Research Report No. 44

THE SLOWING DOWN OF THE GROWTH OF TOTAL FACTOR PRODUCTIVITY IN PAKISTAN

SOCIAL POLICY AND DEVELOPMENT CENTRE

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December, 2002

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1. INTRODUCTION

The growth rate of Pakistan's economy has plummetted from over six percent during the decade of the 80s to just over four percent in the 90's. This loss of economic dynamism has generally been attributed to the sharp fall in the rate of investment in the economy, especially by the public sector and more recently also by the private sector. Little emphasis has been placed on the impact of changes in total factor productivity (TFP) on the overall growth rate.

This paper quantifies the trend in TFP in Pakistan over the 25 years period, 1972-73 and 1997-98. This leads to the conclusion that a significant part of the decline in growth rate during the decade of the 90s is also due to a slowing down of the growth in TFP and not just because of a lower level of investment in the economy. The paper then attempts to answer the following questions: Is the phenomenon of stagnation in TFP observed in all sectors of the economy? What are the causative factors behind the loss of growth momentum in TFP?

The paper is organized as follows: Section 2 develops a framework for growth accounting within which the contribution of TFP to growth can be quantified. Section 3 presents a review of literature on the elements of TFP and its determinants. Section 4 derives the trends of TFP in Pakistan. Section 5 undertakes econometric analysis of the determinants of TFP. Section 6 highlights the key policy implications which emerge from the analysis. Finally, in Section 7 are presented the conclusions.[1]

2. GROWTH ACCOUNTING

Total factor productivity is essentially a measure of technical progress in the production process. Technical progress has two components: technical change and improvement in technical progress respectively. The former represents improvements in 'best' production practice while the latter occurs when actual production practices move closer to the existing best practice.

[1]The research was undertaken when Hafiz A. Pasha was the Managing Director and Aisha Ghaus-Pasha, the Deputy Managing Director of SPDC

Solow (1957) first proposed a growth accounting framework, which attributes the growth in TFP to that part of growth in output which cannot be explained by growth in factor inputs like land, labor and capital. Therefore, the aggregate production function is seen as follows:

$$Y = f(TFP, I)$$

Where Y=output, I=factor inputs, TFP= total factor productivity

This implies that

$$g_Y = g_I + g_{TFP}$$

Where g is the growth rate.

Since g_y and g_I are observed, then

$$g_{TFP} = g_Y + g_I$$

Therefore, the growth in TFP is seen essentially as a residual.

3. REVIEW OF LITERATURE

Initial research in the 60s and 70s found that growth in developed countries was due more to increase in TFP than to increase in factor inputs. For example, Kanamori (1972) showed that between 1955 and 1968, 60 percent of Japan's output growth was due to TFP improvement. More recent research on developing economies reveals that the role of TFP is perhaps less important.

There is in fact, a major controversy today about the sources of growth of fast growing East and South East Asian economies. Krugman (1994) argues that most of the growth of these economies was due to increase in factor inputs and was, therefore, not sustainable. Various studies have estimated that the contribution of TFP to growth ranged from a high of 41 percent in the case of Hong Kong and Taiwan, to 31 percent in Thailand, 26 percent in Indonesia, 24 percent in Singapore, 22 percent in Korea and a low of 11 percent in the case of Malaysia and minus 8 percent in Philippines.

There has been limited research on trends in TFP in Pakistan. Wizarat (1988) showed that for the period, 1955-56 to 1980-81, TFP contributed only 7 percent to growth of the large scale-

manufacturing sector, despite the fact that the sector grew rapidly during this period. Beyond this, there is no published research on what happened to TFP during the decade of the 80s and 90s. This paper represents perhaps the first attempt in this regard.

The literature on TFP also generally presents evidence to the effect that improvement in TFP in developing countries can be attributed more to improvements in technical efficiency than to technical change. For example, Yanrui Wu [1995] finds that substantial scope exists for raising TFP by enhancing technical efficiency. He demonstrates that technical efficiency in state industry, rural industry and agriculture in post reform China was only 50 to 60 percent between 1985 and 1991.

Technical progress also appears to be more 'endogenous' in nature. Important determinants are factors like human capital, infrastructure, vintage of capital, research and development (R&D) investment, technology purchase expenditures by firms, extent of exposure to foreign competition, learning by doing, etc. This has important implications on the strategy which needs to be adopted for raising TFP.

4. TRENDS IN TOTAL FACTOR PRODUCTIVITY

As highlighted earlier, the growth rate of TFP corresponds to the growth rate of output minus the growth rate of factor inputs. Therefore, we present first the annual growth rate for the economy as a whole and for individual sectors-agriculture, manufacturing and services. The analysis is conducted separately for different plan periods, from 1972-73 to 1997-98. The latter year corresponds to the last year of the Eighth Plan period (1992-93 to 1997-98).

Table 1 demonstrates that the overall growth rate of the economy has varied significantly over the different plan periods, ranging from a low of 4.5 percent during the Eighth Plan period (1992-93 to 1997-98) to a high in the Fifth Plan period (1977-78 to 19882-83) of 6.7 percent. Much of the fluctuation is attributable to variation in the growth rate of the manufacturing sector which reached a peak of almost 10 percent during the fifth plan period (1977-78 to 1982-83) and has since declined to below 5 percent. The basic question is whether the changes in growth rate of the economy are due more to changes in the growth rate of factor inputs or in TFP.

TABLE 1
GROWTH PERFORMANCE OF PAKISTAN'S ECONOMY IN VARIOUS PLAN PERIODS
Annual Growth Rate (%)

Period	Agriculture	Manufacturing	Services	Total
1972-73 to 1997-98 *(Non-Plan Period)*	2.4	4.0	6.7	4.8
1977-78 to 1982-83 *(Fifth Plan Period)*	4.5	9.8	6.9	6.7
1982-83 to 1987-88 *(Sixth Plan Period)*	3.5	8.2	7.0	6.4
1987-88 to 1992-93 *(Seventh Plan Period)*	3.7	5.9	5.3	4.9
1992-93 to 1997-98 *(Eighth Plan Period)*	5.4	4.6	4.1	4.5
1972-73 to 1997-98	**3.9**	**6.5**	**6.0**	**5.5**

Source: *Pakistan Economic Survey*

The growth rate of factor inputs has been derived on the assumption that the underlying production function is Cobb-Douglas in nature with constant returns to scale and 'neutral' technical progress. This implies that the overall growth rate of factor inputs is the weighted sum of the growth rate of individual inputs of land, labor and capital, with the weights adding up to unity. Serious measurement issues arise with regard to the estimation of the capital stock series. This series has been extracted from the database of the Integrated Social Policy and Macroeconomic Model of the Social Policy and Development Centre, which is described in detail in Pasha, Hasan and others [1996]. Time series on land and labor have been taken from the usual sources.

Resulting estimates of the annual growth rate in factor inputs are presented in Table 2. These estimates range from a high of 3.9 percent during the Seventh Plan period (1987-88 to 1992-93) to a low of 2.8 percent during the Non-Plan period (1972-73 to 1977-78). The variation is due primarily to changes in the growth rate of the capital input, which grew rapidly in the Seventh Plan period (1987-88 to 1992-93) at over 6 percent per annum. This period was characterized by

buoyancy in private investment. As apposed to this, the capital stock showed only modest growth during the Non-Plan period (1972-73 to 1977-78), as a consequence primarily of the slump in private investment following the wave of nationalization.

TABLE 2

GROWTH IN FACTOR INPUTS

Annual Growth Rate (%)

Period	All Factor Inputs	Capital	Labor	Land
1972-73 to 1997-98 *(Non-Plan Period)*	2.8	2.8	3.4	1.0
1977-78 to 1982-83 *(Fifth Plan Period)*	3.0	4.4	2.5	0.2
1982-83 to 1987-88 *(Sixth Plan Period)*	3.6	5.9	1.9	0.4
1987-88 to 1992-93 *(Seventh Plan Period)*	3.9	6.1	1.5	0.7
1992-93 to 1997-98 *(Eighth Plan Period)*	3.8	5.0	2.7	0.6
1972-73 to 1997-98	**3.3**	**4.6**	**2.4**	**0.6**

***Source**: Pakistan Economic Survey*
Pasha, Hasan and Others [1996]

Tables 1 and 2 reveal that there is no direct correlation between the growth rate of output and the growth rate of factor inputs. For example, output growth was the fastest, as highlighted above, during the Fifth Plan period (1977-78 to 1982-83). But this period witnessed only moderate growth in factor inputs. As opposed to this, the last (Eighth) plan period (1992-93 to 1997-98) witnessed relatively slow growth while the growth of factor inputs was relatively fast. The capital stock expanded fairly rapidly at 5 percent per annum along with increase in employment of almost 3 percent. The decline in private investment essentially came after 1997-98, following

the deterioration in the investment climate resulting from sanctions imposed upon Pakistan in the aftermath of the nuclear blasts.

Table 3 decomposes the overall growth rate of the economy into the growth rate of factor inputs and TFP respectively. The table clearly shows that the economy has tended to grow fast in those periods when TFP has risen relatively rapidly. Between 1977-78 and 1987-88, the economy exhibited a growth rate in excess of 6 percent while TFP increased by over 3 percent per annum. In fact, changes in TFP contributed as much as 55 percent to the highest growth rate of the economy, Observed during the Fifth Plan period (1977-78 to 1982-83). Overall, on a long term basis (over the 25 year period of 1972-73 to 1997-98) TFP is responsible for 40 percent of the growth in the economy. This is a relatively high contribution by international standards.

TABLE 3

SOURCES OF GROWTH OF PAKISTAN'S ECONOMY

Annual Growth Rate (%)

Period	GDP	Factor Inputs	Total Factor Productivity	Contribution of TFP (%)
1972-73 to 1997-98 *(Non-Plan Period)*	4.8	2.8	2.0	42
1977-78 to 1982-83 *(Fifth Plan Period)*	6.7	3.0	3.7	55
1982-83 to 1987-88 *(Sixth Plan Period)*	6.4	3.6	2.8	44
1987-88 to 1992-93 *(Seventh Plan Period)*	4.9	3.9	1.0	20
1992-93 to 1997-98 *(Eighth Plan Period)*	4.5	3.8	0.7	16
1972-73 to 1997-98	**5.5**	**3.3**	**2.2**	**40**

Source: *Derived from Tables 1 and 2*

More recently, however, the growth rate of the economy appears to have faltered because of the slowing down in the rate of increase of TFP to less than 1 percent per annum. Therefore, for the better part of the 90s' the story behind the poor growth performance is less one of low level of private investment but more one of failure of TFP to rise. The question which arises then is what explains the stagnation of TFP during the 90's.

We attempt to answer this question by determining if the lack of growth in TFP during the last decade is observed for all sectors of the economy of if it is concentrated in particular sectors. Table 4 shows the evolution of TFP in different sectors of the economy. During the Eighth Plan period (1992-93 to 1997-98) there are widely divergent trends of TFP by sector. TFP appears to have actually fallen in the services sector by over 2 percent per annum, increased by over 1 percent annually in the manufacturing sector and demonstrated exceptional buoyancy in the agricultural sector of over 4 percent per annum. Therefore, the stagnation and even fall in TFP is observed primarily in the services sector and to some extent in the manufacturing sector.

TABLE 4

ANNUAL GROWTH RATE OF TFP BY SECTOR

Annual Growth Rate (%)

Period	Agriculture	Manufacturing	Services	Overall Economy
1972-73 to 1997-98 *(Non-Plan Period)*	0.4	1.3	1.6	2.0
1977-78 to 1982-83 *(Fifth Plan Period)*	2.7	9.4	1.3	3.7
1982-83 to 1987-88 *(Sixth Plan Period)*	1.9	6.6	1.8	2.8
1987-88 to 1992-93 *(Seventh Plan Period)*	2.7	4.2	-0.1	1.0
1992-93 to 1997-98 *(Eighth Plan Period)*	4.2	1.4	-2.3	0.7
1972-73 to 1997-98	**2.4**	**4.6**	**0.7**	**2.2**

Source: *Pakistan Economic Survey*
Pasha, Hasan and Others [1996]

5. DETERMINANTS OF TFP

We now turn to an examination of the role of different factors in influencing the level of TFP. As highlighted earlier, the literature has demonstrated the importance of 'endogenous' factors in influencing developments in TFP. We first specify a number of common explanatory variables across sectors. These include, first the level of human capital embodied in the labor force, which has been proxied by the average number of years of schooling of employed persons. Second, the impact of provision of physical infrastructure like transport and communication, energy, etc.), on TFP has been captured by the level of real public sector development expenditure.

A number of variables could not be included in the analysis because of the lack of data. This includes research and development expenditures by firms in Pakistan. Such expenditures are very low and, therefore, this variable is unlikely to have a material impact on TFP. The other phenomenon is 'learning by doing'. One way of capturing this is to measure the average age (or experience) of members of the labor force. However, there appears to be little variation in this magnitude over time, because Pakistan's labor force is expanding rapidly and, consequently, a large proportion of the labor force consists of relatively new entrants.

Beyond this, a number of sector-specific variables have been specified to explain the variation in TFP. In agriculture two additional variables have been included. The first is non-factor inputs, relating to the use of inputs like water, fertilizer, improved seeds, pesticides, etc. The second variable, the cotton yield, captures the randomness in agricultural output arising from natural disasters.

For manufacturing, two additional variables have been specified. The level of manufactured exports is expected to capture the effect on TFP of exposure to foreign competition. A 'vintage' of capital variable has been included, measured by the share of new investment in the capital stock, with the possibility of an ambiguous impact. On the one hand, new plants are expected to embody the latest technology with current 'best' practices. On the other hand, there is a gestation lag in the full utilization of recent investments. In the case of service sector, we also specify a vintage of capital variable. In addition, real home remittances is included to reflect the fluctuation in demand for services in the economy.

The Technical Appendix presents the results of the OLS regressions of the level of TFP with respect to the above mentioned explanatory variables for each sector and for the economy as a whole. The human capital variable emerges as significant throughout while development expenditure appears to be important in the case of the service sector. The vintage of capital variable has a positive sign in the case of the manufacturing sector, but a negative sign for the service sector. The level of exports appears to be an important determinant of TFP for the manufactured sector. Similarly, the results emphasize the importance of non-factor inputs in agriculture.

Based on the regression results, we are now in a position to quantify the contribution of different factors to the change in TFP in different periods. These results are presented in tables 5 to 8, first for individual sectors and then for the economy as a whole.

TABLE 5

CONTRIBUTION OF DIFFERENT

FACTORS TO GROWTH OF TFP IN AGRICULTURE

(Average Annual %)

Period	1972-73 to 1997-98	1992-93 to 1997-98
Human Capital	1.8	1.6
Non-Factor Inputs (Fertilizer water etc.)	0.6	2.1
Cotton Yield	0.2	0.0
Unexplained	-0.2	0.5
Total	2.4	4.2

Table 5 highlights the contribution of different factors to growth of TFP in agriculture both on a long-term basis, 1972-73 to 1997-98, and for the most recent period, 1972-73 to 1997-98. Human capital improvement accounts for 1.6 to 1.8 percent increase annually in TFP. This is a significant contribution and highlights the importance of raising the human capital endowment of the labor force to achieve increases in TFP. The faster growth of TFP in recent years is due largely to the enhanced contribution of non-factor inputs. It also appears that the agricultural sector is becoming more efficient by shedding some of its surplus of largely underemployed

labor. The rate of incremental labor absorption has decreased in the 90's as compared to the previous two decades.

We turn now to an examination of the factors contributing to the growth of TFP in the manufacturing sector. Results are presented in Table 6. In this sector also, human capital appears to have made a major contribution to the growth rate of TFP annually of about 1.8 percent. The slowing down of the rate of increase in TFP during the 90s is due, first, to the lack of contribution of manufactured exports, which have stagnated, second, due to a decline in the share of new investment in the total stock which has implied less transfer of technology and, third, because of the fall in the level of real development expenditure arising from the emerging fiscal constraints.

TABLE 6

CONTRIBUTION OF DIFFERENT FACTORS

TO GROWTH OF TFP IN MANUFACTURING

(Average Annual %)

Factor	1972-73 to 1997-98	1992-93 to 1997-98
Human Capital	1.7	1.8
Manufactured Exports	2.7	0.2
Vintage of Capital	-0.2	-0.8
Development Expenditure	0.6	-0.2
Unexplained	-0.2	0.4
Total	**4.6**	**1.4**

The contribution of different factors to the growth of TFP in the service sector is highlighted in Table 7. Human capital appears to have played a smaller role in raising TFP during the Eighth Plan period (1992-93 to 1997-98). Other factors have all acted negatively in this period, with the vintage of capital having the largest effect. Altogether, this factor appears to be the major factor responsible for restricting the growth of TFP in the service sector.

TABLE 7

CONTRIBUTION OF DIFFERENT FACTORS

TO GROWTH OF TFP IN SERVICES

(Average Annual %)

Factor	1972-73 to 1997-98	1992-93 to 1997-98
Human Capital	2.2	0.8
Vintage of Capital	-2.5	-1.4
Development Expenditure	0.9	-0.7
Remittance	0.2	-0.6
Unexplained	0.1	-0.4
Total	**0.7**	**-2.3**

We are now in a position finally to quantify the role of different factors in influencing the path of TFP for the whole economy. Results are given in Table 8. As for individual sectors, the importance of human capital formation in raising TFP clearly stands out. The main reasons for the slowdown in the growth of TFP for the economy as a whole are the effect of recent vintages of capital, fall in public sector development expenditure and stagnation of exports.

TABLE-8

CONTRIBUTION OF DIFFERENT

FACTORS TO GROWTH OF TFP IN THE ECONOMY

(Average Annual %)

Factor	1972-73 to 1997-98	1992-93 to 1997-98
Human Capital	1.8	1.5
Vintage of Capital	-1.0	-0.7
Development Expenditure	0.5	-0.2
Manufactured Exports	0.8	0.0
Cotton yield	0.2	0.0
Remittances	0.1	-0.1
Unexplained	-0.1	0.2
Total	**2.3**	**0.7**

6. POLICY IMPLICATIONS

Based on the analysis above of the contribution of different factors to growth of TFP in Pakistan, we proceed to derive some of the major policy implications. First, the research has highlighted the importance of human capital endowments of the labor force in influencing the level of TFP in all sectors of the economy. This is largely dependent on the degree of formal schooling, which is likely to determine the extent of 'trainability' of workers and their ability to absorb technology and better production practices. But the level of schooling of workers remains exceptionally low in Pakistan. It is currently estimated at about 3.7 years, with over 54 percent illiterate workers and 18 percent with education only up to primary level.

It has also increased slowly at about 3 percent per annum. Therefore, there exists substantial scope for increasing TFP by investing more in education, especially at the primary and secondary levels. Pakistan has clearly had to pay a high price already in terms of lost productivity due to its chronic under investment on education.

The results also indicate that public sector development expenditure confers gains to TFP probably by increased access of firms to physical infrastructure. The sharp fall in development expenditure from close to 10 percent of the GDP to only about 3 percent of GDP by the end of the decade of the 90s has led to the emergency of bottlenecks of infrastructure to production in transport, communications, etc., and has begun to constrain future gains in TFP. This is yet another reason why if the growth rate of the economy is to be raised once again then the public sector development program has to be enhanced substantially in size.

Exposure to foreign competition through greater participation in export markets appears to stimulate higher levels of productivity as domestic firms get exposed to the latest international practices and are, therefore, able to improve their operations in areas like quality control. marketing, inventory and liquidity management, etc. The stagnation of manufactured exports since the mid-90s has been a retarding factor to productivity gains. Emphasis will have to be placed on making Pakistani firms more export oriented and on diversifying the export base. Policies like maintaining the real effective exchange rate, enhanced availability of export credit at reasonable interest rates and operating an efficient duty drawback regime will have to be focused on, if the overall environment for export growth is to maintain conducive. Unless the

manufacturing sector faces competitive pressures, TFP in the sector is unlikely to improve dramatically. In particular, incentives need to be provided to firms to obtain ISO 9000 certification.

A disturbing finding is that for the economy as a whole the effect of 'vintage' of capital as measured by the share of new investment in the capital stock is negative, although it is positive in the manufacturing sector. Investments in the service sector appear to have a significant lag before full utilization is achieved. Perhaps the best example of this is that of the substantial investment made by the Independent Power Producers (IPP) in additional (thermal) electricity generation in the mid 90s.There has been significant under utilization of this new capacity, due to high prices allowed and the depressed state of demand in the economy. Future policies will, therefore, have to focus less on capacity expansion and more on utilization of existing capacity.

The research also demonstrates that a fundamental structural transformation is taking place in the sectoral distribution of the labor force of Pakistan. The agricultural sector has begun to shed its surplus labor which is finding its way increasingly in the form of underemployment in the service sector, especially in informal activities in cities. This has implied that while TFP in agriculture has shown buoyancy, it has actually begun to decline in the service sector. The labor force in services has expanded at the rate of almost 4.5 percent in the 90s as compared to about 3 percent in the 80s.

This transformation in the distribution of the labor force has important policy implications. The component of underemployment in the informal sector will have to be reduced to the extent possible by larger injections of micro-credit and various forms of support to small and medium enterprises. Simultaneously, it appears that limits to growth on the basis of increased use of inputs are being reached in agriculture. Priority will have to be given to improving farm management practices by more effective agricultural research and extension relating to improved water management, investment in improved disease resistant seed varieties plus greater balance in fertilizer use.

The casual evidence demonstrates the extremely low R&D expenditures by firms in Pakistan. Fiscal incentives will need to be introduced to encourage such expenditures as well as payments

on royalties for acquisition of technology. In addition, a significantly lower corporate tax rate may be offered to joint ventures among foreign and domestic firms, especially in the export sector. Simultaneously, the government needs to increase substantially its outlays on science and technology, especially in areas which have immediate applications in the production process. The information technology (IT) revolution offers significant breakthrough in raising TFP. This should be exploited by offering special incentives in the form of tax credits to firms which invest in IT.

Finally, given the demonstrated importance of TFP in overall economic growth, a national productivity campaign needs to be launched. Productivity councils at the national, regional and sectoral level should be activated, with the apex council being chaired preferably by the Chief Executive. In addition, the Education Ministry may contemplate grants to business and engineering schools for setting up programs in the area of production management. Special awards may be given by the President to firms which have made special productivity enhancing innovations.

CONCLUSIONS

The paper has demonstrated that the economy has tended to grow fast in those periods when TFP rather than private investment has risen rapidly. The economy grew by over 6 percent in the 80s when TFP increased annually by 3 percent. As opposed to this the growth rate of TFP has been less then 1 percent during the 90s and this has led to a fall in the GDP growth rate to just above 4 percent. Factors which have contributed to a slow down in the growth of TFP during the 90s are the effect of recent vintages of capital characterized by underutilization, fall in real public development expenditure and stagnation of manufactured exports. The paper presents a comprehensive package of policies designed to boost the growth in TFP and thereby enhance once again the growth rate of the economy.

REFERENCES

Basart, R. and Brian Fikkert. 1996 ' The effects of R&D, Foreign Technology Purchase, and Domestic and International Spillovers of Productivity in Indian Firms, ***Review of Economics and Statistics,*** Vol. 60, no 2, pp 187-197.

Chen, Edward K.Y. 'The Total Factor Productivity Debate: Determinants of Economic Growth in East Asia', ***Asia-Pacific Economic Literature.***

Kanamori, H 1972. 'What Accounts for Japan's High rate of Growth?', ***Review of Income and Wealth,*** 18(2), pp 155-71.

Krugman, Paul. 1994 'The Myth of Asia's Miracle', ***Foreign Affairs,*** 73(6), pp 62.

Nadiri, M. Ishaq. 1970. 'Some Approaches to the Theory and Measurement of Total Factor Productivity: A Survey', ***Journal of Economic Literature,*** 8(4), pp 1137-77.

Pasha, H.A., Aynul Hasan, and others 1996, 'Integrated Social-Sector Macroeconometric Model for Pakistan', Pakistan. ***Development Review, 35(4) 1996. PP 567-79***

Solow, R.M. 1957 'Technical Change and the Aggregate Production Function', ***Review of Economics and Statistics,*** Vol 39, No 3, pp 312-20.

Wizarat, S. 1981 'Technological Change in Pakistan's Agriculture', Pakistan. ***Development Review,*** *20(4), 1981, pp 427-45 1953-54 to1978-79.*

Yanrui Wa (1995) Productivity Growth, Technological Progress and Technical Efficency change in China: ***A Three-sector Analysis Journal of Comparative Economics,*** 21, 207-229.

TECHNICAL APPENDIX

This appendix presents the results of the OLS regressions of the determinants of TFP, for individual sectors and for the economy as a whole. Based on these results, the contribution of different factors to the change in TFP can be quantified.

AGRICULTURE

The factors influencing TFP in agriculture are specified as follows:-

Human Capital: The human capital endowment of the labor force is expected to be an important determinant of TFP. It is proxied by the average number of years of schooling of employed persons in the sector. This was 1.1 years in 1992-93 and is estimated to have increased to 2.6 years by 1997-98.

Non-Factor Inputs: The level of use of non-factor inputs like water, fertilizer, improved seeds, pesticides, etc is also expected to influence TFP.

Randomness: Agricultural production is characterized by a degree of randomness depending upon weather conditions and the incidence of natural disasters like draught, floods, pest attacks, etc. Fluctuations are particularly severe in the case of the cotton crop. Therefore, randomness in agriculture has been captured by the variable relating to cotton yield.

The best regression results are obtained by focusing on fertilizer use within non-factor in puts in quadratic form. These results are given below:-

$$IFPRA = 12.146 + 0.882\,HCIA - 0.259\,IFER + 0.00047\,IFER2 +$$
$$(0.500)(3.624)*(-4.587)*(8.755)*$$
$$+ 0.135\,ICOY$$
$$(3.668)*$$

$$\overline{R}^2 = 0.973, \text{D-W} = 1.729, \text{F} = 226.4$$

Figure in brackets are t-ratios.*indicates significance at 5% level

Where IFPRA = Index of total factor productivity in the agricultural sector, HCIA = Index of human capital in the agricultural sector, IFER = Index of fertilizer use per acre, ICOTY = Index of Cotton Yield. All indices have the base year of 1972-73.

MANUFACTURING

The explanatory variables chosen are as follows:-

Human Capital: This is proxied by the average number of years of schooling of employed person in the sector. This is estimated have increased from 3.7 years in 1972-73 to 6.3 years in 1997-98.

Exports: Exposure to foreign markets is expected to have a favorable effect on TFP. Therefore, the variable used is the real level of manufactured exports.

Vintage of Capital: This variable is measured by the share of new investment in the capital stock. The impact, however, on TFP is ambiguous. On the one hand, new plants are expected to embody the latest technology with current 'best' practices. On the other hand, there is a gestation lag in the full utilization of recent investments.

Expenditure: Improvements in the availability of physical infrastructure like transport and communications, power, etc, are likely confer gains in TFP of manufacturing enterprises. Real development expenditure in the public sector is expected to capture this effect.

The best regression results obtained are given below:-

$$IFPRAM = -59.999 + 0.738HCIM + 0.430IXGR + 2.473SVINM +$$
$$(-2.257)*(3.405)*(7.655)*(2.326)*$$
$$+ .084IDE$$
$$(1.453)$$

$$\overline{R}^2 = 0.976, \text{ D-W} = 1.884, \text{ F} = 204.7$$

Figure in brackets are t-ratios.* indicates significance at 5% level.

Where IFPRM = Index of total factor productivity in the manufacturing sector, HCIM = Index of human capital in the manufacturing sector, TXGR = Index of real manufactured

exports, SVINM = Share of new investment in the capital stock and IDE = Index of real development expenditure

Results demonstrate the high level of significance of exports. Also, the vintage effect appears to be positive in the case of the manufacturing sector. Development expenditures has the right sign but is not significant.

SERVICES

The explanatory variables chosen are as follows:-

Human Capital: This is proxied by the average number of years of schooling of employed persons in the sector.

Vintage of Capital: This variable is measured by the share of new investment in the capital sector. As mentioned earlier, the impact is ambiguous.

Development Expenditure: Real public sector development expenditure is used to capture the effect of improvements in infrastructure on the sectors' TFP.

Remittances: The real level of remittances has been included as an explanatory variable to reflect variations in overall demand for services in the economy.

The best regression results obtained are as follows:-

$$IFPRS = 120.515 + 0.123HCIS - 3.305SVINS + 0.096IDE + 0.0001RMR$$
$$(17.557)*(6.579)*(-6.567)*(6.833)*(1.788)*$$

$$\overline{R}^2 = 0.886, \text{ D-W} = 2.001, \text{ F} = 49.4$$

Figure in brackets are t-ratios.* indicates significance at 5% level.

Where IFPRS = Index of total factor productivity in the service sector, HCIS = Index of human capital in the service sector, IDE = Index of real development expenditure, SVINS = Share of new investment in the capital stock and RMR = Real remittances.

It is of interest to note that in the case of the service sector the capital vintage effect on TFP is negative.

OVERALL ECONOMY

Given the choice of explanatory variables for individual sectors, we are now in a position to specify these variables for the economy as a whole as follows:-

Human Capital: This is measured by the average years of schooling of all employed person in the economy, which is estimated to have increased from 1.6 years in 1972-73 to 3.7 years in 1997-98.

Vintage of Capital: measured as the share of new investment in total capital stock of the economy.

Development Expenditure: measured as total real public sector expenditure to capture the infrastructure effect on TFP.

Exports: Total real manufactured exports.

Cotton Yield: Included to capture fluctuations in agricultural outputs due to random factors.

Remittances: to capture the simulative effect on demand of home remittances.

The best results obtained are as follows:-

$$IFPR = 66.208 + 0.346HCI - 2.076SVIN + 0.066IDE + 0.098ICOTY$$
$$(6.403) * (2.662) * (-2.233) * (2.747) * (2.426) *$$
$$+ 0.0003rmr + 0.057ixgr$$
$$(2.499)(1.685)$$

$$\overline{R}^2 = 0.979 \text{ D-W} = 1.4788, \text{ F} = 150.73$$

Where IFPR = Index of total factor productivity in the economy, HCI = Index of human capital in the economy, SVIN = Share of new investment in total capital stock, IDE = Index of real development expenditure, ICOTY = Index of cotton yield, RMR = Real remittances and IXGR = Real manufactured exports.