PAKISTAN KLEMS DATABASE AND PRODUCTIVITY MEASUREMENT AT THE INDUSTRY LEVEL

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This version:
March 2, 2016

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Table of Contents

List of Tables

List of Figures

Acknowledgements

Partial funding for this study was received from the research Competitive Grants Program, a joint initiative of the Planning Commission of Pakistan and the Pakistan Strategy Support Program, International Food Policy Research Institute (IFPRI), funded by USAID, and the International Growth Centre, London under their firm capabilities program. We would like to thank David Orden and two anonymous reviewers for comments on an earlier draft. We also wish to acknowledge research assistance provided by Anum Ali Khan, Hira Bilal Malik, Muhammad Husnain Ijaz, Zunaira Mehmood and Muhammad Raza Mustafa Khan. Technical support provided by Abubakar Memon is also gratefully acknowledged.

Acronyms

CMI	Census of Manufacturing Industries
EMS	Energy, Material & Services
FBS	Federal Bureau of Statistics
GOP	Government of Pakistan
GVO	Gross Value Output
HIES	Household Integrated Economic Survey
IT	Information Technology
LFS	Labor Force Survey
MFA	Multi Fibre Arrangement
MFP	Multi Factor Productivity
PBS	Pakistan Bureau of Statistics
PIHS	Pakistan Integrated Household Survey
PSLM	Pakistan Social and Living Standards Measurement
SHMI	Survey of Small Scale and Household Manufacturing Industries

Abstract

This paper develops Pakistan KLEMS database for seven industries on the pattern of internationally comparable data of EU KLEMS. The paper uses this database to evaluate the sources of output growth and also derives measures of multifactor productivity at the industry level. Our analysis of data from 1980 to 2010 reveals some interesting patterns in the time-path of MFP growth. We find that MFP growth has been positive only in agriculture, paper and paper products and machinery industries while MFP growth has been negative in all other industries. Factor accumulation (rather than MFP growth) has played a key role in the growth of output in all industries, except agriculture. We find strong evidence to suggest that capital to labor ratio is declining in agriculture overtime, which indicates the increasing reliance of agriculture on labor input rather than capital input. Intermediate inputs to output ratio has also increased in agriculture since 1995. However, at least since 1990s the demand for labor has continued to fall in all other industries while the demand for capital has continued to increase. The rising demand for capital includes the impact of new investments on intangibles due to advances in information technology. However, some of the lost demand for labor may have gone to services sector, which is growing in most industries.

PAKISTAN KLEMS DATABASE AND PRODUCTIVITY MEASUREMENT AT THE INDUSTRY LEVEL

1. Introduction

Since the late 1960s, Pakistan's economy has witnessed some fundamental changes in the structure of the economy including growth in human and physical capital, technological change and institutional change. However, the relative impact of factor accumulation, technological change and institutional change on economic growth is largely unclear. Firstly, the green revolution technologies introduced in late sixties and their intensification in seventies and eighties has been impressive in reversing the food crisis, but there were concerns on the sustainability of the gains of green revolution in 1990s and 2000s (Ali and Byerlee, 2002; Murgai and Byerlee, 2001; Pingali, 2012).

Secondly, the 1970s also witnessed nationalization of manufacturing industries, banks and insurance companies as well as land reforms. These reforms significantly altered private sector initiative in manufacturing development, which in turn forced public sector to make major investments in capital-intensive intermediate and capital goods industries. However, these policies were gradually reversed in the late seventies and early eighties. Since 1990, regulatory controls have been removed, which have led to level playing field for state-owned, private and foreign banks, which in turn helped improve technical efficiency of the banks (Burki and Niazi, 2010; Burki and Ahmad, 2010; Patti and Hardy, 2005).

Thirdly, the next round of IMF interventions that started in the mid-1990s have paved the way for trade liberalization, tariff rationalization and deregulation of the economy. These reforms have virtually eliminated protection to the manufacturing industries. One may expect that this trade openness may have allowed Pakistan to absorb technological advances in other countries (Coe and Helpman, 1995).

Fourthly, the size of the labor force has dramatically increased due to high population growth rates, decline in birth rates and increase in female labor force participation rate. Likewise, capital input has increased in some industries more than the others. The information revolution of 1990s and 2000s may also have played a role in productivity growth. Empirical evidence from the US and Europe indicates that the fundamental changes in business practices that resulted from the information revolution and knowledge economy have significantly altered productivity growth (Jorgenson et al., 2008; van Ark et al., 2008). It would be no surprise to see similar results in the Pakistani industry.

Lastly, in the last few years, a number of factors have continued to hamper growth in Pakistan's economy, which include the continuous problems of power and gas shortages, the ongoing war against extremism and terrorism, devastating rains and floods, continuing law and order problems in Karachi and unprecedented surge followed by a decline in oil and commodity prices.

How these developments have impacted the national economy is largely unclear. Moreover, its impact on productivity growth at the industry level is a black box that no one has been able to open. It is unclear how productivity growth in manufacturing, agricultural and services sectors has contributed to the national level productivity in different time periods. Moreover, we also do not know how individual industries have contributed to the aggregate growth in the national economy. Non-availability of consistent industry-level measures of inputs and outputs is the major problem due to which such comparisons are not easy to make. Moreover, how industry growth compares with other countries is also hampered by lack of comparable data with other countries. The EU KLEMS Growth and Productivity Accounts project has recently created a new database for 25 member states of the European Union, Japan and the US from 1970 onwards (O'Mahony and Timmer, 2009). This database provides industry level measures of output, input and productivity, which can be used to make international comparisons.

This study is aimed at creating a new multi-industry database of Pakistan on the pattern of EU KLEMS data. Due to its large scale, the data of 31 industries would be generated in more than one phase. In the present phase, we generate data of 7 industries, namely (1) Agriculture, (2) Food Products, Beverages, and Tobacco, (3) Pulp, Paper, Paper Products, Printing and Publishing, (4) Textile, Textile Products, Leather, and Footwear, (5) Machinery, NEC, (6) Basic Metals and Fabricated Metal Products, and (7) Other Non-metallic Mineral Products.

We generate data and productivity estimates of these industries. The data includes gross output, capital, labor, energy, raw material and services. This data is used to generate total factor productivity growth at the industry level. The measured inputs include various categories of capital (K), labor (L), energy (E), material (M) and service inputs (S) and thus is termed as KLEMS data. The method used to generate this database is rooted in the neo-classical growth accounting framework. The estimates of productivity at the industry level should be helpful to formulate policies that help revive productivity and competitiveness of the country.

2. Methodology of the KLEMS Framework

The growth accounting framework used in the Pakistan KLEMS is based on the Jorgenson et al. (1987) input-output framework. This methodology has recently been employed by O'Mahony and Timmer (2009) in the study of EU KLEMS. We start by specifying a production function of the gross output of an industry.

$$Y_{i,t} = A_{i,t} f_{i,t}(K_{i,t,} L_{i,t,} X_{i,t}) \quad (1)$$

where $Y_{i,t}$ is the gross output of industry i at item t. The inclusion of t in the subscript on the functional form of the production function shows that it is indexed by time; K is an index of capital ; L is an index of composite labor, X is an index of intermediate goods and A is the industry-specific technology. Under the assumption of constant returns to scale, the growth rate of output of industry i can be expressed as a weighted average of the growth rates of the factor inputs and technology.

These weights of the factor inputs are based on the shares of costs of these inputs in total production. Specifically,

$$\Delta \, ln \, Y_i^t \; = \; \Delta \, ln \, A_{i,t} + \; \omega_{i,t}^K \Delta \, ln \, K + \; \omega_{i,t}^L \Delta \, ln \, L + \; \omega_{i,t}^X \Delta \, ln \, X \qquad (2)$$

where $\omega^{Z}{}_{i,t}$, $Z \in \{K, L, X\}$ is the share of input Z in total nominal value of output.

$$\omega_{i,t}^Z \; = \; \frac{P_{i,t}^Z Z_{i,t}}{P_{i,t}^Y Y_{i,t}}$$

Note that the assumption of constant returns to scale assumption implies that

$$\sum_Z \omega_{i,t}^Z = 1 \qquad \forall t$$

2.1 Factor Input Quantity Indices

The composite indices of the factor inputs are defined as Tornqvist quantity indices of different types of that input

$$\Delta \ln Z_{i,t} \; = \; \sum_j \lambda_{i,t}^j \Delta \ln Z_{i,t}^j \qquad (4)$$

where again $Z \in \{K, L, X\}$ and l represents different types of inputs used in forming the composite index of that particular factor input. For capital, we divide the total input growth into component growths contributed by three types of categories of capital: plant & machinery, transport equipment, and other fixed assets

$$\Delta \ln K_{i,t} \; = \; \lambda_{i,t}^P \Delta \ln K_{i,t}^P + \; \lambda_{i,t}^T \Delta \ln K_{i,t}^T + \; \lambda_{i,t}^O \Delta \ln K_{i,t}^O \qquad (5)$$

where the λ's represent the shares of three types of capital in the total capital cost of industry i.

Labor input growth can simply be written as

$$\Delta \ln L_{i,t} \; = \; \Delta \ln H_{i,t} \qquad (6)$$

where $H_{i,t}$ is the total number of hours worked in industry i at time t. Finally the growth of intermediate inputs is divided into growth of three sub-inputs namely, energy (E), materials (M), and services (S) and written as

$$\Delta \ln X_{i,t} \; = \; \lambda_{i,t}^E \Delta \ln E_{i,t} + \; \lambda_{i,t}^M \Delta \ln M_{i,t} + \; \lambda_{i,t}^S \Delta \ln S_{i,t} \qquad (7)$$

2.2 Multi-Factor Productivity

Substituting equation (5), (6) and (7) into equation (2), the full decomposition of output growth of a particular industry can be written as

$$\Delta \ln Y_{i,t} = \Delta \ln A_{i,t} + \omega_{i,t}^{K}\lambda_{i,t}^{P}\Delta \ln K_{i,t}^{P} + \omega_{i,t}^{K}\lambda_{i,t}^{T}\Delta \ln K_{i,t}^{T} + \omega_{i,t}^{K}\lambda_{i,t}^{O}\Delta \ln K_{i,t}^{O}$$

$$+ \omega_{i,t}^{L}\Delta \ln H_{i,t} + \omega_{i,t}^{X}\lambda_{i,t}^{E}\Delta \ln E_{i,t} + \omega_{i,t}^{M}\lambda_{i,t}^{M}\Delta \ln M_{i,t} + \omega_{i,t}^{S}\lambda_{i,t}^{S}\Delta \ln S_{i,t} \quad (8)$$

Equation (8) shows that the contribution of each factor input is a product of its growth rate and its share in the total costs. The difference between total output growth and the sum of growths of factor inputs is the growth in multi-factor productivity. This productivity index can then be compared to similar indices from other countries.

3. Construction of Pakistan KLEMS Database

We have used different procedures to construct the Pakistan KLEMS database for gross output, labor, capital, and intermediate inputs for the seven industries. Due to limitations in data availability, the data series for food & beverages; textile & footwear; paper & paper products; and machinery industries were constructed for the 1982-2005 period. Data for non-metallic mineral products; and basic metals & fabricated metal products industries was constructed for the 1980-2005 period whereas data for agriculture was constructed for the 1981-2010 period.

Multiple sources were used to construct gross output and input variables for each of these industries[1]. We used both published reports and firm-level or household-level data from these sources. The main sources of data were multiple rounds of the census of manufacturing industries (CMI) (FBS, 2005), and the survey of small-scale & household manufacturing industries (SHMI) (FBS, 1995). These data sets allowed us to compute separate series of data for registered and unregistered establishments. Gross output and input data from these sources were adjusted for survey non-response using weights given in each of the datasets.[2] For agriculture, data reported in the Pakistan economic survey (GoP, 2015) was used as the main source. Other sources include Pakistan statistical yearbooks (FBS, 2007), 50 years of Pakistan in statistics (FBS, 1997), monthly statistical bulletins (FBS, 1990), agriculture statistics of Pakistan (GoP, 2009), labor force survey (FBS, 2010), Pakistan integrated household survey (PIHS) (FBS, 2001), household integrated economic survey (HIES) (FBS, 1993) and Pakistan social and living standards measurement survey (PSLM) (PBS, 2010).

[1] The gross value added measure has not been included in this report due to data constraints. We are still looking for suitable micro-level data which will help construct this series, and intend to include this in the proposal for the next phase of this project. One of our reviewers emphasized the importance of intra-industry purchases in this analysis. Unfortunately, the only source of such information is the 1991 input-output (I/O) table. Using the I/O ratios from that table for the entire time period examined would result in hugely biased results since technology and input-usage have changed a lot over the years (the use of inputs in different industries has changed which could not be captured by fixed I/O ratios).

[2] For CMI, this was done using weights adjusted for non-response firms reported within the 2005-06 CMI data itself. For the gross output series, the inverse of these weights were multiplied with the value of output at firm level, and then these inflated/adjusted output values were aggregated at industry level. For gross input series, input-output ratios were first computed using the unadjusted values. These ‘unadjusted’ input-output ratios were then adjusted using the reported weights. Finally, the inflated/adjusted input values were aggregated at industry level. SHMI also reports weights which were used to adjust and aggregate the data using statistical software.

Gross output and input data series were constructed using direct estimates/figures for gross value of output/input and indirectly by computing estimates for the remaining years for which data was not available. For all manufacturing industries, information on gross value of output; number of employees by industry, labor compensation; values of capital assets like plant & machinery, transport, furniture & fixtures, and other fixed assets; consumption of fuel and electricity, consumption of raw materials, and consumption of services was extracted from CMI which reports data on registered establishments. Missing values for gross output were filled by using quantum and price indices for the respective years, and missing values for the input variables were estimated using cubic spline interpolation method.[3] Data on outputs and inputs was also extracted from SHMI which is a source of information on un-registered establishments. However, since SHMI data was available only for the years 1988 and 1995, missing values of output and inputs were computed by using the ratio of SHMI gross value to CMI gross value of the respective output or input for the available year.[4] Separate series for energy, materials, and services consumed were constructed and then aggregated to form one composite intermediate input index. All nominal values were deflated using the relevant price indices. These deflated gross values of output and inputs from CMI and SHMI were then aggregated to form comprehensive series, which account for both the formal and informal sectors of Pakistan.

The methodology employed to construct data for agriculture industry was different from the procedures used for the manufacturing industries for two reasons. First, the agriculture industry includes agriculture, hunting, forestry, and fishing sectors, which meant that data reported separately for each of these sectors needed to be aggregated. Second, investment in capital and consumption of raw materials and services varies in agriculture and manufacturing activities.[5] In view of these differences, gross value of output for the agriculture sectors were extracted at constant prices from the Pakistan Economic Survey and aggregated at industry level. Similarly, capital investment was extracted in aggregate form from the Pakistan Economic Survey at constant prices. Aggregate number of employees, labor compensation and total hours worked were extracted from the Pakistan Economic Survey and LFS. Since LFS is micro-level data, these variables were further modified to form the required aggregate labor variables. In intermediate inputs, the value of energy was computed by using the amount of energy consumed, which was reported in the Pakistan Economic Survey, and the relevant price index. The values of materials

[3] In cubic spline interpolation, different variables like gross output, year, and price indices were used as explanatory variables to interpolate the missing values for each of the input variables. The validity of this method was tested by dropping observations of different years for which data was available, one at a time, and interpolating the remaining series on the basis of the explanatory variables and then comparing the interpolated values with the actual values.

[4] The gross value series for each of the manufacturing industries up till the year 1988 were estimated using SHMI-CMI ratio for the year 1988; and the series for all years after 1995 were estimated using the SHMI-CMI ratio for 1995. Missing values for the remaining years were filled in by calculating the percentage change in SHMI-CMI ratio from 1988 to 1995, and then spreading that percentage change evenly across the intervening seven years.

[5] In particular, the agriculture industry invests in capital goods such as tractors, threshers, combined harvesters, tube wells, and bullock carts, etc.; relies more on locally available raw materials like seeds & planting stock, fodder for animals, maintenance of buildings, etc.; and consumes services which include loans, repair and maintenance, transport, commission, insurance, postage, and land revenue tax.

and services were extracted from multiple sources and aggregated to form separate series. These series were then deflated using the relevant price indices and aggregated to form a single intermediate input index. Finally, the value of land for this industry is computed using the total amount of land used in production (or total cropped area) and rent per acre of land. Missing figures in the land price series were filled in using cubic spline interpolation. Details of the construction of output and input series from the available data sources are discussed in Appendix-A.

4. Growth of Outputs and Inputs at the Industry Level

This section offers a cross-industry comparison of growth in output and inputs across seven industries in Pakistan. We present trend growth rates of real gross output and each of the inputs to highlight the important trends.

4.1 Growth of Output

Average trend growth rates of real gross output for the seven industries are reported in Table 4.1. Output growth is found to be most rapid in pulp, paper, paper products; printing & publishing; textiles; and other non-metallic mineral products. However, growth is most volatile in machinery; and basic metals & fabricated metal products.

The agriculture, and food & beverages industries remain relatively stable, except for the 1996-2000 and 2006-2010 periods when the growth rate for agriculture was relatively low, and the period 2001-05 for food & beverages when the growth rate for output was extremely high. Similarly, the textile & footwear industry remained relatively stable during the years 1980-85, and 1991-2000, exhibiting respectable output growth and showed higher growth than the industry mean for the remaining years.

Table 4.1: Growth in gross output by industry, 1980 to 2010

Industry Description	Average GVO growth	GVO growth by period					
		80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	3.69	3.99	4.30	5.55	2.10	3.89	2.31
Food, Beverages & Tobacco	3.54	2.90	2.33	1.96	2.68	7.56	-
Pulp, Paper, Paper Prod, Printing & Publishing	11.08	10.28	15.08	4.08	6.94	18.72	-
Textile, Textile Products, Leather & Footwear	7.89	3.11	13.60	3.76	4.84	12.20	-
Machinery, NEC	-1.21	21.85	0.80	-1.17	5.34	-23.64	-
Basic Metals & Fabricated Metal Products	1.90*	20.72	0.09	-5.09	6.27	3.29	-
Other Non-Metallic Mineral Products	7.49	10.92	7.16	2.21	-1.75	22.76	-
Industry Mean	4.91	10.54	6.20	1.61	3.37	6.40	2.31
Industry Median	3.69	10.28	4.30	2.21	4.84	7.56	2.31

Note: All growth rates are reported in percent per annum. Average GVO growth for basic metals & fabricated metal products industry was 5.05% for 1980-2005. However, average GVO growth has been reported here for 1983-2005 (1.90%) since the MFP for this industry was also calculated for same time period. MFP for 1980-1982 could not be calculated because services and labor data was not available for this industry during these years.

4.3 Growth of Labor Input

Table 4.2 presents trend growth rate of labor input by industries. Labor input is measured by employees' hours worked since it encompasses both the number of persons employed and the number of hours worked. Agriculture sector remained relatively stable throughout the study period. Average growth in labor in each five-year interval ranged from 2.4% to 4.8%, except 1991-95 and 2001-05 when the sector experienced a dismal growth in labor. All industries except agriculture experienced a reduction in total hours worked as depicted by their negative growth rates between 1991 and 2000. This reduction is most pronounced in textile & footwear industry during the 1996-2000 period. Additionally, this reduction is higher, on average, during the late 1990s compared to the early 1990s for all industries.

Table 4.2: Growth in labor hours worked by industry, 1980 to 2010

Industry Description	Average labor growth	Labor growth by period					
		80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	2.25	2.68	3.20	0.04	2.40	0.43	4.76
Food, Beverages & Tobacco	1.73	2.54	3.16	-1.64	-10.55	15.48	-
Pulp, Paper, Paper Products, Printing & Publishing	-0.87	3.52	0.24	-1.58	-11.14	6.37	-
Textile, Textile Products, Leather & Footwear	0.54	4.94	2.80	-1.62	-14.67	13.01	-
Machinery, NEC	-2.10	4.85	-5.65	-5.45	-28.61	27.13	-
Basic Metals & Fabricated Metal Products	-1.67	0.34	-0.93	-6.96	-13.33	13.33	-
Other Non-Metallic Mineral Products	5.90	8.62	1.75	-5.96	-5.56	31.73	-
Industry Mean	0.83	3.93	0.65	-3.31	-11.64	15.35	4.76
Industry Median	0.54	3.52	1.75	-1.64	-11.14	13.33	4.76

Note: All growth rates are reported in percent per annum.

Furthermore, all the manufacturing industries show considerably lower labor growth rates during the period 1980-2000 and show extremely high growth rates during the 2001-05 period. Accordingly, the industry mean and median are at their peak during the period 2001-05, with the other non-metallic mineral products, and machinery industries exhibiting the highest growth in labor.

4.4 Growth of Capital Input

Trend growth in real value of capital by industry is reported in Table 4.3, which reveals that during the study period, on average, growth in capital was highest in textiles; other non-metallic mineral products; pulp, paper and paper products; and food and beverage industries. The industry mean for capital growth was highest during the periods 1980-85 and 2001-05, but remained low during the remaining periods. In particular, pulp, paper, & paper products; and basic metals & fabricated metal products industries were above the industry mean during 1980-1985. However, both industries experienced a considerable reduction in capital investment as depicted by their negative growth rate during the following period. The pulp, paper, & paper products industry managed to recover its capital growth rate by 2001-05, but capital growth remained low for the basic metals industry.

Table 4.3: Growth in capital by industry, 1980 to 2010

Industry Description	Average capital growth	Capital growth by period					
		80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	4.16	2.51	14.07	1.40	-4.07	3.05	8.00
Food, Beverages & Tobacco	8.00	16.73	1.17	4.71	8.88	12.00	-
Pulp, Paper, Paper Products, Printing & Publishing	10.43	19.53	-0.15	6.07	1.48	28.84	-
Textile, Textile Products, Leather & Footwear	14.03	9.54	12.05	9.36	7.67	29.75	-
Machinery, NEC	-5.59	12.16	-1.40	-1.40	-10.10	-20.10	-
Basic Metals & Fabricated Metal Products	0.70	20.08	-4.28	-10.96	5.14	1.29	-
Other Non-Metallic Mineral Products	13.31	25.13	3.97	3.33	11.53	22.59	-
Industry Mean	6.43	15.10	3.67	1.79	2.93	11.06	8.00
Industry Median	8.00	16.73	1.17	3.33	5.14	12.00	8.00

Note: All growth rates are reported in percent per annum.

Similarly, other non-metallic mineral products industry was well above the industry mean during the 1980-85 period, but in the following decade capital growth fell considerably. However, by 2001-05 this industry also managed to recover its capital growth rate.

Capital growth rate for the machinery industry was positive only during the period 1980-85 and has persistently fallen thereafter. This industry experienced its lowest capital growth during the 2001-05 period when its growth rate fell to an extremely low level showing a huge reduction in capital investment.

The agriculture, food & beverages, and textile & footwear industries have remained relatively stable except for the years between 1996 and 2000 for agriculture, 1986-90 for food & beverages, and 2001-05 for textile & footwear.

4.5 Growth of Intermediate Inputs

Next three tables report growth rates of energy, materials and services for the seven industries. Data on agriculture industry was available from 1980 to 2010, but for other industries it pertains to 1980 to 2005. Tables 4.4 to 4.6 indicate that the industry mean and median are relatively high for the years 1980-90 for each of the intermediate input suggesting that, on average, all industries invested more in these inputs during this time span than they did during the following years.

Table 4.4: Growth in energy by industry, 1980 to 2010

Industry Description	Average energy growth	Energy growth by period					
		80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	1.27	-0.19	7.36	15.88	-12.61	-0.38	-2.40
Food, Beverages & Tobacco	1.58	6.91	5.08	-1.84	-2.68	2.57	-
Pulp, Paper, Paper Products, Printing & Publishing	4.38	5.68	6.35	5.47	2.60	2.34	-
Textile, Textile Products, Leather & Footwear	5.37	4.69	15.77	4.84	-0.27	1.54	-
Machinery, NEC	2.06	5.57	15.34	-4.04	14.58	-19.76	-
Basic Metals & Fabricated Metal Products	1.45	9.47	2.23	-4.87	-0.83	1.27	-
Other Non-Metallic Mineral Products	6.21	18.96	4.91	-1.71	-2.62	11.52	-
Industry Mean	3.19	7.30	8.15	1.96	-0.26	-0.13	-2.40
Industry Median	2.06	5.68	6.35	-1.71	-0.83	1.54	-2.40

Note: All growth rates are reported in percent per annum.

Table 4.5: Growth in material input by industry, 1980 to 2010

Industry Description	Average material growth	Material growth by period					
		80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	1.65	-2.42	0.04	-2.19	9.02	2.84	-2.22
Food, Beverages & Tobacco	4.10	2.75	4.83	2.44	0.02	9.90	-
Pulp, Paper, Paper Products, Printing & Publishing	5.45	8.78	9.08	1.66	3.69	5.34	-
Textile, Textile Products, Leather & Footwear	6.72	5.52	12.90	4.58	-0.17	10.31	-
Machinery, NEC	-0.76	10.89	13.66	0.93	-1.84	-22.80	-
Basic Metals & Fabricated Metal Products	4.73	12.51	8.75	-7.70	-4.03	14.12	-
Other Non-Metallic Mineral Products	5.59	8.60	7.17	5.46	-8.28	14.98	-
Industry Mean	3.92	7.35	8.06	0.74	-0.23	4.96	-2.22
Industry Median	4.73	8.60	8.75	1.66	-0.17	9.90	-2.22

Note: All growth rates are reported in percent per annum.

Table 4.6: Growth in services by industry, 1980 to 2010

Industry Description	Average services growth	Services growth by period					
		80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	1.18	3.15	-2.06	-3.90	9.54	8.70	-8.33
Food, Beverages & Tobacco	5.87	3.52	7.61	2.81	3.85	10.64	-
Pulp, Paper, Paper Products, Printing & Publishing	7.33	18.25	2.74	2.74	0.10	17.21	-
Textile, Textile Products, Leather & Footwear	6.23	10.49	19.14	-1.06	8.10	-3.80	-
Machinery, NEC	-3.01	17.30	4.24	-9.74	4.87	-23.62	-
Basic Metals & Fabricated Metal Products	3.04	23.15	-0.91	-5.93	6.12	0.84	-
Other Non-Metallic Mineral Products	11.42	38.83	17.49	0.29	-5.38	16.85	-
Industry Mean	4.58	16.38	6.89	-2.11	3.89	3.83	-8.33
Industry Median	5.87	17.30	4.24	-1.06	4.87	8.70	-8.33

Note: All growth rates are reported in percent per annum.

We also witness reduction in investment during 1991-95 period in energy, materials, and services for almost all industries. In particular, basic metals & fabricated metal products is the only industry which experienced negative growth rates for all three intermediate inputs during this time span. In contrast, the remaining industries exhibit reduction, but only for one or two of the intermediate inputs during this time period. Growth rate of energy for food, beverages, & tobacco; machinery industry; basic metals & fabricated metal products; and non-metallic mineral products are negative indicating reduction in investment for this input. Growth rate of material input was negative for agriculture; and basic metals. Growth of services input was negative for agriculture; textile; machinery; and basic metals during this period. However, pulp, paper & paper products is the only industry, which showed positive growth for all intermediate inputs during the study period.

4.6 Growth of Land Input for Agriculture

In Table 4.7 we also report growth rate of land as an additional input for agriculture industry. Growth in land input has remained relatively stable, attaining its highest value during 1986-90, and its lowest during 1991-95. Even though the range of values is small, the trend growth rates show that there has been an increase in the use of land in agricultural production (except for the period which exhibits negative growth) but this change has not been considerable.

Table 4.7: Growth in land input for agriculture, 1980 to 2010

Industry Description	Average land growth	Land growth by period					
		80-85	86-90	91-95	96-00	00-05	06-10
Agriculture, Hunting, Forestry & Fishing	0.60	0.96	1.46	0.69	-0.49	0.28	0.03

Note: All growth rates are reported in percent per annum. Industry mean and median are not reported here since land is treated as a separate input for only the agriculture industry.

5. Multifactor Productivity Growth and its Sources by Industry

This Section highlights some interesting findings on multifactor productivity growth and its sources across seven industries in Pakistan on the basis of Pakistan KLEMS database. Table 4.8 presents estimates of MFP growth for the period 1980 to 2010 for the agriculture industry, and for the period 1982 to 2005 for the manufacturing industries.

The estimates suggest a large variation in productivity across industries. On average, MFP growth has been positive for agriculture; pulp, paper and paper products; and machinery industry. In contrast, MFP growth in all other industries has been negative. Since the mid-1990s, MFP growth has considerably slowed down in almost all industries, as compared with the earlier period. This trend was most pronounced in the textile industry.

Table 4.8: Multi factor productivity growth in seven industries, 1980 – 2010

Industry Description	GVO growth	MFP	MFP 80-94*	MFP 1995 onwards**
Agriculture, Hunting, Forestry & Fishing	3.69	2.89	3.44	2.41
Food, Beverages & Tobacco	3.54	-1.69	-1.40	-2.00
Pulp, Paper, Paper Products, Printing & Publishing	11.08	2.97	5.12	0.62
Textile, Textile Products, Leather & Footwear	7.89	-2.19	-1.36	-3.11
Machinery, NEC	-1.21	1.20	1.29	1.09
Basic Metals & Fabricated Metal Products	1.90	-1.09	-2.11	0.01
Other Non-Metallic Mineral Products	7.48	-4.44	-3.99	-4.93
Industry Mean	4.91	-0.34	0.14	-0.84
Industry Median	3.69	-1.09	-1.36	0.01

Note: All the figures reported are in percent per annum. GVO is for gross value of output and MFP is for multi-factor productivity

*Refers to MFP growth for agriculture from 1980 to 1994, and for other industries from 1982 to 1994.

**Refers to MFP growth for agriculture from 1995 to 2010, and for other industries from 1995 to 2005.

We also account for sources of output growth by estimating the contribution of each factor input in production. Table 4.9 decomposes output growth by inputs. One key observation to be drawn from this table is that factor accumulation (rather than MFP growth) has played a dominant role in the growth of output in all industries, except agriculture. To illustrate, growth in services alone

Table 4.9: Sources of output growth, 1980 to 2010*

Industry Description	GVO growth	Contribution of labor to output	Contribution of capital to output	Contribution of energy to output	Contribution of materials to output	Contribution of services to output	MFP
Agriculture, Hunting, Forestry & Fishing	3.69	0.02	0.29	0.17	0.15	0.16	2.89
Food, Beverages & Tobacco	3.54	0.05	3.03	0.40	0.10	1.65	-1.69
Pulp, Paper, Paper Products, Printing & Publishing	11.08	0.31	3.19	0.47	0.03	4.12	2.97
Textile, Textile Products, Leather & Footwear	7.89	0.28	4.37	0.25	0.07	5.11	-2.19
Machinery, NEC	-1.21	0.01	-1. 64	-0.27	0.20	-0.71	1.20
Basic Metals & Fabricated Metal Products	1.90	0.24	1.90	0.22	-0.36	0.99	-1.10
Other Non-Metallic Minerals	7.49	1.47	0.87	0.50	0.34	8.75	-4.44
Industry Mean	4.91	0. 34	1.72	0.25	0.08	2.87	-0.34
Industry Median	3.69	0. 24	1.90	0.25	0.10	1.65	-1.10

Note: All figures are reported in percent per annum. For the agriculture industry, the observed period is 1980 to 2010. For the remaining industries, the observed period is 1982 to 2005. GVO refers to gross value of output. MFP is for multi-factor productivity have contributed 58% to the growth in output in all industries (see industry means), followed by growth in capital, which contributed 35% in growth in output. The contribution of labor and energy in output growth was meagre at 7% and 5%, respectively, while the least contribution to growth in output came from growth in materials at 4% only. In sharp contrast, MFP growth has played a dominant role in agriculture where its contribution to output growth has been 78% while the remaining 22% growth in output has been contributed by factor accumulation.

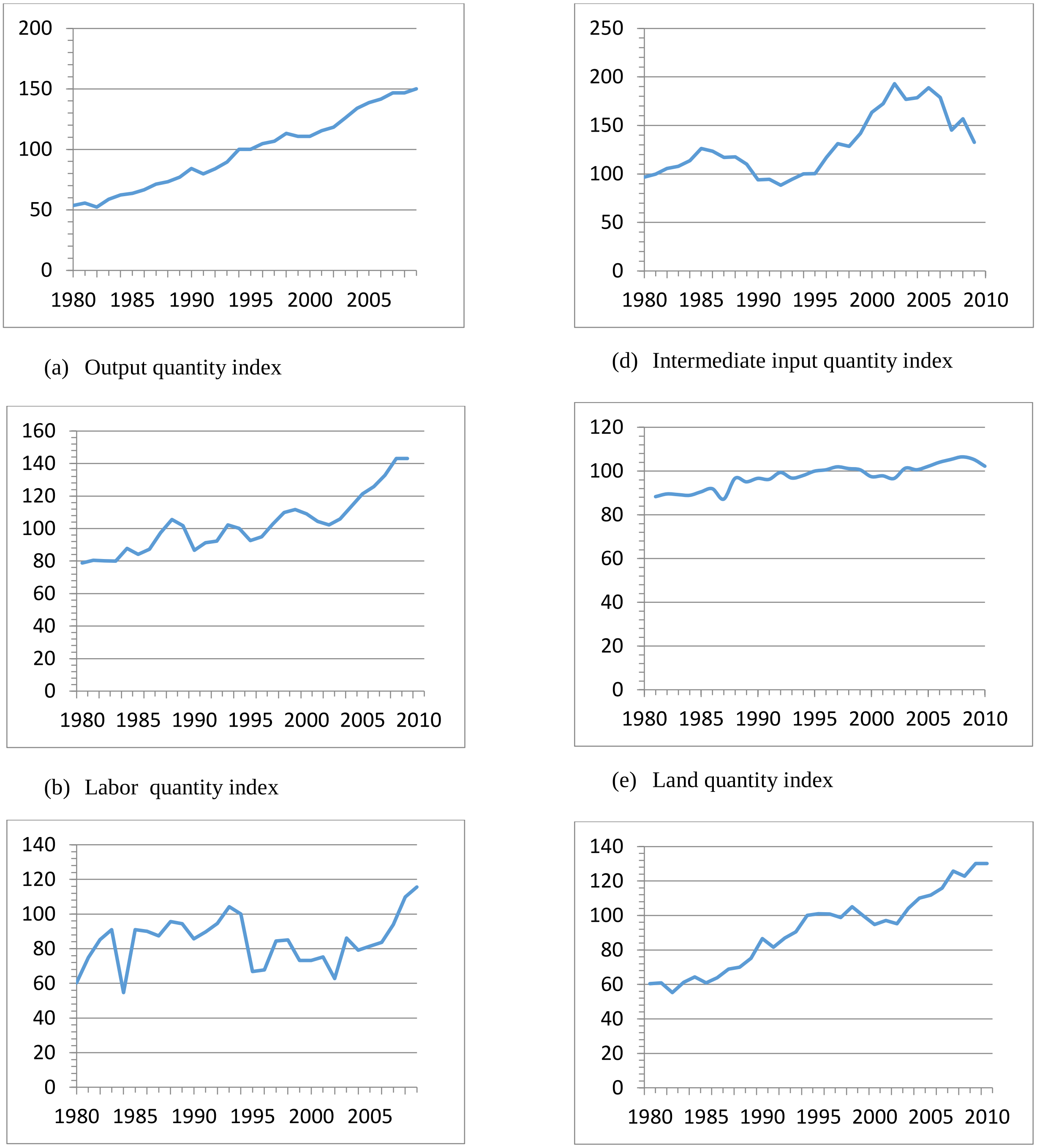
Next, we present the multifactor productivity growth by sectors by tracing relative input and output growth for each input over the study period. Some key findings for respective sectors are summarized below.

5.1 Growth and Productivity in Agriculture

Together, agriculture & livestock account for 96% of the gross value of output for this industry; the remaining 4% is accounted for by forestry and fishing sectors. Figure 5.1 maps output, input, and MFP growth over the 1980-2010 period for the agriculture industry. Panel (a) indicates that agricultural output has consistently increased from 1980 to 2010, except some minor fluctuations. A sharp growth in the livestock and fisheries sectors and development of value added products have contributed to growth in output in post-2000 period.

Panel (b) shows that there has been an overall increase in hours worked by the agricultural labor force that has sharply increased after 2000 largely due to rapid growth in the dairy and livestock sector, affirming an increased reliance of agriculture on labor. Panel (c) show that capital growth suffered a major decline in 1990s and early 2000s before its recovery in mid-2000. Consequently, capital-output ratio fell in 1990s and did not recover to its original level (see Appendix-B, Table A1). Additionally, the overall rise in labor-output ratio (Appendix-B, Table A2), and decline in capital-labor ratio (Appendix-A, Table A4) between 1980 and 2010 suggest a heavier reliance on labor in agriculture over time.

Panel (d) indicates that the use of intermediate inputs by agriculture industry fell roughly between 1985 and 1995, but increased significantly between 1995 and 2005. Growth rates of the real value of materials and services were high between 1995 and 2005 (see, Table 4.4 – Table 4.6) and the services–output ratio (Appendix-B, Table A3) increased significantly from 1996 onwards. However, the intermediate input quantity index declined between 2006 and 2010 – a trend which is evident since all intermediate inputs for this industry has negative growth rates during this period (see, Table 4.4 – Table 4.6). Panel (e) is for land quantity index, which has gradually increased.



(a) Output quantity index

(d) Intermediate input quantity index

(b) Labor quantity index

(e) Land quantity index

(c) Capital quantity index

(f) Multi-factor productivity index

Figure 5.1: Growth patterns for agriculture

Note: For all quantity indices, the year 1995 has been used as the base year.

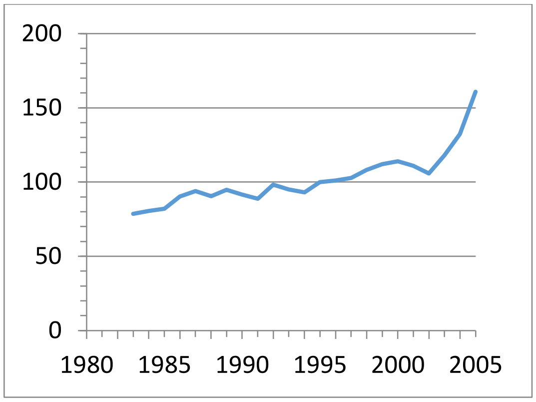
There has been an overall increase in MFP between 1980 and 2010 (see, panel (f)) indicating a rise in productivity of the agriculture industry. The MFP was relatively stable in the early 1980s, but increased between 1985 and 1997. However, there was a considerable fall in MFP between 1997 and 2001, reflecting the decline in gross output for the industry during this period. Thereafter, the MFP stabilized and began to rise again in 2005.

5.2 Growth and Productivity in Food, Beverages, and Tobacco

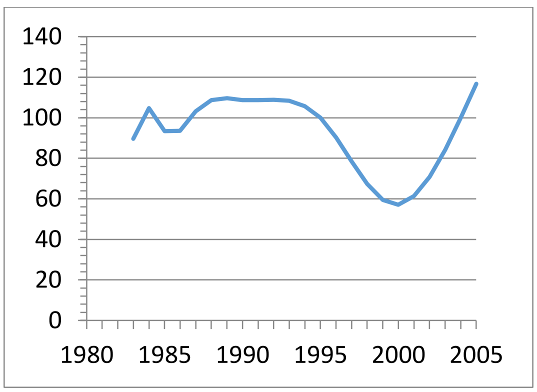
Based on the growth rates of output and inputs in food & beverage industry, our key observation is that the growth in output was mainly triggered by accumulation of factor inputs while growth in MFP remained negative (see Figure 5.2). Panel (a) shows that there has been an overall increase in gross production for this industry between 1980 and 2005, and that this increase has been most pronounced in post-2000 period. Panels (b) and (c) indicate that the demand for labor has significantly declined in 1990s, mostly due to emerging demand for new capital. Investment in new capital include the impact of information technology (IT) revolution of 1990s leading to investments on intangibles such as changes in organizational matters related to use of IT. That food & beverage industry has gradually become capital intensive is also confirmed by the capital-output, labor-output and capital-labor ratios (see, Appendix-B, Tables A1, A2 and A4). Panels (d) indicates that intermediate inputs also increased, especially in post-2000 period. Some of the labor may have been absorbed by the services. Sharp growth in intermediate inputs suggests that the displaced labor may have entered through the growth in services. Therefore, negative MFP growth in food & beverage industry appears to be the result of differences in output and input growth rates.

5.3 Growth and Productivity in Pulp, Paper and Paper Products

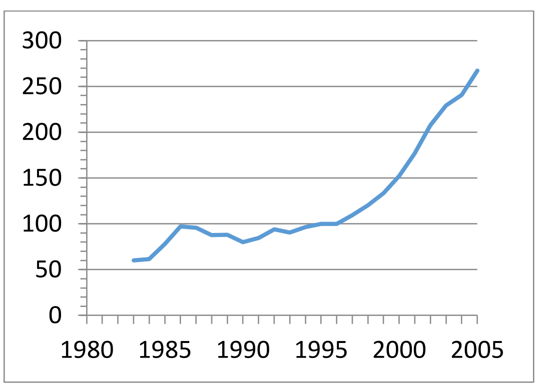
The developments in relative inputs, output and MFP in pulp, paper and paper products industry are traced in Figure 5.3, which reveal that despite minor fluctuations, gross output has steadily increased in this industry from 1983 to 2004; this increase was more rapid during the period 2004 to 2005 (panel a). Just like food & beverage industry, the demand for labor has significantly dropped since mid-1980s (panel b) while the demand for capital has consistently increased in the same period (panel c). This is confirmed by increasing capital-labor ratio (see, Appendix-B, Table A4). Similarly, growth in intermediate input was another important factor behind an impressive growth in output in the industry (panel d). Moreover, rising intermediate inputs suggests that some of the displaced labor may have entered through growth in services sector. While factor accumulation has played a fundamental role in explaining growth in output in the industry, a much faster growth in output has contributed to give the industry a considerably high MFP growth in pre-2000 period, which has considerably slowed down in the later period (panel e).



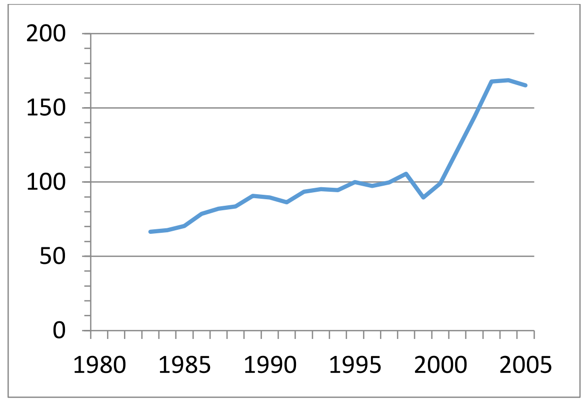
(a) Output quantity index



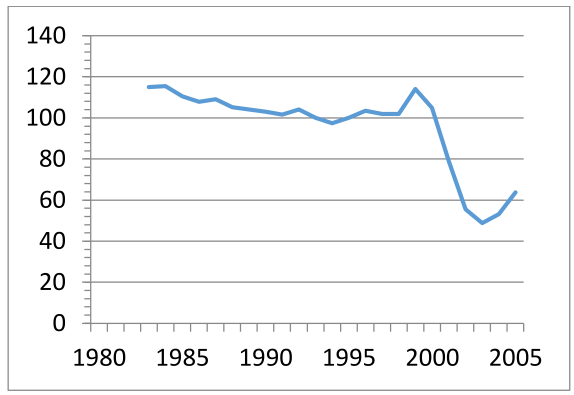
(b) Labor quantity index



(c) Capital quantity index

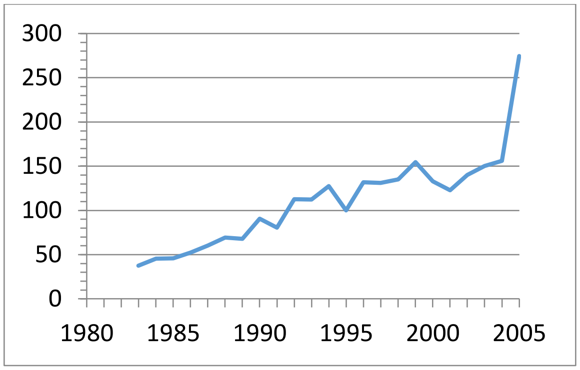


(d) Intermediate input quantity index

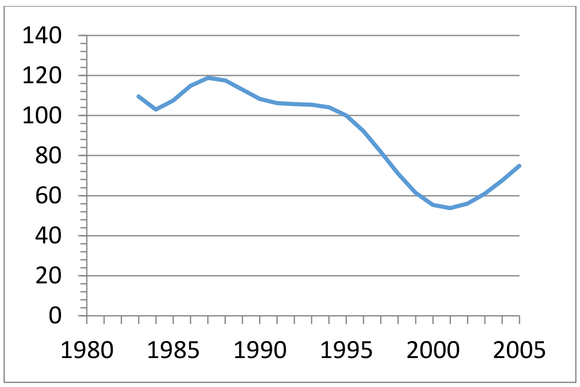


(e) Multi-factor productivity index

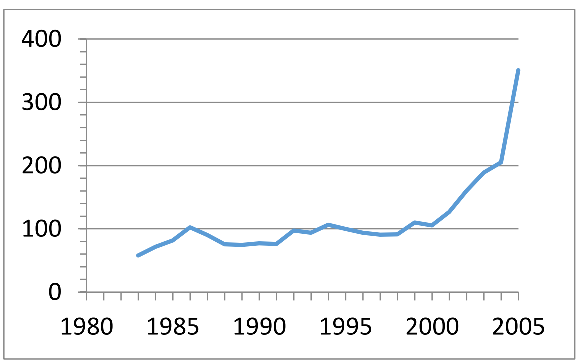
Figure 5.2: Growth patterns for food, beverages & tobacco
Note: For all quantity indices, the year 1995 has been used as the base year.



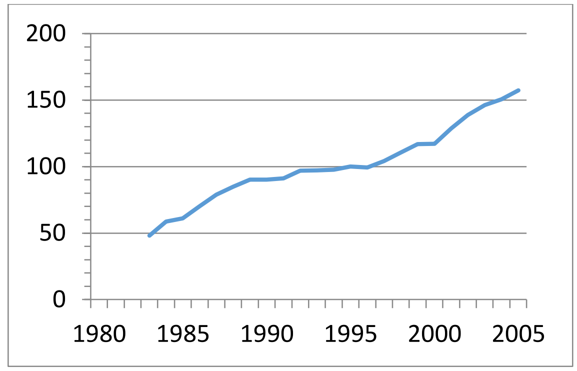
(a) Output quantity index



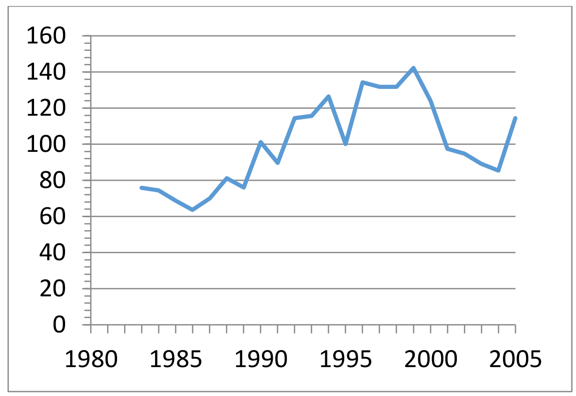
(b) Labor quantity index



(c) Capital quantity index



(d) Intermediate input quantity index



(e) Multi-factor productivity index

Figure 5.3: Growth patterns for pulp, paper, paper products, printing industry
Note: For all quantity indices, the year 1995 has been used as the base year.

5.4 Growth and Productivity in Textiles

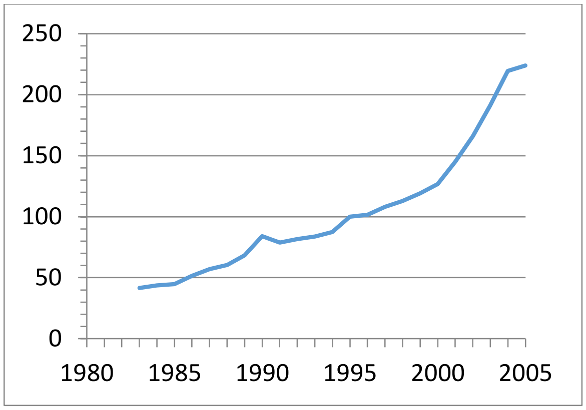
Figure 5.4 maps output, input, and MFP growth over time for the textile industry. Overall, gross output has posted a high growth throughout the study period. However, capital and intermediate inputs deepening has contributed to a negative average MFP residual for the textile industry.

Panels (b) and (c) indicate that demand for labor in textile units has significantly declined in 1990s while at the same time the demand for capital has rapidly increased suggesting high labor to capital substitution in the textile industry. This is also confirmed by a steady increase in the capital-labor ratio over time (Appendix-B, Table A4). However, a sharp increase in the capital index in post-2000 era is explained by a large-scale import of high-tech used textile machinery from the countries in EU and USA who were phasing-out their textile production due to lifting of the quota restrictions in 2005 under the Multi-Fiber Agreement. In the post-2000 period, a sharp increase in the growth of capital, intermediate inputs and labor has contributed to a dramatic productivity decline in the textile industry.

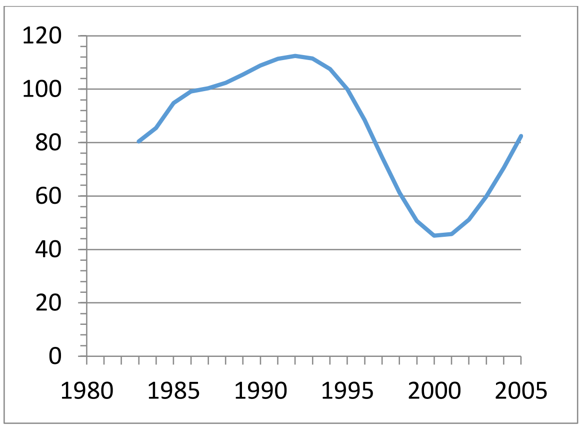
5.5 Growth and Productivity in Machinery Industry

Figure 5.5, panel (e) summarizes the developments in the machinery industry. It reveals that MFP in the machinery industry has passed through four diverse phases. First, during the period from 1982 to 1988, MFP has consistently declined. Second, during the period from 1989-93 MFP has remained largely unchanged. In the third phase, from 1993 to 2000, MFP has increased by about 50%. Finally, since 2000, MFP has fallen and returned to the pre-1993 levels by 2005.

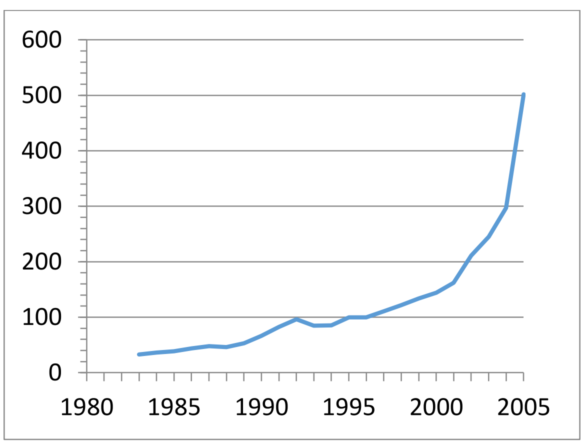
More specifically, panel (a) reveals that output growth has largely declined throughout the study period. Panels (b) and (c) suggest that both gross labor and capital have been on the decline since 1985, but labor quantity began to rise in post-2000 era. Additionally, intermediate input quantity followed a volatile trend increasing in 1983- 90, remaining stable in 1990-2000, and decreasing in 2000-05. However, in net terms, despite volatility witnessed in output and inputs, average MFP growth has remained positive.



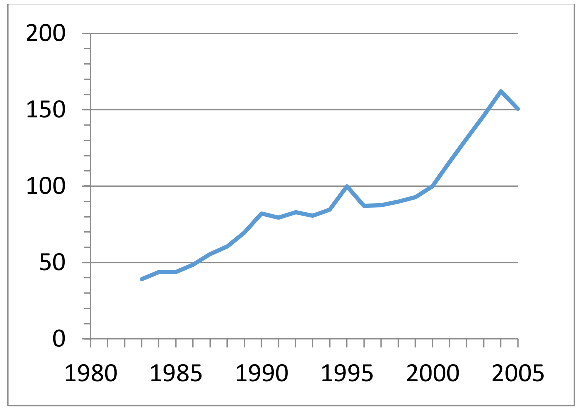
(a) Output quantity index



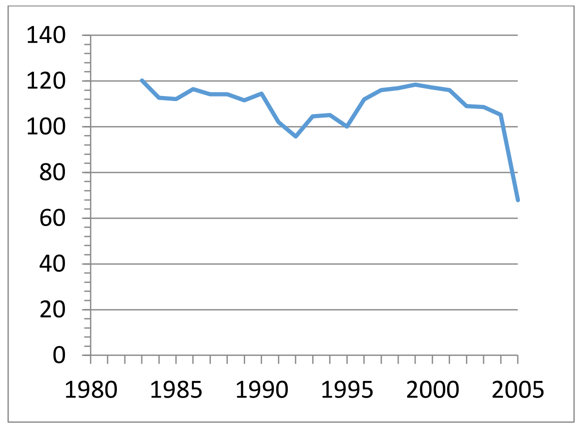
(b) Labor quantity index



(c) Capital quantity index

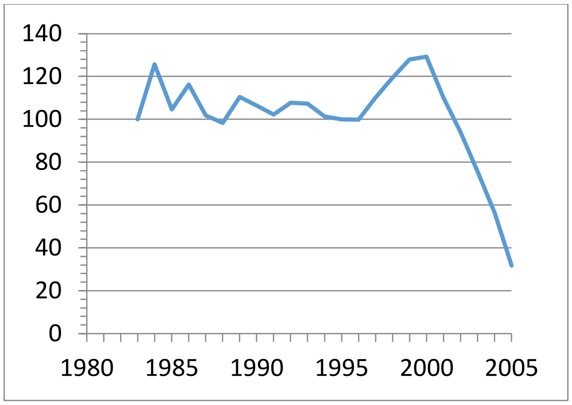


(d) Intermediate input quantity index

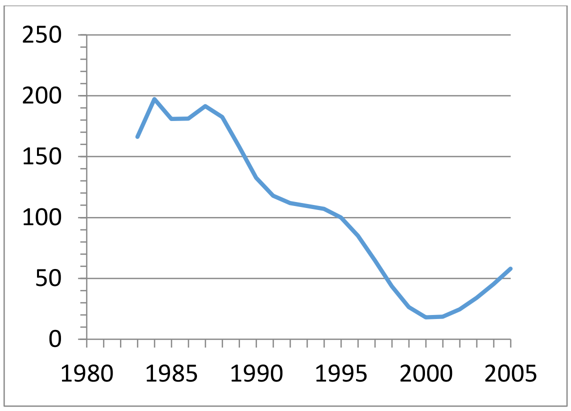


(e) Multi-factor productivity index

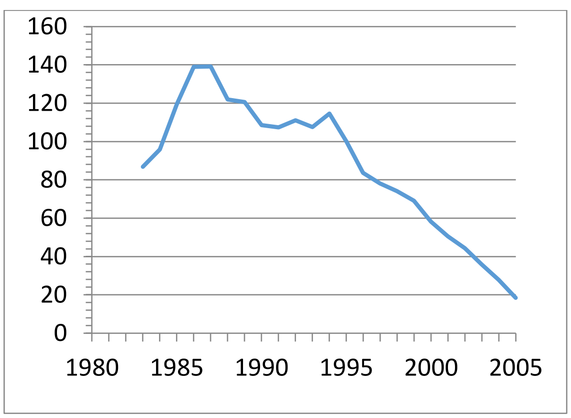
Figure 5.4: Growth patterns for textile, textile products, leather & footwear industry
Note: For all quantity indices, the year 1995 has been used as the base year.



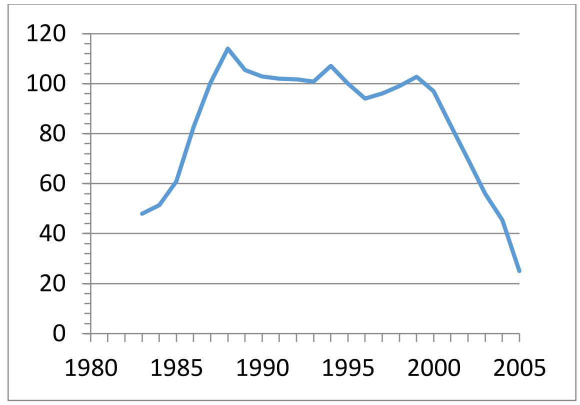
(a) Output quantity index



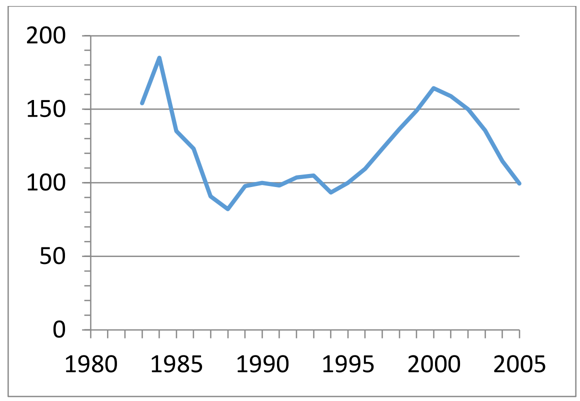
(b) Labor quantity index



(c) Capital quantity index



(d) Intermediate input quantity index



(e) Multi-factor productivity index

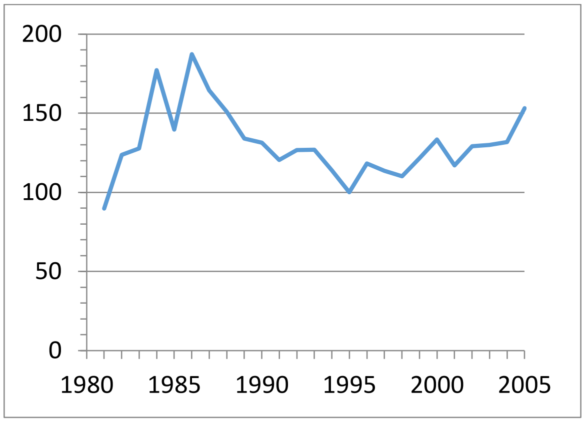
Figure 5.5: Growth patterns for machinery industry
Note: For all quantity indices, the year 1995 has been used as the base year.

5.6 Growth and Productivity in Basic Metals Industry

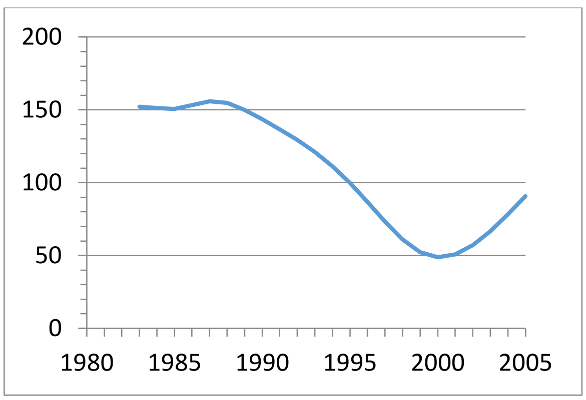
Our estimates for output growth in basic metals & fabricated metal products industry indicate that growth was high between 1980 and 1985 (see, Table 4.1). This is because the government subsidized inputs used in steel production during this period, thereby protecting the basic metals industry. Figure 5.6, panel (a) reflects this high output growth rate in the early 1980s in the form of a rapid increase in gross output during this period. Gross output for this industry remained volatile in the remaining years: it fell until 1995 and then gradually increased.

Gross labor quantity, capital quantity, and intermediate input quantity all increased between 2000 and 2005, as shown in panels (b) – (d). Additionally, capital quantity increased between 1980 and 1985, and intermediate input quantity increased till 1990. On the other hand, labor quantity fell in 1987- 2000, capital quantity fell in 1986-95, and intermediate input quantity fell in 1989-98.

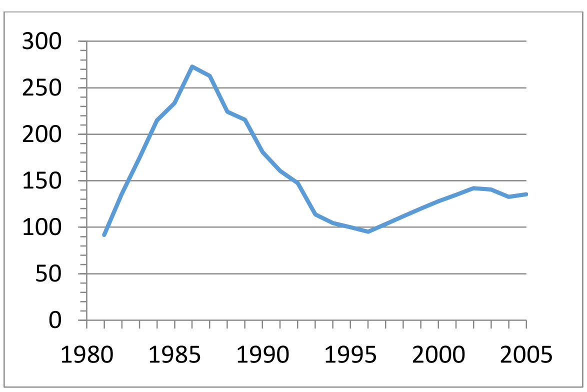
These graphs indicate that even though MFP declined between 1983 and 1987, gross output increased due to an overall increase in the use of all inputs. Labor, capital and intermediate inputs all fell during the decade that followed, but MFP increased from 1987 to 1998. This increase in productivity compensated for the fall in gross input usage so that, even though output fell rapidly between 1987 and 1989, but stabilized somewhat and began to increase again. However, MFP fell between 2000 and 2005, however, increased use of inputs by the industry kept the gross output from plummeting again.



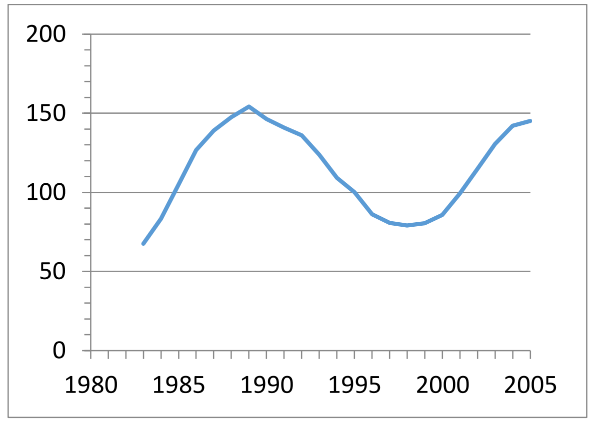
(a) Output quantity index



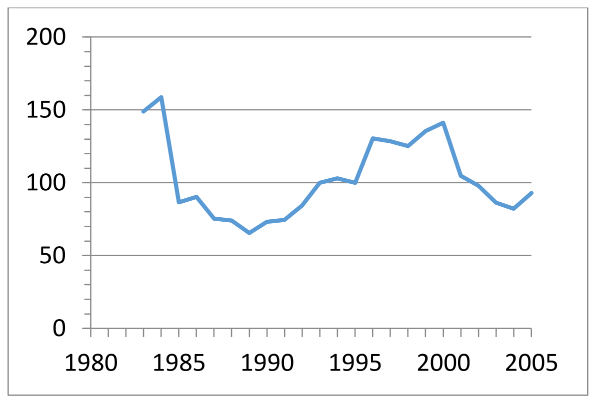
(b) Labor quantity index



(c) Capital quantity index



(d) Intermediate input quantity index



(e) Multi-factor productivity index

Figure 5.6: Growth patterns for basic metals & fabricated metal products industry
Note: For all quantity indices, the year 1995 has been used as the base year.

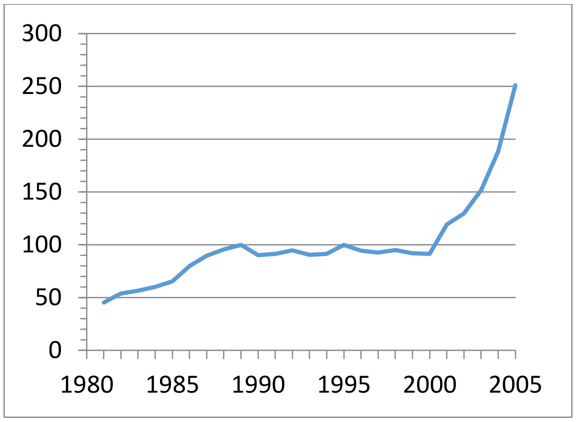
5.7 Growth and Productivity in Other Non-Metallic Mineral Products

Figure 5.7 maps output, input, and MFP growth over time for the other non-metallic mineral products industry of Pakistan. Gross output for this industry has increased overall between 1980 and 2005 as shown in panel (a). However, gross output has remained stable in the 1990s. One possible reason for this could be that cement production declined during the late 1990s.

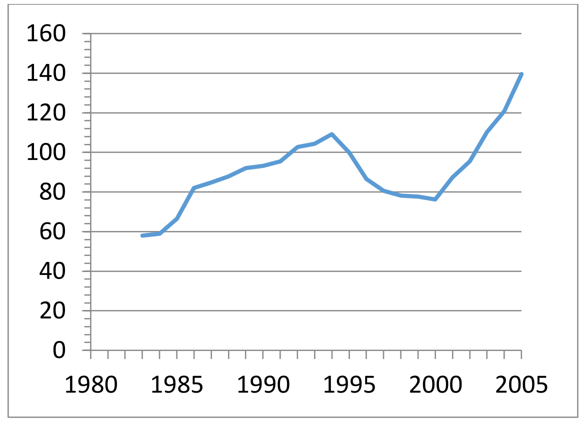
Partial closure of plants, and lower demand due to escalating prices of cement reduced its production. Also, public sector investment in large scale manufacturing fell significantly in this period as a result of economic sanctions imposed on Pakistan in the aftermath of nuclear tests carried out in the country in 1998, lowering the level of production.

However, output growth increased significantly in all the manufacturing industries of Pakistan in 2000-05 due to revival of economic activities in the country. Labor quantity first increased till 1989, and then decreased between 1990 and 2000 (see, panel b). However, labor increased significantly after 2000, reaching its peak in 2005. On the other hand, capital grew consistently during the entire period examined, increasing considerably in 2003-05 (panel c). Finally, intermediate input quantity increased initially, and then fell between 1995 and 2000 (panel d). But, like labor and capital, it increased rapidly in 2000-05.

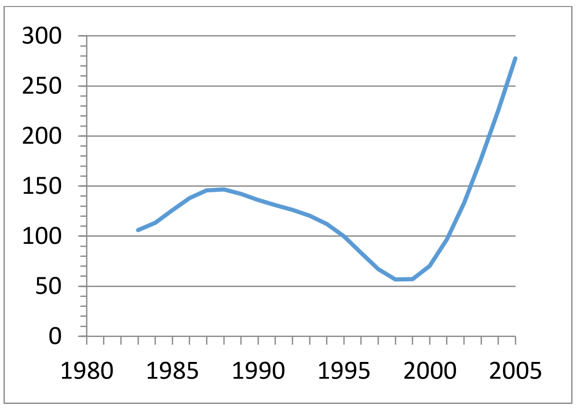
The MFP for this industry remained volatile but followed a decreasing trend over the period examined (panel e), indicating that investment in inputs for this industry may have risen by 2005, but the productivity of the industry had declined over time. Therefore, the rapid rise in output may be explained by the increase in gross input rather than productivity.



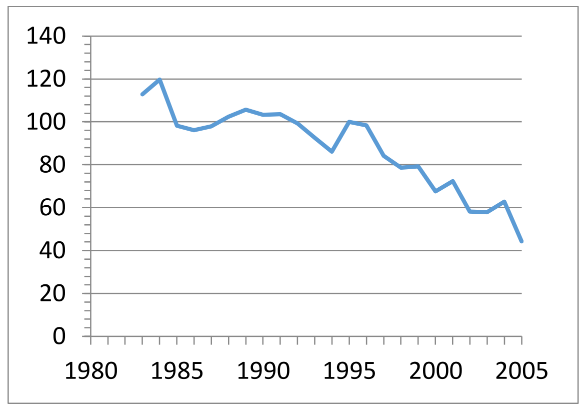
(a) Output quantity index



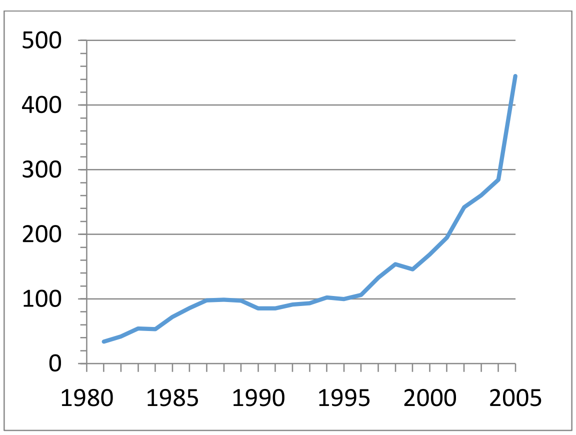
(d) Intermediate input quantity index



(b) Labor quantity index



(e) Multi-factor productivity index



(c) Capital quantity index

Figure 5.7: Growth patterns for other non-metallic mineral products industry
Note: For all quantity indices, the year 1995 has been used as the base year.

6. Conclusions

This paper develops an internationally comparable Pakistan KLEMS database at the industry level by using the framework employed by EU KLEMS Growth and Productivity Accounts project, which includes growth in output, growth in inputs and derived measures of multifactor productivity at the industry level. The paper also evaluates the sources of output and productivity growth at the industry level and relates factor accumulation and growth in productivity to growth in output at the industry level. Our analysis of data from 1980 to 2010 for agriculture and from 1980 to 2005 for other industries has revealed some interesting patterns in the time-path of MFP growth in respective industries.

First, this paper has shown that there is a large variation in productivity across the selected industries. While MFP growth has been positive in agriculture, paper and paper products and machinery industries, in all other selected industries MFP growth has been negative. Moreover, productivity growth has considerably slowed down since mid-1990s in all industries, but the slowdown has been most pronounced in the textile industry.

Second, our results provide strong evidence that factor accumulation (rather than MFP growth) has played a key role in the growth of output in all industries, except agriculture. Our estimates of the sources of growth suggest that 58% growth in output of all industries is accounted for by services growth, 35% is due to capital growth and 12% is due to growth in labor and energy inputs. The contribution of MFP in the growth of the gross value of output is negative. However, MFP growth has been a key factor in the growth of output in agriculture with its 78% share while the rest of the share is attributable to accumulation of factor inputs.

Third, the growth in output in all the manufacturing industries has mostly been caused by the accumulation of factor inputs. The negative growth in MFP in some of the industries has been the outcome of widening differences in output and input growth rates.

Fourth, we find unequivocal evidence to show that capital to labor ratio in agriculture has declined overtime, indicating an increasing reliance of agricultural production on labor rather than capital. This is a surprising result especially when it is compared with contrasting trends from the other industries. Moreover, the services to output and materials to output ratios have also increased in agriculture since 1995.

Last, since 1990s, the demand for labor in manufacturing industries has declined while capital demand has increased suggesting substitution from labor to capital. The rising demand for capital includes the impact of new investments on intangibles due to innovations in information technology, e.g., changes in organizational matters related to information technology. Some of the lost demand for labor in the manufacturing industries may be accounted for by increasing demand for labor in services.

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Appendix–A: A Description of Pakistan KLEMS Database

This data appendix describes the data sources and methodology used to construct gross output, labor, capital and intermediate inputs. Moreover, the appendix also describes the procedures used to construct data for the agriculture industry.

Construction of Gross Output

Gross value of output for an industry is defined as value of production using primary factors such as capital, labor, and purchased intermediate inputs. It can also be defined as the product of gross output quantity and current producer prices, where the quantity of gross output is aggregated by the Tornquist index.

The gross output data series was constructed using direct estimates/figures for gross value of output (GVO) and indirectly computed estimates for GVO for the remaining years for which data was not available. This series was computed separately for registered and unregistered establishments using data from CMI and SHMI, respectively. CMI and SHMI are the main sources of data for gross output in the manufacturing industries. CMI covers manufacturing establishments that are registered or they qualify for registration under the Factories Act of 1934. It provides data on quantities and values of outputs and inputs by industry at both aggregate and disaggregated levels. SHMI covers all unregistered household units and small establishments engaged in manufacturing activities in both urban and rural areas. Like CMI, this data also provides information on outputs and inputs by industry. Combining these sources of data allowed us to account for both the formal and informal sectors of Pakistan and provide holistic estimates of gross output for six of the seven industries covered in this analysis.

Since CMI and SHMI are not conducted at an annual frequency, or at regular intervals, direct estimates of GVO could not be obtained for each year. To fill out the values of the remaining years, we combined the data from CMI and SHMI with the quantum index and price indices of different industries. The quantum indices for each industry were extracted from 50 Years of Pakistan in Statistics for the period 1982 – 1988, and from the Pakistan Statistical Yearbook for the period 1989 – 2005.[6] Since the quantum indices reported in different sources used different base years, we first converted them to a common base year. Similarly, price indices were obtained for each industry using information from the Monthly Statistical Bulletins for the period 1980 – 1990, from the Pakistan Statistical Yearbook for the period 1991 – 2005. Like the quantum indices, the price indices were also converted to a common base year for consistency.

Next, the GVO series for registered establishments was filled in by computing the ratio of CMI gross quantity of output to the quantum indices for all available years. The average of these ratios was then applied to the years with missing GVOs to calculate the gross quantity of output. Finally,

[6] Both these sources are published by the Pakistan Bureau of Statistics (PBS) and cover different socio-economic aspects of the country including, but not limited to, labor force, education, health, national accounts, agriculture, energy & mining, manufacturing, transport & communications, and prices.

the gross quantity of output series was multiplied by the respective years' price indices to estimate the missing gross values of output for registered establishments.

For unregistered establishments, direct estimates of GVO were obtained from SHMI but they were available only for the years 1988 and 1995. Missing values of GVO, in this case, were computed by calculating the ratio of SHMI gross value of output to CMI gross value of output for the years 1988 and 1995. GVO series for each industry up till the year 1988 was estimated using SHMI-CMI ratio for the year 1988; and GVO series for all years after 1995 was estimated using the SHMI-CMI ratio for 1995. GVO series for the remaining years (i.e., between 1988 and 1995), were filled in by calculating the percentage change in SHMI-CMI ratio from 1988 to 1995, and then spreading that percentage change evenly across the intervening seven years. The resulting percentage change was used to inflate the SHMI-CMI gross output ratio, and to fill in GVO figures for this interval.

This methodology was employed for six of the seven industries with a few minor adjustments. In particular, for the non-metallic mineral products; machinery; and basic metals & fabricated metal products industries, moving averages for the ratio of CMI gross quantities to the quantum indices were used instead of simple averages in order to fill up missing values of the GVO series for registered establishments. The rationale for using moving averages was that the ratios for these industries were relatively higher in the year 2005 due to which using fixed or simple average of ratios was causing kinks in the estimated data for the missing years.

Gross output data for the agriculture industry was available from the Pakistan Economic Survey, which covers a wide range of topics that provide a collective overview of the economy.[7] The structure of this data as well as the composition of the agriculture industry necessitated the construction of a composite output index. In particular, agriculture industry includes agriculture, hunting, forestry, and fishing sectors. Since the gross value of output is reported separately for each of these sectors in the Pakistan Economic Survey at constant prices, the reported values were extracted and simply added up to form the final composite GVO series for the agriculture industry.

Construction of Labor Input

The main sources of data used to construct labor variables for six manufacturing industries were CMI and SHMI. Each of the variables was computed separately from CMI and SHMI and then combined to form the final aggregate.

For registered establishments, the number of employees and labor compensation by industry were readily available from CMI. However, no direct estimates/figures were reported for the total number of hours worked by employees at the industry level. To compute this series, data on the total number of days and shifts worked at firm level were extracted from CMI. Since employees work up to 8 hours in each shift, this data along with the number of employees at firm level was

[7] Areas focused on in this data include agriculture, manufacturing and mining, inflation, capital markets, health and nutrition, education, population, labor force and employment.

used to calculate the number of hours worked by all employees throughout the year in each registered firm in the industry. This figure was then multiplied by the number of firms in the respective industry to obtain total number of hours worked by employees at industry level.

Since unregistered establishments are small units which do not employ more than 10 persons, the bulk of the labor force for each of the manufacturing industries comes from registered establishments. Further, data constraints make it impossible to construct these labor variables for the informal sector. However, SHMI does contain information on labor compensation but only for the years 1988 and 1995. Values of labor compensation for the remaining years were computed by calculating the ratio of SHMI aggregate labor compensation to CMI aggregate labor compensation for each industry for the years 1988 and 1995. The labor compensation series for each industry up till the year 1988 was estimated using SHMI-CMI ratio for the year 1988; for all years after 1995 was estimated using the SHMI-CMI ratio for 1995; and for the intervening years (that is, between 1988 and 1995) was estimated by calculating the percentage change in the SHMI-CMI ratio from 1988 to 1995, and then spreading that percentage change evenly across the six years. The resulting percentage change was used to inflate SHMI-CMI labor value ratio, and fill in the labor compensation figures for this interval. This technique is similar to the technique used to fill in GVO series for the informal sector.

Additional variables that divide labor compensation and hours worked by gender, skill, and age[8] were constructed from the Labor Force Survey, which provides an industry-wise overview of labor in Pakistan. This survey includes micro data on gender, age, education level, wages and earnings, hours worked, etc. Skill was quantified in terms of the level of education acquired by each employee so that workers whose highest educational qualification was below middle school were classified as 'low-skilled'; those with a higher education level than middle school but less than intermediate level were categorized as 'medium-skilled'; and workers with a higher education level than intermediate were considered as 'highly skilled'. Similarly, the age variable for workers was categorized into 4 age-brackets: under 14 years of age, between 15 to 29 years of age (inclusive), between 30 to 49 years of age (inclusive), and above 50 years of age. Since the Labor Force Survey data was only available for the years 1990-94, 1996-97, 1998-99, 2001-02, 2002-03, 2005-10, after dividing labor compensation and hours worked at industry level by gender, skill, and age, the missing values for these variables for the remaining years were estimated using cubic spline interpolation method. In cubic spline interpolation, different variables like gross output, year, and price indices were used as explanatory variables to interpolate the missing values for labor compensation and hours worked. The validity of this method was tested by dropping observations of different years for which data was available, one at a time, and interpolating the

[8]Our estimates of multi-factor productivity are based on aggregate measures of different outputs and inputs including labor. These additional variables were not used in the construction of gross labor or the calculation of multi-factor productivity, but were intended to provide estimates of labor composition by industry for the reader.
The MFP estimates will not change even if we use disintegrated measures of different inputs. Therefore, to keep the report and data set compact, we have constructed only one measure of MFP. This data on labor composition and other sub-categories of inputs is available so that users of the KLEMS database can easily construct any measure of MFP as required.

remaining series on the basis of the explanatory variables and then comparing the interpolated values with the actual values.

For the agriculture industry, the primary sources of data used were the Pakistan Economic Survey and the Labor Force Survey. The Pakistan Economic Survey series reports the aggregate[9] number of employees for different sectors of the agriculture industry for the years 1980 to 2010. Employee/labor compensation and total hours worked were extracted from the Labor Force Survey, which reports labor compensation in weekly, monthly, and yearly terms, and total hours worked per employee at sector level. For consistency in multi-factor productivity estimates, labor compensation was converted to annual terms, and total hours worked per employee were multiplied by the total number of employees to obtain total hours worked by employees in the industry for the entire year. Finally, additional variables that divide labor compensation and hours worked by gender, skill, and age were constructed using the same procedure described for manufacturing industries.

Construction of Capital Input

The capital input used in the production process consists of different asset types. This input is grouped into different types of fixed assets and is later aggregated to form one composite series for manufacturing industries. For six of the seven industries analyzed, this input is categorized into plant & machinery, transport, furniture & fixtures, and other fixed assets. Capital value for each of these assets is simply the average value of the respective asset over the year, unless a singular estimate for asset value is provided in the data employed. As for the agriculture industry, capital value consists of the value of goods such as tractors, threshers, combined harvesters, tube wells, and bullock carts, etc., and is available in the data in aggregate form.

Information on the year opening and year ending values of plant & machinery, transport, furniture & fixtures, and other fixed assets for registered manufacturing units is reported in CMI. However, the series for these different asset types contained missing values. The missing values for year opening and ending values were filled in using cubic spline interpolation[10] and the validity of this method was tested by dropping observations for different years and interpolating/estimating the remaining series. The nominal value of each of the asset types was then computed by taking the arithmetic average of the year opening and ending values for each respective asset. These asset values were then deflated using information on price indices extracted from the Monthly Statistical Bulletins for the period 1980 – 1989, and the Pakistan Statistical Yearbook for the period 1990 – 2005. More specifically, the nominal value for plant & machinery was deflated using the wholesale price index for machinery; the value for transport equipment was deflated using the wholesale price index for transport; and the values for furniture & fixtures, and other fixed assets were collectively deflated using the wholesale price index for timber. Finally, we computed the

[9] This number was aggregated at the industry level to provide a comprehensive measure of the labor force employed in agriculture, hunting, forestry, and fishing.

[10] In cubic spline interpolation, variables like gross output, year, and price indices were used as explanatory variables to estimate the missing values in the fixed asset series.

percentage change in the deflated values for each of the three asset types, and share-weighted these values to form the final composite capital value series for the formal sector of each of the six manufacturing industries in Pakistan KLEMS.

SHMI was employed to compute the indexed capital value series for un-registered manufacturing establishments. Single estimates of asset values for each year were directly available in this data, so there was no need to take the average of year opening and ending values. The remaining procedure remained the same as the one described above for registered units. The only difference was that instead of filling in missing values using interpolation, missing values of capital assets were filled in using the ratio of SHMI aggregate capital asset value to the CMI aggregate capital asset value by industry for the years 1988 and 1995. More specifically, the capital input series for each industry up till the year 1988 was estimated using the SHMI-CMI ratio for the year 1988; for all years after 1995 was estimated using the SHMI-CMI ratio for 1995; and for the intervening years was estimated by calculating the percentage change in the SHMI-CMI ratio from 1988 to 1995, and then spreading that change evenly across the years. The resulting yearly percentage change was used to inflate the SHMI-CMI capital asset ratio, and fill in the values of capital assets for this interval.

Investment in capital in the agriculture industry differs significantly from industries involved in manufacturing activities. Capital in agriculture consists of investment goods like tractors, threshers, combined harvesters, tube wells, and bullock carts, etc. The aggregate value of these forms of capital input was extracted from the Pakistan Economic Survey series at constant prices, and then converted to a common base year for coherence.

Constructing Intermediate Inputs

Intermediate inputs used in production consist primarily of energy, materials, and services. In the Pakistan KLEMS database, energy consumed is equivalent to the combined consumption of fuel and electricity, materials consumed refers to the consumption of raw materials, and services consumed vary across industries. For industries involved in manufacturing activities, these services are more widespread and encompass wholesale and retail trade; transport, storage, and communications; finance, insurance, real estate, and business services; community, social, and personal services; health and social work; education; social security; and other services like refuge and sewage disposal, etc. For the agriculture industry, services consumed are limited to loans; expenditure on water, electricity, and fuel; repair and maintenance of materials; rental expenses of materials; transport expenses; commission, insurance, and postage; and land revenue tax.

Separate series for the value of energy, materials, and services were constructed for each of the seven industries using data from the formal and informal sectors. For manufacturing industries, the principal data sources used were CMI and SHMI; and for the agriculture industry, the *Pakistan Economic Survey* series was used as the main source.

For registered manufacturing units, the values of fuel and electricity consumed at firm level were extracted from CMI and then aggregated at the industry level. Since CMI was not available for all the years in the time period examined, missing figures for the value of energy consumed were filled in using cubic spline interpolation with gross output, year, and price indices used as explanatory variables. Materials and services consumed were also extracted at firm level from CMI and converted to industry level data using the same methodology to form two distinct value series. Next, the nominal value series for energy, materials, and services were deflated by using wholesale price index for fuel, lighting, and lubricants (for energy) and GDP deflator (for materials and services). These deflators were obtained from the Monthly Statistical Bulletins, the Pakistan Statistical Yearbook, and the Pakistan Economic Survey series, and were converted to a common base year. Finally, the value series for energy, materials, and services were share-weighted to form one composite EMS (energy, materials, and services) series which combines all three intermediate inputs into one indexed measure.

The same procedure was used to construct EMS value series for unregistered units using SHMI. The only difference in this case was that the missing figures in the series for energy, materials, and services were not estimated using interpolation. Instead, the ratios of SHMI aggregate energy value to CMI aggregate energy value, SHMI aggregate materials value to CMI aggregate materials value, and SHMI aggregate services value to CMI aggregate services value were computed. These ratios were then inflated to fill in all missing values.

For the agriculture industry, the choice of raw materials and services differs significantly from the manufacturing industry. In particular, the agriculture industry relies more on locally available raw materials like seeds & planting stock, fodder for animals, maintenance of buildings, etc. Fertilizers, pesticides, and veterinary medication are often imported. Data on the value of fertilizers and pesticides used was obtained from the Statistical Supplements of the Pakistan Economic Survey.[11] For the remaining raw materials, data was extracted from HIES, and PSLM-HIES. Missing values of materials were filled in using interpolation as before. Lastly, services for the agriculture industry are not as widespread as the manufacturing sectors and include loans, repair and maintenance, transport, commission, insurance, postage, and land revenue tax. Information on loans was collected from the Agriculture Statistics of Pakistan; and the remaining data on services was obtained using the HIES, PIHS and PSLM-HIES. Like before, the nominal value series for energy was deflated using the wholesale price index for fuel, lighting & lubricants. The value series for materials and services were combined and then deflated using GDP deflator obtained from the Pakistan Economic Survey. These series were also share-weighted to form the final indexed EMS value series for the agriculture industry.

Construction of Land Input

We treated land as a separate input for the agriculture industry in Pakistan. Total amount of land used in production is defined simply as the sum of net area sown and area sown more than once, where net area sown is that area which is sown at least once a year (i.e., during kharif & rabi

[11] HIES data was available for the years 1990 and 1993; PIHS was available for 1998 and 2001; and PSLM-HIES was available for 2007 and 2010.

seasons). Rent per acre of land is used as an approximation of land price. And the value of land for this sector over the period 1980 – 2010 is computed using the total amount of land used in production (or total cropped area) and rent per acre of land.

The Pakistan Economic Survey series and the Pakistan Integrated Household Survey are used as the primary sources of data in the construction of the land input variable. The total cropped area or total amount of land used in production for the period 1980 – 2010 was extracted from the Pakistan Economic Survey series and converted in to acres.

The average per acre price of land was computed using data from the Pakistan Integrated Household Survey. In particular, rent per acre at the household level was obtained from the Pakistan Integrated Household Survey and used to calculate the industry average of land price per acre for the years 1990 to 2010. Since the Pakistan Integrated Household Survey data was available only for the years 1990-91, 1992-93, 1998-99, 2001-02, 2004-05, 2007-08, and 2010-11, missing figures in the land price series were filled in using cubic spline interpolation. Using this technique, explanatory variables like gross output and years were used to interpolate/estimate missing values of land price during the period 1990 to 2010. A separate method was employed to fill in the price of land for the preceding period 1980 to 1990. Using the interpolated price series, we computed the ratios of each year's price to the preceding year[12] for the period 1990 to 2010, and then used these ratios to extrapolate the series and estimate the per acre price of land for the remaining time period as well (from 1980 to 1990).

Finally, the value of land for this sector was computed by multiplying the total amount of land used in production (or total cropped area) with the per acre price of land for the period analyzed. This nominal value series was then deflated using the prices computed for each respective year and converted to an indexed series for the real value of land.

[12] That is, we computed the series $P_{i+1}/P_i,\ P_{i+2}/P_{i+1},\ \cdots, P_{i+20}/P_{i+19}$ where P is the average price of land per acre for the industry and *i* is the starting year (i=1990).

Appendix – B: Tables of Factor Ratios

Table A1 : Capital to output ratio

Industry Description	80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	0.3693	0.3806	0.3160	0.2048	0.1815	0.2206
Food, Beverages & Tobacco	0.1434	0.1952	0.2024	0.1894	0.2862	-
Pulp, Paper, Paper Products, Printing & Publishing	0.3520	0.3340	0.2854	0.2105	0.4382	-
Textile, Textile Products, Leather & Footwear	0.2344	0.2449	0.3478	0.3068	0.4466	-
Machinery, NEC	0.2114	0.2315	0.2339	0.1465	0.1177	-
Basic Metals, & Fabricated Metal Products	0.8204	0.6833	0.4669	0.3618	0.3195	-
Other Non-Metallic Minerals Products	0.4954	0.6155	0.6194	0.7690	0.9345	-

Table A2: Labor to output ratio

Industry Description	80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	0.6991	0.8266	0.7424	0.9596	1.0156	2.1329
Food, Beverages & Tobacco	0.0458	0.0492	0.0495	0.0347	0.0436	-
Pulp, Paper, Paper Products, Printing & Publishing	0.1364	0.1173	0.0785	0.0550	0.0706	-
Textile, Textile Products, Leather & Footwear	0.0760	0.0767	0.0723	0.0593	0.0643	-
Machinery, NEC	0.0974	0.1132	0.1405	0.1087	0.2098	-
Basic Metals and Fabricated Metal Products	0.1348	0.1228	0.1573	0.1222	0.0937	-
Other Non-Metallic Minerals	0.0945	0.0918	0.0916	0.0552	0.0542	-

Table A3: Services to output ratio

Industry Description	80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	0.9479	1.2356	1.2417	2.3893	5.0038	8.0777
Food, Beverages & Tobacco	0.0342	0.0518	0.0593	0.0580	0.0989	-
Pulp, Paper, Paper Products, Printing & Publishing	0.0632	0.0559	0.0516	0.0547	0.0647	-
Textile, Textile Products, Leather & Footwear	0.0350	0.0401	0.0424	0.0400	0.0316	-
Machinery, NEC	0.0635	0.0912	0.0720	0.0790	0.0854	-
Basic Metals & Fabricated Metal Products	0.0468	0.0687	0.0467	0.0542	0.0595	-
Other Non-Metallic Minerals Products	0.0263	0.0669	0.0789	0.0622	0.0528	-

Table A4 : Capital to labor ratio

Industry Description	80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	0.5948	0.4656	0.4397	0.2133	0.1803	0.1042
Food, Beverages & Tobacco	3.1241	3.9784	4.1213	5.4788	6.5591	-
Pulp, Paper, Paper Products, Printing & Publishing	2.5982	2.8590	3.6982	3.8452	6.6466	-
Textile, Textile Products, Leather & Footwear	3.0846	3.2060	4.8451	5.1840	6.9207	-
Machinery, NEC	2.1337	2.1055	1.6644	1.3369	0.6331	-
Basic Metals & Fabricated Metal Products	6.1458	5.6757	2.9602	2.9692	3.4193	-
Other Non-Metallic Minerals Products	5.2288	6.7411	6.8623	14.0463	17.5980	-

Table A5 : Capital to services ratio

Industry Description	80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	0.3978	0.3082	0.2565	0.0911	0.0377	0.0270
Food, Beverages & Tobacco	4.4180	3.7828	3.4117	3.2687	2.9181	-
Pulp, Paper, Paper Products, Printing & Publishing	5.7321	5.9432	5.5338	3.8553	6.7173	-
Textile, Textile Products, Leather & Footwear	7.2074	6.4030	8.2456	7.7825	15.3790	-
Machinery, NEC	3.3903	2.6697	3.2821	1.9064	1.3766	-
Basic Metals & Fabricated Metal Products	19.7938	10.1370	9.9901	6.7161	5.3489	-
Other Non-Metallic Minerals Products	20.5597	9.2667	7.8760	12.3354	17.7238	-

Table A6: Services to labor ratio

Industry Description	80-85	86-90	91-95	96-00	01-05	06-10
Agriculture, Hunting, Forestry & Fishing	1.4022	1.4995	1.6864	2.3222	4.8404	3.8447
Food, Beverages & Tobacco	0.7039	1.0520	1.2007	1.6642	2.2473	-
Pulp, Paper, Paper Products, Printing & Publishing	0.4384	0.4783	0.6601	0.9922	0.9086	-
Textile, Textile Products, Leather & Footwear	0.4272	0.4988	0.5869	0.6683	0.4757	-
Machinery, NEC	0.6184	0.7765	0.5071	0.7134	0.4094	-
Basic Metals & Fabricated Metal Products	0.3093	0.5258	0.2968	0.4386	0.6387	-
Other Non-Metallic Minerals Products	0.2505	0.7252	0.8656	1.1246	0.9669	-