Productivity Growth in Small Enterprises - Role of Inputs, Technological Progress and 'Learning By Doing'

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PRODUCTIVITY GROWTH IN SMALL ENTERPRISES – ROLE OF INPUTS, TECHNOLOGICAL PROGRESS AND 'LEARNING BY DOING'

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The contribution of Small Manufacturing Enterprises (SMEs) to the economy is being questioned on grounds of their low productivity and their sustainability is argued to depend on improving labour productivity through technological upgradation. In a developing economy this is a costly proposition due to capital scarcity, and the effect of technological changes on productivity levels has to be estimated before taking such policies. However, for the SMEs, technological diffusion is more important rather than the 'modernity' of the technology itself. This paper seeks to disassociate the effects of pure Technological Progress from those of Technological Efficiency Changes in few selected industries within the SMEs and examines their relative importance. It is found that in about 70 per cent of the situations where indeed there has been some technological improvement, technological diffusion has by far outstripped the role of pure technical progress. A combination of better technology and wider diffusion is thus recommended for productivity rise.

I. INTRODUCTION

Small Manufacturing Enterprises (SMEs) in an overpopulated developing economy serve the dual role of job-creation and shifting the occupational structure. Combined with low capital requirement (sometimes one-fifth of that in the factories per worker), indigenous resources, and localised market, they serve as an important player in transforming a predominantly subsistence, agro-based economy to a market-based industrial economy. However, their contribution to the overall health of the economy and the policy of encouraging them are being questioned nowadays on grounds of economic viability and returns to the entrepreneur. It has been commented that much of the recent increase in non-farm employment is distress-induced and leads to overcrowding of workers and low productivity (Bhalla, 2000). As much as 40 per cent of Value Added and 50 per cent of Employment in the SMEs are reported to be concentrated in the low productive (Labour productivity less than 3000 Rupees per worker per annum in 1980-81 prices) segments and activities (Shah, 2002). About 25

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per cent of the workers in the unorganised manufacturing sector are said to be seriously underemployed (Oberai and Chadha, 2001). Under such conditions, researchers have argued that the sustainability of SMEs depend crucially on getting out of the 'cheap labour' syndrome and improve labour productivity (LP) followed by improving labour conditions (Shah, 2001). They have also stressed on technological improvement (Mukherjee and Mathur, 2002), technical adaptation (Mamgain et al, 2002), promotion of links between SMEs and organised sector (Ghate et al, 1992, Mukherjee and Mathur, 2002), smoothening credit disbursements to SMEs (Mukherjee and Mathur, 2002), etc. as means to improve productivity. However, the focal point of almost all of them is upgradation of technology through greater capital use. In context of a developing economy this may turn out to be a costly proposition due to scarcity of capital. Moreover, desired changes in production process may also be brought about by better mastering of the existing technologies or diffusion. This paper seeks to disassociate the effects of pure Technological Progress (TP) from those of Technological Diffusion or Learning-by-Doing in few selected industries within the SMEs to examine the relative importance of them in improving the health of the SMEs.

The paper has five sections. In the next section we discuss the methodological background of the study. The third and fourth section analyse the results obtained and interpret them. The final section summarises the main findings and provides few policy suggestions in their light.

II. TECHNOLOGICAL PROGRESS AND TECHNOLOGICAL DIFFUSION METHODOLOGICAL ISSUES

1. Theoretical Background

Improvements in labour productivity as a consequence of increase in capital stcok have often been termed as cosmetic. It is argued that 'Capital Deepening' shifts in technique of production necessarily lead to a rise in labour productivity and fall in capital productivity, and the changes in LP is merely a reflection of substituting one factor by another (higher LP levels in factories relative to the SMEs has to be viewed against this backdrop and does not always reflect higher efficiency of the former). Therefore, changes in productivity levels due to changes in technology are advised to be measured by changes in Total Factor Productivity or Total Factor Productivity Growth (TFPG). Following Growth Accounting Approach as formulated by Solow

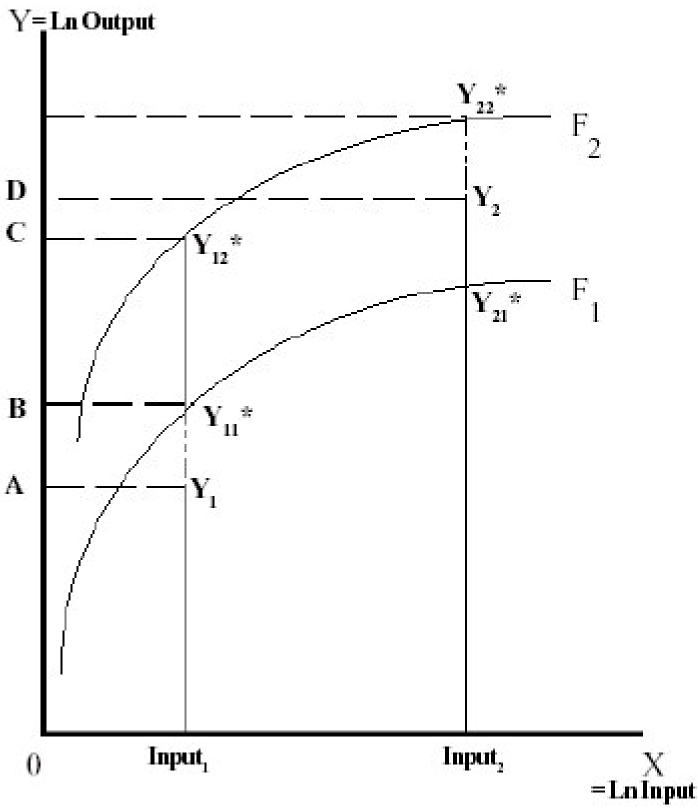
(Solow, 1957), Output growth is decomposed into two components – growth due to changes in inputs, and that due to other factors. The second component is termed as TFPG and is generally taken as a measure of TP (or, more specifically, contribution of TP towards productivity rise). A positive TFPG implies that the production frontier has expanded outward and there has been a more than proportionate rise in output compared to that in inputs. By decomposing output growth into TFPG and that accounted for by input growth, researchers have compared the relative importance of the two. Also, in cases where TFPG has been substantial and positive, it has been concluded that they are clear instances of TP leading to productivity rise. And naturally, technological upgradation has been suggested as the main policy instrument for productivity improvement.

However, one must remember that TFPG in the growth accounting approach is a residual measure and encompasses the effect of not only TP, but also of better utilisation of capacities, learning by doing, improved labour efficiency, etc. Thus, it is a combination of improved technology and the skill with which known technology is applied by the units, i.e. Technological Efficiency (TE). This second component, i.e. growth in output because of greater experience & skill of workers, better organisation by the entrepreneurs, better utilisation of existing resources, etc. are significant for the SMEs. Most of these units rely on indigenous resources & adaptive technology, and the workers acquire their skill mostly 'on the job'. As a result, they go on experimenting till they achieve the optimum mix of technology, resource, skill and organisation. Consequently, diffusion of technology is more important to them rather than the 'modernity' of the technology itself. One must therefore try to alienate the effects of pure TP from that of Technological Efficiency Changes (TEC) for these units.

In technical terms, a TP may be measured by the outward shift of the production frontier. But given the nature of the SMEs, and the diversity therein, it is quite realistic to postulate that the 'frontier' would be achieved by only a few, and most of the units would operate within the envelope. Output growth may therefore occur due to three factors – rise in input/resource use (a lateral movement on the 2-dimensional Input-Output Plane), improvement in technology (upward shift of the production frontier), and improvement in technological efficiency (movement from a sub-frontier position towards the frontier). In reality, output growth occurs due to a combination of one or more of these three factors. Following Kalirajan et al (Kalirajan, Obwona and

Zhao, 1996), this decomposition of total Output Growth into Input Growth (INPG), Technical Progress (TP), and Technical Efficiency Changes (TEC) can be illustrated by Figure 1. The production frontiers are F_1 and F_2 respectively. For a firm on the frontier, output would be Y_{11}* in period 1 and Y_{22}* in period 2. But, most of the firms will operate within the envelope. Let a representative firm' s realized output is Y in period 1 and Y_2 in period 2. The vertical distance between the frontier output and the realized output of the firm, that is, TE1 [= (Y_{11}* - Y_1)] in period 1, and TE2 [=(Y_{22}* - Y_2)] in period 2, respectively, are measures of Technical Inefficiency. Hence, the difference between TE1 and TE2 is the Technical Efficiency Change (TEC) over time. The distance between the two frontiers F_1 and F_2 [that is, (Y_{22}* - Y_{21}*) using period 2 input levels, or (Y_{11}*-Y_{12}*) using Period 1 input levels] are measures of Technological Progress (TP). The contribution of input growth (INPG) to output growth between periods 1 and 2 would be (Y_{22}* - Y_{12}*) using F_2 frontier, or (Y_{21}* - Y_{11}*) using F_2 frontier.

Figure 1
Decomposition of Output Growth into TP, TEC and INPG



The output growth from A to D can therefore be decomposed into AB + BC + CD.

Output growth = $Y_2 - Y_1$ = CD + BC + AB

$= (Y_2 – Y_{12}*) + (Y_{12}* - Y_{11}*) + (Y_{11}* - Y_1)$

$= [(Y_{11}* - Y_1) – (Y_{22}* - Y_2)] + (Y_{12}* - Y_{11}*) + (Y_{22}* - Y_{12}*)$

= [TE1 - TE2] + TP + INPG

= (TEC + TP) + INPG = TFPG + INPG

The present structure breaks up observed output growth to lateral movements on or beneath the production frontier (INPG), movement towards the production frontier (TEC), and shifts in the production frontier itself (TP).

Using Stochastic Frontier Production Function in its Translog form, one can get estimates of Efficiency for each firm in both initial and final periods and thereby calculate TEC.[1] Figures on TFPG can be obtained using Solow's growth accounting approach using a Translog formulation.[2] The contribution of Inputs and TP can thereafter be obtained as INPG = (Output growth – TFPG), and TP = (TFPG – TEC) respectively. One can then study the relative importance of the roles played by each of these three players – Inputs, Technology, and Diffusion, in achieving Output growth.

In the present paper, we follow this methodology to study the roles of these three factors in four selected industry groups of SMEs. We consider a Translog production function to be operative with Value Added being dependent on Labour (Number of Workers) and Fixed Capital (Fixed Assets). The Value terms are at constant 1981-82 prices.

2. Database and Operational Methodology

We use the NSSO database on Unorganised Manufacturing sector for our study, and the reference periods are 1994-95 and 2000-01, as defined by the two latest NSSO surveys.[3] Out of the three types of enterprises surveyed by NSSO, the smallest ones (OAMEs) do not use any hired labour. Consequently, for them, the data on emoluments to workers are not dependable, and so TFPG has not been calculated therein. We thus consider the DMEs and the NDMEs within the unorganised manufacturing sector. We restrict our study to 16 major states of India and consider Rural and Urban sectors separately. Thus we have 64 possible observations (16 states X 2 types of enterprises X 2 sectors) for each of the 2-digit NIC groups for 1994-95 and 2000-01.[4] We consider these 64 observations as individual firms (e.g. rural DMEs of West Bengal as one firm, urban NDMEs of Gujarat as another firm, and so on). This allows us to find out Value Added Growth (VAG), TEC, TP, TFPG and INPG for each of the two types of enterprises for rural and urban sectors separately for each of the 16 states.

Among the industry groups, we concentrate on Food product, Textiles, Leather product, and Non-electrical & electrical equipment sectors.[5] The first one represents consumer non-durables, the next two are semi-durables, and the last one represents intermediate & durable capital goods. Thus we have 256 possible 'firms' for our study – each one representing a particular enterprise type in a particular sector of a particular state producing a particular commodity. We estimate the efficiencies, TFPG and related parameters separately for each of the industries, as it is quite natural that different industries will have different production functions. Out of the possible 256 combinations, we could get only 222 comparable observations (107 for DMEs and 115 for NDMEs) present both in 1994-95 and 2000-01. Let us now explore the results in details.

III. FACTOR PRODUCTIVITY IN SMES

A substantial part of growth in Value Added in developing economies is due to rapid increase in input use and little is attributed to improvements in factor productivity. In fact, the average contribution of inputs to output growth in developing nations has been estimated to be close to 70 per cent (Chenery et al, 1986). India's performance, especially that of the organised manufacturing sector, has been much worse as regards TFPG is concerned. During 1959-60 to 1985-86 rate of growth of TFP has been –0.4 per cent per annum (Ahluwalia, 1991). This miserable situation had improved in the later decades and TFPG during 1979-90 has been estimated to be 1.8 per cent p.a. (Unel, 2003). The performance improved further in the post-reform period to post a TFPG rate of 4.7 per cent p.a. during 1991-97 (Unel, op cit). However, for the unorganised manufacturing sector, TFPG has been fluctuating between positive and negative. Rates of TFPG for this sector on the aggregate have been estimated to be –14.6 per cent p.a. during 1978-85, 11.4 per cent p.a. during 1985-90, -3.1 per cent p.a. during 1990-95 (Unni et al, 2001).

In the recent years, i.e. for our study period of 1994-2000, Value Added in the unorganised manufacturing sector have increased at 5.2 per cent p.a., Employment at 1.9 per cent p.a., and Capital stock at 5.1 per cent p.a. This has resulted in a rise in TFP at the rate of 0.9 per cent p.a. We are however more interested in the trends shown by our selected segment.

Of the 222 cases considered by us, TFPG has been positive in 89 cases (Table 1). Between the two types of enterprises, TFPG has been higher in the NDMEs compared to the DMEs for all industries taken together. While about half of the cases in the Urban areas yielded positive TFPG, only one-third of the cases in the Rural areas showed positive TFPG. Incidence of positive TFPG is substantially lower in the Northern states compared to the national average, while relatively better performance are exhibited by Gujarat, Madhya Pradesh and Maharashtra.[6] Among the four industries considered by us, positive TFPG is more frequent in Food products and Textiles relative to the other two.

Table 1

Incidence of Positive TFPG, Positive Input Growth and Positive Value Added Growth

Categories	*TFPG*	*INPG*	*VAG*	*Total Nos.*
Enterprise Types				
Rural DME	27	24	28	48
Urban DME	21	42	41	59
Rural NDME	24	31	30	53
Urban NDME	26	44	46	62
All DMEs	48	66	69	107
All NDMEs	50	75	76	115
Industry Groups				
Food Products	29	45	39	62
Textiles	27	23	27	56
Leather Products	19	28	32	47
Equipment	23	45	47	57
Regions				
Central	13	18	18	27
East	17	23	23	38
North	18	33	35	50
South	26	40	39	61
West	24	27	30	46
Total	**98**	**141**	**145**	**222**

Source: Author's Calculation based on NSSO (1998,1998a, 2002, 2002a)

As against this, contribution of inputs (measured by INPG) has been positive in 141 cases, more prominently in urban areas compared to rural areas, and in NDMEs compared to DMEs. Positive contribution of inputs has been relatively less frequent in Textiles compared to the other industries, and in eastern and western states compared to the other states. Positive INPG has been most frequent in Punjab, followed by Orissa and Karnataka.

Combining them, Value Added Growth (VAG) has been positive in 145 cases. We find that VAG has been affected mostly by INPG and follows the sign (positive or negative) of INPG in more than 85 per cent of the cases. Only in few cases, positive TFPG have been able to offset the negative contribution of INPG to yield positive VAG. However, for the Food product sector, negative TFPG have offset the positive effect of INPG in quite a few cases.

The mean contribution of INPG has been 3.17 per cent p.a. while that of TFPG has been only 1.10 per cent p.a. (Table 2). Among all the cases, contribution of INPG is higher than TFPG in 136 cases. Among the 145 cases where VAG have been positive, contribution of TFPG exceeds that of INPG in only 32 cases. In addition, positive INPG leads to positive VAG in more than 90 percent of cases while positive TFPG leads to positive VAG in just 75 per cent cases. This indicates that major part of VAG has been possible because of increase input use and technological upgradation has had only a moderate effect.

Table 2

TFPG, Input Growth and Value Added Growth 1994-2000

Categories	*Average Annual Rates of*			*Number of Cases Where TFPG > INPG*	
	TFPG	*INPG*	*VAG*	*Among All Cases*	*Among Cases with Positive VAG*
Enterprise Types					
Rural DME	0.51	-4.78	-4.27	25 (48)	8 (28)
Urban DME	-0.02	7.31	7.29	15 (59)	6 (41)
Rural NDME	1.45	-0.07	1.38	26 (53)	8 (30)
Urban NDME	1.42	5.00	6.42	20 (62)	10 (46)
All DMEs	0.94	2.94	3.88	40 (107)	14 (69)
All NDMEs	1.50	3.35	4.85	46 (115)	18 (76)
Industry Groups					
Food Products	-0.02	3.95	3.93	19 (62)	6 (39)
Textiles	1.39	-1.45	-0.06	33 (56)	9 (27)
Leather Products	3.63	-1.20	2.43	20 (47)	10 (32)
Equipment	2.12	8.78	10.90	14 (57)	7 (47)
Regions					
Central	-1.79	5.61	3.82	10 (27)	5 (18)
East	2.51	0.12	2.63	17 (38)	4 (23)
North	2.01	6.92	8.93	16 (50)	7 (35)
South	0.59	3.62	4.21	24 (61)	10 (39)
West	2.47	0.91	3.38	19 (46)	6 (30)
Total	**1.10**	**3.17**	**4.27**	**86 (222)**	**32 (145)**

Note: Figures in Parentheses are total number of cases in respective groups.

Source: Same as Table 1.

However, given the fact that TFPG has been positive in about 45 per cent of the cases, and of them 75 per cent also have positive VAG, we can not ignore its contribution. Researchers working with TFPG have naturally focussed on similar results and have recommended that TP is the way out from low productivity trap for the SMEs and upgrading technology through injection of fresh capital is the panacea. This however seems to be too hasty a conclusion. As has been commented earlier, for the SMEs, organisation of available resources, training and skill acquisition of the workers, and learning by doing are equally (if not more) important factors. Let us now decompose TFPG into pure TP and TEC (or Diffusion) to examine the relative contribution of them.

IV. TECHNOLOGY: UPGRADATION VERSUS DIFFUSION

1. Overview

It is observed that during the period 1994-2000, Efficiency levels have improved in 140 cases and TEC have been positive therein (Table 3). Compared to this, TP has been positive in just 68 cases – less than half of the former!

Table 3

Incidence of Positive TEC, Positive TP and Positive TFPG

Categories	*TEC*	*TP*	*TFPG*	*Total Nos.*
Enterprise Types				
Rural DME	29	18	27	48
Urban DME	37	19	21	59
Rural NDME	37	14	24	53
Urban NDME	37	17	26	62
All DMEs	66	37	48	107
All NDMEs	74	31	50	115
Industry Groups				
Food Products	57	2	29	62
Textiles	1	56	27	56
Leather Products	34	9	19	47
Equipment	48	1	23	57
Regions				
Central	17	9	13	27
East	25	12	17	38
North	34	11	18	50
South	34	22	26	61
West	30	14	24	46
Total	**140**	**68**	**98**	**222**

Source: Same as Table 1.

The average value of TEC is positive while the average TP is negative (Table 4). Among all cases, TEC is greater than TP in 153 cases. If we consider only those 140 cases where TEC is positive, TP is out weighed by TEC in 70 cases. Thus, in about one-third of the cases, TEC is greater than TP and is positive. Against this, TP is positive and greater than TEC in 66 cases. It therefore follows that the contribution of TP and TEC are equally important. If anything, the balance is marginally tilted towards TEC.

If we now consider only those 98 cases where TFPG is positive, we find that TEC is greater than TP in 70 cases, i.e. in about 70 per cent of the situations where indeed there has been some technological improvement, technological diffusion has by far outstripped the role of pure technical progress. This underlines the importance of diffusion and learning by doing etc. for improving the conditions of the SMEs.

Table 4

TEC, TP and TFPG during 1994-2000

Categories	*Average Annual Rates of*			*Number of Cases Where TEC > TP*	
	TEC	*TP*	*TFPG*	*Among All Cases*	*Among Cases with Positive TFPG*
Enterprise Types					
Rural DME	1.96	-1.45	0.51	31 (48)	16 (27)
Urban DME	1.77	-1.79	-0.02	39 (59)	16 (21)
Rural NDME	1.52	-0.07	1.45	40 (53)	19 (24)
Urban NDME	1.56	-0.14	1.42	43 (62)	19 (26)
All DMEs	1.86	-0.92	0.94	70 (107)	32 (48)
All NDMEs	1.54	-0.04	1.50	83 (115)	38 (50)
Industry Groups					
Food Products	6.99	-7.01	-0.02	62 (62)	29 (29)
Textiles	-30.20	31.59	1.39	0 (56)	0 (27)
Leather Products	13.88	-10.25	3.63	36 (47)	18 (19)
Equipment	16.14	-14.02	2.12	55 (57)	23 (23)
Regions					
Central	5.18	-6.97	-1.79	18 (27)	9 (13)
East	-4.07	6.58	2.51	25 (38)	10 (17)
North	4.64	-2.63	2.01	39 (50)	16 (18)
South	-1.41	2.00	0.59	40 (61)	19 (26)
West	5.61	-3.14	2.47	31 (46)	16 (24)
Total	**1.75**	**-0.65**	**1.10**	**153 (222)**	**70 (98)**

Note: Figures in Parentheses are total number of cases in respective groups

Source: Same as Table 1.

2. Disaggregated Results

The results regarding TEC and TP that we have outlined so far have variation across enterprise types, regions, and industries.

It is observed that TP is more prominent in the DMEs compared to NDMEs, while the reverse is true for TEC. TP has been positive in just about 20 per cent cases for the Northern states compared to the national figure of about 35 per cent. On the other hand, TEC is positive in about half of the cases for the Southern states compared to the national ratio of two-third.

But wider variations are observed across the industry groups. While for Food products, Leather products, and the Equipment sector TEC has been positive in more than 80 per cent of the cases, for the Textiles sector, only one positive TEC is observed (rural DME of Madhya Pradesh). Contrary to this, almost all cases for Textiles show positive TP during 1994-2000, while that for Food products and Equipment sector are only one and two respectively. However, for Textiles, even with TEC being negative in almost all cases, in half of the cases positive TP acts as a boost and makes TFPG positive, the trend being more pronounced for smaller and rural units. But, for urban DMEs, TEC is negative in all the cases, and in most of them TP cannot compensate for it.

For Food product and Equipment sectors, TEC is mostly positive. But in half of these cases, negative TP acts as a drag and makes TFPG negative. For Food products, this phenomenon is more pronounced in the urban sector where 29 cases have positive TEC and negative TP acts as a drag in 20 of them.

For Leather products, TFPG is dictated by TEC in two-third of the cases, especially in the urban areas. But, for rural DMEs, TP outweighs TEC.

More significant however, is the observation that, all the 28 cases (save 1) where TFPG is positive but TP is greater than TEC, belongs to the Textiles sector. Compared to this, none of the Food products industries appear in the list of positive TP and TP greater than TEC.

It can thus be commented that for Food product and Equipment sectors, both TP and TEC are observed to have been equally important in determining TFPG. On the other hand, TP has played a dominant role in the Textiles sector and TEC a more vital role in the Leather products sector.

What explains these inter-industry differences? One possible explanation may lie in the dynamics of these industries in India over the last decade. It is widely accepted that the Leather industry in India is suffering from outdated technology (leading to adverse environmental impact and outright closure notices in various regions). It is extremely conservative and managed by people with little technical education. They are used to the old technology and traditional ways of doing things and are very reluctant to introduce changes. This lack of positive attitude towards new technology and management methods acts as a serious barrier to the upgradation of the sector.

Moreover, upgrading technology in the leather industry is a comprehensive changeover programme and the cost is very high. This hinders the small firms while the cheaper Indian machines mostly embody older technologies. Under such situations, whatever improvement in productivity has been observed in this sector has been mainly due to better use of existing machineries and techniques.[7] On the other hand, there has been a tremendous technological upgradation in the Textiles sector in the post-reform period. Faced with global competition and favourable domestic supply of raw materials, and aided by the Technology Upgradation Fund set up by the government for this sector, it has been able to induct modern technology up to a large extent. This is reflected in the greater role of TP in this sector. AS against this, Food products and Equipment sectors in India are the ones where one sees the fiercest competition along with a wider spread of the firms in terms of size-class. While there are modern large firms catering to the global niche market, there are also tiny units producing traditional items for a closed local market. As a result, these sectors have seen both incorporation of better technology (mostly by the larger firms) and better use of existing techniques (by the smaller firms). Consequently, these two sectors have seen both TP and TEC acting together towards improved productivity.

V. CONCLUSION

The results thus clearly bring out the fact that Efficiency parameters are significant determinants of productivity and growth of the SMEs. In fact, in many cases they outweigh the role of pure technological progress. This results are but expected because the nature of the SMEs make them more reliant on their skill and organisation, rather than on scarce capital resource. They depend more on innovation and adaptation, rather than on significant changes in capital-labour ratio. Effectiveness of labour for these units depends more on training, experience, and familiarity of the workers, rather than on the range of tools that complement them. As a result, Diffusion plays a prominent role in their productivity rise and output growth. This has crucial policy implications and questions the blanket policy suggestion of injecting more capital into the SMEs to upgrade their technology.

Consequently, policies for the productivity rise and growth of the SMEs should give stress on these issues rather than trying to change the basic technology applied therein. Innovation and Adaptation process should be encouraged through knowledge sharing and fine-tuning of the production process. Training programmes for the workers may be organised to make them better acquainted with the machines they work with. The entrepreneurs must be imparted the basics of optimum organisational skills. In all these aspects formation of local groups, sharing experiences of successful units, and even sharing of 'idle' resources may prove helpful. In other words, efficiency enhancement should be the prime target for the SMEs.

Moreover, any effort to improve the technology involves capital induction and requires substantial amount of financial resources. Given the nature of the SMEs and the background of most of the entrepreneurs, this is a costly, and often difficult, proposition. On the other hand, diffusion of existing technology and improvements in organisation, skill, and efficiency require less capital and more 'human involvement', the latter being abundant with the SMEs. Thus as a policy choice, Efficiency Upgradation appears more viable, effective and lucrative compared to Technological Upgradation.

Saying all these, it must be acknowledged that Technological Progress also has a special role to play and any technological upgradation will raise productivity and improve performance. Among the various product groups, there are few that have benefited more from TP rather than TEC. This diversity must be clearly brought out and policies must be framed accordingly. Only when better technology combines with wider diffusion can one expect the SMEs to come out of their low productivity syndrome and ensure better returns, both for their entrepreneurs and for the economy.

Notes

[1] For theoretical details on Frontier Production Functions, see Aigner et al (1977) and Meeusen and van den Broeck (1977). These original specifications have been altered and extended in a number of ways. For comprehensive reviews of this literature look at Forsund et al (1980), Schmidt (1986), Bauer (1990) and Greene (1993). Battese and Coelli (1992) propose a stochastic frontier production function for (unbalanced) panel data, which has firm-specific 'inefficiency' effects that are assumed to be distributed as truncated normal random variables (as inefficiency can at least be zero when the firm is on the frontier). The 'inefficiency' effects are also permitted to vary over time. This model has been supplemented by their computer programme Frontier Version 4.1 used to empirically measure Efficiency of firms over a number of periods. This programme has been used here.

[2] In this formulation TFPG can be obtained from $\Delta \ln \text{TFP} = \Delta \ln Y_t - \varpi \Delta \ln L_t - (1-\varpi)\Delta \ln K_t$,

where $\Delta \ln Y_t = \ln Y_t - \ln Y_{t-1}$, $\Delta \ln L_t = \ln L_t - \ln L_{t-1}$, $\Delta \ln K_t = \ln K_t - \ln K_{t-1}$, ϖ = average of share of labour in output in period t and (t-1).

[3] The NSSO survey on Unorganised Manufacturing Sector distinguishes three types of enterprises – (i) Own Account Manufacturing Enterprise (henceforth OAMEs) - manufacturing enterprise operating with no hired worker employed on a fairly regular basis; (ii) Non-Directory Manufacturing Establishments (henceforth NDMEs) - units employing less than 6 workers including household workers; and (iii) Directory Manufacturing Establishments (henceforth DMEs) - units employing 6 or more workers with at least 1 hired worker but not registered under the Factory Act. The two latest surveys are the 51st and the 56th Round surveys.

[4] The 56th round (2000-01) NSS data uses NIC 1998 codes. They have been reclassified by the author using Annexe-III of 'National Industrial Classification 1998' to bring comparability with the 51st Round that use NIC 1987 codes.

[5] The Textiles sector according to NIC-1998 includes Cotton Textiles, Natural Fibre products and Wool & Silk Textiles.

[6] The 16 major states can be regionalised in the following manner. Northern – Punjab, Haryana, Himachal Pradesh and Delhi; Eastern – Bihar, West Bengal, and Orissa; Western – Rajasthan, Gujarat, and Maharashtra; Southern – Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu; and Central – Uttar Pradesh and Madhya Pradesh.

[7] In the last couple of years though, there has been some improvements in the technology front of the leather sector with the Central Leather Research Institute coming up with modern technology at cheaper rates, and the government supplementing it with the Indian Leather Development Programme wherein it provides 25 per cent subsidy towards the cost of modernisation.

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