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A Disaggregated Analysis of Productivity and Growth for Pakistan's Large Scale Manufacturing Sector

Fauzia Kamal

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ABOUT THE AUTHORS

Fauzia Kamal, Staff Economist and Ph.D. student, Applied Economics Research Centre, University of Karachi.
fauzia_15@hotmail.com

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INTRODUCTION

Productivity is widely accepted as an indispensable factor for sustained economic growth, and many economists consider productivity as a fundamental driver for economic development. The consensus within the literature is that a dynamic production process is often the result of the growth of total factor productivity (TFP). The two-way causality between TFP growth and output growth has been shown by several authors, significantly by Harberger (1998) and Robles (2000) among others. These authors recognize that TFP can be described as the residual of value added (VA) growth that could not be explained by increases in quantity or quality of traditional inputs (capital and labor). This residual is described or labeled with various names in various studies, for instance TFP improvement, technical advancement, real cost reduction (RCR), etc. The term used reflects the perception of the author, but the underlying concept is similar for all of the above.

Harberger (1990, 1998) described this residual as a 'Real Cost Reduction' that could be achieved either by the advancement of technology, managerial efficiency, or through innovation. Individuals involved in the reality of the production process seldom understand the production function of their businesses. For them, the main objective is to reduce the real costs of their business. According to Harberger (1998), "RCR is something every business executive understands and identifies with". Hence, considering TFP as RCR opened new avenues for policy recommendation, as RCR could be achieved in far more ways than simply implementing new technology into the production process. Harberger (1998) described at least 1,001 ways to reduce real costs. Some examples are through improved management techniques, computerizing databases or payroll, specializing in a few products while importing the rest, providing a better working environment, etc. Understanding the concept of TFP as RCR would be significant for developing countries like Pakistan because of an acute shortage and misuse of resources. In the contemporary era, it becomes imperative for Pakistan to achieve efficient and productive production processes in every sector, especially the manufacturing sector.

This research study is thus designed to compute TFP growth for Pakistan's large scale manufacturing (LSM) sector for each five year period from 1970-71 to 2005-06. It covers LSM activity according to the 2 digit Pakistan Standard Industrial Classification (PSIC) 2007, which is comparable with the 3 digit PSIC 1970[1]. The 'Two Deflator Growth Accounting Framework' (TDM) introduced by Harberger (1991) is employed in the study to compute the sources of LSM growth, along with the 'Sunrise-Sunset Approach' for determining the concentration pattern of TFP. Previous studies on productivity in Pakistan used aggregated data to examine the role productivity has played in economic performance. Even though aggregate productivity is a good measure of the overall efficiency and effectiveness of the economy, substantial information about the distribution of productivity across sectors of the economy is lost. An attempt is thus instigated hereto fill the gap of research on the issue of productivity measurement at the disaggregated level.

The paper is organized as follows. The next section describes the recent growth trends of the LSM sector of Pakistan. The third section presents a brief and selected review of existing literature. The fourth section describes the methodological framework of TDM and the Sunrise Sunset Approach. The fifth section presents the analysis of the empirical findings on sources of growth, the concentration pattern within various subsectors of Pakistan's LSM sector, and the correlation between total VA growth and TFP growth. The final section concludes the study with policy suggestions and recommendations.

PERFORMANCE OF PAKISTAN'S LSM SECTOR

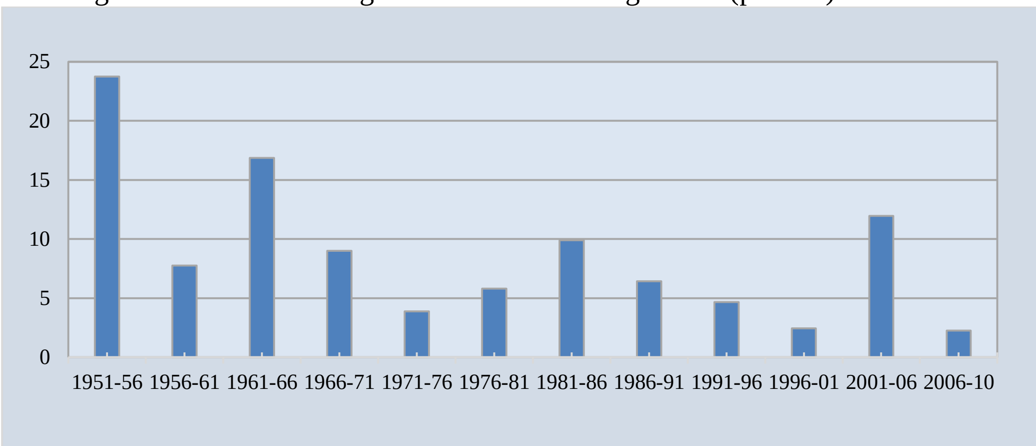
Over time Pakistan's economic growth has been marked by volatility. Episodes of high growth rates followed by periods of lower rates are found throughout Pakistan's history.

Figure 1 depicts the fluctuations in the growth rate of the LSM sector of Pakistan. The earliest decade shows an impressive growth rate of more than 20 percent, as the largely agrarian country began with a small industrial base. Throughout the sixties, Pakistan shows an impressive, sustained growth of more than 12 percent on average (somewhat lower in the late sixties) due to strong policy preferences towards the LSM sector. However, the seventies present an upsetting trend, and negative industrial growth was recorded consecutively from 1975 to 1977. This is due in part to

[1] For detail comparison, see Appendix A

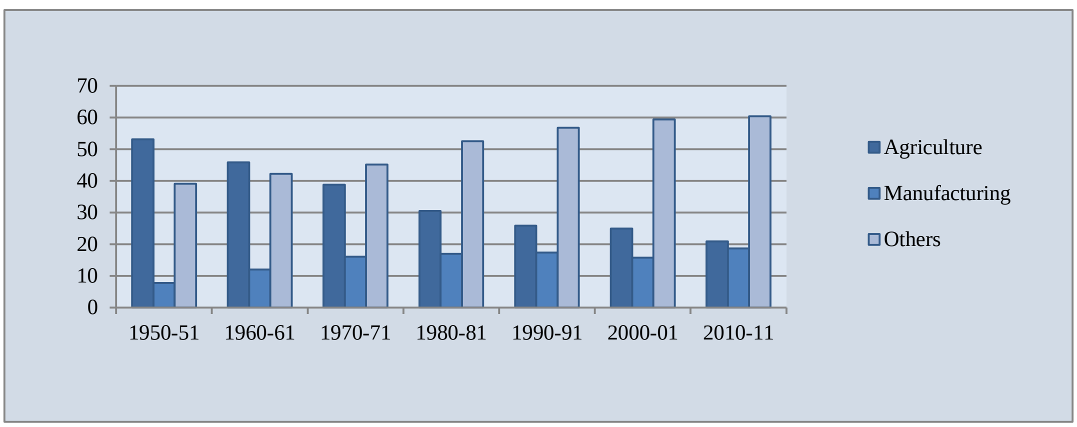
bad exogenous conditions[2] and in part to the nationalization policies[3] of Bhutto. Ahmed and Amjad (1984) explain the dismal performance of 1975-77as being the result of the 'big push' in public sector investments in projects with long gestation periods. Zaidi (2005)considers the 'loss of East Pakistan', as a result of 1971 war, as another major factor responsible for declining rate of growth[4].Although the sector recovered its growth to some extent in the eighties through gradually reversing the nationalization policies, again Pakistan showed a low growth slump during the nineties, mainly because of political turmoil. Statistics show an impressive performance in the LSM sector from 2003 to 2007, however, from 2008 onwards, the sector once again entered into a phase of stagnation.

Figure 1: Average Growth Rate of Large Scale Manufacturing Sector (percent)



Evidence shown in Figure 2 reveals that the manufacturing sector, which is considered an integral component of sustainable growth and development for any country, contributes the lowest share of GDP compared to agriculture and other sectors (including services). Despite the existence of strong policy preferences towards the sector in some periods, manufacturing output failed to surpass an 18 percent share in total output.

Figure 2: Share of Different Sectors in GDP



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[2] Two exogenous shocks were recorded during this phase that greatly affected the national economy. First was the oil price shock of 1973 that not only increased international petroleum prices fourfold, but the inflation rate rose to the highest recorded levels in 1973-74. The second shock was the result of weather conditions. The failure of the cotton crop in 1975-76 resulted mainly because of heavy flooding in 1973-74 coupled with the lowest recorded discharge of Tarbela during 1974-75 and followed by a devastating flood and pest attack in 1976. For more details see Government of Pakistan (GoP 1977) and Zaidi (2005).

[3]The nationalization policies of the seventies were criticized by various authors mainly on the grounds that it undid the pro-private investment policies of the previous two decades. According to GoP (1977), private sector investment declined from 94.7 percentage of total investment in 1970-71 to 16.7 percentage in 1976-77.

[4] By 1969-70, 50 percent of West Pakistan's products were exported to East Pakistan (now Bangladesh), while about 18 percent of West Pakistan's imports came from East Pakistan.

Table1 shows the share of VA for 19 subsectors of the LSM sector. The data paints a gloomy picture of the preferred trend of structural transformation from technologically simple products to more sophisticated ones. Consumer goods industries like food products & beverages, textile, and leather, comprised mainly of indigenous raw material, contributed the highest share in total manufacturing output. In Pakistan, like most other countries, these low technology, labor intensive manufacturing units established during the initial stage of industrialization not only require lower levels of skill and capital but filled the existing demand at the time they were founded. Although Pakistan has advanced into producing medium technology outputs (capital good industries like chemical & chemical products and motor vehicles & transport equipment beginning in the 1960s) their share in total manufacturing output has stagnated in the last two to three decades.

Table 1: Share of Major Industries in Total Manufacturing Value Added (percent)

PISC 2007	Industry	1975-76	1985-86	1995-96	2005-06
15	Food Products & Beverages	24.6	19.9	16.8	17.4
16	Tobacco Products	8.3	10.1	6.2	4.2
17	Manufacture of Textiles	24.3	15.5	22.3	24.4
18	Wearing Apparel	0.3	1.1	1.4	4.3
19	Leather Products	2.2	1.9	1.3	0.9
20	Wood & Wood Product	0.2	0.3	0.2	0.5
21	Paper & Paper Products	1.6	1.1	1.6	2.5
22	Publishing, Printing & Reproduction	1.1	1.1	2	0.3
23	Petroleum	3.7	7.5	3.1	5
24	Chemical & Chemical Products	10.5	16.1	16.3	15.7
25	Rubber & Plastics Products	1.5	2.1	1.3	1
26	Other Non Metallic Mineral Products	4	7.4	7.7	7.4
27	Basic Metals	3.4	4	4.2	4
28	Fabricated Metal Products	1.6	0.8	0.7	0.8
29	Machinery & equipment	2.9	2.4	1.6	1.9
31+32	Electrical Machinery & Apparatus & Radio, TV, & Communication Equipment	3.2	3.4	7.7	2.1
33	Medical & Optical Instruments	0.5	0.1	0.2	0.5
34+35	Motor Vehicles, Trailers, & Other Transport Equipment	6.4	2.5	3.5	6.4
36	Furniture	0.7	0.4	0.9	0.5

Source: Author's calculation from Census of Manufacturing Industries; Various editions

Taken with other factors, a low literacy rate in the country, and the concomitant scarcity of skilled labor, are among the root causes of this stagnation. The foremost determinants of lower literacy rates in Pakistan are an elite bias and a strong feudal system. The dominant elites and feudal lords do not believe in investing in human capital as they consider education to threaten their supremacy and power. As Hussain (1999) noted, "the low rates of literacy among the population have actually played into the hands of the elite and helped to reinforce the tendency of concentration of economic and political power". Another important dimension contributing to lower literacy rates for an agrarian country like Pakistan is explained by Easterly (2001):"At an early stage of development, when labor and land are abundant and capital is scarce, there will be lower return to investing in mass education." This explains that during the initial stage of development landowners lacked foresight and thus found it less profitable to invest in the human capital development. Recently, Malik and Mirza (2015) showed that the presence of politically influential and powerful families in Punjab, Pakistan had a detrimental impact on development; particularly literacy rates. Their conclusion was that this was due to the incentive for the powerful families to maintain their position by restricting opportunities for education and advancement for the lower classes.

Low expenditure on education by the Government of Pakistan (GoP) is another factor leading to the dismal literacy rate. Since independence, public spending on education has lingered between 1 to 2 percent of GNP compared to 3 to 4 percent of GNP in most developing countries (Hussain 1999). Skilled human resources are considered a pillar of competitiveness. This modern era requires a high level of professional, vocational, and/or technical education along with in-service training and retraining of employees. However, in Pakistan, this is not happening. Pakistan's National Skill Strategy, 2009-13, revealed that "students in Technical and Vocational Education and Training (TVET) are only 14 percent of those pursuing general education up to college level". According to UNESCO, Pakistan had only 58 technicians per million people in 2011, while Korea had981, Singapore 461, and Turkey144. The incidence of in-service training is also lower in Pakistan. According to the Pakistan Bureau of Statistics (2012), 8 percent of Pakistanis receive in-service training; the lowest among the four largest South Asian economies (about 18 percent for India, 22 percent for Bangladesh, and 25 percent for Sri Lanka).

Table 2 shows Pakistan's export structure by technological classification of manufacturing exports. The share of primary products in total exports has decreased by almost 50 percent during 1985 to 2012. Although this led to a corresponding boost in manufacturing exports, the economy failed to escape the trap of low technological manufacturing exports which still occupies the highest share (64 percent) of total exports. The table shows that low technological manufacturing exports are dominated by the textile sector which alone contributed about 70 percent of total exports in 2005. However, with the end of the Multi-Fiber Arrangement (MFA)[5], its share dropped to about 54 percent in 2012.

In the era of fierce globalized competition, the future growth and development of any country is dependent on what is being produced and exported. The concentration of exports towards a single product, especially one with a lower technological base and lower income elasticity of demand, could become a hindrance to future growth. Among others, Felipe, Kumar, and Abdon (2010) argue that "a sustainable growth trajectory must involve the introduction of new goods and not merely involve continual learning on a fixed set of goods". Pakistan's export basket needs accretion of sophisticated equipment, skilled human capital, and, most importantly, efficient processes by which these factors of production are combined, i.e., TFP. All three factors of production are necessary to enhance the overall productivity and competitiveness of the industrial sector of a country.

Table 2: Pakistan's Export Structure (Percentage Share)

Technology Level	1985	1990	1995	2000	2005	2012
Primary Products	33.4	19	13.1	12.8	11	16.6
Resource Based Manufacturers	4.1	2.3	1.9	2.5	8	9.6
(a) RB 1: Agro-Based	2.2	1.3	1.1	1.5	2.7	4.2
(b) RB 2: Other	1.9	1	0.8	1	5.4	5.4
Low Technology Manufactures	53.5	70.8	76.1	75	72.8	64.1
(a) LT1: Textile, Garment, and Footwear	50.7	67.7	72.5	70.8	68.6	54.3
(b) LT2: Other Products	2.9	3	3.7	4.2	4.2	9.8
Medium Technology Manufactures	8.7	7.2	8.4	8.9	7	8.5
(a) MT 1: Automotive	0.1	0	0	0.1	0.2	0.2
(b) MT 2: Process	5.2	5.2	6.6	6.8	4.7	6.1
(c) MT3: Engineering	3.4	1.9	1.8	2.1	2.1	2.3
High Technology Manufactures	0.3	0.7	0.5	0.8	1.2	1.2
(a) HT 1: Electronic and Electrical	0.2	0.2	0	0.2	0.6	0.4
(b) HT 2: Other	0.1	0.5	0.5	0.6	0.7	0.7

Source: Author's calculation from UN Comtrade Database based on methodology of Lal and Weiss (2003)

Structural transformation of production processes towards highly sophisticated manufacturing activities is a complex and time consuming process requiring decades of effort put towards the necessary capacity accumulation. Although Pakistan's economic experts and scholars have recognized and acknowledged the importance of enhancing the technological expertise within the country, which is evident by the establishment of the National Scientific Commission of Pakistan in 1960 followed by approval of the first 'National Science and Technology Policy' in 1984, the 'National Technology Policy and Technology Development Plan' in 1993, and most recently the 'National Science,

[5] The MFA was initiated in 1974 and expired on January 1, 2005. Through the MFA, quantitative restrictions in the form of quotas were imposed on the developing countries, including Pakistan, for the export of textile and clothing to the developed countries.

Technology and Innovation Policy, 2012',these efforts seem in vain, as the economy has failed to catch-up with most other developing countries in technology adoption. This is evidenced by the fact that high technological manufacturing exports accounted for only 1.2 percent of total exports in 2012. Lal and Weiss (2003) also noted that "despite this awareness, and despite ambitious plans for improvement, Pakistan continues to lag badly in this field. There is little sign of dynamism in the technology scene; if anything, there seems to be deterioration over time".

Table 3 shows the total expenditures incurred by the LSM sector of Pakistan for copyrights and royalty payments. Motor vehicle and transport equipment, which is considered a medium technology good, spent about 16 percent of the total non-industrial costs on these payments. Most of the low technology manufacturing industries like tobacco, textile, leather, paper products, etc., spent a negligible proportion of their costs on such activities. It is astonishing that the firms manufacturing electrical goods, which are considered a high technology industry, spent only 1 percent on such payments.

Table 3: Share of Copyrights and Royalties in Total Non-Industrial Costs, 2005-06

PISC 2007	Industry	Share of Royalties
15	Food Products & Beverages	4.3
16	Tobacco Products	0
17	Manufacture of Textiles	0.5
18	Wearing Apparel	0.3
19	Leather Products	0.2
20	Wood & Wood Product	2.6
21	Paper & Paper Products	0.1
22	Publishing, Printing & Reproduction	0.7
23	Petroleum	0.4
24	Chemical & Chemical Products	1.5
25	Rubber & Plastics Products	5
26	Other Non Metallic Mineral Products	6.8
27	Basic Metals	0.8
28	Fabricated Metal Products	0.4
29	Machinery & equipment	5.5
31+32	Electrical Machinery & Apparatus & Radio, TV, & Communication Equipment	1
33	Medical &Optical Instruments	0.3
34+35	Motor Vehicles, Trailers, & Other Transport Equipment	16
36	Furniture	0.7

Source: Author's calculation from CMI 2004-05

One reason for the poor performance of the LSM sector in terms of intellectual property is that little effort was made by the government to improve the human capital and social structure of the country. Although a number of policies, commissions, and programs were initiated by the government[6] right after independence, it failed to improve the country's rank in terms of literacy and skill level in the region[7], as discussed before. For this reason, all of the sectors of Pakistan's economy, and the manufacturing sector in particular, faced serious consequences. The proponents of endogenous growth theory explain that the marginal productivity of capital can be increased only by accumulating skilled human resources and by investing resources towards research and development. The theory explains that an increase in physical capital stock, with a fixed stock of human capital and little R&D effort, leads the sector to experience diminishing marginal productivity of capital.

[6] For details see Easterly (2001).

[7] According to the Ministry of Finance's (2014) economic survey the current literacy rate of Pakistan is only 60 percent, which is lower than India, Sri Lanka, Nepal, Maldives, and Bangladesh. According to the World Economic Forum's (2011) Global Competitiveness Report, Pakistan ranked 116th and 137th out of 148 countries in terms of 'quality of primary education' and 'primary education enrolment rate' respectively.

We observed this, not only after liberalization, but also during the phase of strong protectionist policies when Pakistan adopted a cascaded tariff structure, in which, the tariff rates were always found lower for the import of capital goods. Although this policy helped the manufacturing sector move up the ladder from producing low technology goods to medium technology goods by the mid-1960s, the process of upgrading technology halted due to a lack of skilled labor in the country. In addition, Pakistan made little effort to retain skilled and educated workers within the country, especially during the 1970s. The relaxed immigration policies of European and Gulf countries for developing country citizens left the manufacturing sector of Pakistan further short of skilled labor. Although the increased remittances from abroad[8] as a result of this policy helped the country recover from the foreign exchange deficit problem, the manufacturing sector, which is considered as one of the main pillars of attaining sustained growth, was weakened.

REVIEW OF SELECTED LITERATURE

Realizing the importance of TFP growth, many researchers began attempting to quantify the sources of growth for different economies. Thus, in the mid-twentieth century, methodologies for productivity analysis were developed and have subsequently been modified and updated. A brief and selected review of the existing literature on computing of sources of growth and productivity is undertaken below.

International Review

According to Christensen, Cummings, and Jorgensen (1980) and Jorgenson (1988), Jan Tinbergen was the first to empirically measure TFP in 1942. The notion and empirics of TFP was furthered by John Kendrick, Moses Abramovitz, and Robert Solow in the 1950s. Solow (1957) employed the neo-classical production function for estimating the share of conventional inputs (labour and capital) and TFP in the growth of output for the US for the period 1909 to 1949. He considered the impact of all tangible, as well as intangible, factor inputs other than labour and capital as TFP (termed as technical change). He attributed an 87.5 percent change in output to the residual (or TFP), while only 12.5 percent to capital and labour inputs. However, the substantial magnitude of the residual was challenged by Abramovitz (1956) who called it a "measure of our ignorance".

Since then, efforts have been made in narrowing down the residual to thus minimize the ignorance in computing the sources of growth. One such significant effort was by Edward F. Denison in 1962, which was later improved and updated in 1974. Denison (1974) estimated the sources of growth for the US for the period 1929 to 1969. In his work he disaggregated the labour input into various components such as education, employment, hours of work, participated age-sex composition, etc. Similarly, capital input was also disaggregated into various components, such as inventories, dwellings, international assets, nonresidential structures, and equipment to eliminate the effect of these factors from the residual. By eliminating the effect of various components other than advances in knowledge, the residual was reduced to 31.1 percent. He found education as a significant component of labour input, contributing 14.1 percent out oflabour's42.8 percent share of growth. Capital input contributed 15.8 percent.

Along with Denison, Jorgensen and Griliches (1967) and Christensen and Jorgenson (1973) published on the subject. This work was elaborated on by Gallop and Jorgenson (1980) and Christensen, Cumming, and Jorgensen (1980), not only by adjusting the labor input as Denison did, but by amending the output and capital inputs as well, thus trying to correct further for errors associated with the measurement of TFP. Gallop and Jorgenson (1980) investigated productivity growth of 51 industries in the US for the period 1947 to 1973. They disaggregated the labour input for each year into eight age groups, both sexes, five educational levels, ten occupational groups, and classes of work. Capital inputs were disaggregated for each year into six asset types and three legal organizational forms. Although the results are difficult to compare with that of Denison's study because of dissimilar factor input groups and dissimilar methodologies[9], this study showed a considerably larger share of factor input and a smaller share of residual than Denison.

Christensen, Cumming, and Jorgensen (1980) provided an international comparison for the US and its eight major trading partners for the period 1947 to 1973. Employing a similar methodology as above, they decomposed the labour input only by educational attainment, as compared to the extensive decomposition of Gallop and Jorgenson (1980). Although not disaggregated by industry, the procedure of dealing with capital input is similar in both studies. This study found that during 1960 to 1973 variation in economic growth was associated with the variation in the

[8] According to Felipe, Mc. Combie, and Naqvi (2009), workers' remittances from abroad had increased substantially from a mere $136 million in 1973 to $1.7 billion in 1980.

[9] They employed the Translog production function and Tornquist's discrete version of index numbers.

growth of factor inputs. Kendrick (1976) went one step further in minimizing the "measure of ignorance" by estimating the total capital stock for the period 1929 to 1969. He assessed the contribution of overall capital and the final residual to economic growth in the US by including all manner of tangible, as well as intangible, capital stock (such as R&D, education, health, safety, and mobility)to eliminate the effects of these factors from the residual and to improve the efficiency in the measurement of factor inputs. The magnitude of the residual was however similar to Denison's study.

Looking at more contemporary studies, Kim and Lau (1994) and Young (1994) attained significance by analyzing the effects of TFP contribution to the growth of East Asian economies. They argued that TFP played only a minimal role in the development, whereas, high capital investment and high labor force participation were major drivers of growth and development in these countries. Kim and Lau (1994) employed an aggregate meta-production function framework for four newly industrialized East Asian economies and five previously industrialized countries. They found capital accumulation as the most important source of economic growth, accounting for between 48 to 72 percent of the growth in the four newly industrialized countries. In contrast, for the five previously industrialized countries, technological progress was found to be the main source of economic growth, accounting for between 46 to 71 percent of growth. However, these studies were criticized by Felipe (1999), Nelson and Pack (1999), Liang (2002), and Hsieh (2002) among others. For instance, Liang (2009) criticized the Kim and Lau study for ignoring the heterogeneous characteristics of factor inputs. Similarly, Harberger (1996) was skeptical of the use of the regression technique by Kim and Lau for various reasons. Of those, he explained the most important one as:

> "To the degree that technical advances, RCR, TFP improvement, and so forth, really exist and are important, they imply that production functions themselves, at micro- and macro-levels, are undergoing important shifts. Why should we expect these shifts to be so nicely regular that the production function at the end of our period is in some sense or other the same as the production function in the beginning?"

To account for the heterogeneous properties of factor inputs, Harberger (1996) compared the growth performance of selected East Asian economies and Latin American economies through a TDM approach (described further below). Like Jorgenson's methodology, TDM provides a highly disaggregated analysis of input contribution to output growth, however, by using VA as the final output, it is less data intensive compared to the one applied by Jorgenson and associates. This approach discerns TFP as a main factor in explaining the differences in GDP performance between two sets of countries.

Harberger (1998) considered TFP growth as a heterogeneous rather than homogenous phenomenon, and he coined the analogy of a mushroom process as compared to yeast process to explain the TFP growth process. According to him "not only were the contributions to RCR highly concentrated in a relatively few industries, these industries also were very different as one shifted from decade span to decade span". Harberger (1998) thus coined an approach called the 'Sunrise-Sunset Diagrams' (also described in detail below) to demonstrate the concentration pattern of TFP among various sectors or subsectors of industry. Employing Roble's (1997) data for 20 industrial branches of the US, he confirmed that the contribution of TFP was concentrated among a few industries that varied across different time periods.

Harberger's TDM and sunrise-sunset diagrams were further applied in a number of contemporary studies for analyzing the growth performance of different economies. Torre (2000) computed growth and concentration of TFP for 44 industrial branches of Mexican manufacturing industries based on annual data for the period 1984 to 1994. He compared his results for TFP growth with other studies applying various parametric and non-parametric approaches and found the results computed by TDM to be reliable. After investigating various issues such as measurement of labour input, use of different price deflators, and aggregation concerns, he concluded that TFP growth in the Mexican manufacturing industries was not dynamic.

Robles (2000) also employed the TDM for five Central American Countries, namely, Costa Rica, Nicaragua, Honduras, El Salvador and Guatemala. Like Harberger, he also found highly correlated results between TFP and VA growth. This study also confirms Torre's findings that TDM was a reliable method, and showed that TFP was concentrated among only a few branches of industries. Miyajima (2004) investigated the process of growth at the industry level for the Japanese economy by employing a similar methodology. He found that productivity growth is higher for tradeable sectors than those of non-tradeable sectors. Alvan and Gosh (2010) analyzed the factors affecting the VA growth for 29 Turkish private and public manufacturing industries by applying the same methodology for the period 1980 to 2001 and found a more significant contribution of raw labor than skilled labor to VA growth. She showed that

TFP was concentrated among only a few industrial sectors. Her results also indicate that the distribution of TFP growth varies across sectors and time periods.

Literature on Pakistan

Continuing from the above cited literature, there is a limited but valuable literature on estimating the sources of growth in Pakistan. An early study, Cheema (1978), computed productivity indices separately for VA and output statistics through a simple methodology of output to input ratio for sixteen LSM industries of Pakistan for the period 1959-60 to 1969-70. He further distributed the productivity gains amongst labor and capital inputs. He found that, although most of the industries showed significant growth in their productivity levels, the major share of the productivity gains were accrued to capital in more than half of the industries.

Extensive work has been done by Dr. Nawab Haider Naqvi in modeling and analyzing various economic sectors of Pakistan, including the manufacturing sector. Naqvi et al. (1983) developed simultaneous equation models for Pakistan's economy for the period of 1959-60 to 1978-79. Under the production-expenditure sub-model, a Cobb-Douglas production function and input demand functions were estimated for Pakistan's LSM sector. They found constant returns to scale and a very high degree of capital intensity in the LSM sector, whereas technological change was found to influence growth positively at the rate of 4.8 percent annually.

Widespread work on the issue of productivity measurement and analysis for Pakistan's manufacturing industries was carried out by Dr. Shahida Wizarat. Of these, the most important in the context of the present study is Wizarat (1989), in which sources of growth for Pakistan's LSM sector were identified for the period 1955-56 to 1980-81 at the aggregate level. Unlike the above two studies, she discussed in detail various parametric and non-parametric approaches to productivity measurement and considered the Cobb-Douglas production function as the most appropriate functional form for the analysis. The findings of this paper confirmed the findings of the above mentioned studies and discerned capital accumulation as the main source of output growth. She concluded that capital contributed the highest share at 54 percent, labor contributed about 18 percent, and technology 29 percent. She also revealed that economies of scale exhibited only a negligible share in the overall growth of the sector.

Relating to the methodological issues, it could be argued here that, at the disaggregated level, the functional form for the production function could not only vary across various subsectors but could also vary within the same subsector across different time periods. Thus, there is a need for cautious investigation while applying certain methodologies at the disaggregated level. However, it was noticed that most of the research in Pakistan was undertaken at the aggregated level by employing various functional forms without determining its appropriateness at the industry level. For instance, Ali and Hamid (1996) estimated the impact of technological change and efficiency for both the agricultural and manufacturing sectors of Pakistan for the period 1973 to 1995. They employed a Cobb-Douglas and translog production function without specifying the aptness of these functional forms. They found that, for both sectors, capital input contributed more than 50 percent to the share of growth, whereas labour contributed about 20 percent share for agricultural sector growth and about 10 percent for the manufacturing sector's growth. The share of technological change was about 36 percent of output growth and 30 percent of VA growth for the manufacturing sector.

Mahmood and Siddiqui (2000) computed TFP and its important determinants for the LSM sector of Pakistan at the aggregate level. They employed the growth accounting framework established by Solow (1957).Analyzing the period from 1972 to 1997, the authors concluded that the slowdown of economic growth in the late 1980s and 1990s was associated with the sluggish growth of the manufacturing sector's TFP, and that almost 30 percent of the changes in productivity growth were explained by knowledge capital and 18 percent by human capital. Although two of the previously mentioned studies, Ali and Hamid (1996) and Mahmood and Siddiqui (2000), employed different methodological frameworks for the computation of TFP, they recommended similar policy directions for the improvement of TFP. These studies emphasized the crucial need of enhancing the technological capacity of the LSM sector.

Another valuable study was carried out by Hamid and Pichler (2009) on determining the sources of VA growth for the aggregate manufacturing sector by using a translog production function for the period 1971-72 to 2004-05. Results indicated that traditional factors of production (labor and capital) are the major factors of VA growth, contributing about 65 percent of overall growth, compared to a share of about 15 percent for human capital and 20 percent for TFP.

SOURCES OF GROWTH MODELS

Two Deflator Growth Accounting Approach

As shown in the previous section, various methodologies have been developed dealing with the issue of TFP measurement. Of these, the non-parametric approach developed by Harberger (1990), recognized as the TDM, is considered a robust, simplified method of estimating TFP growth[10]. Harberger (1998) compared the results of the TDM with Jorgenson's methodology for US manufacturing industries for the period 1948-1979 and found highly correlated results. This methodology is employed by various contemporary authors for studying the sources of growth for various economies. In this method, VA is used as the final output. TDM has several benefits in the case of studying Pakistan's LSM sector compared to other parametric and non-parametric approaches. The major advantage of this method is that it is less data intensive compared to the method applied by Jorgenson and associates, hence is useful for countries like Pakistan where there are scarce data resources.

Like most modern growth analysis, the TDM starts with the following simple equation:

$$TFP_{i,t}=\frac{\Delta Y_{i,t}}{Y_{i,t-1}} - \frac{w_{i,t-1}\Delta L_{i,t}}{Y_{i,t-1}} - \frac{(\rho_{i,t-1}+\delta_i)\Delta K_{i,t}}{Y_{i,t-1}}; \text{ or}$$

$$TFP_{i,t}=\frac{\Delta Y_{i,t}}{Y_{i,t-1}} - [(\frac{w_{i,t-1}L_{i,t-1}}{Y_{i,t-1}})\frac{\Delta L_{i,t}}{L_{i,t-1}}+(\frac{(\rho_{i,t-1}+\delta_i)K_{i,t-1}}{Y_{i,t-1}})\frac{\Delta K_{i,t}}{K_{i,t-1}}] \quad (1)$$

Where, ΔY= Change in output (VA)

W=Wages

ΔL=Change in labor (labour days)

ρ=Rate of return to capital

δ= Rate of depreciation to capital

ΔK= Change in capital stock

This study deals with the estimation of TFP at sub-sectoral level, thus the subscript "*i*" represents 16 of the 19 subsectors defined in Appendix A, whereas, subscript "t" refers to time periods. Equation 1 shows that the growth rate of TFP is equal to the growth rate of output ($\frac{\Delta Y_{i,t}}{Y_{i,t-1}}$) less the sum of an explained portion, i-e, share of labor ($\frac{w_{i,t-1}L_{i,t-1}}{Y_{i,t-1}}$) times rate of growth of labor ($\frac{\Delta L_{i,t}}{L_{i,t-1}}$) plus share of capital ($\frac{(\rho_{i,t-1}+\delta_i)K_{i,t-1}}{Y_{i,t-1}}$) time rate of growth of capital stock ($\frac{\Delta K_{i,t}}{K_{i,t-1}}$).

The key distinguishing feature of the TDM, as summarized from Harberger (1996), is that the two deflator approach is characterized (1) by the use of single numeraire cum deflator (usually the GDP deflator or the consumer price indexes) to deflate all nominal flows that enter into an exercise in growth analysis, and (2) the use of a "standard worker" as the basic unit in which labour is measured and the measurement of any worker's labour quantum by his total earnings divided by w*, the (real) wage of the standard worker.

Hence, the main feature of the TDM is the use of two types of deflators. The first is the GDP Deflator, used to deflate nominal values of VA and capital stock, and the second is the wage deflator (w*) employed as a labor deflator. In this study, labor is further disaggregated into (1) skilled and (2) unskilled labor, thus to evaluate the contribution of skilled and unskilled labour in the growth of VA.

[10] The robustness of the TDM is well documented and proven in the literature. For instance, see Harberger (1998), Robles (1997), Guillermo and Tanka (2007) among others.

FIRST DEFLATOR

While other growth accounting methods used factor or product specific deflators, the TDM employs a single numeraire (GDP deflator) to deflate all nominal values of capital and output. This common numeraire not only helps in aggregating across the entire economy but also allows for a formulation of the rate of return to capital (Robles, 1997; Alvan 2006).

By definition the gross rate of return to capital $(\rho + \delta)$ can be estimated by subtracting from real output the total payments (in real term) to inputs other than capital, and dividing this result by the capital stock in real terms.

$$(\rho_{i,t}^{*}+\delta_{i,k}) = \frac{Y_{i,t}^{*}-\mathrm{w_{i,t}L_{i,t}}}{K_{i,t}^{*}} \quad (2)$$

where, $Y_{i,t}^{*}$ is real VA of industry *i* at time *t*, $\mathrm{w_{i,t}L_{i,t}}$is the real payment to labor input in industry *i* at time *t*, $K_{i,t}^{*}$ is the real capital stock of industry *i* at time *t*, and $\delta_{i,k}$ is rate of depreciation to capital in industry *i* at time *t.*

SECOND DEFLATOR

Equation 1 shows that, in the disaggregated form, labor's contribution to growth will be $\frac{\sum_j w_{i,j,t}\Delta L_{i,j,t}}{Y_{i,t}}$ where $w_{i,j,t}$ is the wage of labour category j in subsector i at time t, and $\Delta L_{i,j,t}$ represents the change in working days by category j in subsector i at time t. If the real wage bill of any subsector *i* in time *t* is$\sum_j w_{i,j,t}\, L_{i,j,t}$, then by dividing this by real annual wages of a standard workerw_t^{*} we obtain

$$L_{i,t}^{*} = \sum_j L_{i,j,t}\left(\frac{w_{i,j,t}}{w_t^{*}}\right) \quad (3)$$

In Equation 3,$L_{i,j,t}$ are the days worked by labour of any specific skill or occupation j in any particular sub-sector i and $\left(\frac{w_{i,j,t}}{w_t^{*}}\right)$ computes their contribution per man-day in terms of standard labour $(L_{i,t}^{*})$. Thus,$L_{i,t}^{*}$ is measured as a number of basic labor units in terms of human capital skills, for instance, the managing director in an IT firm might be characterized as 15 basic units, while a computer engineer as 10, a computer operator as six, a peon as two, and a sweeper as one third. w_t^{*} represents the wage of unskilled workers and is used as a common numeraire to deflate the wage bills of all subsectors. Thus, as explained by Harberger (1996),"when we divide wage bill by w* we are counting each individual worker on the basis of his or her wage, as contributing the number of labour units represented by that particular $\left(\frac{w_{i,j,t}}{w_t^{*}}\right)$".

In the present study, the contribution of skilled and unskilled labour in total VA for each subsector is calculated separately. Thus, with a little mathematical manipulation, we can rewrite equation 3 by separating the total wage bill of industry *i* into two separate remuneration packages for unskilled labor $(w_t^{*}L_{i,t})$ and skilled human resource$(w_t^{*}L_{i,t}^{*}$ - $w_t^{*}L_{i,t})$.

$$\sum_j w_{i,j,t}\, L_{i,j,t} = w_t^{*}L_{i,t} + (w_t^{*}L_{i,t}^{*} - w_t^{*}L_{i,t}) \quad (4)$$

Equation 4 reveals that any change in the total wage bill of industry *i* would imply changes either in the standard labor unit or in the skill level of the workers.

CHOICE OF SECOND DEFLATOR

In the TDM, $w_t^{*}$is the standard wage and represents the remuneration package of the relatively unskilled worker. However, the choice of w_t^{*} may vary from one country to another depending on the economic conditions of that country. In most studies, two thirds of real per capita GDP is taken as the wage deflator. Other studies have taken the wage rate of textile workers as the wage deflator (Alvan, 2008). The rationale behind considering the textile worker's wage as a wage deflator is that they are of relatively low skill and are of a skill level that is comparable across countries. Harberger (1996) insinuated in his study that the median of a substantial band of industries, all of which are like textile in typically employing low skilled labor, could also be taken as w_t^{*}. Hence, following Harberger's study, and keeping in view the industrial and wage structure of Pakistan, this study calculates standard wage from the wage bill of production (blue collar) workers[11]. The rationale behind considering the blue collar worker's wage as standard is that they are assumed to earn less compared to professional and other white collar office workers in Pakistan. w_{it}^* is obtained by dividing the wage bill of blue collar workers in subsector i at time t by the total number of blue collar worker in that particular subsector and time. w_t^* is then calculated as an average of w_{it}^* for time t of all the subsectors under study, mathematically:

$$w_{it}^* = \frac{bcw_{it}}{bcn_{it}}$$

$$w_t^* = \widetilde{w_{it}^*}$$

Where, bcw_{it} is the wage bill of blue collar worker in subsector i at time t. bcn_{it} is the total number of blue collar workers in subsector i at time t. $\widetilde{w_{it}^*}$ is the average of blue collar worker's wage rate in all subsectors of industries under study at time t.

TFP GROWTH RATE

Using the TDM, TFP as a percentage of output at a disaggregated level can be calculated as follows:

$$TFP_{i,t}^* = \frac{\Delta Y_{i,t}^*}{Y_{i,t-1}^*} - \frac{(\rho_{i,t-1}^* + \delta_{i,k})\Delta K_{i,t}^*}{Y_{i,t-1}^*} - \frac{w_{t-1}^*\Delta L_{i,t}}{Y_{i,t-1}^*} - \frac{(w_{t-1}^*\Delta L_{i,t}^* - w_{t-1}^*\Delta L_{i,t})}{Y_{i,t-1}^*} \quad (5)$$

where equation 5 can be interpreted as the growth rate of TFP for industry i in time t ($TFP_{i,t}^*$) is equal to the growth rate of real output for industry i in period t ($\Delta Y_{i,t}^*/Y_{i,t-1}^*$) less the contribution of capital to the growth rate of industry i in period t [$(\rho_{i,t-1}^* + \delta_{i,k})\Delta K_{i,t}^*/Y_{i,t-1}^*$], the contribution of raw labor to the growth rate of industry i in period t [$(w_{t-1}^*\Delta L_{i,t})/Y_{i,t-1}^*$], and the contribution of skilled labor to the growth rate of industry i in period t [$(w_{t-1}^*\Delta L_{i,t}^* - w_{t-1}^*\Delta L_{i,t})/Y_{i,t-1}^*$].

We can also calculate the aggregate TFP growth for the manufacturing sector consisting of N industrial subsectors by the following formula:

$$TFP_t^* = \sum_{i=1}^{N}\left[\left(\frac{Y_{i,t}^*}{Y_t^*}\right) TFP_{i,t}^*\right] \quad (6)$$

Where TFP_t^* is the aggregate TFP growth rate for the manufacturing sector. However, it can be aggregated to any desired level (the entire economy or for any particular economic sector) depending upon the scope of study.

Sunrise Sunset Productivity Approach

As noted previously, Harberger (1998) described an approach to TFP analysis called 'Sunrise-Sunset Diagrams' to demonstrate the concentration pattern of TFP among various subsectors of industry. These are Lorenz like curves in which the upward slope of the curve is constructed by finding the cumulative contribution of subsectors experiencing RCR, while the downward slope of the curve is constructed by the cumulative contribution of subsectors experiencing real cost augmentation. The diagrams are called 'sunrise productivity diagrams' if the aggregate TFP growth is positive or called 'sunset productivity diagram' if the aggregate TFP growth is negative. These diagrams visually represent, not only the fraction of subsectors accounting for RCR in any particular period of time, but also the percentage of winning and losing subsectors in terms of efficiency as well. They are also helpful in depicting the persistency of any particular subsector as leader from one period to another.

The construction of the sunrise-sunset diagram is described below:

1. Industrial subsectors are arranged in descending order with respect to the TFP growth rates and their corresponding VA for all time periods.

[11]The 2005-06 CMI defined blue collar workers as the production workers engaged in manufacturing, assembling, packing, repairing, maintenance etc.

2. The rupee value of real cost reduction/increase for each subsector is calculated by multiplying each subsector's TFP growth with their corresponding VA.
3. After obtaining the cumulative sum of RCR and cumulative sum of VA, their percentages are calculated to find the aggregate TFP growth rate, as given by equation 6, of an economy consisting of N industrial sectors.
4. Sunrise-sunset productivity diagrams are then created by plotting the percentage value of cumulative TFP contribution to growth on vertical axis and percentage value of cumulative VA on horizontal axis.

DATA LIMITATIONS

In this study we employ secondary data to compute TFP growth for Pakistan's LSM sector. The major sources of data are the Pakistan Bureau of Statistics' (2009) Census of Manufacturing Industries (CMI) and the Ministry of Finance's (2014) Economic Survey. Pakistan, like most of other developing countries, lacks reliable and high quality data on various sectors and issues. For instance, the CMI was conducted almost every year up until 1990-91. From then only three censuses were conducted, each with a five year gap. Although the questionnaire of CMI 2010-11 is available, the data has not been compiled and published yet. Since the latest CMI available is for the year 2005-06, our empirical findings are limited to the same year.

Besides the issue of unavailability of data, non-response is another major issue that exists in almost all of the economic data in Pakistan. According to Pakistan Bureau of Statistics (2009) "the problem of CMI, as well as with other economic statistics in Pakistan, is unit no-response and also item no response". Response rates for the registered firms were found to be about 67 percent for 2005-06, 64 percent for 2000-01, and around 70 to 80 percent for previous years. Detailed statistics on the response rate are given in Appendix B. Moreover, the under-registration of the existing firms is also a matter of concern. Given these issues, the CMI is still the only census available for Pakistan's LSM sector. Various studies endeavored to adjust the data for non-response factors. Kemal (1978) dealt with the issue by generating an independent series of physical capital stock over time by assuming that 70 percent of the sanctioned investment is in fact executed. He then prepared the separate estimates of output, employment, wage, industrial cost, etc. with the capital-output, capital-employment, capital-wage, and capital-industrial cost ratios. However, the assumption of 70 percent of sanctioned investment was criticized by various authors[12]. It was argued that the investment in various subsectors would not only be different but also vary over time. According to Khan (1989) the estimates by Kemal were overly dependent on the capital stock series.

In contrast, Wizarat (1989) and Sayeed (1995) argued that the non-response factor in the CMI data would be a matter of concern only if systematic distribution could be detected across sectors. They tested out this assertion by plotting the indices of output, labor, and capital stock series at the disaggregate level. Since the movement in the three indices did not concur with each other over any particular period of time, they did not consider under-reporting to effect productivity growth estimates.

Although various other studies acknowledge this limitation of the CMI data, they did not endeavor to adjust the values for non-response[13]. Thus some results are suggested to underestimate the actual values of TFP growth. This study opts for the technique described in the CMI 2005-06 for adjusting the values for the non-response factor. In CMI 2005-06, contribution to GDP for non-responding firms was estimated by calculating the weights on the basis of reporting establishments. These weights were then applied to the defaulting firms to estimate the contribution of such establishments in GDP[14]. As a similar technique is employed, it is acknowledged that the values for defaulting firms are dependent on the values of responding firms, with the percentage of non-responding firms in the range of 30 percent in most time periods.

Various important issues are also neglected in the census. For instance, information on trading activities of firms, research and development activities, technological innovation, technical expertise, etc. are not included in the CMI. This information is believed to be fundamental for estimating the components of TFP growth. Lack of such information limits our study from decomposing TFP into its primary components. As well, firm level computerized data is available only for the year 2005-06, and for the rest of the years it is available only up to the five digit level PSIC 2007. Explanation of each subsector and their codes are presented in Appendix A.

[12] For instance, Khan (1989)

[13] For instance, Majeed (2010).

[14] For details, see Pakistan Bureau of Statistics (2009).

Data for estimation is collected from various publications issued by the Government of Pakistan. For instance, statistics on VA, labour (working days), wage bill, capital, and depreciation rate are collected from various issues of the CMI. Data on GDP deflator is gathered from various issues of Economic Survey. Definition of each variable is presented in Appendix C.

EMPIRICAL FINDINGS

In this section, evidence from the application of the TDM and Sunrise Sunset Productivity Diagrams are reported and analyzed.

Sources of Value Added Growth

Table 4 presents the sources of growth for each five years period under study, which are obtained by employing equation 5.

Table 4: Sources of Value Added Growth for Pakistan's LSM Sector

	1971-76	1976-81	1981-86	1986-91	1991-96	1996-01	2001-06
Value Added (VA) Growth	0.21	0.49	0.6	0.33	0.14	0.16	1.12
Contribution of TFP	0.02	0.21	0.06	0.09	0.095	-0.39	0.4
Contribution of Capital	0.12	0.32	0.496	0.19	0.09	0.48	0.63
Contribution of Labour	0.068	-0.044	0.043	0.053	-0.049	0.06	0.08
i. Raw Labour	0.099	-0.059	0.045	0.045	-0.025	0.11	0.07
ii. Skilled Labour	-0.032	0.015	-0.003	0.007	-0.024	-0.05	0.01

Source: Authors calculation; Note: 1.00 is 100%

The above table reveals that, on aggregate, the LSM sector of Pakistan experienced positive TFP growth for all five year periods except for the period 1996-01. Not only was TFP growth negative during this period, but VA growth was also its lowest. One possible explanation for this negative growth is that the 1990s was the most destabilized period economically and politically in Pakistan's history[15].

Table 4 reveals that physical capital remains the main contributor to VA growth throughout the whole period under study. The contribution of labor is not only found to be low, but also contributed negatively during 1976-81 and 1991-96. These results are similar to those of earlier studies. The contribution of skilled labor is found to be the lowest in almost all periods. As discussed previously, Pakistan has done a poor job of improving the human capital in the country. This has had ramifications for the contribution of labor to VA growth.

The interlude of 2001-06 is shown to be the fastest period of growth. During this period the growth rate of TFP not only reached its highest level, but the contribution of capital peaked, and Pakistan's manufacturing sector experienced relatively improved contributions from labor. The labor contribution increased from -4.9 percent during 1991-96, to 8 percent in 2001-06. The growth experienced during this period complements the above explanation as well. This point is considered interesting for the reason that TFP is found by subtracting capital's and labor's contribution from VA growth. This may lead one to think that higher levels of productivity in capital and labor would drive down TFP contribution to VA growth. But in reality it should not. Harberger (1998) considered periods of higher TFP and labour and capital contributions to VA growth as "a genuine syndrome in which all sort of good things go together".

TFP Growth

Table 5 provides the estimates of TFP growth for 16 LSM subsectors.[16] It reveals that during each five year period some manufacturing subsectors experienced positive TFP growth while others experienced negative TFP growth. Harberger considered all the industries exhibiting positive TFP growth as winners, having achieved RCR in the manufacturing processes. Industries showing negative TFP growth rates are considered losers, as they experienced real cost augmentation. Almost all the subsectors were found losers during the second half of the 1990s, exhibiting

[15]The period 1988 to 1999 was ruled by nine different civilian governments.

[16] Three subsectors are omitted from the analysis: 20, manufacture of wood; 23, petroleum refining; and 27, iron, steel and non-ferrous metal basic industries. These were omitted due to lack of reliable data. They represent less than 10 percent of total VA growth.

negative TFP growth, except for five major subsectors, i-e, textile, leather products, paper products, fabricated metal products, and furniture.

A notable point in Table 5 is that none of the subsectors showed consistent pattern of TFP growth over the entire period under this study, or in other words, little evidence exists of the persistency of any particular subsector in achieving the highest TFP growth rate from period to period. For example, in 1971-76, the top three subsectors in TFP growth were apparel, motor vehicle, and medical instruments. During 1981-86, these were publishing & printing, chemical & chemical products, and motor vehicle. During 1991-96, the top three winners were electrical machinery, motor vehicle, and furniture, and during the latest period they were leather products, furniture, and fabricated metal products. Only the motor vehicle industry appeared three times during these four periods. The results seem very natural when analyzing at a more disaggregated level. The tendency of firms of a particular subsector in responding to shifting economic challenges and technological innovations is not only different from one subsector to another, but could also vary across different periods of time, thus creating a heterogeneous mix within the industry. The applied sunrise–sunset diagrams shown next presents a further analysis of estimated TFP growth.

Table 5: TFP Growth Rates of Pakistan's LSM Subsectors (percentage)

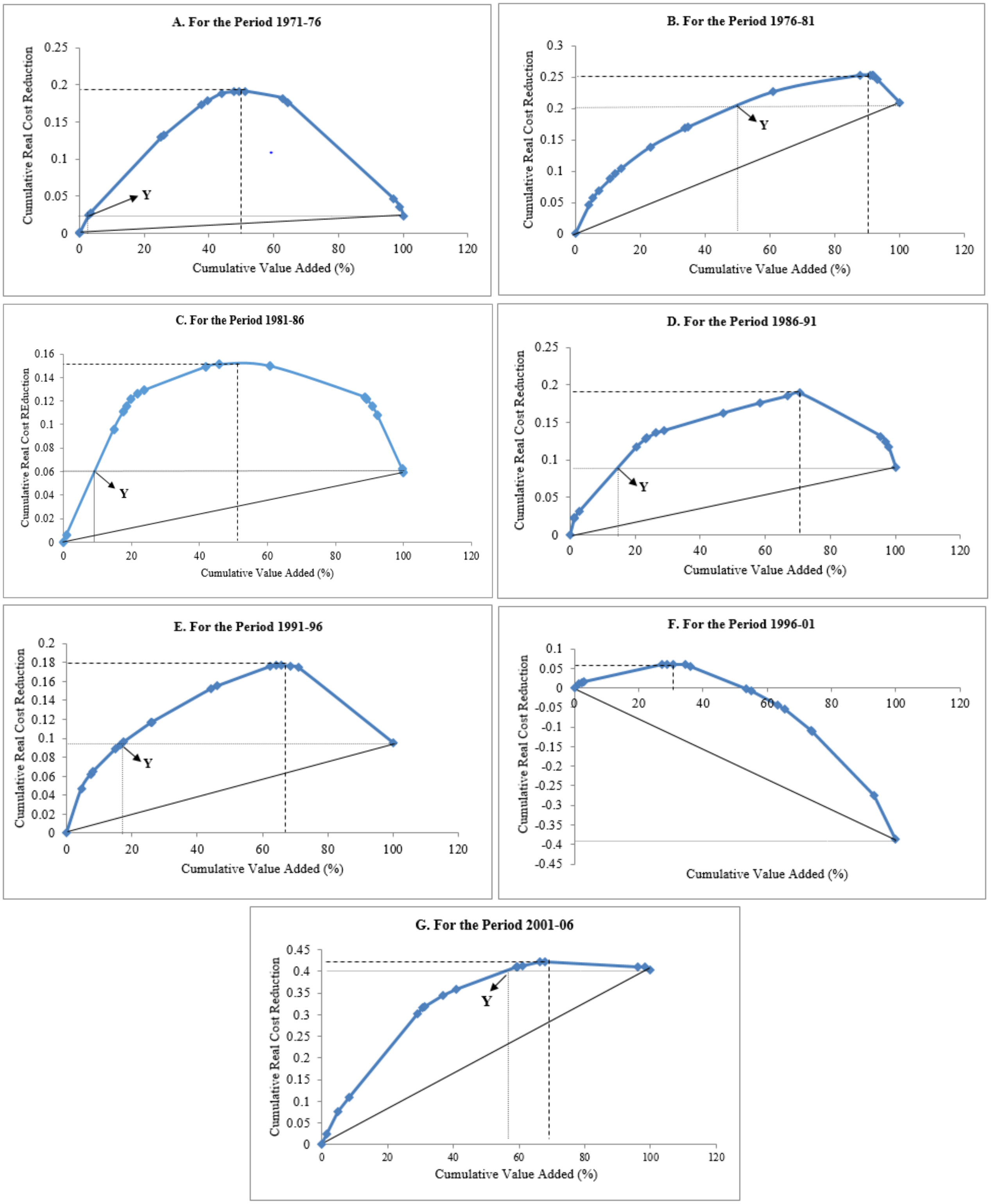
PSIC 2007	Industry	1971-1976	1976-1981	1981-1986	1986-1991	1991-1996	1996-2001	2001-2006
15	Food Products & Beverages	0.46	0.1	-0.09	-0.23	0.19	-0.85	0.93
16	Tobacco products	0.36	0.38	-0.01	0.12	0.35	-1.65	0.14
17	Manufacture of Textiles	-0.4	0.21	0.11	0.49	-0.27	0.18	-0.04
18	Wearing apparel	1.08	-0.1	0.5	-0.59	0.3	-0.24	1.04
19	Leather products	-0.37	0.91	0.14	-1.26	0.15	0.76	-0.05
21	Paper & paper Products	0.26	0.63	-0.36	0.58	0.04	0.1	0.82
22	Publishing, printing & reproduction	0.02	-0.45	0.74	1.73	-0.07	-0.58	0.23
24	Chemical & chemical products	-0.08	0.28	0.64	0.13	0.13	-0.33	0.27
25	Rubber & Plastics products	0.04	0.51	-0.53	0.13	-0.01	-0.42	0.2
26	Other non metallic mineral products	0.23	1.08	-0.63	0.11	0.25	-0.43	0.45
28	Fabricated metal products	-0.55	0.49	0.47	-0.65	0.27	0.27	0.1
29	Machinery & equipment	-1.19	0.01	0.25	0.24	-0.02	-0.02	1.78
31+32	Electrical machinery & apparatus & Radio, TV & communication Equipment	0.06	0.52	0.06	0.1	1.04	-0.66	0.39
33	Medical & Optical instruments	0.61	-0.08	-0.81	0.95	0.2	-0.74	0.72
34+35	Motor vehicles, & trailers & other transport equipment	0.84	-0.53	0.53	0.37	0.54	-0.04	1.38
36	Furniture, sports, handicraft etc.	0.36	0.24	-0.32	0.34	0.39	0.37	-0.39

Source: Author's calculation

Concentration of TFP Growth

As described before, the concentration of TFP among various subsectors of industry can be determined by constructing Lorenz like curves, described by Harberger (1998) as Sunrise-Sunset Productivity Diagrams. After performing the necessary calculations for the construction of the diagrams, we can depict the concentration of productivity among various industrial subsectors. Based on the calculations from tables D.1 to D.7 of Appendix D, sunrise-sunset diagrams are constructed for 16 industrial branches over seven successive five year periods. The shape of sunrise-sunset diagrams in Figure 3 is determined by the magnitude and the direction of TFP growth for each subsector, as described above. The rising slope of the curves in these diagrams is due to the cumulative contribution of subsectors experiencing RCR, whereas, the downward sloping part of the curve is because of the subsectors exhibiting real cost augmentation.

Figure 3: Sunrise Sunset Productivity Diagrams of Pakistan's LSM Industries



The dashed lines in each panel of Figure 3 indicates the maximum value of the curve. Panel G shows that during 2001-06, the winning subsectors (as defined by Harberger) contributed about 70 percent of the share in manufacturing VA, whereas the losing subsectors contributed only about 30 percent. Contrary to this, during 1996-01 (panel F), winning subsectors contributed only 30 percent of the share in VA, whereas losing subsectors contributed about 70 percent of VA. For the preceding five year periods starting with 1991-96 and working back, these shares are 64(36), 71(29), 46(54), 91(9),and 52(48)[17].

The above analysis reveals a very significant and interesting fact, that if all the negatively productive subsectors would be excluded from the economy, or if there would be only a zero percent change contributed by the losers, aggregate TFP would increase in every period. In 2001-06 it would increase from 40 percent to 42 percent, from -40 percent to 60 percent in 1996-01, from 9 percent to 18 percent in 1991-96, from 9 percent to 19 in 1986-91, from 6 percent to 15percent in 1981-86, from 20percent to 25 percent in 1976-81, and from 2 percent to 20 percent in 1971-76.

The cardinal point on these diagrams is point 'Y', showing the percentage of the winning subsectors which attained the aggregate TFP growth. During the period 2001-06, the cumulative contribution of RCR of the first 55 percent of the most productive subsectors attained the aggregate TFP growth of the whole LSM sector. This point is found to be even more pronounced during 1991-96 as the contribution of just 17 percent of the subsectors achieved the aggregate RCR of the whole LSM sector. Although another 47 percent of the manufacturing units also exhibit positive TFP growth rate during this period, 36 percent of the negative productive subsectors offset their contribution. For the period 1986-91, the situation was similar, as around the first 17 percent of the most productive subsectors achieved the aggregate TFP growth for the whole sector, and the positive TFP growth of the other 54 percent of winning subsectors was cancelled out by the negative productivity of the final 29 percent. During1981-86, only the first 10 percent, in 1976-81 a little more than 50 percent, and during 1971-76 just 2 percent of subsectors with positive TFP growth achieved the aggregate TFP growth rates of the whole LSM sector. This description shows an interesting point of analysis. Only a small proportion of industries accounted for achieving the aggregate RCR of the whole LSM sector, while the remaining proportion in each period consists of both winners as well as losers, with the losers offsetting the additional contribution to aggregate TFP growth. This shows that negative contributing subsectors played a significant role in reducing performance of TFP during most of the periods.

Contributions of Capital and Labour

Table 6 reveals the contribution of capital for 16 LSM subsectors. It shows that in the period 2001-06 all subsectors, except for food products, leather products, and electrical machinery, exhibited a positive contribution of capital to VA growth. As explained previously, this five year period was the fastest growing period. During this period, not only was VA growth at its highest, but TFP and other sources of growth are also found to be at their highest among the study period. In contrast to 2001-06, 1971-76 period reveals the least contribution of capital to VA growth, in which 50 percent of subsectors (8 out of 16) show a negative contribution. This provides evidence of the negative impact of nationalization policies on Pakistan's LSM sector.

Table 6 identifies that capital contributed positively and significantly in the chemical & chemical products industry in all periods. The medical & optical instrument industry and furniture, sports,& handicraft industry are the only two subsectors identified where capital contribution is found positive in all periods after the end of nationalization policies. During 1991-96 (considered the most destabilized period), various subsectors like tobacco products, apparel, leather products, nonmetallic mineral products, fabricated metal products, and machinery & equipment exhibited a negative contribution of capital.

Overall, capital contributed significantly and positively on the aggregate level throughout the study period, as shown also in Table 4.

[17] Here figures without parenthesis represents the share of those subsectors in VA growth which enjoyed RCR and figures in the parenthesis represents the negatively productive subsectors.

Table 6: Capital Contribution to Value Added Growth

PSIC 2007	Industry	1971-76	1976-81	1981-86	1986-91	1991-96	1996-01	2001-06
15	Food Products & Beverages	-0.03	0.44	0.47	0.19	0.07	1.07	-0.01
16	Tobacco products	-0.42	1.09	0.24	-0.3	-0.25	1.59	0.62
17	Manufacture of Textiles	0.27	-0.05	0.46	0.56	0.27	0.07	0.92
18	Wearing apparel	0.37	3.29	0.31	0.8	-0.01	1.03	0.92
19	Leather products	0.36	0.36	0.57	1.09	-0.11	0.02	-0.05
21	Paper & paper Products	-0.11	-0.22	0.59	0.22	0.14	-0.09	1.72
22	Publishing, printing & reproduction	-0.09	0.53	0.33	-0.08	0.09	-0.15	0.66
24	Chemical & chemical products	0.14	0.63	0.37	0.03	0.1	0.46	0.69
25	Rubber & Plastics products	0.13	0.02	1.84	-0.13	0.02	0.55	0.48
26	Other non metallic mineral products	-0.11	0.46	1.32	0.2	-0.05	0.24	1.47
28	Fabricated metal products	0.65	-0.34	-0.1	0.89	-0.24	0.72	0.22
29	Machinery & equipment	3.22	-0.04	0.81	-0.04	-0.12	0.02	0.13
31+32	Electrical machinery & apparatus & Radio, TV & communication Equipment	-0.04	0.24	0.47	0.44	0.04	0.22	-0.08
33	Medical & Optical instruments	-0.04	0.09	0.57	0.07	0.05	1.5	0.38
34+35	Motor vehicles, & trailers & other transport equipment	0.83	0.14	0.21	-0.1	0.12	0	1.59
36	Furniture, sports, handicraft etc.	-0.16	0	0.55	0.43	0.2	0.27	0.21

Source: Author's calculation

Table 7 shows the contribution of labour to VA growth for 16 LSM subsectors. These contributions are decomposed into the contributions of unskilled and skilled labour Appendix E.

Table 7: Labour Contribution to Value Added Growth

PSIC 2007	Industry	1971-76	1976-81	1981-86	1986-91	1991-96	1996-001	2001-06
15	Food Products & Beverages	0.04	0.01	0.05	0.01	-0.06	0.01	0.06
16	Tobacco products	-0.01	0	-0.01	-0.01	0	-0.01	0.05
17	Manufacture of Textiles	0.11	-0.15	-0.01	0.14	-0.04	0.1	0.16
18	Wearing apparel	0.39	0.52	0.23	0.35	-0.18	0.77	0.11
19	Leather products	-0.03	0.16	-0.06	0.21	-0.11	0.16	-0.01
21	Paper & paper Products	0.08	-0.02	-0.02	0	-0.03	0.06	0.08
22	Publishing, printing & reproduction	-0.09	-0.05	0.33	-0.05	-0.03	-0.06	0.08
24	Chemical & chemical products	0.04	0.02	0.08	0.05	-0.02	0.07	0.04
25	Rubber & Plastics products	0.03	-0.18	0.39	-0.09	-0.06	-0.03	0.02
26	Other non metallic mineral products	0.07	-0.03	0.14	0.01	-0.06	-0.02	0.12
28	Fabricated metal products	0.01	-0.13	-0.09	0.07	-0.14	0.5	-0.14
29	Machinery & equipment	0.66	-0.05	0.2	0.15	-0.14	-0.06	0.21
31+32	Electrical machinery & apparatus & Radio, TV & communication Equipment	0.05	-0.06	0.02	0.04	0.01	0	-0.07
33	Medical & Optical instruments	-0.1	-0.11	0.03	0.09	-0.08	0.37	0.15
34+35	Motor vehicles, & trailers & other transport equipment	0.35	-0.01	-0.11	0.06	-0.14	0.14	0.16
36	Furniture, sports, handicraft etc.	-0.08	-0.06	0.07	0.32	-0.15	0.24	-0.04

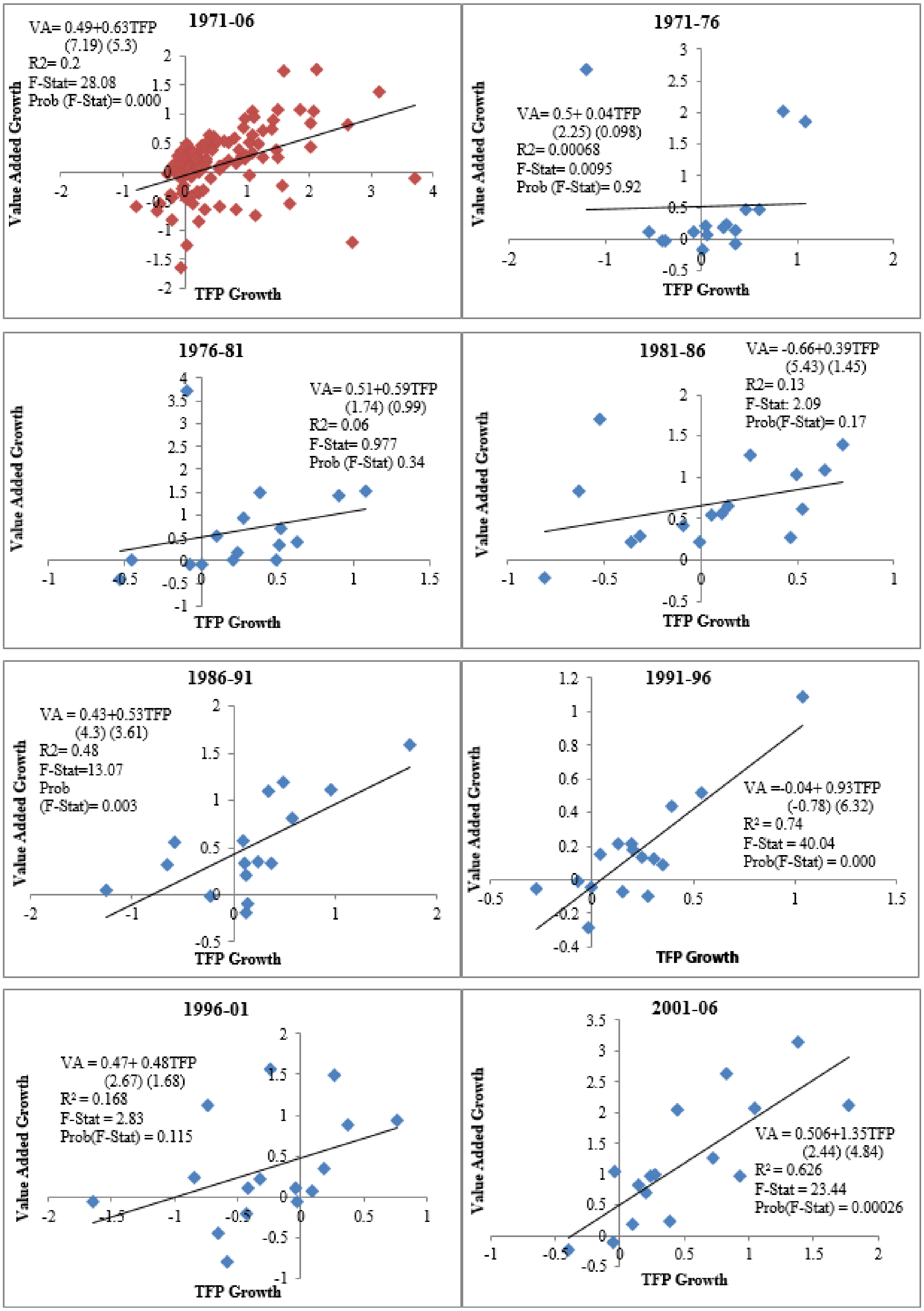
Source: Author's calculation

Table 7 shows that the contribution of labour is small in almost all of the 16 subsectors, substantiating the previous analysis. During 1991-96, almost all subsectors exhibited a negative contribution of labour to VA growth, reflecting the economic and political instability of 1990s. In contrast, the table shows that the period 2001-06 is relatively better in terms of the overall contribution of labour to VA growth across many subsectors.

Relationship between Value Added Growth and TFP Growth

The empirical evidence in the literature highlights the existence of an important relationship between VA growth and TFP growth. Harberger (1994, 1998), Beyer (1997), Robles (1997, 2000), and Torre (2000) among others provide evidence on the existence of a positive relationship between TFP growth and VA growth at the industrial level. For the case of Pakistan's LSM sector, pooled and cross-sectional regressions (shown in Figure 4) reveal some significant observations for all seven successive periods under study.

Figure 4: Correlation between Value Added Growth and Total Factor Productivity Growth in Pakistan's LSM Sector



The first panel of the figure, which is plotted between TFP and VA for all branches of the LSM sector for all seven periods, shows the existence of a strong and significant positive relationship. However, the other seven panels of the figure, which show the different disaggregated time periods, show varying degrees of correlation across different times. The reason behind this most likely lies in the changing politico-economic environment from one period to another. Pakistan's economic history can be divided generally into two broad periods. First is the pre-liberalization period that ends by the mid-1980s, after which the second period of liberalization started. Figure 4 shows that in the liberalization phase, a strong correlation exists between TFP growth and VA growth during all the periods except for 1996-01[18].This suggests that through liberalization number of channels positively impacted the TFP growth of domestic firms of various subsectors. For example, besides the mutation effects, with the reductions in tariff rates, the import of intermediate and final products from abroad compelled manufacturers to increase efficiency by improved productivity through competition. The quality of imported intermediate products also offered more choices to the local manufacturers for the selection of inputs at reduced prices, thus helping in increasing productivity. On top of all of this, technology transfer through various channels such as foreign direct investment and multinational corporations are considered major contributors of increased productivity.

For the pre-liberalization period, Figure 4 reveals a very weak correlation between the two variables. This suggests that the positive growth in VA during the pre-liberalization phase was attained by other factors of production, such as labor or capital, and not by TFP. An additional explanation for the statistically insignificant relationship during the 1970s is the nationalization policies. In addition, external shocks, such as the high oil prices of 1973and the poor weather conditions of the 70s, adversely impacted TFP growth, as described above.

Table 8 substantiates the results shown in Figure 4. The table is constructed by arranging all 16 subsectors of the manufacturing sector in ascending order for each period. From these 16 subsectors, the five with the highest VA growth and the five with the lowest VA growth were selected. The mean and median of VA growth, and the corresponding TFP growth, of both groups were calculated to determine the ratio of the difference in VA growth between the high and low growth sectors accounted for by the difference in TFP growth.

[18] As already explained, during the period 1996-2001 political and economic instability was at its peak in the country, and that translated into every sector of the economy.

Table 8: Relationship between Value Added Growth and TFP Growth Rates

	1971-76	1976-81	1981-86	1986-91	1991-96	1996-01	2001-06
Value Added Growth Rate							
5 Highest VA Growth Rates							
Mean	1.5	1.81	1.3	1.16	0.49	1.2	2.4
Median	1.85	1.48	1.26	1.11	0.44	1.13	2.12
5 Lowest VA Growth Rates							
Mean	-0.04	-0.11	0.16	-0.01	-0.11	-0.31	0.16
Median	-0.04	-0.09	0.22	-0.02	-0.07	-0.21	0.19
Difference in Mean	1.54	1.92	1.14	1.17	0.6	1.51	2.24
Difference in Median	1.88	1.56	1.04	1.14	0.5	1.34	1.93
TFP Contribution							
5 Highest VA Growth Rates							
Mean	0.36	0.51	0.32	0.82	0.46	0.08	1.09
Median	0.61	0.38	0.5	0.58	0.39	0.27	1.04
5 Lowest VA Growth Rates							
Mean	-0.07	0.02	-0.21	-0.22	0.03	-0.67	0.05
Median	0.02	0.01	-0.32	0.12	-0.01	-0.58	0.1
Difference in Mean	0.43	0.49	0.53	1.04	0.43	0.75	1.04
Difference in Median	0.59	0.38	0.81	0.46	0.4	0.85	0.94
Ratio of Differences							
Mean	0.28	0.25	0.47	0.89	0.72	0.5	0.47
Median	0.31	0.24	0.78	0.4	0.79	0.63	0.49

Source: Author's calculation

The table reveals that during 2001-06, the mean VA growth of the five fastest growing subsectors was 240 percent, while it was only 16 percent for the five slowest growing subsectors. The difference in VA growth between the two groups of subsectors is found to be 224 percent, of which 47 percent was accounted for by the difference of 104 percent in TFP growth. For the period 1996-01, the difference in TFP growth between the two sets of subsectors accounted for 50 percent of the difference in VA growth. Table 8 also shows the same calculation for all other periods under study. For the period 1986-91 and 1991-96, a very high ratio of differences, 72 percent and 89 percent respectively, in VA growth rates is accounted for by the difference in mean rates of TFP growth. However, during 1971-76 and 1976-81, only 25 percent and 28 percent respectively of VA growth is accounted for by the difference in TFP growth. As suggested above, high VA growth attained by the industries in the1970s is attributed to investing more in other factors of production like labour and capital rather than TFP.

CONCLUSION

The ultimate objective for conducting any policy oriented economic research is to put forward empirical evidence in the light of which practical policies could be devised for the betterment of an economy. In this study, sources of VA growth are estimated in aggregate and for 16 LSM subsectors for seven, five year periods from 1971-76 to 2001-06.The most important source of VA growth considered is the change in TFP or new ways of RCR. However, other means of enhancing VA growth are the traditional sources; for instance, utilization of more labor, utilization of more skilled labor, e.g. more educated, more trained, more experienced labor, and utilization of more capital by means of net investment or through investments of higher real rates of return.

The empirical evidence reveals that, at the aggregated level, TFP contributed positively in all the study periods except for the most destabilized period of the nineties. While analyzing the results of TFP growth for 16 LSM subsectors, no evidence was found for the persistency of any particular subsector in attaining the highest TFP growth. The list of subsectors attaining the highest growth consistently changed from one period to another. Therefore, the first important conclusion drawn is that winners cannot be foreseen in advance. It was also revealed that in the nineties most of the subsectors failed to achieve positive TFP growth, or in other words experienced real cost augmentation. These two results show that political instability can directly affect the efficiency and performance of any productive subsector. The evidence thus points to macroeconomic instability, corruption, and politicized institutions hindering the productivity of many subsectors. It is, of course, recommended for the government to undertake corrective measures to bring macro-economic stability.

Furthermore, in determining the concentration of TFP among various subsectors, it was found that only a small proportion of subsectors accounted for achieving the aggregate RCR for the whole LSM sector. The study thus describes the important role played by negatively productive subsectors in reducing the overall performance of the LSM sector. Although technological adoption is considered a major component of TFP growth, several other ways of RCR can be executed at the subsector level. Towards this end, the government can act as a collaborator and catalyst in improving RCR among research organizations, local entrepreneurs, and foreign firms. This will aid in the continuous up-gradation of the technological structure of the manufacturing sector and also in providing new ways of achieving RCR. The manufacturing commodities of Pakistan were, and still are, considered as being of erratic quality, not on par with international standards due to sub-standard raw material, outdated designs, and inadequate technology. Policy needs to focus more on the demand side rather than the supply side. The National Science, Technology and Innovation Policy (Ministry of Science and Technology 2012) acknowledged that the "R&D system of the country is currently oriented towards the supply side, with very little interaction with the industry, which is the ultimate user of the products or processes developed in the R&D".

The contribution of physical capital is found to be the major source of growth throughout the study period, a result consistent with previous studies. This suggests that the contribution of physical capital could be further improved by importing capital goods and machinery of medium and high technology manufactured products at preferential tariff rates. This will in turn help with the structural transformation of the LSM sector.

The contribution of labour to VA growth is found to be lowest and needs the special attention of policy makers. The study decomposed labors' contribution further into two components, (i) skilled labors' contribution to VA growth and (ii) unskilled labors' contribution to VA growth. Decomposition revealed that in most of the subsectors and time periods, skilled labour contributed significantly less compared to unskilled labor. As discussed earlier, an educated and skilled labor force is a prerequisite for development. Competitiveness in production processes cannot be improved without enhancing and retaining a skilled labor force. Pakistan is currently facing two human capital dilemmas. There is a deficiency of skilled labor, and conversely, skilled workers often migrate to other countries because of the limited employment opportunities in Pakistan. Empirical evidence presented in this study reveals that both skilled and unskilled labour contribution reached a negative peak during the period of relaxed immigration policies, as the skilled labor force migrated in search of better employment opportunities. Therefore, the government should devise policies on both ends. According to Easterly (2001) "twenty-four percentage points more of Pakistan's population is illiterate than is normal for a country of its income level, reflect[ing] excess illiteracy of 32 percentage points for females and 16 percentage points for males. Public spending on education is 1.4 percentage points lower than the benchmark for income level". A two-pronged strategy can be suggested to control the supply side factor of illiteracy. First, the central government should divert more funds and resources to the development of schools and vocational training institutes, including in far flung poor and deprived rural areas of Pakistan, and develop a proper monitoring system for these. Monitoring units need to keep an eye on the fair transfer and utilization of funds. Second, the government should further encourage the private sector in developing vocational and industrial training institutions on a large scale to help young people obtain the skills and expertise demanded by the LSM sector.

Government institutions should also support and strengthen the data collection agencies of Pakistan. Policy makers need to devise a multi-pronged strategy for the proper collection and storage of data. Although the industrial statistics act of 1942 empowers provincial officers of the government to collect firm level data, the current situation at the main data collection agency is quite poor; from the collection of the data to its compilation and publication. Policies should thus be devised for the implementation of the latest technology for data publishing. The current questionnaire format and dimensions are also in a poor state. We suggest new information related to imports, exports, and research & development activities should be included in the upcoming surveys.

Summarizing the above, it is recommend for engaging sustainable growth there needs to be an increase in the quality of all inputs (labor, capital, etc.), that in turn reciprocally enhance the marginal productivities of one another. Total VA growth and TFP growth can be positively combined to bring economic prosperity.

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APPENDIX A: CENSUS OF MANUFACTURING INDUSTRY

Table A.1: Census of Manufacturing Industry

PSIC 2007	PSIC 1970	Name of Industries
15	311+312+313+325	1) Food Manufacturing 2) Beverages Industries 3) Ginning pressing & baling of fibers
16	314	Tobacco manufacturing
17	320+321	Manufacture of Textiles
18	322	Manufacture of Wearing apparel except foot wear
19	323+324	1) Manufacture of leather and leather products, leather substitutes and fur, except foot wear and wearing apparel; 2) Manufacture of footwear except vulcanized or molded rubber or plastic foot wear
20	331	Manufacture of wood, and cork products except furniture
21	341	Manufacture of Paper and Paper products
22	342	Printing, Publishing and Allied Industries
23	353+354	1) Petroleum Refining 2)Manufacturing of miscellaneous products of petroleum & coal
24	350+351+352	1) Manufacture of drugs and pharmaceutical products 2) Manufacture of Industrial Chemical 3) Manufacture of other chemical product
25	355+356	1) Manufacture of rubber products 2)Manufacture of Plastic products n.e.c
26	36	1) Manufacture of pottery, china and earthenware 2) Manufacture of glass and glass products 3) Manufacture of non-metallic mineral products
27	37	1) Iron and Steel and basic industries 2) Non-ferrous metal basic Industries
28	380 & 381	Manufacture of Fabricated metal products except machinery and equipment
29	382	Manufacture of Machinery except electrical
31+32	383	Manufacture of electrical machinery, apparatus appliances and supplies
33	385+386	1) Manufacture of scientific, precision and measuring instruments and equipment 2) Manufacture of photographic and optical goods
34+35	384	Manufacture of Transport Equipment
36	332+391+392+393+394	1)Manufacture of sports and athletic goods 2) Handicrafts 3) Other manufacturing industries 4) Manufacture of furniture and fixture except primarily of metal

Source: CMI, various issues

APPENDIX B: INDUSTRY RESPONSE RATES

Table B.1: Response Rate of Industries

Years	Total Industries	No. of Returns Received and Qualified for Tabulation	No. of Returns Rejected	Factories Closed	Non Responding Factories	Total Remaining Factories	Response Rate	Non Response Rate
1970-71	5691	3549	473	1319	350	3899	91	9
1975-76	5336	3248	359	514	1215	4463	72.8	27.2
1980-81	5668	3815	486	468	899	4714	80.9	19.1
1985-86	8365	4349	873	1413	1730	6079	71.5	28.5
1995-96	8104	4474	627	1456	1547	6021	74.3	25.7
1990-91	7542	4792	642	612	1496	6288	76.2	23.8
2000-01	9823	4528	281	2438	2576	7104	63.7	36.3
2005-06	12813	6417	819	2364	3213	9630	66.6	33.4

Source: CMI (Various Editions) and author's calculation

APPENDIX C: EXPLANATION OF VARIABLES

Here we explain all variables used in estimating the sources of growth of LSM sector of Pakistan.

Value Added: Census value added is obtained by subtracting input value from the value of output of a particular manufacturing unit. Input value covers most of the industrial costs involved in purchasing raw material, fuel, electricity, remuneration to workers, maintenance cost, etc. Value of output includes the value of final products and by products of the manufacturing unit. Receipts of services provided by these units to others are also included in the output value.

Employees/ Labors: This includes all the persons hired for a manufacturing unit. This variable consists of all the employees hired part time, full time, or on contract.

Wage Bill: This is the cost incurred by a manufacturing unit to remunerate their employees. It includes wages and salaries along with all cash and non-cash benefits.

Capital: Capital refers the tangible assets such as value of land & buildings, plant & machinery, transport equipment, furniture & fixtures, and other fixed assets used by the manufacturing firm.

Gross Fixed Capital Formation: This includes acquisition of fixed assets, either by purchasing (locally or from abroad) or produced internally for internal use, less any sale or loss of fixed asset during the year.

Depreciation: The allocated cost for wear and tear of tangible assets by different manufacturing firms for the reduction in its value over the accounting year.

Stock of Physical Capital: Stock of physical capital is calculated by employing the 'Perpetual Inventory Method' (PIM). In estimating the capital stock database, a geometric pattern of decay is considered an appropriate approximation (Hulten and Wykoff 1981). However, in this study we used the value of depreciation provided by various editions of the CMI. According to PIM, capital stock series can be calculated by applying the following formula:

$K_{i,t}$= (1-δ) $K_{i,t-1}$ + $I_{i,t}$ + $Inv_{i,t}$

Where, $K_{i,t}$ = Capital stock by the end of year t

$K_{i,t-1}$ = Fixed asset at the beginning of year t

$I_{i,t}$= Gross fixed capital formation for the year t

$Inv_{i,t}$ = Value of inventory during year t, including value of fuel, raw material & other inputs, by products, semi finished goods, etc.

i = represents different industrial sectors

APPENDIX D: CONTRIBUTION OF TFP TO VALUE ADDED GROWTH

Table D.1: Contribution of TFP to Value Added Growth; 1970-71 to1975-76

PSIC 2007	TFP Growth	Value Added: Base Year '70-'71 (Mil. Rupees; 1999-00 =100)	Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative VA: Base Year '70-'71 (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (% of total VA)	Cumulative VA (% of Total VA)
18	1.08	128.69	138.99	138.99	128.69	0.00	0.13
34+35	0.84	2,667.88	2,241.02	2,380.01	2,796.57	0.02	2.92
33	0.61	429.71	262.12	2,642.13	3,226.28	0.03	3.37
15	0.46	20,914.82	9,620.82	12,262.95	24,141.10	0.13	25.22
36	0.36	760.43	273.75	12,536.70	24,901.53	0.13	26.01
16	0.36	11,192.74	4,029.39	16,566.09	36,094.28	0.17	37.7
21	0.26	1,673.06	435.00	17,001.09	37,767.33	0.18	39.45
26	0.23	4,212.85	968.96	17,970.04	41,980.18	0.19	43.85
31+32	0.06	3,713.86	222.83	18,192.87	45,694.04	0.19	47.73
25	0.04	1,512.10	60.48	18,253.36	47,206.14	0.19	49.31
22	0.02	1,703.86	34.08	18,287.43	48,909.99	0.19	51.09
24	-0.08	11,305.44	-904.44	17,383.00	60,215.43	0.18	62.9
19	-0.37	1,541.57	-570.38	16,812.62	61,757.00	0.18	64.51
17	-0.4	31,186.59	-12,474.63	4,337.98	92,943.59	0.05	97.09
28	-0.55	1,795.51	-987.53	3,350.45	94,739.10	0.03	98.97
29	-1.19	989.11	-1,177.04	2,173.41	95,728.21	0.02	100

Source: Author's calculation

Table D.2: Contribution of TFP to Value Added Growth; 1975-76 to1980-81

PSIC 2007	TFP Growth	Value Added: Base Year '75-'76 (Mil. Rupees; 1999-00 =100)	Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative VA: Base Year '75-'76 (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (% of total VA)	Cumulative VA (% of Total VA)
26	1.08	4,992.08	5,391.44	5,391.44	4,992.08	0.05	4.32
19	0.91	1,485.83	1,352.10	6,743.55	6,477.91	0.06	5.6
21	0.63	2,065.58	1,301.31	8,044.86	8,543.48	0.07	7.39
31+32	0.52	3,959.88	2,059.14	10,104.00	12,503.36	0.09	10.82
25	0.51	1,817.19	926.77	11,030.76	14,320.55	0.10	12.39
28	0.49	2,007.78	983.81	12,014.58	16,328.33	0.10	14.12
16	0.38	10,405.08	3,953.93	15,968.51	26,733.41	0.14	23.12
24	0.28	12,459.08	3,488.54	19,457.05	39,192.49	0.17	33.9
36	0.24	858.04	205.93	19,662.98	40,050.53	0.17	34.64
17	0.21	30,578.50	6,421.48	26,084.46	70,629.03	0.23	61.09
15	0.1	30,854.47	3,085.45	29,169.91	101,483.50	0.25	87.78
29	0.01	3,646.39	36.46	29,206.37	105,129.89	0.25	90.94
33	-0.08	629.74	-50.38	29,156.00	105,759.62	0.25	91.48
18	-0.1	366.34	-36.63	29,119.36	106,125.97	0.25	91.8
22	-0.45	1,425.49	-641.47	28,477.89	107,551.45	0.25	93.03
34+35	-0.53	8,058.38	-4,270.94	24,206.95	115,609.84	0.21	100

Source: Author's calculation

Table D.3: Contribution of TFP to Value Added Growth; 1980-81 to1985-86

PSIC 2007	TFP Growth	Value Added: Base Year '80-'81 (Mil. Rupees; 1999-00 =100)	Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative VA: Base Year '80-'81 (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (% of total VA)	Cumulative VA (% of Total VA)
22	0.74	1,461.79	1,081.72	1,081.72	1,461.79	0.01	0.85
24	0.64	23,931.99	15,316.47	16,398.20	25,393.78	0.10	14.79
34+35	0.53	4,798.18	2,543.03	18,941.23	30,191.96	0.11	17.59
18	0.5	1,724.63	862.31	19,803.55	31,916.58	0.12	18.59
28	0.47	2,053.65	965.21	20,768.76	33,970.23	0.12	19.79
29	0.25	3,329.24	832.31	21,601.07	37,299.47	0.13	21.73
19	0.14	3,609.99	505.40	22,106.47	40,909.46	0.13	23.83
17	0.11	30,974.12	3,407.15	25,513.62	71,883.58	0.15	41.87
31+32	0.06	6,741.71	404.50	25,918.12	78,625.29	0.15	45.8
16	-0.01	25,781.54	-257.82	25,660.31	104,406.83	0.15	60.81
15	-0.09	47,830.65	-4,304.76	21,355.55	152,237.48	0.12	88.67
36	-0.32	1,016.42	-325.25	21,030.30	153,253.90	0.12	89.26
21	-0.36	2,879.18	-1,036.50	19,993.79	156,133.08	0.12	90.94
25	-0.53	2,460.31	-1,303.97	18,689.83	158,593.39	0.11	92.37
26	-0.63	12,521.24	-7,888.38	10,801.44	171,114.63	0.06	99.67
33	-0.81	571.78	-463.14	10,338.30	171,686.42	0.06	100

Source: Author's calculation

Table D.4: Contribution of TFP to Value Added Growth for 1985-86 to 1990-91

PSIC 2007	TFP Growth	Value Added: Base Year '85-'86 (Mil. Rupees; 1999-00 =100)	Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative VA: Base Year '85-'86 (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (% of total VA)	Cumulative VA (% of Total VA)
22	1.73	3,500.01	6,055.02	6,055.02	3,500.01	0.02	1.28
33	0.95	447.53	425.15	6,480.17	3,947.54	0.02	1.44
21	0.58	3,498.47	2,029.11	8,509.28	7,446.00	0.03	2.71
17	0.49	48,328.38	23,680.90	32,190.19	55,774.38	0.12	20.33
34+35	0.37	7,783.77	2,879.99	35,070.18	63,558.15	0.13	23.17
36	0.34	1,318.36	448.24	35,518.42	64,876.51	0.13	23.65
29	0.24	7,535.68	1,808.56	37,326.99	72,412.19	0.14	26.39
25	0.13	6,633.42	862.35	38,189.33	79,045.61	0.14	28.81
24	0.13	50,077.95	6,510.13	44,699.46	129,123.56	0.16	47.07
16	0.12	31,551.08	3,786.13	48,485.59	160,674.64	0.18	58.57
26	0.11	22,928.98	2,522.19	51,007.78	183,603.61	0.19	66.92
31+32	0.1	10,440.61	1,044.06	52,051.84	194,044.22	0.19	70.73
15	-0.23	68,192.44	-15,684.26	36,367.58	262,236.66	0.13	95.59
18	-0.59	3,511.94	-2,072.04	34,295.54	265,748.60	0.13	96.87
28	-0.65	2,632.23	-1,710.95	32,584.59	268,380.83	0.12	97.82
19	-1.26	5,967.88	-7,519.53	25,065.06	274,348.70	0.09	100

Source: Author's calculation

Table D.5: Contribution of TFP to Value Added Growth; 1990-91 to 1995-96

PSIC 2007	TFP Growth	Value Added: Base Year '90-'91 (Mil. Rupees; 1999-00 =100)	Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative VA: Base Year '90-'91 (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (% of total VA)	Cumulative VA (% of Total VA)
31+32	1.04	16,489.21	17,148.78	17,148.78	16,489.21	0.05	4.51
34+35	0.54	10,392.79	5,612.10	22,760.88	26,882.00	0.06	7.34
36	0.39	2,754.00	1,074.06	23,834.94	29,636.00	0.07	8.1
16	0.35	25,486.92	8,920.42	32,755.36	55,122.91	0.09	15.06
18	0.3	5,467.20	1,640.16	34,395.52	60,590.12	0.09	16.55
28	0.27	3,457.00	933.39	35,328.91	64,047.12	0.10	17.5
26	0.25	30,425.70	7,606.42	42,935.34	94,472.81	0.12	25.81
33	0.2	945.96	189.19	43,124.53	95,418.78	0.12	26.07
15	0.19	66,702.81	12,673.53	55,798.07	162,121.59	0.15	44.3
19	0.15	6,208.71	931.31	56,729.37	168,330.31	0.15	45.99
24	0.13	60,343.22	7,844.62	64,573.99	228,673.53	0.18	62.48
21	0.04	6,306.84	252.27	64,826.27	234,980.37	0.18	64.2
25	-0.01	6,053.86	-60.54	64,765.73	241,034.23	0.18	65.86
29	-0.02	10,125.44	-202.51	64,563.22	251,159.67	0.18	68.62
22	-0.07	9,086.21	-636.03	63,927.18	260,245.87	0.17	71.11
17	-0.27	105,752.16	-28,553.08	35,374.10	365,998.03	0.10	100

Source: Author's calculation

Table D.6: Contribution of TFP to Value Added Growth; 1995-96 to 2000-01

PSIC 2007	TFP Growth	Value Added: Base Year '95-'96 (Mil. Rupees; 1999-00 =100)	Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative VA: Base Year '95-'96 (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (% of total VA)	Cumulative VA (% of Total VA)
19	0.76	5,788.22	4,399.05	4,399.05	5,788.22	0.01	1.39
36	0.37	3,955.50	1,463.54	5,862.59	9,743.73	0.01	2.34
28	0.27	3,104.07	838.10	6,700.68	12,847.79	0.02	3.09
17	0.18	100,316.00	18,056.88	24,757.56	113,163.82	0.06	27.2
21	0.1	7,239.14	723.91	25,481.48	120,402.96	0.06	28.94
29	-0.02	7,252.74	-145.05	25,336.42	127,655.70	0.06	30.69
34+35	-0.04	15,756.02	-630.24	24,706.18	143,411.72	0.06	34.48
18	-0.24	6,128.82	-1,470.92	23,235.27	149,540.54	0.06	35.95
24	-0.33	73,111.15	-24,126.68	-891.41	222,651.69	0.00	53.52
25	-0.42	5,773.15	-2,424.72	-3,316.14	228,424.84	-0.01	54.91
26	-0.43	34,479.95	-14,826.38	-18,142.52	262,904.80	-0.04	63.2
22	-0.58	9,024.31	-5,234.10	-23,376.62	271,929.11	-0.06	65.37
31+32	-0.66	34,471.89	-22,751.44	-46,128.06	306,400.99	-0.11	73.66
33	-0.74	1,112.49	-823.24	-46,951.30	307,513.48	-0.11	73.93
15	-0.85	80,687.90	-68,584.71	-115,536.02	388,201.38	-0.28	93.32
16	-1.65	27,777.22	-45,832.41	-161,368.43	415,978.60	-0.39	100

Source: Author's calculation

Table D.7: Contribution of TFP to Value Added Growth; 2000-01 to 2005-06

PSIC 2007	TFP Growth	Value Added: Base Year '00-'01 (Mil. Rupees; 1999-00 =100)	Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (Mil. Rupees; 1999-00 =100)	Cumulative VA: Base Year '00-'01 (Mil. Rupees; 1999-00 =100)	Cumulative Contribution of TFP to VA (% of total VA)	Cumulative VA (% of Total VA)
29	1.78	6,848.17	12,189.74	12,189.74	6,848.17	0.03	1.43
34+35	1.38	17,430.29	24,053.80	36,243.54	24,278.46	0.08	5.05
18	1.04	15,672.08	16,298.97	52,542.51	39,950.54	0.11	8.31
15	0.93	99,682.73	92,704.94	145,247.45	139,633.28	0.30	29.06
21	0.82	7,720.07	6,330.46	151,577.91	147,353.35	0.32	30.66
33	0.72	2,368.08	1,705.02	153,282.93	149,721.43	0.32	31.16
26	0.45	27,305.12	12,287.31	165,570.23	177,026.55	0.34	36.84
31+32	0.39	19,171.93	7,477.05	173,047.28	196,198.48	0.36	40.83
24	0.27	88,476.63	23,888.69	196,935.97	284,675.11	0.41	59.24
22	0.23	1,852.44	426.06	197,362.04	286,527.55	0.41	59.62
25	0.20	6,359.28	1,271.86	198,633.89	292,886.83	0.41	60.95
16	0.14	26,086.55	3,652.12	202,286.01	318,973.38	0.42	66.37
28	0.10	7,718.47	771.85	203,057.86	326,691.85	0.42	67.98
17	-0.04	135,260.07	-5,410.40	197,647.45	461,951.92	0.41	96.13
19	-0.05	11,193.16	-559.66	197,087.79	473,145.08	0.41	98.46
36	-0.39	7,420.37	-2,893.95	194,193.85	480,565.46	0.40	100.00

Source: Author's calculation

APPENDIX E: LABOUR CONTRIBUTION TO VALUE ADDED GROWTH

Table E.1: Skilled Labor Contribution to Value Added Growth

PSIC 2007	1971-76	1976-1981	1981-1986	1986-1991	1991-1996	1996-2001	2001-2006
15	-0.03	0.44	0.47	0.19	0.07	1.07	-0.01
16	-0.42	1.09	0.24	-0.3	-0.25	1.59	0.62
17	0.27	-0.05	0.46	0.56	0.27	0.07	0.92
18	0.37	3.29	0.31	0.8	-0.01	1.03	0.92
19	0.36	0.36	0.57	1.09	-0.11	0.02	-0.05
21	-0.11	-0.22	0.59	0.22	0.14	-0.09	1.72
22	-0.09	0.53	0.33	-0.08	0.09	-0.15	0.66
24	0.14	0.63	0.37	0.03	0.1	0.46	0.69
25	0.13	0.02	1.84	-0.13	0.02	0.55	0.48
26	-0.11	0.46	1.32	0.2	-0.05	0.24	1.47
28	0.65	-0.34	-0.1	0.89	-0.24	0.72	0.22
29	3.22	-0.04	0.81	-0.04	-0.12	0.02	0.13
31+32	-0.04	0.24	0.47	0.44	0.04	0.22	-0.08
33	-0.04	0.09	0.57	0.07	0.05	1.5	0.38
34+35	0.83	0.14	0.21	-0.1	0.12	0	1.59
36	-0.16	0	0.55	0.43	0.2	0.27	0.21

Source: Author's calculation

Table E.2: Raw Labor Contribution to Value Added Growth

PSIC 2007	1971-76	1976-1981	1981-1986	1986-1991	1991-1996	1996-2001	2001-2006
15	0.04	0.01	0.05	0.01	-0.06	0.01	0.06
16	-0.01	0	-0.01	-0.01	0	-0.01	0.05
17	0.11	-0.15	-0.01	0.14	-0.04	0.1	0.16
18	0.39	0.52	0.23	0.35	-0.18	0.77	0.11
19	-0.03	0.16	-0.06	0.21	-0.11	0.16	-0.01
21	0.08	-0.02	-0.02	0	-0.03	0.06	0.08
22	-0.09	-0.05	0.33	-0.05	-0.03	-0.06	0.08
24	0.04	0.02	0.08	0.05	-0.02	0.07	0.04
25	0.03	-0.18	0.39	-0.09	-0.06	-0.03	0.02
26	0.07	-0.03	0.14	0.01	-0.06	-0.02	0.12
28	0.01	-0.13	-0.09	0.07	-0.14	0.5	-0.14
29	0.66	-0.05	0.2	0.15	-0.14	-0.06	0.21
31+32	0.05	-0.06	0.02	0.04	0.01	0	-0.07
33	-0.1	-0.11	0.03	0.09	-0.08	0.37	0.15
34+35	0.35	-0.01	-0.11	0.06	-0.14	0.14	0.16
36	-0.08	-0.06	0.07	0.32	-0.15	0.24	-0.04

Source: Author's calculation

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

2033 K Street, NW | Washington, DC 20006-1002 USA | T+1.202.862.5600 | F+1.202.457.4439 | Skype: ifprihomeoffice | ifpri@cgiar.org

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