial sector, the government also recognized the need

[33] Foreign collaboration is different from foreign technology collaboration. The former involves one-way transfer of knowledge (supplier to recipient) while the latter involves two-way exchange of knowledge (Alcorta, 1998).

to import technology[34]. The policy regarding import of technology took shape during 1966-80 (Desai, 1988). Some of the major features of technology import policy were, restriction on imports of technology those are available in the country, progressive import substitution of components, lump sum payment for technology transfer, restriction in the use of brand name/trade marks of the collaborator, restriction on import of technology for similar products and extension of collaboration period (Kumar, 2004).

In 1969, the government categorized industries into three categories based on perceived complexity of technology. Machine tools come under high priority industries where both foreign technology and investments were encouraged. However, with passage of time, the distinctions between this categorization weakened and import of technology was allowed in almost all industries (Lall, 1984, 1987). The foreign collaboration policy also acted as a measure for conserving the scarce foreign exchange reserves, self-reliance and protection of domestic industries (Desai, 1988). To accomplish them government-introduced measures such as imposition of upper limit on the rate of royalty payment, controlling outright payment for technology, restricting duplication of import for the same item, limiting the duration of the agreement etc.

During the reform period, foreign collaboration policy underwent significance changes. The restrictions on technology purchase were relaxed and government role in purchasing and negotiation agreement between private parties limited. The government started to considers only those cases, which do not fall under the purview of automatic route. The import of foreign technology was encouraged through foreign technology collaboration and foreign direct investments.

Government also realized the importance of developing indigenous technological capability and undertook number of initiatives. Indian Patent Act of 1970 to boost domestic R&D, establishment of a national committee on science and technology (NCST) in 1971 to provide fiscal and non- fiscal incentives, and technology policy statement (TPS) in 1983 for boosting indigenous development of new products and processes and assimilating and adapting imported technologies were some of the measures adopted in this regard. During the 1990s these policy vigour persisted and government-initiated measures such as CSIR 2001 Vision & Strategy, in 1996, amendment of Indian Patent Act in 1999 and New Millennium Indian

[34] There are several studies on different dimension of this policy. See among others Desai, (1988), Lall (1984, 1987).

Technology leadership in 2000 etc. Mani, (2003) while assessing the technology policy held the view that the overall approach seems to be creating enabling environment for R&D in terms of improving technology infrastructure, enhancing industry- institution linkages, development of science & technology work force and providing fiscal incentives for encouraging in-house R&D.

The convergence of technology of the three previously separated areas-Machine tools; computers and communications have resulted in major changes in the boundaries of the markets and technology involved for machine tool manufactures. It has led to the accelerated development, refinement and diffusion of new devices and concepts in this industry that are popularly known as Flexible automation[35].

### 2.8.1 Technology in machine tool sector

The machine tool industry is one of the technology intensive sectors, as it requires large amount of skilled workforce in its production process. Machine tool manufacturing often involve topical ingenuity, troubleshooting and informal innovation that demand the presence of competent engineers and workers (Desai *et al,* 1999). The technological capability in machine tool industry includes the selection of new technology, its implementation, the operation of the production facilities so implemented, their adaptation and improvements, the potential to develop new process and products (Amsden, 1985). Government of India has placed much emphasis over building technological capability in this industry.

In the machine tool sector, the acquisition of design capabilities drives innovation. Hence R&D activities of firms that lead to basic design capability enable product or process innovations, which further boost the competitiveness of products. However it is argued that inward looking policy failed to provide the incentive for technological innovation (Suresh, 2007). Another significant source of innovation in machine tool manufacturing is the user supplier interaction[36]. The demand emanating from the main users of machines tools like automobile, general engineering, consumer goods induce firms to continuously improve new variety and design in the machines, understand specific user industry requirements, impart more flexibility in machine operations etc (Suresh, 2007).

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[35] For a detail account of Flexible automation, see Alcorta (2001), Edquist and Jacobson (1988)
[36] See Lee, (1996) for an account of how the user firms played a role in inducing innovation in Japanese machine tool manufacturing sector.

The government also has acted as a catalyst in significant technological improvement in machine tools. The establishment of public sector undertaking such as HMT, Praga tools etc was expected to act as a leader in producing technological capability in the country. HMT for example, diversified its production structure over the years and able to supply wide range of machines in the market. Since machine tool is a sector where total self-sufficiency is very hard to achieve because of the complex nature of technology involved, most firms relied on foreign technology either through foreign collaboration or technology imports to satisfy domestic need[37].

During the earlier regime the basic premise of government regarding technology-related policy was, a) to maximize the benefit of the technology entering the country through a variety of government controls, and b) to promote and protect locally available technologies. To develop indigenous development of technological research and upgrade technology in the capital good sector in general and machine tool industry in particular, government created necessary infrastructure by way of establishing research institutes such as Central machine tool institute (now known as Central Manufacturing Technology institute; CMTI) in Bangalore, Institute for machine tools Technology (IMTT) in Punjab. The primary attempt of the existing institutes for machine tools technology is to provide technical services in terms of new designs, precision engineering facilities, laboratory and testing, expert advice and training (IMTMA, 2006).

The indigenous development of technology was supplemented by policies like restriction on foreign direct investment, limited import of capital good and controlled technology licensing, technical assistance and other forms of disembodied technology imports. With respect to import of technology it is argued that for the most part, Indian engineering firms that imported technology from abroad made only minor adaptations leaving the core technology untouched. A number of case studies of modification of imported technology have documented the minor adaptations made to technology in the Indian context (Ito, 1986).

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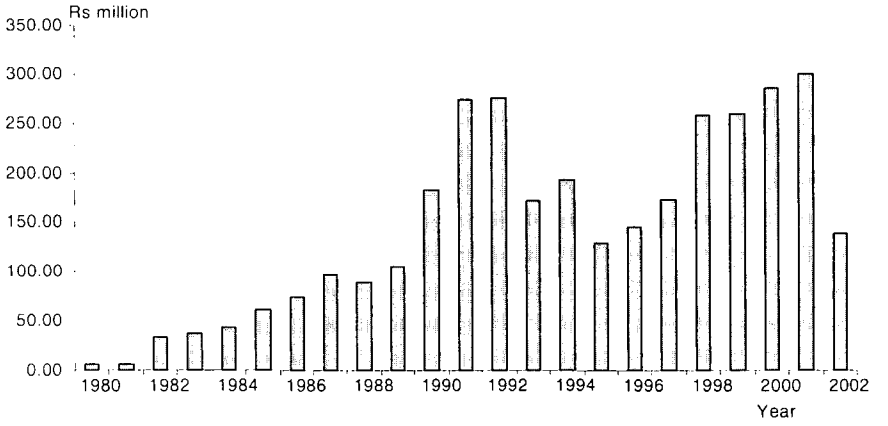
[37] Mani (2003) in a study on technology management of HMT highlighted four broad strategies of foreign technology acquisition. They are (1) broad based turnkey contracts for the initial establishment of the unit (e.g. HMT with Oerlikon for machine tools and Citizen for watches) (2) acquiring technology through bulk purchase of machinery like machines, SKD/CKDs, components and along with it the right to manufacture these machines (3) joint development with the collaborator for design of sophisticated machines for the domestic market and (4) purchase of technology through formal technical collaboration agreements.

The economic reform made significant changes in the technology environment in which firms operate. Firms are operating in a more competitive environment than before, which forces them to undertake more innovations. Desai (1996) argued that during 1990s, not only formal R&D but also incremental changes like small modification done on the shop floor, swift improvements in machine design to meet the brisk demand etc, propelled firm's innovative behaviour. Since access to technology developed elsewhere has made relatively easier there increasing demand for skilled personnel in this industry. Here the development of technological capability requires an understanding of the principles behind the technology brought it from outside and an ability to introduce modification in order to get better results (Dahlman, 1982).

The figure 2.7 shows that during 1980-2002, there has been a steady rise in R&D expenditure by machine tool industry. The initial level of R&D was only Rs 6.4 million, which steadily increased during the mid period of 1980s only to record its highest level of Rs 104.9 million in 1989. The growth of R&D expenditure was 96 percent and 32 percent respectively (see table 2.15). This increased R&D effort of the firms was mainly channelled to improve the existing product structure and compete and replicate the foreign products.

**Figure 2.7 R&D Expenditure in Machine tool Industry (1980-2002)**




Source: DST, Various issues

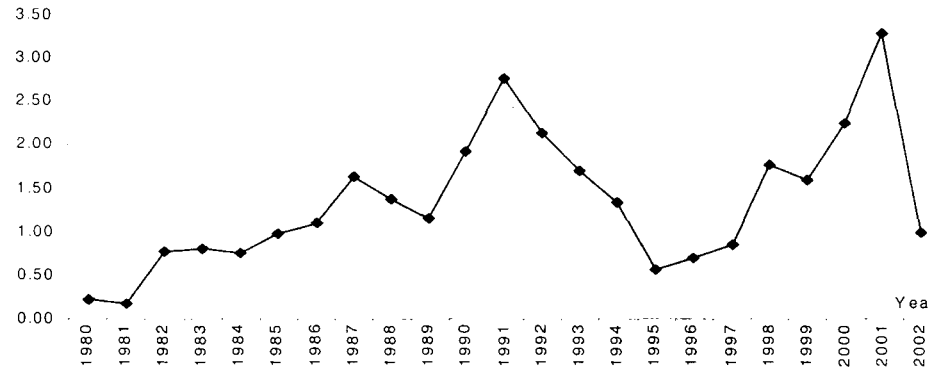
**Table 2.15 Average Growth rate of R&D expenditure and R&D intensity in Indian machine tool industry (1980-02)**

| Year | R&D Expenditure | R&D intensity |
|---|---|---|
| 1980-85 | 95.89 | 74.72 |
| 1985-91 | 32.08 | 24.20 |
| 1991-96 | 0.75 | 1.53 |
| 1996-02 | 6.04 | 22.83 |

Source: Computed from DST.

The R&D expenditure during post liberalisation period was found to be cyclical. It started with a high level of Rs 274 million during the initial period of 1990s. It continuously declined thereafter and recovered since 1998 and recorded an all time high of Rs 299 million in 2001 but declined since then. Similarly, the growth was less during the first period, as evident from table 14. One interesting observation emerging from the trend in R&D expenditure is that compared to previous decade there seem to be an inverse relationship between R&D expenditure and value added in machine tool industry. For instance, there was marginal rise in value added during till 1995 whereas R&D expenditure declined sharply from 1992 to 1995. The wedge between two is more pronounced since 1995. The value added started declining from 1995 onwards on the contrary R&D expenditure increased sharply since 1995[38].

**Figure 2.8 R&D intensity in Machine tool industry (1980-2002)**

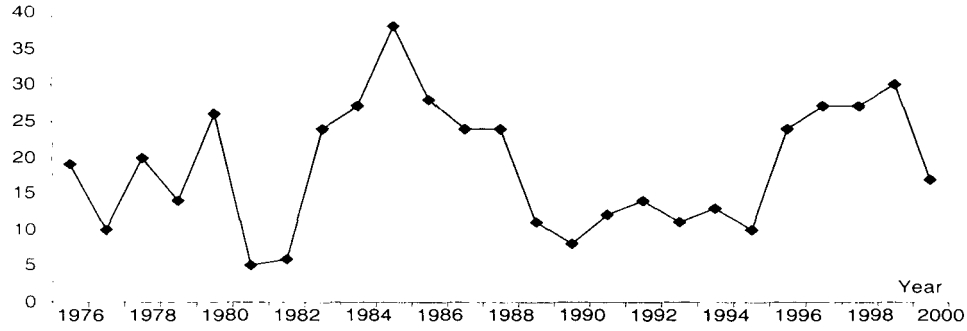



Source: DST, Various issues

In order to have a better understanding of R&D effort in the industry an examination of R&D intensity is carried out. R&D intensity is defined as R&D as a percentage of total output. The R&D intensity of machine tool industry during the two decade is given in figure 2.8. R&D intensity remained between 0.5 and 3 percent during the entire period. The trend and growth pattern was similar to the R&D expenditure although it is more cyclical. The R&D intensity became unstable since reform. It reinforces our earlier findings regarding R&D and value added. These facts direct us to note that technology development in India machine tool sectors is supplemented by factors other than formal R&D like foreign collaboration or foreign direct investments.

[38] The sharp fluctuation in R&D expenditure may also be due to changes in coverage, sample selection and method of survey adopted by DST.

**Figure 2.9 Foreign collaboration Approvals in Machine tools (1976-2001)**




Source: Computed from SIA, Department of Industrial Policy & Promotion, Ministry of Commerce & Industry, Govt. of India.

The data on trends in foreign collaboration approvals is given in figure 2.9. The trend shows that foreign collaboration approval has increased since 1980s but it instability has also widened. As we mentioned earlier, the period saw number of firms seeking collaborations for manufacture of CNC machine tools. During initial period of 1990s it remained at a steady level although R&D expenditure showed a declining trend. The latter period saw both of them moving in the same direction. During 1985-90 altogether 50 foreign collaboration agreements came into force for complete CNC machine tools, while after the liberalisation only 20 agreements have been approved till the end of 2001 (Suresh, 2007).

**Table 2.16 Actual inflow of FDI (million $)**

| Year | Economy | Industry | Machine tool Industry | |
|---|---|---|---|---|
| | Value | Value | Value | As % of Industry |
| 1991 | 109 | 109 | 0.13 | 0.12 |
| 1992 | 264 | 262 | 0.23 | 0.09 |
| 1993 | 608 | 566 | 0.27 | 0.05 |
| 1994 | 1090 | 1035 | 2.00 | 0.19 |
| 1995 | 2209 | 1745 | 2.00 | 0.11 |
| 1996 | 3023 | 2609 | 21.70 | 0.83 |
| 1997 | 4579 | 4107 | 10.3 | 0.25 |
| 1998 | 3377 | 2326 | 6.48 | 0.28 |
| 1999 | 4016 | 3200 | 2.38 | 0.07 |
| 2000 | 4498 | 3487 | 2.41 | 0.07 |
| 2001 | 4281 | 3187 | 3.04 | 0.10 |
| Total | 28054 | 22633 | 50.94 | 0.23 |

Source: DIPP (2002)

The data regarding the inflow of foreign direct investment in the economy, industry and machine tool is given in table 2.16. Economic liberalisation has been often accredited with the increase in the flow of FDI. During 1991-00 almost 12000 FDI proposals worth Rs. 2,405

billion have been approved (DIPP, 2002) as against only 2000 in the eighties and 386 proposals in the seventies (Debroy, 1998). The actual inflow of FDI has increased from mere $109 million in 1991 to $4281 million at an annual growth rate of 54 percent. The comparable figure for total industry is $ 109 million to $3187 billion at annual growth rate of 51 percent.

It can is fairly obvious from the table that foreign direct investment in machine tool industry has been meagre compared to rest of the industry and economy. It account for only 0.23 percent of total FDI flow in the industry. Also, compared to other capital good sectors like electrical and electronic equipment (9.83 per cent) and transport industry (7.38 per cent) FDI inflow is lower in non-electrical machinery like machine tools (2.02 percent) (Suresh, 2007).

The analysis shows that there is definite decline in import of technology since liberalisation. According to Kumar (2004) there are two reasons behind this. Firstly, foreign firm find it more convenient to export machines to India due to low restrictions on imports. Also, world market for machine tool is in recession, which forces foreign firms to seek market abroad. Secondly, the small market size and low or negative growth of machine tools discourages foreign firms to enter Indian market.

Having examined the production, composition and technological profile of the machine tool industry, let us focus on the trade scenario.

### 2.9 Indian Machine tools and international Trade

In this section we present an account of the trade performance of machine tool industry over the years. We will discuss international trade of machine tool with brief introduction of the trade policy regime that existed in India and then examine how far Machine tool performed in terms of import and export over the years[39].

#### 2.9.1 Indian Trade Regime and Machine tool Industry

In the earlier period, India adopted an inward looking policy that favoured domestic production for domestic consumption. The trade regime was believed to be one of the highly restrictive in the world. There was an inherent anti- export bias in the import substitution regime that retarded any significant growth in export. Export was promoted only because it provides necessary foreign exchange and not because of any development criteria. Whenever the trade balance becomes worse, strict import controls were imposed.

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[39] A detailed account of trade liberalisation is provided in the next chapter.

In order to protect the industry from foreign competition, a very complex regime consisting of tariff and non-tariff barriers were initiated. Machine tool industry, being a strategic industry was one among the many industries that enjoyed the umbrella of protection by the government. The imports of machine tools were allowed incase of domestic non-availability and technological requirements of modern industries. There were no serious attempts by the government to consider an export oriented industrial development for Indian industries as considerable pessimism prevailed regarding the nature of demand in external markets, the low competitive advantage and sustainability.

This began to change since the mid 1985 and explicitly from 1991 onwards as integration with rest of the world was seen as a way out for the development of domestic industries. Gradually the protection offered to domestic manufacturing industries and especially capital good industries were relaxed. The emphasis shifted from control based regime to more market oriented incentive based regime. Trade liberalisation process gradually relaxed the regulation on imports, reduced tariff levels considerably on all items and removed most quantitative restrictions on imports. The dismantling of trade restrictions is based on the belief that these measures will make manufacturing sector more efficient. The restrictions on import of machine tool industry were relaxed and competitive pressure has been ushered in the market.

### 2.9.2 Trade performance of machine tool industry

In order to understand the trade behaviour of machine tool sector we classified the whole time period into four phases, as done in the earlier section. The discussion will try to understand the general pattern emerged from a protective regime to a liberalised regime

**Phase I (1950-66)**

During the initial years, India relied heavily on foreign machines to build its domestic manufacturing capacity. As a result, the import share in total consumption remained around 90 to 70 percent. The import of machine tools increased rapidly from Rs. 24.9 million to Rs 242 million during 1950-61 (see table 2.17). This surge was soon arrested as government initiated number of measures to check imports because of balance of payment considerations. By the end of this period the import penetration rate came down to 60 percent.

The inward looking policy created no incentive for domestic firms to seek external demand for their product. So export was virtually absent for the first 12 years. It was only during 1962 that India began to export machine tools[40]. Perceptibly, the trade balance remained negative throughout this period.

**Table 2.17 Machine tool Trade scenario (1950-2003) (Rs million)**

| Year | IM/C | EX/P | TOT | NX | Year | IM/C | EX/P | TOT | NX |
|---|---|---|---|---|---|---|---|---|---|
| 1950 | 89.7 | 0 | 0 | -24.9 | 1977 | 27.14 | 12.47 | 38.24 | -220.6 |
| 1951 | 84.09 | 0 | 0 | -25 | 1978 | 28.46 | 16.94 | 51.25 | -195 |
| 1952 | 83.28 | 0 | 0 | -22.11 | 1979 | 36.91 | 13.59 | 26.88 | -576 |
| 1953 | 87.64 | 0 | 0 | -31.27 | 1980 | 26.58 | 9.19 | 27.96 | -703.05 |
| 1954 | 89.13 | 0 | 0 | -38.64 | 1981 | 25.8 | 6.54 | 20.13 | -1054.81 |
| 1955 | 88.61 | 0 | 0 | -52.9 | 1982 | 27.71 | 6.38 | 17.77 | -1294.97 |
| 1956 | 88.57 | 0 | 0 | -83.7 | 1983 | 31.93 | 7.16 | 16.45 | -1675.37 |
| 1957 | 86.17 | 0 | 0 | -146.4 | 1984 | 27.77 | 5.81 | 16.03 | -1776.03 |
| 1958 | 80.87 | 0 | 0 | -144.2 | 1985 | 24.76 | 5.7 | 18.38 | -1594.22 |
| 1959 | 79.7 | 0 | 0 | -163.3 | 1986 | 23.78 | 9.53 | 33.77 | -1258.26 |
| 1960 | 78.13 | 0 | 0 | -209.4 | 1987 | 27.92 | 10.11 | 29.04 | -1463.94 |
| 1961 | 73.98 | 0 | 0 | -242.2 | 1988 | 31.58 | 14.22 | 35.91 | -1667.45 |
| 1962 | 68.63 | 0.92 | 0.42 | -259.3 | 1989 | 28.43 | 8.57 | 23.61 | -2531.43 |
| 1963 | 65.38 | 0.6 | 0.32 | -314 | 1990 | 36.35 | 11.13 | 21.92 | -3780.95 |
| 1964 | 62.28 | 0.57 | 0.35 | -343.2 | 1991 | 33.13 | 11.96 | 27.43 | -3139.29 |
| 1965 | 57.96 | 0.55 | 0.4 | -347.9 | 1992 | 33.74 | 11.25 | 24.9 | -4387.91 |
| 1966 | 60.71 | 2.32 | 1.54 | -423.3 | 1993 | 36.1 | 13.46 | 27.52 | -3586.46 |
| 1967 | 61.37 | 2.63 | 1.7 | -387.3 | 1994 | 35.28 | 11.97 | 24.96 | -5163.24 |
| 1968 | 65.89 | 9.02 | 5.13 | -343.9 | 1995 | 37.77 | 8.4 | 15.11 | -10846.21 |
| 1969 | 44.45 | 11.06 | 15.53 | -160.4 | 1996 | 50.71 | 9.6 | 10.32 | -17067.59 |
| 1970 | 34.55 | 7.45 | 15.25 | -155.1 | 1997 | 48.78 | 14.86 | 18.32 | -13251.39 |
| 1971 | 31.46 | 6.06 | 14.06 | -186.5 | 1998 | 57.68 | 23.86 | 22.99 | -11635.67 |
| 1972 | 33.3 | 4.25 | 8.88 | -215.4 | 1999 | 47.7 | 19.57 | 26.67 | -8759.22 |
| 1973 | 32.86 | 5.93 | 12.87 | -249.8 | 2000 | 57.39 | 36.35 | 42.41 | -6274.8 |
| 1974 | 26.6 | 8.05 | 24.16 | -223.5 | 2001 | 71.55 | 55.84 | 50.27 | -5043.39 |
| 1975 | 31.49 | 7.86 | 18.57 | -358.7 | 2002 | 62.15 | 43.51 | 46.9 | -6828.33 |
| 1976 | 30.81 | 14.48 | 38.03 | -275.7 | 2003 | 73.8 | 45.58 | 29.73 | -15624.67 |

Note: IM= Imports, EX= Exports, P= Production, TOT= Terms of trade, NX= Net exports
Source: Data from 1950-1979 is complied from Mathews (1986), Mehta (1990), and IMTMA publication. Data from 1980-2003 is from ASI, DGCI&S and UNCTAD COMTRADE *online database*.

**Phase II (1966-79)**

During 1966-70 the government adopted strict measures to curb import and as a result import drastically reduced from Rs. 430 million in 1966 to Rs. 183 million in 1970. The share of import in consumption declined from 60 percentages to 30 percentages in the same period. As mentioned earlier, the self-sufficiency rate increased during this period. Import picked up in the latter period and by 1979 reached Rs 788 million and supplied 37 percent of domestic demand for machine tools.

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[40] See Mehta, (1990), Mathews (1986), Srinivasan (1986) for an account on the poor performance of machine tool export of Indian during this period.

The industry was under recession during mid 1960s, which forced domestic producers to seek market abroad (Kumar, 2004). Around 11 percent of production were exported in 1969 and the balance of trade, although negative showed marginal improvement. The net terms of trade also improved during this period. During the latter part of 1970s, export again increased as other engineering firms including HMT got substantial number of turnkey projects in the Middle East and Africa including machine tool supply and consultancy services (Lall, 1987, Wograt *et al* 1993). The share of export in domestic production reached 17 percent in 1978, which further improved the terms of trade. The percentage growth of export was higher than import during this period.

**Phase III (1980-91)**

The period of 1980s saw some significant changes in the external policy of the government. One important step was import liberalisation, which resulted in significant surge in import volume. The import accelerated during the late 1980s and the import penetration rate increased from 26 percent to 36 percent. Apart from the import liberalisation, other factors such as growing demand for precise and accurate machines by an expanding automotive sector and widening technology gap in India and developed countries favoured this expansion. The import primarily consisted of technology intensive machines like CNC machines, machining centres, precision and special purpose grinders, high speed multi spindle drilling machines, gear cutting machines and wire cut EDMS.

After an initial surge in exports in the 1970s, the export share fluctuated during this period, and remained less than 10 percent for most of the years. It was during this period that most of the leading competitive exporters across the world moved up the value chain and began to manufacture technology intensive commodities. But India failed to diversify its product range and exported mainly conventional machines (Mehta, 1990). There too, uncompetitive price of products lowered world preference for our products.

Wograt *et al,* (1993) argue that we failed to break into the world market due to factors such as high steel prices in India[41], lack of quality infrastructure, poor export incentives, lagging exchange rate system and the change in user demand for advanced CNC machines. The relatively late entry in the international arena and the negative

[41] Suvrathan (1991), showed that the Indian steel prices were 80-100 percent above the world prices; while special steel were almost 200 percent more expensive. The high input price and inefficient incentives made Indian machine tool relatively expensive to foreign counterpart. In 1980-81, compared to East Asian machines, Indian tools were 45-84 percent more expensive supplemented by a lagging exchange rate policy.

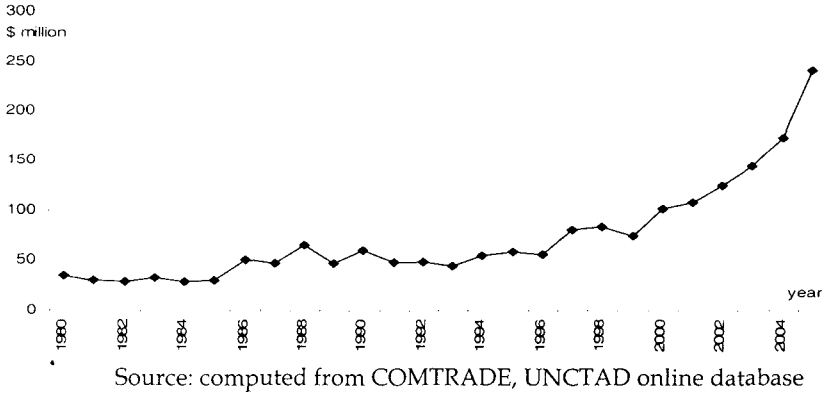
correlation between domestic consumption and export shows that export has remained as a residual activity for most of the firms in India. The bulk of the export is carried out by a handful of firms. Most firms concentrated on domestic market and were not bothered about attaining international competitiveness.

The late 1980s saw a revival in Indian machine tool export and export intensity stood at 14 percentages in 1988 and consequently there was an improvement in terms of trade and trade balance (see table 2.17). But the growth of export fluctuated as Indian tools failed to penetrate in the advanced capitalist markets[42].

**Phase IV (1990-2003)**

During this phase, India moved from an inward orientation to outward orientation and recognized the role of export in expanding economic growth. The gradual reduction in tariff and non-tariff measures gave domestic manufactures to widen their choice and freely import machines, which are not available domestically. This indeed resulted in a huge inflow of imported machines from abroad and caused a sharp rise of import consumption ratio from 33.1 percent in 1991 to 50.7 percent in 1996 and further to 73.8 percent in 2003. The competitive pressure has become more severe for domestic machine tool makers and the need to improve production capabilities to survive in the market has increased.

**Figure 2.10 Machine tool Export (1980-2005)**




Source: computed from COMTRADE, UNCTAD online database

One notable development in the machine tool industry during this period was an expansion in exports. The machine tool export registered a steady increase in the early 1990s, picked up in 1997 and started growing from 1999 onwards (see figure 2.10).

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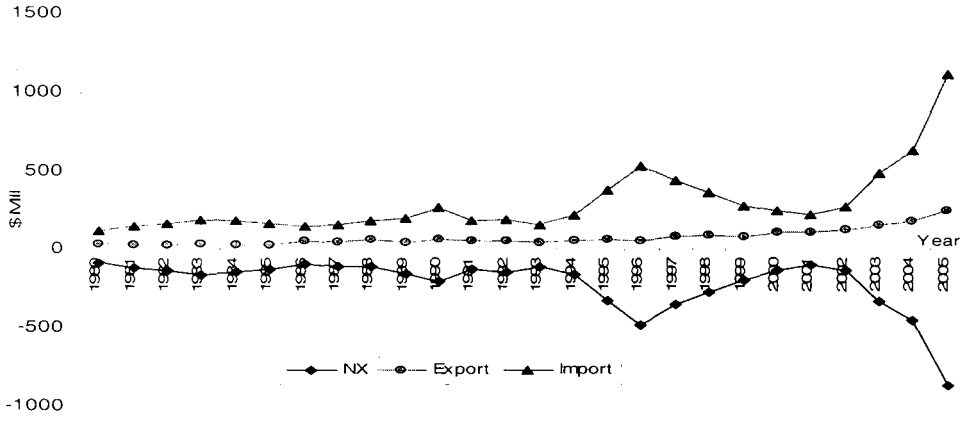
[42] For a description of the development of Indian export prior to 1991, see Dua, (1992), Suvrathan (1991), Mathews (1988).

In dollar terms, export was 48 million in 1991, which increased marginally around 50-60 till 1996 and jumped to 80 million in 1997. Thereafter it has increased progressively and by 2005, India exported 240.7 million worth machines abroad. The export intensity has also increased during this period. In 1996 it was 14.8 percent, which increased to more than 40 percent after 2000. As a result, terms of trade improved from 10.3 percent in 1996 to 47 percent in 2002. It declined thereafter due to rising imports. The net export ratio, which was negative throughout different phases, showed similar trend (see figure 2.11).

**Figure 2.11 Machine tools Trade (1980- 2005)**




Source: computed from COMTRADE, UNCTAD online database

So there is definitely a market improvement in the external scenario of machine tool industry in India. In order to further substantiate this we will have examine the growth performance of machine tool industry from 1980-2005.

### 2.9.3 Growth Performance of Machine tool Trade (1980-2005)

Here, we are examining the trade performance Indian machine tool from 1980-2005 by fitting an exponential growth rate. In this analysis we used machine tool export and import value in terms of million US dollar[43]. Table 2.18 shows that export growth was significantly higher during the nineties (12 percent) compared to what was recorded during 1980s (7 percent).

[43] Contrary to our earlier section where we have used values in Rs terms, this section will try to assess the growth performance by using US dollar. The US dollar is a stable currency, which is affected less by price changes. In addition, it is a common practice by trade economists to use dollar instead of domestic currency.

**Table 2.18 Growth rates of Machine tool trade**

| Period | MTEX | MTIM |
|---|---|---|
| 1980-91 | 6.6** | 3.5** |
| 1991-05 | 11.9** | 7.9** |

Note: MTEX= Machine tool export, MTIM=Machine tool Import
** Significant at 5 percent level

The growth of import was also found to be significantly higher during the second period (7.9 percent) compared to the first period growth rate (3.5 percent). The analysis reconfirms our earlier observation that Export and import of machine tool have notably increased during the post liberalisation period. There too, the significant growth of export is noteworthy.

So far, the discussion has been confined only to aggregate trade performance. As we have noted earlier, machine tool consist of heterogeneous product groups having different growth potential. Therefore, it is necessary to look into the product profile of machine tool trade.

**Table 2.19 Share of Metal cutting and Metal Forming Machines in India's Machine tool trade (%)**

| | Machine tool Export | | Machine tool Import | |
|---|---|---|---|---|
| Year | Metal Cutting | Metal Forming | Metal Cutting | Metal Forming |
| 1980 | 55.18 | 6.71 | 45.12 | 6.55 |
| 1982 | 61.01 | 6.09 | 46.73 | 4.61 |
| 1984 | 58.89 | 8.37 | 31.79 | 6.42 |
| 1986 | 52.78 | 3.57 | 29.59 | 4.72 |
| 1988 | 33.10 | 8.56 | 32.21 | 10.96 |
| 1990 | 45.52 | 5.24 | 42.89 | 15.54 |
| 1992 | 40.57 | 11.40 | 47.92 | 10.45 |
| 1994 | 36.66 | 7.40 | 34.58 | 25.76 |
| 1996 | 26.73 | 8.75 | 45.35 | 11.89 |
| 1998 | 23.83 | 9.05 | 34.13 | 17.79 |
| 2000 | 19.51 | 9.01 | 34.99 | 15.94 |
| 2002 | 14.25 | 7.11 | 30.75 | 11.34 |
| 2003 | 11.81 | 10.76 | 33.87 | 12.22 |
| 2004 | 14.79 | 10.72 | 29.81 | 15.14 |
| 2005 | 13.56 | 10.48 | 33.46 | 15.81 |

Table may not add up to 100 as the trade statistics uses much boarder definition of machine tool that includes tool holders, parts and accessories, and other machine tools.
Source: Own calculation based on SITC Rev 2, code 7361, 7362, UN COMTRADE, *online database.*

We have categorized the available trade statistics into different groups and find out the corresponding share in total machine tool trade. We first categorized machine tools into its major two sub categories, namely metal cutting and metal forming machines (see table 2.19). It is evident from the table that Indian machine tool trade is concentrated on metal cutting variety. During 1980s, the export category consisted mainly of metal cutting machines i.e., 55 percent, whereas metal-forming machines were 7 percent. But

we can see that over the years, the share of metal cutting machines have declined sharply (45 percent in 1990 to 20 percent in 2000 and further to14 percent in 2005) and metal forming machines have increased marginally (5 percent in 1990 to 9 percent in 2000 and 10 percent in 2005). Similar trend can be seen in machine tool import also, although the rate of decline has been relatively less.

**Table 2.20 Machine tool export composition (Share in %)**

| Year | 1989 | 1991 | 1992 | 1994 | 1996 | 1998 | 1999 | 2001 | 2003 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| Lathes | 21.3 | 20.8 | 15.8 | 11.9 | 8.1 | 8.7 | 9.6 | 7.6 | 5.2 | 6.2 |
| Drilling/ Boring | 2.87 | 6.39 | 3.51 | 2.62 | 5.55 | 2.15 | 1.35 | 1.47 | 1.41 | 2.75 |
| Milling | 14.47 | 8.29 | 8.06 | 5.66 | 6.59 | 4.80 | 2.24 | 3.37 | 1.71 | 0.87 |
| Grinding, Sharpening & Honing, Lapping | 6.22 | 7.51 | 7.33 | 5.23 | 4.12 | 3.21 | 3.66 | 4.07 | 1.62 | 1.93 |
| Shaping, Broaching, Gear Cutting, Sawing | 1.41 | 2.41 | 6.56 | 11.47 | 2.67 | 4.08 | 5.42 | 2.99 | 2.75 | 3.02 |
| Forging, Hammering, die-stamping | 6.58 | 9.16 | 11.40 | 7.40 | 8.75 | 9.05 | 10.92 | 11.47 | 10.76 | 10.48 |
| Machining centre, single/multistation | 1.0 | 0.9 | 0.1 | 0.1 | 0.6 | 0.3 | 0.3 | 1.0 | 0.9 | 0.9 |
| Parts and accessories for machine tools | 27.4 | 27.2 | 27.8 | 25.6 | 34.7 | 42.3 | 41.6 | 50.2 | 54.9 | 55.0 |

Source: Own calculation based on SITC rev 3, and HS 1992; UNCTAD, COMTRADE online database

Table 2.20 and 2.21 provides information regarding machine tool trade according to different types. The table reveals that the share of lathes, milling machines and grinders have drastically reduced over the years. On the other hand, the share of tool holders and accessories has increased considerably. Another notable feature is the increasing share, although marginal, of forging, hammering and die-casting machines in total export.

**Table 2.21 Machine tool import composition (Share in %)**

| Year | 1989 | 1991 | 1992 | 1994 | 1996 | 1998 | 1999 | 2001 | 2003 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| Lathes | 5.9 | 5.1 | 3.5 | 4.5 | 6.3 | 4.9 | 4.5 | 4.2 | 6.4 | 7.1 |
| Drilling and Boring | 9.1 | 5.2 | 9.3 | 6.0 | 7.9 | 6.3 | 4.7 | 4.6 | 6.0 | 4.8 |
| Milling | 5.9 | 2.6 | 3.4 | 6.4 | 4.9 | 5.8 | 3.9 | 4.8 | 6.9 | 4.9 |
| Grinding, Sharpning & Honning, Lapping | 14.1 | 24.7 | 22.9 | 11.6 | 17.4 | 11.7 | 10.8 | 6.5 | 7.6 | 10.5 |
| Shaping, Broaching, Gear Cutting, Sawing | 9.2 | 11.8 | 8.6 | 6.2 | 15.0 | 9.2 | 9.1 | 7.1 | 10.6 | 7.0 |
| Forging, Hammering, die-stamping | 7.7 | 9.2 | 10.5 | 25.8 | 11.9 | 17.8 | 16.7 | 17.6 | 12.2 | 15.8 |
| Machining centre, single/multistation | 2.0 | 0.8 | 1.4 | 6.1 | 17.4 | 14.8 | 15.7 | 13.2 | 13.6 | 17.2 |
| Parts and accessories for machine tools | 35.2 | 26.4 | 21.9 | 17.2 | 11.5 | 20.2 | 19.0 | 22.1 | 20.6 | 15.6 |

Source: Own calculation based on SITC rev 3, and HS 1992; UNCTAD, COMTRADE online database

In the case of machine tool imports, we can see that the highest share has been accounted by machining centers, followed by grinders and forging machines. Since a single lathe machines have different varieties and qualities it is impossible to examine the exact nature of product specialization, we can still note that the superior machines have accounted a major chunk of machine tool imports since liberalisation.

**Table 2.22 Share of CNC machines in total machine tool trade (%)**

| Year | 1989 | 1991 | 1993 | 1995 | 1997 | 1999 | 2001 | 2003 | 2005 |
|---|---|---|---|---|---|---|---|---|---|
| CNC/Machine tool Exports | 6.9 | 6.9 | 6.5 | 4.5 | 9.1 | 2.3 | 3.2 | 3.5 | 3.2 |
| CNC/Machine tool Imports | 12.0 | 13.4 | 17.2 | 22.3 | 20.5 | 25.9 | 22.0 | 21.0 | 20.6 |

Note: EX= machine tool export, IM= Machine tool import
Source: Own calculation based on SITC rev 3, UNCTAD COMTRADE online database

This is evident in table 2.22, which shows the share of advanced CNC machines in total machine tool trade. In the earlier section regarding product specialization, we have noted that there was some progress towards the production of advanced machines tools. But, there is hardly any dynamism in the export basket. The export basket is still dominated by low to medium technology intensive products. Although the share of CNC in total export increased from 6.9 percent in 1989 to 9.1 percent in 1997, it has declined since and reached 3.2 percent in 2005. On the other hand, the import of these machines has recorded a steady upward trend and currently account around 21 percent share in total import of machine tools in India. This may be a reflection of growing technological gap between India and the rest of the world.

This points out that there are only marginal changes in the export composition of machine tool over the years. Although the share of some traditional simple and conventional machines has come down over the years, the export basket generally remained of low to medium technology intensive products. On the other hand the import basket mainly consists of medium to advanced technology products.

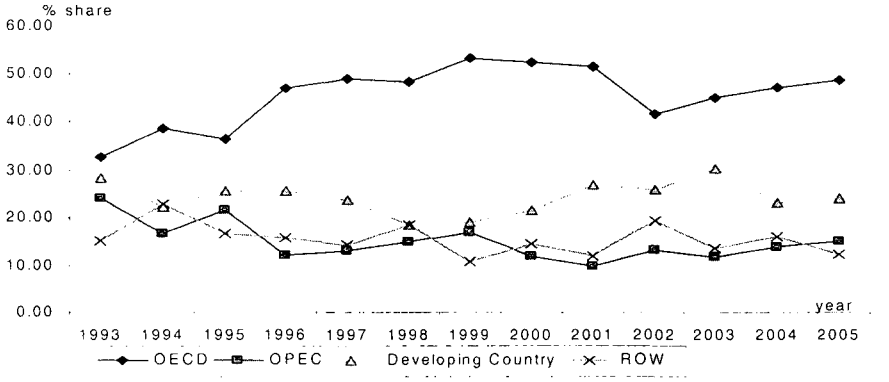
We next examine the source and destination of India's machine tool trade. It is argued that concentration and dependence on any single market may not be desirable as it can increase our vulnerability and risk. In a sense, export penetration to advanced markets such as OECD can be interpreted as creditable since success in these market calls for better competency. In addition, the establishment of international trade organisation like World Trade Organisation (WTO) in 1995; there is a gradual reduction in protectionist barriers across countries, which widened the market access for merchandise products from developing countries.

### 2.9.4 Machine tool Trade Direction

In the initial period, around 60 percent of export growth was towards advanced developed countries. The trend continued till 1975-76. Thereafter, it continuously declined and reached around 14 percent in the mid eighties (Dua, 1992). Machine tool export shifted towards non-competitive markets like Eastern Europe. USSR and Bulgaria accounted for 31 percentage during 1984 which increased to 83 percent in 1987 i.e., relative share of hard currency declined. 20 CNC machining centres were exported in 1987. This indicated lack of competitiveness and dependence on few countries (Suvrathan, 1991).

During the early nineties the demand for machine tool suffered due to the collapse of USSR, one of its main destinations. Export to Russia dropped from Rs. 742.3 million in 1991 to Rs124.33 million in 1992 (Uchikawa 1999). Developing countries share in machine tool export continued to decline till 1998, thereafter it has increased marginally (see figure 2.12). But most remarkable trend in export destination is that since mid 1990s, Indian export is destined towards OECD countries. The share has increased from 32.6 percent in 1993 to 48.5 percent in 2005. During 1999-01 the share was within 50-to55 percent ranges. The share of developing countries has remained around 30-20 percent over the years. The increase in export since 1997 is largely propelled by demand generated from advanced developed countries. The share is almost stable over the years and recent period have shown an increasing trend.

**Figure2.12 Destination of Machine tool Export 1993-05 (% Share)**




Source: Computed from UN COMTRADE and CMIE, Foreign trade Review, Various issues

An examination of individual countries share in total machine tool export shows that ten countries namely, USA, UAE, Germany, Belgium, Italy, Singapore, china, Indonesia, Bangladesh, Sri Lanka accounts for the largest consumer of machines tools over the years

(see table Appendix A (2)). There too, the five countries (USA, UAE, Germany, Belgium and Italy) accounted for more than 40 percent of the total export supplied. For instance, during 1993, these countries had a share of 33 percent, which rose to 44 percent in 2005. The major type of machines that India supply to these countries are of simple variety such as capstan turret, central lathe, die casting and tool holders and machine tool accessories (Exim Bank, 1996).

This made us to an exploration of the nature of market diversification (concentration) of machine tool trade based on Hirschman (H) index of concentration. The analysis is done for the period 1993-05. As done earlier, the countries are grouped into three main groups, OECD, OPEC and developing countries and in some cases the sub groups are also reported. The H index is calculated based on the following formula[44].

$$H_i = \sqrt{\left(x_i / X_t\right)^2}$$

Here, $x_i/X_t$ is the share of group i in India's total export of machine tools. A lower index signifies market concentration and vice versa. The results are reported in table 2.23

**Table 2.23 Export Concentration Index (1993-05)**

| Year | 1993-96 | 1996-99 | 1999-02 | 2002-05 |
|---|---|---|---|---|
| I. O E C D | 0.780 | 0.990 | 1.000 | 0.910 |
| a) E U | 0.280 | 0.420 | 0.490 | 0.470 |
| b) North America | 0.440 | 0.450 | 0.440 | 0.380 |
| c) Asia & Oceania | 0.050 | 0.140 | 0.070 | 0.060 |
| II. O P E C | 0.380 | 0.280 | 0.260 | 0.270 |
| III. Developing Country | 0.510 | 0.440 | 0.470 | 0.520 |
| a) Asia | 0.370 | 0.320 | 0.310 | 0.310 |
| b) Africa | 0.140 | 0.110 | 0.150 | 0.200 |

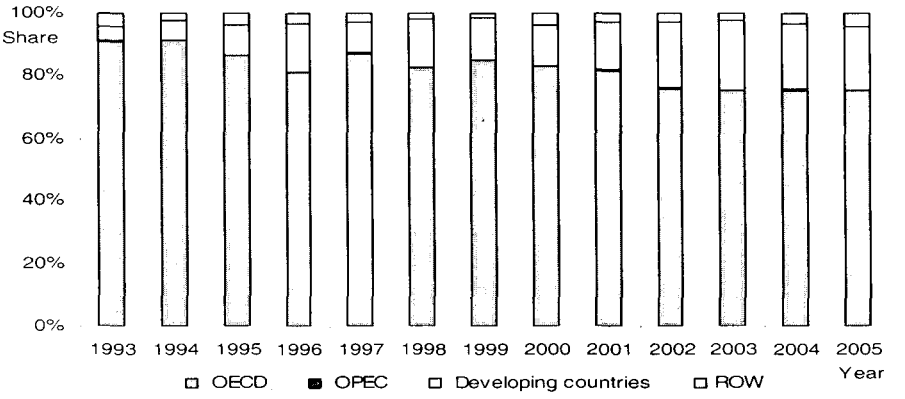
Source: Same as figure: 2.12

An examination of the table 2.23 reveals that export basket is not diversified over the years and it is more concentrated in the advanced countries market. At the disaggregate level; the export is concentrating more towards EU. The market of machine tool export has been fairly constant in OPEC and Asia in developing country. This is an indication of the nature of comparative advantage and specialisation pattern of machine tools. Since machine tools have large diversity, no country has 100 percent self-sufficient in its production. Countries that are moving to technology superior products may find it

[44] The calculation of the index is based on Bernard *et al* (2003). Some of the common trade indicators are discussed in this book.

uneconomical to produce machines that are relatively simple and labour intensive. Most of the OECD countries are on the forefront in the technologically superior products, which have higher income elasticity and better prospects for long-term growth. Therefore, they demand simple products and accessories from developing countries like India and China.

**Figure 2.13 Source of India's Machine tool Import (1993-2005)**




Source: CMIE, Foreign trade Review, Various issues

**Table 2.24 Import Concentration Index (1993-05)**

| Year | 1993-96 | 1996-99 | 1999-02 | 2002-05 |
|---|---|---|---|---|
| I.OECD | 0.778 | 0.528 | 0.756 | 0.375 |
| a) E U | 0.597 | 0.299 | 0.411 | 0.211 |
| b) North America | 0.065 | 0.059 | 0.087 | 0.043 |
| c) Asia and Oceania | 0.124 | 0.178 | 0.263 | 0.122 |
| d) Eastern Europe | 0.007 | 0.003 | 0.003 | 0.002 |
| II.OPEC | 0.001 | 0.001 | 0.003 | 0.002 |
| Developing countries | 0.082 | 0.078 | 0.139 | 0.105 |

Source: Same as figure: 2.13

An examination of the sources of machine tool imports reveals that, in absolute term, India is heavily depending on advanced countries for their machine tools imports as it share stood between 75-90 percent (see figure 2.13). But since 1994 there is a notable shift in this pattern as the share of OECD is found declining and correspondingly the share of developing countries is increasing. Therefore, we can conclude that although, we heavily depend on advanced countries, the relative importance of developing countries is showing an improvement in the later part of 1990s. In order to substantiate this argument, we have calculated the concentration index as described earlier (see Table 2.24). The result reveals that there is a significant reduction in the dependency of OECD countries (the index has declined from 0.78 in the first period to 0.38 in the last period) and there is an upward trend in the case of developing countries (a rise from 0.08 in 1993-96 to 0.11 in 2002-05).

## 2.10 Conclusion

In this chapter we examined in detail regarding the evolution of machine tool industry in national and international level. It was found that, the major producers and consumers of machine tools are few OECD countries. But lately, developing countries particularly some Asian countries have registered a strong presence in the world market.

A detailed account of the development of machine tool industry in India was carried out in this chapter. The performance of the industry was assessed in accordance with the changing policy regimes. It was found that the growth of machine tools was higher during the golden period of import substitution regime and since the onset of economic reforms the instability in growth of value added has increased. There was a significant change in the composition of machine tool production as new players entered in the market and production had gradually shifted towards non-conventional machines. There is also some evidence to show that the technology profile of the machine tool industry have improved over the years.

An examination of the trade performance of machine tool industry reveals that since the introduction of trade liberalisation policies, there has been a significant growth in the volume of export and import. One notable development was the significant rise of machine tool exports during this period mainly catering to the needs of advanced OECD countries. A disaggregates level analysis revealed that, the export basket consists primarily of simple products like simple lathe, turret and parts and accessories whereas the import basket carried some dynamic products machine centres, forging machines and advanced numerical machines. The source of import has also witnessed a gradual shift towards developing countries.

Although the trade performance of Indian machine tool industry is laudable, a definite conclusion regarding the export competitiveness and viability cannot be drawn from the above findings. The trade liberalisation policy has certainly eased the export pessimism prevailed in the economy and industry has shown its ability to serve the foreign market. In this context, a successful export orientation requires the industry improve its technological and organisational efficiency and try to improve the value chain. The policy shift is expected to supplement industries in achieving this goal and thus become internationally competitive. Therefore, it is necessary to see whether machine tool industry was able to attain international competitiveness during the period of trade liberalisation. We will address this issue in the next chapter.

# ANNEXURE - I

**Table A 1: World Machine tool production and Trade (1980-2000), US million$**

| Country | 1980-81 | | | | 1990-91 | | | | 2000-01 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | IM | EX | CN | P | IM | EX | CN | P | IM | EX | CN |
| Japan | 4312 | 222 | 1608 | 2926 | 10373 | 581 | 3955 | 6999 | 9390.7 | 660.1 | 4796.7 | 5254.1 |
| Germany | 4330 | 809 | 2775 | 2364 | 11227 | 1806 | 4677 | 8356 | 7732.2 | 2268.7 | 4288.5 | 5712.4 |
| Italy | 1621 | 340 | 821 | 1140 | 3387 | 1225 | 1607 | 3005 | 3794.5 | 1227 | 1942 | 3079.5 |
| USA | 4962 | 1363 | 879 | 5446 | 3298 | 2197 | 860 | 4635 | 2853.5 | 3411.3 | 1033.7 | 5231.1 |
| China | 430 | 133 | 29 | 534 | 907 | 422 | 195 | 1134 | 2624 | 2406 | 290 | 4740 |
| Switzerland | 920 | 207 | 805 | 322 | 2365 | 700 | 2268 | 797 | 2046.7 | 426 | 1755.9 | 716.8 |
| Taiwan | 248 | 112 | 180 | 180 | 980 | 333 | 650 | 663 | 1634.9 | 845.5 | 1362.7 | 1117.7 |
| Korea | 157 | 334 | 30 | 461 | 773 | 825 | 86 | 1512 | 803.9 | 931 | 411 | 1323.9 |
| France | 882 | 565 | 503 | 944 | 1223 | 1870 | 478 | 2615 | 813.5 | 1188.5 | 485.9 | 1516.1 |
| Spain | 336 | 123 | 217 | 242 | 908 | 435 | 389 | 954 | 886 | 470.7 | 476.1 | 880.6 |
| UK | 1164 | 528 | 606 | 1086 | 1636 | 893 | 764 | 1765 | 824.3 | 780.9 | 708.4 | 896.8 |
| Brazil | 310 | 150 | 73 | 387 | 380 | 101 | 34 | 447 | 307.3 | 506.1 | 118.1 | 695.3 |
| Canada | 231 | 495 | 92 | 634 | 376 | 444 | 91 | 729 | 406.8 | 739.3 | 212 | 934.1 |
| Netherlands | 63 | 130 | 84 | 109 | 83 | 318 | 186 | 215 | 297.1 | 479.7 | 368.7 | 408.1 |
| Austria | 137 | | 119 | 18 | 294 | 343 | 328 | 309 | 275.6 | 302.5 | 308.8 | 269.3 |
| Finland | 22 | 67 | 20 | 69 | 50 | 158 | 28 | 180 | 196.9 | 118.1 | 165.6 | 149.4 |
| Belgium | 120 | 172 | 163 | 129 | 238 | 526 | 470 | 294 | 159.3 | 550.4 | 563.8 | 145.9 |
| Sweden | 539 | 188 | 173 | 554 | 328 | 351 | 253 | 426 | 177.2 | 226.7 | 151.2 | 252.7 |
| India | 187 | 90 | 24 | 253 | 250 | 269.9 | 59.2 | 460.72 | 111.7 | 212.65 | 106.3 | 217.45 |
| Russia | 2999 | 970 | 272 | 3697 | 4790 | 1850 | 380 | 6260 | 180.7 | 162.7 | 82.8 | 260.6 |
| Denmark | 52 | 39 | 35 | 56 | 77 | 126 | 86 | 117 | 57.3 | 143.2 | 66.2 | 134.3 |
| Romania | 606 | 314 | 139 | 781 | 620 | 103 | 186 | 537 | 44.4 | 92.3 | 60.2 | 76.5 |
| Portugal | 16 | 47 | 5 | 58 | 18 | 35 | 10 | 43 | 35.8 | 109.2 | 19.7 | 125.3 |
| Argentina | 34 | 70 | 29 | 75 | 40 | 28 | 30 | 38 | 15.4 | 87.7 | 10.9 | 92.2 |
| World Total | 26941 | 9383 | 11205 | 25119 | 47450 | 16052 | 20146 | 43356 | 36235.8 | 18944 | 20141.8 | 35038 |

P= Production, EX=Export, IM =Import, CN=Consumption

Source: Based on American Machinist and Garden Publication.

**Table: A (2) Destination of India's machine tool Export (1993-2005) (million $)**

| Country | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Australia | 0.41 | 0.63 | 0.76 | 0.68 | 0.90 | 0.78 | 0.57 | 1.19 | 1.09 | 1.40 | 1.96 | 2.10 | 3.11 |
| Bangladesh | 1.90 | 1.97 | 3.00 | 2.02 | 3.16 | 1.79 | 1.26 | 5.79 | 7.43 | 2.66 | 9.37 | 7.79 | 2.26 |
| Belgium | 0.23 | 0.11 | 0.53 | 1.01 | 0.87 | 1.44 | 1.32 | 1.90 | 5.87 | 5.68 | 5.10 | 6.16 | 8.33 |
| Brazil | 0.04 | 0.00 | 0.00 | 0.15 | 0.12 | 0.12 | 1.06 | 1.00 | 0.46 | 0.69 | 0.31 | 0.54 | 1.69 |
| Canada | 0.47 | 0.58 | 0.91 | 0.37 | 0.57 | 0.54 | 0.96 | 1.43 | 1.51 | 1.55 | 2.37 | 2.80 | 2.43 |
| China | 0.04 | 0.08 | 0.18 | 0.31 | 0.21 | 0.31 | 0.10 | 0.40 | 1.38 | 5.19 | 2.63 | 3.02 | 5.15 |
| Egypt | 0.41 | 0.48 | 0.68 | 0.75 | 0.85 | 0.99 | 0.39 | 0.66 | 1.06 | 0.91 | 1.58 | 2.39 | 1.43 |
| France | 1.04 | 0.57 | 0.20 | 0.65 | 0.98 | 1.56 | 1.03 | 1.65 | 2.29 | 1.85 | 2.66 | 1.91 | 4.00 |
| Germany | 1.64 | 2.52 | 2.44 | 1.89 | 3.98 | 5.68 | 7.45 | 7.69 | 7.04 | 7.23 | 8.26 | 11.8 | 16.27 |
| Hong Kong | 2.62 | 2.04 | 1.05 | 0.72 | 0.46 | 0.44 | 0.35 | 0.46 | 0.53 | 0.40 | 0.76 | 0.92 | 1.44 |
| Indonesia | 0.46 | 0.55 | 3.48 | 1.48 | 1.02 | 0.58 | 0.38 | 1.01 | 0.82 | 5.30 | 1.95 | 2.09 | 2.54 |
| Iran | 1.20 | 0.07 | 0.42 | 0.13 | 0.42 | 0.33 | 1.09 | 0.62 | 1.09 | 1.96 | 1.61 | 2.65 | 1.24 |
| Italy | 0.07 | 2.23 | 0.33 | 0.51 | 3.04 | 1.74 | 0.90 | 3.52 | 2.96 | 5.07 | 9.60 | 7.74 | 6.06 |
| Japan | 0.27 | 0.27 | 0.53 | 0.62 | 0.99 | 1.06 | 0.36 | 0.76 | 1.85 | 1.12 | 2.69 | 1.31 | 1.53 |
| Kenya | 1.00 | 1.37 | 2.14 | 1.46 | 1.36 | 0.99 | 1.38 | 0.94 | 0.79 | 2.74 | 2.14 | 2.04 | 2.72 |
| Malaysia | 1.49 | 0.83 | 0.54 | 2.98 | 2.26 | 0.70 | 0.88 | 1.11 | 1.63 | 1.51 | 2.37 | 2.11 | 3.16 |
| Nepal | 0.35 | 0.23 | 0.40 | 0.11 | 0.80 | 0.44 | 1.74 | 0.87 | 0.95 | 0.66 | 2.25 | 1.45 | 1.59 |
| Netherlands | 0.37 | 0.40 | 0.29 | 0.27 | 0.58 | 0.85 | 1.02 | 0.73 | 4.06 | 1.50 | 1.39 | 1.80 | 2.02 |
| Nigeria | 1.17 | 0.67 | 1.00 | 0.79 | 0.68 | 0.98 | 0.71 | 1.42 | 3.41 | 4.42 | 7.85 | 4.66 | 7.57 |
| Oman | 0.49 | 0.55 | 0.73 | 0.63 | 0.80 | 1.02 | 0.89 | 3.12 | 0.94 | 0.65 | 1.69 | 2.08 | 1.69 |
| Saudi Arabia | 1.81 | 2.20 | 1.34 | 1.05 | 2.14 | 2.71 | 1.64 | 1.83 | 1.75 | 2.64 | 3.69 | 3.29 | 5.52 |
| Singapore | 1.42 | 1.59 | 1.99 | 2.11 | 4.06 | 3.55 | 1.13 | 1.79 | 2.68 | 4.38 | 3.57 | 4.62 | 5.72 |
| south Africa | 0.01 | 0.02 | 0.15 | 0.08 | 0.21 | 0.24 | 0.40 | 0.61 | 1.37 | 1.64 | 1.81 | 1.70 | 2.14 |
| South Korea | 0.02 | 0.15 | 0.27 | 0.24 | 0.87 | 0.01 | 0.06 | 0.47 | 0.34 | 0.94 | 0.36 | 0.96 | 2.50 |
| Spain | 0.09 | 0.11 | 0.03 | 1.38 | 1.02 | 0.97 | 0.29 | 0.67 | 0.47 | 0.48 | 0.87 | 1.06 | 1.99 |
| Sri Lanka | 0.75 | 1.09 | 1.11 | 1.25 | 1.10 | 2.25 | 2.81 | 2.27 | 2.37 | 2.36 | 2.84 | 3.41 | 4.30 |
| Sudan | 0.05 | 0.12 | 0.11 | 0.04 | 0.23 | 0.37 | 0.13 | 0.20 | 0.41 | 0.73 | 0.70 | 0.74 | 2.60 |
| Switzerland | 0.30 | 0.19 | 0.06 | 0.46 | 6.32 | 3.23 | 0.63 | 1.24 | 0.41 | 0.09 | 0.01 | 0.02 | 0.00 |
| Syria | 0.08 | 0.08 | 0.10 | 0.10 | 0.37 | 0.14 | 0.09 | 0.44 | 1.73 | 0.78 | 0.89 | 0.98 | 3.01 |
| Tanzania | 0.22 | 0.52 | 0.49 | 0.20 | 0.68 | 0.27 | 0.42 | 0.46 | 0.56 | 0.63 | 0.77 | 1.88 | 2.22 |
| Thailand | 0.56 | 0.81 | 1.42 | 0.57 | 0.97 | 1.16 | 0.57 | 1.11 | 0.26 | 0.80 | 2.03 | 1.46 | 2.05 |
| Turkey | 0.06 | 0.05 | 0.08 | 0.22 | 0.18 | 0.13 | 1.50 | 0.28 | 0.14 | 0.20 | 1.00 | 1.88 | 2.22 |
| UAE | 5.27 | 3.92 | 5.20 | 3.18 | 4.69 | 7.00 | 7.13 | 4.46 | 5.47 | 5.46 | 7.04 | 14.25 | 18.33 |
| UK | 2.12 | 2.63 | 2.98 | 2.88 | 4.32 | 5.29 | 5.81 | 5.12 | 5.40 | 4.69 | 6.34 | 11.88 | 11.58 |
| Ukraine | 1.07 | 1.62 | 1.14 | 0.03 | 1.05 | 0.05 | 0.65 | 0.08 | 0.00 | 0.05 | 0.29 | 0.05 | 2.90 |
| USA | 6.85 | 10.55 | 11.69 | 14.36 | 14.36 | 15.14 | 15.50 | 22.44 | 19.60 | 19.31 | 20.91 | 32.65 | 44.40 |

Source: CMIE, Foreign Trade and Balance of Payments, UNCTAD COMTRADE, *online database*

## Table A (3) Sources of India's Machine tool Import (1993-2005)

| Country | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Germany | 42.91 | 88.29 | 117.15 | 150.19 | 108.02 | 101.97 | 45.81 | 34.65 | 43.23 | 51.75 | 82.35 | 134.08 | 240.68 |
| Japan | 9.35 | 13.16 | 44.54 | 114.46 | 65.06 | 66.93 | 84.54 | 61.9 | 38.31 | 36.56 | 119.01 | 121.72 | 212.67 |
| Italy | 36.78 | 28.25 | 48.96 | 31.63 | 32.18 | 28.24 | 29.22 | 20.52 | 20.0 | 27.78 | 48.91 | 61.55 | 110 |
| Korea | 2.62 | 3.42 | 7.17 | 50.22 | 12.01 | 25.02 | 10.27 | 4.84 | 6.94 | 19.49 | 51.93 | 38.11 | 81.48 |
| USA | 12.07 | 13.06 | 28.87 | 40.84 | 47.97 | 26.66 | 19.33 | 25.7 | 18.02 | 20.9 | 29.11 | 47.6 | 78.22 |
| Taiwan | 2.7 | 3.7 | 12.2 | 12.41 | 12.32 | 10.85 | 12.52 | 11.57 | 12.89 | 15.27 | 21.4 | 48.62 | 62.85 |
| Switzerland | 8.29 | 17.56 | 23.83 | 26.6 | 23.55 | 16.43 | 14.32 | 8.87 | 10.37 | 18.55 | 18.16 | 28.58 | 44.73 |
| China | 0.86 | 3.21 | 9.3 | 10.64 | 8.57 | 9.07 | 5.13 | 4.85 | 3.35 | 4.36 | 8.18 | 16.22 | 34.91 |
| UK | 11.5 | 11.51 | 18.28 | 26.98 | 26.39 | 15.11 | 9.62 | 6.3 | 5.06 | 10.38 | 12.71 | 25.02 | 34.85 |
| Singapore | 0.38 | 1.84 | 4.84 | 6.74 | 4.37 | 4.69 | 3.67 | 5.71 | 3.59 | 6.4 | 10.91 | 15.18 | 23.09 |
| Russia | 0.39 | 0.27 | 9.31 | 4.61 | 2.24 | 2.58 | 0.64 | 1.23 | 0.72 | 0.41 | 1.15 | 3.56 | 19.77 |
| Spain | 3.58 | 4.96 | 9.14 | 6.25 | 3.64 | 10.9 | 0.7 | 1.68 | 3.09 | 1.61 | 4.28 | 12.33 | 17.65 |
| France | 5.54 | 2.5 | 5.6 | 3.21 | 3.78 | 3.51 | 6.16 | 4.53 | 6.37 | 3.98 | 6.37 | 9.79 | 16.18 |
| Sweden | 2.55 | 3.67 | 3.75 | 4.43 | 6.31 | 2.79 | 2.33 | 3.06 | 4.46 | 3.32 | 4.56 | 4.27 | 12.82 |
| Israel | 0.04 | 0.33 | 1.31 | 0.83 | 2.45 | 1.1 | 2.3 | 0.95 | 1.43 | 5.2 | 7.18 | 10.05 | 10.18 |
| Netherlands | 0.14 | 1.3 | 2.45 | 4.21 | 1.15 | 0.74 | 1.4 | 3 | 1.2 | 0.47 | 0.71 | 2.39 | 8.91 |
| Belgium | 5.3 | 7.62 | 11.48 | 12.3 | 15.51 | 8.49 | 53.84 | 7.06 | 4.44 | 6.95 | 9.15 | 8.96 | 6.51 |
| Czech | 1.77 | 1.95 | 4.24 | 2.55 | 2.37 | 1.54 | 0.26 | 3.31 | 0.72 | 0.57 | 1.27 | 3.1 | 8.28 |
| Austria | 0.28 | 0.29 | 1.91 | 0.61 | 0.57 | 0.2 | 1 | 0.38 | 0.87 | 1.12 | 3.27 | 1.81 | 4.42 |
| Thailand | 0.17 | 17 | 1.37 | 0.66 | 0.37 | 1.55 | 0.73 | 0.49 | 0.76 | 0.65 | 0.9 | 1.14 | 3.93 |
| Canada | 0.27 | 0.04 | 0.63 | 0.32 | 29.86 | 0.33 | 0.66 | 0.6 | 0.32 | 1.85 | 3.39 | 4.24 | 3.08 |
| Hong Kong | 0.33 | 0.5 | 0.74 | 0.12 | 0.86 | 0.86 | 0.72 | 0.1 | 0.22 | 0.43 | 0.41 | 1.01 | 2.18 |
| Finland | 0 | 0.09 | 0.03 | 0.05 | 0.74 | 0.29 | 0.31 | 0.57 | 0.58 | 0.44 | 0.79 | 0.53 | 2.12 |
| Australia | 0.07 | 0.5 | 0.78 | 0.88 | 1.19 | 1.84 | 1.26 | 0.45 | 0.87 | 1.35 | 2.15 | 2.77 | 1.82 |
| UAE | 0.25 | 0.31 | 0.13 | 0.31 | 0.28 | 0.41 | 0.3 | 0.24 | 1.13 | 0.87 | 1.38 | 1.23 | 1.19 |

Source: CMIE, Foreign Trade and Balance of Payments.

# CHAPTER 3

# TRADE LIBERALISATION AND MACHINE TOOL EXPORT COMPETITIVENESS

In this chapter an assessment of India's machine tool export competitiveness will be carried out in the context of trade liberalisation initiated during the mid 1980s. We argue that liberalising trade can act as a vehicle for imparting competitiveness in the industry. The chapter begins with a discussion on trade liberalisation and competitiveness. The next section tries to identify the link between trade liberalisation and export competitiveness. This is followed with an empirical assessment of India's Machine tool export competitiveness since liberalisation. The last section provides summary of the entire discussion.

## 3.1 Trade Liberalisation: A brief overview

Trade liberalisation generally involves reduction in barriers among the countries to the movement of goods and services. The barriers can be tariff or non-tariff. The non-tariff barriers consist of quota restrictions, exchange rate controls, export subsidies etc. If a nation opens its economy or introduces a trade sector reforms, it tries to reduce or eliminate these restrictions, which limit the free flow of goods and services across countries. Thus, openness naturally leads to more and more integration with rest of the world.

The guiding principle behind industrialisation in India was protection and import substitution policies. There are several reasons behind these policies. The most prominent one was the infant industry argument, elasticity pessimism and deterioration in terms of trade argument. Under this strategy, export earnings, earned mainly through the export of primary products are used to import capital goods and machinery from industrialized countries. The experience of countries like Japan, Germany, France, USSR and China inspired the newly independed nations to think of inward oriented strategy to achieve development. These thinking were further supported by the writings of Prebish (1950), and Singer (1950).

In the initial period, the import substitution policies worked well. However, inefficiency began to creep into the system at later stages. Under this system, the export sector was severely affected because of overvaluation of currency and diversion of investment from the exporting industries to the lucrative import substitution industries. The economies that adopted this strategy slowly began to experience low growth and high trade deficit.

Moreover, in the early 1980s, many of these countries were forced to borrow heavily from international market to meet the trade deficit associated with the import substituting regime and finally most of them fell into debt crisis. The slow growth, high trade deficit and debt crisis of these economies on the one hand and the stunning success of east Asian countries which followed more liberal trade regime on the other hand changed the thinking of academician and the multilateral organisation like International Monetary fund (IMF) and World Bank (WB). Thus they began to advocate the idea of outward orientation. East Asian countries like Korea, Singapore and Taiwan not only yielded superior results in terms of economic performance, but also helped to withstand the severe interest rate and oil price shocks of the 1970s. As a result many developing countries began to open their economies in the 1980s. However, the first groups of countries to switch from import substitution regime to outward oriented regime were the countries located in far east, especially Taiwan, Singapore and South Korea.

At the beginning of the 1990s, many developing countries had already embarked on or were starting ambitious economic reforms that included reduction in the levels of import protection and trade liberalisation. While some of these reforms were unilateral, others were accomplished in the context of multilateral trade agreements such as the Uruguay Round. Important components of those reforms included large tariff reductions and elimination of quotas, as well as the relaxation of restrictions on foreign investment. Now trade liberalisation is an ongoing process across countries and sectors.

### 3.2 The Concept of Competitiveness

Competitiveness generally identified as the relative efficiency in producing tradable goods. But the concept of competitiveness has been highly debated and often controversial in recent years. There seems to be no consensus regarding what the concept really means. For instance, we often see that competitiveness and comparative advantage are used interchangeably. Although both are related, there are certain distinct features between them. Comparative advantage is driven by differences in the cost of inputs such as labour or capital. But competitive advantage, on the other hand is driven by differences in the capacity to transform these inputs into goods and services at maximum profits (Kogut, (1985). According to Siggel (2006) the distinction between competitive advantage and comparative advantage depends upon the measurement of costs. But these two concepts are closely related because competitive advantage is built to some extent upon the factors that determines comparative advantage and how we manage to maintain this advantage.

Another major reason behind this controversy is that competitiveness is often identified at different levels. Generally, competitiveness is applied at three levels, national, industry and firm level. At the national level the most common acceptable definitions of competitiveness is the "ability of a country to produce goods and services that meet the test of international markets and simultaneously to maintain and expand the real income of its citizens" (OECD, 1992). According to Haque (1995) an economy is competitive 'if it is able to grow without being constrained by balance of payment difficulties and market share is maintained'.

But this concept of competitiveness is highly controversial and the term has remained rather ambiguous and often resulted in heated debate among academicians. One of the leading critics is Krugman (1996), who argue that it is firms that compete for exports, not countries (although it is true that trade statistics are presented as an aggregate). According to him national economies simply do not compete with each other as corporation do, and that increases in productivity rather than international competitiveness are all that matter for increasing the standard of living of a nation. Krugman argued that the notion of competitiveness at the national level makes no sense, and claimed that the term was becoming, in fact, a "dangerous obsession."

While Krugman's argument has great deal of validity, scholars have pointed out some serious flaws in his argument. The basic argument of krugman rest on the basic neo classical model of international trade which depends upon extremely restrictive and unrealistic assumptions like perfect competition with efficient markets, homogeneous products, universal access to technology with no learning costs, absence of externalities or scale economies and fully employed resources. Lall (2001) argues that, in the real world, export structures are path depended and difficult to change. Most often, the world's pattern of specialization and trade is the result of history, accidents, and past government policies and generally less responsive to factor price changes. The less developed countries have to incur large cost in shifting its comparative advantage from low technology sector to high technology intensive trade, which are highly demanded across the world. This requires frequent intervention by the government. So, in Lall's view, national competitiveness is, in fact, a real issue that can be defined and measured.

The issue of competitiveness is less controversial at the industry and firm/industry level[45]. A firm is competitive if it can produce products and services of superior quality and at lower costs than its domestic and international competitors (Buckley, *et al*, 1998). The ability to compete implies doing better than comparable firms/rivals in terms of sales, market share and profitability. Competitiveness at the industry level arise from superior productivity, either by facing lower costs than international rivals in the same activity or by the ability to offer products with higher value. A well competitive industry provide an environment for developing specialised infrastructures such as research centres and educational institutes and vertical linkage that can enhance a countries industrial development.

At the firm level, competitiveness originates from its production and organisation methods (reflected in the price and quantities of final products) relative to its rival in the market. Thus loss of competitiveness would result in the loss of sales, market share and finally exit from the market. Therefore, the nature of market crucially influences the level of competitiveness. When the market is more competitive, the ability of the firm to compete depends upon prices. As the market tends towards imperfection, competitiveness is driven by non-price characteristics such as technology, product differentiation and quality.

Traditionally, competitiveness was identified in terms of prices only. In this case, exchange rate depreciation was viewed as a sole factor for increasing competitiveness. Along this, a relatively low unit cost of production would ensure competitive success in the world market. But Kaldor (1981) questioned this view by empirically showing that in the long run, market share for exports and relative unit costs or prices tended to move together. This raised the significance of non-price factors such as improved technology and quality, other forms of quantity competition and development in marketing skills and ability for enhancing competitiveness. One crucial component is technological capability of the industry. The importance of the development of domestic technological capability to strengthen competitiveness at all levels lies in the fact that over time, the industrial process involves more complex and demanding tasks in terms of adaptation, improvement, design, engineering, development and innovation. Studies have established that, in order to have successful exporters of manufactures the technological capability should be deepened[46].

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[45] Since an industry is an aggregation of all firms involved in similar economic activities, the discussion regarding competitive performance at the firm level largely applies to industry also. Therefore we will discuss these two levels interchangeably.

[46] See for instance Kaldor (1981), Fagerberg (1988, 1996), Porter (1990), and Lall (2001).

The discussion has pointed out that the concept of competitiveness is a general concept, which is influenced by factors that affect a country's macroeconomic performance. The meaning of competitiveness has varied across different level. Factors that are crucial for competitiveness include both price and non-price factors. The importance of the latter is considered to be critical for the success of firms especially the productivity and technological innovation, which in turn depend on investment in human and physical capital, and on the institutional and structural policy environment. These issues become very important in the process of economic integration. We therefore argue that there are certain links between trade liberalisation competitiveness. Some of them are discussed briefly below.

### 3.2.1 Link between Trade Liberalisation and Competitiveness

Trade liberalisation is one of the instrument through which competitiveness can be injected into an economy. Trade liberalisation leads to an inflow of large amount of goods and services, including the raw materials and other intermediate goods, which are used as inputs in the production process. The use of imported low cost and high quality raw materials and intermediate goods helps the firms to produce better quality goods at a lower cost. This provides one important channel of competitiveness to the industry in the context of trade liberalisation. Trade liberalisation promotes the low cost producers to expand their output well beyond the demand in the domestic market. This helps the domestic producers to reap economies of scale and thereby achieve price advantage.

The increased imports, through trade liberalisation, provide producers with new ideas (which is an externality) and that the restriction of imports reduce the rate at which these producers accumulate and use knowledge capital. Exporters acquire more knowledge by their interaction with foreign buyers than do producers for home market. In other words, learning by doing might take place rapidly in exporting industries[47]. Thus trade liberalisation helps in knowledge spill over among both exporters and other producers in the economy. This is another important link between trade openness and competitiveness.

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[47] A study by Obsteld and Rogoff (1996) reveals that more open economies have greater ability to capture new ideas being developed in the rest of the world. Kruger (1998) argues that countries whose economies are relatively more insulated from international trade do seem to fall behind in production technique, quality, and other attributes of production associated with knowledge. Romer (1992) have concluded that countries that are more open have a greater ability to absorb technological progress generated in leading nations. Grossman and Helpman (1990) argue that the trade liberalization helps in knowledge spillover between exporter and other domestic producers in the economy.

Trade liberalisation brings technology spillover through adaptation and imitation. The country that imports capital goods or machinery tries to imitate the same technology. This technological spill over will lead to cost reduction and thus raises the competitiveness of the firm/economy. In addition, with import liberalisation, firms are under pressure to sell the quality products at the cheaper price (or forcing them to be more competitive). This competitive pressure will ultimately result in innovation by the domestic firm that will leads to higher competitiveness of the firms in the economy.

This shows that there trade liberalisation can be a vehicle for attaining competitive strength to the firms. The trade liberalisation programme initiated by the government of India can be expected to help industries attain higher competitiveness. Therefore, we will examine the impact of trade liberalisation on the export competitiveness of machine tool industry in India. As a background of the analysis we will examine the nature of trade liberalisation in India and some of the empirical studies on the issue of competitiveness in the capital good and machine tool industries.

### 3.3 Trade Liberalisation and India's Machine tool Export Competitiveness

India's trade and industry regime was considered to be one of the most restrictive in Asia, characterised by severe nominal tariff and non-tariff barriers[48], heavy controls and restrictions on industrial activities. To partially offset the negative effects of high protection and regulation, government of India introduced various export incentive schemes like exemption from import licensing, use of import duty drawback, reduced foreign exchange restrictions, and export finance at levels below domestic interest rate. But the lack of depth of coverage and cumbersome procedure of these measures made them less effective and export activity remained mainly unprofitable (ICICI, 1985).

In order to modernise the industry and improve its efficiency an initial step towards liberalisation took place during the mid 1980s[49]. Although the process of relaxation of regulation of industry began in the early 1970s and of trade in the late 1970s, the pace of reform picked up significantly in 1985 onwards (Panagaria, 2004). The basic trait of

[48] India's trade regime was characterized by stringent tariff structure. The import tariffs are collected under the India tariff (second amendment) Act, 1954; custom Act, 1962; and Custom Tariff Act, 1975. The tariff has three components. A) Basic duty - This is usually levied on ad valorem basis, B) special duty levied on the basic duty and special additional duty having regard to the maximum sales tax, local tax or any other charges imposed on a like article on its sale or purchase in India and C) countervailing duty equal to the excise duty on similar, domestically produced goods as well as any surcharge thereon (Kumar, 2004).

[49] For discussions of the pre-1970 period, see Bhagwati and Desai (1970) and Bhagwati and Srinivasan (1975).

liberalisation in the 1980s include, a steady expansion of the OGL list[50], decline in the share of canalized imports[51] from 67 to 27 percent during 1980-87, significant expansion of several export promotion policies and finally significant relaxation of industrial controls and related reforms[52]. Still, restrictions were placed on the working of these instruments. For example, capital goods under OGL can be imported but the importing firm had to be the "actual user" of the equipment and could not sell the latter for five years without the permission of the licensing authorities and that the resulting change in capacity must be compatible with the capacity approved by the industrial licensing authorities (Sen and Chand, 1999).

These policies were further carried out in a more systematic manner in the 1990s. Trade liberalisation process gradually relaxed the regulation on imports, reduced tariff levels considerably on all items and removed most quantitative restrictions on imports and exchange rate controls. The import duties were drastically reduced from a high of 130 percent in 1991 to 20 percent in 1997 (Sutton, 2000). In the case of capital goods, apart from reducing tariff and non-tariff barriers several concessions for imports of capital goods under various schemes were introduced. These are Export promotion capital good scheme (EPCG), concession for import of capital goods for firms operating under Export Processing Zones (EPZs), and a reduction in the import duties of capital goods.

The machine tool industry was one among the major capital good industries to be freed from the severe state controls and regulation. The industry was de-licensed in 1991 and private parties were encouraged to enter the market. The already established firms began to face increasing competitive pressure from the emerging players in the domestic market and foreign imports. This has made domestic manufactures to become highly competitive not only in the domestic market but also in exports. The trade liberalisation has created an environment where machine tool manufactures have to improve not only the price/cost adjustment but also technological capabilities. Since the extent which machine tool exports have been able to achieve competitive strength during the reform period needs empirical support, we carry out this in the next section.

But before the analysis, let us discuss some of the existing studies on capital goods (machine tools) export from India.

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[50] The number of capital goods items included in the OGL list expanded steadily reaching 1007 in April 1987, 1170 in April 1988 and 1,329 in April 1990.

[51] Canalization refers to monopoly rights of the government for the imports of certain items.

[52] A detailed account of these reform instruments can be seen in Panagaria (2004)

Competitive performance of capital good sector during the different policy regime has been focus of analysis for many. There are conflicting views regarding the competitive performance of capital goods sector during import substation regime. Bhagwan (1985) observed that under the protective regime, capital good sector was able to diversify and obtained high scale of production. A World Bank (1984) study on selected non-electrical machinery from India concluded that Indian firms were fully competitive by supplying complete plants for cement, sugar and boilers, 80 percent of the machinery for pulp and paper manufacturing. However, Mundle and Mukhopadhyay (1992) showed that Industry as a whole failed to become internationally price competitive mainly because of higher input prices or taxes.

Studies, which have analysed the impact of trade liberalisation on capital goods, have generally found that competitive performance was insignificant. For instance, Marjit and Ray Chaudhuri (1997) have shown that the performance of machinery sector relative to its competitors was poor and liberalisation did not translate into corresponding growth of exports. Srinivasan (1998) showed that during 1979-94 India had an abysmal share in some machinery items, which shows the inability of Indian capital goods to penetrate into the world market when trade in engineering goods was booming at the international level.

Sinha roy (1999) found that capital good export from India did not reveal competitive advantage during 1980-96. This was significant during the early period of the reform were competitiveness was very low or lowered during the period. This showed that trade liberalisation have failed to generate competitive strength to the capital good sector. The finding was in contrast to Sinha Roy (1991) where the author found that the competitive performance of India's capital good exports greatly varied across commodities and witnessed a pattern of change across time.

### 3.4 Machine tool Export Competitiveness: An Analysis

The measurement of competitiveness has been controversial in the applied research. As with the definitional ambiguity of the term, the competitiveness measures have lot of measurement issues.

The competitiveness indicators are basically addressed price or non- price aspects. The basic indicator of cost competitiveness is the unit labour costs, where a relative lower value is expected to provide competitive advantage in the international market[53]. But Fagerberg (1988) and Wignaraja (2003) have highlighted some of the severe limitation of this index[54]. Attributing competitiveness in terms of prices can be misleading especially in capital good sector where markets are generally imperfect. This is significant in machine tool sectors where international competitiveness requires the use of more advanced design and skill in production process.

This highlights that while measuring competitiveness we should account some of the important non-price factors[55]. Since there are a variety of factors involved, the empirical analysts often have resorted to use measures that will be a reflection of these two attributes. One such measure is revealed comparative advantage, which is an ex-post market share measure[56]. Moreover, previous studies, which examined competitiveness of Indian capital good industries, have utilised revealed comparative advantage (RCA) as a reflection of competitiveness.

### 3.4.1 Revealed Comparative Advantage (RCA)

RCA was developed by Balassa (also known as *Balassa Index*) in 1965. Broadly RCA is based on export performance and observed trade patterns[57]. The Balassa index tries to identify whether a country has a "revealed" comparative advantage rather than to determine the underlying sources of comparative advantage[58]. The RCA is defined as a ratio of the share of particular industry (or product) in a country's total exports to the share of the industry's exports in world's total exports[59].

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[53] This can result for any or all of three reasons: wage rate decreases faster than its competitors, a faster rise in labor productivity than in other countries, and finally a currency depreciation relative to that of other countries.
[54] The index considers only the labor cost of production while capital and intermediate inputs may also be significant, it may be distorted due to bilateral trade agreements, tariff barriers and direct and indirect government subsidies. As pointed out by Kaldor, the market share of manufacturing exports and unit values tend to move together in the long run.
[55] The non-price factors consist of a range of variables, which are often difficult to quantify empirically. These includes market knowledge, marketing skills and ability, and ability to adapt products according to demand, product differentiation, productivity growth, reliability, quality, after-sales services, financing arrangements, technological innovation, and investment in physical and human capital.
[56] Siggel, (2006) have noted that there are two types of competitive indicators, ex-ante and ex-post indicators. The former measures such as unit cost, technological capability capture the capacity to compete whereas the latter indicates the result of such competition and often measured by gauging market shares.
[57] Balassa proposed RCA to assess a nation's comparative advantage. Since the theory asserts that comparative advantage should be evaluated on the basis of relative price differences in autarky, which is not directly observable, Balassa suggest that instead one can use trade data. Thus, inferring comparative advantage from observed data is named "revealed" comparative advantage.
[58] Although this index is originally used to measure comparative advantage, there has been apprehension regarding whether the index identifies comparative advantage or competitiveness. According to Siggel (2006) RCA reflect competitiveness rather than comparative advantage because export success is often due to government intervention like subsidies or other incentives provided like exchange rate misalignment.
[59] For a detailed overview and application of RCA approach, see for example, Balassa (1965, 1979), Hoekman and Djankov (1997), and Lee (1995).

In the case of export of machine tool industry from India, RCA is the ratio of the share of machine tool export in India's total exports to the share of world machine tool export in the world's total manufactured exports[60].

Defined as such, the RCA can be presented as:

$$RCA = \frac{X^{i}_{m} / X^{i}_{t}}{X^{w}_{m} / X^{w}_{t}} \qquad \text{----------} \qquad (1)$$

Where

$X^{i}_{m}$ = value of exports of machine tools by India

$X^{i}_{t}$ = value of total manufacturing exports by India

$X^{w}_{m}$ = value of world exports of machine tools

$X^{w}_{t}$ = value of total manufacturing world exports

A rearrangement of (1) gives the following expression:

$$\frac{X^{i}_{m} / X^{w}_{m}}{X^{i}_{t} / X^{w}_{t}} \qquad \text{----------} \qquad (2)$$

Equation (2) s the ratio of India's export share of machine tools in the world's exports of machine tools to the export share held by India in the world's total export of manufactures. That is RCA = (Countries exports of machine tool/ World export of machine tool)/ (Countries total merchandise export / World total merchandise export). Defined as such, machine tool industry exhibit revealed comparative advantage only in those products for which its market share of world exports is above its average share of world exports, i.e., RCA is greater than one.

One of the problems with RCA index is that it is not comparable on both side of unity i.e. the index is asymmetric[61]. One way to overcome this is to use revealed symmetric comparative advantage (RSCA) index (Lapadre, 2006).

$$\mathbf{RSCA} = \frac{(RCA-1)}{(RCA+1)}$$

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[60] RCA can be compared for world or for selected countries. Panchamukhi (1997) emphasized the significance of dynamic comparative advantage on the basis of selected countries.

[61] The index ranges from one to infinity for products which countries have competitive advantage but only from zero to one competitive disadvantage.

This measure ranges from -1 to +1 and is positive if the RCA is higher than one (competitive advantage) and negative if it is lower than one (competitive disadvantage). We have employed RSCA to assess machine tool export competitiveness from 1980-2003. The results are given in table 3.1

**Table 3.1 India's Machine tool Export competitiveness (1980-2003)**

| Year | RSCA | Year | RSCA |
|---|---|---|---|
| 1980 | -0.42 | 1992 | -0.51 |
| 1981 | -0.41 | 1993 | -0.52 |
| 1982 | -0.44 | 1994 | -0.53 |
| 1983 | -0.36 | 1995 | -0.59 |
| 1984 | -0.39 | 1996 | -0.62 |
| 1985 | -0.16 | 1997 | -0.51 |
| 1986 | -0.26 | 1998 | -0.48 |
| 1987 | -0.23 | 1999 | -0.52 |
| 1988 | -0.33 | 2000 | -0.40 |
| 1989 | -0.53 | 2001 | -0.38 |
| 1990 | -0.48 | 2002 | -0.26 |
| 1991 | -0.53 | 2003 | -0.19 |

Note: RSCA= Revealed Symmetric Comparative Advantage

Source: Own calculation based on UNCTAD Handbook of Statistics, online database.

It is very clear from the table that Indian export was not competitive during 1980-2003 and it remained negative for the entire period[62]. The competitive disadvantage of machine tools increased steadily from -0.16 in mid 1985 to -0.61 in 1996. Since the mid 1990s, there is a steady improvement in export competitiveness as it was during this period the export began to show upward trend. The RSCA reached -0.19 in 2003[63].

This shows that the impact of trade liberalisation on imparting competitive strength to the machine tool export has been marginal. It was expected that greater competitive pressure and market opportunity would induce the industry to increase the productive capacity and supply products at the international level without losing its market share. But we have found that policy reforms did not enhance the necessary channels by which liberalisation can increase export performance. Although we haven't examined the underlying instrument of export competitiveness, we can be fairly sure that the Indian

[62] The comparison of RCA over time is often interpreted as an indication of dynamic comparative advantage. A rise in RCA over time suggestive of improving advantage thus revealed (Sinha Roy, 1999).

[63] We were unable to extend the analysis because of non-availability of world export of machine tools and manufacturing exports for the latest years.

manufactures of machine tools have to increase their capability to offer products at quality level. Although technological learning is important, factors such as organisational infrastructure and institutional flexibility may also be very important.

**Table 3.2 Machine tool export competitiveness of major machine tool exporters**

| Year | 1980 | 1985 | 1990 | 1995 | 2000 | 2003 |
|---|---|---|---|---|---|---|
| Germany | -0.54 | -0.59 | -0.79 | 0.28 | 0.28 | 0.29 |
| Japan | 0.21 | 0.34 | 0.32 | 0.46 | 0.49 | 0.51 |
| Taiwan | 0.01 | 0.01 | 0.10 | 0.25 | 0.31 | 0.44 |
| Italy | 0.27 | 0.26 | 0.30 | 0.29 | 0.33 | 0.39 |
| USA | -0.07 | -0.17 | -0.14 | 0.02 | 0.12 | 0.03 |
| Austria | 0.19 | 0.24 | 0.28 | 0.19 | 0.15 | 0.16 |
| Sweden | 0.12 | 0.08 | 0.12 | 0.10 | 0.17 | 0.13 |
| Korea | 0.66 | 0.79 | 0.58 | 0.33 | 0.28 | 0.37 |
| China | -0.31 | -0.78 | -0.37 | -0.46 | -0.40 | -0.47 |
| Argentina | -0.45 | -0.86 | -0.50 | -0.71 | -0.73 | -0.71 |
| Australia | -0.74 | -0.81 | -0.77 | -0.65 | -0.52 | -0.66 |
| Brazil | -0.59 | -0.63 | -0.65 | -0.33 | -0.34 | -0.40 |
| France | -0.09 | -0.26 | -0.28 | -0.25 | -0.30 | -0.23 |
| Spain | 0.20 | 0.04 | 0.11 | -0.06 | -0.06 | -0.04 |
| UK | 0.05 | -0.11 | -0.04 | -0.11 | -0.11 | -0.11 |

Source: Own computation from UNCTAD Handbook of statistics, online database.

In order to assess the relative position of India's machine tool export in the international market, we considered the performance of other major players of machine tools. The table 3.2 shows that OECD countries like Germany, Italy, USA and Austria and Asian countries like Taiwan and Japan have competitive advantage during this period and also Germany and USA have shifted their competitive position over time.

Most of the other countries have low competitive strength showing market concentration, which is a common feature of this industry. China, which is usually described as a major competitive threat to India in the world market have fairly high insignificant RSCA. Since specialisation in different types of products enables every nation to export certain variety of machines, most of the countries find it worthwhile to engage in trade.

**Table 3.3 Rank Correlation Coefficient between RSCA of India and major competitors**

| Year | 1980-1985 | 1985-1990 | 1990-1995 | 1995-2003 | 1980-2003 |
|---|---|---|---|---|---|
| China | -0.6 | -0.89 | 0.83 | 0.32 | -0.29 |
| Argentina | -0.66 | -0.6 | 0.49 | 0.28 | -0.12 |
| France | -0.54 | 0.2 | 0.2 | 0.35 | 0.17 |
| Australia | -0.2 | 0.14 | -0.77 | -0.43 | -0.38 |
| Brazil | -0.2 | 0.83 | -0.49 | -0.68 | -0.38 |
| Spain | -0.66 | -0.14 | 0.71 | -0.08 | -0.13 |
| UK | -0.77 | -0.77 | 0.37 | -0.27 | 0.1 |

Source: Own computation from UNCTAD Handbook of statistics, online database.

Here, it would be interesting to look into the pattern of similarity or dissimilarity of competitive advantage of India and its major competitors. This can be determined by way of rank correlation coefficient[64]. Therefore, we have calculated rank correlation between India and its major competitors and the results are given in table 3.3. The analysis is done for the entire period and three sub periods. The rank correlation for the entire period shows that the pattern of machine tool export competitiveness is similar to that prevailed in china, Argentina and France since 1990 onwards. The pattern of competitive advantage has not been uniform across time and there is a clear shift over time. But these findings have to be treated as only indicative as we know that the nature of industrialisation in India has been very different from most of these countries.

## 3.5 Conclusion

This chapter analysed whether trade liberalisation has resulted in achieving international competitiveness for machine tool exports from India. In the beginning of the chapter, we discussed the issue of trade liberalisation and competitiveness and then provided some plausible link between trade liberalisation and competitiveness. In the case of India, we found that trade liberalisation was initiated during the later part of eighties and got intensified during the nineties. The major instrument of liberalisation of trade has been removal of quotas and other non-tariff barriers and gradual reduction and rationalisation of tariff structure. The basic aim of the changed regime was to provide a better environment for trade and particularly exports.

[64] See Panchamukhi (1997)

In this changed scenario, it is expected that Indian machine tool export become more competitive in the world market. In the earlier chapter we noted that the machine tool exports have responded positively to the reforms. But an examination of export competitiveness reveals that the relative competitive position has remained low during 1980-2003. Although the competitive advantage has shown an improving trend since the latter part of 1990s, generally we can argue that trade liberalisation have not been instrumental in increasing the competitiveness of exports to a significant extent. One positive aspect of export competitiveness has been its changing trend over time, which in turn means that the degree of comparative disadvantage has been coming down over time.

This analysis, although partial points out that a success in a foreign market requires more than a liberal trade regime. There are various issues like infrastructure, knowledge creation where the government can play an important role. Since the machine tool exports, although not competitive, have shown some surge in recent period, it is necessary to implement policies, which can assist the industries to become competitive in the international market. In this process, it is very essential to identify the factors that are influencing machine tool exports from India. Therefore, in the next chapter we will examine empirically the determinant factors of machine tool exports from India.

CHAPTER 4

# DETERMINANTS OF INDIAN MACHINE TOOL EXPORTS

In this chapter we examine the major determinants of machine tool exports from India. The previous chapter showed that there was a significant expansion of machine tool exports particularly after the mid 1990s. An enquiry into the economic factors underlying machine tool export performance would enable us a better understanding of the market scenario. This chapter tries to ascertain the demand and supply factors influencing India's machine tool export during 1980-2005.

The chapter begins with a brief review of the literature regarding the determinants of exports in general and then proceeds to examine the studies in Indian context. An examination of these studies helps us to identify the factors that can be relevant in machine tool export performance. The methodology of the study and estimation procedure is given in the next section. The last section presents the estimation result and summarizes the major findings of the analysis. The appendix to the chapter provides details on the data used in the study.

## 4.1 Export determination: The literature

The examination of possible factors behind a country's export has been an active area for applied research in international economics. Researchers have mainly concentrated on the estimation of the price and income elasticity of exports primarily because of the assumed relationship between export and economic growth[65]. Generally, literature argues that a better export performance is a necessary instrument for better and sustained economic growth. Therefore there has been substantial interest in estimating the major factors that influence countries export of manufactures.

[65] Studies that examined the relationship between export and economic growth are highly controversial and vast. Some have highlighted that export is a catalyst of growth for a number of countries whereas others have made it as a handmaiden of growth. The development of new growth theory and new trade theory further explored the different channels through which trade or export can act as a vehicle for growth. But recent study by Rodrik and Rodriguez (2001) challenged the earlier conclusion regarding the positive association between export growth and economic growth of the earlier studies and remained sceptical about the relationship. For an extensive and critical review of the literature see Edwards (1993) and Krueger, (1998).

The estimation of price and income elasticity comes under the general literature on trade determination. The calculation of elasicities is relevant since the amount of trade adjustments depends on the sensitivity to price and income variations. The elasticity estimation is important because they can be applied directly to many relevant macro-economic policy issues such as the effect of monetary and fiscal policy on a country's balance of payments, the impact of external balance restrictions on domestic policy measures, the international transmission of changes in economic activity, prices and the employment effects of changes in own or partner countries' trade restraints (Algieri, 2004). Apparently, trade determination follows an assessment of the effects of currency depreciation on the current account. The underlying framework is the 'elasticities' approach of trade balances. From an econometric point of view, the elasticities approaches are based on estimating the import and export demand functions and to check whether Marshall- Lerner- (Robinson) conditions holds[66]. If the condition holds, then it is argued that depreciation will have a favourable impact on trade balances. Therefore, a number of studies were carried out to find out the relevant elasticities of world trade.

Most of the literature on estimation of price and income elasticity relate to industrialized countries[67]. The econometric estimations indicate that generally price elasticities fall in a range of 0 to -4.0, while income elasticities fall between 0.17 and 4.5. The literature survey by Goldstein and Khan (1985) found a 'consensus view' that the price elasticity of export demand is generally between -0.5 and -1.0, whether the estimate was for geographically and economically large or small countries, for developed or developing countries, for primary or manufactured exports[68].

Since elasticity varies considerably across countries along with variance in its significance, there is no consensus on the impact of real devaluation on trade balance. The earlier literature that modeled trade in developing countries, for instance, Houthakker and Magee (1969), Khan (1974) found evidence that relative prices play a

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[66] The condition says that, starting from a position of equilibrium in the current account, a depreciation or devaluation will improve the current account only if the sum of the absolute values of the price elasticity's of domestic and foreign demand for imports is greater than unity.

[67] Excellent survey of the literature can be found in Leamer and Stern (1970), Goldstein and Khan (1985), Hooper *et al* (1998) and Senhadji and Montenegro (1999).Among them the survey by Goldstein and Khan (1985) have critically examined the earlier studies on income and price effects in foreign trade and discussed the specification and econometric issues in modelling trade behaviour.

[68] Large bodies of empirical studies (Lipsey 1978, Giovannini 1988, Wolf and Haskel 2000) have shown that price differentials can be surprisingly large for the same product in different countries, as well as between the domestic and export prices of a given product in the same country. So it is possible to estimate finite price elasticity's of demand and supply for most of the traded goods.

significant role in determining exports. This was further supported by recent studies like Reinhart (1995) and Catao and Falcetti (2002). However, Rose (1991) and Ostry and Rose (1992) questioned the effectiveness of devaluation in correcting trade balance. This has cast doubt on the effectiveness of such expenditure switching policies.

Riedel (1984) showed that developing countries face an inverse demand curve for export and therefore could expand export by improving price competitiveness. Senhadji (1998) challenged this argument by empirically proving that Riedel logic suffers from fallacy of composition in that a country can alone increase its market share through devaluation but not all the countries. The debate thus points out the significance of price and income elasticities of developing countries export demand.

Most of the export determinant models incorporate a foreign activity variable (or scale variable) in order to obtain the income elasticity of demand. Typical variables are the weighted average of trading partner income, gross national product (GNP), or gross domestic product (GDP) for aggregate export and export of specific commodities for individual products. Studies have found that, the income elasticity for industrialised countries export is generally positive (Sato, 1977, Goldstein and Khan 1978, Fuke and Holly, 1992 and Muscatelli, *et al*, 1995). It was found to be varying across developing countries (Marquez and Webb, 1988; Arize 1990; Algieril, 2004 and Edwards and Alves 2006). Some of these studies have also accounted for non-price competitiveness like, product differentiation, labour skill, R& D intensity and found interesting results.

Econometric estimates of income elasticity's of export demand indicate that, by and large, it holds empirically (Houthakker and Magee, 1969). Countries whose export growth rates are relatively high are shown to have correspondingly high-income elasticity's of demand for their exports[69]. The income elasticity of export demand could determine, or at least influence, export growth in number of ways, all of which require that export demand to be price inelastic.

Therefore, an assessment of these studies shows that export determination has been an active area of research for long time. Most of the studies have taken price of export, relative price adjusted for exchange rate differential, scale variable like GNP and a productive capacity as

[69] The one-to-one relationship between estimates of the income elasticity of export demand and the rates of growth of exports relative to world income made Krugman to label it as the '45- degree rule (Krugman (1989)).

the relevant factors in the export determination. But there is hardly any consensus regarding the relative merit of these variables. The divergent results arise mainly due to issues in econometric estimation. In this context, there is a need to understand the magnitude of these variables in particular country or industry.

So far the discussion has generally confined to studies in the context of developed countries. But there are valuable and significant source of evidence to substantiate the working of export performance in developing countries. The introduction of trade liberalisation and outward orientation in these countries has ushered in attempts to understand the dynamics of export performance. The Indian scenario is not different. Therefore, the next section will briefly examine the case of export studies in Indian context.

### 4.2 Indian Scenario

Analysis of export performance and its determinants is one of the major areas of research in India, especially since the recent liberalisation episode there is a general eagerness in understanding the prospects of Indian export and policies. The empirical studies have, however, not been able to provide concrete evidence to the already existing debate in the literature.

Generally there are two divergent views regarding India's export performance. The one prominent view considers the influence of restricted trade policy regime and the resulting biases that adversely affected export performance through price (relative) distortion[70]. The second view stresses the irrelevance of relative prices and the relative merit of world demand in India's export prospects. The former emphases the influence of supply capabilities while the latter on external demand conditions. The econometric investigations of export determinants have also failed to reach consensus view regarding the relative merit of demand and supply side factors in India's export performance. These divergent results arise mainly because of model misspecification, econometric techniques and period of analysis (Sinha Roy 2004)

Apart from prices, domestic policies (Panchamukhi, 1978), and domestic production capacity (Ali, 1985 and Arize, 1990) are found to be significant in explaining India's aggregate export performance. Ali (1985), Joshi and Little (1994) and Kareem, (2000) found

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[70] The Estimation of price responsiveness is possible only under single equation methods where export is the dependent variable and price and other non-price factors as the determinants. The moment we introduce simultaneous equation framework the delineation is ruled out since both export and prices appear as jointly depended variable. Nevertheless, estimation of price elasticises in simultaneous equation framework are common due to its policy significance (see Goldstein Khan, 1978, 1985).

that domestic demand has a negative effect on export performance. Virmani (1991) found an insignificant impact of capacity utilisation on manufacturing exports. Studies by Arize (1990), Virmani (1991), Srinivasan (1998) and Sinha Roy (2002) confirm that world income is a decisive factor in India's export although the last two studies noted that the significance tend to vary across products.

Since these studies have produced divergent results and are carried out in different policy context, an examination of some of the significant issues highlighted by them can provide useful insights to our own modelling of machine tool export determination. Therefore, the following section analyses some important empirical works on export determination in India.

### 4.2.1 Studies on Determination of Export from India

Some of the major export determinant studies are as follows.

Riedel (1984) have analyzed India's export performance during 1968-78 while focusing on the supply capabilities of India's export like relative price and domestic demand. He found that domestic condition strongly influence export performance. Relative price was found to be significant in those commodities in which India have strong comparative advantage[71].

Arize (1990) investigated the demand and supply of export behaviour in seven Asian developing countries including India during 1973-85. He found that the demand for India's export is highly sensitive to changes in relative prices. Moreover, the long run income elasticity's was found to be closer to one. This implies that India's exports are treated as luxury goods by their importing countries or that the income elasticises of these countries might be some function of the income elasticity of the exports of the importing countries. The latter results if the exporting product is largely composed of semi-finished products, which are used for manufacturing final products in other countries. In the case supply side, export was found to be responsive to price incentives.

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[71] During 1970s India possessed comparative advantage in ready made garments, carpet weaving, handicrafts and metal products (Riedel ,1984).

Virmani (1991) found evidence on significance of price and world demand elasticity of India's imports and exports, especially manufacturing exports, during the pre reform period. Domestic capacity measured by capacity utilisation was found to be insignificant. He argued that in order to increase and sustain the competitiveness of India's exports, currency devaluation policies should be initiated while restraining inflationary pressure in the economy.

Aksoy (1992) analysed India's export performance during 1970-88 using ordinary least square method (OLS) under a single equation framework. They found that Indian export is more supply constrained. The manufacturing products mainly catered towards home market which limited the incentive to seek foreign demand. Among the policy variables, devaluation was found to have a favourable impact on export. Also, world demand condition was found to have insignificant impact.

Srinivasan (1998) used a non-structural eclectic model for India's export during 1963-94. The export performance was captured by two measures, namely value of India's export in US $ and India's export share in world export. He found that Indian export is price responsive and a real appreciation of rupee can have adverse impact on exports. The coefficient of GDP was positive and significant which indicates that higher GDP increases the capability to export. The world demand was also positive. The time trend variable, which was intended to capture the effect of all other time varying exogenous factors, was negative.

Sharma (2000) under a simultaneous equation framework analysed the export determination of India during 1970-98. His analysis confirmed Joshi and Little (1994) and Srinivasan (1998) contention that India's manufacturing export is elastic to real exchange rates changes. The demand for export was found to have inversely related to relative prices. Higher domestic demand was found to have an adverse effect on export supply whereas relative price hike induces better incentive for the manufacture to supply products in the world market.

A more recent study by Sinha Roy (2004) analysed the determining factors of India's long run export performance, from 1960 to 1999 using an error correction framework. He found that in the long run, the demand side factors have significant influence on India's export performance. The relative price has acted as a necessary condition for export success. He also noted that real GDP have no significant impact on India's export. According to him, liberalisation *per se* is not sufficient for better export growth and there is a need to properly address the incentive system that exporters face.

Most of the above studies have analysed India's export performance at high level of aggregation. Only few have focussed on specific product categories. There are some studies in the context of capital good industries but basically confined to import substitution era. We will examine some of these studies below.

Goldar (1989) analysed the factors behind India's engineering exports from 1969-79 and found that world demand, real exchange rate are crucial determinants. The result also confirmed the previous finding of Harinarayana (1983) that world demand is a major source of growth in India's engineering export and any slowdown in world demand can constrain the future prospect of export growth. The influence of price competitiveness in engineering products was in contrast with Harinarayana (1983) and Riedel *et al* (1984) where they found low price elasticity of demand. The study fails to find any significant influence of productivity on export performance.

Rath and Sahoo (1990) analysed the determinants of India's capital good exports during 1970-88 using three-stage least square method. He found that during this period the capital good export was experiencing better growth and catering towards some of the developed countries. Following Goldstein and khan (1978) methodology they estimated the demand and supply equation using single equation and proceeded to estimate the simultaneous model. They find that the demand for India's capital good export respond significantly to world income than to world prices thus confirming elasticity pessimism with respect to prices. On the other hand, relative profitability was found to have significant impact on export and thus making a favourable case for export subsidy or devaluation.

Sinha Roy (1995) found that Indian export of capital goods during (1970-84) was not significantly determined by world demand or relative prices. R&D expenditure was found to be positive but had insignificant impact on capital good export during this period. This made him to argue that government should follow effective export promotion policies as an instrument to achieve faster and sustained exports growth. Sinha Roy (2004) also found that the relative importance of price and other factors vary across some products.

Kareem (2000) analysed the determinants of India's machinery exports during 1970-87 using OLS under a single equation framework. The specific variables selected for the analysis were world demand represented by OECD real export, domestic demand measured by apparent consumption and Import substitution. At the aggregate level, the

industries examined were power generating machinery other electric, agricultural machinery, office machinery, Textile and leather machine, metal working machines, machines for special industries and machinery and appliances. Kareem found that world demand had a positive and significant impact on non-electrical machinery exports. Although both domestic demand and import substitution got theoretically correct sign the results were not significant for most industries. At a further disaggregate level, it was found that world demand was highly significant for most of the industries; while the influence of domestic demand and import substitution varied across product groups.

The elasticity for world demand was found to be superior to domestic demand and therefore confirms the argument that domestic demand is not a significant determinant of non-electrical machinery in India. This was found to be true on account of import substitution in the industry. The result of electrical machinery exports showed that import substitution had a positive but insignificant impact in most cases. The domestic demand was found to have negative but statistically insignificant impact on export of most electrical machineries. The world demand was found to have decisive impact. The disaggregate analysis also produced similar results.

The literature surveyed has clearly shown that the performance of Indian export is influenced by a variety of factors and unless we examine these different factors into account the result may be biased. The literature has pointed out that there are various demand and supply side factors, although their relative merit is still ambiguous, that can have decisive role in explaining export performance of a country. There are only a few studies that examined the determinants of disaggregate level of exports and there too the case of capital goods or machinery exports from India. An understanding of the influence of various demand and supply factors at much disaggregate level is useful since most often aggregate exports may mask sector specific variations. Moreover, most of the studies at disaggregate level have confined to a period where Indian manufactures key orientation was towards domestic market because of heavy import substitution. This situations has dramatically changed during the period of trade liberalisation were meeting the external demand is considered as a feasible strategy.

As noted in the earlier chapters, there was a significant increase in the machine tool exports since mid 1990s. This export performance can be the result of various demand and supply factors, which need to be explored. Since there are only few studies that have

analysed the determination of machine tool exports in the context of trade liberalisation, the present study is an attempt to empirically examine the factors underlying India's machine tool exports during 1980-2005. But before going to the framework of the analysis, it is essential to identify from the literature the relevant factors that can affect machine tool exports from India.

### 4.3 Determinant of Machine Tool Export- Demand and Supply Factors

The survey of literature showed that India's export performance is influenced by various demand and supply side factors. We expect that some of these factors can have major effect on machine tool export as well. Therefore, in order to empirically estimate the factors determining machine tool exports from India, we have to incorporate both demand and supply factors. Here, we are examining some of the significant variables that can contribute to machine tool export from India. The choice of variables is guided by our previous discussion and industry specific characteristics.

We have identified several demand and supply side factors that can possibly influence the export of machine tools from India. This section briefly summarizes these various demand and supply factors and the method of constructing these variables. Prior to that, we need to clarify the measurement of our dependent variable, i.e. machine tool export.

In this analysis, the machine tool export is expressed in real value term. This is done by changing the nominal export value into constant price series[72]. Deflating the nominal value of machine tool export by unit value index of machine tool export derives the constant machine tool export price series[73]. The machine tool export unit value is obtained by dividing its export value by quantity. The unit value index construction was based on Paasche index. The base year of the unit value index series is 1993=100. The value and quantity data for machine tool export is collected from Monthly statistics of foreign trade of India, published by Directorate General of Commercial Intelligence and

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[70] We can use the value of export as the depended variable as the volume price elasticity of demand is equal to the value elasticity minus one (Goldstein and Khan, 1985).

[73] The choice of price index in international economics is highly controversial. Trade analyst have generally preferred to use unit value indices compared to any other price measures as they are readily available from trade statistics and easy to calculate (Goldstein and Khan, 1985). Unit value index measures the average price of a particular basket in a commodity group. One of the main problem with this index is that, it can be biased when we use it in aggregate trade data and most often overstate price changes since the index is a reflection of changes in prices and quantity. But the issue is less complicated when applied to a single product category like machine tools. For an account of unit value index see (Kravis, and Lipsey, 1971).

Statistics (DGCI&S), Calcutta, and UN COMTRADE, online database provided by UNCTAD, Geneva. An examination of the series confirms our earlier finding of an upward trend in machine tool exports since 1990s (see Appendix A .1).

### 4.3.1 Demand Side Factors

Traditionally, the demand for export has been specified as a function of the country's price competitiveness and a foreign (domestic) activity factor with the assumption of small open economy. The relevant price factor affecting the competitiveness of export is relative price of exports and the scale variable is the world demand. Therefore, in the present analysis we can hypothesize that demand for Indian machine tools in the world market is affected by relative price and world demand. On the demand side, movement in real effective exchange rate captures the relative prices at the international level.

#### a) Real Effective Exchange Rate

In the international market, Indian machine tool producers face competition from domestic manufacture in the importing country as well as from producers of the rest of the world. In this situation, relative price differences of India and its competitor governs the demand for India's machine tools. This relative price advantage is often identified in terms of real exchange rate variation, which is generally defined as the nominal exchange rate that takes the inflation differentials among the countries into account. As per the trade theory, we know that currency depreciation make Indian machine tools cheaper relative to its competitor in the world market. This will raise demand for our product in the world market resulting increased exports, *ceteris paribus*. Therefore, a depreciation of rupee relative to its competitors is expected to increase the competitiveness of the product in the international market[74].

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[74] Bose (1993) argue that, developing countries under a condition of monopoly, the decision to export depend upon export vis-à-vis domestic profitability. Monopolist will sell the product abroad provided the foreign price is marginal cost of expanding production. The relaxation of capacity constraint through de licensing will further improve the capability of domestic monopolist to sell abroad. Thus, liberalization in terms of exchange rate depreciation increases the opportunity cost of domestic sale and provides incentive to sell abroad.

In India, the exchange rate regime changed from a fixed exchange rate regime to a more market oriented managed float regime since 1994. The Reserve Bank of India (RBI) often intruded in the foreign exchange market to maintain a depreciating rupee so that exports become competitive in the world market[75]. As a result, there was a gradual depreciation of Indian rupee over the years.

There are conflicting arguments regarding the role of exchange rate in influencing the export performance in the context of India[76]. Studies by Bhagwati and Srinivasan (1975), Srinivasan (1998) and Sinha Roy (2002), using single equation model showed that Indian exports are highly responsive to changes in relative prices. Arize (1990), Viramani (1991), Joshi and Little (1994) and Sinha Roy (2002) using simultaneous equation framework confirmed this view. But Lucas (1988) and Sarkar (1994) have arrived at a result that shows a varying responsiveness of prices across different products exported. One of the major reasons behind this variation in results across studies was due to the differences in the construction of real exchange rates.

Generally, there are two methods of calculating REER. One is based on purchasing power parity theory (traditional method) and the other one is the based on the distinction between tradable and non-tradable goods (modern approach)[77]. In this study we prefer to use the modern approach as the short run validity of the former approach is often questioned. The rationale behind this definition is that the cost differentials between the countries are closely related with the relative price structures in these economies. It directly captures the incentives that guide resource allocation between the tradable and non-tradable sectors. A depreciation of the REER increases the relative profitability of producing tradable, thereby inducing resources to move from non-tradable to the tradable sector, while an appreciation of the REER has the opposite effect.

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[75] Some author like Helleiner (1994) argue that trade policy and exchange rate policy are distinct. The exchange rate policy is generally used as an instrument for achieving internal and external balance in the economy while the trade policy relates to incentive for production and trade. But this distinction is not apparent in Indian case (Sinha Roy, 2004)). In India, exchange rate policy was mainly concerned with devaluation and trade policy focussed on various incentive schemes like export promotion schemes, replenishment act, duty draw back etc.

[76] These divergent results mainly arise due to the context and framework of the study and the econometric framework adopted. The earlier studies have analysed the impact of relative price in terms of binding foreign exchange constraint. Some other studies have analysed the issue in the context of change in the trade regime. An elaborate discussion of these issues can be found in Sinha Roy, (2004).

[77] For a detailed discussion of these two approaches and relative merits of each of them, see Edwards (1989) and Trivedi (1996).

Under the assumption that price of tradable will be equal across the world, the real exchange rate is defined as,

$$RER = P_t^x / eP_t^w$$

Here, $P^x$ represent price of tradables and is proxied by unit value index of machine tool exports from India. $P^w$ represent price of non-tradables and is proxied by producer price of capital good industries at the world level[78]. e is the exchange rate of the domestic economy with respect to the trading partners economies calculated in terms of numerate as the SDR. This definition takes into account only bilateral trade which problematic as we know that Indian machine tools are exported to number of countries and there are potential competitors to our products. Therefore, to incorporate multilateral trade scenario we have constructed a REER of machine tool exports.

In order to construct the REER, we have first calculated the bilateral real exchange rate with respect to the twelve trading partners of India. The multilateral or real effective exchange rate of rupee is the weighted average of the bilateral rate, were weight being the 1993 share of India's machine tool export for these twelve trading partner countries. Thus, the real effective exchange rate computed represent industry specific real exchange rate as opposed to the general one used in a number of previous empirical studies. The data of producer price series of capital goods are available from Statistical Yearbook, UNCTAD.

The REER for machine tool export from 1980-2005 is shown in figure A.2 in the appendix. An examination of the movement of real exchange rate reveals that its pattern has been different from the general macro level exchange rate as it is showing significant appreciation, with fluctuation till 1996. Since then, the rate has been continuously depreciating and we have to note that it was during this period a real upward trend in machine tool exports have taken placed.

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[78] We have to rely on producer price of capital goods instead of machine tools as the latter is not readily available for most of the countries. Another proxy was to use import unit value of major trading partners of India. But this was also avoided, as there was no time series data on machine tool quantity since 1980s for various countries.

**b) World demand**

Apart from relative price effect, the demand for India's machine tool export is also affected by external demand condition. In a protected regime, export pessimism was prevalent as it was believed that the nature of demand from the advanced countries may not be conducive for the growth prospects of Indian machine tools. This has been significantly changed with trade liberalisation, as it is believed that every nation can find something worthwhile to produce and sell in the international market and external markets may not be a major constraint. This is true in the case of machine tool also, as there is considerable scope for product specialisation. In the previous chapter, we noted that we are catering to the need of simple machines by the advanced OECD countries, which are far superior in the production of advanced machines.

Although theoretically sound, in practice we can see that countries often impose restrictions and other impediments to the flow of commodities from developing countries like India. It is widely known that developed countries preserve their market with tariff and non-tariff barriers. Although significant improvements have occurred, since the setting up of WTO in 1995 market access conditions in developed countries continue to be a major determinant of India's exports opportunities (Trade and Development Report, 2006). The growing number of free trade agreement and trade blocs like EU and NAFTA, which limit entry to non-members, also supplements this. Here, location advantage plays a critical role, as countries at the centre of a fast growing region are more likely to benefit, ceteris paribus, than countries situated outside that region[79]. This can also influence the demand for machine tools from India.

The economic theory assumes that world income can have a positive or negative effect on the export of domestic economy but usually we assume it is to be positive[80]. That is, higher the level of foreign real income, larger would be the foreign demand for a countries export, *ceteris paribus*. The choice of measurement of level variable has often varied across studies. The income elasticity of demand is expected to differ according to level of aggregation and nature of product (Kareem, 2000). Generally, three income measures are used in the literature, GNP or GDP, industrial production, world real

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[79] There is growing amount of literature that discusses the role of geographic proximity as the basis of trade See Overman *et al* (2001), for an elaborate discussion.

[80] World income will have a negative impact on a countries export if the increase in world income were associated with a faster growth of production than consumption of importable. This can result if exports of a country are a residual demand for the rest of the world (Goldstein and Khan, 1978).

export or import of major export destination of particular products. In this study, we have used the total world export of capital goods as a proxy for world demand for India's machine tool export. This will indicate the rate of expansion of different markets and the distribution of India's export of machine tools in these markets.

In order to construct the index, we have selected 22 major capital good export destination countries of India in 1993. These countries are selected from different region[81]. The countries were grouped into five regions, namely European Union, North America, Asia and Oceania, Asia and Africa. The first three regions represent OECD and the last two the developing countries. Since the structure of demand is different in these regions we have normalized the series using export share as weights. That is, the total capital good exports of these regions were weighted according to the relative share of each region in India's export basket during 1993. The world demand for machine tool is represented by the aggregate of these weighed series. The data on capital good industry, which corresponds to 71, 72, 73 codes under SITC rev2 and 3 were collected from UN COMTRADE online database provided by UNCTAD. The figure A. 3 in the appendix shows that world demand for machine tool exports have increased steadily during 1980-2005. Therefore, we expect that world demand to have a positive impact on machine tool exports from India.

### 4.3.2 Supply Side Factors

In the empirical literature, there is a great deal of controversy in modelling export supply function. Not surprisingly, most of the previous studies have not considered the supply variables explicitly and assumed an infinite elasticity of supply (Sinha Roy, 2004). Generally, the supply capability of export depends upon the development strategy adopted by the government. On the supply side, we identify the following variables affecting machine tool exports.

#### a) Relative Price

On the supply side, the export decision depends upon relative price changes, i.e.; export price relative to domestic prices. This reflects the relative profitability of selling foreign markets. We expect that an increase in the relative price will have a favourable impact on

[81] These countries are Australia, Brazil, Canada, China, France, Germany, Italy, Indonesia, Japan, Kenya, Korea, Malaysia, Netherlands, Pakistan, Singapore, Spain, Sweden, Switzerland, Thailand, Turkey, UK and USA. In country selection, we have excluded OPEC region because of data discontinuity since 1980.

the incentive for machine tool manufacturers to engage in exports i.e., the ratio should be above unity[82]. On the other hand, a better domestic price reduces this incentive and domestic manufactures will be interested to meet domestic demand, *ceteris paribus*.

Goldstein and Khan (1985) showed that relative price plays an important role in the export demand function for developing countries. The price elasticity was high for total export and disaggregates exports. Sato (1977) and Funke and Holly (1992) challenged this view by showing insignificant role of price elasticity among most of the industrialised countries. The elasticity was found to be varying across countries. For developing countries, Goldstein and Khan (1982) found significant price responsiveness for their exports. But later study by Khan and Knight (1988), Riedel (1988), and Panagariya (2001) did not find any conclusive support for this claim.

The relative price in the supply side is the ratio of prices of machine tool export to domestic prices ($P^x/P^d$). The price of machine tool export is measured by the unit value index and the domestic price by wholesale price of machinery and machine tools. Both are at 1993=100 base year. The wholesale price series are available from office of the Economic advisor, Ministry of commerce, Government of India. An examination of relative price movement of Indian machine tools shows that the ratio was above unity for most of the period, but is showing a declining trend since the late 1990s (see figure A 4 in the appendix). We hypothesis that relative price of export to have a positive impact on machine tool exports.

**b) Domestic Demand**

Since most of the studies on Indian export have not reached a consensus on the importance of relative prices, several empiricists have taken non-price factors into account. A significant factor, especially in the context of India is the level of domestic demand pressure. When domestic demand pressure increases selling at home market becomes more profitable than selling abroad, and that this higher profitability is not fully accounted by relative price movements (Goldstein and khan, 1985). Apart from that, the domestic demand also signifies the cyclical effect into the analysis. The hypothesis is that during high domestic demand pressure, firms will operate at full capacity and will export little, while during domestic recession capacity utilisation will be low and firms will attempt to export machine tools as much as possible.

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[82] Theory shows that under perfect competitive markets, an improvement in export supply is ensured when the relative price ratio is above unity. When market is distorted and less competitive, a greater than unity implies mark up for the domestic manufactures.

In this analysis we measure domestic demand for machine tool by the apparent consumption for Capital goods[83]. The apparent consumption is measured by deducting capital good exports from total absorption of capital goods (Production + Import). The production data is collected from Annual survey of Industries (ASI) and the trade data is collected from UN COMTRADE, *online database*. It is expected that apparent consumption would be lower at the time of low domestic demand and hence enhance machine tool exports. Figure A.5 in the appendix shows that, domestic demand for machine tools have significantly increased during the 1990s.

**c) Technological Capability**

One important factor affecting the supply capability is the technological capability. Technological development can enhance export because it improves productive capability and efficiency, expand product base, and improve overall competitiveness (Sinha Roy, 2004). Since machine tools are diverse in terms of designs and specification, competent skilled engineers are required to produce machines according to user specification. Technological capability in machine tool industry includes the selection of new technology, its implementation, the operation of the production facilities so implemented, their adaptation and improvements, the potential to develop new process and products. Therefore, we hypothesise that technology development will have a positive impact on machine tool exports[84].

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[83] Kareem (2000) has also used apparent consumption for measuring domestic demand pressure in his analysis of determinant of machinery export from India during 1970-87.

[84] The role of technology on trade or export pattern is an integral part of international economic research. There are significant theoretical and empirical work, both for developed and developing countries on the relationship between technology and trade. One of the earliest recognition of technology on trade pattern can be found in Ricardo's Law of comparative advantage, where it is predicted that trade among countries occur due to technological differences (productivity or skill differences). The research on technology and trade was further reinforced by the work of neo-technological theories originated from the work of Posner (1961) technological gap theory and Vernon's (1966) Product gap theory. The new trade theory and growth theory have highlighted the role of innovation in explaining the evolution of trade flows and export (see Young, (1991), These theories emphasized the importance of innovation in developing new products and processes making the industry technologically competitive in world market. Therefore, the technological characteristics of a sector have a key role in influencing export performance. Empirical studies have generally found that technological development have a positive impact on export performance. For an excellent survey of the literature on trade and technology see among others, Hughes, (1984) and Krugman (2000).

To capture the technological capability of machine tool sector we have taken two indicators, R&D intensity and skilled workforce in the industry[85]. We have taken R&D intensity as an indicator of innovative effort, which can provide new and varieties of differentiated product as well as improve the quality of the existing product for export. The R&D intensity is measured by taking the share of R&D expenditure incurred by machine tool sector in total production. The data on R&D expenditure is available from R&D statistic, published by Department of Science and Technology (DST).

In order to supplement the technology capability, we have taken skill intensity to represent the number of skilled labourers in machine tool sector. As discussed earlier, the nature of technology in machine tool sector requires competent engineers and workers and therefore the presence of highly skilled workers can improve the product, which is being exported. The accumulation of knowledge and skill through formal education or on-the job training can improve the design and learning capability in this sector. Here to measure the skill intensity in machine tool manufactures we follow the method adopted by Bosshardt and Vishwasrao (1999). They defined skilled manpower as the percentage of skilled workers to unskilled workers. It is proxied by (Employees-Workers)*100/Employees. Data were collected from Annual survey of Industries (ASI). The proportion of skilled workforce in total labour force has remained at around 30 to 35 percent during the same period (see figure A. 7 in the appendix). We expect that both these factors to have a positive impact on machine tool export[86].

**Policy factors**

The supply of machine tool export is directly related to the policies adopted by a country. We expect that trade liberalisation in the form of removal of tariff and non tariff barriers will help domestic machine tool manufactures to expand their scale and provide an incentive regime which encourage export orientation. In this study we have taken 1985 as the year in which trade liberalisation started because it was during this period the government began to introduce liberal trade regime. This is particularly true for machine tool sector as during this period, the tariff structure and import duty for capital goods were rationalised and new instruments for export promotions were initiated. Recent studies on India's trade regime by Sinha Roy (2004) and Veeramani (2002) have

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[85] We could also have taken foreign direct investment or technology imports and output measures like patents to represent technological capability in machine tool sector. But due to lack of data availability we discarded this idea.

[86] Studies which examine the impact of technology on trade flows have generally taken R&D expenditure or patent as independent variable (see Lall 1986), Kumar, and Siddharthan, (1994). There are specific studies which investigated the influence of skilled workforce on trade pattern. Some interesting empirical works are Keesing (1966), Findlay and Keierzkowski (1983).

also taken 1985 as the benchmark. Therefore, to capture the effect of trade liberalisation on machine tool export performance we use a dummy variable, that takes value zero for the year prior to 1985 and one thereafter[87]. That is, $D85_t = 1$ if ≥1985 otherwise 0.

### 4.4 Estimation

The analysis of export determination usually confine to two different types of models[88]. One is perfect substitution model where it is assumed that domestically produced goods are perfect substitutes for foreign goods. This assumption is highly restrictive, as we know that the world market is characterized by the presence of bilateral or multilateral trade and imports as well as domestic production generally coexist[89]. Moreover, if goods were perfect substitutes we can observe three possibilities, one foreign/domestic good in the market, second the existence of law of one price and finally no two-way trade among countries. Clearly empirics do not confirm any of these characteristics.

Therefore, we follow the second choice, i.e. the Imperfect Substitute model, which gives a better account of trade among manufacturing goods. The imperfect substitute model assumes that import and exports are not perfect substitute for domestic good. That is, in a simple two-country world, each country produces a single tradable good that is an imperfect substitute for the good produced in the other country (Goldstein and Khan, 1985)

The main features of the imperfect substitute's model can be summed as follows. Along with the standard consumer theory of utility maximization, it is supposed that the economic agent maximizes his utility subject to a budget constraint. Therefore, the resulting demand functions for exports and imports describe the quantity demanded as a function of the level of monetary income in the importing country, the imported products own price, and the price of domestic substitutes. The model predicts that imperfect substitutability between domestic and export product enables domestic and export prices to differ from one another (Goldstein and Khan, 1985).

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[87] Measurement of trade liberalization is often encountered with methodological issues. The usual practice is to quantify it in terms of outcome measure such as trade intensity (share of total trade in GDP) or trade restrictions such as tariff or non-tariff barriers. These measures are highly problematic and difficult to measure. Rodrik and Rodriguez (2001) argue that openness measures are highly correlated with other economic variables in the regression equation. Simple tariff averages underweight high tariff rate because the corresponding import level tend to be low. If tariff and non-tariff barriers are substitutes, simple tariff averages will be a poor proxy. This has made researchers to use dummy variables, which reflect structural change resulting from trade policy changes.

[88] For an elaborate discussion regarding these models, see Goldstein and Khan, (1985).

[89] According to Goldstein and Khan (1985) perfect substitution model mainly serves to analyze trade among primary commodities.

**Specification of the model**

The determinant of machine tool export is analysed according to the imperfect substitution model framework outlined by Goldstein and Khan, (1985). The determinant of machine tool exports includes both demand and supply variables. The model can be presented as

$$MTEX_t = f(REER_t, WD_t, RP_t, DD_t, RD_t, SK_t) \quad \text{---------- (1)}$$

Where,

$MTEX_t$ = Total real machine tool exports from India.

$REER_t$ = Real effective exchange rate (1985=100)

$WD_t$ = World demand

$RP_t$ = Relative price in (1993=100)

$DD_t$ = Domestic demand

$RD_t$ = R&D intensity

$SK_t$ = Skilled labour force

t = denotes time.

Under a single equation framework, the determination of machine tool export includes both supply and demand variables. In the trade literature there is controversy regarding the appropriate choice of functional form in modelling trade behaviour[90]. Generally a log linear model is preferred due to their generally superior fit and ease of interpretation (Kareem, 2000). Therefore, we use the logarithmic transformation of the model.

The estimated model is

$$ln\ MTEX_t = a_0 + a_1 ln\ WD_t + a_2 ln\ REER_t + a_3 ln\ RP_t + a_4 ln\ DD_t + a_5 ln\ SK_t + a_6 ln\ RD_t + \mu_t \quad \text{---------- (2)}$$

Since we are taking the log of the variable the estimated coefficient represent relevant elasticity's. We expect that $a_1 > 0$, $a_2 < 0$, $a_3 > 0$, $a_4 < 0$, $a_5 > 0$, $a_6 > 0$.

We can see that in this model specification there are two endogenous variable, real export and prices. It is argued that failure to account for this endogeneity will give rise to simultaneous equation bias in the estimation[91]. In these circumstances, we cannot relay on simple OLS method. This requires that we take into account the simultaneity problem

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[90] See Houthakker and Magee, (1969) and Goldstein and Khan (1985)

[91] This arises because the export volume and price in the demand and supply relationship are correlated with the error terms. Domestic prices, wages and the exchange rate may also be endogenous. Export growth can affect the exchange rate, which in turn affects inflation and wages (Edwards Alves 2006). Thus, single-equation estimates of the price and income elasticities can be a weighted average of 'true" demand and supply elasticities and therefore can be biased downward (Goldstein and Khan, 1985).

and estimate the model using any of the two methods. One, solve the model to obtain reduced form, and then estimate by OLS. An alternative approach is to use simultaneous equations method. The most common estimation procedures are two-stage least squares (2SLS) or Three-stage least square (3SLS). We have used the latter approach.

The theoretical specification of machine tool export model in a simultaneous framework is developed using an equilibrium approach introduced by Goldstein and Khan (1978). In this model, machine tool export demand and supply are simultaneously determined. The demand for machine tool export is specified as

**Export demand** $MTEX^d_t = f(REER_t, WD_t)$ ---------- (3)

Here, $MTEX^d$ is real machine tool exports demanded, REER = $\frac{P^x}{eP^w}$ is the real effective exchange rate measured in terms of $P^x$ price of machine tool export, $eP^w$ as exchange rate multiplied world price of capital goods.

Equation 3 can be re-written as

$$MTEX^d_t = f(P^x_t / eP^w_t, WD_t) \quad \text{---------- (4)}$$

$$or\ MTEX^d_t = h(P^x_t, eP^w_t, WD_t) \quad \text{---------- (4a)}$$

The logarithmic transformation of the model gives

$$ln\ MTEX^d_t = a_0 + a_1 ln\ P^x_t + a_2 ln\ eP^w_t + a_3 WD_t + \mu_t \quad \text{---------- (5)}$$

Since equation 5 is specified in logarithms, $\alpha_1$+ $\alpha_2$ and $\alpha_3$ are (relative) price and income elasticites of machine tool export demand. In the estimation, we can expect

$\alpha_1 < 0$, $\alpha_2$, $\alpha_3 > 0$ i.e., $\alpha_1$ be negative and $\alpha_2$ and $\alpha_3$are positive.

The machine tool export supply is specified as a function of relative prices, domestic demand and supply capability measured by technology. The export supply function can be written as

**Export supply** $MTEX^s_t = f(RP_t, DD_t, RD_t, SK_t)$ ---------- (6)

Here $MTEX^s_t$ is the machine tool export supplied; RP is the relative price of machine tool exports expressed as price of machine tool export relative to domestic price ($P^x$/ $P^d$), DD is the domestic demand and T is technology measured by R&D intensity and skilled workforce (RD and SK).

Equation 4 can be re-written as

$$MTEX^s_t = f(P^x/P^d_t, DD_t, RD_t, SK_t) \qquad \text{---------- (6.a)}$$

In a log linear form,

$$ln\ MTEX^s_t = \beta_0 + \beta_1 ln\ P^x_t + \beta_2 ln\ P^d_t + \beta_3 ln\ DD_t + \beta_4 ln\ RD_t + \beta_5 ln\ SK_t + v_t \quad \text{-------- (7)}$$

with $\beta_1, \beta_4, \beta_5 > 0$ and $\beta_2, \beta_3 < 0$

The simultaneous estimation requires the equation to be normalized with respect to prices (Goldstein and Khan, 1978). Therefore, the inverse supply function is

$$ln\ P^x_t = \gamma_0 + \gamma_1 ln\ MTEX^s_t + \gamma_2 ln\ P^d + \gamma_3 ln\ DD_t + \gamma_4 ln\ RD_t + \gamma_5 ln\ SK_t + v_t \quad \text{------ (8)}$$

$$\text{Where } \gamma_0 = -\frac{\beta_0}{\beta_1},\ \gamma_1 = \frac{1}{\beta_1},\ \gamma_2 = \frac{\beta_2}{\beta_1},\ \gamma_3 = \frac{\beta_3}{\beta_1},\ \gamma_4 = -\frac{\beta_4}{\beta_1},\ \gamma_5 = -\frac{\beta_5}{\beta_1}$$

Since, $\beta_1, \beta_4, \beta_5 > 0$ and $\beta_2, \beta_3 < 0$, we expect that $\gamma_1, \gamma_2, \gamma_3 > 0$ and $\gamma_4, \gamma_5 < 0$.

In this model we assume that real export and prices get determined simultaneously when demand equals supply. That is there are no adjustment lags in the system and the equilibrium values are determined instantaneously.

$$\text{In equilibrium,} \qquad MTEX^d_t = MTEX^s_t = MTEX_t.$$

For estimating empirically the determinants of machine tool exports during 1980-05, we will use OLS for equation (2) and 3SLS for equation (5) and (8). The OLS is the estimator of the regression intercept and slopes that minimizes the sum of squared residual. If the classical regression properties are not violated, this estimate will produce efficient and unbiased estimates. Since the OLS method is biased in the presence of simultaneity and there is significant reason to believe that there are significant correlations among equation, we employ simultaneous equation framework and employ 3SLS[92].

[92] Morris and Khan (1978) based on an equilibrium model in an imperfect substitute framework, estimated the export determination model for eight industrialized countries during 1950-70. He adopted a full information maximum likelihood estimation procedure. Since we are following the same framework, we prefer to follow Three stage least squares 3SLS which is asymptotically full information maximum likely hood method (see Morris and Khan, 1978; and Goldstein and Khan, 1985 for the advantage and disadvantages of using 3SLS).

3SLS involves the application of generalized least square estimation to the system of equation, each of which has first been estimated by (2SLS). The estimation procedure involves three stages. In the first stage, the reduced form of the model system is estimated to obtain the instruments. The fitted values of the endogenous variables are then used to get 2SLS estimates of all the equation in the system. Once the 2SLS parameters have been calculated, the residuals of each equation are used to estimate the cross equation variance and covariance. In the final stage, generalized least square parameters are applied in the estimate of the error variance covariance matrix (Pindyck and Rubinfeld, 1991).

3SLS takes into account both (a) cross correlation between error term in different equation and (b) the predetermined variable omitted from the equation being estimated may also be omitted from other equation from the system in the estimation (Mukherjee *et al*, 1998). Compared to 2SLS, 3SLS are more consistent and efficient as it uses the covariance matrix of disturbances leading to smaller standard errors. Also, 3SLS is asymptotically full information maximum likelihood estimators.

### 4.4.1 Estimation Results

The estimation results using single equation method and simultaneous equation method are given in table 4.1, 4.2 (a) and 4.2 (b) respectively. In the first case, we have estimated the export determination model using OSL disregarding the simultaneity bias. The estimation model is equation (2). The estimation results are provided in table 4.1.

**Table: 4.1 OLS estimation results**

| Variable | Coefficient |
|---|---|
| WD | 0.96 (1.85) ** |
| REER | -1.2 (2.79) ** |
| RP | -0.03 (0.07) |
| DD | 0.55 (1.57) |
| SK | -0.31 (0.25) |
| RD | 0.10 (0.77) |
| D85 | 0.19 (0.70) |
| $R^2$ | 0.92 |
| D.W | 1.23 |

** Significant at 5% level
Figure in parenthesis are *t* statistic

The estimation result shows that the model is able to explain 92 percent of variation in the dependent variable. The test on autocorrelation based on DW static showed that it fall under non-conclusive region and therefore the presence of serial correlation couldn't be confirmed. An examination of the coefficient reveals that only world demand and real

effective exchange rate are significant (at 5 percent level)[93]. The income elasticity of export is close to unity (0.96) implies that a 10 percent increase in world demand leads to 9.6 percent rise in India's machine tool export. This result indicates that demand factors are significant for machine tool exports.

But as we explained earlier, the presence of simultaneity among the variables may lead to biased and inconsistent OLS estimation results. This may be the reason why we obtained wrong sign for some of the coefficients. Therefore, by explicitly taking into account the simultaneity relationship, we estimated the export determination model using 3SLS and the results are given in table 4.2 (a) and 4.2(b).

**Table 4.2 (a) Coefficients of 3SLS Estimation (Demand) Dependent Variable: MTREX**

| Variable | Coefficient |
|---|---|
| $P^x$ | -2.11 (7.03) ** |
| $eP_t^w$ | 1.13 (3.42) ** |
| WD | 0.75 (0.38) ** |
| D85 | 0.58 (1.97) ** |
| $R^2$ | 0.83 |
| D.W | 1.79 |

** Significant at 5% level
Figure in parenthesis are t statistic

The table 4.2 (a) indicates the estimated result of machine tool export demand (equation 5). The model was able to explain 83 percent of variation in the depended variable. The result shows an improvement over the OLS estimation. All the variables have expected signs and are significant at five percent level. The coefficients of relative price was found to be more than unity which signify that a 10 percent depreciation of real exchange rate relative to its trading partners will increase India's machine tool exports by 11 percent. The coefficient of the scale variable is less than unity (0.8 which is lower than 1.0 in the OLS estimation), implying that a 10 percent increase in world demand increase machine tool exports by 8 percent. Also, the liberalisation dummy is significant which reveals that policy shift has induced a favourable impact on the demand for machine tools in the world market.

[93] Since the variables we have included in the model corresponding to theoretical formulation, the relevant test is one tailed. That is, we are particularly interested in the sign of coefficient and t statistic. For instance, if we are testing the inverse relationship, to reject Ho against the negative alternative we must get a negative t statistic. A positive t ratio, no matter how large provides no evidence for the alternative (For more discussion see, Wooldridge (2003).

**Table 4.2(b) Coefficients of 3SLS Estimation (Supply) Dependent Variable Px**

| Variable | Coefficient |
|---|---|
| MTREX | 0.68 (1.28) |
| $P^d$ | 1.20 (5.21) ** |
| DD | 0.52 (1.15) |
| SK | -0.56 (1.47) * |
| RD | 0.09 (1.3) |
| D 85 | 0.21 (1.23) |
| $R^2$ | 0.84 |
| D.W | 1.79 |

** Significant at 5 % level,* Significant at 10 % level
Figure in parenthesis are t statistic

An examination of supply equation reveals that the model was able to predict 84 percent of variation (see table 4.2 (b)). The result shows that all variables except R&D intensity has the expected signs but only domestic price and skilled variables are significant at 5 and 10 percent respectively. The machine tool export is found to be responsive to the domestic prices and an improved domestic profitability can have a significant deterrent to the incentive for domestic manufactures to go for export markets. Along with other factors, the significance of skilled workforce (although at 10 percent level) is noteworthy. This result shows the importance increasing the supply of trained workers to improve the technological base of the industry so that export supply can be sustained in the long run. Lastly, if we look at the respective price elasticities of machine tool exports, we can see that exports have been significantly responsive in the demand side as evident from the table 4.3.

**Table 4.3 Price Elasticity of Machine tool Exports**

| Price Elasticity of Demand | Price elasticity of supply |
|---|---|
| -2.1 | 1.5 |

The estimation clearly shows that the export performance of machine tool industry can be explained by the demand side factors such as relative prices at international market and world demand and technological competence in terms of skilled workers. The result also indicates the predominance of demand side factors over supply side variables in explaining machine tool export performance. The changed policy regime was found to have reduced constraints in the demand side by way of correcting real exchange rate misalignments. Currency depreciation is found to have notable impact on improving the export performance and competitiveness of machine tools. A depreciating currency along with growing demand can help Indian manufacturers supply machines in the world market. This

confirms the findings of the earlier studies like Goldar (1989), Rath and Sahoo (1990) and Kareem (2000) for capital or engineering good industries and Virmani (1991) Srinivasan (1998), Sharma (2000) and Sinha Roy (2004) for aggregate export industries that world income and exchange devaluation are significant determinant of Indian Exports.

At the supply level, the industry has to improve the technological profile by way of supplying and training quality workers so that machine tool manufactures can meet the changing demand from the user industries. Since machine tool is technology intensive especially in designing and precision of tools, apart from in-hose R&D, the skilled workers are needed to improve and develop better products. In order to sustain the export market and to increase the market share the industry has to increase its technological competence. In a liberalised regime, the government can also assist industries by way of building quality education system and necessary infrastructure which can lead to better linkages between various institutions.

### 4.5 Conclusion

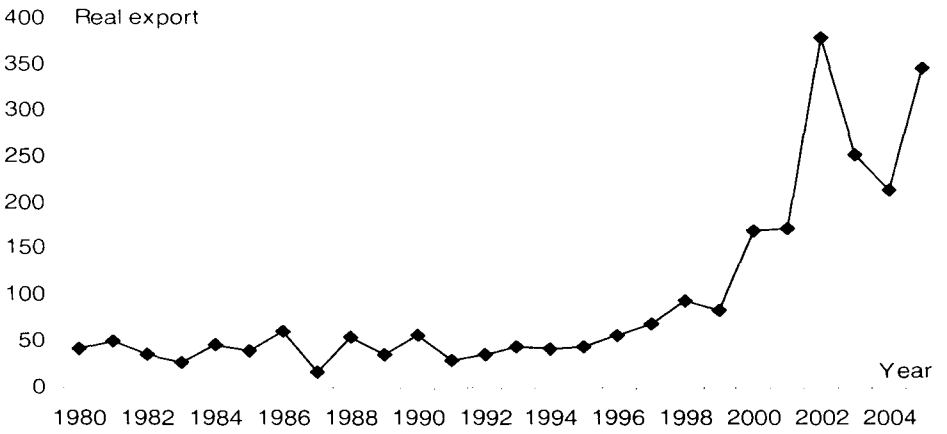
In this chapter, our aim was to analyse the factors behind India's machine tool export performance, especially in the context of trade liberalisation from mid 1980s. The review of literature and past studies on India's export performance showed us that export performance of a country has to be understood by properly delineating the demand and supply side factors. In the Indian context, most of the empirical studies; some of them being fairly aggregate in nature, have failed to focus on this and employed single equation method of estimation. In view of the simultaneity bias, we estimated demand and supply equation of machine tool exports using 3SLS and adopted the methodology of Goldstein and Khan (1978).

The results indicate the importance of demand side factors in Indian machine tool exports. Among the various supply variables, the influence of skilled workforce and domestic price were found to have significant influence while the export price and domestic demand were insignificant. The analysis also shows that trade liberalisation has acted as a major instrument in the export performance through correcting the distortion in the exchange rates. This indicates that, since demand is income elastic, any attempt to promote exports, either by means of subsidies or by lower domestic cost to make exports more competitive, results in enhanced export earnings. Given the demand condition, a better export performance of machine tools depends upon the improved price superiority and technological improvements.

# ANNEXURE - II

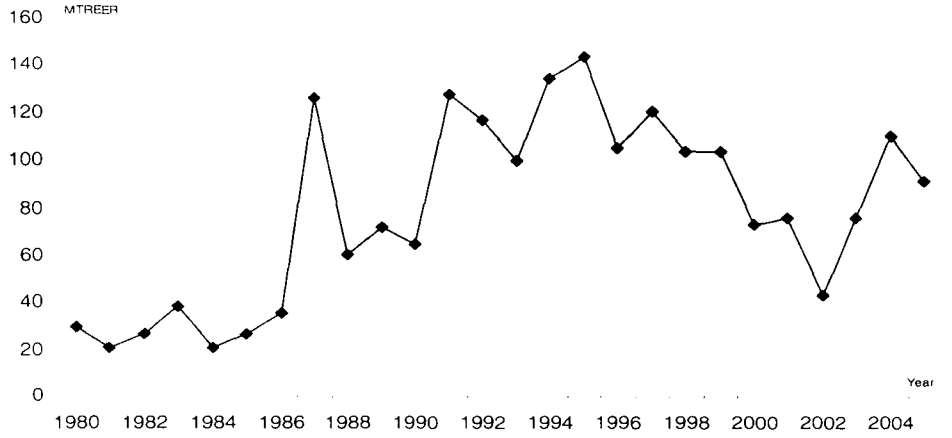
## Determinant of Machine tool Exports

### Figure A 1: Machine tool Real Export (1980-2005)



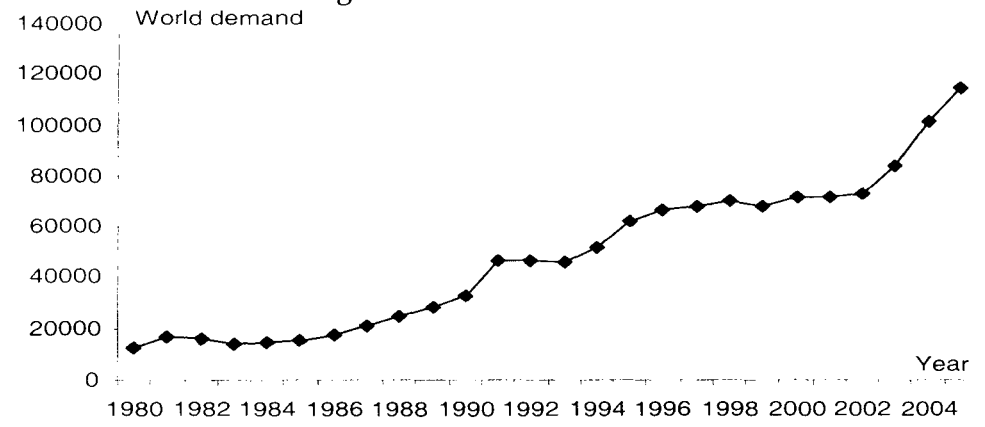

Source: Own calculation based on UN COMTRADE online database, DGCI&S, Monthly abstract of foreign Trade.

### Figure A 2: Real Effective Exchange rate (1993=100)



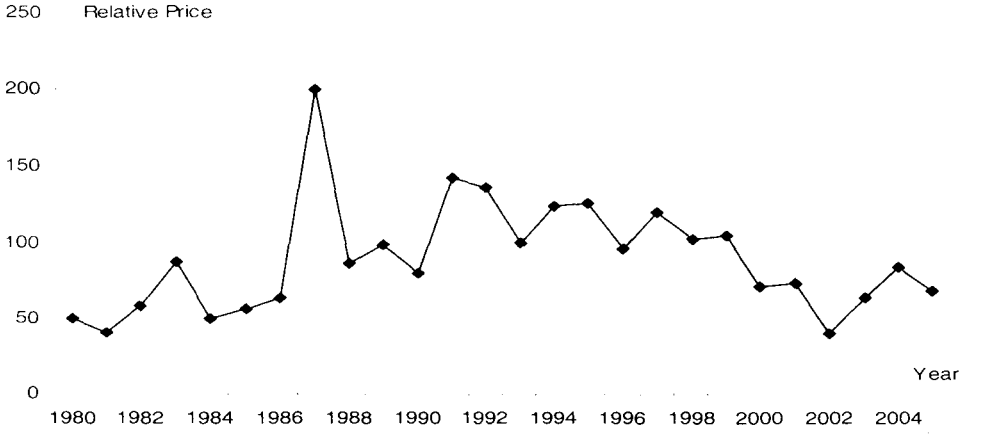

Source: Own calculation based on Statistical Yearbook, and UN COMTRADE, UNCTAD.

## Figure A 3: World Demand



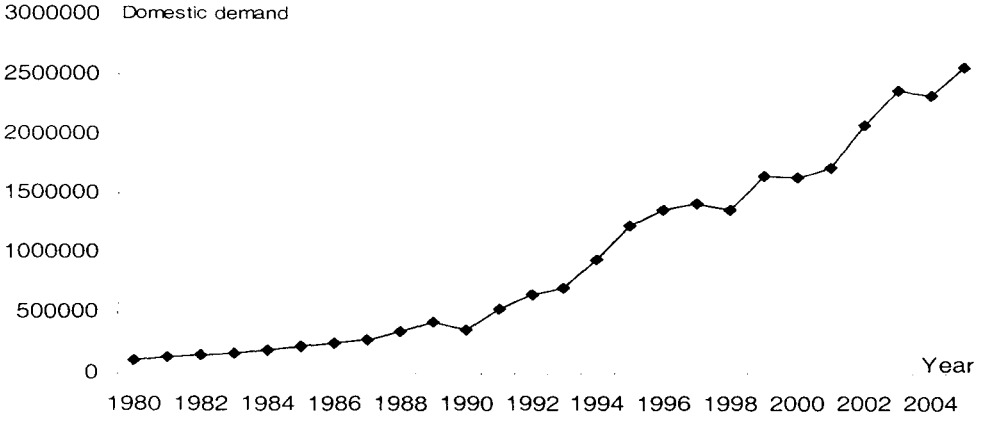

Source: Own calculation based on UN COMTRADE online database

## Figure A 4: Relative Price



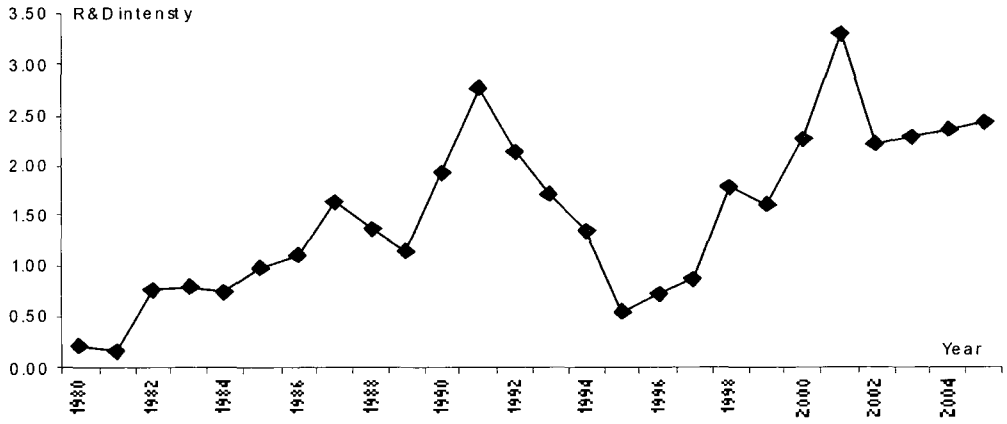

Source: Own calculation based on UN COMTRADE online database, DGCI&S, Monthly abstract of foreign Trade, Office of economic Advisor, Ministry of Commerce and Industry, online database.

## Figure A 5: Domestic Demand



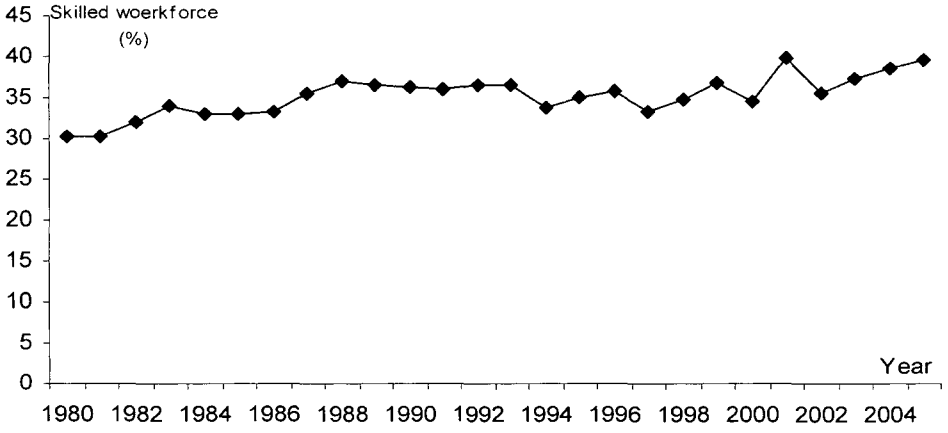

Source: Own calculation from Annual Survey of Industries, CSO.

## Figure A 6: R&D intensity




Source: Own calculation from Annual survey of Industries, CSO various issues, R&D statistics, DST.

## Figure A7: Skilled labour force




Source: Own calculation from Annual Survey of Industries, CSO.

## CHAPTER 5

# SUMMARY AND CONCLUSION

The present study was carried out in order to examine the export performance of Indian machine tools, its determinants and its competitiveness under trade liberalisation. Trade liberalisation policies are an ongoing process across the world as they are expected to bring improvement in the rates of economic growth by adopting an export-oriented industrialisation. An export-oriented strategy is believed to induce efficient utilization of resources, improved technological progress, learning capabilities and relaxation from foreign exchange constraints. It is also believed that, a more open trade regime helps domestic industries to overcome home market constraints and enables them to have scale economies, and competitive advantage. But critics have cautioned against the adaptation of universal trade liberalisation, as most of the benefits envisaged are contingent upon the structural characteristics of the domestic economy concerned and the nature of demand for products of export in the world markets.

The trade liberalisation policies in India, initiated since 1985, aim to help domestic industries orient their production strategies to meet the requirement of external markets. Trade liberalisation has also put pressure on industry to improve domestic capabilities and competitive strength for its products. Empirical evidence, mostly pertaining to the aggregate level, points out that, export performance of manufacturing industries has improved during liberalisation, but that the relative competitive strength of their product has remained weak. But most of these conclusions are too general to reflect variations across sectors and industries. More detailed, sector-specific, study is required to understand the working and performance of these mechanisms, which will also help in assessing their comparative advantage in the international market. The present study has made an attempt to assess the export performance, determinants and competitiveness of the machine tool industry of India in the context of trade liberalisation.

Machine tools represent in general, contrivances used to build parts of machines. Machine tools come under different varieties, from the simple lathe to advanced computer- controlled machines. The Machine tool industry has strategic importance and has high linkages with the rest of the manufacturing sectors. Therefore most of the countries including India have tried to protect this industry from foreign competition. Technological advancements in the machine tools industry lead to external economies of scale for the user industries. Since the industry produces a range of machines, each of its products has its own niche and

specialization. Large economies of scale are required to attain long-run growth, for the attainment of which wide markets and trade opportunities are required. Trade liberalisation could help industry to overcome cyclical variations emerging from domestic market conditions.

An examination of the historical development of machine tools in India revealed instability in production and value added over the years. Fluctuations have been much more pronounced than earlier during the period of trade liberalisation. As a result of the removal of trade barriers, the industry experienced a huge surge in imports and consequently the share of imports in domestic consumption has considerably increased in the past few years. Apparently, the self-sufficiency level of this industry has also declined. It was found that the degree of linkage between capital good industries and machine tools has weakened during the latter part of 1990s and that there has taken place a divergence between them in respect of growth performance. Internal liberalisation has resulted in the emergence of new firms and the introduction of a wide variety of machines including CNCs, machine centre and other complex machines in the domestic market. As a result, the market share of the leading firms has declined. The examination of the technological profile of machine tools, revealed some improvement over the past few years.

The trade profile of machine tools revealed that India has been heavily dependent on foreign machines during the initial period of planning. As import substitution deepened, imports steadily declined and an upward trend was visible in the 1990s. The baskets of commodities imported, mainly from advanced countries, consisted in general, of complex products. In the latter part of the 1990s, there has taken place a marginal increase in the share of developing countries in India's machine tool imports. The liberalisation period has witnessed significant expansion of the machine tools industry in India and most of the machines were exported to advanced countries. But an examination of the export basket revealed that the larger share comprised of simple products like tool holders and accessories. This may be a reflection of the level of specialization in machine tools that India has been having. India has been specializing in technologically less sophisticated products, as developed countries have found it uneconomical for them to produce such products.

An examination of export competitiveness of India during the period of 1980-2003 was carried out using the revealed comparative advantage index (reflecting the market share for the exported product). It was found that Indian machine tools have been uncompetitive in the world market, as the index was found negative for the entire period. But the pattern was not uniform across time. During the latter part of the 1990s, the degree of competitive

disadvantage declined accompanied by improved performance of exports. A similarity (or dissimilarity) analysis revealed that the competitive performance of India was similar to those of China, Argentina and France. Although the analysis did not delineate the sources of competitive advantage, it was evident that there has been both demand and supply factors that had significant impact on the growth of exports of machine tools.

The determinants of machine tool were analysed using an econometric methodology. We identified various demand side and supply side factors that could have a decisive impact on machine tools exports during the period of trade liberalisation. The demand side factors included were effective exchange rates in real terms and, world demand; the supply side factors were relative prices of exports, domestic demand, R&D and the volume of skilled labour force reflecting technological capabilities in the industry. We adopted a simultaneous equation framework and employed 3SLS estimation procedure, which is an improvement over the existing empirical studies on India's export determination. The analysis was done for the period 1980-2005. The results revealed that machine tools exports has been driven more by demand side factors than supply side factors as most of the capability variables were found insignificant. The demand elasticity was greater than unity, a condition that satisfies the marshal-learner condition implying thereby that real depreciation will have a favourable impact on machine tools exports. The importance of skilled workers on the supply side signifies the importance of improving skills and technological levels in the industry.

### 5.1 Concluding Remarks and Policy implication.

The study shows that the change in industrial policy has been instrumental in shaping the machine tools industry as one, which seeks foreign markets for the sale of its products. But, at the same time, the industry has not been able to diversify the product range or achieve international competitiveness. The policy shift has operated by changing the relative prices of machine tools through favourable changes in the real exchange rates. The export prospects of machine tool are highly influenced by the demand conditions in the international markets. Currently, the markets are concentrated in a few countries reflecting an element of risk for production confined to a narrow range of products. The nature of demand and the kind of policy shifts in foreign countries would make Indian exports vulnerable unless the industry becomes able to attain significant competitive advantage in the years to come.

The result of the export determination model shows that liberalisation is only a necessary condition for successful export performance as it is influenced by other factors too. The insignificance of relative price on the supply side points out that the policies have not been instrumental in changing the nature of incentives that the exporters encounter in the domestic market. The building up of competitive strength in machine tools industry significantly depends upon a policy structure of the government which would ensures the stability in the value of its currency along with the necessary infrastructure for skill development. It is argued in general, that trade liberalisation requires a minimum involvement of the government. But having examined the working of machine tool industry in detail, we find that there exist areas in which government could play a meaningful role.

We have seen that, exports of machine tool from India consist of simple to medium technology products. Although we find a niche for these products in the world market, the sustainability of this level of specialization in the long run is in doubt. This is because the demand for these products may be transitory and due to increased use of automation, the cost efficiency of making more complex products may become economical in the long run. Moreover, the value addition of these products and their contribution to growth are in general low. Therefore, it is necessary that Indian machine tool production shift its level of specialization to superior value-added products, which carry high-income elasticities. Since such products are fairly competitive in the world market, India should focus on providing low cost, but quality, machines.

The success of the country would depend on the improvements made in the supply capability of machine tool manufacturing. The government should assist the industry to enhance capability by providing it with efficient institutional infrastructure like a highly skilled and well-trained workforce and encourage domestic R&D. The research effort of the industry has to be supplemented by an active supplementary role by institutions like CMTI and IMTT. To achieve this objective an improvement in the overall educational system and the establishment of strong linkage between university and industries are essential. Such an improvement would enhance technological capabilities essential for efficient production.

The government should also alter the demand structure for products of the machine tools industry by providing it with a competitive currency in the world market. For this objective to be realised, the maintenance of an exchange rate, which fluctuates within a specified narrow band and a lower inflationary conditions, have to be ensured. Under such a regime, the Indian machine tools industry would be expected to penetrate successfully in the world market.

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