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Technical Change, International Competitiveness, and Role of the State: Indian Machine Tool Industry's Experience

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Abstract

The production of machine tools has long been associated with industrialisation besides a formidable factor of technical change and international competitiveness. This potent role of machine tool industry was amply recognised by several countries. As a consequence, they framed policies to influence the technical change and competitiveness of the industry. The present paper is an enquiry into the role of the state in India to see, whether the intervention led to generation of capabilities and an internationally competitive industry or not? The comparison with Taiwan shows that Indian industry is highly uncompetitive with respect to many parameters. The historical description shows that the multi-facet role of the state as a major user, producer and restructurer resulted in conflicting policies at several instances. Despite a better head start, Indian industry fell into a 'vicious circle' of low production, less feedback and inferior quality machines. One of the ways to puncture this trap is to venture out for exports in a big way.

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Introduction

The technical change and technological progress have two important aspects. First, technological change is seen as one of the most important determinants of economic growth and industrial development (Dixon, 1997). In fact, industrial development is the process of acquiring technological capabilities and translating them into product and process innovations in the course of continuous technological change (Pack and Westphal, 1986). Second, among all the industries, technical change in machinery producing sector holds the pivotal role in the economic development process of many industrialised countries (Fransman, 1986a). The role of machinery producing (especially, the machine tool, MT) industry in introducing and diffusing technical change is multidimensional. This is because all the innovations whether they involve introduction of a new product or provide a cheaper way of producing an existing product, require that the capital goods (CG) sector need to produce a new MT according to certain specifications (Rosenberg, 1976). This implies the CG industry acts as the main locus for the diffusion of innovations throughout the economic system. Further, cost reduction by the CG industry is capital saving for the economy, as the lowering of cost raises the marginal efficiency of capital of other MT using industries. In addition, the pace of industrialisation is determined by the celerity with which technical knowledge is diffused from its point of origin (i.e., the MT industry) to other sectors of the economy, where such knowledge has useful applications.

The machinery-producing sector is also important from the 'learning' point of view. This is because most machinery production processes involve a broadly similar set of skills and technical knowledge in their solutions. The development of American MT industry as documented by Rosenberg (1976), where any new process learnt in firearms industry was successfully transferred to sewing machine or bicycle producing sector and/or vice versa, testifies this. This potent role of MT industry was amply recognised by several countries including Japan, Taiwan, South Korea (henceforth Korea) etc. As a consequence, they tried to influence the technical change and hence the competitiveness of the industry by supporting it or making desirable changes in the policies as and when required.

The Indian planners have also placed a strong thrust and intervened painstakingly to develop the local CG sector since 1950s with a clear objective of meeting the requirements of Indian industrialisation. Despite strong intervention by the planners in the development of Indian machine tool industry (IMTI), the industry has

performed badly in terms of competitiveness and technological capabilities. The IMTI, though is as old as Taiwanese MT industry, and started from the same technological level (Desai *et al*., 1996), yet differs significantly in-terms of technical change, performance and competitiveness. The comparison shows that Indian MTs are much expensive than the Taiwanese MTs despite their poor quality in terms of breakdown and having less advanced features. Similarly, on the export front, where India accounted for a tiny 0.06 per cent of world exports for the year 1995-96, Taiwan had a share of over 5 per cent (Indian Machine Tools Manufacturers Association, IMTMA, 1995-96). This divergent performance despite strong thrust by the government motivates to look for the factors / forces that detrimentally affected the development of the industry.

The twentieth century history of developing countries and NIEs is, in fact, replete with instances of pervasive influence of the state as an institution and actor. In the initial stages of industrialisation, there are widespread information and entrepreneurial gaps besides the externalities that depict missing markets. It is these missing markets, and institutional deficiencies and lack of co-ordinated investment decisions in the absence of information that necessitated comprehensive planning by the state in many countries. The analysis of what made some states more effective in generating technical change and international competitiveness than others would offer considerable headway in framing policies in the long run. Thus, the involvement of state is given. The paramount question is not 'how much' but 'what kind' of involvement.

The present paper is an enquiry into the role of the state in explaining the technical change leading to competitiveness of the industry using Indian and Taiwanese MT industries as examples. The organisation of the paper is as follows. Section 2 compares the international competitiveness of Indian and Taiwanese MT industries. The role of different agents of technical change leading to international competitiveness has been discussed briefly in section 3. Section 4 critically analyses the role of the state by documenting the evolution of Indian MT industry followed by summarisation of the role of agents in section 5. The paper ends with some concluding remarks and future policy implications in section 6.

2. International Competitiveness – Machine Tool Industry in India and Taiwan

Under conditions of free trade the best indicators of international competitiveness are probably the change in market share and export growth (Fransman, 1986b: 1378). In the presence of trade restrictions of one form or the other, total factor productivity growth (TFPG), the unit cost and the product quality etc. would reflect the competitiveness. Since trade was not free in India until 1991, one needs to use the latter group of indicators to compare the competitiveness. Given the fact that one of the characteristics of the industry is 'economies of scope', this implies many firms in both the countries produce different MTs besides also manufacturing

intermediate products and other engineering goods. Thus, it is not easy to calculate the TFPG. The present analysis hence uses mainly the unit cost and the quality of the product as indicating variables explaining the competitiveness. Tables 1 and 2 compare the unit price and output from Taiwan and India for two years 1993 and 1997 respectively.

Table 1: Machine Tool Output and Unit Price, Taiwan and India, 1993

		Units		Price ($m)		Value (per cent)		Price
S.no	**Machine Type**	**Taiwan**	**India**	**Taiwan**	**India**	**Taiwan**	**India**	
1	**NC Machines**	**6,567**	**291**	**323.6**	**40.9**	**49.28**	**140.55**	**2.85**
	Lathes	2,486	122	134.1	9.8	53.94	80.33	1.49
	Drilling	36	10	1.3	1	36.11	100.00	2.77
	Milling	1,010	9	12	1.4	11.88	155.56	13.09
	Grinding	93	14	5	4.4	53.76	314.29	5.85
	Machining centres	2,702	101	165.8	22.3	61.36	220.79	3.60
	EDM	240	35	5.4	2	22.50	57.14	2.54
2	**Non-NC metal**	**745,724**	**3,015**	**384.8**	**64.7**	**0.52**	**21.46**	**41.27**
3	**Metal Forming**	**58,986**	**322**	**389.3**	**12**	**6.60**	**37.27**	**5.65**
4	**Others**		**650**		**17.8**		**27.38**	
	Total	**811,117**	**4,638**	**1,097.7**	**135.4**	**1.40**	**28.90**	**20.64**

Note: India's total NCMT production for the year was 425. Some categories of NCMTs like Boring-milling machines, NC Gear cutting machines, NC Presses etc. were produced in India only, so price comparison could not be made.

Source: Desai *et al*. (1996: 21-22)

Table 2: Machine Tool Output and Unit Price, Taiwan and India, 1997

		Units		Price ($m)		Unit Price		Price
Sno.	**Machine Type**	**Taiwan**	**India**	**Taiwa**	**India**	**Taiwa**	**India**	
1	**NC Machines**	**15,596**	**798***	**681.1**	**63.86**	**43.67**	**80.02**	**1.83**
	Lathes	5,410	513	237.2	30.9	43.85	60.40	1.38
	Drilling	159	8	4.8	1.7	30.27	206.68	6.83
	Milling	790	15	18.9	3.3	23.90	217.15	9.09
	Grinding	97	81	4.3	7.2	44.20	88.80	2.01
	Machining centres	6,826	111	371.4	17.3	54.41	156.05	2.87
	EDM	2,314	70	44.5	3.5	19.22	49.28	2.56
2	**Non-NC metal**	**877,789**	**5,596**	**572.1**	**98.1**	**0.65**	**17.53**	**26.9**
3	**Metal Forming**	**174,490**	**342**	**562.6**	**25.8**	**3.22**	**75.36**	**23.37**
4	**Others**		**240**		**26.6**		**110.64**	
	Total	**1,067,87**	**6,976**	**1,815.8**	**214.3**	**1.70**	**30.72**	**18.07**

Note: * India's total NCMT production for the year was 1038.
Source: IMTMA,(various years) for India; for Taiwan http://www.tami.org/990323e/ 2_1.htm

The cost comparison shows that Indian numerically controlled (NC) MTs are about 2-3 times as expensive, non-NC cutting tools are about 27-42 times and non-NC forming tools are roughly six times the cost of Taiwanese tools in 1993 and 23 times in 1997. Further, to achieve the 1993 output level, Taiwan employed 13,140 workers against India's employment figure of roughly 60,000. This implies in comparison to Indian worker, Taiwanese worker produced 37 times higher value of output. As stated earlier, given the regimes of the two countries and the nature of the production in the industry, the comparison is not very meaningful, yet it gives some indication of the labour productivity in two countries.

The huge price difference could also be due to quality machines from Indian producers. The performance and technical features of Indian NCMTs, however, reveal a contrasting picture. In terms of features, the comparison shows that Taiwanese CNC lathes have 50 per cent turret indexing time than that of comparable Indian CNC lathes, besides the toothed belt as used in Taiwanese lathe makes better feedback for size control compared to V belt used by Indian CNC lathes. The other superior features of Taiwanese CNC lathes are absence of spillage of lubricating oil and highly reliable coolant guards (EXIM, 1996: 41-42). IMTMA reports that Indian machines have a spindle speed of 10,000-rpm (revolutions per minute) and a tool-change time of 3 seconds, whereas some of the machines from Taiwan have spindle speed of 20,000-30,000 rpm and tool change time of half to 1 second. These low quality features, in turn, have a dampening effect on the performance of the machines. For instance, the Taiwanese Goodways CNC lathes have a breakdown of 1 per cent compared to 20-30 per cent of the comparable HMT CNC lathes (STC series) despite Indian machines costing 50 per cent more (Firodia, 1996). Similarly, Praga MPA 50 machining centre costing Rs. 3.5-4.0 million[1] has a 20 per cent breakdown against half a percent of Leadwell from Taiwan, which costs Rs. 1.8-2.0 million (*ibid.*). A recent survey carried out by IMTMA (1996) also confirms the inferior quality of Indian machines. Table 3 reproduces the results of the survey.

The survey finds that of the 213 users having 1,055 installation of Indian NCMTs and 904 foreign NCMTs, approximately 9 per cent of the Indian machines are working below satisfaction and only 3 per cent are showing excellent performance compared to 3 per cent and 17 per cent of the foreign machines respectively. The user satisfaction is 89 per cent with foreign machines against 77 per cent with that of Indian machines. In terms of down time, 25 per cent of Indian machines have a down time of 10 per cent or more compared to only 15 per cent of foreign machines.

As stated earlier, prior to 1991 one cannot compare the export performance of the MT industries of the two countries, but 1991 liberalisation slashed down a number of barriers and exposed Indian firms to outside competition. The sudden assault on Indian market by imports forced local firms to exports. If this has resulted in

[1] Rs. 44 (appm.) = 1 US $.

competitiveness, it should be reflected in the high export growth after the liberalisation. Table 4 compares the intensity of exports for Indian and Taiwanese MT industries. The figures indicate that the Taiwanese export intensity has increased from 64 per cent in 1992 to over 75 per cent in the past 4 years, whereas Indian MT exports declined till 1996 and thereafter showing some recovery.

Table 3: User's Satisfaction Level and Breakdown Level: per cent of Total Machines Installed

	User Satisfaction Level (per cent)			Breakdown Statistics (per cent)	
Sno.	**Satisfaction Level**	**Indian**	**Foreign**	**per cent Down Time**	**Indian**	**Foreign**
1	**Not Specified**	14.9	7.9	0-3	20	37.6
2	**Not Satisfactory**	8.6	3.0	3.1-7	26.1	27
3	**factory**	16.2	9.1	7.1-10	29.1	20.5
4	**Good**	34.6	26.5	11-20	20	11.8
5	**V. Good**	23.1	36.9	21-30	3.2	1.8
6	**Excellent**	2.6	16.6	31-100	1.6	1.3
	Total	100	100		100	100

Source: National Survey on Performance of Machine Tools, IMTMA (1996)

Table 4: Exports as a per cent of Total Value of output – Taiwan and India

Year	Taiwan	India
1992	64.1	6.38
1993	67.5	7.22
1994	66.9	6.72
1995	70.8	5.35
1996	76.4	3.07
1997	75.02	4.03
1998	75.32	9.05
1999	76.08@	na

Note: @ - provisional, na – Not available.
Source: IMTMA, (various years) for India; for Taiwan http://www.tami.org/990323e/2_6.htm

The above discussion and figures thus suggest that performance of Indian MT industry is in complete contrast to that of Taiwanese industry. The next section looks into the forces that can have impact on the competitiveness of the firms followed by historical narration of IMTI to see what deterred the generation of these forces.

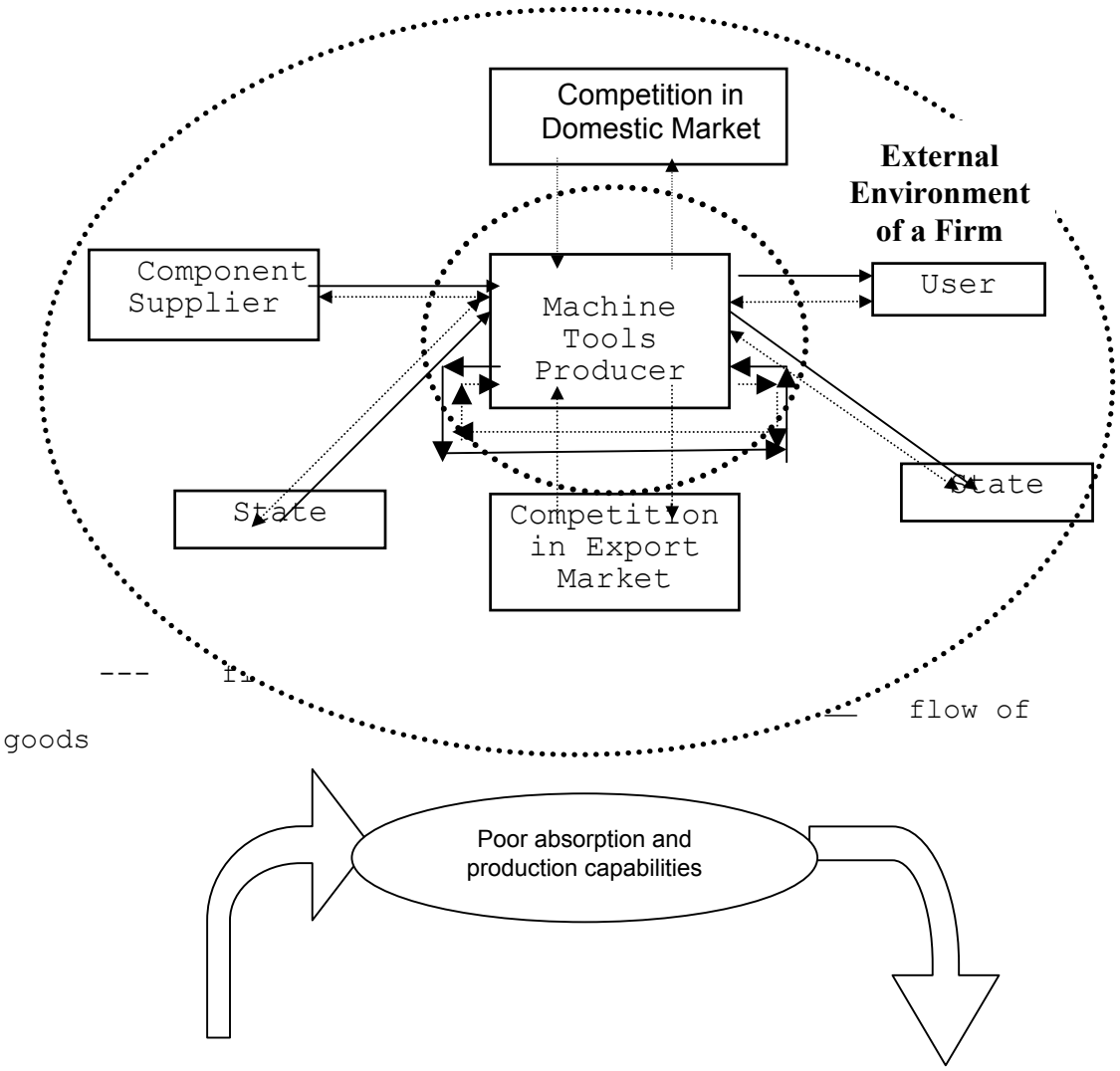

Figure 1. Determinants of Technical Change and International

3. Technical Change and International Competitiveness – Agents

The firms' in an industry consists of four main agents interacting with it – users, suppliers, competitors and the state. The interaction of these agents results in technical change and hence the competitiveness of the industry. Figure 1 displays the agents in the environment of a firm. Dark lines indicate the flow of goods, whereas dotted lines indicate flow of information. A closed loop within the producer firm implies that some information is internalised also as the machinery-producing firms are themselves major users.[2]

Competitiveness

The agents interact with the firm through three environmental factors – pressure, incentive and information flow. Competition from other firms in domestic and/or export markets constitutes an example of environmental pressure. Similarly, user industries might exert pressure by demanding low cost and improved quality products. The incentives on the other hand are giving tax rebates for opening a plant in backward area or protection from competing imports in return for export efforts, etc. Lastly, the information in itself can not be acquired automatically. It requires significant and conscious allocation of resources by the recipient firm. Still, the acquired information may not be effectively used, unless there exists some pressure or incentive to utilise it. In fact, information flows rather freely and innovations diffuse much faster through conduits of suppliers or customers, who have contact with multiple competitors (e.g., in Silicon Valley).

3.1 User-producer interaction

The users of MTs are much more important in inducing technical change than users of any other industry for two reasons: a) they influence the development activity of specialised MT producers by way of 'demand pull'; and b) they themselves are directly involved in the development of new machines for own production process (Lee, 1996). Sophisticated and demanding buyers put pressure on local firms to meet high standards in terms of product quality, features and service. The evidence suggests that since the early 19th century, user industries have played a significant role in shaping technical change in machinery producing sector. See for example, Rosenberg (1976) for US industry. Amsden (1985: 221) has also documented the important role of the user in the development of Taiwanese MT industry. The local textile machinery manufacturers in Taiwan, which bought some of its capital equipment locally, demanded MTs so as to cater to the needs of the textile industry.

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[2] For example, as on 1988-89, the 5 top CNC lathes producing firms in India were using 2, 3, 5, 7 and 10 CNC lathes respectively (Wogart *et al*., 1993: 141-42).

The user-production interaction also has a significant bearing on the technological trajectory and international competitiveness of the MT industry. One of the factors responsible for Japanese international competitiveness in the 1970s was the specific nature of user demand (Watanabe, 1983). The automobile industry was a major user of NCMTs in Japan. The strong competition that prevailed between automobile producers in both local and export markets forced them to put increasingly stringent demands on their subcontractors in terms of quality and price. As subcontracting networks were widespread, these small firms demanded high performance, medium-priced and standardised MTs. Watanabe (1983) and Fransman (1986b) on the basis of their surveys of MT producers also found that these users were an active source of incremental technical change.

Fransman's (1986b: 1386) survey of nine Taiwanese MT firms also finds the important role played by users in inducing technical change. Desai *et al*. (1996) also suggest that one of the factors facilitating the competitiveness of Taiwanese MT industry is their concentration on the high (quality) demanding users of OECD countries.

3.2 User-supplier interaction

The presence of internationally competitive supplier industries creates advantages in downstream industries in several ways. First is via efficient, early, rapid and sometimes preferential access to the most cost-effective inputs. Second, quality suppliers provide ongoing co-ordination. Suppliers help firms perceive new methods and opportunities to apply new technology and firms gain quick access to information, ideas and insights and supplier innovations (Porter, 1990).

One of the important factors leading to the competitiveness of the Japanese MT industry has been the presence of world-class suppliers of NC units, motors and other components (Porter, 1990: 100). The introduction of microprocessors into NCMTs resulted in the separation of the brain from the main body. The first NCMT was demonstrated and commercialised by US in the mid-1950s. However, based on a report, Fanuc worked in collaboration with another Japanese MT firm, Makino and produced the first prototype of a NC milling machine in 1958 (Fransman, 1986b). Over the years, working closely with major Japanese MT producers, Fanuc has contributed significantly to their international success.[3] Fransman's (1986b: 1384) survey also finds that Fanuc has been instrumental in the development of Taiwanese MT industry through the sale of its control systems and assisting in the design development of Taiwanese control producers.

[3] This has also facilitated Fanuc to capture most of the world market in CNC controls. In 1990 itself, Fanuc was controlling nearly 50 per cent of the world CNC control systems market (Porter, 1990: 232).

3.3 Competition

The competition has a multi-facet role in deciding the 'technological trajectory' of an industry. A group of strong domestic rivals, locked in active competition, not only helps attract and upgrade established suppliers, but also can raise the standard of competition in supplier industries via entry. They are also the source of 'spin-offs', as employees leave to produce components, machinery or services.

It is often argued that competitive pressures are far greater in the export markets than in the domestic market as the exposure to international competition creates an absolute productivity standard for the firm, a pre-requisite to meet foreign rivals, besides raising the relative productivity level within the national economy (Kathuria, 1999a). The export competition forces the firm to be more efficient in terms of varied criteria such as price, quality, aesthetic, delivery time and after sales-service. The users in the export market may also be an important source of feedback, thereby facilitating the process of 'learning by exporting.'

This process of 'learning by exporting' explains a significant part of the economic success of export oriented NICs (Krueger, 1981). In case of Korea, machinery producing firms were forced to export soon after they started production, thereby benefiting from 'export externalities', besides earning precious foreign exchange (Amsden and Kim, 1986). The building of significant technological capabilities in Taiwan and Singapore has also been attributed to the export oriented approach of their respective MTs sector.

3.4 Role of the State/Government

The state has played a very prominent role in the development and international competitiveness of MT industries in Japan, Korea, Taiwan etc. Technical change and international competitiveness of the MT industries in these countries appear to be a result of three specific interventions by the state[4] – by stimulating demand i.e., procurer; by protecting industry from outside competition i.e., protector; and lastly by promoting through selective interventions i.e., restructurer of domestic industry (Fransman, 1986a). In India, the role of the state was more omniscient, as it was/is not only a significant MT procurer, but also a major producer of finished MTs and components like ball-screws, controls etc.

a) State as a Procurer

The state as a procurer/user of machines, especially in Space, Defence and Railways, has a direct bearing on the trajectory of design development of machinery.

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[4] Besides these three major roles, the state has played a fourth role as a 'protector of foreign markets', especially in case of Japan (Fransman, 1986a: 36).

First, its large size relative to other users carries a significant weight on the producers in shaping the design features. Second, if machinery is needed for some strategic application, the emphasis is on the quality, and not the price (i.e., a 'price-insensitive and quality-sensitive' user).

These special characteristics explain why US MT producers did not give enough attention to carmakers and small job-shops that were demanding standardised and low/medium priced MTs. This relative neglect of the segment facilitated entry of Japanese MT firms into the USA and enabled them to capture a large segment of the market. Melman (1983) argues that the international competitiveness of the US MT industry has been detrimentally influenced by its involvement with military production. Yamauchi (1986) also contends that the Japanese MT industry's delay in achieving international competitiveness was because of Japan's 'strategic defence objective' prior to WW2 in 1930s, which slowed down the assimilation of the most advanced 'civil mass-production' technology.

The public procurement has other benefits also. In the initial phase, it can stimulate innovations by reducing uncertainty associated with introduction of innovative products and R&D efforts. This also facilitates firms to acquire the volume on which 'scale' and 'learning' economies can depend (Stewart and Ghani, 1991: 578).[5]

b) State as a Protector of Domestic Industry

The role of the state as a protector of domestic industry can be viewed in a larger domain as a restructurer of the industry. In countries like Japan, Korea, Taiwan, etc., the state has promoted local industry by protecting against the outside competition. The state imposed various forms of import restrictions to protect the domestic industry under the guise of 'law of similars' (i.e., no import was allowed if the 'similar' MT was available in those countries).

The role can be analysed in tandem with the long-term objective(s) of the country. In case of Korea, the state exerted significant pressure on MT producing firms to export immediately after they started production. As an incentive, the state guaranteed access to the domestic market by restricting imports. Thus, the long-term objective of international competitiveness induced the state to enact protective measures.

c) State as a Restructurer

The strategic nature of the MT industry has prompted various countries to restructure it depending upon their vision and long term objectives. One of the characteristics of the industry is the co-existence of economies of 'scale' and 'specialisation' and

[5] The stimulation of innovations in the semi-conductor industry at Silicon Valley, in its initial phase, is a concrete example of this benefit of public procurement (Stewart and Ghani, 1991: 578).

attaining both is a pre-requisite for the competitiveness of the industry.[6] In order to realise these economies, Japan and Korea prevented excessive competition in the industry (Fransman, 1986a: 35).

Direct subsidies to MT producers and users or indirect subsidisation of technological inputs through the state run research institutes was another tool used in several NIEs to promote the local MT industry. For instance, in Korea, Daewoo Heavy Industries, which opened a MT plant in 1977, received preferential loan of 44 million US$ (Jacobsson, 1986). Fransman's (1986b: 1388) survey also finds a significant role of the state in providing long term technical assistance and subsidised credit to MT producers in Japan and Taiwan. In case of Korea, evidence suggest that the state stimulated the demand for Korean made MTs through tax and credit incentives as well as special depreciation allowance for the local market; and for the export market, credit incentives were given to the MT producers (Kim, 1999).

In Taiwan, government established an integrated steel mill for high quality alloys steels, steel forging and iron for castings so that local firm produces high-quality MTs. Other state support included vocational and management training, technical assistance, export promotion and subsidised finance (Amsden, 1977: 229). Besides, the state was also instrumental in the late 1970s for organising exhibitions for Taiwanese-made MTs at many overseas locations to create awareness among foreign buyers about the available MTs (*ibid*.).

In view of the significant technological-gap that existed between Japan and other developed countries in the 1950s and 1960s and a similar gap that existed between Korean and Taiwanese producers and their competitors in the 1970s, the supportive or orchestrating role of the state seems to have proved quite effective as all these countries have developed significant technological capabilities and currently have internationally competitive MT industries.

4. *Evolution of Indian Machine Tool Industry (IMTI)*

Since its inception, IMTI has passed through 4 development phases under different sets of controls. Machine tool manufacturing in the country dates back to 1890, when some workshops in (undivided) Punjab started producing MTs to satisfy their own requirements. The commercialisation of the industry, however, took place during the First World War (WW1), when the war induced a limited number of small firms to produce MTs specifically for manufacturing shells. This activity, however, ceased at the end of the war in 1919 (Mathews, 1988: 2061). It was only in the 1930s, during the WW2 that the real development of IMTI started.

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[6] Besides these, there are economies of 'scope' and 'purchase', which have been exploited by Korean and Taiwanese MTs manufacturers in order to attain international competitiveness (Kathuria, 1999b).

4.1 Phase I – Pre-independence Developments

The first phase of IMTI began with the establishment of the organised sector in the early years of WW2. During the six years of war, problems associated with the imports forced the government to encourage local MT industry (SSI, 1958: 12). In February 1941, the Government of India (GOI) passed the Machine Tool Control Order and appointed a Machine Tool Controller to promote the industry in a systematic manner. The important measures taken were: a) strict control for imports with import licenses to be issued mainly for MTs not produced in the country; b) the government agreeing to purchase the entire production of leading firms if they meet standards; c) obtaining services of 7 technicians from the UK to guide the Indian producers; and lastly d) to classify MTs as 'graded' and 'ungraded,' the services of the Machine Tool (Inspection) Branch of Industries and Supplies Department was offered at a nominal fee.

On the other hand, private users had to apply to the Controller through their regional representatives to acquire MTs. Thus, the systems of both production and consumption were controlled (Thomas, 1948: 176). As a result of these efforts, the total number of MTs manufactured in India increased from 316 in 1942 to 8,810 in 1946 (SSI, 1958: 12).

With the end of the war, the assistance from the state was withdrawn resulting in a severe setback to the industry. The liberalisation of imports further weakened its competitive position. As a result, MTs production in nominal terms declined from a peak of Rs. 11.2 million in 1945 to Rs. 2.9 million in 1950 (SSI, 1958: 13). The producers requested the state for protection. In 1947, the Tariff Commission recommended, amongst other things, a protective duty of 25 per cent *ad valorem* on MTs. The government did not accept this recommendation, yet agreed to purchase indigenously produced MTs as far as possible (*ibid*.). This marked the first phase of IMTI.

4.2 Phase II – Planning Era (1950-1966) - High Growth of the Industry

The second phase started with the second five-year plan (FYP) in which the role of CG sector in fostering economic growth and self-reliance was recognised unambiguously. The planners also recognised the distinction between two kinds of CG: (i) those that produce consumer goods; and (ii) those that produce other CG. In tune with the primary objective of long-term maximisation of growth, greater significance was given to the production of second category of CG (i.e., 'machines to build machines'). As a result, the scale of investment in the economy in descending order of importance became - the MT industry; the machine building industry; and the consumption goods industries.

The importance accorded to the industry is evident from the fact that during mid-1950s, a number of committees/groups was set up by the GOI to evaluate the status and its future prospects. This emphasis to the industry led to its rapid expansion during the first two FYPs as also reflected in the production figures. The value of MTs production, which was around Rs. 13.6 millions at the end of first FYP sharply increased to over Rs. 100 millions in real terms at the end of second FYP. Refer Table 5, which gives the production and consumption of Group A (or 'graded') MTs since 1951.

Despite increase in production, the MTs requirement of the country was still met to a major extent from the imports as the internal demand arising from the development programme outstripped the expansion of indigenous production. Another factor for continued reliance on imported MTs was that the foreign manufacturers because of the quality and performance of their MTs, had ready acceptance in the Indian market (SSI, 1958: 31). Nevertheless, in October 1957, in consonance with its 1956 Industrial Policy Resolution (IPR), the GOI imposed following restrictions to control the imports of MTs: a) established importers will not be granted licenses for the import of lathes, shapers, milling machines, etc. (total 12 categories) and the applications of actual users will be considered on merits; b) grant of licenses for spares of these banned MTs will be at the discretion of the Development Officer (Tools); and lastly c) licenses will be granted *ad hoc* to meet the orders placed by DGS&D, Railways etc. As a result of these import restrictions, imports as a ratio of total MTs consumption started falling from 1957 onwards (refer column 6, Table 5).

The instrument of control that probably had the most significant impact on the development of IMTI was the system of 'licensing', introduced under the Industries (Development and Regulation) Act, 1951. The act provided teeth to implement the IPRs of 1948 and 1956. Broadly, the objectives of the resolutions were: the control of growth and the industrial composition of output capacity; the saving of foreign exchange; the control of monopoly and encouragement of smaller industrial units; and finally, the control over the location of industry. Through the 1956 IPR, the GOI established an 'Industrial Licensing Committee' for MTs to act as an arbiter on its capacity. Unless the Committee granted a new license, every producer in the organised sector was permitted to manufacture only those types and sizes of MTs assigned to it. In addition to this, the GOI created a 'Development Council' for MTs in 1958 to assess the demand for MTs and recommend the types to be produced in India (Mathews, 1988: 2065).

Table 5: Machine Tools Production and Consumption in India since 1951 (Group A only)*

Year	Productio	Production (Rs. million)		Imports	Exports	Imports/
	No.	Current Prices	1970-71 Prices			
	(1)	(2)	(3)			
1951	1143	4.7	10.47	39.33	0	84.09
1952	1070	4.4	9	34.79	0	83.28
1953	1070	4.4	7.97	49.20	0	87.64
1954	1216	5	9.14	60.79	0	89.13
1955	2003	7.4	13.63	83.23	0	88.61
1956	2943	12	21.43	131.68	0	88.57
1957	3015	25.1	43.88	230.33	0	86.17
1958	3868	37.6	63.95	226.87	0	80.87
1959	4071	43.9	73.29	256.92	0	79.70
1960	5332	61.8	100.98	329.45	0	78.13
1961	8511	77.6	121.25	381.05	0	76.77
1962	10293	108.8	164.85	409.68	1.73	71.68
1963	11058	154.4	223.77	495.59	1.57	65.38
1964	13370	189	264.71	541.84	1.89	62.28
1965	15423	222.6	298.79	549.55	2.20	57.96
1966	14931	257.8	328.83	506.50	7.78	60.71
1967	12330	215.8	257.52	393.58	6.69	61.37
1968	7879	171.4	196.33	362.11	18.58	65.89
1969	10455	219.2	249.09	188.80	29.47	44.33
1970	11654	289.4	320.13	182.80	27.87	34.70
1971	11447	371.1	371.1	217.00	30.50	31.49
1972	8750	344.7	329.86	233.22	20.72	33.30
1973	10178	441.6	399.28	277.44	35.71	32.86
1974	13549	645.3	528.07	272.51	65.84	26.60
1975	12191	778.8	498.59	394.01	73.17	31.49
1976	11895	863.7	498.67	372.01	141.48	30.81
1977	11536	784.9	459.54	306.23	117.11	27.14
1978	10364	806.1	466.49	365.78	187.46	28.46
1979	12079	1028.1	562.11	726.24	195.18	36.91
1980	11546	1184.1	560.12	999.12	198.66	39.99
1981	11448	1462.1	631.3	1122.55	162.66	38.48
1982	10187	1717.5	675.65	1399.35	156.10	41.72
1983	9930	1776.4	663.83	1568.28	179.53	44.70
1984	9460	1867.3	657.96	1287.68	116.04	40.33
1985	9284	1955.8	658.74	938.85	179.29	33.15

Year	Productio	Production (Rs. million)		Imports	Exports	Imports/
	No.	Current Prices	1970-71 Prices			
	(1)	(2)	(3)			
1986	9272	1939.4	593.82	1039.65	275.66	34.96
1987	10487	2463.6	715.12	1155.99	404.60	36.56
1988	8526	2752.2	767.91	1076.67	247.63	32.41
1989	7911	3392.5	860.6	923.46	369.38	29.63
1990	8963	4132.4	978.13	963.04	594.94	28.66
1991	6998	5042.9	1100.91	1120.08	411.79	34.34
1992	5692	4997.9	943.89	1390.69	144.53	39.59
1993	4817	4213.3	718.77	1191.62	113.76	44.92
1994	7429	5870.0	970.66	1496.30	131.58	45.03
1995	7191	7106	1063.71	2888.03	126.61	56.30

Note: @ - not available; From 1980 onwards, data is from Handbook of Machine Tools.

* MT are classified into two categories: Group A and Group B. Group A (or 'graded') MTs include Lathes, Presses, Milling machine and CNC machines. Group B includes Die-casting, Woodworking machine, CNC control and MT accessories etc. All the statistics refer to in the present study, is of Group A only.

Source: Table 1 given in Mathews (1988: 2064); Handbook of Machine Tools (1993, 1995); IMTMA, Annual Report (Various years).

Rapid Growth of IMTI

This ban on the imports of MTs that were produced at home, and discouragement to produce those 'similars' (MTs), which were already in production, resulted in significant 'product monopolies' with each producer producing a different kind of MT (Mathews, 1988: 2065). A direct outcome of this 'monopoly' was artificial pricing system and an indirect outcome was suppressed competition with deleterious impact on efficiency (*ibid*.). Highly regulated imports forced import agents of foreign companies like Batliboi Ltd., Allen Bradley, Advani-Oerlikon, Traub India etc. to start production of MTs under the license from their collaborator(s). Few other firms, like Bharat Fritz Werner, Kirloskar Brothers Ltd.–MT division, etc. started production during this time. As a consequence, the production in third FYP clearly outdid the performance in the second FYP. The MTs production, which was less than Rs. 10 millions in 1954 rose to over Rs. 325 millions in 1966 in real terms (a phenomenal growth of over 3000 per cent). On the other hand, during the same period, Taiwanese MT industry grew at much faster rate. The production figures, which were just over a quarter of India's output in 1961, overtook India in 1965 and doubled to that of India's in next 5 years in 1970. Table 6 gives the production figures and ratio of Indian and Taiwanese MT production for some selected years.

Table 6: Production Figures for Indian and Taiwanese Machine Tools – Selected Years

Year	1961	1965	1967	1970	1975	1980	1982	1993	1997	1998
India	8,511	15,423	12,330	11,654	12,191	11,546	10,187	4,817	6,976	7,406
Taiwan	2,319	8,735	13,466	23,296	41,780	436,233	597,274	811,117	1,067,875	1,078,090
Ratio	0.27	0.57	1.09	2.00	3.43	37.78	58.63	168.39	153.08	145.57

Source: IMTMA, (various years) for India; For Taiwan till 1982, Amsden (1985); after 1982 http://www.tami.org/990323e/2_1.htm

This product monopoly and restriction on entry of both domestic firms and imported MTs (i.e., the 'constrained competition') also led to a highly concentrated production. For example, in 1964, 5 large firms accounted for 72 per cent of the country's official output with 44 per cent as HMT's share (Desai *et al*., 1996: 34). One of the characteristics of these large firms was that they were highly vertically integrated as it was difficult to find component suppliers.[7] The few that existed were reluctant to take on the small production requirement of MTs producers. For example, HMT's requirement for fasteners (in the Metric System) in late 1950s was not entertained by Guest Keen Williams Ltd., a maker of precision fasteners (using British Standards) under the pretext that the quantity needed was small (Nagraj, 1989: 189). This structure of low degree of specialisation and high vertical integration was not specific to India as till the early 1970s even small MT producing firms in Taiwan had a low degree of specialisation and a high degree of vertical integration (Amsden, 1977: 221).

The period can be marked as the second phase of IMTI, characterised by rapid growth in production and horizontal expansion in the types of MTs such as Gear Cutting Machines, Special Purpose Machines (SPM), Broaching Machines, etc. by highly vertically integrated producers. In this phase only, in 1963, the Central Machine Tool Institute (CMTI), (renamed to Central Manufacturing Technology Institute in 1987), a state owned R&D institute, was established to help and promote technical skills in the industry.

4.3 Phase III – Years of Drift (1966-1979)

The MTs production boom, which began in 1954, fizzled out in 1966-68 when Indian industry was passing through a recession. The recession affected mainly CG investment and the level of public expenditure, which again indirectly affected the consumption of CG. The problem was compounded with the declaration of 'plan holiday' in 1967 by the GOI. As a result of the fall in consumption, the (official) output

[7] The possible reason for high vertical integration was the prevalence of small market for the products, resulting in long hours of slack in the MT producing firms, valued at almost zero opportunity cost. This slack might have been filled by producing every conceivable part for the final product.

of MTs fell by nearly 40 per cent. Desai *et al*. (1996: 34), however, contend that this fall was not entirely real as the demand shifted from HMT and other large firms to small firms, which were not members of the IMTMA and whose output did not figure in official statistics.[8] Two factors responsible for this shift was - (i) a shift in the market from government to private purchases; and (ii) the end of sellers markets for important inputs like steel. With the fall in the government investments, the level of demand for the main input, steel, shrank compared to the production, resulting in easy availability of steel. This availability benefited the small firms most, which were earlier buying from the black-market[9] (*ibid*.: 36). As the slump in demand affected mainly large firms, they could hardly break-even. This in turn affected the capital formation and investment in the industry and inhibited specialisation and efficiency.

Export Opportunities during Phase III

The sudden slump in demand after the mid-1960s forced MTs manufacturers to look for alternate markets.[10] In the 1970s, not only the IMTI, but also MT industries of many NIEs became more export-oriented. The data shows that the exports as a percentage of total output, which were 38, 6 and zero percent respectively in case of Taiwan, India and Korea in 1973 increased to 75 per cent, 22 per cent in 1978 for Taiwan and India and 20 per cent in case of Korea in 1980 (Desai *et al*., 1996: 35). This suggests that the export growth of India was somewhat comparable to that of Taiwan and Korea in the mid-1970s.[11] In case of Taiwan, the developed countries accounted for less than half a percent of the total exports in 1966. This figure increased to 6.7 per cent in 1970 and then jumped to over 28 per cent in 1973 (Amsden, 1977: 225). The items exported were general-purpose MTs, which met the

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[8] Even today, the official statistics compiled by IMTMA does not contain the production figures of this sector.

[9] The fact that small-firms were relying on black-market for their main inputs have been well documented in a report by Development Commissioner, Small Scale Industries (1958). The report states that "(T)he main raw materials used in MTs industry are pig iron, steel, coal and non-ferrous metals like gun metal and white metal. All the large-scale units are quota holders of iron, steel and coal. But many of the small-scale units have not been sanctioned any quota of iron and steel and in some cases even of coal. They have either to purchase the raw materials to feed their foundries from the black-market or buy the casting (in case of assemblers) from outside. Even the quota holder small-scale units are not able to get the raw materials in adequate quantity or of the desired quality. On the other hand, some quota holders, instead of undertaking the manufacture of MTs sell iron and steel, obtained in quota, in the black-market" (SSI, 1958: 39-40). This also reflects the extent of vertical integration in small firms in the industry.

[10] Though Indian firms started exporting MTs since 1962, the exports in real earnest began only in 1968. A nearly three fold increase in exports in 1966 (column 5, Table 5) was the result of currency devaluation in 1965-66.

[11] The probable reason for export growth of Taiwan, Korea and India was that the Japan and Germany moved to high value-added NCMTs in the 1970s and 1980s. The place thus left by them was occupied by these countries.

needs of relatively small-scale machine shops or the maintenance departments of larger factories (*ibid*.). The evidence suggest that the retooling of US car and aircraft industries in the mid-1970s gave opportunity to Taiwan to produce conventional machine tools at quality but competitive prices (Amsden, 1985). The other important linkage that resulted in fillip to the production of quality MTs in case of Taiwan was the demand by the producers of leading export items such as sewing machines and bicycles (Amsden, 1977: 221).

Nature and Type of Collaborations

The import restrictions and other policy regulations since the early 1960s seemed to have a bearing on the nature and number of collaborations signed. Evidence suggest that before 1966 there was a nexus between HMT and purchasing departments of the state like Railways, Defence and Heavy engineering on one side and large firms and other government departments on the other side. Whenever departments like Defence or Railways could identify the need for a new MT already available in the world market, the GOI banned its import and to capitalise on this ban (or protection), HMT approached the government to get a license to manufacture (Desai *et al*., 1996: 36). The foreign firms, realising the futility of their attempts to export to India, acceded to HMT's request to collaborate to produce the MT in India.[12] However, in several instances, no effort was made to adapt the technology to local conditions or to improvise on it. The agreements were renewed from time to time with the belief that more modern technology was being obtained (RBI Bulletin, 1974: 1082). Not only was there a limited effort to adapt or upgrade the technology, but also, in several cases, inappropriate technology was imported. The Ministry of Industry (1977) cites a few examples of the inappropriateness of foreign collaborations, viz., production of gear hobbers for gears upto 400 mm dia., while the demand in the country is for gears upto 250 mm, etc. Regarding an agreement between Renault (France) and HMT, the Committee on Public Undertakings (COPU, 1975: 3) remarked that it was unable to understand how the collaboration agreement was entered into without taking into account the technical requirements of sophisticated machines in India. The RBI (1974: 1082) in its report observed that "often simple technology was imported because it came along with capital or with a brand name of an international manufacturer or its trade mark".

The other large firms also targeted the MT imports and replaced them with local production. It has been suggested that large firms regularly used subsidiaries to obtain licenses for the products, which they themselves could not procure. This facilitated them in foreclosing lines of manufacture to new entrants (Chaudhuri, 1978: 243). The clout of large firms is evident from the fact that the GOI in 1966-67 added a wide range of MTs including centre, capstan, turret and automatic lathes, and several varieties of drilling, milling, grinding, gear cutting and boring machines apart from

[12] The Ex-President of IMTMA has also echoed the existence of such nexus (interviewed on 3.6.1997).

mechanical, hydraulic and power presses, etc. in the banned list for which licences were not ordinarily issued to actual users. The import restriction, devaluation of currency and the recession in Indian industry led to significant fall in imports. The share of imports, which was 66 per cent in 1968, reduced to less than 32 per cent in 1971 (column 6, Table 5). On the other hand in early 1975, the Taiwanese government appropriated US$ 5 million to finance imports by the machinery industry so as to acquire the latest technical know-how (Amsden, 1977: 233). The government, however, restricted the import of MTs from the US and Europe in an attempt to help upgrade the technical level of the local machinery industry (*ibid*.). This indicates that in India the regulation on imports by the government would have contributed significantly to technological stagnation of Indian MTs manufacturers.

Policy Changes in the late 1960s and 1970s

Throughout the course of planned industrialisation in India, the investment in public sectors has been subjected to direct measures designed to influence the nature and pattern of manufacturing in the organised sector, whereas the investment in the organised private sector was also controlled by the planners through licensing[13] and other directives such as target-setting. The severe criticism of these policies (see for example, Bhagwati and Desai, 1970) led to setting up of a number of committees by the GOI in the late 1960s and early 1970s e.g., Hazari Committee, Dutt Committee etc. These committees also condemned the licensing system, and argued that the licensing system has led to the growth of monopoly and economic concentration in the hands of a few large business houses (Mathews, 1988: 2066). The implementation of reports led to enactment of the Monopolies and Restrictive Trade Practices Act (MRTP) in 1969. The effect of MRTP, however, proved contrary as there is a widespread criticism that it did not permit technological dynamic firms to develop their full potential (Jacobsson, 1990: 46). Lall (1984: 231) has argued that MRTP controls prevented the natural exploitation of technological dynamism through growth in competitive manufacturing industries. The Act induced large firms to diversify into completely unrelated activities. This resulted in thinly spread resources with a lack of specialisation.

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[13] The small firms were not subjected to industrial licensing, but had strong disincentives to grow, as they were entitled to many benefits in the form of access to subsidised bank credit, exemption from excise taxation and reservation of over 800 products for them. Once the firm ceases to be small (as per the norm), all the benefits were to be withdrawn. These disincentives to grow created duality in the IMTI. There were large firms with product monopolies and small firms, who wished to remain small. This duality was also one of the factor detrimentally affecting the competitiveness of IMTI (Desai *et al*., 1996: 51). The duality was/is not specific to India. It is a feature of Brazil, Argentina, Taiwanese, UK and German MT industries also. For example, in 1980, top 5 firms in Taiwan accounted for roughly 44 per cent of all lathes produced in value terms, 65 per cent of drilling machines and 78 per cent of grinding machines (Amsden, 1985: 273). This implies it is not the 'duality' as such but how the 'duality' was/is created that matter.

In February 1970, based on the recommendations of Dutt Committee, the GOI delineated a 'core' sector consisting of industries of critical and strategic importance to the economy or possessing the greatest linkages with other sectors of the industry. The 1973 amendment to the 1970 IPR widened the scope of core industries with inclusion of those industries which had shown high export potential in the past like the MT. Liberalisation of licensing procedures was also promised in the 1973 amendment to some of the larger private sector companies on the premise that it would assist the units to utilise their capacities fully.

In 1973 itself, the GOI enacted the Foreign Exchange Regulation Act (FERA), which forced foreign firms to reduce their equity holding to less than 40 per cent. This forced divestment of foreign controlling shares and the fall in domestic demand after 1966 made industry unattractive to licensors from 1966 till late 1970s as the number of licenses in MT industry fell from an average of 16 a year during 1961-67 to less than 6 a year over the next 15 years (Desai *et al*., 1996: 36). However, the withdrawal by foreign firms forced Indian firms to tinker with the machines and extend the product range by reverse engineering.

4.4 Phase IV – Changing Market Conditions and Initial Liberalisation of Industry

The fourth phase of IMTI began in the late 1970s when the GOI was slowly liberalising the economy to make Indian industry competitive. At the international level also, a great deal of restructuring of industry was taking place during that period, because of the use of micro-computers in MTs.

Change in Import Policy - Shift from Quota to Tariff

In 1975-76, the GOI proposed to relax the existing policy of import controls on CG, including MTs, under the premise that indigenous MT industry has made considerable progress; and the industry is capable of facing international competition especially in the range of standard MTs. To implement these proposals, GOI removed several MTs from the banned list and placed on open general licence (OGL) in 1978-79, thereby for the first time, shifting from quota to tariff restriction. A near doubling of imports in 1979 can be attributed to this change in import policy. As a follow-up to this, the number of MTs placed on OGL increased from 24 in 1979-82 to 128 in 1982-85 and 300 in 1985-88 (Wogart *et al*., 1993: 78). Though the number of MTs on OGL increased, tariffs were also raised. The two tariff bands for MTs - 25 per cent and 48 per cent in 1979-82 increased to four - 35 per cent, 55 per cent, 95 per cent and 115 per cent by 1986-89. The higher duties were mainly for NCMTs with the rationale that higher protection would lead to generation of technological capabilities. For instance, a study in 1985 found that the effective protection on ordinary lathes was 9 per cent, while on the CNC lathes, it was 83 per cent (BICP, 1988). The effect, however, proved quite contrary. The demand for CNC machines

was already low and higher protection margin increased their prices, reducing their demand even further. Over time, the small volume of domestic production kept the costs high and this made domestically produced NCMTs highly uncompetitive. The low production levels also resulted in less feedback from the users, thereby detrimentally affecting the further design improvement capabilities. In other words, the NCMTs production fell into a 'vicious circle' trap (refer Figure 2).

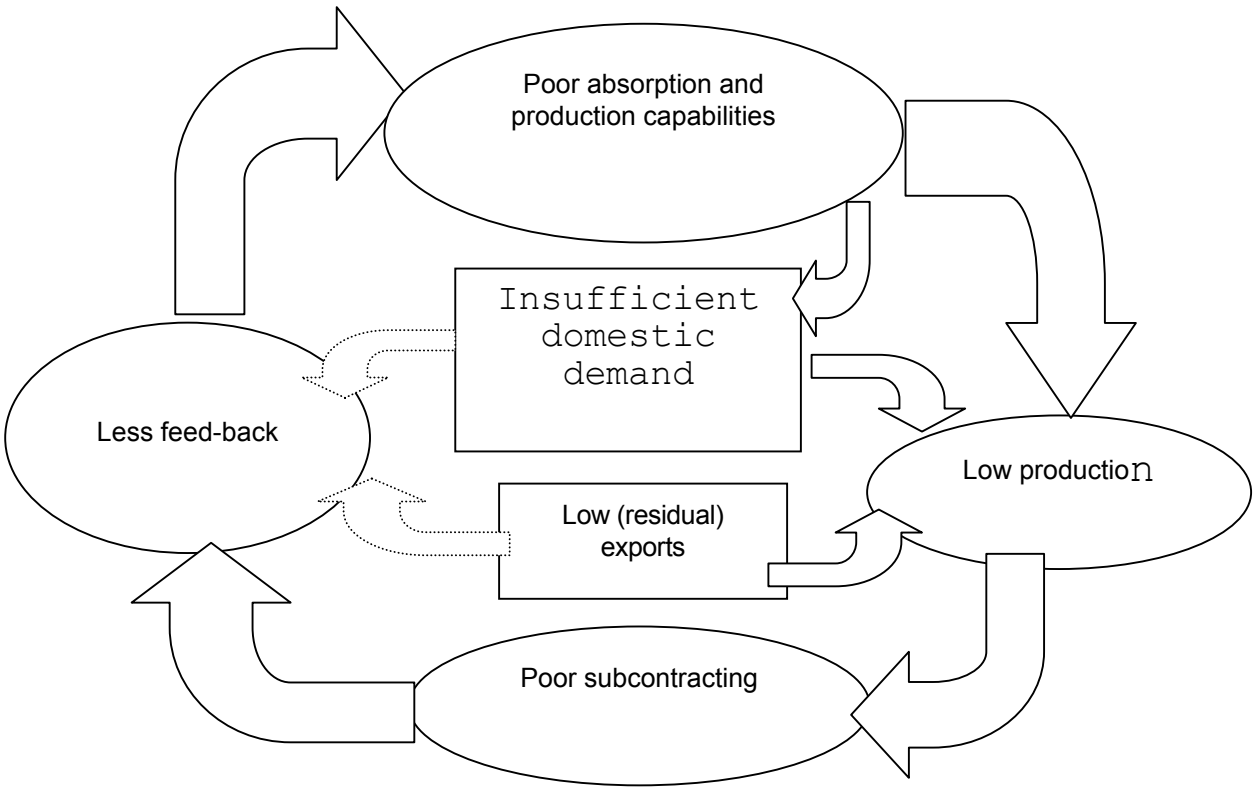

Figure 2: Vicious Circle leading to Poor Technological Capabilities

Two indirect damaging effects of curtailed imports (by way of increased duty) were - depriving Indian industry to copy new models (i.e., learning by reverse-engineering)[14] and reduced opportunity for the workers to broaden their skills. The evidence

[14] The relevance of this type of learning is evident from the fact that in Taiwan, in 1980 baring one, all other firms - large or small - acquired their initial know-how through copying or reverse engineering (Amsden, 1985: 279).

suggests that in case of Taiwan, the production of CNC lathes and assembly of machining centre accelerated when imports of such products also increased (Amsden, 1985: 277-78). The imports of large number of NCMTs also led to broadening of the skill requirement of the labour force (*ibid*.). Not only Taiwanese firms could import NCMTs easily, their tariff structure indicates that they could import duty free or had very low tariff levels. For instance, CNC lathes had a tariff of only 15 per cent (*ibid*., 282). Even in case of 'similars' MTs produced in Taiwan, imports were freely permitted except from machinery distributors and from those countries, which tend to pose a genuine competitive threat like Japan, Korea and Hong Kong. The regularisation of imports too could have kept Indian firms abreast of the product innovations occurring abroad. The relevance of this channel was multi-fold as the frontier in NCMTs continually shifts outwards. Thus, the attempt of GOI to restrict the exposure backfired.

Exports in 1980s

The export growth of the mid-1960s petered out by 1980s in all markets, except in Eastern Europe, where they could be sold because of bilateral trade arrangements. On the other hand, Taiwanese exports to US, considered as the most sophisticated and most competitive market, as the share in total imports to US increased from 4 per cent in 1976 to 7 per cent in 1981 (UNIDO, 1984). Table 7 gives the direction of Indian MTs exports for few selected years. Wogart *et al*. (1993) attributes this loss of competitiveness to the rise in domestic steel prices. In 1985, Indian steel prices were 80-100 per cent above world prices, while special steels were almost 200 per cent more expensive (World Bank, 1987). A BICP (1988) study for the year 1985 also concluded that there was a significant difference between domestic and international prices of raw materials and components ranging from 45-90 per cent for conventional MTs.

Table 7: Direction of Indian Machine Tool Exports (Selected Years)

	1975	1978	1981	1983	1986	1991	1995
Total Exports (Rs. Millions) (Current prices)	82	210	233	266	533.7	428.3	651.2
Of which (In per cent)							
W. Europe	26	17	19	10	10.1	12.4	22.2
E. Europe	3	10	7	58	69.3	69.8	19.8
Other	71	73	74	32	20.6	17.8	57.9

Source: Till 1983, Desai *et al.* (1996: 37). After 1983, Handbook of Machine Tools (1993, 1995).

In order to partially offset the negative effects of high protection and the myriad regulations put on industry, the GOI initiated several export incentive schemes like exemption from import licensing, use of import duty drawbacks, reduced foreign exchange restrictions and export finance at levels below the domestic rate of interest. The measures though were comparable with the incentives used by other countries, the lack of depth of coverage and complicated procedures made them less effective (World Bank, 1987). During same time, a study by ICICI (1985) on its 65 financed companies concluded that there existed an anti-export bias in the MT sector to the tune of nearly 11.5 per cent in 1980-81. The anti-export bias was however found for most of the sectors studied. The study also found that even with incentives, exports were unprofitable (*ibid.*: 18). As a consequence, exports remained a residual activity for most of the producers.

The high input prices and shallow incentives resulted in high prices of the Indian MTs relative to foreign products. A study in 1983, comparing the prices at which Indian and foreign machines were sold in the year 1980-81, showed that Indian MTs were 45-84 per cent more expensive than those from the Far Eastern NIEs (Development Council Report, 1983). Table 8 reproduces the results of the study.

Table 8: Export Price Comparison - Indian and Foreign-Produced MTs, 1980-81 (In Rs. Thousand)

Product	Indian Product Price	Comparable Foreign Product	Country of Origin	Indian price / Foreign price
Centre Lathe				
LCI	160	110	Taiwan	1.45
HCI	280	160	Taiwan	1.75
Milling Machine				
LCI	250	160	Korea	1.56
HCI	350	190	China	1.84

Notes: LCI: Simple, lower cost items; HCI: Sophisticated version and higher cost items

Source: Development Council Report (1983).

Further, a lagging exchange rate policy pursued in the early 1980s intensified the bias relative to other MTs exporters of the developing world. As a result, firms mainly concentrated on the East European markets. These markets offered better prices, less quality control and a welcome opportunity to avoid competition prevailing in the OECD markets.[15] This was in complete contrast to what was happening in Taiwan as

[15] Even exports were concentrated in a handful of firms. For example in 1986, 3 large firms accounted

the firms' market orientation changed away from Southeast Asia towards more demanding USA (Amsden, 1985: 275). The reliance of Indian MT manufacturers on trade-agreements rather than the quality and price competitiveness vis-à-vis successful penetration by Taiwanese MTs to US indicates that the low quality demand (as prevalent in Eastern Europe) can easily block both penetration to advanced markets and graduation to high quality models (*ibid*.). It is interesting to note that the Taiwanese inroads to highly competitive US market was not due to shift from conventional to NCMTs exports, instead concentrating on durability, reliability and precision of traditional products. This increased in market size largely by exports also led to pronounced changes in the division of labour in Taiwan as over time a well-articulated system of subcontracting and satellite shops evolved similar to that in Japan.

Dissatisfaction with Phased Manufacturing Program (PMP)

On the other hand, in India, a BICP (1988) study showed dissatisfaction with the prevailing phased manufacturing programme (PMP) policy, which required 85 per cent indigenisation within 4 years. In their study of automobile and electronic components, they found high domestic cost of import substituted components as compared to internationally available products. Moreover, the quality of the substituted components was also found to be sub-standard. In fact, PMP had a large detrimental implication on generation of technological capabilities as it often forced Indian engineers to undertake a great deal of design efforts on the final product as compared to their OECD counterparts (Jacobsson, 1990: 52). Edquist and Jacobsson (1986: 2057), based on their survey of machining centres producers, argued that to some extent, the indigenisation efforts might have 'squeezed out' own product development work.

Other Important Policy Changes in the 1980s

A major policy change was introduced in 1984 in the form of 'broad banding,' to industries like MT with a view to optimise the utilisation of capacity and encourage large volumes of production. It meant MT producers no longer needed an industrial license to produce new models within their licensed capacity. By 1987, the 'broad-banding' policy was extended to 35 industries.

In 1985, some major changes were initiated in the industrial licensing regulations. In 1987, the government permitted MRTP and FERA companies to set up production facilities for MTs without obtaining industrial licenses provided such projects are set up outside a radius of 150 Kms. of seven identified metropolitan centres (Ministry of

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for more than 85 per cent of the total exports for the year (IMTMA, Annual report, 1987), whereas in Taiwan exports originated from both small and large firms because of their reputation of quality products.

Industry, 1987-88). In August 1987, the GOI introduced a Technology Upgradation Scheme for the MT industry through the Industrial Development Bank of India. Under the scheme, the main benefits included import duty reductions to 40 per cent, concessional rate of interest for funds at 11.5 per cent, flexible approach to debt-equity ratio, liberalised bills rediscounting scheme etc. (Ministry of Industry, 1990-91). However, the scheme was withdrawn in 1993 for no apparent reason.

The technology import policy also underwent few changes in the 1980s, more in terms of the implementation than in the rules themselves. This had a clear impact on the number of foreign technical collaborations approved after 1981 as the numbers, which were hovering around 370 before 1980, rose to over 1,000 in 1985. In MT industry, Jacobsson (1990: 48) finds that after the initial liberalisation, all the firms that entered to manufacture machining centres tied up with foreign firms for technical collaboration.

Indian Firm's response to CNC Revolution

In the late 1970s and early 1980s, there was a structural change in the world MT industry as the leading MT producers of the world moved to NCMTs. This 'technological opportunity' also created opportunity for 'product diversity' for Indian firms, however, there are studies that argue that most MTs manufacturers (as well as users) let this technological revolution bypass them (see for example, Wogart *et al*., 1993; Mehta, 1990). The reason given is that the Indian manufacturers were complacent as several studies like UNCTAD (1982) etc. hailed the industry about their achievement in developing significant technological capabilities in the light of import substitution (ISI) regime. The complacency was, however, short-lived, as when the Japanese automobile firm Suzuki decided to invest in India in collaboration with the GOI in the early 1980s, it refused to buy even those MTs, which were considered to be of good quality (from Indian firm's point of view) (Wogart *et al*., 1993: 71). There are counter views also, which argue that the state itself did not let learning opportunities available to IMTI as it showed indifference to HMT's efforts (in a consortium of public and private firms) to supply MTs to Suzuki, and exclusively relied on Japanese MT manufacturers (Raj, 1985: 18).

Irrespective of the reasons, this made apparent to the industry that to survive it needed to modernise and venture into CNC, the 'sunrise segment'. Immediate fall-out of this realisation led to signing of a number of foreign collaborations in CNC segment during the period. For instance, 11 foreign collaborations were signed within two years (i.e., from 1984 to 1985) to manufacture machining centre (Jacobsson and Alam, 1994: 138-39). DSIR (1990) report states that as on 1986, 15 firms had foreign collaborations for a number of NCMTs including lathes, turning centres, milling machines, machining centres, CNC systems, ball-screws etc. One reason for Indian firms to go for wide-ranging technological collaborations, was to short-circuit the learning process as the risks, and often costs are lower, and lead time shorter, if

firms' go for collaborations instead of developing their own technology. In addition, using a foreign brand name may have given the licensee a marketing premium (Jacobsson, 1990: 53).

In the mid-1980s, when the pace of liberalisation picked-up, several Japanese joint ventures (JVs) were cleared in the light commercial vehicles sector. To supply them MTs, several technical licensing agreements were signed immediately with Japanese MTs producers. Incidentally, these Japanese MT makers were also major suppliers to the respective Japanese automakers in their home country.

The requirements of precision MTs by the growing automotive sector and the huge gap in technological sophistication domestically available MTs led to significant growth in imports during the period. Imports consisted primarily of NCMTs. One hundred NCMTs (valued at Rs. 180 million) were imported in 1983, 187 NCMTs worth Rs. 500 million in 1984, and 160 NCMTs costing Rs. 350 million were imported in 1985 comprising 11.5 per cent, 39 per cent and 37 per cent of total imports respectively (IMTMA, Annual reports). The installation data also reflect this reliance on imports as of the total 1,182 NCMTs installations in 1986, 1,046 (i.e., over 88 per cent) were imported (CMTI, 1989).

Rise of Technocrat Entrepreneurs

In the 1980s, a significant event happened in IMTI in the form of emergence of few small firms set up by technocrats. These technocrats, being dissatisfied with the existing working environment, left the public sector giants like HMT, Praga or CMTI to start their own set-up. These new entrepreneurs went into one of the two lines of business. One group developed relationships with large users and designed MTs especially for them e.g., Machine Tool Aids and Reconditioning (MTAR) group made precision MTs for the space programme (Desai *et al*., 1996: 40). The other group makes standardised MTs and buys out most of its requirement, hence relies on vertical disintegration similar to the one used by Taiwanese MT producers. In fact, the entry of technocrats due to their small size might be the cause (and effect) of increasing vertical disintegration as they would have stimulated the subcontracting activities by rationalising the size and scope of production activities within component producing enterprises. Another characteristic of this group is manufacturing a mutually exclusive set of MTs and being sold/marketed and serviced by one company under the common brand name. During the recession in 1990-93 and subsequent policy changes, these technocrats run firms were less affected than others.

Thus, in third and fourth phase, a number of events occurred such as venturing of Indian firms into export markets in a big way and stagnation of MTs production (in quantity terms) after reaching a high in 1966. Also, during the period, the shares of

small firms increased at the expense of HMT and other large firms,[16] and a new breed of entrepreneurs termed as 'technocrat entrepreneurs' rose in prominence. The discussion so far captures the evolution of IMTI till the late 1980s with the state influencing through policy making. As stated earlier, in India the state was/is a major producer also, how that role affected the development of IMTI, is illustrated in the next subsection.

4.5 Role of State run Institutes

HMT

One aspect of the role of HMT, the state owned MT producer and CMTI could be assessed from the fact that most of the 'technocrats entrepreneurs' were 'spin-offs' from them. Another important role played by HMT was the development of highly sophisticated and state-of-art MTs. Since any successful development of a product requires substantial finance, the private firms do not enter into the development unless they are assured of market. It was HMT, which developed and produced every conceivable MT (CNC and conventional), thereby hedging against the risk of failure for private firms. Once the product was displayed and some demand created, several private entrepreneurs invested to capitalise on it. For instance, HMT started working on the design of horizontal machining centre in 1979 and it took 4 years and around Rs. 8 million and 24 man-years to develop it. The implication of this development is evident as in 1984-85 itself, 8 collaborations were signed to produce machining centres (Jacobsson and Alam, 1994: 137-39).

Similarly, the first NC lathe and the CNC system in India were developed in the early 1970s in a collaborative effort between HMT, CMTI and two foreign firms. However, the company could not find any domestic customer for these. These developments were jettisoned when it tied-up with Siemens for CNC systems in the early 1980s (Wogart *et. al.*, 1993: 17). In 1979, when the demand for CNC machines started picking up, HMT again developed a slant-bed CNC lathe and this time they could find customers. HMT was also the first to produce flexible manufacturing systems (FMS) in 1988.[17] The examples also demonstrate the technological capabilities of HMT. Till the early 1990s, HMT had a reputation of a 'quality' producer. Unfortunately, the monopoly of producing so many MTs has made the company too big to handle (i.e., an example of 'core-rigidities'). Besides, a number of foreign collaborations[18]

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[16] Incidentally, the small firms could capture the market because they produced a poor quality MT with less modern, but simple and crude techniques for 'price-sensitive' and 'quality-insensitive' customers. In fact, in the initial phase, when reliance was primarily on domestic market, Taiwanese MTs firms also followed this path (Amsden, 1977: 219).

[17] At present, HMT is manufacturing products like CNC Broaching machines etc., which no private company finds profitable to produce due to their negligible demand.

[18] As of now, HMT has entered into more than 60 foreign collaborations to produce over 40 products.

covering a wide range of MTs has resulted in its failure to acquire strength in any product line (Hindu, 19.2.1993).[19] With increased size, the flexibility seems to have been lost and decision making has become tardy. This has also resulted in erosion of its monopoly position. Earlier HMT used to be given preference even if its products were costlier by 5-10 per cent - especially in Defence purchase, where 'quality' rather than 'price' is the criterion. Now the situation has changed. Other large firms get a larger share of orders than HMT.

HMT was also the first public sector to consciously promote ancillaries in the late 1950s so as to have uninterrupted supply of components and parts, i.e., a move towards division of labour.[20] Using its own resources, HMT constructed an ancillary industrial estate to house 50 exclusive ancillaries (Nagraj, 1989: 202). Though these ancillaries were promoted with the sole purpose of supplying to HMT, after 1966 slump, when it did not have sufficient orders to buy from them, they started selling to private MT producers. At present, most of the production of these ancillaries is sold to other manufacturers. The study by Nagraj (1989: 202), however, concluded that the scheme did not yield requisite results because of the short-term motive of HMT.

Thus, the role of HMT in the development of MTs is substantial as it brought MT culture in India. The firm also serves as a benchmark for several MTs makers in India e.g., Batliboi.[21] If the firm sets standards for other producers then its role increases multi-fold.

Role of CMTI

CMTI was established with technical and financial assistance from the government of Czechoslovakia. During its best phase in the late 1960s and 1970s, CMTI developed a number of products including special purpose CNC universal cutting and milling machines, SPM for drilling linear tubes, etc. CMTI has also developed a number of quality SPMs for Defence. In order to familiarise the industry with NCMTs, CMTI established a NC centre in the early 1980s. The centre helped the industry by getting its personnel trained in the programming, tooling, maintenance, and production aspect of using NCMTs. Also in the initial stages, it was instrumental in providing consultancy in the selection of NCMTs to many industrial organisations, which did not

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[19] There are evidence that find when products increasingly become multi-technology, the successful firms are those that narrow down their product focus while simultaneously broadening the technological focus. Refer Gambardella and Torrissi, 1998 for an example of electronics industry. However, in HMT's case, this product focus has not been attained.

[20] Apparently, this was also one of the reasons for termination of collaboration with Oerlikon, Switzerland in 1958. To the collaborator, subcontracting means diffusion and leakage of its proprietary technology (Nagraj, 1989: 188).

[21] The GM Design of Batliboi told that his firm tries to achieve the quality comparable to that of HMT products, but at a price 5-10 per cent lower (interviewed on 27.5.1997).

have any such machine. In order to promote design-engineering capabilities in the industry, PMT trust award was started under the auspices of CMTI in 1975. The award is especially for firms in the small sector, which display design development capabilities.

Despite all these activities, CMTI has not been as close to the industry as the Taiwanese research institutes like Machine Industry Research Lab (MIRL) and the Precision Machinery and Development Centre (PMDC) with their MT industry (Desai *et al.*, 1996). PMDC for example, produces prototypes and sells technical assistance, whereas MIRL undertakes research in NC, computers and robotics to help small firms technically in areas where their small size precludes scientific research (Amsden, 1985: 282). The MIRL has been instrumental in Taiwanese firms' success by providing assistance for the design of NCMTs and machining centres. For instance, by mid-1983 MIRL had 22 contracts with 18 firms, all involving complex design of new NCMTs and machining centres (Fransman, 1986: 1387-88). Of the 8 firms responded, Fransman finds that 5 got assistance from the MIRL for the design of CNC machine tools (*ibid*.: 1384). Whereas, in case of India, Kathuria (1999a) finds that barring one or two, most of the firms in the CNC lathe segment have not benefited from the CMTI.[22]

4.6 Phase V – IMTI after the 1991 Liberalisation

The fifth and the current phase began in 1991, when the GOI introduced major policy changes in its trade, technology and industry policies. The major changes in MT industry was delicensing in 1991 followed by abolishing of import licensing for MTs and industrial inputs; and abandoning of PMP in 1992. Lastly the import duties on MTs were progressively reduced from a high of 130 per cent in 1991 to 20 per cent in 1997. However, this progressive fall in import duties is more on finished MTs than on components (except the CNC control) resulting in a duty structure, which is now skewed against the import of raw materials and components like ball-screws etc.

Unfortunately, when changes were being introduced, Indian industry was passing through recession (1990-93). At the same time in 1990, an unrelated event occurred in the form of collapse of former Eastern Europe. The collapse affected the India's exports as bilateral trade agreements were no longer in place. As a consequence, exports, which were over 10 per cent of the total output during late 1980s, fell below 3 per cent. Recession, collapse of Eastern Europe and major policy changes brought a complete turn-around in the industry resulting in bankruptcy of few firms like XLO

[22] The 'excessive bureaucracy' in the institute is the factor resulting in lack of its orientation. This has been emphasised by ex-president of IMTMA also, who earlier, was in the board of CMTI (interviewed on 3.6.1997). He stated that during his tenure, more than 80 per cent of the time used to be wasted in discussing routine matters like workers' absence, workers not obeying the supervisor etc. (Kathuria, 1999b).

India Ltd. etc. and several others made huge losses (e.g., MKL, KWS etc.). Over time, with liberalisation gaining momentum, lots of JVs were signed. The improved economic environment ameliorated the performance of the industry. One important outcome of these changes is reduction in the prices of NCMTs. The machining centre, costing Rs 7.2 million before 1991, now cost Rs. 2.4 million and a NC lathe, which had a cost of Rs 2.2 million, is available for Rs. 1.4 million (Desai *et al*., 1996: 42). The reduction in prices was mainly the result of abolition of import licensing, which greatly cut down the problems of importing, and reduced import lead times as well as inventory of imported inputs. Since more than 60 per cent cost of a CNC lathe or a machining centre (or any other CNC product) comprises of imported components (including control unit),[23] the fall in prices was inevitable. However, the differential duty structure is militating against further fall in prices.

Some of the features of this phase are increased production of NCMTs and a rise in the market share of technocrat-owned firms. Table 9 gives the production (and exports) of NCMTs in India since 1984. In terms of quantity, the share of NCMTs has increased from less than half a percent in 1984 to over 13 per cent in 1998, whereas in value terms, the share has risen from 4 per cent to over 37 per cent in 1998. From the table one can infer that the share in value terms has stagnated in the past 2-3 years to around 38 per cent.

[23] This compares with only 5 per cent for a conventional lathe (Fransman, 1986b: 1393).

Table 9: Production and Exports of NCMTs (Units and Rs. million) since 1984

Year	NCMTs Production		NCMTs /Group A		Exports				NCMT / Total MT Export(	
					Total MTs		NCMT			
	No.	Value	No.	Value	No. (5)	Value (6)	No. (7)	Value (8)	No.	Value
1984	42	76.36	0.44	4.09						
1985	65	128.56	0.70	6.57						
1986	93	174.82	0.84	9.01	1649	420.4	0	0	0	0
1987	200	478.8	1.91	19.43	1629	592.4	0	0	0	0
1988	282	671.82	3.10	24.41	1169	300.8	17	24.7	1.45	8.21
1989	461	1054.19	5.83	31.07	1885	492.88	29	52.03	1.54	10.56
1990	560	1368.69	6.25	33.12	2035	809.4	68	158.98	3.34	19.64
1991	680	1824.87	9.72	36.19	127	449	32	71.68	25.20	15.96
1992	513	1862.02	9.01	37.26	459	236.03	20	63.18	4.36	26.77
1993	425	1715.03	8.82	40.71	220	158.17	19	27.09	8.64	17.13
1994	717	2627.71	9.97	44.77	810	325.2	24	34.41	2.96	10.58
1995	949	2708.83	13.12	38.12	445	192.87	35	51.88	7.87	26.90
1996	1050	3178.89	15.39	39.42	323	247.47	35	46.75	10.84	18.89
1997	1038	3159.7	14.88	39.68	531	320.99	89	141.51	16.76	44.08
1998	1000	2480.14	13.5	37.11	951	604.87	159	262.5	16.72	43.4

Source: IMTMA annual report (various years); Machine Tools Handbook (1993, 1995), EXIM (1996: 97-9).

Given the low level of export of Indian NCMTs, it is apparent that this 'sunrise segment' is unable to realise the economies of 'scale' - a pre-requisite for the industry to develop capabilities and be internationally competitive.[24] The data shows that in the past 15 years only 527 NCMTs have been exported, whereas Taiwan exported 2,788 NCMTs in 1993 itself. The relevance of economies of 'scale' in influencing price competitiveness is clear from the fact that in 1993, where the Taiwan had a production of 6,567 NCMTs, India could produce only 291 NCMTs resulting in three times unit price difference between Indian and Taiwanese MTs (refer Table 1). For the year, Korea produced 3,824 NCMTs at one-half the price of that of Indian machines. According to Jacobsson (1986), a large-scale producer of CNC lathes producing 2,000 units per year can achieve a unit cost approximately 40 per cent lower than a small-scale producer producing 100 units. This is also clear from Tables 1 and 2 that for most of the products, when Indian output level rose sharper than that of Taiwanese output, the unit price difference fell. For instance, the CNC lathe output figure ratio fell from 20 in 1993 to less than 11 in 1997 resulting in 10 per cent fall in unit price difference. Still, the production of most of the CNC machines is India is highly uneconomical and well below international norm. For instance, Boston Consulting Group (1985) states that 400 lathes per year are necessary to have an economic production. The difference seems quite glaring as the whole industry comprising nearly 20 firms could produce only 497 lathes in 1995 (IMTMA, 1995-96). Thus, the small production level has resulted in firms forgoing benefits from realisation of Verdoorn's law, besides getting trapped in the 'vicious circle' leading to further quality erosion.

5. *Role of Different Agents in the Development of IMTI*

User-producer interaction

The above description shows that the user-producer interaction of the kind prevalent in Japan, Taiwan and other OECD countries exerting pressures on producers to provide MTs to their specifications or quality standards, was absent in India. Moreover, the extensive reliance on local market foreclosed another channel of learning unlike the Taiwanese and Korean MT producers. As a result, MT manufacturers tinkered with the machines, conventional and CNC, of their own, without integrating them into production programme (Kathuria, 1999b). There are evidence suggesting that major private users themselves were infatuated with foreign branded machines, thereby denying the local MT industry the benefit of 'learning from doing'.[25]

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[24] Since a substantial part of a NCMT is still imported, the small scale of Indian producers implies that smaller the order, higher will be the transaction cost of importing due to fixed cost of paper work and specifying order in a foreign language for components of diverse grades.

[25] For instance, in the 1980s, one of the auto giants agreed to purchase a number of MTs from a local producer provided the local firm tied up with a reputed foreign firm to produce the product (Source:

Moreover, as the size of the market was stagnated in India, it never became profitable for the firms to introduce new machinery or new MT. The prevailing demand preferences of low-income indigenous customers bounded the technical horizons of Indian MT makers. The division of labour and consequently improvement in quality and hence the technical change was arrested in many ways. Once the demand from the state as a user dwindled after 1966, the rest of the market characterised by a high price elasticity of demand and preference for cost at the expense of quality, did not let the MT builders to enhance the quality.[26] Only after the 1991 liberalisation, the pressure to survive forced many firms to upgrade quality. A recent example is MKL, which has replaced a number of conventional lathes by CNC lathes to achieve close tolerances (Kathuria, 1999b).

User-supplier interaction

The limited volume of MT production had also not been attractive for component suppliers to invest in production. This resulted in a weak or non-existent subcontracting network till the end of fourth phase. As a result, all the large firms became highly vertically integrated and did not lead to a more efficient local 'division of labour'. In fact, spreading thin and dispersion of skills over wide range of jobs appears to have been prevalent in the history of MT building in the Taiwan and China (Amsden, 1977: 223), but real test comes once the industry graduates from production of simple machines to complicated machines. As sophisticated machinery involves thousands of parts, which a single plant cannot supply, specialisation and close co-ordination becomes imperative. In China, since 1963 measures were taken to move towards specialisation so that a finer 'division of labour' could be attained. In India, even after 1991 liberalisation, the situation has not changed much except in few pockets. In Taiwan, on the other hand, the foreign firms and JVs in few branches of the machinery sector were forced to subcontract by law since the early 1970s (Amsden, 1977: 223). Thus, the benefit of suppliers to improve competitiveness was missing in India in contrast to that of Japan, Taiwan or even China.

Competition

In India, the Competition among producer firms was not only constrained because of product monopolies, but was also distorted. A 10 per cent price preference used to be given to public sector producers in GOI contracts (Wogart *et al*., 1993: 106). This resulted in most of the MT orders in favour of HMT or Praga as the state was the major buyer (except for few years after 1966). Thus, the pressure to produce quality

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interview with ex-employee of the producer on 3.6.97).

[26] A recent survey by Kathuria (1999a) also demonstrates that firms which are catering to the lower end of the segment are virtually crippled to improve the quality because of demand characteristics of the 'price sensitive' customers.

products at minimum costs was missing. Besides, product monopoly and restricted imports (detrimentally) helped the firms to break-even despite a low demand. On the other hand, in Taiwan, the low demand till sixties led to shakeout in the industry as many firms closed or left the industry. As a consequence, for the remaining firms the demand shifted upward (Amsden, 1977: 224).

A minimal competition in India resulted in a 'product-out' approach, where manufacturers paid very little attention to the needs of the customer to improve features on the machines. There was hardly any pressure to pay attention to service aspects such as delivery time, spare parts supply and after sales service (Srinivasan, 1995). With respect to competition from imports, the price comparison had always been on the landed cost of the machine, which included substantial customs duty elements. This provided enough margins for inefficiency (*ibid.*).

'Learning from exports,' in India, was also non-existent as exports were treated as a residual activity because of anti-export bias and low profitability vis-à-vis domestic sales. Besides, exports were mainly to the protected markets of (formerly) Eastern Europe, because of the prevailing bilateral rupee-trade agreement.

Role of the State/Government

The various policy measures taken by our policy makers suggest that the state was very pro-active in its endeavour to promote IMTI. However, in several instances, the conflicting policies and their implementation did not yield healthy growth of the industry. Further, the major policy plank used was 'import substitution' and '*autarky*' instead of international competitiveness. The state tried to protect domestic industry by imposing import restrictions, which unfortunately resulted in product monopolies with inefficiency as its by-product. The excessive protection given to the local firms and the anti-export bias in policies made exports a residual activity, thereby foreclosing this avenue of learning and competitiveness. The state's dual role as producer and procurer resulted in distorted competition with little emphasis on competitiveness. Thus, the forces, which helped Japan, Korea and Taiwan in attaining international competitiveness, were either non-existent or they worked in the opposite direction in India till the end of fourth phase. In the fifth phase (i.e., the liberalised scenario), a new incarnation of the government, where it is assuming a minimal role and allowing market forces to restructure the industry is, however, yet to show results.

In the terminology of Evans (1995), India pursued more a role of 'custodian' and 'demiurge', which proved costly and absorbed scarce state capacity. On the other hand, in Taiwan, the government mainly acted as 'midwifery' and finally embarked to 'husbandry' that helped sustain the local industries created by it.[27] In fact, in both the

[27] 'Custodian' is the role of regulator that privilege policing over promotion; whereas 'demiurge' is the

countries the initial act of government was that of 'midwifery' to support local industries, which in India transcended to 'demiurge' rather than to 'husbandry' over time. The analysis thus suggests that it is not only the *degree* but also the *form* of state intervention that decides the building of technological capabilities and international competitiveness.

6. Concluding Remarks and Policy Implications

The production of machine tools has long been associated with industrialisation besides a formidable factor of technical change and international competitiveness, since MTs are the building blocks of a dynamic CG sector. The realisation of this role of MTs has dawned to Indian planners' way back in fifties. As a consequence they tried to shape and restructure the industry within the overall policy objective of *autarky*. The present paper is an enquiry into this role of the state to see, whether the degree of support cum intervention led to generation of technological capabilities and an internationally competitive industry or not?

The comparison with Taiwan shows that Indian MT industry is high uncompetitive with respect to unit price, or quality or in terms of exports. The historical description shows that the government overplayed its role in the development of the industry. In India, the state was not only a major user and restructurer of the industry, but also a major producer. Such a multi-facet role had justification only in the initial stages of development, when the level of private investment in the industry was abysmally low because of uncertainty in demand and the risks involved. Over time such varied responsibilities resulted in conflicting policies. The nexus between HMT and other government departments to forestall the import of MTs and help HMT to enter into foreign collaboration for the product, was the most glaring example of this conflicting role. In another instance, the state itself denied local firms to benefit from learning by doing, when it was most desired i.e., the period when there was structural change at the global level. On the other hand, the competitiveness of Japanese, Taiwanese, and Korean MT industries was facilitated by the proper focus of their respective governments to restructure the industry.

In fact, India had a better head start compared to Taiwan because the state as a major user (at least till 1966) used to procure from large MT producers. Compared to this Taiwan's demand emanated from small machine-making and metal-working enterprises or the small processing and repairing shops (Amsden, 1977: 220) as for

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more generic role of producer that competes in the markets for normal private goods. The role of 'demiurge' assumes the limitations of private capital. Instead of substituting itself for private producers if the state tries to assist in the emergence of new entrepreneurial groups or induces existing groups to venture into more challenging kinds of production, the role becomes of 'midwife'. The examples include providing subsidies and incentives, tariffs to protect local industry etc. The 'husbandry' is cajoling and assisting private entrepreneurial groups to meet international challenge (Evans, 1995).

armaments industry, or shipyard, the state produced its own MTs with foreign assistance and security precautions prevented an exchange of technology with the private sector (*ibid*.: 221). This implies, the Indian MT industry had a welcome opportunity to produce quality MTs given the nature of the buyer, besides generation of technological capabilities was relatively easier. Whereas, the technical known-how of Taiwanese MT builders was acquired without the assistance of the small minority of its users which were technologically advanced. After 1966, the sudden collapse of demand forced Indian firms to export, which they could do successfully but did not capitalise on it fully as their growth in the quality-discerning markets was replaced by bilateral trade agreements. On the other hand, the initial MT exports from Taiwan was mainly of labour-intensive manufacturers, but later on they graduated to quality exports but of traditional variety.

Thus, all these opportunities were lost and Indian MT industry fell into a 'vicious circle' of low production, less feedback and inferior quality but costly machines. Now, in the liberalised scenario, with greater opportunities to learn, one of the ways to puncture this trap is to venture out for exports in a big way. The recent upgradation by several MT makers would lead to building of a more reliable MT and enable the industry to penetrate higher-income markets. However, this would still require a catalytic action so as to initiate a vigorous export activity. Ideally, such impulses should have come from the state. Since the state is now moving to other extreme i.e., of minimal involvement, the firms may have to take recourse of other route to transform the 'vicious circle' to the 'virtuous circle.' One of such routes could be by forming strategic alliances with OECD or NIEs MT producers,[28] where concept design can be seeded there and detail work can be done in India to utilise its low-priced but skilled manufacturing base.[29] There are estimates indicating that such a strategic alliance can result in around 40 per cent overall saving in development cost (Malik, 1995: 6).

While a small nucleus of firms in India have now succeeded in building MTs of both conventional and CNC of limited variety, the real test is the ability to produce a wide assortment of high precision MTs. This can be accomplished as the country has both the ingredients of success – availability of enterprising and energetic entrepreneurs and an abundant supply of cheap and skilled labour to cushion the costs of mistakes. But to do so, it may require overcoming traditions and habits such as verticalisation,

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[28] The idea is not new as HMT pioneered this concept in the late 1970s with firms in UK and US to jointly develop centre lathe and a vertical machining centre in India based on the broad concept design made in US and UK. After the development was completed, 24 turning centres and 14 machining centres were assembled abroad with components supplied by HMT for customers in UK especially to British Aerospace (Malik, 1995: 4).

[29] The skill base of Indian MT producers is evident from the fact that MT units in the country were first to receive ISO certificates from internationally reputed agencies and today over 75 per cent of the official production of MTs in the country is from 25 major ISO certified companies.

sub-optimal size firms, which became entrenched in the early stages. Though cheap labour can be a factor in enhancing competitiveness in conventional MTs production, its relevance gets significantly reduced due to high bought-out components with the change over to design and production of NCMTs. This implies a strong reliance on economies of 'scale' is must to be more competitive.

As a first step, attempts need to be made to quantify the price and quality differential that exists between Indian NCMTs and the best quality competing products in export markets. The resulting indices can also serve as measure of the distance of Indian firms from the best-practice technology frontier.

The second step to attain competitiveness would be to merge firms and gain from the benefits of the economies of 'scale', 'scope' and 'specialisation'. Otherwise, these firms will be at an increasing disadvantage vis-à-vis penetrating Taiwanese firms or Korean *chaebol*. Since most of the Indian firms are significantly small, the state provided research facilities, assistance with design and training of engineers will certainly help compensate for the lack of size.

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