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PRODUCTIVITY TRENDS IN PAKISTAN'S MANUFACTURING: 1955-81

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We have computed a total factor productivity index for Pakistan's large-scale manufacturing sector for the period 1955-81. The impact of the violation emanting from the use of growth accounting techniques has been minimized by treating our index as a residual and using marginal product weights. We have computed another total factor productivity index based on factor share weights in order to show the extent of the bias that emerges from using methodologies that assume conditions which do not prevail in a developing economy like Pakistan.

I. Introduction

The pioneering study on the sources of growth by Abramovitz (1956) was followed by a substantial literature in this and related areas.[1] The criticism on the methodology, however, proliferated as fast as the literature.[2] Some of the criticisms relate to the restrictive assumptions underlying the methodology. However, in spite of limitations the methodology does have the advantage that it brings out, rather explicitly the total cost incurred in terms of the resources. Partial productivity indices, on the other hand, do

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[1] See for example the works by Solow (1957); Fabricant (1959); Kendrick (1956), (1961) and (1973); Griliches (1963), (1964) and (1967); and Denison (1967a) and (1967b).

[2] For a detailed criticism of the residual method see Jorgenson and Griliches (1967) and Massel (1962). The index number problem has been discussed at length in Nadiri (1970), Kennedy and Thirlwall (1972), Rhymes (1983) and Norsworthy (1984).

not reflect the total cost incurred in the growth process, but have the advantage that they are not based on unrealistic assumptions. An attempt has been made in this paper to compute total factor productivity for Pakistan's large-scale manufacturing sector based on a methodology which is less restrictive than the conventional one. The conventional use of factor shares as weights for the inputs implies competitive markets. We have, instead, used marginal products as weights.

In an earlier study, Cheema (1978) computed total factor productivity for sixteen large-scale manufacturing industries of Pakistan for the period 1959-60 to 1969-70. The objectives pursued in this study are twofold. The first is to get estimates on total factor productivity for Pakistan's large-scale manufacturing sector for the period 1955-56 to 1980-81.[3] The second objective is to estimate the bias that emerges when competitive factor markets are assumed. The paper is divided into four sections. Following the introduction in Section I, the model is laid out in Section II. This section also includes a brief discussion of the data and their sources. The empirical findings are contained in Section III, followed by the conclusion in Section IV.

II. Methodology and Data Sources

As stated earlier in the introduction, the models used in the computation of total factor productivity generally assume that the factor markets are competitive, the aggregate production function is linear and homogeneous and technical progress is Hicks neutral. Since empirical evidence suggests that there is substantial disequilibrium in the factor markets of both developed and the developing countries [Bruno (1968); and Thurow (1968)], we have tried not to invoke the assumption of competitive markets. In computating our aggregate input index, we have weighted each input directly by its marginal product.

Let the aggregate production function in Pakistan's large scale manufacturing sector be linear:

$$Y = \sum_{i=1}^{n} \alpha_i \ x_i \qquad (1)$$

Where Y is manufacturing value-added. x_1 stands for inputs like labour, capital, etc., and the coefficient α_i is the marginal value product of each of the inputs.

[3] Since the CMI surveys were not conducted every year, there are only fifteen observations for the period 1955-56 to 1980-81.

Adding the residual and introducing time, we rewrite equation (1) as:

$$Y_t = A(t) \sum_{i=1}^{n} \alpha_i \, x_{it} \qquad (2)$$

Rewriting equation (2) in index number form and holding A equal to one for the base year:

$$\frac{Y_t}{Y_o} = A(t) \frac{\Sigma(\alpha_i \, x_{it})}{\Sigma(\alpha_i \, x_{io})} \qquad (3)$$

Rewriting equation (3) after substituting

$$S_t \text{ for } Y_t/Y_o \text{ and } Z_t \text{ for } \frac{\Sigma(\alpha_i \, x_{it})}{\Sigma(\alpha_i \, x_{io})}$$

$$S_t = A(t) \, Z_t \qquad (4)$$

where S_t is the value added index, Z_t is the aggregate input index and $A(t)$ is the total factor productivity index.

Writing the equation for A(t)

$$A(t) = S_t/Z_t \qquad (5)$$

Where Z_t is composed of

$$Z_t = \sum_{i=1}^{n} \left[\alpha_i \; \frac{X_{it}}{X_{io}} \right] \qquad (6)$$

where α_is are the marginal value product weights[4] and X_{it}/X_{io} are the corresponding input indices.

Data on manufacturing value-added, employment and that used in the computation of the capital stock variable come from various issues of the Census of Manufacturing Industries (CMI). The consumer price index (CPI) used to deflate employment cost and the data used in the computation of the building material price index are taken from the 25 Years of Pakistan in Statistics and the 10 Years of Pakistan in Statistics. The data used in the computation of the machinery deflators come from the Com-

[4] The weights used by us are 0.45 for labour and 0.55 for capital. These are the marginal value products obtained by estimating a Cobb Douglas production function in an earlier study by one of the authors [Wizarat, (1988)].

modity Trends and Prices (1986) and the Annual Report of the State Bank of Pakistan. The computation of the capital stock and its deflator have been discussed in detail in Wizarat (1988) and Wizarat and Jaffry (1988), parts of which have been reproduced in the Technical Appendix.

III. Results

The methodology developed in Section II was applied to the data discussed partly in the same section and partly in the Technical Appendix to get estimates on the value-added, the aggregate input and the total factor productivity indices. The estimates computed by using marginal product weights are contained in Table 1. Table 2 contains another set of estimates of the three indices based on factor share weights. A comparison of the two tables reveals that there is substantial bias in the estimation of the aggregate input index and the total factor productivity index when competitive factor markets are assumed. We find that by and large, from 1959-60

TABLE 1

The Value-Added Index, the Aggregate Input Index and the Total Factor Productivity Index (Using Marginal Product Weights)

Year	Value Added Index	Aggregate Input Index	Total Factor Productivity Index
1955-56	52.56	73.90	71.72
1957-58	63.89	80.16	79.70
1958-59	98.92	89.99	109.92
1959-60	100.00	100.00	100.00
1962-63	261.99	210.99	124.17
1963-64	273.40	232.31	117.69
1964-65	343.01	259.09	132.39
1965-66	365.94	294.26	124.36
1966-67	412.62	333.85	123.59
1969-70	516.88	462.79	111.69
1970-71	533.42	528.44	100.94
1975-76	553.53	951.99	58.15
1976-77	626.79	1038.49	60.36
1977-78	733.38	1040.57	70.96
1980-81	941.04	1790.48	53.00

to 1969-70, the aggregate input index in Table 2 increases at a faster pace as compared with the aggregate input index in Table 1. But from 1970-71 onwards the rate of increase of the aggregate input index contained in Table 1 is much faster. On account of this till 1969-70 the rate of increase in the total factor productivity index in Table 1 is higher than that of the total factor productivity index in Table 2. From then onwards the decline in the total factor productivity index in Table 1 is steeper than the decline in the total factor productivity estimates of Table 2. We find that ignoring the disequilibrium between factor payments and marginal products in the large-scale manufacturing sector causes the increases and the declines in the total factor productivity index to be under-estimated.

The average annual rates of growth of these indices have been recorded in Table 3. We find that during the period 1955-56 to 1980-81 total factor productivity has recorded an annual average rate of increase of one per cent when marginal product weights are used. The analysis reveals that of the observed increase in manufacturing value added about 7 per cent

TABLE 2

The Value-Added Index, the Aggregate Input Index and the Total Factor Productivity Index (Using Factor Share Weights)

Year	Value Added Index	Aggregate Input Index	Total Factor Productivity Index
1955-56	52.56	75.12	70.00
1957-58	63.89	85.65	74.59
1958-59	98.92	120.06	82.89
1959-60	100.00	100.00	100.00
1962-63	261.99	220.66	108.73
1963-64	273.40	236.60	115.55
1964-65	343.01	275.36	124.57
1965-66	365.94	337.14	108.39
1966-67	412.62	337.50	122.26
1969-70	516.88	475.84	108.62
1970-71	533.42	522.21	102.15
1975-76	553.53	680.17	81.38
1976-77	626.79	690.94	90.72
1977-78	733.38	825.03	114.83
1980-81	941.04	1245.79	75.54

may be attributed to total factor productivity, while about 93 per cent may be due to the use of inputs. On the other hand, the estimates based on factor share weights declined at the average annual rate of one per cent. We find that the negative contribution of total factor productivity during this period was about 7 per cent, while the positive contribution of inputs was around 107 per cent.

Dividing the period into smaller sub-periods we find that the value added index grew at a spectacular rate during the sub-period 1955-56 to 1959-60. The aggregate input index grew at the rate of 7.3 per cent and the total factor productivity index at 12.3 per cent per annum (using marginal product weights). We find that of the observed increase in manufacturing value added about 63 per cent may be attributed to the residual, while about 37 per cent was due to the use of inputs. The spectacular growth of the manufacturing sector during this sub-period may partly be due to starting from the scratch. It may partly be attributed to the favourable industrial and trade policies adopted by the government, which helped to enhance the profitability of the manufacturing sector. The rate of increase of the aggregate input index is higher, while that of the total factor productivity index lower when factor shares are used as weights.

During the 1960s the value-added index grew at a faster rate, but because of the massive flow of inputs to the manufacturing sector during this sub-period, the rate of growth of total factor productivity was reduced to 3 per cent per annum during this sub-period. We find that of the observed growth of manufacturing value added during this sub-period about 89 per

TABLE 3

Average Annual Rates of Growth of the Value-Added, The Aggregate Input and the Total Factor Productivity Indices

	Using Marginal Product Weights			Using Factor Share Weights	
	Value Added Index	Aggregate Input Index	Total Factor Productivity Index	Aggregate Input Index	Total Factor Productivity Index
PERIOD					
1955-56 to 1980-81	15.00	14.00	1.00	16.00	−1.00
SUB-PERIODS					
1955-56 to 1959-60	19.50	7.30	12.30	9.00	10.50
1959-60 to 1969-70	26.00	23.00	3.00	34.00	−8.00
1969-70 to 1980-81	6.40	13.40	−7.00	10.40	−4.00

cent may be attributed to the use of inputs, while about 11 per cent may be on account of the residual. The contribution of inputs is much higher, while total factor productivity is having a negative effect when factor shares are used as weights.

During the 1970s we find total factor productivity declining at the annual average rate of 7 per cent, which works out to be about 109 per cent of the growth of manufacturing value-added of 6.4 per cent during this sub-period. The decline in total factor productivity during the 1970s may be attributed to several factors, notable among which are the war with India, nationalization of basic industries and the stagnation of private investment as an aftermath, the devaluation of the Rupee in 1972 which increased the prices of machinery and industial raw material.

IV. Conclusion

We have computed the first ever total factor productivity index for Pakistan's large-scale manufacturing sector using marginal product weights. We have shown that the disequilibrium in the factor market causes the upturns and the down turns in the growth of total factor productivity to be under-stated. Our total factor productivity index increases at the average annual rate of one per cent, whereas the one based on factor shares declines at the average annual rate of one per cent. According to the earlier estimates total factor productivity makes a positive contribution of 7 per cent to the manufacturing value-added growth, the latter estimates reflect a negative contribution of an equal amount. The analysis thus clearly brings out the extent of the bias that emerges from using methodologies that assume conditions which do not prevail in a country like Pakistan.

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Technical Appendix

Considerable adjustments have to be made to the CMI data in Wizarat (1988) and Wizarat and Jaffry (1988). Some parts of the section on data adjustments in that study have been reproduced in this appendix to inform the reader of the adjustments and refinements made on the data. Two specific tasks undertaken in the earlier study that are of interest to us in the present study are the computation of a capital stock series and a capital stock deflator. The capital stock series computed by us is more refined than the capital data available in the CMI. Moreover, we have computed separate building material and machinery price indices, in order to be able to deflate both the components of capital by their respective deflators. Following is a discussion of the steps taken with regard to these tasks.

Capital Stock Series

The first step towards building our capital stock series was to generate net annual investment for available years. Since

$$KB + GI - DP = KE \qquad (1)$$

where KB = Capital stock at the begining of the year.
GI = Gross investment during the year.
DP = Depreciation during the year.
KE = Capital stock at the end of the year.

Bringing KB on the right hand side, we rewrite equation (1) as:

$$GI - DP = KE - KB \qquad (2)$$

Net investment can therefore be estimated either by estimating the identity on the left or the right hand side of equation (2) i.e., gross investment minus depreciaton or capital stock at the end of the year minus capital stock at the beginning of the year. We used the identity on the left hand side[1] to generate a net investment series i.e., subtracting depreciation from gross investment. Two definitions of depreciation were used i.e., actual depreciation as a percentage of beginning year capital stock for the years 1970-71 to 1980-81. We then took the average of these percentages to compute a depreciation series. The second depreciation series has been generated assuming depreciation at 5 per cent of beginning year capital stock.

The two depreciation series were used to generate two net investment series. The first net investment series is gross investment minus actual average percentage of depreciation in beginning year capital stock.[2] While the second net investment series is gross investment minus depreciation estimated at 5 per cent of beginning year capital stock. The latter net investment series was selected for computing the capital stock series, since it appears to be free of the violent year to year fluctuations that are present in the first series.

[1] First we used the identity on the right hand side to generate a net investment series. But this series showed violent yearly fluctuations and would give weird results when used. This procedure therefore had to be abandoned.

[2] The average percentage of actual depreciation does not give good results, as we have actual depreciation only for the latter years. This gives a very high depreciation rate, and creates problems in generating the net investment series.

We used data on building/equipment breakdown of capital stock for the year 1980-81 to divide net investment into these two components. The proportion of net investment on buildings was deflated by the building material price index computed later, while the proportion of net investment on machinery was deflated by the machinery price index also computed later. Next by aggregating the two deflated components of investment, we got a deflated net investment series. Total net investment for the intervening years was generated by interpolating total net investment for these years. We then obtained a merged net investment series by putting together our original (deflated) net investment series and the interpolated values for the intervening years.

The adjusted capital stock series was computed by starting with beginning of year capital stock in year 1. This is the capital available for production in that year, investment in that year is assumed not to be productive until the next year. We then added net investment recursively in each year from the merged net investment series obtained earlier. This gave a capital stock series for every year from 1955-56 to 1980-81. We then selected capital stock values for the years for which the other data are also available.

Capital Deflator

We computed two capital deflators i.e., a building material price index to deflate the proportion of investment on buildings and a machinery price index to deflate investment on account of machinery.

Building Material Price Index

The building material price index is a composite index of the prices of cement, pig iron, timber, paints and varnishes. The four components were aggregated on the basis of their weights in the total building material price index during 1976-77 to 1983-84.

Machinery Price Index

The machinery price index has been obtained by multiplying international manufacturing price index by the exchange rate. This appears to be an appropriate machinery deflator as domestic production of capital goods is in its initial stages, the bulk of the capital goods used by the large-scale manufacturing sector are still imported.