Technology and Market Structure Under Government Regulation: A Case Study of the Indian Textile Industry

Ashok V. Desai[1]

Although the small market limits the number of competitors and the intensity of competition within most Indian industries, the textile industry remains an exception. It was, perhaps, more competitive 30 years ago, when a large number of mills produced undifferentiated yarn or grey cloth and sold it at prices over which they had little control. Today, there is greater product differentiation, but the number of competitors is greater and among them are groups (e.g., powerlooms) between which collusion is possible.

The intensity of competition is not reflected in the speed of adoption of innovations or their diffusion. New technology, embodied in equipment, has been imported from abroad after considerable lags, although the lags have been shorter when the rate of investment has been high. The range of technologies in use at any point in time has also been great, largely because new investment has tended to go into new enterprises and old enterprises have been sheltered from competition by low depreciation costs.

In general, a number of new elements were introduced during the postwar period. (1) With the separation of Pakistan, India lost some prime cotton-growing areas, a shortage of foreign exchange limited cotton imports, and the size and quality of domestic cotton output began to influence the growth of the textile industry, which has only recently been modified by the supply of man-made fibres. (2) Quantitative import restrictions led to the growth of a diversified textile machinery industry, which made equipment more widely and easily available than was the case prior to the 1950s. (3) The government discriminated against various segments of the industry both by fiscal means and through its control of productive capacity. The discrimination was against mills, which, as a result, faced more intense competition. The purpose of this paper is to review the influence of these forces on the technology and market structure of the textile industry.

It should be noted that virtually all of the available data refer to the mill sector and almost none to the small-scale sector. Hence, conclusions made about the latter are necessarily in the way of inferences, although they have a basis insofar as the small-scale sector buys its yarn from the mills. Another important point is that it is treacherous, in India, to judge the success of a firm or industry from its rate of profit. The taxation of declared profits creates a strong incentive to take profits in undeclared forms. There are, undoubtedly, some large corporations that are fair to shareholders and have a strong enough competitive position to make high declared profits even after tax, but in companies and other types of firms controlled by a family or a small group of people, profits are, to a great extent, distributed without being called profits. In the textile industry the rate of profit is doubly misleading because its capital equipment is old and, hence, valued at extremely low historical costs. If it were valued at replacement costs, a large part of the industry would be operating at a loss. Hence, the success of firms and groups is judged on the rate of growth of sales, based on the assumption that a firm would not be expanding if its owners found it unprofitable to do so.

Cotton Textile Technology

Cotton textile technology has three essential stages: cotton preparation, spinning, and weaving. Preparation entails cleaning, straightening, and aligning the fibres; spinning involves drawing out and twisting the fibres into a thread with

[1]Consultant, National Council of Applied Economic Research, New Delhi, India.

some tensile strength; and weaving consists of stretching the threads and arranging them into a dense grid, which constitutes cloth.

In the manual form, which can still be observed in khadi (handspun cloth) production in India, the preparation of cotton consists of three stages. Firstly, the cotton is ginned, i.e., cotton received from the field is passed between rollers that are too close together to allow the seeds to pass; in this way, the lint is separated from the seeds. The lint is then blown: a taut string passing through the cotton is beaten and as it springs up it throws up cotton tuffs that open out and shed dust and grit. In the third stage, the clean cotton is passed through rollers with teeth or knives that stretch out the fibres in a single direction, producing a pad of more or less even thickness. This pad, or lap, is then rolled into slivers.

All of these stages are present in the mechanized version of the technology as well. Blowing is accomplished using air jets but apart from that machine operations duplicate the manual processes. The productivity of labour and equipment in the succeeding process, spinning, depends upon the quality of the sliver (or roving, as it is called in the mechanized version). Hence, as the speed of spinning increases, the preparatory processes become more elaborate and better controlled.

In handspinning, the spinner draws out the sliver with one hand to thin it down and turns the spindle with the other to give the emerging yarn a twist. In the next movement, the yarn is wound onto the spindle. By varying the relative rates of drawing and twisting, the spinner can vary the thickness of the yarn: a skilled spinner can spin thinner and more even yarn with fewer breaks. Thus, the spinner's skill can compensate, to some extent, for the quality of the cotton as well as the preparation. In mechanized spinning, the twisting of fibre into yarn as well as its winding onto the spindle are simultaneous operations carried out at a constant speed. Hence, the roving being fed into the ring frame must be more standardized and homogenized than the sliver used on the spinning wheel. Open-end spinning machines, which have been introduced abroad within the last 15 years and which operate at higher speeds than ring frames, require even better processed cotton; in particular, they require cleaner raw material as well as a dust-free environment.

In handweaving, the weaver uses one hand for shedding, i.e., for raising and lowering the strands of yarn running forward (the warp), and the other for picking, or moving the shuttle that carries the crosswise strand (the weft) across the warp. A powerloom performs the same operations mechanically. In an automatic loom the shuttles are replaced mechanically when they run out of yarn, so that an operator, whose remaining task is to mend yarn breaks, can look after more looms. In shuttleless looms, the shuttle, which is relatively heavy ($\approx$ 50 g), is replaced by either a lighter projectile, a gripper or a rapier, which picks up the yarn at one end and drops it at the other, or by a jet of air or water. The energy consumption is, thereby, reduced and the speed increased.

Manual spinning and weaving make different demands upon workers. The process of twisting fibre to produce yarn does not require strength; thus spinning was traditionally carried out by women. Spinning wheels are light, and workers' strength does not set a limit on their output (although this may not be true of the new multispindle devices such as the Ambar Charkha). The rate of manual spinning is limited by the worker's speed in turning the wheel and skill in controlling the twist and evenness of the yarn. The moving of the shuttle on a loom, on the other hand, is physically exhausting, thus handweaving is generally carried out by men.

The mechanization of the two processes also poses very different problems. Twisting of fibre requires a rotary motion, which is easily mechanized by means of shafts connected to prime movers. Moving of the shuttle, on the other hand, is a lateral motion and, although rotary power can be and is converted into lateral motion, there is loss of power in the process, and the process cannot be speeded up as much as spinning by mechanization or as long as the powerloom is a close imitation of the handloom. As a result, handweaving survived much longer in all countries than handspinning and productivity in mechanized weaving still continues to be lower (in terms of yarn woven per man-hour) than in spinning (in terms of yarn output per man-hour).

In India, handspinning died out, for all practical purposes, by World War I, if not before. Despite its promotion by M.K. Gandhi and subsidization by the government after independence, it remains quantitatively insignificant. Handweaving, however, never died out, and continues today, although it probably does not account for more than 25% of current yarn consumption.

Government Policy

The government has discriminated against textile mills for over 25 years on the grounds that more labour-intensive technology than is being used is available and its usage should be encouraged. The discrimination takes a number of forms.

(1) The government subsidized the Khadi and Village Industries Commission, which organizes the production and sale of handspun and handwoven cloth. It also buys khadi for the uniforms of its lower paid employees.

(2) In 1956, the government banned the installation of new looms by mills. Since that time, mills have been allowed to purchase looms only for replacement or for export production.

(3) The government charges excise duties on the mills' output of yarn and cloth. The ban on new looms in mills and the differential excise duties greatly benefited powerlooms set up outside mills to the detriment of handlooms. Since 1976, however, excise duties have been levied on the processed output of powerlooms as well, although not at such high rates as those placed upon the mills' output.

(4) Between 1965 and 1978 the government required that a certain proportion of mill output should consist of coarse cloth and must be sold below a controlled maximum price. The idea was to subsidize poorer buyers at the expense of the rich. Apart from the losses this scheme imposed upon weaker weaving mills, however, neither handlooms nor mills taken over by the government could face the resulting competition in the market for coarse cloth. As a result, the government now uses the mills that went bankrupt and were subsequently nationalized to make the bulk of cheap cloth for sale, and supplements its supply by purchasing a small quantity of coarse yarn from mills.

(5) The government has used the industrial licencing mechanism to encourage cooperative spinning mills, which are expected to sell their yarn to member weavers.

Spinning

Except for the very small amount of cotton that is handspun, all yarn is made in large-scale textile mills in India. There are two types of mills: those that only spin yarn (spinning mills) and those that weave it as well (composite mills). The latter, as a group, produce more yarn than needed for their own cloth manufacturing and sell the balance in the market. The yarn supplied by spinning and composite mills is bought by handloom and powerloom weavers through traders or through their own cooperatives (Table 1).

Among synthetics, the only yarn that is of much significance is viscose rayon, which is prized by less-affluent women as a substitute for silk and is used in saris and dresses for weddings and ceremonies. The demand for rayon has always been buoyant. Production is profitable, but because there is a domestic shortage of pulpwood, a large proportion of the quantity consumed is imported. Rayon is woven mainly by powerlooms outside textile mills and there is an active market for it.

It has been a standing complaint of the small-scale sector that composite mills meet their own yarn requirements first and sell only the surplus. If this were so, the proportion of yarn sold to the small-scale sector should have fallen whenever there was a yarn shortage, which has not always been the case. Given the differential excise duties, the wage differentials, and the restrictions on technological change in weaving by mills, it appears that the small-scale powerloom sector has enjoyed a competitive edge over the mills (spinning yarn for sale is more profitable than weaving, even for composite mills) and the small-scale sector's complaints of yarn shortage are

Table 1. Cotton yarn supply (thousand tons).

	For cloth production							
	Sales to small-scale sector			Self-consumption of composite mills				
Year	Composite mills	Spinning mills	Total		Total	Nonfabric uses	Exports	Total
1960	—	—	246	516	762	12	11	785
1965	—	—	337	568	905	16	11	932
1970	—	—	406	524	930	15	26	971
1975	105	333	438	513	951	16	3	970
1976	104	345	449	523	972	18	15	1005
1977	96	310	406	411	817	21	12	850
1978	117	332	449	432	881	23	5	909

Sources: Indian Cotton Mills Federation (1976); Textile Commissioner (1980).

Table 2. Spinning capacity utilization, 1950–1978.

Year	Spinning mills: Number	Spinning mills: Spindles (× 10³)	Spinning mills: Average spindles per mill (× 10³)	Composite mills: Number	Composite mills: Spindles (× 10³)	Composite mills: Average spindles per mill (× 10³)	Spindle capacity utilization (%): 1st shift	2nd shift	3rd shift	Average
1950	94	1860	20	268	8695	32	85.3	75.9	25.4	62.2
1955	116	1768	15	292	10189	35	85.2	79.5	32.1	65.6
1960	186	2931	16	293	10619	36	87.0	85.3	44.8	72.4
1965	253	3941	16	290	11493	40	86.0	86.6	65.2	79.3
1970	366	5463	15	290	12205	42	78.0	78.2	68.4	74.9
1975[a]	330	6539	20	288	12308	43	72.4	73.2	66.7	70.8
1976	330	6884	21	288	12406	43	69.0	69.8	63.8	67.5
1977	338	7404	22	289	12296	43	77.3	78.2	70.9	75.5
1978	357	7680	22	291	12400	43	80.8	81.8	76.4	79.7
1979	370	8160	22	291	12520	43	78.8	79.6	78.2	78.9

[a]The number of spinning mills from 1975 onward excludes waste spinning mills.
Sources: Millowners' Association (1979); Southern India Mills' Association (1980, Tables 11, 19).

only a reflection of the powerlooms' profitability.

Nevertheless, these complaints have evoked a policy response. In contrast to its freeze on the weaving capacity of mills, the government liberally sanctioned the expansion of spinning capacity (Table 2). In sanctioning such capacity it gave preference to spinning mills and particularly to spinning mills started by loom cooperatives, of which there were 54 by 1978 and another 10 under construction (Committee on Controls and Subsidies 1979). The expansion in spindleage, therefore, was accompanied by an increase in the number of mills; the average size of a spinning mill, however, changed little between 1950 and 1979.

This expansion led to competition between three sets of mills: old spinning mills, composite mills, and new mills. New mills installed ring frames of postwar design, which were appreciably faster than the prewar models used in old spinning mills and composite mills.

The old mills met the competition in two ways. Firstly, they increased multiple-shift production: the proportion of spindles in second-shift operation rose from 76% in 1950 to 87% in 1965, whereas the proportion in third-shift operation went up even more sharply from 25% to 65% during the same period. Thus, by 1965 virtually the entire spinning industry was working two shifts, and two-thirds of it was working three shifts. This high level of capacity utilization was not maintained after 1965, however, because the cotton supply could no longer keep pace with the growth of spindles. In addition to the increased capacity of old mills, new mills began to achieve equally high levels of capacity utilization. Due to the ensuing competition, a number of spinning mills closed down or were taken over by the government; there was, however, no decrease in multiple-shift operation.

Secondly, the expansion of spindleage was accompanied by investment in cotton preparations, i.e., blowroom machinery, carding engines, draw frames, speed frames, and doubling frames. Although much of the investment went into new spinning mills, old mills also improved their processes in two ways: they installed new carding engines, including the new Crosrol Varga models, to improve the quality of slivers (domestic manufacturers' sales of carding engines were much in excess of those required by new ring frames, approximately three for each ring frame) (Table 3) and they installed high-draft conversion attachments designed to increase the speed of draw frames and ring frames, which raised their capacity by 10–20%.

There was, however, one change that did not occur. Until 1966, India grew very little long-staple cotton; what little was used was imported. New local hybrids then went into cultivation and their output rose so rapidly that they replaced imports and supplied nearly a quarter of the cotton by 1978 (Table 4). With this change in the staple pattern of cotton supply, one would have expected a corresponding change in the count composition of yarns. The yarn output pattern did move toward higher counts, but not nearly as much as the shift in the staple composition would have permitted. Evidently, the new supplies of long-staple cotton were being used to produce medium counts. The reason for this was clearly related to the demand pattern for cloth.

Apart from its implications for capital utilization, multiple-shift operation enabled mills

Table 3. Output of textile equipment, 1958–1979.

Year	Blow-room lines	Carding engines: Old model	Carding engines: Crosrol Varga	Combers	Draw frames	Speed frames	Doubling frames	Ring frames	High-draft conversion systems: No.	High-draft conversion systems: Rs (× 10^3)
1958		1148			9	28		877	136	4115
1959		763			40	16	7	1077	210	2400
1960	1	1075			47	45	156	1127	287	3157
1961	5	1308			75	70	113	1380	348	5065
1962	10	1501			61	45	115	1571	531	7093
1963	16	1696			52	96	80	1990	526	7469
1964	15	1938			38	49	140	2134	NA	13120
1965	17	1808			16	30	134	2308	1831	29434
1966	16	1809			26	68	174	1507	1240	18542
1967	22	432	148		112	90	97	1256	555	13042
1968	9	172	247		164	44	86	813	570	12788
1969	14	296	465		223	87	154	880	NA	16237
1970	16	381	600		255	132	198	1357	NA	20699
1971	15	317	401		332	129	212	1161	NA	21453
1972	15	171	222	2	297	129	84	885	NA	21607
1973	20	436	46	36	258	125	123	1225	NA	31737
1974–75[a]	31	556	669	60	496	214	98	1795	NA	69337
1975–76	31	532	226	59	480	309	73	1598	NA	51089
1976–77	28	524	455	66	502	407	185	1436	NA	61558
1977–78	33	259	499	41	370	259	249	1356	NA	45997
1978–79	38	372	566	59	572	366	195	1661	NA	93743

NOTE: NA = not available.
[a]Financial years (April–March) from this time onward.
Sources: Textile Machinery Manufacturers' Association (1961; 1965; 1970; 1971; 1975; 1979; 1980).

Table 4. Staple length composition of mills' cotton consumption.

Staple length (mm)	Consumption by weight (thousand tons)					Consumption by percentage				
	1960	1965	1970	1975	1978	1960	1965	1970	1975	1978
⩾27										
Foreign	178.65	136.62	128.52	33.15	92.82	19.31	11.91	11.21	2.74	8.25
Indian			18.20	249.56	280.50			1.57	20.65	24.94
24.5–26	144.89	154.98	153.34	90.78	115.77	15.66	13.51	13.37	7.51	10.29
22–24	274.03	616.14	430.27	432.14	351.05	29.63	53.72	37.51	35.75	31.22
20–21.5	288.55	174.24	298.01	244.46	163.54	24.71	15.19	25.98	20.23	14.54
⩽19	98.66	64.80	118.66	158.61	120.53	10.67	5.65	10.34	13.12	10.72

Sources: Textile Commissioner (1960; 1972); Indian Cotton Mills Federation (1973; 1976); Millowners' Association (1979).

to improve labour productivity in two ways: (1) some of the surplus workers could be transferred to the second and third shifts and (2) because workers were not as readily available for the night shift, lower manning levels were accepted for it (the number of spindles per worker was 79 in the first shift and 117 in the third shift in 1960; by 1979, it had risen to 117 in the first shift and 181 in the third (Textile Commissioner 1962; Southern Indian Mills' Association 1980)).

Weaving

According to the latest figures published by the Textile Commissioner, the number of handlooms covered by cooperatives was 1.4 million in 1969 (Textile Commissioner 1972). Their capacity (estimated at 5 m/day, 300 days per year) should be 2.1 × 10^9 m, or nearly 60% of the small-scale sector's output in that year. However, their capacity utilization is poor, their capital costs are low, and so are the wages of handloom weavers. As a result, when alternative employment offers better wages, weavers take up outside work. It is doubtful if more than 30% of small-scale production is woven on handlooms.

The important competing groups, therefore, are composite mills and powerlooms in the small-scale sector. This competition has been regulated by the government by means of differential excise duties. Powerlooms were untaxed until 1955, at which time a duty was introduced at rates of Rs25, 75, and 150 per loom on units with 5–24, 24–49, and more than 50 looms respectively. In practice, however, larger units evaded duty by dispersing looms in a number of sites until the exemption given to units with 1–4 looms was removed in 1965 (Millowners' Association 1979). In 1976, this loom duty was replaced by duties on processed cloth from handlooms and powerlooms, which amounted to 30 and 70%, respectively, of the duties paid by mills; handloom cooperatives, however, continued to be exempt (Millowners' Association 1979). In order to evade the duty, however, a great many looms operated without the licence, from the Textile Commissioner, that they required.

Mill production was almost free of excise until 1949; there was only a 25% duty on superfine cloth. In 1949, small revenue duties were imposed on all cloth, which increased with its fineness. In 1953, a punitive duty was imposed on dhotis produced by mills if their output exceeded 60% of the output in the financial year 1953–1954. The discrimination was so strong that mills, for the most part, gave up dhoti production to small-scale industry.

Revenue duties began to rise in 1956, when the government's budgetary demands started increasing in order to finance the Second Five-Year Plan. In 1958, a system was introduced that lasted until 1977, under which the rates increased with the fineness, as well as the degree, of processing. In 1977, this system was replaced by one under which the duty increased with the price of the cloth, except for fine and superfine cloth, which bore the highest duty regardless of its price.

This differential taxation had two effects:

(1) It discouraged the production of finer cloth. Fiscal discrimination explains the fact that the pattern of yarn output did not move toward finer counts nearly as much as the pattern of cotton consumption moved toward long-staple fibres. In the 1970s, spinning mills were producing coarser yarn than necessary with the available cotton because at postduty cloth prices there was not enough demand for fine cloth.

An incidental effect of this shift in the output pattern was that less cloth was produced. Although 1 kg of yarn (of the appropriate count) produces about the same length of superior medium or fine cloth, it produces 50–60% more superfine cloth. Thus, the use of cotton, which could have produced superfine cloth, to make less fine cloth resulted in a commensurate loss of output. If the long-staple fibre, constituting approximately one-quarter of the total consumption by the late 1970s, had been used to make superfine cloth, it would have added 12–15% to aggregate cloth production. This is an overestimate, however, because it is not evident that all the cotton could have produced superfine cloth and because such a large increase in superfine cloth output might not have been absorbed by the market despite the lower prices that lower excise duties would have permitted. The possibility of substitution, on the other hand, makes the demand for varieties of cloth highly price-elastic. It is possible to argue, therefore, that less strongly progressive excise duties would have brought about a better balance between the pattern of cotton supply and the pattern of demand for cloth. This may not be equally true today, however, because, since 1977, the degree of progression has been reduced and the maximum duty on unprocessed cloth is now 15%. The continuing duty on fine and superfine cloth, regardless of its price, is clearly capable of influencing the production pattern in the same way as before 1977. Virtually all fine and superfine cloth is processed further and, therefore, bears additional processing duties.

(2) The duties diverted production to powerlooms, and the diversion was greater in the case of fine fabrics, which were more heavily taxed. It was commonly believed that fine cloth was a preserve of the mill industry and that the small-scale sector concentrated on coarse cloth. In general, the small-scale sector produced a larger proportion of coarse cloth. This is particularly the case with handlooms. The time required on the loom per metre increases with the fineness of the cloth and so, therefore, does the weaving cost per metre. Because handlooms are much slower than powerlooms (50 times slower according to Bruce (1977)), the cost difference between fine and coarse handloom cloth is greater than with powerloom cloth. Because fine cloth takes longer to weave on a handloom, inventory costs are also higher. Although handlooms specialize in coarse cloth (and fabrics with complicated weaving patterns that require longer loom setup times), there is no reason for powerlooms to do so. They are plain looms, but they are no less efficient than plain looms in mills; if anything, they are newer on the average (although mills

have not been allowed to increase their loomage since 1956 and have largely been operating with prewar looms, most of the powerlooms of the small-scale sector were acquired in the 1950s and 1960s). Mills have been allowed to acquire some automatic looms or to replace plain looms with automatic looms, but such acquisitions have been allowed only for exports and are confined to a small number of mills; thus, the overall proportion of automatic looms remains small. Although concentrating on coarse dhotis and saris, powerlooms have increasingly ventured into the production of fine cloth. In 1960, powerlooms consumed about the same quantity of yarn with a count of 41 and above as mills and in 1970 they consumed more than twice as much as consumed by mills. The entire increase in fine yarn output between 1960 and 1970 went to powerlooms (Table 5).

Weaving mills countered the competition of powerlooms in three ways:

(1) They increased the capacity utilization of looms by increasing third-shift operation, which rose from 10% in 1950 to 66% in 1979. Thus, virtually all looms were working two shifts and two-thirds of them three shifts by 1979 (Textile Commissioner 1962; Tables 13, 19). As with spinning, the rise in capacity utilization coincided with and contributed to the increase in the number of looms per worker, which rose from 1.27 in 1960 to 1.86 in 1979.

(2) The mills increased the number of picks per metre of cloth and wove more closely (cf. Mohota 1976), thus weaving stronger and more durable cloth. The metres woven per kilogram decreased throughout the 1960s, more so for fine cloth (Table 6). (Two other possibilities for this decrease, i.e., understatement of output and increase in width, may be ruled out. The incentive for both would be evasion of excise duty, but if output had been understated in metres, it would have been understated in terms of weight also, leaving their ratio unchanged. Also, an increase in breadth would not have reduced the incidence of the duty, whose base was changed from linear to square metres in 1955. Part of the increase in weight (less than 10%), however, is explained by the wider application of preshrinking processes such as mercerizing and Sanforizing.) The resulting impact occurred as a fall in per capita cloth consumption in the early 1970s.

(3) The mills began to process an increasing proportion of their cloth. Preshrinking processes, which were virtually unknown in the 1950s, were applied to over half of the output by 1979 (Table 7). An increasing proportion of the cloth

Table 5. Count composition of yarn consumed.

Count	1960	1965	1970	1975	1976	1977	1978
	Self-consumption by weaving mills (thousand tons)						
1-20	216.9	248.0	204.6	177.5	212.7	160.8	177.1
21-30	206.5	224.2	210.8	194.7	179.6	144.5	147.1
31-40	91.6	98.3	106.9	107.1	97.4	81.2	86.0
41 and above	27.2	32.0	38.5	33.7	32.9	24.5	21.4
	Deliveries to handlooms and powerlooms (thousand tons)						
1-20	120.3	155.6	177.2	206.0	204.6	161.1	182.7
21-30	49.8	66.9	73.3	65.8	68.2	63.8	67.4
31-40	42.0	54.5	75.0	80.7	91.5	106.8	115.7
41 and above	33.6	59.8	81.1	85.2	84.9	73.6	82.8

Sources: Textile Commissioner (1962; 1973; 1980).

Table 6. Metres per kilogram of mill cloth produced.

	Grade of cloth				
Year	Coarse	Medium	Superior medium	Fine	Superfine
1961	5.19	8.29	10.10	9.41	16.35
1965	4.92	7.98	9.69	8.89	15.10
1970	4.78	7.86	9.18	7.92	14.41
1972	4.72	7.94	8.98	8.12	13.24

Source: Textile Commissioner (1973).

was dyed or printed. Printing used to be, and to a considerable extent still is, a manual process in India, geared to short production runs and often custom-made orders. Mills began to compete with handprinters; in this venture they were helped by the advent of new azo dyes, in attractive colours, and by rotary screen printing machines, which brought flexibility into printing.

Not all cloth mills adopted these innovations. Those that lagged behind were driven into bankruptcy. One hundred and eleven mills, the majority being composite mills, went bankrupt in the late 1960s and early 1970s and were, subsequently, nationalized. Those that improved their technology emerged with a product that was clearly differentiated from that of powerlooms in durability, quality, and finish and that could, therefore, bear the higher duties. Many of these mills started, or expanded, their own retail shop networks, advertised their textiles, and built up a brand image. Weaving mills as a group, however, continued to lose ground. Even the sharp increase in the supply of synthetic fibres after 1975, in whose blending and utilization composite mills had a certain lead, did not reverse the continuing decline in their market share (Table 8).

Textile Machinery and Embodied Technological Change

Textile technology has progressed rapidly since World War II. There have been two major inventions: open-end spinning and shuttleless weaving. Furthermore, all processes have been greatly speeded up. Labour time required per kilogram of yarn has fallen from 10 min in 1959 to 2–3 min on ring frames and 1–2 min on open-end spinners. In weaving, labour productivity has risen from 63 000 weft-metres per hour in 1959 to 383 000 weft-metres per hour. Output of cotton

Table 7. Processing of cloth by mills, 1960–1979.[a]

Process	1960	1965	1970	1975	1979
Total mill output			4238	4267	4155
Bleached	1784	1736	1799	1807	2315
Dyed	750	890	1228	1264	1390
Printed	590	777	1088	1134	1079
Mercerized	63	713	811	744	1187
Sanforized	43	323	430	314	675
Other chemical processes	NA	49	100	76	218
Total cloth processed[b]	3230	4488	5456	5339	6864

[a]All values in million metres.
[b]Total cloth processed exceeds total mill output because some of the cloth undergoes multiple processing.
Sources: Indian Cotton Mills Federation (1976; 1980); Textile Commissioner (1980).

Table 8. Output of cloth by fibre and blend, 1960–1979.[a]

	1960	1965	1970	1975	1979
	Mills' output				
Cotton	4616	4587	4157	4032	3203
Viscose and other synthetics	3	4	1	1	9
Cotton–viscose	NA	NA	17	83	397
Cotton–polyester	NA	NA	53	118	162
Other blends	NA	NA	10	33	383
	Small-scale sector's output				
Cotton	2013	3056	3692	4002	4334
Synthetics[b]	544	866	932	863	NA
Blends	NA	NA	55[c]	166	771

[a]All values in million metres.
[b]Almost entirely viscose rayon.
[c]Estimated from yarn consumption by applying the mill ratio of number of metres to weight.
NA = not available.
Sources: Indian Cotton Mills Federation (1969; 1973); Textile Commissioner (1968; 1972; 1973; 1980).

per card has risen from 8 kg/h in 1960 to 80–120 kg/h. Drawing frames have increased their speed from 90 m/min in 1960 to 600 m/min, ring frames from 12 000 rpm to 18 000 rpm, and looms from 40 000 weft-metres per hour to 65 000 weft-metres per hour. Thus, every type of machinery has been speeded up with a consequent saving in labour and space (Hartmann 1980).

This rapid technological change has been engineered by a textile machinery industry with its centre in continental Europe. The open-end spinner was an invention of Investa, a Czechoslovakian firm, whereas the first shuttleless loom was made by Sulzer, a Swiss firm. Swiss and German firms are technological leaders, but the flow of information among the leading firms throughout the world — chiefly German, Swiss, French, and Italian, with a sprinkling of American and Japanese firms — through fairs, meetings, and journals is extremely rapid. There is considerable cross-licencing and imitation, and no invention remains exclusive to the originating firm for long. Most of the firms are small by European standards, production runs are short, quite a few retain an old family tradition of craftsmanship, and most specialize in a limited range of equipment. Large firms, which can set up turnkey textile mills, are scarce.

European firms are located in old textile centres — Saxony, Alsace-Lorraine, Basel, the Rhone valley, Milan — some of which have since declined. They continue to respond to the needs of the local textile industry. The spectacular increases in the speed of new equipment and the labour productivity achievable with it have been a reaction to the loss of manpower by and the rise of wages in the European textile industry during the postwar years. This depressed industry has not been a good customer for machinery, and many of the textile equipment manufacturers have diversified into other types of machinery. They are less specialized in textile machinery now than during the 1960s, and what characterizes them today is their pool of engineering and chemical talents, which are put to use in designing new machinery and processes. Knowledge of this nature has never existed in India, nor does it exist now.

The origin of the Indian textile machinery industry can be found in three types of firms: (1) Repair and service specialists. A small number of firms started as repairers of equipment and graduated to the fabrication of parts and, later, equipment. (2) Stores importers and manufacturers. There are numerous wearing parts of textile machinery that require frequent replacement, such as spindles, shuttles, healds, reeds, bobbins, and pricking sticks. There was a shortage of these items during the war and their makeshift manufacture was taken up. The number of stores manufacturers has always been considerable. (3) Confederates of foreign manufacturers. There are few in this industry. All confederates began business after blanket import substitution started in 1957.

In the years following World War II, a large number of textile machines and accessories were being made by the first two types of firms; but they were making what were essentially prewar British models, and the orders they filled were mainly small replacement orders. New mills and mills taking up major reequipment programs still placed their large orders abroad. They did so, basically, because they trusted foreign brand names more, but the assumption behind this preference, that they would get a more standardized, more reliable machine than at home, was, perhaps, not without substance.

The situation changed after 1956. The sudden rise in imports wiped out the sterling reserves built up during the war and led the government to impose stringent quantitative restrictions on imports. The principle behind these restrictions was that if an item was being produced in India it could not be imported unless its Indian manufacturer could not supply it.

The import restrictions gave Indian manufacturers control of the entire Indian market if they could supply it with goods. Supplying it did not require much manufacturing during the early stages because liberal imports of components were initially allowed to be phased down in later years. There was, however, a boom in the textile industry, and the market for textile machinery was growing. To exploit it, a manufacturer had to be able to increase supplies rapidly. It also helped if the manufacturer could cater to the buyer's preference for a foreign brand name. The result was an enormous increase in the number of technology-import agreements (Textile Machinery Manufacturers' Association 1961).

It should be noted that the machinery manufacturers imported technology not because they had none, as was the case in a number of other industries, but because they could not otherwise have raised production fast enough or supplied as good machinery. There was considerable repetitive importing of technology. Not only was technology imported to produce machinery that was already being produced within the country, but manufacturers also imported technology for goods they were already manufacturing. In each case, the manufacturers imported technology not to acquire a foreign name but to improve their own technology. Thus, the late 1950s saw a radical updating of textile technology and in 1965 the gap between Indian and foreign technology was narrower than ever before or after.

Three-quarters of the early technology import agreements were with firms in West Germany and Japan (Textile Machinery Manufacturers' Association 1961). Generally speaking, finishing processes, involved in product differentiation for the market, are operated on a smaller scale than the preparatory stages, i.e., spinning and weaving. Hence, a larger number of firms produce finishing machinery.

If what is known about technology imports into India applies to the textile machinery industry, it was not foreign machinery producers who sought to sell technology but Indian manufacturers who went looking for technology abroad. If so, the question arises: Why did they go to West Germany and Japan? Why did they not go, for instance, to Britain, which had, until then, been the prime source of textile machinery for India? It is impossible to answer this question with any accuracy 20 years after the event, but the answer probably is that technology from Britain was not readily available. The British textile machinery industry was more concentrated than on the continent and in Japan and it had its contacts with the Indian textile industry through import agencies in Bombay and Calcutta. Anticipating more restrictive import policies, Indian textile mills placed large orders for machinery with them in the late 1950s. Hence, it is likely that British firms failed to anticipate the tremendous advantage accorded to firms based in India by the new import policy and, therefore, to cash in on the Indian demand for technology.

The role of market structure on the supply of technology is worth stressing. Switzerland, for example, has a small number of large equipment manufacturers that, in the absence of an extensive domestic market, export a high proportion of their output. Technological superiority is an important selling point for them in the world market. These firms are, basically, exporters and will sell technology only when such sales would not conflict with their exports, i.e., when the technology sold is of an earlier generation or when the technology is accompanied by investment and, therefore, adds to the sales of the group.

In West Germany, on the other hand, there are a large number of firms, many of which are small, with a largely domestic or at most European market. For them, there is no conflict between their own sales and the sale of technology, particularly to a distant country that is unlikely to export machinery to Europe. Even then, of the West German firms that exhibit novel machines in the International Textile Machinery Exhibition, it is remarkable to note that only 5, of a total of about 20, have sold technology to India.

It may be argued that this is because there is little demand for advanced technology in India. This is true to some extent but Indian manufacturers have, generally, been quite aware of major innovations abroad and quick to take licences. The reason is that, because the textile industry is not a priority industry, equipment imports continue to be restricted on the basis of domestic capacity. A machinery manufacturer can secure the Indian market against imports, for a machine, at least for a time, by simply signing a technology import agreement. If the market develops, the return on the cost of the technology is high; if it does not, all that the technology importer loses is the initial payment. Technology imports are used to restrict potential competition from product imports just as industrial licences are used to restrict potential competition within the country.

Under the circumstances, technology import agreements have a speculative use; if the domestic market does not grow or the prospective technology importer does not have the capacity to exploit it, there is no need to import the technology. Often the prospective technology importer takes a licence from the technology supplier and then waits until a market develops for the product.

Between 1955 and 1965 the risk of going into production was less because the textile industry was expanding and, at least during the initial stages, manufacturers received such liberal import licences that they had to manufacture (or procure within the country) very little: the business was similar to assembling imported components and not much different from direct importing. A number of manufacturers held import agencies for some products and licences to produce others, and converted one into the other if the market seemed likely to expand steadily.

During the 1960s, however, as India's foreign exchange resources continued to fall short of industry's requirements, import licences were cut, more and more components had to be produced within the country, production and procurement became increasingly difficult, and equipment prices were progressively raised to maintain profit margins. This cost and price escalation continued until 1965. In that year, the cotton crop was poor, cotton prices rose sharply, a drought reduced rural demand for textiles, and the textile industry went into a slump. Despite liberal credits given by the Industrial Development Bank of India for machinery purchases, the sales of textile equipment fell drastically. The firms that withstood the depression best were those that had specialized in high-wear items such as bearings, top arms, spindle inserts, and fluted rollers.

Conclusions

The promotion of small-scale production has been and continues to be an important element of Indian ideology and government policy. The means adopted to promote it in the textile industry consisted of discrimination in taxation and licencing against large mills and subsidies to small industry through the Khadi and Village Industries Commission and through cooperatives. On the whole, these policies have had little success in changing the technology mix, but they have had a strong influence, quite unrelated to policy objectives, on firm size and composition. They have prevented the growth of composite mills and have led to the installation of most of the new looms in extremely small enterprises.

Furthermore, they have had a number of unintended and, indeed, little-noticed effects. Under pressures created by them, the mill industry has improved its capital utilization and the quality of its product, and endeavoured to meet the competition presented by powerlooms by means of product differentiation. It has met the competition of new enterprises with new and better equipment by means of small improvements in technology and product, which have cumulatively added up to a substantial change. At the same time, however, it has produced less fine yarn than cotton supplies permitted, and, thereby, reduced national cloth output below its potential.

The developments within the textile industry have dictated the shape of the textile machinery industry. The small, new spinning mills and the even smaller weaving sheds have created a demand for cheap, simple, and sturdy spinning and weaving equipment. The improvements in the mills have required ancillary equipment such as high-draft systems, carding engines, and finishing machines and the increase in frame speeds has raised the demand for high-wear goods such as bearings. Hence, the textile machinery industry has based its foundation on ancillary equipment and items that wear. Although well aware of innovations being made abroad in the chief processes, the industry has, after having had problems with automatic looms in the 1960s, tended to specialize in old and tested equipment, waiting to bring in new technology until the domestic market clearly calls for it.

Bruce, R. 1977. A search for an appropriate technology for a decentralized cotton spinning industry in India. Lucknow, India, Appropriate Technology Development Institute.

Committee on Controls and Subsidies. 1979. Report. New Delhi, India.

Hartmann, U. 1980. How do textile machinery makers cope with the changing structure of the textile industry? A consultant's view. Paper presented at the International Textile Engineering Symposium, Bombay, India, 27 November 1980.

Indian Cotton Mills Federation. 1969. Handbook of statistics on the cotton textile industry. 2nd ed. Bombay, India.

1973. Handbook of statistics on the cotton textile industry. 6th ed. Bombay, India.

1976. Handbook of statistics on the cotton textile industry. 9th ed. Bombay, India.

1980. Handbook of statistics on the cotton textile industry. 13th ed. Bombay, India.

Millowners' Association. 1979. Annual report, 1978. Bombay, India.

Mohota, R.D. 1976. Textile industry and modernization. Bombay, India, Current Book House.

Southern India Mills' Association. 1980. Annual statistical bulletin — Indian cotton textile industry 1979. Coimbatore, India.

Textile Commissioner, Government of India. 1960. Indian Textiles Bulletin, VI(1), January.

1962. Indian Textiles Bulletin, VIII(1), April.

1968. Indian Textiles Bulletin, XIV(5), August.

1972. Indian Textiles Bulletin, XVIII(9), December.

1973. Indian Textiles Bulletin, XVIII(11), February.

1980. Indian Textiles Bulletin, XXV(4), October–December.

Textile Machinery Manufacturers' Association. 1961. Annual report (January 1960–June 1961). Bombay, India.

1965. Annual report (July 1964–June 1965). Bombay, India.

1970. Annual report (July 1969–June 1970). Bombay, India.

1971. Annual report (July 1970–June 1971). Bombay, India.

1975. Annual report (July 1974–June 1975). Bombay, India.

1979. 19th annual report, 1978. Bombay, India.

1980. 20th annual report, 1979. Bombay, India.

Comments: Jamal Ahad Khan

So far, discussion has centred on the import of technology and its subsequent absorption, assimilation, and diffusion within related industries. In some of the papers the question of government regulations and market came up as a side issue. However, this paper deals primarily with govern-

ment regulations and their effect on the technology of the country directly or through market forces. This topic is of considerable importance because government regulations and market forces play a dominant role in the technology of any country.

The paper deals with the following government regulations: (1) support of the nonmill sector against the mill sector through the imposition of excise duty on the mill sector, subsidy of the nonmill sector, and provision of a market to the khadi and village industries; (2) support of the small-scale powerloom sector through an industrial licencing mechanism to encourage cooperative spinning mills; and (3) a ban on the import of machinery that could be manufactured locally.

From figures within the paper it is evident that: (1) the number of spindles installed increased with time; (2) spindle capacity utilization showed some fluctuations but an improvement, nevertheless, over the year 1950; (3) cotton consumption increased within the mill sector; (4) the increased use of cotton was mainly for finer counts of yarn; (5) labour utilization within the spinning sector rose over the year 1960; (6) yarn consumption (by weight) decreased within the mill sector but increased within the small-scale sector; (7) loom capacity utilization within the mill sector increased; (8) the amount of processed cloth increased within the mill sector; and (9) the number of technology import agreements in textile machinery mushroomed between 1961 and 1975.

The conclusion drawn is that the mill industry has improved its capital utilization; however, Table 2 shows that capacity utilization dropped from 74.9% in 1970 to 70.8% in 1975 and 67.5% in 1976. How much of the increase to 79.7% in 1978 was a result of an increase in the local textile market due to (1) reduction of imports; (2) reduction in price and, therefore, increase in total market; (3) growth in population; and (4) increase in per capita income compared with (1) improvement in the quality of cloth produced by the mill sector and consequent product differentiation; (2) restriction on expansion of mill weaving capacity; and (3) increase in exports? Without these answers the observation appears quite biased.

The paper states that the powerlooms employed in the small-scale sector "are plain looms, but they are no less efficient than plain looms in mills; if anything, they are newer on the average (although mills have not been allowed to increase their loomage since 1956 and have largely been operating with prewar looms, most of the powerlooms of the small-scale sector were acquired in the 1950s and 1960s)." If this is true and other conditions remain the same, the powerlooms should have been able to compete with the mill sector even in the manufacture of fine cloth. In fact, the study states that the "powerlooms have increasingly ventured into the production of fine cloth." Under the circumstances, the reasons why the mill weaving sector, with higher overheads and excise duty, has not been driven out of business have not been detailed.

The aspect of transfer of technology has been clearly identified through government sanctions against imported products that could be produced locally by increasing the import of technology through licencing. The paper, however, would have been much improved if it had also covered the role of the government regarding import vis-a-vis selection of source, contractual agreements, royalty payments, market restrictions, and restrictions on diffusion of know-how.

IDRC-171e

Absorption and diffusion of imported technology

Proceedings of a workshop held in Singapore, 26-30 January 1981

The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

IDRC, Ottawa CA

IDRC-171e

Absorption and Diffusion of Imported Technology : proceedings of a workshop held in Singapore, 26-30 January 1981. Ottawa, Ont., IDRC, 1983. 112 p. : ill.

/Science policy/, /technology transfer/, /choice of technology/, /technological change/, /South Asia/, /Indonesia/, /Korea R./, /Philippines/ — /small-scale industry/, /textile industry/, /self-reliance/, /employment opportunities/, /foreign investments/, /case studies/, /comparative analysis/, /list of participants/.

UDC: 62.001.1 ISBN: 0-88936-298-X

Microfiche edition available

IDRC-171e

Absorption and Diffusion of Imported Technology

Proceedings of a workshop held in Singapore, 26–30 January 1981

Contents