7 *Productivity growth in India under different policy regimes*

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7.1 Introduction

Following the substantial liberal market reforms, the Indian economy has been growing at a spectacular rate in the last decade and this has attracted much attention in the literature (e.g. Bhagwati and Panagariya 2013; Eichengreen *et al.* 2010; Panagariya 2008; Bosworth and Collins 2008).[1] In 1991, when India started liberalizing the economy, its size was only 3% of global gross domestic product (GDP), while in 2013 it was almost double at 6% (The Conference Board 2014), definitely suggesting a faster growth compared to most other emerging economies, except China. The Indian economy grew at an average annual rate of 7% since 1996 for a period of fifteen years, with little deviation from the mean growth rate. Even when the global economy was suffering from recession in 2008 and 2009, the Indian economy grew at about 6–8%, although the rate of growth slowed down significantly to an average of 5% after.[2]

[1] This chapter is from a paper presented at the 3rd world KLEMS conference held in Tokyo, Japan on May 16–17, 2014, organized by REITI (Japan). The authors would like to thank REITI for travel and other support for Deb Kusum Das and Suresh Aggarwal, and all conference participants especially Barbara Fraumeni and Harry Wu for useful comments. Detailed comments by Marcel Timmer and Dale Jorgenson on the first draft are also acknowledged. The authors thank K. L. Krishna and B. N. Goldar for advisory support in discussions relating to the construction of India KLEMS dataset. Financial support from Reserve Bank of India in building the India KLEMS dataset is gratefully acknowledged. The usual disclaimers apply.

[2] The recent set-backs, particularly after 2012, are sometimes attributed partly to the global financial crisis (Mohan and Kapur 2015). However, multiple factors played a substantial role in dragging down India's growth. These include both internal and external factors including soaring inflation, increased fiscal and current account deficit, and a weakening of Indian Rupee.

Concerns, however, have been raised about the underlying dynamics of the Indian growth process, in particular whether growth is trickling down to reduce poverty and inequality and whether fast growth can be sustained in the longer term. In particular the question of sustainability, which has been raised in the past in the context of East Asian economies as well, gains importance, as economic growth in emerging economies are often driven heavily by capital accumulation, which owing to diminishing returns would stall the long-term growth momentum. For instance, China has been able to maintain high growth rates by consistently high investment rates over the past decades but is already experiencing a slowdown in its economic growth (see for instance Dorrucci *et al*. 2013). For India, given its still unexploited demographic dividend and underdeveloped infrastructure, potential for investment-driven growth might still be existing, though productivity growth will remain the most important source for sustaining the return over capital in the longer term.

An important factor that is argued to play a significant role in enhancing productivity growth is appropriate policy atmosphere. Trade and investment liberalization are often considered to be major policy aspects in this context. Lowering of trade barriers could lead to increased productivity via increased import competition, better access to foreign technology, and improved managerial efficiency, innovation, and exploitation of economies of scale (Bernard *et al*. 2003; Melitz 2003). With the aim of improving its manufacturing competitiveness, Indian policy-makers initiated a number of trade and industrial policy reforms as part of the broader economic policy reforms since the mid-1980s. Studies that analyzed productivity performances in India's (organized) manufacturing suggest a positive impact of these policy reforms on productivity growth through directly impacting the sector and through inter-sectoral linkages with the overall economy (Das 2004; Balakrishnan *et al*. 2000; Krishna and Mitra 1998). However, these studies are mostly confined to the formal manufacturing sector, which constitutes only a minor part of the economy, particularly in terms of employment generation.[3]

[3] Kathuria *et al*. (2010) is an exception, which looks into the productivity performance of both organized and unorganized manufacturing, but for the provincial aggregate manufacturing.

This chapter takes a broader perspective on the empirical association between liberal market policy reforms and productivity. We analyze the productivity performance of the entire economy divided into twenty-six sub-sectors, using a recently developed KLEMS (capital, labor, energy, material, and services) database, and relate it to various liberal policy reforms that have been initiated in Indian economy during the last three decades. Previous studies, which are conducted using aggregate economy data, suggest relatively better productivity growth in the post-liberalization period (Bosworth and Maertens 2010; Bosworth and Collins 2008). Bosworth and Collins (2008) and Jorgenson and Vu (2005) suggest a total factor productivity (TFP) growth of above 2% in the 1990s through early 2000s. Taking account of a number of heterogeneities – both in terms of differences in factor inputs across assets and worker categories, as well as in industries – our results suggests a lower TFP of 1.2% for the aggregate economy during 1980–2011, without much deviation over the three decadal averages (1980s, 1990s, and 2000s). Excluding 1992 from the analysis, our study suggests 1.4% TFP growth during the 1990s, which is slightly higher than the other two decades.

Even though we do not find acceleration in aggregate economy productivity growth, this aggregate picture masks several industry dynamics. Our detailed industry analysis, which clearly documents the structural shift in the Indian economy, indeed suggests a positive impact of economic reforms on productivity growth in several industries, but it does not appear to be broad-based. In particular, our sectoral analysis suggests that the driver of aggregate productivity growth is the market services sector. We find both the agriculture and market services sectors have gained substantial productivity growth during the 1990s, whereas the manufacturing sector has weakened significantly.[4] The manufacturing sector – inclusive of formal and informal sectors – however, has regained its 1980s TFP growth rates in the 2000s. Nevertheless, even while improving its overall efficiency in using labor and capital, there is no substantial expansion in the manufacturing sector in terms of employment and investment, compared to the previous decades. This points to several hurdles,

[4] This weak performance of manufacturing in the 1990s has been acknowledged by several studies in the context of formal manufacturing (Goldar 2014; Trivedi *et al.* 2011; Kathuria *et al.* 2010). There is also limited evidence on the unorganized sector (Kathuria *et al.* 2010).

particularly in the formal sector, such as labor market rigidities, that hampers expansion of formal sector activities.

Market services had the most impressive TFP growth in the 2000s, being the main driver of India's economic growth. In general the market economy has been performing substantially better than the non-market economy, which reflects the impact of several pro-market reforms. This becomes particularly clear as this study distinguishes between market and non-market segments, in contrast earlier studies such as Bosworth and Collins (2008) which only considered all services sectors together.[5] A breakdown of the services sector is of high importance given that public administration, education, and health do not follow the market principles, such that output and productivity is hard to measure and not particularly meaningful.

The rest of the chapter is organized as follows. Section 7.2 documents the economic growth and associated structural changes that have taken place in the Indian economy under different policy regimes. In Section 7.3 the data and methodology used for analyzing India's sources of growth are detailed. In Section 7.4, the empirical analysis of the sources of growth is provided with emphasis on the contributions of input versus productivity. Industry origins of aggregate productivity growth are also discussed. Section 7.5 presents results on sectoral productivity using a gross output production function approach, and an analysis of the pattern of productivity growth across industries. In Section 7.6, we provide a discussion on sectoral productivity dynamics under policy reforms, by comparing productivity growth in the 1990s and 2000s, and discuss some future policy perspectives. The final section concludes the study.

7.2 Economic growth and structural change: an overview

The first set of postcolonial economic policies in India was characterized by the "License and Permit Raj" with substantial emphasis on public

[5] Verma (2012), while analyzing India's service sector growth during 1980–2005, distinguishes between trade, transportation, and communication services; financial and business services; and community, social, and personal services. We analyze the services sector for a longer period, 1980–2011, at further disaggregation, considering nine sub-sectors, five of which are market service sectors (see Appendix Table 7.1).

Table 7.1 *Growth rates of GDP and labor productivity in the Indian economy – pre- and post-1980s*

Total economy	1951–1980	1981–2011	1981–1990	1992–1999	2000–2011
GDP	3.5	6.3	5.4	5.9	7.4
GDP per worker	1.8	3.4	2.1	3.7	4.4

Note: All growth rates are measured in log differences. Growth rates in GDP and labor productivity for 1980–2011 are based on weighted growth rates of sectoral employment and GDP.
Source: 1950 to 1980 are from the Conference Board Total Economy Database (2014); all others are author's calculation using India KLEMS data.

sector investment.[6] Import substitution, control on the private sector and large domestic firms, resistance to foreign direct investment, technology transfer, and interventions in factor markets were notable features of these policies. Arguably, these strict policy measures led to a stifling of market forces, resulting in a low rate of economic growth. In Table 7.1, we provide the average growth rates of GDP and labor productivity in India since 1950.[7] The Indian economy grew at an annual average rate of around 3.5 percent (also known as the "Hindu rate" of growth, a term to rationalize the sluggish economic growth) during 1950–1980 period.

The process of reforms continued during the 1980s, during which a mix of industry-specific and more generic policies aimed to reduce the license barriers and to ease restrictions on imports were introduced.[8] However, the tariff rates remained by and large high. GDP growth has increased in the post-1980 period from the "Hindu rate" of about 3.5% during 1950–1980 to 6.3% during 1980–2011, with 1980–1990 period registering an average growth of 5.4% per annum. Indeed, there has

[6] The elaborate system of licenses, regulations, and accompanying red-tapes required to set up and run businesses in India between 1947 and the 1990s is often called "License Raj."

[7] Indian economic statistics are generally available for a financial year, starting from April 1 to March 31. For instance data for 1980–1981 refers to the period of April 1, 1980 to March 31, 1981. Since it covers three quarters from the first year and one quarter from the second year, for ease of use throughout this chapter, we refer to the first three quarters. I.e. 1980–1981 is generally referred to as 1980.

[8] See Panagariya (2008) and Bhagwati and Panagariya (2013) for discussions on various policy reforms in India.

been a marked increase in both GDP and labor productivity growth in the post-1980 period compared to the previous period. However, the growth acceleration could not be sustained, and the economy witnessed a serious balance of payment crisis in the early 1990s. It is often argued that the policy reforms in the 1980s were pro-business supporting the incumbent firms rather than pro-market or pro-liberalization, thus limiting the entry of new firms to encourage healthy competition (Rodrik and Subramanian 2005).

However, as argued by Srinivasan and Tendulkar (2003), they did help change the political perspective on liberalization, which made it easier for the government to introduce widespread liberalization policies in the aftermath of the balance of payments crisis. In 1991, India introduced substantial structural reforms, characterized by the increased role attributed to the private sector, massive delicensing, easing of quantitative controls, and increased integration with the global market.[9] However, the growth performance of the Indian economy in the first decade after did not show any sharp upward trend, being 5.9% during 1992–2000, compared to 5.4% during 1980–1990.[10] The economy grew at 7.4% during 2000–2011 period. As is clear from Table 7.1, labor productivity growth acceleration had already started in the 1980s, it gained further momentum in the 1990s, and increased substantially in the 2000s, owing to the liberal market reforms in the early 1990s (Balakrishnan and Parameswaran 2007; Rodrik and Subramaniam 2005).

While there is a reasonable degree of agreement on growth acceleration in the 1980s there exist divergent views on what caused this growth turnaround. While Rodrik and Subramanian (2005) attribute growth acceleration in the 1980s to manufacturing sector productivity gain, Balakrishnan and Parameswaran (2007) and Bosworth *et al.* (2007) also assign a substantial role to the reallocation of resources from low productive sectors like agriculture to high productive sectors

[9] Both the level and dispersion of tariffs were lowered and tariff rates were reduced across the board. The peak rate of customs duty was lowered to around 65% from over 200%. The non-tariff barriers in the form of quantitative restrictions (QR) on intermediate and capital goods import were completely withdrawn. Moreover, the economy has moved from a fixed and overvalued exchange rate to a market-determined flexible exchange rate (see Das 2004).

[10] We exclude 1991 while averaging productivity and output growth in the 1990s throughout this chapter, because it was a year of extreme turbulence in the Indian economy due to severe external imbalances and the consequent balance of payments crisis.

like manufacturing and services. A recent study by De Vries *et al.* (2012) also signifies the important role of structural change in the Indian economy both in the 1980s and in 1990s.

In Table 7.2 we provide the sectoral composition of the Indian economy in order to see how economic structure has been evolving over time. The table shows that the value added share of the agriculture, hunting, and fishing sector has declined steadily from 35.6% in 1980 to 17.5% in 2011. This decline, however, is not mirrored by an increase in the manufacturing share, which declined from 17.4% to 14.4%. Within manufacturing we distinguish between labor intensive and non-labor intensive segments (See Appendix Table 7.1 for the sector classifications). As is evident from the table, the GDP share of the most labor-intensive sectors has declined rapidly, while that of others increased only marginally. Thus manufacturing did not absorb the release of agricultural labor. Sen and Das (2014) attributes this decline in labor intensive manufacturing to increasing substitution of labor by capital, facilitated by reforms in capital goods and falling import tariffs on capital goods. Yet another possibility is that the rigid labor market regulations provided fewer or no incentives for formal firms to create more jobs.[11] The value added share of non-manufacturing industries, which includes utilities (electricity, gas, and water supply), mining, and construction, has increased from 7.9% in 1980 to 12.4% in 2011.

The most important feature of structural transformation in the Indian economy is the emergence of the service sector, which makes India defy the conventional structural change hypothesis of moving from primary to secondary and then to services (Erumban *et al.* 2012). The service sector remains the single largest contributor to value added in the post-1980 period. The share of the service sector increased rapidly from 39.1% in 1980 to 55.7% in 2011, with greater acceleration since 1990 being observed in market services share in value added.[12] The distinction of market and non-market services is of high

[11] See Moreno-Monroy *et al.* (2014), for an analysis of increasing outsourcing of formal sector activities to informal sector in order to avoid many rigidities in the formal labor market.

[12] Market services includes trade, transport services, financial services, post and telecommunications, and hotels and restaurants. Ideally it should also include business services, which is a fast-growing segment in the Indian economy. However, it was almost impossible to split this sector from other services for investment data – an essential variable in our productivity analysis – making us keep it under "other services."

Table 7.2 ***Gross value added and employment shares in GDP, 1980–2011 (%)***

Sector	Value added				Employment			
	1980	1990	2000	2011	1980	1990	2000	2011
Agriculture	35.6	29.4	23.0	17.6	69.8	64.7	59.8	48.1
Industry	25.3	26.6	26.0	26.8	13.2	15.2	16.5	22.7
Manufacturing	17.4	16.4	15.3	14.4	10.4	10.7	11.1	11.4
High labor intensive	10.2	7.5	7.1	5.3	8.5	8.4	8.3	8.3
Medium labor intensive	4.2	5.2	4.2	4.5	1.2	1.4	1.7	1.9
Low labor intensive	3.0	3.7	4.0	4.6	0.8	0.9	1.0	1.1
Non-manufacturing	7.9	10.3	10.7	12.4	2.8	4.5	5.4	11.3
Services	39.1	44.0	51.0	55.7	16.9	20.0	23.7	29.2
Market services	18.6	22.6	27.6	30.9	8.9	11.5	14.6	16.8
Non-market services	20.4	21.4	23.4	24.7	8.0	8.5	9.1	12.4

Note: Agriculture is inclusive of hunting and fishing activities.
Source: Authors calculations using India KLEMS database.

significance, as most reforms were oriented towards the development of a solid private market sector in Indian economy.

The observed high value added share of the service sector, however, does not appear to have translated into an increasing employment generation of similar magnitude. The primary sector remains the leading contributor to employment in all three decades, although its share has declined steadily over time by about 20 percentage points from 69.8% in 1980 to about 48.1% in 2011. The employment share of the manufacturing sector has been rather stagnant over the years, whereas there is a sharp rise in the employment share in non-manufacturing industries in the 2000s due to large employment generation in the construction sector. Services, on the other hand, see an employment gain of 12%, while its output share increased by 17%.

The increasing share of services in GDP has clear implications for its role in driving growth in the Indian economy, and several studies have attributed economic growth in India to the service sector (Eichengreen and Gupta 2009; Gorden and Gupta 2003 among others). The declining share of manufacturing, and the increasing role of the service sector in the Indian economy, however, raises the question of what is the impact of economic reforms, which were primarily aimed at increasing efficiency and competitiveness of the manufacturing sector, on

boosting productivity and economic growth? Many studies assert that for a developing country like India, it is important to maintain a high manufacturing growth without which the pace of growth of the service sector cannot be sustained (Rodrik 2013; Panagariya 2008; Acharya *et al.* 2003). Except for a few countries with abundant natural resources, almost all countries that sustained high growth did so with the help of the manufacturing sector (Rodrik 2013). This chapter is the first to deal with this issue in a satisfactory way by providing detailed, industry-level data, and as such makes an important contribution to the discussion of Indian economic growth policies.

7.3 Data and methodology

7.3.1 Methodology

In order to analyze sources of India's economic growth, this chapter uses the standard growth accounting approach as outlined in Jorgenson *et al.* (1987, 2005). We decompose total output growth into the contributions from growth rates of primary inputs (capital and labor) and TFP growth as:

$$\Delta lnY_t = \Delta lnA_t + \overline{v}_{K,t}\Delta lnK_t + \overline{v}_{L,t}\Delta lnL_t \quad (1)$$

where Y is the real output, measured by value added, K is the capital input, L is the labor input, $\overline{v}_{K,t}$ is the compensation share of capital in value added averaged across current and previous period, and $\overline{v}_{L,t}$ is the compensation share of labor. Under constant returns to scale the income shares of labor and capital sum to unity. A is the measure of TFP.

Equation (1) has been widely used in the literature, including in studies on productivity in the Indian economy (Bosworth and Collins 2008). In several previous studies in the Indian context, K is represented by capital stock measured using standard perpetual inventory method (PIM) often not even allowing for depreciation of older vintages, and L is measured by number of employees. We, however, differ from these in terms of the treatment of factor inputs K and L, and consequently the measured TFP growth. Following the theoretical arguments (Jorgenson 1963), and international practices (see for instance Timmer *et al.* 2010; OECD 2001), in this chapter aggregate capital and labor inputs are measured as the flow of services from these inputs to the production process. Since aggregate capital and aggregate

labor inputs consist of different types of capital assets (e.g. machinery, computers, buildings etc.) and labor types (low skilled, high skilled etc.), it is important to account for the possible heterogeneity while measuring these inputs, as their marginal productivities may differ. In order to take account of asset heterogeneity of capital and skill heterogeneity of labor, we distinguish between five types of labor and three types of capital assets (see section 7.3.2 on data). Our approach to measuring capital and labor input will be discussed in detail subsequently.

Equation (1) is a value added function, which is appropriate for measuring productivity for the aggregate economy. We also measure productivity at detailed sectoral level, for which a more appropriate approach would be to use a gross output function (Jorgenson *et al.* 1987). As in equation (1) we can decompose the growth rate of gross output into L, K and TFP, but also to the contributions of intermediate inputs, energy (E), material (M), and services (S):

$$\Delta lnQ_{j,t} = \Delta lnA^{*}_{j,t} + \overline{v}^{*}_{K,j,t}\Delta lnK_{j,t} + \overline{v}^{*}_{L,j,t}\Delta lnL_{j,t} + \overline{v}^{*}_{E,j,t}\Delta lnE_{j,t} + \overline{v}^{*}_{M,j,t}\Delta lnM_{j,t} + \overline{v}^{*}_{S,j,t}\Delta lnS_{j,t} \quad (2)$$

where Q is the real gross output, $\overline{v}^{*}_{X,t}$ is the compensation share of input x (capital, labor, energy, material, and services) in nominal gross output averaged across current and previous period – all for any given industry j. As before, under constant returns to scale the income shares of all inputs sums to unity. A^{*} is the measure of TFP based on gross output function, which is different from, but related to A in equation (1). Hulten (1978) shows that there is an accounting relationship between A and A* such that A is the product of A* and the ratio of gross output to gross value added. This relationship can be expressed to obtain A* from A as:

$$\Delta \mathrm{lnA}^{*}_{\mathrm{j,t}} = \frac{\mathrm{VA}}{\mathrm{GO}} * \Delta \mathrm{lnA}_{\mathrm{t}} \quad (3)$$

While A, which is indicative of improvements in the productivity of factor inputs, labor and capital, is more interesting from an aggregate economy and welfare perspective, A*, which accounts for the efficiency of all inputs, is important from a technological change point of view. Therefore, in our industry growth accounting analysis we focus on A* and in our aggregate analysis we use A.

7.3.2 Data and variables

The data used in the empirical analysis of this study is from the India KLEMS data compiled from various sources, and cover the period 1980–2011. Though the primary source of India KLEMS data is the National Accounts Statistics (NAS), published annually by the Central Statistical Organization (CSO), various other sources have been used to construct variables that are not often available in national accounts. This includes input–output (IO) tables, and various rounds of National Sample Survey Organizations (NSSO) surveys on employment and unemployment. Our analysis requires industry-wide data on nominal and real value added, investment by asset type, number of workers and labor compensation by type of worker, and intermediate inputs.[13] In what follows we discuss these sources more specifically with regard to each of the variables used in our analysis.

Gross output (GO): National Accounts provides data on gross output in agriculture, hunting, forestry and fishing, mining and quarrying, construction, and fourteen manufacturing sectors at current and constant prices. However, NAS does not provide gross output series for other sectors in our twenty-six industry classification. Moreover, the manufacturing sectors available in NAS classification were not fully consistent with our KLEMS classification. Therefore, to estimate output in our KLEMS sectors, additional information is used from Annual Survey of Industries (ASI) for registered manufacturing sectors, NSSO quinquennial surveys for unregistered manufacturing sectors, and input–output transaction tables for the service sectors. For seven manufacturing industries, for which the sectoral data is not available from NAS, the output data for a higher level aggregation from NAS is split using output distribution from ASI and NSSO rounds to arrive at desired KLEMS sector estimate.[14] We aggregate registered and unregistered manufacturing data to obtain KLEMS consistent total manufacturing sector.

[13] See Appendix Table 7.1 for a list of twenty-six industries in the India KLEMS database (also see Table 7.4).

[14] These sectors are wood and wood products, coke refined petroleum and nuclear fuel, rubber and plastic products, basic metals and fabricated metal products, machinery not elsewhere classified, electrical and optical equipment, and other manufacturing.

For service sectors, except public administration and defense, and electricity, gas, and water supply, output estimates are constructed using information from IO tables.[15] We take the benchmark year gross output to value added ratio for the relevant sector from IO tables for years 1978–1979, 1983–1984, 1989–1990, 1993–1994, 1998–1999, 2003–2004, and 2007–2008. These ratios are linearly interpolated for intervening years and applied to the gross value added series obtained from national accounts to derive the output estimates consistent with NAS at current prices.

For constant price series, the NAS estimates are directly used wherever the sector classification matches the KLEMS classifications. For the seven KLEMS manufacturing industries where direct NAS estimates are not available, the nominal estimates constructed are deflated with suitable wholesale price deflators. For services sectors and utilities, for which the wholesale price deflators are not available, the nominal estimates are deflated with implicit value added deflators from NAS to arrive at constant price series.

Intermediate inputs: Time series of intermediate inputs, energy, material, and services, are constructed using the methodology developed by Jorgenson *et al.* (1987) and extended by Jorgenson (1990). This approach involves extensive of use of IO tables from where we can obtain the flows of all commodities in the economy (Jorgenson *et al.* 2005; Timmer *et al.* 2010). For constructing the current price series, proportions of energy, material, and service inputs in total intermediate inputs are calculated from the benchmark IO tables for years mentioned before, and for intervening years these are linearly interpolated. This interpolation involves an implicit assumption that for each IO sector input–output coefficients change progressively between the benchmark years. For years after 2007, the last IO table, a similar assumption is made; we assume that the input–output coefficients vary at a similar rate as in between 2003 and 2007. In order to ensure consistency of final estimates with published National Accounts series, the projected input vector has been proportionately adjusted to match the gap between gross output and value added of NAS sectors.

[15] Public administration and defense is a special case where no intermediate inputs are given in IO tables. In this case, we use value added to output ratio from System of National Accounts tables, available from the CSO.

For constructing the constant price series, the nominal values of intermediate inputs are deflated using weighted intermediate input deflators, constructed for each of the three inputs – energy, material, and services.[16] For any given intermediate input (energy, material, or services), the intermediate input price for any industry is obtained as the weighted sum of wholesale prices of each commodity used by that industry, with the weights being the share of these commodities in the total basket of the intermediate inputs. For instance, the intermediate price deflator for energy input in the agricultural sector is the weighted sum of wholesale prices of all energy inputs (e.g. electricity, gas) used by the agricultural sector, with weights being the share of each of these inputs in total energy consumed by this sector. These weights are obtained from IO tables and the wholesale prices are obtained from the Ministry of Commerce and Industry, Government of India.

Gross value added (GVA): NAS provides estimates of GVA by industries at both current and constant prices since 1950. We use the GDP data since 1980 from the most recent National Accounts series which is based on 2004–2005 prices. GDP estimates are adjusted for Financial Intermediation Services Indirectly Measured (FISIM). The value of such services forms a part of the income originating in the banking and insurance sector and, as such, is deducted from the GVA. The KLEMS sectors for which value added are directly taken from NAS are the agriculture sectors, mining, electricity, construction, manufacturing, and the service sectors. For manufacturing sectors, registered and unregistered segments from NAS are added. As in the case of output, for sectors where no KLEMS industry classification was available, we use additional information from ASI and NSSO to arrive at desired KLEMS sector estimates. The estimates of real value added for each industry are arrived at by subtracting real intermediate input from real gross output, i.e. using a double deflation approach.

Employment and labor composition: National Accounts does not provide data on employment. Therefore, we rely on Employment and Unemployment Surveys (EUS) published by NSSO every five years.

[16] This approach is similar to Balakrishnan and Pushpangadan (1994), who were the first to use a double deflated value added function to estimate productivity growth in India's organized manufacturing sector.

EUS provides estimates of work participation rates by sectors classified on the basis of National Industrial Classification (NIC), which are used to derive number of employees in each sector using population estimates from various population censuses. However, EUS provides more than one definition of employment based on activity status, which are usual principal status (UPS), usual principal and subsidiary status (UPSS), current weekly status (CWS), and current daily status (CDS). Since UPSS is the most liberal and widely used of these concepts, we estimate the number of employed persons using UPSS definition (Aggarwal 2004).[17]

We obtain numbers of all persons employed including self-employed in each industry, using UPSS assumption from the EUS. However, our measure of labor input also takes account of worker heterogeneity in terms of educational attainment and therefore, following Jorgenson *et al*. (1987) we define labor input in any industry j (Lj) as a Tornqvist volume index of workers by individual labor types '*l*' categorized on the basis of educational attainment:

$$\Delta \ln \mathrm{L_j} = \sum\nolimits_1^5 \overline{\mathrm{v}}^{\mathrm{L}}_{\mathrm{l,j}} \Delta \ln \mathrm{L_{l,j}} \tag{4}$$

We use five education categories (l=5 in the above equation) namely: up to primary, primary, middle, secondary and higher secondary, and above higher secondary. The weights $\overline{v}^{L}_{l,j}$ are obtained as the compensation share of worker category *l* in total wage bill of industry j, averaged through current and previous year i.e.

$$\overline{v}^{L}_{l,j} = \frac{P^{L}_{l,j} L_{l,j}}{\sum\nolimits_l^5 P^{L}_{l,j} L_{l,j}} \tag{5}$$

The EUS also provides statistics on compensation received by regular and casual workers in each industry, and can be directly used. However, it does not provide any information on wages of self-employed. To obtain a complete picture of wage composition, we supplement the

[17] However, UPSS definition suffers from limitations such as: (1) it seeks to place as many persons as possible under the category of employed by assigning priority to work; (2) there is no single long-term activity status for many as they move between statuses over a long period of one year; and (3) it requires a recall over a whole year of what the person did, which is not easy for those who take whatever work opportunities they can find over the year or have prolonged spells out of the labor force.

wage data directly obtained from EUS for casual and regular workers by econometrically estimated self-employed compensation (see Aggarwal and Erumban 2013).

Note that equation (4) can be decomposed into pure employment growth, measured by the growth rate of aggregate employment (sum of all workers, disregarding their skill differences), say $\Delta \ln H = \Delta \ln \sum_l L_l$ and a labor composition effect $\Delta \ln LC$. If the proportion of highly educated workers is increasing, the later component will be positive, suggesting an improving quality of work force. Thus, subtracting $\Delta \ln H$, the growth rate of aggregate employment from (4), we obtain the labor composition growth rates. In our growth accounting equations (1) and (2) we divide our labor input L, into the contributions of pure labor quantity, $\Delta \ln H$ and that of labor composition $\Delta \ln LC$.

Capital services: As in the case of labor input we measure capital input in any given sector j (K_j) as a Tornqvist volume index of individual capital assets as follows:

$$\Delta lnK_j = \sum\nolimits_k \overline{v}^K_{k,j} \Delta lnK_{k,j} \tag{6}$$

where ΔlnK_j is the growth rate of aggregate capital services in any given industry j, $\Delta lnK_{k,j}$ is the growth rate of capital stock in asset k (we distinguish between three types of capital assets: construction, machinery, and transport equipment) and the weights $\overline{v}^K_{k,j}$ are given by the period average shares of each type of asset in the total value of capital compensation, such that the sum of shares over all capital types adds to unity. The asset shares in total capital compensation are calculated as:

$$v^K_{k,j} = \frac{P^K_{k,j} K_{k,j}}{\sum_k P^K_{k,j} K_{k,j}} \tag{7}$$

where individual capital stocks K_K are estimated using standard perpetual inventory method (PIM) with geometric depreciation rates:

$$K_{k,j,t} = K_{k,j,t-1}(1 - \delta_k) + I_{k,j,t} \tag{8}$$

and the rental prices of capital $p^K_{k,j}$ are computed as

$$P^K_{k,j,t} = P^I_{k,tj,-1} i^*_t + \delta_k P^I_{k,j,t} \tag{9}$$

where p_k^I is the investment price of asset k, i^* is real external rate of return and δ_k is the assumed geometric depreciation rate of asset k.[18] We assume a depreciation rate of 2.5% for construction, 8% for machinery, and 10% for transport equipment, based on a double declining balance rate derived using the average lifetimes of these assets used in the National Accounts. We measure the real external rate of return, i^* by a long-run average of real bond rate and market interest rate, obtained from Reserve Bank of India. Nominal investment and investment deflators by asset type (I_k) and industries are obtained from National Accounts, and therefore are consistent with our measure of output and value added.

As in the case of labor, one can also add up the capital stock measured in (8) across assets to obtain the growth rate of aggregate capital stock (K^s) in any given industry j as:

$$\Delta ln K_j^s = \Delta ln \sum K_{k,j} \tag{10}$$

The difference between (6), the growth rate of capital services, and (10), the growth rate of capital stock, reflects the compositional changes in the capital stock. This composition effect will be positive if the share of fast depreciating assets such as information and communication technology increases compared to slow depreciating assets such as buildings.

Labor Income: For empirically evaluating the relative roles of factor inputs and productivity in driving growth using growth accounting approach (equations 1 and 2) we also need the nominal compensation shares of factor inputs in value added and output. There are no published data on factor income in Indian economy at a detailed disaggregate level. The NAS publishes the net domestic product (NDP) series comprising of compensation of employees (CE), operating surplus (OS), and mixed income (MI) for the NAS sectors. However, this series does not separate the income of the self-employed persons, rather it is included in the mixed income (MI) category, which also includes

[18] In the present version of the India-KLEMS database, we use an external rate of return. However, one can also use an internal rate of return, which will ensure consistency with NAS (see Jorgenson and Vu 2005). Oulton (2007) suggests a hybrid approach, where both external and internal rates are used in the measurement of capital services and productivity. See Erumban (2008) for a discussion on the empirical implications of alternative approaches to the measurement of rental prices.

a capital component of the income. Therefore, to compute the labor incomes, one has to take the sum of the compensation of employees and the part of the mixed income that is wages for labor.

We delineate the self-employed income component from mixed income as: $CS^*_{j,t} = \eta_j MI_{j.t}$, where $CS^*_{j,t}$ is the estimated self-employed income, MI is the mixed income in industry j in year t obtained from National Accounts, and η_j is the fraction of mixed income attributed to self-employed workers. η_j, which is assumed to be a fixed parameter for each industry, is obtained as an average of two alternate measures of self-employed to mixed income ratio.

In the first case, the wages of the self-employed are estimated using a Mincer equation with Heckman two step regression procedure (see Aggarwal and Erumban 2013). Wages for regular and casual workers are regressed on workers' properties in terms of gender, age, education, location, socio-economic group, marital status, and industry dummies – all obtained from employment surveys. The estimated coefficients are applied to worker properties of self-employed, in order to estimate self-employed labor compensation. We estimate income of self-employed workers for each industry for six benchmark years of employment and unemployment surveys (i.e. t = 1983–1984, 1987–1988, 1993–1994, 1999–2000, 2004–2005, and 2009–2010). The ratio of thus obtained self-employed income to the NAS estimates of mixed income is considered as the first estimate of self-employed to mixed income ratio ($\eta 1_{j,t}$) in industry j. In other words, in this case, self-employed income is a direct estimate from NSSO employment surveys, based on income of regular and casual workers.

In the second approach, the proportion of self-employed income to mixed income is computed as: $\eta 2_{j.t} = \frac{CE_{j,t} \cdot_{j,t}}{MI_{j,t}}$, where CE is the compensation of employees from national accounts, θ is the ratio of estimated labor income of self-employed (CS^* in approach 1) and the labor income of regular and casual workers (CR) also from employment surveys ($_{j,t} = CS^*_{j,t}/CR_{j,t},$). The numerator $CE\,\theta$ provides self-employed income consistent with NAS. However, in this case, it is possible that the estimated $\eta 2_j$ exceeds one, in which case, we assumed it to be unity.[19]

[19] This has been the case for industries mining (in 2004–2005), electricity, gas, and water supply (in 1993–1994 and 2004–2005), and construction (in 1983–1984, 1987–1988, 1993–1994, and 1999–2000).

Finally, η_j is obtained as an average of $\eta 1_{j,t}$ and $\eta 2_{j,t}$, over the five benchmark years for which employment surveys are available. For industries for which estimates of CE and MI are available directly from NAS, η_j has been computed and applied directly.[20] For the remaining industries, the ratio of the higher industry aggregate has been applied.

Income shares of capital and intermediate inputs: Following constant returns to scale assumption, the capital income share in value added is obtained as a residual: it is defined as one minus labor income over gross value added (GDP). Shares of intermediate inputs in gross output are directly obtained from their nominal cost divided by nominal gross output, and again the residual after adjusting for intermediate and labor shares in gross output, we obtain capital income share in gross output.

7.4 Sources of economic growth: results

7.4.1 Productivity growth in major sectors of the economy

Using equation (1) we decompose the growth rate of GDP into contribution of capital services (capital stock and capital composition), labor input (employment and labor composition), and TFP growth. In Figure 7.1 we depict GDP growth along with input and productivity contributions in agriculture, manufacturing, and market services sectors of the economy in the 1980s, 1990s, and 2000s.[21] The overall economy-wide productivity shows a moderate increase in the 1990s compared to the 1980s. However, aggregate productivity growth fell marginally from 1.4% during 1992–1999 to 1.2% during 2001–2011, thus being back to the rate at which it grew during 1981–1990. The stagnant productivity growth even while the economy is growing faster suggests a decline in the relative share of TFP growth in aggregate

[20] These are industries agriculture, mining and quarrying, total manufacturing (but not by sub-sectors), electricity, construction, trade, hotels and restaurants, transport and storage, communication, financial services, public administration, and all other services (available separately for real estate and business services, ownership of dwelling, social and personal services, and other services).

[21] Results for non-manufacturing industries and non-market services are not discussed here, but are available in the detailed industry results section.

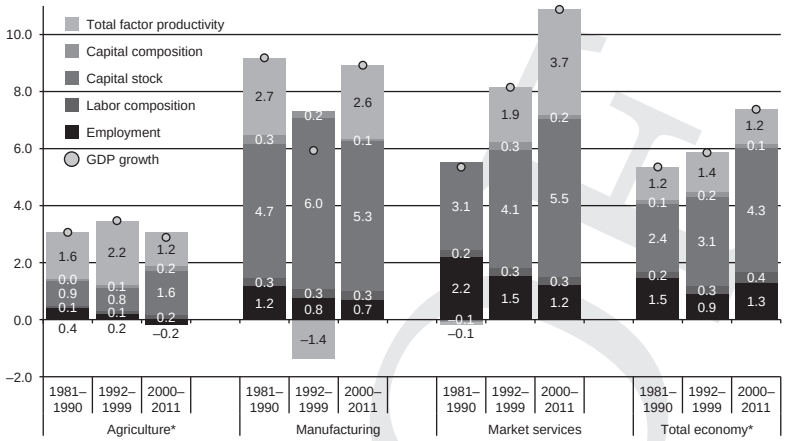

Figure 7.1 Contribution of factor inputs and total factor productivity growth to GDP growth, 1980–2011

growth. Whereas TFP growth contributed 22% of output growth (1.2 percentage points out of 5.4%) during 1981–1990, and 24% (1.4 out of 5.9%) during 1992–1999, it declined by almost 8%to 16% (1.2 out of 7.4%) during 2000–2011. In the subsequent analysis we will see this decline has been largely driven by the non-market economy. Almost 45% to 60% of output growth during the entire period of analysis has been due to capital, whereas the contribution of workers (excluding the contribution of labor quality) declined from 27% in the 1980s to 16% in the 1990s and increased only marginally to 18% during the 2000s.

Productivity growth in agriculture: TFP growth appears to be an important driver of output growth in the agricultural sector throughout the period. The 1980s was a period of a widespread green revolution in Indian agriculture across different crops, which is often argued to have impacted agricultural growth positively (Binswanger-Mkhize 2013).[22] Our results suggest that more than half of the output growth in the 1980s was due to productivity gain in the sector, whereas one-third of the growth was due to increased capital services (sum of capital

[22] Indeed the green revolution in the 1980s also helped to improve the rural income and create a market for non-agricultural products and services which might also have helped growth in other sectors in the 1980s.

stock and capital composition). In the 1990s, almost 65% of total value added growth is due to increased TFP, which grew at 2.2% per annum. Certainly, the surge in TFP growth from 1.6% in the 1980s to 2.2% has been clearly the source of acceleration in value added growth, while the contribution from capital services has remained the same at 0.9 percentage point. However, capital services increased its contribution substantially during the 2000s, while that of TFP growth declined. The increased contribution of capital in the agricultural sector is, perhaps, due to increased mechanization of the sector. This is also evident from the declining contribution of employment, even dragging output growth down during the 2000s with a contraction in employment. However, the labor composition contribution has been increasing, though marginally, over time.

The observed acceleration in agricultural productivity growth in the 1990s, however, seems to defy previous findings. A strict comparison of our results with previous studies is less feasible due to both methodological differences and the time period covered by previous studies. However, we provide a broad comparison for the 1980s, 1990s, and 2000s using select studies on sectoral productivity in Indian economy. Fuglie (2012) reports TFP growth of 2% during 1981–1990 in agriculture, which declined by almost half a percentage point during 1991–2000. Our estimate for the 1980s is lower by 0.4 percentage points at 1.6%, and moreover, it suggests an increase during 1992–1999. This opposing trend is driven by the fact that we exclude 1991 from our analysis of the 1990s (see footnote 10). Therefore, for comparison purposes we recalculated the average TFP growth using our data for comparison.[23] In 1991, agricultural TFP growth fell by –3.2%, and if we include it in our estimates, our TFP growth estimates for the 1990s will be 1.2%, which is 0.6 percentage point lower than the TFP growth in the 1980s. Our estimates for 2000–2007 is 1.5% compared to their estimate of 1.9%, both suggesting an increase over the 1990s, whereas in the post-2007 years TFP growth has fallen, thus causing our estimate for the entire 2000s decade to decline. Thus the trends in our results are comparable to that of Fuglie (2012), though the growth rates are lower.

Bosworth and Collins (2008) also see a decline in productivity growth from 1.0% during 1978–1993 to 0.5% during 1993–2004,

[23] This has been done for all studies compared in subsequent sections.

which is a trend that is consistent with our results, as well for the same period (a decline from 1.4% to 0.9%).[24] However, our estimate is higher by 0.4 percentage point in both periods. Bosworth and Maertens (2010) report a productivity growth of 1.9% compared to 1.6% in our estimate, in the 1980s, which declines drastically to 0.7% during the 1990s, which is again primarily due to a massive decline in 1992. Our estimate also suggests a decline in the 1990s (if the same period is considered), but not to the same magnitude. This clearly suggests that the agricultural productivity decline in the 1990s, reported by previous studies, is primarily driven by the sharp decline in 1991, a year of severe economic imbalances in Indian economy.

Productivity growth in manufacturing: While the agricultural sector registered the highest growth in the 1990s, the golden period of India's *manufacturing* seems to be the 1980s, during which it registered nearly 10% growth rate with about 30% coming from increased TFP growth. Nevertheless, capital remains the single largest contributor to growth in manufacturing throughout the period. Its contribution averaged around 73%, varying from 55% (5 out of 9.2 percentage points) in the 1980s to more than 100% (6.2 out of 5.9 percentage points) in the 1990s, though declined to about 60% in the 2000s (Figure 7.1).

TFP growth has been substantial in driving manufacturing growth in the 1980s, with 2.7% of TFP growth.[25] However the 1990s, the period of massive liberalization focusing on manufacturing, has seen a deceleration in TFP growth, registering –1.4%, being the primary cause of a declining value added growth. During this period, contribution of capital services increased while that of labor composition remained the same as in the previous period. Even though employment contribution declined, the main source of growth deceleration was the deceleration in TFP growth. A turnaround in productivity is seen in the 2000s, arguably suggesting the lagged effect of substantial liberal

[24] As in Bosworth and Collins (2008), we also include land as part of our capital input in agricultural sector, though we do not present its contribution separately. Bosworth and Collins (2008) have shown that the role of land, however, is negligible in explaining aggregate growth.

[25] Ahluwalia (1991) has argued that there has been a turnaround in productivity growth in the organized manufacturing sector in the mid-1980s, owing to the economic policies of the 1980s. Such conclusions, however, are often contested on methodological grounds (Hulten and Srinivasan 1999; Balakrishnan and Pushpangadan 1994).

market reforms in the 1990s, registering 2.6% (almost 30% of total value added growth). The contribution of employment growth has declined in the 1990s, and remained at about 0.7 percentage point in the 2000s, while labor quality maintained a contribution of 0.3 percentage point.

This sluggish productivity performance in the Indian manufacturing sector in the 1990s is largely confirmed by previous studies that looked at the productivity growth in the registered manufacturing (Goldar 2004; Kathuria *et al.* 2010). There is hardly any study that looks into the manufacturing sector as a whole which makes a strict comparison of our results less possible. A recent study by Kathuria *et al.* (2010), which looks into the productivity performance of both organized and unorganized manufacturing, suggests a large and increasing gap in TFP growth between the two segments, with the unorganized productivity growth being substantially lower than the organized.[26] Clearly the productivity differences between organized and unorganized sector reflects in the aggregate manufacturing productivity. They also confirm a negative productivity growth in the manufacturing sector – both in organized and unorganized – in the 1990s, which is in conformity with our finding. A weighted average of their registered and unregistered manufacturing results, using relative shares of value added, suggests a negative TFP growth in the 1990s, which is close to our estimate of –1.4%. However, if we stick to their periodization, our results are even worse, at about –2% for 1994–2001 period. For the 2000s, our results are quite impressive for the entire 2000–2011 period, and for 2000–2007 it is just 0.5% compared to almost –4% in their estimates.

Even after several improvements in data and measurement, our results confirm that manufacturing – inclusive of formal and informal – has not performed well in the 1990s in terms of productivity growth. Clearly the sector has been pursuing a capital intensive growth path, accompanied by considerable productivity growth in the 1980s, while

[26] Their results suggest that the unorganized sector TFP growth has been negative and 4% lower than the organized sector during 1994–2001, while it deteriorated further to 19% lower than formal productivity growth during 2001–2005. A strict comparison of our results with Kathuria *et al.* (2010) is not feasible, as they provide a simple average of regional manufacturing TFP growth by registered and unregistered separately. What we compare here is an average of the registered and unregistered regional averages, to obtain a comparable national TFP growth, which is what we are interested in.

the 1990s was a period of productivity slow down. Both investment growth and job creation has declined in the 2000s, whereas the sector's overall efficiency in using these resources has improved, even though output growth has not surpassed its performance in the 1980s. Certainly, the sector needs further boost for rapid expansion both in terms of employment and output. Nevertheless, it is worth mentioning that the policies in the 1980s and 1990s seem to have paid off in terms of productivity gain in the sector, though after a time lag.

Productivity in services: While the 1990s was a period of productivity slowdown in manufacturing, interestingly it has been a period of rapid productivity growth in the market services sector. TFP grew at an annual average rate of 1.9% during 1992–1999, as compared to a decline at –0.1% during the previous decade. The contribution of capital services also increased substantially, while that of employment declined. Thus, clearly the increased service sector growth in India in the 1990s can be largely attributed to productivity growth (also see Verma 2012) and capital accumulation. Market service sector productivity growth continued to be high and positive in the 2000s, and it grew at a much faster rate compared to the 1990s. It registered a 3.7 average TFP growth during 2000–2011, which is higher than the TFP growth in manufacturing and agriculture. Contribution of capital to output growth also increased during this period, while that of employment declined marginally and that of labor composition remained the same. The growth acceleration in the Indian economy is therefore largely due to accelerated productivity and capital accumulation in the market service sector, while the manufacturing sector still needs to raise the speed at which it grows.

A broad comparison of our results with those of Bosworth and Collins (2008), which is one of the very few studies that looks into productivity growth in the entire economy, suggests the trend in our results are quite comparable for the service sector. They report a TFP growth of 1.4% during 1978–1993, whereas our estimate for the entire services economy (including market and non-market segments) suggests 1.1% productivity growth during the same period, which in our case increased to 2.4% during 1993–2004, whereas their estimate increased to 3.9%. Indeed, both suggest acceleration in productivity growth in the 1990s, though the acceleration in our estimates for the entire service sector is much less.

A major part of the differences between our results and previous studies can be attributed to several methodological and data improvements. If factor inputs are not properly accounted for their compositional differences, which is the case with several previous studies on the Indian economy, it is likely that TFP growth will be overstated. For instance, if we add labor and capital composition effects to our measured TFP growth, we will have a TFP growth closer to 2% in both the 1990s and the 2000s. Our analysis also relaxes the assumption of constant factor income share in GDP, which is the case in several studies in the context of aggregate economy growth accounting. Bosworth and Collins (2008), for instance, assume a constant wage share of 0.6 over time and across sectors, whereas our data – which includes estimated income of self-employed workers – suggests that on average during 1980–2011 wage share in GDP varied from 9% in the petroleum sector to 77% in construction and 85% in public administration. We allow factor income share to vary across years and industries, which will also have an impact on measured productivity growth. For instance, if we assume a wage share of 0.6, as in Bosworth and Collins (2008), our TFP growth estimates for the 1990s and 2000s approximates to about 2%, which is closer to their estimate.

7.4.2 Sectoral contributions to aggregate productivity growth

Given that the service sector is expanding and manufacturing sector is shrinking in terms of their relative size in the overall economy, productivity growth in the service sector would be decisive in driving aggregate productivity growth. In Table 7.3, we provide the contribution of various sectors of the economy to aggregate TFP growth. These are arrived at using their relative shares in nominal GDP as weights.

The aggregate TFP growth in the 1980s was driven by both manufacturing and non-manufacturing sectors (also see Balakrishnan and Parameswaran 2007), primarily by non-market services and agriculture. Other industries which include market services and non-manufacturing industries (utilities and construction) pulled productivity growth down, with high negative contribution from non-manufacturing industries, and almost no contribution from market services. Within manufacturing low labor intensive sectors had a relatively larger TFP growth contribution, though the differences between low and high

Table 7.3 *Sectoral contribution to aggregate total factor productivity*

	1981–1990	1992–1999	2000–2011
Agriculture	0.52	0.60	0.23
Industry	0.09	–0.28	0.12
Manufacturing	0.44	–0.21	0.39
High labor intensive	0.15	–0.16	0.14
Medium labor intensive	0.10	0.11	–0.04
Low labor intensive	0.19	–0.16	0.29
Non-manufacturing industries	–0.35	–0.07	–0.27
Services	0.51	1.06	0.92
Market services	–0.02	0.48	1.09
Non market services	0.53	0.58	–0.17
Market Economy	0.59	0.81	1.45
Total economy	**1.15**	**1.39**	**1.21**

Note: Market economy consists of all sectors excluding non-market services. Non-manufacturing industries are utilities (electricity gas and water) and construction. For manufacturing sector classification based on labor intensity and details on other industry aggregations, see Appendix Table 7.1.
Source: Author calculation using India KLEMS data.

labor intensive manufacturing sectors in terms of TFP growth contribution are not large.

However, the picture started changing in the 1990s, as market services started picking up substantially, and manufacturing, in particular high- and low-labor intensive manufacturing sectors, witnessed productivity slowdown. Agriculture and non-market services continued to grow faster in the 1990s, each contributing approximately 40 percent of aggregate productivity growth. This clearly suggests that immediately after the market reforms in the 1990s, productivity gains in the manufacturing sector were less evident, while the accompanied information and communications technology (ICT) revolution might have helped India's market service sector gain productivity growth.

In the 2000s, the period of high growth in India, most of the productivity gains are due to market services. Even though manufacturing contribution has increased in the 2000s, primarily due to low-labor intensive segments within the manufacturing sector, more than 90 percent of productivity gain was from market services. Interestingly, contribution of high-labor intensive manufacturing also increased during this period, while medium labor intensive segments witnessed a

slowdown. Productivity contribution from agricultural as well as non-market services declined significantly during this period.

Also, there is a large difference in the productivity pattern in the 2000s compared to the 1980s and 1990s. In the 1980s 53% (0.6 out of 1.2% TFP growth) of aggregate productivity was driven by the market sector (both manufacturing and services) and 47% was driven by the non-market economy. In the 1990s the market economy increased its productivity contribution to 58% (0.8 out of 1.4) and in the 2000s its contribution has gone up to 114% (1.4 out of 1.2), during which the non-market economy witnessed a deceleration in productivity, thus pulling down aggregate productivity by almost 14%. The non-manufacturing industries, which are largely utilities and construction, had a negative productivity contribution throughout. The utilities sector in India largely operates under administrative control. If this sector is also excluded from the market economy, then the contribution of the market economy to aggregate productivity growth increases to 135% (i.e. 1.7 percentage points out of 1.2% TFP growth) in the 2000s. Indeed, the market economy has taken over the productivity drive, which is suggestive of the impact of policy reforms aimed at promoting market principles. TFP growth in the market economy grew at an annual rate of about 2% in the 2000s, compared to 0.8% during 1980s and 1% during the 1990s. Below we will examine which sectors within and outside of market services that gained productivity acceleration in 2000s.

7.5 TFP growth in India using aggregate production function

Using equation (2) we computed the output growth decomposition of all the twenty-six industries in the KLEMS database. The results for the three sub-periods are given in Figure 7.2. Also, in Table 7.4, we provide the sectoral TFP growth obtained using a value added function (equation 1), along with value added/output ratio, the product of which provides the gross output based TFP growth presented in Figure 7.2. Capital is the main driver of growth in the mining and education sectors in the 1980s, while intermediate inputs drive output growth in almost all other sectors. In the manufacturing industries contribution of intermediate inputs is substantial in driving output growth, which is in conformity with many previous studies on organized manufacturing in Indian economy (Banga and Goldar 2007).

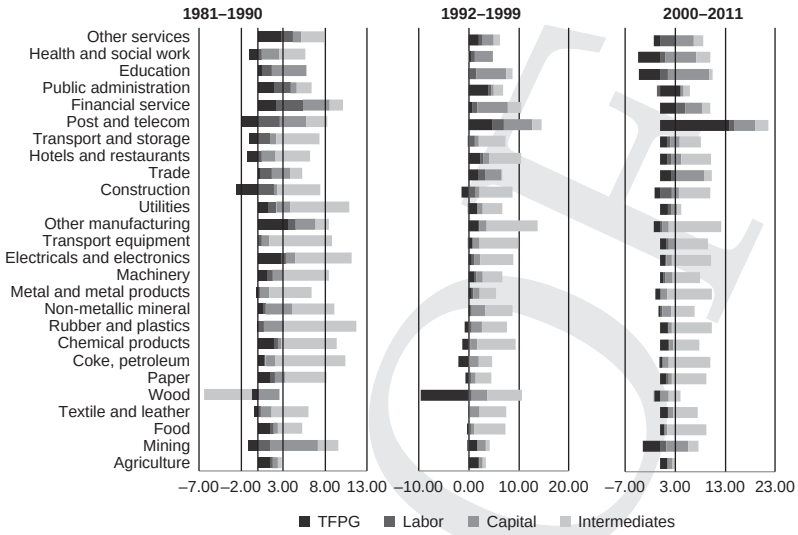

Figure 7.2 Decomposition of output growth into contribution from factor inputs and TFP growth, twenty-six industries, 1980–2011

Industries such as rubber and plastics, transport equipment, chemical products, and electrical and optical equipment were ranked high in terms of material contribution. TFP growth played an important role in some sectors, which includes electrical and optical equipment, chemical and chemical products, food products, beverages and tobacco, financial services, and agriculture. In particular, the first three industries registered 8 to 10 percent productivity growth in the 1980s.

The picture changed substantially in the 1990s, where TFP growth almost vanished in a large number of manufacturing sectors, while some service sectors like post and telecom showed high productivity growth. There was no industry that registered a TFP growth of the similar magnitude that was witnessed in fast growing sectors like electrical and optical equipment and chemical and chemical products in the 1980s. Moreover, the role of capital also increased substantially across all the service sectors, while manufacturing output growth was largely material driven. Electrical and optical manufacturing, transport equipment, wood and wood products, and chemical and chemical products had the highest material contribution among the twenty-six industry groups.

Table 7.4 *Sectoral total factor productivity using value added function and value added/output ratio*

	Total factor productivity growth (value added based)			Value added/output ratio		
	1981–1990	1992–1999	2000–2011	1981–1990	1992–1999	2000–2011
Agriculture, hunting, forestry, and fishing	1.6	2.2	1.2	0.72	0.75	0.76
Mining and quarrying	–1.5	2.3	–4.5	0.75	0.74	0.77
Food products, beverages, and tobacco	8.0	–1.8	5.2	0.19	0.19	0.15
Textiles, textile products, leather, and footwear	–1.5	0.3	6.1	0.31	0.29	0.25
Wood and products of wood	–2.2	–20.3	–2.5	0.43	0.47	0.39
Pulp, paper, paper products, printing, and publishing	5.0	–2.6	5.7	0.28	0.26	0.24
Coke, refined petroleum products, and nuclear fuel	7.5	–16.0	1.9	0.09	0.14	0.14
Chemicals and chemical products	9.8	–6.3	7.5	0.19	0.22	0.22
Rubber and plastic products	–0.6	–4.8	8.6	0.23	0.20	0.17
Other non-metallic mineral products	1.7	1.0	–0.9	0.36	0.33	0.31
Basic metals and fabricated metal products	–1.1	2.7	–5.0	0.23	0.22	0.19
Machinery, nec.	3.7	4.7	1.8	0.27	0.24	0.26
Electrical and optical equipment	10.1	2.8	4.7	0.27	0.22	0.21

Table 7.4 (*cont.*)

	Total factor productivity growth (value added based)			Value added/output ratio		
	1981–1990	1992–1999	2000–2011	1981–1990	1992–1999	2000–2011
Transport equipment	0.0	4.7	7.2	0.21	0.17	0.18
Manufacturing, nec; recycling	7.8	5.0	−6.5	0.46	0.36	0.21
Electricity, gas, and water supply	3.0	4.5	4.5	0.39	0.36	0.38
Construction	−7.5	−4.4	−3.5	0.34	0.34	0.34
Wholesale and retail trade	0.4	2.4	2.6	0.71	0.79	0.84
Hotels and restaurants	−4.3	6.6	4.3	0.30	0.34	0.33
Transport and storage	−2.2	−0.2	3.2	0.48	0.45	0.42
Post and telecommunication	−2.2	5.5	17.7	0.83	0.84	0.78
Financial services	2.7	1.1	4.0	0.81	0.81	0.80
Public administration and defense	2.6	5.3	5.4	0.73	0.73	0.74
Education	0.6	0.1	−4.8	0.86	0.88	0.89
Health and social work	−2.5	0.6	−7.0	0.38	0.51	0.62
Other services	3.4	2.4	−1.7	0.80	0.81	0.79

Note: TFP growth in this table is based on value added function (equation 1). The gross output based TFP growth presented in Figure 7.2 is the product of TFP growth presented in the first three columns here, and the value added/output ratio given in the last three columns (see equation 3).
Source: Author calculation using India KLEMS data.

In the 2000s, the economy started regaining productivity growth in some sectors, with market services being the largest recipient. In particular, post and telecom and financial intermediation sectors had registered high TFP growth, while non-market sectors education, health, and other services had negative TFP growth. The manufacturing sector seemed to be moving out of the negative TFP growth territory in the 2000s, with most sectors except wood and wood products, other non-metallic minerals, and other manufacturing, registering a positive TFP growth. Nevertheless, the relative role of materials in driving output growth is dominant, and the role of capital is less than what is seen in the service sector. In general employment contributions were larger in the financial service, post and telecom, public administration, education, and construction sectors during all the three periods.

Thus, in general, output growth in the Indian economy, particularly in goods producing sectors, is heavily material driven. This is not surprising, given the material intensity of these sectors, compared to, for instance, most services sectors. There is, nevertheless, clear indication that the market economy in general has witnessed an improvement in TFP in the post-2000 period. Moreover, the increasing intermediates' contribution could also be a reflection of increased outsourcing and vertical specialization of trade. As is shown by the recent World Input–Output Database (Timmer *et al.* 2015, see also Chapter 15 in this volume), the imported intermediate content of India's export has been increasing steadily since 1995, and in particular in the 2000s, which might suggest the increased use of intermediate inputs to increase output and exports. This aspect, however, requires further examination, which is beyond the scope of this chapter.

While the sectoral productivity growth rates provided in Table 7.4 and Figure 7.2 are insightful and informative on the performance of individual industries, it is hard to get a visual image of the pattern of productivity growth across industries – whether it is concentrated in some specific sectors or widespread across the board. To understand how widespread productivity growth and its changes are within the Indian economy during the last three decades, we use the Harberger diagram (Harberger 1998). The Harberger diagram, which plots the cumulative contribution of industries to aggregate productivity growth against the cumulative share of these industries, provides a graphical

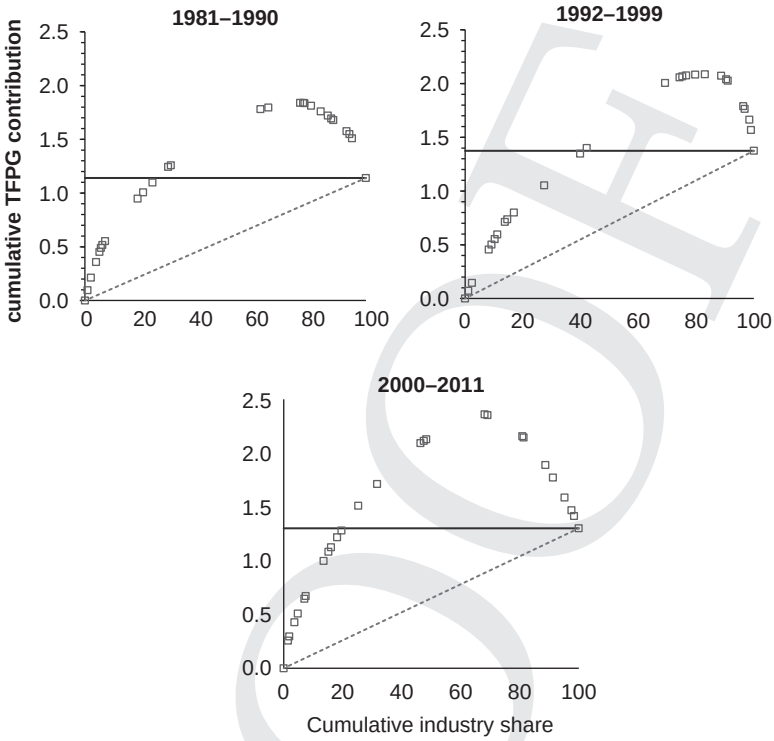

Figure 7.3 Harberger diagrams of aggregate total factor productivity growth in the Indian economy

summary of the industry pattern of productivity growth (Timmer *et al.* 2010).[27]

Figure 7.3 provides the Harberger diagrams for the three periods. Further, in Table 7.5 we provide the pattern of aggregate economy TFP growth over the three sub-periods, using useful summary statistics from Harberger diagram (see Inklaar and Timmer 2007). The first row of the table suggests a picture of stagnant productivity growth in

[27] To plot the Harberger diagrams, we first rank the industries according to their TFP growth. Then the cumulative contribution of industries (i.e. the share weighted TFP growth of each sector) is plotted against the cumulative shares of these industries (Timmer *et al.* 2010; Harberger 1998). The resulting curve, which is concave in shape, tells us how equal the distribution of productivity growth across industries is. The area under the curve will be less if growth is broad-based ("yeast-like" pattern), and it will be larger if the growth is concentrated in a few sectors ('mushroom-like" pattern).

Table 7.5 ***Pattern of aggregate economy TFP growth, 1981–2011***

	1981–1990	1992–1999	2000–2011
Aggregate TFP growth	1.2	1.4	1.2
Percentage of industries with positive TFP growth	61.5	69.2	65.4
Value added share of industries with positive TFP growth	77.7	83.1	68.1
Relative area under Harberger	0.55	0.59	0.55

Note: Value added-based TFP growth aggregated using value added shares. Relative area under Harberger is the curvature measured by the area between the diagram and the diagonal line (dotted line in Figure 7.3) divided by the total area below the diagram.
Source: Author calculation using India KLEMS data.

the Indian economy over years, which stayed at a range of 1.2% to 1.4%. However, the number of industries with positive TFP growth has increased in the post-liberalization period. Before the liberalization regime, there were about 62% of industries with positive TFP growth, which has increased to 69% during the 1990s (also see the next section). However, in the 2000s, this declined again to 65%, still being higher than the 1980s. Thus even when more industries were registering positive TFP growth, aggregate TFP growth does not seem to be increasing faster. This is because the relative size of these industries in aggregate GDP in the 2000s is lower than it was in the 1980s, though it was about 5% higher in the 1990s. As evident from the figure, while the positive contributions from industry TFP growth to aggregate TFP growth added up to 1.8 percentage points in 1980s, it added up to 2.1 and 2.4 percentage points respectively in the 1990s and 2000s. The negative contributions added up to –0.7 percentage point in both the 1980s and 1990s and up to –1.1 percentage points in the 2000s, pulling down aggregate TFP growth.

The last row of the table shows the area under Harberger – the area between the curve and the dotted line in the figure – which will take a value between 0 and 1, with it being zero when all industries have equal growth. The closer the relative area to one, the more divergent the growth rates across industries. The relative area did not change in the 2000s compared to the 1980s, whereas it increased marginally in 1990s. Even though there is no substantial difference in the relative

area statistics between three decades, this pattern is suggestive of a relatively more uneven growth in the 1990s compared to the 1980s and 2000s. TFP growth was not broad-based, rather it seem to have become more "mushroom-like" (i.e. being concentrated in a few industries), rather than "yeast-like" (i.e. being spread across all industries).

7.6 Productivity under policy regimes: a discussion

India's economic policy regime since independence to the present time has been a mix of socialism and market experimentation followed by an open economy (see Virmani 2004). Out of the several policy reforms initiated, two stand out in the context of productivity improvements. They are the domestic industrial deregulations and the external trade reforms, as these potentially allow firms a level playing ground to face international competition and in turn become globally competitive. In Figure 7.4, we look into the specific industries which performed better in 2000s compared to the 1990s. We distinguish between: (1) positive TFP growth in the 1990s as well as the 2000s; (2) positive TFP growth in 2000 only; (3) negative TFP growth in both the 1990s and the 2000s; and (4) positive TFP growth in the 1990s only.

We find that nine out of twenty-six industries had positive productivity growth both in the 1990s and the 2000s, with five of them being in the service sector, and within which post and telecommunication being the best performer. The telecommunication sector has been a national development priority since the 1980s. Whereas the 1980s was a period of state dominance and administrated prices, telecom services (and the service sector in general) in India witnessed massive liberalization with increased role for private sector and foreign participation in the post-1990s. Significant reforms took place in 1984, 1999, and the 2000s, including delicensing of telecom equipment manufacturing.[28] The sector seems to have benefitted from these policies; we see a productivity growth that outpaces many other sectors.

[28] These reforms include: allowing foreign collaboration, setting up of a national telecom policy in 1994, opening up of value added services to private and foreign players, setting up of the Telecom Regulatory Authority of India in 1997 to separate regulatory functions from policy-making, allowing multiple fixed services operator and opening domestic long distance services to private operators in 1999, a broad band policy initiative in 2004, regulation on quality of service introduced in 2006, and allowing increased FDI participation in telecom services in 2012.

Other industries that registered positive productivity growth in both periods include financial services, trade, hotels and restaurants (all service sectors), electrical and optical equipment, transport equipment and machinery (manufacturing), and agriculture (Figure 7.4). Though the core of economic reforms of 1991 centered on trade and industrial policy changes, significant changes were also introduced aiming to create a competitive and efficient financial sector.[29] The reforms put in place envisaged to take care of the fiscal deficit issues through augmenting revenues by removing anomalies in the tax structure through restructuring, simplification, and rationalization of both direct and indirect taxes. Aiming to create a competitive as well as efficient financial sector, several reforms were also introduced in the debt and securities markets as well as in the banking and insurance sectors. Historically, banking sector in India has been highly state dominated, ever since the banks were nationalized in 1969. This picture started changing drastically, as several reforms, varying from liberalization of the sector in the mid-1990s to allowing increased foreign participation in the early 2000s, were introduced to enhance competition in the sector. Similar reforms were also introduced in the insurance sector, even though at a slower pace. Indeed, these policies have helped the sector gain substantial productivity improvement. However many issues still remain for policy advocacy, which includes promoting competition, bringing financial stability, and strengthening inter-regulatory coordination (Krishnan 2011).

Apparently, the manufacturing industries that gained productivity growth in the post-reform period are primarily equipment producing industries, including the ICT goods producing sector. It is important to point out here that these sectors were beneficiaries of delicensing, broad banding, capacity reendorsements, and scale expansions announced in the India's industrial policy reforms of the mid-1980s and further liberalization in the 1990s.[30] The delicensing announced in the mid-1980s encompassed industries such as machinery and machine tools, electronics, electronic components, iron and steel, automotive components, and drugs and chemicals.

[29] See Mohan (2006) for a list of several policy measures advocated for reforms in banking, the government securities market, and foreign exchange markets as well as a monetary policy framework.

[30] See Government of India (1986).

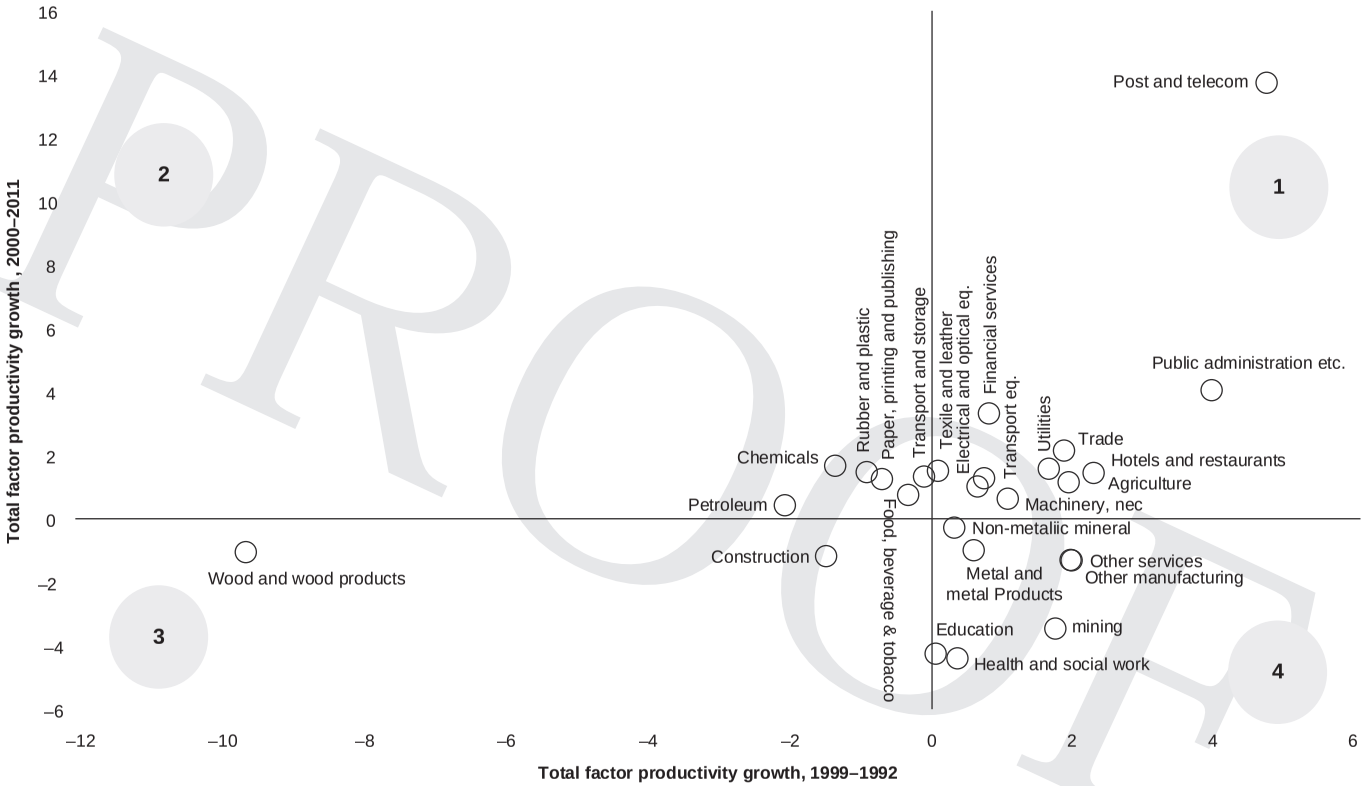

Figure 7.4 Productivity performance and policy regimes: 1990s versus 2000s

In terms of trade policy, the tariff levels in the 1980s remained high across all product groups. Indeed, the substantial tariff reforms in the 1990s along with removal of import restrictions on many of these industries have paved the way for productivity improvements in both the 1990s and 2000s.

The sectors in category 2, with positive productivity growth in 2000s, even though they had negative growth in the 1990s, include petroleum, chemicals, rubber and plastics, paper and paper products, and the only service sector in this group, transport and storage. Transport services, in particular air transportation, were opened to private players in the late 1990s, and apparently its impact on productivity seems to have appeared in the 2000s. India's airline industry has been predominantly a government monopoly until 1986, the year in which private participation was allowed in the sector and a limited number of players entered the market. With the Air Corporation Act 1994, and the subsequent massive entry of several low-cost service providers in 2003, the industry has seen fierce competition, which might have also helped the transport sector in general to acquire better productivity growth in 2000s.

Despite being in the list of industries subjected to delicensing, and exposed to trade liberalization, sectors like chemicals did not even see a positive productivity growth in the 1990s. It often seems that trade liberalization takes time to result in efficiency of firms as benefits of tariff reductions and import restrictions facilitates access to technology embodied in imported inputs as well as better imported inputs themselves (Das 2005).[31] Indeed these industries, which moved out of the negative territory in 1990s to positive TFP growth in the 2000s, along with transport equipment, electrical and optical equipment, and machinery and textiles, which maintained their positive TFP growth in both decades, helped the overall manufacturing sector register an improved productivity growth in the 2000s.

Two sectors that have witnessed negative productivity growth in both the 1990s and the 2000s (category 3) are construction and wood products. The construction sector is particularly interesting, because this is the sector that absorbed a large chunk of workers moving out of agriculture. The share of construction in total employment has

[31] Also see Topalova and Khandelwal (2011) and Chand and Sen (2002) for evidence on a lagged impact of policy changes on productivity growth.

increased from a mere 2% in 1980 to 3% in 1990, to 5% in 2000, and further to 10% in 2011. In contrast, its output share has increased from 5% in 1980 to only 8% in 2011, thus suggesting that its employment share has surpassed its output share. On average nearly half of the additional employment generated in the Indian economy between 2000 and 2011 is in the construction sector. There have been about 73 million more workers in the Indian economy in 2011, compared to 1999, out of which 32 million jobs were created in construction sector, thus driving down average productivity.[32]

The industries in group 4, registering positive productivity growth in the 1990s, but negative TFP growth in the 2000s are non-metallic minerals, basic metals and metal products, other manufacturing, and all non-market sectors except public administration and defense. Interestingly, one of the manufacturing sectors that lost the productivity momentum in the 1990s – basic metals and metal products – is one to which the post-independence policy reforms have given substantial importance, though it was not given any special importance in the later liberal policy reforms. Since a productivity analysis in the non-market sectors may not be very helpful, one may not give significant importance to the observed decline in its productivity in the 1990s. Yet, it may be noted that two major sectors within this group – health and education – in India needs to be enhanced in order to improve India's human capital, and thereby to improve productivity in other sectors (see our discussion below).

Thus, defying the growth path followed by countries like China, Japan, or South Korea, much of the growth and productivity in India has been in the service sector. This service output expansion, however, did not generate proportional employment growth. Given a large demographic dividend and a vast majority of its population still not high-skilled, one may doubt the ability of the Indian economy to sustain this service-led economic growth in the longer run.[33] This warrants particular attention, as most service sector industries that witnessed acceleration in productivity and growth

[32] Other notable sectors where jobs were created are other services (17 million) and trade (10 million), with agriculture losing about 14 million jobs. The entire manufacturing sector added only 10 million jobs, with the highest being in other manufacturing (2.7 million) and textiles (2 million).

[33] India's working age population is projected to increase while that of China will stagnate in the next two decades (UN population division).

are skill-intensive sectors such as telecommunication, financial services, and non-market sectors like public administration. The share of tertiary educated working age population in India is a mere 6 percent in 2010, which has increased only by 1 percent over a decade (Barro and Lee, 2013). In fact, several recent quality and accessibility indicators of education are suggesting mixed results. Most recent economic surveys (2014–2015) acknowledge that the overall standard of the Indian education system is well below global standards, and the learning levels have not improved. Even though the overall school enrolment ratio has gone up, the survey suggests stagnation in rural enrolment, decline in teacher–student ratios and in student attendance in rural areas. Moreover, the share of the formally skilled work force in India is as small as 2 percent, which is substantially lower compared to 80–95 percent in countries like Japan and South Korea (Government of India 2015). Therefore, if India does not invest substantially in improving both quality of and accessibility to education, it may fail in translating its demographic dividend into growth.

Another possible consequence of the service-led growth, with a shrinking manufacturing sector, would be a rise in wage inequality across sectors, as the service sector pushes up wages of high skilled workers, while a major chunk of (uneducated) work force still remains at primary and secondary sectors (Drèze and Sen 2013). There is a huge and increasing gap between the market services wage rate and the manufacturing wage rate; the latter has steadily declined from 75 percent of the former's wage rate in 1980 to 55 percent in 2011. On the contrary, if the increasing wages in the service sector lead to faster wage growth in the manufacturing sector, it might affect India's manufacturing competitiveness. Indeed, the impact of raising wages on competitiveness could be overcome only by achieving faster productivity growth, and thereby reducing unit labor cost.

However, rigidities in the (formal) labor market, the presence of a large informal sector, a weak infrastructure and insufficient energy availability are adding challenges to achieving higher productivity growth and job creation, particularly in the manufacturing sector. The lack of job creation even within the labor intensive sectors (Sen and Das 2014), along with the shrinking the organized manufacturing sector, clearly calls for substantial labor market reforms in India, to reduce rigidities in the labor market that make formal firms

shy away from expanding their activities. The inflexible labor regulations, indeed, foster faster expansion of the informal sector of the economy at the cost of a more productive and stable formal sector.[34] Another major supply side constraint on India's productivity growth is its weak infrastructure and insufficient energy availability. India's infrastructure spending has been relatively low at about 5 percent (with private sector spending even lower at 1 percent) of GDP (Planning Commission 2014; Mohan and Kapur, 2015), which is only half of Chinese spending. Therefore, policies that would help firms grow in size, modernization, and formalization of the informal sector, better environment for foreign investment, and better infrastructure, are among measures that would help the sector perform better in terms of productivity, growth, and employment generation.

7.7 Conclusions

This chapter attempted to explore the link between different policy regimes prevalent in India and productivity performance of the economy. In particular, the productivity dynamics for the period 1980–2011 – a crucial period of substantial policy changes – was examined from a policy perspective. Three different policy regimes were identified: (1) 1980–1990, a phase of piecemeal and ad hoc policy changes; (2) 1992–2000, a phase of major changes in economic policy; and (3) 2001–2011, a period of consolidation of economic reforms. The study was conducted at detailed industry level – dividing the entire economy into twenty-six subsectors – thus trying to understand the dynamics of policy effects at sectoral level. Using the India KLEMS database and a growth accounting methodology,

[34] As of 2011, within manufacturing, more than three-quarters of total employment is generated in the unregistered sector, whereas it produces less than only one-quarter of output (residual estimates based on India KLEMS total manufacturing and Annual Survey of industries registered manufacturing data). The story is not any different in the services sector. Depending upon the definition one uses, the informal employment share in services varies from 74–90 percent in 2006 (Ghani *et al.* 2013). Moreover the informality of the Indian economy has not shown any declining tendency. Rather, existing estimates are suggestive of moderate increase over time (Joddar and Sakthivel 2006).

we assessed the productivity performance of each of the individual industrial as well as broad sectors during the different policy regimes. Our analysis suggests that, indeed, the policy changes had substantial impact on productivity and economic growth in India, though it is still debatable whether the sectors that were intended to benefit from the reforms have really gained or not. The underlying data used in this study – the India KLEMS – is an important contribution to empirical research and policy-making, as it can help researchers better investigate India's economic growth and the underlying dynamics since the 1980s.

Overall, the Indian economy registered a moderate TFP growth rate of 1.2 percent during 1980–2011 without much deviation from the last three decadal averages. Market services seem to be the main driver of productivity growth both in the 1990s and 2000s, whereas agriculture, non-market services, and manufacturing all contributed to productivity growth in the 1980s. However, the productivity performance of the manufacturing sector, which showed a TFP growth of 2.6 percent in the 2000s as against a negative TFP growth in the 1990s, is commendable in the light of widespread consolidation of economic reforms initiated in the 1990s. For the manufacturing sector, the 1990s was a decade of factor accumulation and gradual diffusion of technology. The widespread reforms in industrial and trade policies in that period, however, seem to have contributed to a surge in productivity growth in the 2000s. Yet, its declining share in overall value added has reduced its overall role in boosting aggregate productivity growth. While the manufacturing sector still appears to be suffering from many policy constraints, several liberalization policies in the 2000s seem to have helped market services gain faster productivity growth. In particular, the telecom and financial services sectors, which have witnessed several market enhancing reforms, have shown impressive productivity performance.

Indeed, the removal of policy barriers in the mid-1980s and early 1990s in the form of bans, controls, and restrictions on production, investment, and trade, have helped firms improve TFP growth as well as factor input accumulation, especially capital input in several sectors of the Indian economy. However there still remain many barriers to overcome. While India's agriculture is yet to be integrated fully with the world markets, its manufacturing sector witnesses many factor market inflexibilities and supply side constraints.

As Bhagwati and Panagariya (2013) point out there is a clear need for reforming the labor market in India, in order to promote manufacturing jobs, production, and export, by creating a competitive product and factor market. Moreover, focusing on infrastructure and energy efficiency is essential to ease many supply side constraints.

Recently, there has been some discussion in the context of India's economic growth and its policy challenges, centering on whether to focus on social sector spending first or on growth first. Drèze and Sen (2013) advocate investment in social infrastructure to improve the quality of life and also to raise productivity and growth, whereas Bhagwati and Panagariya (2013) argue that growth can bring necessary resources to improve the social sector, and therefore policies should focus on achieving faster growth. It is quite obvious from our results that India needs a balanced policy approach. Given that the growth is concentrated in the services sector (of relatively high skill intensity), which can ultimately push the overall wages up, it is unlikely that India will be able to step into the Chinese style of low-cost manufacturing. Focusing on productivity is essential to maintain competitiveness and also create more jobs in the manufacturing sector. Even though it is highly acknowledged that the reallocation of workers from primary to secondary and tertiary sectors are beneficial for aggregate growth, reallocation of the labor force from primary to other sectors in India will be highly constrained by the lack of appropriate skill, which makes workers with low marginal productivity stay in the farm sector or move to less skill intensive sectors like construction. The only way to raise productivity and growth is therefore to improve quality of and accessibility to education, and thereby improve its human capital, which, however, should not be at the cost of policies aimed at achieving economic growth. Improved human capital would ultimately facilitate the availability of appropriate skills required by the rapidly expanding service sector as well. Most of today's advanced economies benefitted from better human capital endowment, and most countries that sustained long-term high growth were supported by a solid manufacturing sector. It is clear that what India needs is a balanced policy perspective, which focuses on improving its human capital, and creating opportunities for its younger population by focusing on economic growth, particularly in the manufacturing sector.

Appendix Table 7.1 ***Classification of industries***

KLEMS description	ISIC 3.1
Agriculture, hunting, forestry, and fishing	**A to B**
Manufacturing*	**D**
High labor intensive	
Food products, beverages, and tobacco	15 to 16
Textiles, textile products, leather, and footwear	17 to 19
Wood and products of wood	20
Other non-metallic mineral products	26
Manufacturing, nec; recycling	36 to 37
Medium labor intensive	
Rubber and plastic products	25
Basic metals and fabricated metal products	27 to 28
Machinery, nec.	29
Electrical and optical equipment	30 to 33
Low labor intensive	
Pulp, paper, paper products, printing, and publishing	21 to 22
Coke, refined petroleum products, and nuclear fuel	23
Chemicals and chemical products	24
Transport equipment	34 to 35
Non-manufacturing industries	
Mining and quarrying	C
Electricity, gas, and water supply	E
Construction	F
Services	
Market services	
Wholesale and retail trade	G
Hotels and restaurants	H
Transport and storage	60 to 63
Post and telecommunication	64
Financial services	J
Non-market services	
Public administration and defense	L
Education	M
Health and social work	N

Appendix Table 7.1 (*cont.*)

KLEMS description	ISIC 3.1
Other services**	K+O+P
Total economy	

* Classification of manufacturing industries is done on the basis of percentile of employment to capital stock ratio (L/K). Low labor intensive are sectors with below 33.3 percent K/L of the entire data range; medium labor intensive are sectors with K/L between 33.6 and 66.6; and high labor intensive are those with K/L above 66.6 percent of the entire data range.

** Other services include real estate, renting, and business services (K), other community, social, and personal services (O), and activities of private households (P). Ideally, business services should be part of market economy, which however, was hard to separate from other services in the investment data.

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