Comparative Aspects of Capacity Utilization:
Evidence from Bangladesh Jute Weaving Industry

M.G. Kibria*
and
C.A. Tisdell**

I. Introduction

Studies on capacity utilization for advanced countries mostly stress the 'measurement' aspect of capacity [Klein and Preston (1967) and Briscoe, O'Brien and Smith (1970)]. The emphasis of similar studies for developing countries is on determining the full capacity level, examining the causes underlying the underutilization of resources, and finally, seeking policy implications for it [Hogan(1968), Winston(1971, 1977), Steel(1972), Bailey(1976) Bautista, et.al. (1981)]. The discussion in this paper is a departure from both, in the sense that it is concerned with exploring how capacity utilization typically varies with the age of manufacturing mills in an industry in a LDC, namely in jute weaving in Bangladesh. Because machines are rarely or slowly replaced in mills in LDCs [Kibria and Tisdell(1983)], the typical pattern of life-time utilization of installed capacity is likely to differ to some extent from that in developed countries. Failure or inability to utilize installed capacity because of machine failure results in a considerable loss of manufacturing production in the Third World.

The nature of capacity utilization and methods of measuring it are first discussed. Important differences between sources of

*Research scholar of Department of Economics, University of Newcastle, N.S.W. 2308 Australia
**Professor of Economics, University of Newcastle, N.S.W. 2308 Australia.

excess capacity in developed countries and those in Third World are noted. These differences are such that some economic literature dealing with excess capacity, although relevant to developed countries, cannot be applied in the Third World. Once the background discussion of these matters are completed, the actual results obtained for the jute weaving mills surveyed are reported and interpreted. A typical pattern for capacity utilization over the life of a jute weaving mill is observed and its nature and sources are explained. The pattern which emerges for capacity utilization in mills in this industry in Bangladesh seems to differ from the pattern for factories in developed countries.

II. The Nature of Capacity Utilization

The literature on capital and capacity utilization can be divided into two main categories: that dealing with the intended (ex-ante) idle capacity resulting from the decisions made at the investment planning stage; and that concentrating on unintended (ex-post) idle capacity resulting from non-physical capital constraint where inefficiencies and rigidities of one sort or another tend to operate after the plant is already built. The rationale behind ex-ante decisions by the entrepreneurs of the advanced countries to leave their capital stock idle for part of the time may be explained by a variety of factors like anticipated dynamic, unanticipated stochastic or rhythmic changes in product demand and in factor prices (due in particular to shift-differential, i.e., premium wage or salary for night shift) which make it profitable to do so [Marris(1964), Winston(1974) and Betancourt and Clague (1981)].[1] However, instances of intended (ex-ante) low utilization of capital in industries in LDCs are not altogether uncommon even though they are based on factors completely different from those of developed countries. Where 'capacity in ex-

[1] The other kind of explanation for the intended idleness of capital is occasionally based on anticipated supply characteristics. Although an increase in the level of capital utilization reduces capital costs, it may have the effect of increasing some other costs arising from increasing depreciation or rising prices of other inputs, thus offsetting the potential savings in capital costs with greater use. The depreciation models hold that physical deterioration, and hence depreciation of the capital stock increases so sharply with the continuous use that it is optimal to leave the plant idle for a part of time to avoid these high and increasing depreciation rates. [Taubman and Wilkinson(1970)] However, there is little empirical evidence of such alarming rate of deterioration.

istence' is used as a criterion for granting import or product licences — not an uncommon practice in developing countries with restrictive trade regimes — it becomes privately profitable to invest in excess manufacturing capacity so that more inputs can be acquired in times of scarce supply. In private terms, the rents associated with input rationing serve to reimburse the entrepreneur for excess capacity. In social terms, however, there is capital wastage because of planned capital idleness. In the study of jute weaving industry, however, this possibility may probably be ignored, since no close relationship between capacity utilization and sizes of the mills is evident in our data series. Our earlier study also indicates that economies of scale are in fact insignificant in Bangladesh jute weaving industry [Kibria and Tisdell (1983)].

It is also argued that large-size firms are better placed to exploit economies of scale in technology and management and thus to operate at higher levels of utilization and productivity. Particularly in developing countries, firm size is positively related to political power, which is sometimes necessary for getting around problems that bear on utilization. These may include the supply of import of raw materials and spare parts, access to working capital,[2] energy and transportation facilities, and the organization of training programme. In Bangladesh jute weaving, while the supply of spare parts and the availability of working capital could be factors in favour of large plants for jute manufacturing in the pre-nationalized era, the question of differential privilege does not arise in post-nationalization period. But as mentioned above, the size or scale factor did not have any noticeable bearing on the performance of our sample of jute weaving mills in either post-nationalization or pre-nationalization periods.

The reasons might be the distinctive characteristics of the growth of jute manufacturing industry itself and the implications of the government policy in this regard. To attain the dual objectives of increasing urban employment and maximizing foreign ex-

[2] In LDCs, price of working capital is higher than that of fixed capital in official markets (fixed capital is often subsidized for those with previleged access to it), and very high in the curb markets (a market which is government regulated, see for example, Bautista *et al.*, (1981)) to which smaller borrowers have to resort. This often results in investment decisions that lead to low capacity utilization. [See, Thoumi (1978) quoted in Bautista *et al.* (1981), p. 29; Schydlowsky (1974) quoted in Bautista, *et al.* (1981)].

change earnings, the industrial policies of the government of Pakistan encouraged the immediate and quick growth of jute manufacturing industry. To this end, the government banned the export of raw jute and offered several incentive schemes to the private jute manufacturers including tax holidays, accelerated depreciation allowances and exemption of reinvested income from both corporation and personal income taxes, exemption of exports from domestic sales and excise taxes, income tax rebates on the portion of income earned from exports and other measures aimed at the promotion of exports [Lewis(1970)]. But the most important was that heavy protection given to the industry in the form of the underpricing of inputs and the overpricing of outputs (in terms of domestic currency) via the import licensing system and the export bonus scheme [Bruton and Bose (1963) and Ahmad (1966)]. These provided large profits to the jute manufacturers but only at a high social cost, since it adversely affected the growth of efficiency in production in the jute manufacturing industry of Bangladesh [Ahmad and Anwaruzzaman(1973) and Ahmad(1977)]. Unlimited access to raw materials i.e. raw jute (Bangladesh produces one-third of world's total raw jute production) due to the imposition of restriction on the export of raw jute together with the above mentioned incentive schemes, in the pre-nationalization days, could possibly explain the lack of initiative by Bangladesh jute weaving mills to exploit any economies of scale. After nationalization, the centralized policy of the government of Bangladesh did not offer any specific incentive to the management of the bigger mills to explore the possible economies that could be gained from their sizes.

Thus, while the use or idleness of capital has been an economic variable ex-ante for the manufacturers in advanced countries, ex-post idleness of capital is often a characteristic phenomenon with the industries in less developed countries — countries with a chronic shortage of capital and which can least afford the underutilization of their existing productivity capacity. Unanticipated events and misfortunes frequently occur after a plant is built and thus prevent the entrepreneur from utilizing his capital stock fully. This type of idleness of capital in industries in LDCs may arise from demand or supply bottlenecks. When there is a product-demand misfortune,[3] it may be profitable for the entrepreneur to reduce output by leaving the capital stock idle for a part of the time. Explanations on the supply side concentrate on the bottleneck created by the shortage of critical inputs like raw materials, spare parts, skilled manpower, etc. The negative effect of import restrictions and production licensing on utilization as commonly practised in LDCs, make it difficult or impossible for most of the firms to obtain needed raw materials, spare part and associated materials during periods of continued foreign exchange difficulties. Thus in LDCs, plants in general are underutilized involuntarily because of unanticipated shortages of input requirements complementary to the flow of capital services.

It appears therefore that while the possibility of inadequate product and demand misfortune cannot be ruled out, supply bottlenecks may be more important for explaining the low level of capital utilization in LDCs.[4] In case of jute weaving industry in Bangladesh, production of mills is not constrained by a lack of demand for their products [Mujeri(1978) and BJMC Study Group (1980)]. As a higher wage rate is not paid for night work in Bangladesh jute manufacturing industry, the rhythmic variation in input prices owing to longer hours worked does not affect the level of utilization. Hence such underutilization of capacity as occurred in Bangladesh jute weaving industry seems to be due to supply-side bottlenecks, this is *ex post* supply factors rather than *ex ante* ones. It was found during the survey that the shortage in the supply of yarn is one of the major causes for the low (jute) weaving productivity in Bangladesh. Several other studies support this view [IBRD/IDA(1975), Ministry of Overseas Development, Government of UK(1978) and BJMC Study Group, Vol. I(1980)]. It was also found that replacement of parts is a long process because all the machinery is imported and worse still all such purchases have to be made through a single central government

[3] Product-demand misfortune frequently refers to the Keynesian type. Demand failure however can occur for other than Keynesian causes. Certain shifts in the world demand curve for jute goods as a result of increasing competition from bulk-handling techniques and more seriously from relatively low-cost and easily available synthetic materials and man-made fibres, may cause temporary disequilibrium in the jute market. This lag until adjusted through price and associated factors over a period of time, may cause deficiency in demand for jute goods and may therefore contribute to the temporary accumulation of excess (idle) capacity in jute manufacturing industry.

[4] For several examples of how a shortage of critical inputs like raw materials, spare parts, skilled manpower, etc. can force the entrepreneur to leave capital idle, see Mason (1966), Erselcuk (1972), UNIDO (1972), Hogan (1968), Huq (1970) and Thoumi in Bautista, *et al.* (1980).

authority. Shortage of parts has been one of the biggest bottlenecks in the industry and its reasons "have been traced to a cumbersome administrative machinery for spare parts procurement, shortfall of funds actually released as opposed to funds allocated, and lack of working capital funds to claim spares after they have arrived in Bangladesh ports" [IBRD/IDA(1975), Appendix II, p.5].

With this in mind let us now consider an appropriate measure of capacity utilization of Bangladesh jute weaving mills.

III. Measurement of Capacity Utilization

Attempts to measure capacity utilization often suffer from the lack of distinction in the literature between the concept of 'capital stock' and 'capacity' on the one hand, and inadequate distinction betwen 'capital utilization' and 'capacity utilization' on the other.[5] In fact, neither capacity and capital stock nor capacity utilization and capital utilization are synonymous. The maximum flow of services that can be had from a given capital stock and the amount of services actually utilized are quite different concepts. The rate of capital utilization is a measure of the utilized input of capital relative to the available inputs of capital. While this utilization ratio is expressed as the percentage use of a single factor, i.e. capital, the rate of capacity utilization reflects the use of all the resources together, i.e., manpower, capital and other relevant factors of production.

It is not uncommon, however, to take capital as a proxy in measuring the rate of capacity utilization. This is defensible where capital is the scarce factor and the main constraint on the effective use of other factors. In Bangladesh, though shortage of yarn can constrain the utilization of capital in jute weaving to some extent and the possibility of general shortage of skilled manpower cannot be ruled out, it is the shortage in the flow of services of the physical capital stock that basically limits the use of the labour services available within the industry. Capital utilization is therefore used as a proxy for capacity utilization

[5] Some studies have noted this distinction; see for example, Hilton and Dolphin (1970), Lund (1971), Heathfield (1972) and Winston (1974). There are also studies that confuse the two concepts, see for example UNIDO (1972).

over time of our large sample of sacking and hessian jute weaving mills in Bangladesh.

Problems of aggregation of capital as raised by the 'capital controversy' [Sen(1975)] are of obvious relevance for measuring capital utilization. However, the problem of aggregation does not arise in this microeconomic part of the study because physical capital stock (looms) within a mill are identical and are of the same vintage for each product. There has been no machine-determined technological change within mills since their inception. [Kibria and Tisdell(1983)].

Various methods of measuring capacity utilization have been used in the literature.[6] The choice of an appropriate method depends on the purpose of the study as well as on the quality of data available and the nature of the industry itself.

In jute weaving, the loom is the main machine to which all the other machinery is ancillary equipment. There is also a high degree of complementarity betwen the employment of looms and the emplyment of capital equipments at other stages of production. Thus the average number of looms in operation during a year is a useful index of the total operating capital input in the entire production process for that period. This provides us with an opportunity to compare directly the operating machines (looms) as a ratio of installed machines (looms) per period of time (a year) to find an index of capacity utilization in weaving phase. This ratio, in turn, reflects the utilization level of the total capital stock available for the entire weaving production process if installed ancillary equipment is in fixed proportion to the total number of looms and if its utilization is in fixed proportion to the number of looms operating.

A defensible measure of capacity utilization may thus be:

(1) $U_1 = K/K^*$

where U_1 is the index of capacity utilization and K^* is the number of looms installed and K is the number of looms that ef-

[6] For discussion about various measures of capacity utilization, see Briscoe, O'Brien and Smith (1970), Phillips (1970) and Bautista *et al.* (1981), and for a comparison of the various measures, see Hilton and Dolphin (1970).

fectively operated throughout the year.

Since the amount of time a mill actually works varies widely from year to year, capital utilization cannot be measured by ratio of operating looms to installed looms, as set out in expression (1). If however this ratio is adjusted for the percentage of available time the mill actually worked, we can get a reasonable approximation to capacity utilization. A *percentage* of realistically *available* time rather than the absolute maximum available time is taken because the feasible number of hours of machine operation is much less than the available hour during a year. Taking year as the observation period, the maximum number of hours available is 8760 on the basis of operation of three full shifts which comes to 2920 per shift basis (8 hours a shift). But the *feasible* maximum number of hours that a machine can be operated in a year depends on maintenance requirements, industrial practices, closures for holidays, etc. The normal practice in Bangladesh is such that the machines are not operated one day every week plus about two weeks in every year (mostly public holidays). This means that on the average machines can be operated for about 300 days a year [Ahmad(1976) and Islam(1976)]. It may also be assumed that with a one-day lay-off every week for repair and maintenance or cooling-off, the machine can work efficiently for the full available hours per shift. Hence the total number of hours that each loom can be operated in a year is $300 \times 24 = 7{,}200$ hours for a mill which works on three shifts a day basis, 4,800 hours for those mills which run on a two-shift basis and 2,400 hours for the mills which work on one-shift basis.

The *pattern* of the levels of utilization of each mill over time rather than the absolute levels of utilization or underutilization is most relevent for this study. We have therefore chosen that percentage of time-use incorporated in the measure of capacity utilization should be based on the actual number of shifts an individual mill runs rather than on the absolute maximum number of shifts a mill *can* run (attainable i.e., 3 shifts). This seems particularly relevant for our study in view of the wide variation in the number of shifts operated by jute weaving mills in Bangladesh. Thus the method of measurement followed in our study is of the following form:

$$(2) \quad U_2 = (K/K^*) \times (s \cdot t \cdot T/T^*)$$

which is U_1 multiplied by $s \cdot t \cdot T/T^*$, the percentage of available time the mill actually worked. The explanation of individual components of this fraction are, T = actual time of operation of the mill in a particular year measured in hours; T^* = maximum time available for work per shift of eight hours which comes to 2920 per year; s = the number of shifts worked; and t = the ratio of maximum attainable working time to total available hours which in our case has been calculated to be .822.

This measure (U_2 in expression (2)) is similar to one used by Ahmad (1976) except that his measure allows for the productivity-ratio as a component. Ahmad defines capacity utilization "...as the relationship between the output actually obtained in a given period and the feasible output from the installed capital stock in that period." (p. 79). The feasible capacity rate of output is often assumed to be the equipment manufacturers' estimate of output for a given piece or sequence of equipment. This capacity rate of output can only be produced with an uninterrupted flow of variable inputs and without actual breakdown. Moreover it does not take into consideration of marginal cost of operation. Problems therefore arise in making use of this measure in empirical analysis, particularly in developing countries. First, the rated engineering capacity is not a uniquely determined output level; second, the capacity that is specified by the makers of the equipment for its use in developed countries may disregard the limitations of its physical potential posed by the socio-economic factors in a developing country; and finally, the rated capacity is neither the ideal nor the economically optimal level of production. Economic capacity is usually less then the engineering capacity. The engineering capacity therefore may not be an appropriate index of potential capacity available for use.

Aware of these potential shortcomings with the engineering capacity rate of output, Ahmad's study relied on the managerial appraisal (assessment) of the technical capability of the machines under the existing condition of a mill, as a representative index of the feasible output for the relevant machines of that mill. The view of the industry on the feasible efficiency level is naturally much lower than the engineering level, but nevertheless is much closer to reality and seems to be a better approximation to utilization in developing countries.

Nevertheless, Ahmad's measure is not appropriate for our study of capacity utilization in jute weaving industry in Bangladesh. The sample covered by Ahmad's cross-section study consists of only 12 Bangladesh jute weaving mills, each having machinery of the same vintage. A target of a single feasible capacity rate of output of machinery for all mills in this sample may therefore be a reasonable assumption for his study. On the other hand, the sample in our study consists of large number of mills with machinery of different vintages and so with different potential productive capacity.

In an effort to avoid problems of aggregation and to attain the advantage of intra-mill as well as inter-mill comparability over time, Ahmad's productivity-ratio component has been dropped in favour of the time-related capacity utilization measure used here for Bangladesh jute weaving industry. In fact, a number of studies have adopted the ratio of operating hours and the maximum attainable hours as the measure of capacity utilization [Islam (1976) and Winston (1977)]. In developing countries time utilization schedules of firms and industries appear to remain close to intended target utilization in hours (as is also observed in our study) while actual output fluctuates considerably over time. Thus, capacity utilization measures based on time will be, to quote Winston (1977), "... higher and less variable than capacity utilization measured as output."

IV. Empirical Evidence from Bangladesh on Relationship Between Capacity Utilization and Age of Mill

In 1981, one of the authors went to Bangladesh to collect data directly from 39 jute-weaving mills throughout the country. The sample included mills from Khulna, Chittagong, and Dacca and their production accounted for the major portions of aggregate jute fabric production in Bangladesh. In order to examine the relationship between capacity utilization and the duration of operation (age) of jute weaving mills in Bangladesh the following data were compiled for each mill for each year since its inception: its annual number of installed looms, number of looms actually operated annually, annual number of hours available adjusted for the number of shifts in operation (as explained in detail in previous section) and the actual annual number of hours for which the mill worked. These data were collected and compiled separately for each of the two products, hessian and sacking. Data used are all in physical terms because of its ready availability and in order to avoid indexation problems inherent in monetary data. Relative homogeneity within the jute weaving industry assures that this is not an unreasonable approach.

The variable to which we are relating the rate of capacity utilization is the age of the mill. The dependent variable, i.e., the rate of capacity utilization for each year for each mill as explained in previous section, is obtained by multiplying the percentage use of the installed looms by the percentage of the available time the mill actually worked in each year. The independent variable i.e., the age of the mill on the other hand corresponds to a yearly unit of time since the inception of its operation. However, from the operational ages of the mills we have omitted five years (1970-71 to 1974-75) because of the liberation war and the sudden move to nationalization of the industry following the war which had substantial disruptive consequences during this period.

Data for any mill irrespective of its commencing month during a year has been extended for the rest of the year on the basis of the actual average of the utilization rate attained. However, in cases where mills started their operation late in the year the initial year of operation has been omitted for this study. Also, data for some mills for the initial year was incomplete and therefore was not used in this base. Data for 1979-80 (the last year covered by the present study), were not available from some mills.

Data on capacity utilization of each mill when plotted against its age shows a typical pattern. After the commencement of a new mill capacity utilization tends to rise and reaches its peak level usually 2-5 years of operation, then for a period of around 8-12 years capacity utilization remains nearly stationary, in fact actually declines almost imperceptibly. This second phase is followed by a period of accelerated decline in capacity utilization, but the decline occurs at a slower pace compared to its rise during the initial expansionary phase. The typical pattern and the three distinct phases in the life-cycle of capacity utilization for both the products, hessian and sacking, can be illustrated by the results for a representative mill, Victory Jute Mill, Chittagong, Bangladesh. The actual capacity utilization values observed are shown by the curves in Figures 1 and 2 respectively. Each of the three phases, I, the rising phase; II, the almost stationary phase; and III, the declining phase, correspond approximately to the observations enclosed by the broken lines and appropriately identified. In the case of hessian, phase I extends over 5 years and phase II is of about 10 years in length and is followed by phase III. In the case of sacking, phase I consists of 3 years, phase II of at least 11 years, and is followed by phase III, the state of sharper decline in capacity utilization. The exact boundaries of these phases are not precise in particular cases but their general existence is supported by the observations from all of the mills sampled.

Figure 1

PERCENTAGE OF INSTALLED CAPACITY FOR PRODUCING HESSIAN UTILIZED ANNUALLY BY VICTORY JUTE MILL, CHITTAGONG, BANGLADESH, IN ITS LIFE-TIME. THE OBSERVED RELATIONSHIP IS A TYPICAL ONE.

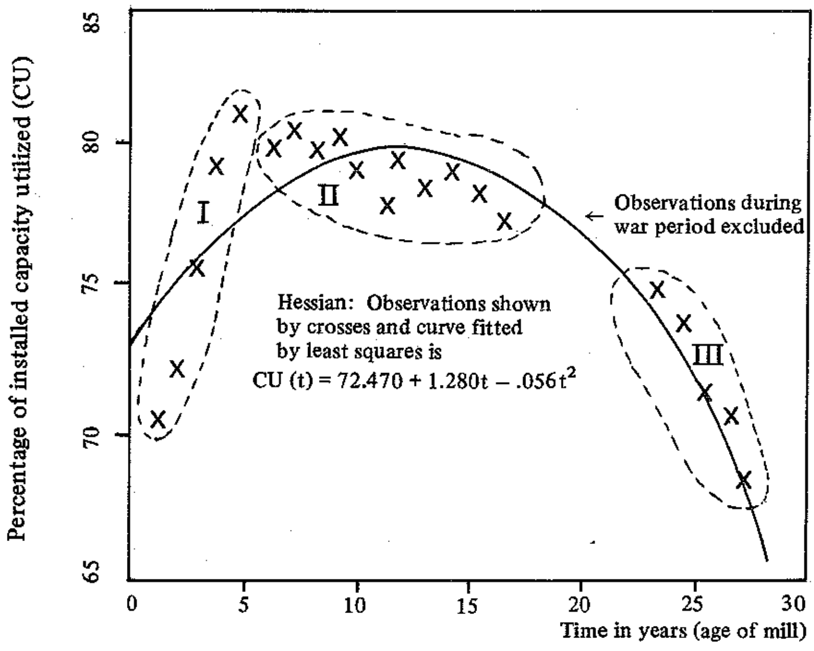
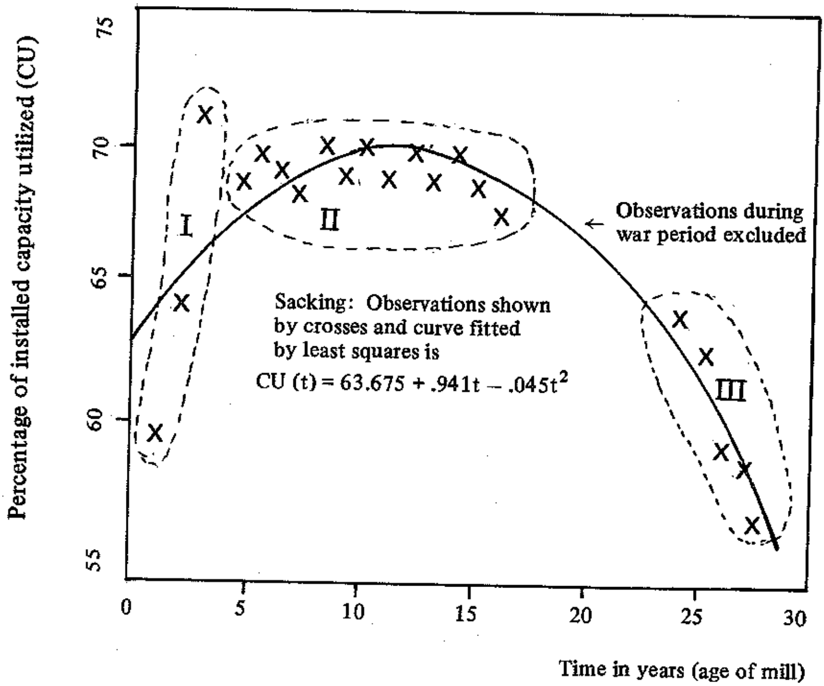


Figure 2

PERCENTAGE OF INSTALLED CAPACITY FOR PRODUCING SACKING UTILIZED ANNUALLY BY VICTORY JUTE MILL, CHITTAGONG, BANGLADESH, IN ITS LIFE-TIME. THE OBSERVED RELATIONSHIP IS A TYPICAL ONE.



The length of phase I for the mills considered in Figures 1 and 2 is longer than the average for all mills sampled. Table 1 sets out the number of years for mills in the sample to complete phase I (attain maximum capacity utilization). The average number of years required for hessian production is 2.92 years and that for sacking production is 2.89 years. The acutal number of years range from 2-5 years. The percentage increase in capacity utilization from the initial level to the peak level is considerable. It averages 17.30 percent for hessian and 15.57 percent for sacking.

It is difficult to approximate the typical life-time pattern of capacity utilization by a simple mathematical function. The pat-

Table 1

PERIOD OF OPERATION OF WEAVING MILLS IN BANGLADESH REQUIRED FOR CAPACITY UTILIZATION TO PEAK AND CORRESPONDING INCREASES IN CAPACITY UTILIZATION IN PERCENTAGE

Mill	Hessian		Sacking	
	Years to peak	% Gain[a]	Years to peak	% Gain[a]
1	3	21.37	3	17.28
2	5	24.18	3	17.58
3	5	27.78	3	13.07
4	5	14.85	3	20.41
5	3	8.54	3	9.80
6	4	22.55	3	15.30
7	4	19.21	4	14.36
8	3	6.31	3	18.56
9	4	24.53	4	18.34
10	4	14.61	5	10.37
11	4	21.79	4	28.53
12	3	21.19	3	9.23
13		Data unusable		
14	4	6.59	3	24.79
15	4	23.55	4	15.62
16	3	18.07	3	10.40
17	2	21.39	4	19.64
18	2	24.37	3	12.79
19	2	12.56	2	14.40
20	2	13.23	2	21.59
21	2	16.81	2	16.65
22	2	29.95	3	14.50
23	2	13.51	2	9.33
24	3	20.85	3	5.02
25	2	43.45	Not producing sacking	
26	2	11.84	2	10.58
27	2	14.68	3	17.49
28	2	15.42	2	10.49
29	2	10.92	3	15.53
30	4	14.76	2	12.39
31	3	13.65	2	15.08
32	3	13.13	2	4.13

Table 1 (Continued)

Mill	Hessian		Sacking	
	Years to peak	% Gain[a]	Years to peak	% Gain[a]
33	2	15.33	Not producing sacking	
34		Data unusable		
35	3	14.04	3	19.78
36	2	5.34	3	27.03
37	2	13.76	3	17.09
38	2	8.81	2	13.05
39	2	17.07	2	24.75

[a] from initial value to peak

tern of utilization is asymmetric (in fact skewed to the left) even though the approximate relationship appears to be unimodal. Because of the asymmetry of the relationship a quadratic function fails to give a good fit to the data even though it has some relevance as the approximations fitted to the data by least squares in Figures 1 and 2 indicate.

The results for fitting a quadratic function to the 17 oldest mills (those for which observations for 15 years or more were available) are set out in Tables 2 and 3. The quadratic function

$$(3) \quad U = a + bt + ct^2$$

where U represents capacity utilization measured as a percentage of installed capacity and t is the age of the mill measured in finite years since the inception of the mill was fitted to the data by the method of ordinary least squares. Mills of the age considered can exhibit all three phases of the life-time pattern of capacity utilization.

Estimated parameters of the equation have the expected signs. Except for three sacking mills, the parameters are found to be significant at the 1% to 5% level.

Table 2

CAPACITY UTILIZATION PERCENTAGES AS A FUNCTION OF MILL AGE (HESSIAN) REGRESSION RESULTS

Coefficients of Equation (3)						No. of
Mill	a	b	c	R^2	F-ratio	observations
1	78.445	.641 (.399) (1.608)	– .036* (.014) (–2.673)	.615	13.587	21
2	71.315	1.211** (.384) (3.154)	– .040** (.013) (–3.019)	.371	5.006	21
3	81.120	1.661** (.490) (3.394)	– .067** (.017) (–4.040)	.568	11.152	21
4	72.470	1.280** (.198) (6.456)	–.056** (.007) (–7.998)	.837	46.334	21
5	63.568	–.702** (.184) (–3.824)	.009 (.006) (1.441)	.876	59.913	21
6	70.933	1.191** (.387) (3.078)	–.054** (.014) (–3.926)	.631	13.688	20
7	84.997	.858 (.446) (1.925)	–.042* (.016) (–2.647)	.502	8.076	20
8	67.404	–.686** (.152) (–4.510)	.004 (.005) (.662)	.952	157.599	20
9	71.106	1.288* (.504) (2.556)	–.059** (.019) (–3.212)	.544	8.937	19
10	63.508	.759* (.293) (2.597)	–.041** (.011) (–3.780)	.733	20.556	19

Table 2 (Continued)

Coefficients of Equation (3)						No. of
Mill	a	b	c	R^2	F-ratio	obser-vations
11	72.921	1.219* (.421) (2.895)	-.056** (.016) (-3.496)	.513	8.440	19
12	58.356	.971* (.415) (2.343)	-.047* (.016) (-2.889)	.456	6.296	18
13	Data unusable					
14	70.105	1.265 (.604) (2.095)	-.059* (.023) (-2.541)	.495	5.886	17
15	75.630	1.462* (.663) (2.204)	-.069* (.027) (-2.603)	.430	4.912	17
16	74.274	.841 (.535) (1.573)	-.047* (.021) (-2.195)	.506	6.652	17
17	70.555	1.575* (.572) (2.753)	-.084** (.026) (-3.234)	.545	7.183	15

Standard error in first parenthesis, t-statistic in second parenthesis.

** 1% level of significance

* 5% level of significance

V. Explaining the Typical Life-Time Pattern of Capacity Utilization and Conclusion

It is observed that the life-time pattern of capacity utilization in Bangladesh jute weaving mills typically has three distinct phases. Several factors need to be taken into account to explain each of these phases. Phase I corresponds to the 'running-in' of newly installed machinery. In the initial phase, management and workers are likely to be relatively unfamiliar with the new equip-

Table 3

Capacity Utilization Percentages as a Function of Mill Age (Sacking) Regression Results

Coefficients of Equation (3)						No. of
						obser-
Mill	a	b	c	R^2	F-ratio	vations
1	68.155	.776*	−.041**	.767	27.908	21
		(.280)	(.010)			
		(2.770)	(−4.247)			
2	63.744	.423	3 −.022*	.502	8.581	21
		(.274)	(.009)			
		(1.547)	(−2.364)			
3	66.769	.748**	−.040**	.848	47.259	21
		(.225)	(.008)			
		(3.324)	(−5.277)			
4	63.675	.941**	−.045**	.767	27.958	21
		(.278)	(.010)			
		(3.382)	(−4.783)			
5	87.850	−.142	−.010	.795	33.050	21
		(.237)	(.008)			
		(−.600)	(−1.222)			
6	68.344	.698*	−.041**	.789	29.992	20
		(.292)	(.010)			
		(2.390)	(−3.937)			
7	77.516	.257	−.024*	.719	20.501	20
		(.313)	(.011)			
		(0.819)	(−2.183)			
8	78.393	.215	−.021	.539	9.356	20
		(.398)	(.014)			
		(0.540)	(−1.461)			
9	64.355	.886*	−.045**	.694	16.988	19
		(.331)	(.012)			
		(2.679)	(−3.716)			
10	69.926	.667	−.038*	.784	23.587	19
		(.395)	(.014)			
		(1.687)	(−2.805)			

Table 3 (Continued)

Coefficients of Equation (3)						No. of
Mill	a	b	c	R^2	F-ratio	observations
11	57.270	1.616** (.371) (4.355)	-.070** (.014) (-4.963)	.642	14.331	19
12	62.445	.057 (.302) (0.189)	-.021 (.012) (-1.808)	.817	31.191	18
13		Data unusable				
14	66.720	1.523* (.612) (2.490)	-.076** (.024) (-3.109)	.574	8.766	17
15	72.311	1.297* (.526) (2.464)	-.067** (.020) (-3.298)	.718	15.259	17
16	77.242	.554 (.338) (1.643)	-.041** (.013) (-3.090)	.818	29.131	17
17	70.826	1.355* (.464) (2.919)	-.072** (.020) (-3.676)	.769	16.672	15

Standard error in first parenthesis, t-statistic in second parenthesis.

** 1% level of significance

* 5% level of significance

ment and the machinery itself is being subjected to stress for the first time so initially breakages and down-time of machines is likely to be frequent and repairs may take longer than later because of the relative unfamiliarity of mechanics or engineers with the new machines. However, this phase passes rapidly and maximum capacity (even though less than installed capacity) is achieved in most mills within 2-5 years from their commencement of operation.

The almost stationary phase which follows and in which capacity utilized declines only slightly, is typically of 8-12 years in duration. Engineers and operators are now relatively familiar with the installed equipment, machinery has been run-in and has not yet been subjected to sufficient wear and tear to show substantial physical deterioration.

In the third phase, physical deterioration of machinery advances and breakage due to wear and tear becomes more frequent. Given the advancing age of the machine spare parts may be more difficult to obtain from suppliers, most of whom are overseas. However, the problem is exacerbated by the grave shortage of funds in LDCs for importing replacement parts and poor planning and management of inventories in some cases [Ministry of Overseas Development, Govt. of U.K. (1978) and BJMC Study Group, Vol. I, (1980)]. In the case of nationalized industries, such as the jute weaving industry in Bangladesh, where finance tend to be centrally controlled this further adds to delays in procuring replacement parts [IBRD/IDA(1975)]. An inadequate maintenance system in this nationalized industry accentuates the frequency of mechanical breakdown in older machinery and thereby reduces the average number of operating looms in older mills.

Lost potential production in phase III is considerable and widespread in manufacturing in LDCs. Evidence from several studies: Hogan (1968), and Huq (1970) on Pakistan, Bautista (1981) on Philipines, Thoumi [in Bautista *et al.* (1981)] on Colombia, and a report from Tanzania [Sunday News Tanzania (1982)] indicate that a considerable loss in national manufacturing production occurs due to the inability to utilize installed capacity because of the shortage of foreign funds needed to import replacement parts and ancillary equipments and necessary raw materials. Inappropriate and unstable industrial policy often adds to the problem [Hogan(1968)]. In developed countries the sharply declining phase of capacity utilization is likely to be absent in factories [Lund(1971)] because of the ready availability of replacement parts and the greater frequency with which machines are replaced. [Cf. Winston(1974), p. 1302]

In conclusion, a typical pattern of utilization of installed capacity in jute weaving mills in Bangladesh has been observed. This pattern may be common in manufacturing industry in LDCs. It also seems likely that the pattern differs from the time-pattern of utilization of installed capacity in manufacturing plants in developed countries.

References

Ahmad, Q.K., "The Operation of Export Bonus Scheme in Pakistan's Jute and Cotton Industries," *The Pakistan Development Review,* 6, 1:1-37, 1966.

Ahmad, Q.K., and Anwaruzzaman, C., "Productivity Trends in the Manufacturing Sector of Bangladesh: A Case Study of Selected Industries," *The Bangladesh Economic Review,* 1, 2, pp. 119-148, 1973.

Ahmad, Q.K., "The Jute Manufacturing Industry of Bangladesh, 1947-74," Unpublished Ph.D. dissertation, London School of Economics and Political Science, 1976.

——— , "Was the Jute Manufacturing Industry Profitable in Pre-Liberation Days?" *Bangladesh Development Studies,* 5, 3, pp. 367-370, 1977.

Bailey, M.A., "Capital Utilization in Kenya Manufacturing Industry," Unpublished Ph.D dissertation, M.I.T., 1974.

Bautista, R. et al., *Capital Utilization in Manufacturing: A World Bank Research Publication,* London: Oxford University Press, 1981.

Betancourt, R.R., and Clague, C.K., *Capital Utilization: A Theoretical and Empirical Analysis,* Cambridge: Cambridge University Press, 1981.

BJMC Study Group, *Report on Manufacturing of Jute Goods: Main Report,* 1, Dacca: BJMC, 1980.

Briscoe, G., O'Brien, P., and Smyth, D.J., "The Measurement of Capacity Utilization in the United Kingdom," *The Manchester School of Economics and Social Studies,* 38, pp. 2:91-117, 1970.

Bruton, H.J., and Bose, S.R., *The Pakistan Export Bonus Scheme,* Monograph 11, Pakistan Institute of development Economics, Karachi, 1963.

Erselcuk, M., "Case Studies of the Causes of Excess Capacity in Industry," Industrialization and Productivity, Bulletin 15, UNIDO, New York, 1972.

Heathfield, D.F., "The Measurement of Capital Usage Using Electricity Consumption data for the U.K.," *Journal of Royal Statistical Society,* Series A (General), Part 2, 135, pp. 208-222, 1972.

Hilton, K., and Dolphin, H., "Capital and Capacity Utilization in the United Kingdom: Their Measurement and Reconciliation," *Bulletin of Oxford University Institute of Economics and Statistics,* 32, 3, pp. 187-218, 1970.

Hogan, W., "Capacity Creation and Utilization in Pakistan Manufacturing Industry," *Australian Economic Papers,* 7, 10, pp. 28-53, 1968.

Huq, S., "Patterns of Industrialization in Pakistan," In E.A.G. Robinson and M. Kidron, eds., *Economic Development in South Asia,* London: Macmillan, 1970.

IBRD/IDA, *Bangladesh: Survey of the Jute and Cotton Textile Industries*, Washington DC: IBRD/IDA, Industrial Project Department, 1975.

Islam, R., "Factor Intensity and Labour Absorption in Manufacturing Industries: The Case of Bangladesh," Unpulished Ph.D. dissertation, London: School of Economics and Political Science, 1976.

Kibria, M.G., and Tisdell, C.A., "An Analysis of Technological Change in Jute Weaving in Bangladesh, 1954-55 to 1979-80," *The Developing Economies,* 21, June 1983.

Klein, L.R., and Preston, R.S., "Some New Results in the Measurement of Capacity Utilization," *American Economic Review,* 57, 1, pp. 34-58, 1967.

Lewis, Jr., S.R., *Pakistan: Industrialization and Trade Policy,* London, 1970.

Lund, P.J., "Capacity and Capital Utilization, A Note," *The Manchester School of Economics and Social Studies,* 39, 1, pp. 45-52, 1971.

Marris, R., *The Economics of Capital Utilization: A Report on Multiple Shift Work,* Cambridge: Cambridge University Press, 1964.

Mason, E.S., *Economic Development in India and Pakistan,* Occasional Papers in International Affairs, No. 13, Cambridge: Harvard University Center for International Affairs, Sept. 1966.

Ministry of Overseas Development, Government of the United Kingdom, *Jute Sector Study,* 1, London, 1978.

Mujeri, M.K., "The World Market for Jute: An Econometric Analysis," Unpublished Ph.D. dissertation, Hamilton, Canada: McMaster University, 1978.

Sen, A.K., *Employment, Technology and Development,* Oxford: Clarendon Press, 1975.

Steel, W.F., "Import Substitution and Excess Capacity in Ghana," *Oxford Economic Papers,* 24, 2, pp. 212-240, 1972.

Sunday News Tanzania, "Tight Budget Next Year," No. 1526 Dar-es-Salaam, Tanzania, May 23, 1982.

Taubman, P., and Wilkinson, M., "User Cost, Capital Utilization and Investment Theory," *International Economic Review,* 11, 2, pp. 209-215, 1970.

UNIDO, *Guidelines for Project Evaluation,* New York: UNIDO, 1972.

Winston, G.C., "Capital Utilization in Economic Development," *Economic Journal,* 81, 321, pp. 36-60, 1971.

———, "The Theory of Capital Utilization and Idleness," *Journal of Economic Literature,* 12, 4, pp. 1301-1320, 1974.

———, *Increasing Manufacturing Employment Through Fuller Utilization of Capacity in Nigeria,* World Employment Programme Research Working Paper, Geneva: International Labour Organization, 1977.