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Abstract

This paper attempts to identify the industry origins of aggregate value added and productivity growth in Indian economy during the last three decades. Unlike most other studies on productivity in India, the present study studies the productivity dynamics for Indian economy at sectoral level, using a decomposition method suggested by Jorgenson, Ho and Stiroh (2005) and incorporating better measures of capital, labor and intermediate inputs. Our results suggests that the economic reform process during the late 1980s and the early 1990s have made a clear impact on aggregate economic and productivity growth, though the effect of the same has not been broad-based. The observed surge in the aggregate value added and labor productivity growth is predominantly due to increased capital deepening. However, multifactor productivity has been increasing after the reforms as well. While the relative contributions from agriculture has declined over time, and from manufacturing has stagnated, financial and other market services, along with trade and distributive services drives much of the recent aggregate output and productivity growth. While the labor reallocation effect is generally positive, suggesting a movement of labor from low productive to high productive sectors, the capital reallocation is negative in general, suggesting that the misallocation of capital might be a factor that pulls down aggregate productivity in Indian economy.

Keywords: *Aggregate Productivity Growth; Multi Factor Productivity; Industry Origins; Reallocation Effects*
JEL classification: D24, L6, F43, O47, O53

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1. Introduction

Economic growth in India and China has attracted much attention in recent years (e.g. Bosworth and Collins, 2008, Eichengreen, Gupta and Kumar, 2010). This has been due to the spectacular growth experienced by these countries after the economic reforms in the late 1980s and early 1990s. Economic growth in India and China during the last decade has bypassed any other country of the similar economic situation. Concerns have, however, been raised about the many underlying dynamics in these economies on whether the observed economic growth is trickling down to reduce poverty and inequality. Furthermore, whether the observed economic growth is broad-based, and whether it feature the traditionally hypothesized structural transformation, as observed in the development of many of today's advanced countries. A major difference between the observed growth process in India[1] and China is the importance of manufacturing in the aggregate growth in China and that of services in India. While China appears to be more in the direction of traditionally hypothesized structural transformation (Kuznets, 1966), where resources moving from primary sector to manufacturing and further to services, India's growth process seems to have bypassed the second stage in the structural transformation. Latest developments in economic growth literature reiterate the importance of the nature and the speed of structural transformation in enhancing and sustaining economic growth (Lin, 2011; McMillan and Rodrik, 2011). Recent studies on structural transformation in India, suggest that the observed structural transformation in India has been growth enhancing (McMillan and Rodrik, 2011; Bosworth and Collins, 2008; Vries, Erumban, Timmer, Voskobynikov and Wu, 2012).[2] However, Vries et al (2012) goes further by examining the effect of dualism in Indian economy and observe that the growth enhancing effect of structural transformation disappears once accounted for the co-existence of formal and informal sector in Indian economy. This is due to the massive expansion of the informal sector, which is relatively less productive.[3] It has been observed by recent studies that the formal manufacturing sector in India has been outsourcing many of its production activities to relatively less productive informal sector, in order to evade many labor market rigidities in

[1] Apart from many comparative studies, that try to compare the growth performance of India and China, there have also been many studies in recent years attempting to understand the growth process in Indian economy (See for instance, Panagaria, 2008; Vaidyanathan and Krishna, 2007; Balakrishnan, 2011 among others).

[2] Verma (2012) argues that the observed faster growth in services in India is mainly due to higher productivity growth in this sector.

[3] Eichengreen and Gupta (2011) argues that the expansion of relatively less productive informal activities happen side-by-side with dynamic formal activities both in manufacturing and services sector.

the formal sector (Ramaswamy, 1999; Pieters, Moreno-Monroy and Erumban, 2012). Thus, labor seems to be moving from high productive to less productive sectors.

Most of the above-mentioned studies that attempt to understand the structural transformation and productivity in Indian economy are conducted either using a high aggregate data or partial productivity measures. This paper is an attempt to understand the industry origins of India's economic growth and multi factor productivity growth. Apart from being the first of its kind, that analyzes the industry origins of aggregate economic growth in India, the paper differs from previous research in that we use detailed industry level data to understand the growth process in India, and more importantly, we use better measures of capital and labor inputs, that takes account of heterogeneity among different types of capital assets and different types of labor types. Researchers have presented different perspectives on the growth process which India has undergone during the past two decades (Kochhar, Kumar, Rajan, Subramanian and Tokatlidis, 2006; Verma, 2012; Rodrik and Subramanian 2005; Panagariya 2008, Srinivasan and Tendulkar 2003). A common element in all these studies is the role of economic reforms that started lightly in the late 1980s and introduced more aggressively during the early 1990s and further sustained during the 2000s.[4] The emphasis on gradualism and evolutionary transition rather than rapid restructuring (Ahluwalia, 1994) was the underlying feature of India's economic reforms. Therefore, we analyze the industry origins of aggregate economic growth in India during the last 3 decades, sub-divided into the pre and post economic reform period. In particular we look at how the resources, both capital and labor, have been moving across sectors, during the growth process, and whether the pattern of observed aggregate growth is broad based. Using detailed industry level data we examine the industry origins of observed aggregate value added and productivity growth in India. Such a detailed sectoral analysis is novel in the context of India, as most previous studies have used highly aggregate data to analyze the growth process, and thereby ignoring many possible sectoral heterogeneity.[5] We use a decomposition method proposed by Jorgenson, Ho and Stiroh (2005),

[4] The debate on factors underlying the observed growth in India is far from settled, however. See Rodrik and Subramaniam (2005), Panagariya (2008), Srinivasan and Tendulkar (2003), Kohli, (2006), Kochar et al (2006) and Vaidyanathan and Krishna (2007) for an assessment on the implications of reforms.

[5] There are studies drawing upon sectoral perspectives, but confined mostly to the sub-sectors of organized manufacturing (see Das and Kalita, 2011). Multi factor productivity in organized manufacturing in India has been subject to significant research (see Ahluwalia, 1991; Goldar, 2002; Balakrishnan and Pushpangadan, 1994 and Das, 2004 among others). However, only a few studies have attempted to analyze the aggregate economy productivity (see for e.g. Brahmananda, 1982; King and Levine, 1993; and recent studies by Bosworth and Collins, 2008 and Verma, 2012).

subsequently used by many recent studies (Jorgenson, Ho, Samuels and Stiroh, 2012; Timmer, Inklaar, O'Mahony and van Ark, 2010). This method helps us identify the sources of aggregate productivity growth, and also the resource re-allocation across sectors.

We find that there has been an improvement in aggregate value added, labor productivity and multifactor productivity growth in Indian economy after the economic reforms have been initiated. However, the growth effect has not been broad-based. More importantly the aggregate growth has been substantially high after 2000, which is clearly an indication of the effect of economic reforms in the 1990s. While the measured multifactor productivity has registered a remarkable increase after the reforms, capital deepening continued to be the main driver of aggregate economic growth and labor productivity. Moreover, the importance of agricultural sector as a contributor to aggregate growth has declined substantially, while that of manufacturing has remained almost stagnant. Service sector, in particular, financial and other market services, along with trade and distributive services drives much of the recent aggregate output and productivity growth. There has been some evidence of labor moving from less productive to more productive segments of the economy, while such a tendency is not observed in the case of capital.

The paper is presented in five sections. Following the introduction, in the second section we present the methodology. In the third section we discuss the data and construction of variables, and the fourth section discusses the empirical results. This has been organized in five sub sections, where we discuss respectively, the industry origins of value added growth, input and productivity contribution to aggregate value added growth, contributions of factor deepening and productivity to aggregate labor productivity growth, industry origins of aggregate productivity growth and pattern of observed aggregate growth. The final section concludes the paper.

2. *Methodology*

In this section, we discuss the methodology used to construct aggregate estimates of productivity growth and the sources of aggregate value added and labor productivity growth. The methodology is heavily drawn from Jorgenson et al (2012). We use the direct aggregation method suggested by Jorgenson et al (2012), which is explained in detail below. Estimates of productivity and output growth using the below-mentioned methodology are estimated for 26 industries that cover the entire

Indian economy during the time period 1980-2008. In addition, in order to get a detailed picture of the pattern of observed productivity growth, we also provide a graphical representation of the observed sectoral productivity growth, using the approach suggested by Harberger (1998), and employed in Timmer et al (2010).

The most common approach to measure aggregate economic growth and its sources is to assume an aggregate production function. In this setting inputs and value added are aggregated across industries to obtain aggregate volume indices under strict assumptions on the nature of production function and industry detail (Jorgenson et al, 2012)[6]. Jorgenson et al (2005) employ a less restricted production possibility frontier approach that relaxes the restrictions on industry value added functions, that value added prices are identical across industries. In this setting, the aggregate value added is not aggregated across industries; rather it is a translog index of industry value added. The production possibility frontier, however, does not relax the assumptions on input measurement. In this paper, we use another approach, suggested by Jorgenson et al (2012). This is the direct aggregation across industries that relax many assumptions on input and output measurement. The difference between the production frontier and direct aggregation will give us indication on resource reallocation. In what follows we discuss the production possibility frontier and direct aggregation approaches in detail.

Define aggregate value added as a translog index of industry value added

$$\Delta \ln V = \sum_i \bar{s}_i \Delta \ln V_i \quad (1)$$

where V_i is the industry value added and s_i is the share of industry i in aggregate nominal value added, measured as

$$s_i = \frac{P_{vi} V_i}{\sum_i P_{vi} V_i} \quad (2)$$

where P_v is the price of industry value added and $\bar{s}_i$ is the two-period average share, defined as

$$\bar{s}_i = \frac{s_{i,t} + s_{i,t-1}}{2} \quad (3)$$

[6] The underlying assumptions include separability of gross output production function in value added for each industry and same value added function across all industries. We do not intend to discuss the different aggregation approaches available in the literature. Interested readers may refer to Jorgenson et al (2012), who provide an in-depth and detailed discussion on the same.

Following the standard growth accounting methodology, the aggregate value added growth under production possibility frontier approach can be decomposed into contributions from aggregate capital inputs (K), aggregate labor inputs (L) and aggregate MFPG (A) as:

$$\Delta \ln V = \bar{s}_K \Delta \ln K + \bar{s}_L \Delta \ln L + \Delta \ln A \quad (4)$$

where s_K is the share of aggregate capital compensation in aggregate nominal value added and S_L is the share of aggregate labor compensation in aggregate nominal value added. Aggregate capital and labor compensation are derived from the identity that total nominal value added is the sum of aggregate labor and capital compensation. 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 consists of different types of capital assets (e.g. machinery, computers, buildings) 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. Therefore, following Jorgenson (1963), we define aggregate capital services and labor input as translog aggregates of heterogeneous type of capital and labor.[7]

$$\Delta \ln K = \sum_k \bar{v}_k \Delta \ln K_k ; \text{ and } \Delta \ln L = \sum_l \bar{v}_l \Delta \ln L_l \quad (5)$$

where v_k is the share of each type of capital k in aggregate capital compensation, and v_l is the share of each type of labor l in total labor compensation, defined as:

$$v_k = \frac{P_{K,k} K_k}{\sum_K P_{K,k} K_k} \quad \text{and} \quad v_l = \frac{P_{L,l} L_l}{\sum_l P_{L,l} L_l} \quad (6)$$

As before $\bar{v}$ is the two-period averages of these shares. In our analysis, we distinguish between five types of labor (see section on data), and three types of capital assets. They are respectively employees with education 1) up to primary; 2) primary school; 3) middle school; 4) secondary and higher secondary school; and above 5) higher secondary school and capital assets 1) transport equipment; 2) machinery; and construction.. Note that aggregate capital and labor input can also be measured as the growth rate of simple aggregated capital and labor across different types, which is the standard approach followed in most earlier studies in the Indian context. This will provide us

[7] Also see Erumban (2008), for a detailed discussion on this approach to measure capital services.

$$\Delta \ln K^{*} = \Delta \ln \sum_{k} K_{k}\,; \text{ and } \Delta \ln L^{*} = \Delta \ln \sum_{l} L_{l} \quad (7)$$

where K* and L* are respectively the growth rates arrived at by simply aggregating different types of capital and labor. Such an approach undermines the importance of heterogeneity among different types of capital and labor, as it assumes that the marginal productivities of these different types of assets and labor are the same. The difference between capital and labor input growth rates aggregated using equation (5) and the standard aggregation across assets in equation (7) is often called respectively as capital quality (or capital composition effect) and labor quality (or labor composition effect), as they capture the heterogeneity within these inputs (see Erumban, 2008; Jorgenson, 2001).[8] Our empirical analysis presents the contribution of labor split into the contribution of employment and labor quality (LQ) and the contribution of capital split into to equipment capital (eq) services and non-equipment capital (neq) services where the latter basically consists of construction. Then, equation (4) can be re-written as

$$\Delta \ln V = \bar{s}_{K,eq} \Delta \ln K_{eq} + \bar{s}_{K,neq} \Delta \ln K_{neq} + \bar{s}_{L} \Delta \ln L^{*} + \bar{s}_{L} \Delta \ln LQ + \Delta \ln A \quad (8)$$

where $\bar{s}_{K,eq} = \bar{s}_{K} \bar{v}_{eq}$ and $\bar{s}_{K,neq} = \bar{s}_{K} \bar{v}_{neq}$, with $\bar{v}_{eq}$ and $\bar{v}_{neq}$ being the share of equipment capital and non-equipment capital in total capital compensation. By subtracting the growth rate of employment, equation (8) can be re-written to understand the sources of aggregate labor productivity growth as:

$$\Delta \ln v = \bar{s}_{K,eq} \Delta \ln k_{eq} + \bar{s}_{K,neq} \Delta \ln k_{neq} + \bar{s}_{L} \Delta \ln LQ + \Delta \ln A \quad (9)$$

[8] The premise of this view is that the difference between growth rate of capital (labor) services measured using (5) and aggregate capital stock (hours or employment) using equation (7) represents the substitution towards assets (workers) with higher marginal productivities. For instance, a shift towards highly skilled workers may improve the quality of aggregate labor input as there relative marginal productivity is higher.

where v is the aggregate labor productivity growth, measured as the difference between aggregate value added growth, as measured in equation (1), and aggregate employment growth, as measured in equation (7) and k is aggregate capital depending, measured as the difference between aggregate capital service growth (equation 5) and aggregate employment growth (equation 7).

The above decomposition is for the aggregate economy where the production function is a value added function. At the industry level, using a gross output function, where gross output is a function of capital (K), labor (L) and intermediate input (X), output growth can be decomposed into

$$\Delta \ln Y_i = \bar{s}_{K,i}\Delta \ln K_i + \bar{s}_{L,i}\Delta \ln L_i + \bar{s}_{X,i}\Delta \ln X_i + \Delta \ln A_i \quad (10)$$

where $s_{K,}$ $s_{L,}$ and s_X are respectively the share of capital, labor and intermediate input in total nominal output in industry i. The aggregate output concept we used in equations (4) and (8) is a value added concept, and the relationship between industry output and industry value added can be written as

$$\Delta \ln Y_i = \bar{s}_{V,i}\Delta \ln V_i + \bar{s}_{X,i}\Delta \ln X_i \quad (11)$$

where V_i is the industry value added, and s_v is the share of industry value added in industry gross output. Re-arranging equations (10) and (11), and assuming that aggregate value added is a translog sum of industry value added (equation 1), we can re-write aggregate value added in equation (4) as

$$\Delta \ln V = \sum_i \bar{s}_i \frac{\bar{s}_{K,i}}{\bar{s}_{V,i}}\Delta \ln K_i + \sum_i \bar{s}_i \frac{\bar{s}_{L,i}}{\bar{s}_{V,i}}\Delta \ln L_i + \sum_i \bar{s}_i \frac{1}{\bar{s}_{V,i}}\Delta \ln A_i \quad (12)$$

In equation (12), aggregate value added growth is the weighted contribution of industry capital input, industry labor input and industry MFPG. The weights on capital and labor consists of s_i, the share of industry value added in aggregate value added, $s_{K,i}$ and $s_{L,I}$, the share of industry capital and labor compensation in industry gross output and s_{vi}, the share of industry value added in industry gross output. The first and last components of the input weights (s_i and s_{vi}) also reflect in the MFPG weights. In equation (4), we had aggregate MFPG, defined as

$$\Delta \ln A = \Delta \ln V - \bar{s}_K \Delta \ln K + \bar{s}_L \Delta \ln L \quad (13)$$

Subtracting equation (12) from (13), and rearranging, we obtain

$$\Delta lnA = \sum_i \frac{\bar{s}_i}{\bar{s}_{V,i}} \Delta lnA_i + \left(\sum_i \bar{s}_i \frac{\bar{s}_{K,i}}{\bar{s}_{V,i}} \Delta lnK_i - \bar{s}_K \Delta lnK \right) + \left(\sum_i \bar{s}_i \frac{\bar{s}_{L,i}}{\bar{s}_{V,i}} \Delta lnL_i - \bar{s}_L \Delta lnL \right)$$

$$= \sum_i \frac{\bar{s}_i}{\bar{s}_{V,i}} \Delta \ln A_i + \mathrm{REAL_K} + + \mathrm{REAL_L} \qquad (14)$$

Equation (14) suggests that aggregate MFPG can be decomposed into weighted average of industry MFPG and the capital and labor reallocation across industries. Note that the weights attributed to industry MFPG in this setting is equivalent to the well-known Domar weight (Domar, 1961). The weight in equation (14) is the ratio of s_i, or industry share in aggregate value added and s_{vi} or the industry value added share in aggregate output, which approximates to the Domar weight, which is the ratio of industry gross output to aggregate value added. These weights will be greater than one, as industry MFP improvement can have a direct effect through industry output, but also an indirect effect through output in other industries, by means of intermediate input sold to other industries (Jorgenson et al, 2012).The difference between Domar weighted MFPG and the aggregate MFPG is the sum of labor and capital reallocation effects, which reflects the movement of these resources across industries. For instance, a positive reallocation term would indicate a movement of resources from less productive to more productive industries. In the subsequent sections of the paper, we present results based on equation (14), along with equations (1), (4) and (9). In all the cases, capital is distinguished between equipment and non-equipment capital and labor between labor quantity and labor quality.

3. Data and variables

This section provides a description of the data, their sources, construction of variables and the industrial classifications used in the study. The data used in the empirical analysis of this study is National Accounts Statistics (NAS), published annually by the Central Statistical Organization. This data is supplemented by Input-Output tables, Annual Survey of Industries (ASI) and various rounds of National Sample Survey Organizations (NSSO) surveys on employment & unemployment and

unorganized sector. In what follows we discuss these sources more specifically with regard to each of the variables used in our analysis.

In our analysis, we basically employ equations (1), (4), (9) and (14), for which we require industry wise data on nominal and real value added, investment by asset type, number of employees and labor compensation by type of workers and intermediate inputs. We describe the source and construction of these variables in detail.

Value added: NAS provides estimates of Gross Domestic Product (GDP or gross value added) by industry at both current and constant prices since 1950 for the detailed industrial classification. We use the data for the period 1980-2008 from the most recent National Accounts series which provides constant price data in 1999-2000 prices. For those industries especially for some subsectors within the manufacturing sector, where detailed data are not available from NAS, estimates have been made using the Annual Survey of Industries (ASI) and NSSO surveys for registered and un-registered manufacturing industries. While the former source is used to split aggregate value added data from NAS into sub-sectors in the organized sector, the latter is used for the unorganized sector.

Gross output: National Accounts also provides estimates of gross output for some sectors, say agriculture, hunting, forestry and fishing, mining and quarrying, construction and manufacturing sectors at current and constant prices. For splitting some sectors, as in the case of value added, additional information is used from ASI and NSSO. For other sectors, mainly service sectors, where there was no output information available from NAS, we use input-output transaction tables, which provides output and value added. The ratio of these two is applied to value added in NAS to obtain consistent estimates of gross output. We use the benchmark input output tables for the years 1978, 1983, 1989, 1993, 1998 and 2003, and for the intermediate years they are interpolated.

Intermediate inputs: Intermediate inputs are basically the difference between nominal value added and nominal output, which are derived from National Accounts Statistics, supplemented by ASI, and input-output tables. The commodity inputs going into the production process of output industries are aggregated into energy, material and service inputs. In this way, for each benchmark year, estimates are obtained for material, energy and service inputs used to produce output in the different industries. The time series of input proportions for industries are compiled for the benchmark years and then

linear interpolation is used to obtain the series for 1980 to 2008 at current prices. To generate a price deflator for intermediate inputs, we use wholesale price indices published by the Office of the Economic Advisor, Ministry of Commerce and Industry. We use weighted deflators for materials, energy and service inputs for each of the industries.

Employment and labor composition: Employment data is basically obtained from the quinquennial rounds of Employment and Unemployment Surveys (EUS) published by National Sample Survey Office (NSSO). Using the EUS, we estimate the total workforce by industry groups, as per the National Industrial Classification (NIC). The work participation estimates obtained from EUS are adjusted for population, using various population censuses. In the EUS, the persons employed are classified on the basis of their activity status into usual principal status (UPS), usual principal and subsidiary status (UPSS), current weekly *status* (CWS) and current daily status (CDS). UPSS is the most liberal and widely used of these concepts. Despite that the UPSS has some limitations[9] this seems to be the best measure to use given the data and hence we estimate the number of employed persons using UPSS definition. The labor composition index has been computed as the difference between equations (7) and equation (5), both calculated for individual industries. The index has been computed using five education categories namely- up to primary school, primary school, middle school, secondary & higher secondary school, and above higher secondary school. This data also is taken from the EUS

Capital services: We measure capital services for the aggregate economy and by industries using equation (5). In order do this, it was essential to obtain investment data by asset type. We distinguish between 3 different asset types – construction, transport equipment, and machinery.[10] Therefore, we exploit multiple sources of information for the construction of our database on capital services given

[9] Problems in using UPSS includes: 1) the UPSS seeks to place as many persons as possible under the category of employed by assigning priority to work; 2) no single long-term activity status for many as they move between statuses over a long period of one year; and 3) usual status 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.

[10] Land has been excluded from the assets to maintain consistency with CSO, Government of India. CSO includes buildings, construction, residential and non-residential buildings and excludes land in the computation of gross fixed capital formation by industry type.

the nature of the industrial classification. This includes the National Accounts Statistics (NAS) that provide information on broad sectors of the economy, the Annual Survey of Industries (ASI) covering the formal manufacturing sector, and the National Sample Survey Organizations (NSSO) rounds for unorganized manufacturing. Even though we use multiple sources of data, our final estimates are fully consistent with the aggregate data obtained from the NAS. Sectoral investment data are used to construct capital stock using perpetual inventory method, i.e.

$$K_{K,t} = K_{K,t-1}(1 - \delta_K) + I_{K,t-1}$$

where K_K is the capital stock in asset K, δ_K and I_K is the real investment in asset K, and the subscript t stands for year t. We assume depreciation rates of 8 percent for machinery, 2.5 percent for construction and 10 percent for transport equipment, which is derived assuming a double declining balance to the assumed life times of these assets in National Accounts.

4. Sources of aggregate economic growth

This section discusses the decomposition results for output and labor productivity growth rates for Indian economy during 1980-2008. The period of analysis roughly covers the three phases of economic reforms in India, say the pre (or partial) reform period, the transition period and the full reform period. For convenience of analysis, we subdivide the entire period 1980-2008 into 5 year sub-periods that roughly tally with the pre and post reform era. The period 1980-90 is considered as pre-reform period, as the major economic reforms in India started in 1991. However, there has been substantial policy changes in the mid 1980s, which is often termed as pro-business reform (Rodrik and Subramanian, 2005),[11] and therefore a sub-division of 1980-1990 into two equal parts would be meaningful. The period 1990-95 is more of a transition period, as the economy witnessed severe reforms, and consequent transition to the market economy. The period after 1995 is considered as post-reform period, as one would expect to see the fruits of economic reform after a substantial lag. Further this period also has been sub-divided into 5-year sub-periods. As mentioned before, our analysis is conducted taking into account the significant industry heterogeneity within the Indian

[11] Rodrik and Subramanian (2005) makes a distinction between pro-market and pro-business reforms. Panagaria (2008), however, argues that these two do not form mutually exclusive sets. Though we do not intend to delve into this debate, we maintain that though the reforms in the 1980s have started the momentum, it was the extensive reform process in the early 1990s that was further sustained in the subsequent periods that helped achieve faster economic growth in India.

economy and its consequences for aggregate economic growth. However, for analytical feasibility, we aggregate the 26 industry groups into 8 sub-sectors (see Table 1). Since agriculture is a major employment providing sector in Indian economy, which is often argued to be an important and key sector for future sustainability of India's economic growth (Balakrishnan, 2010), we keep it as a distinct sector.[12] Mining, utilities and construction are clubbed into one single sector, which we call as other goods production. Manufacturing is divided into two broad groups, consumer and intermediate goods manufacturing and investment goods manufacturing, where the latter includes machinery and transport equipment manufacturing. Service sector is divided into four distinct sectors; trade and distributive services, financial services, all other market services and non-market services.

4.1 Industry origins of aggregate value added growth

In Figure 1 we provide the results of aggregate value added growth rates and the industry origins of the observed aggregate growth. The Figure shows the relative contribution of the eight industry groups[13] presented as percentage contribution, and the corresponding percentage points are provided in Table 2. These are based on aggregate production possibility frontier approach (equation 1), where aggregate value added growth rate is computed as a weighted sum of industry value added growth rate, with the weights being the nominal share of each industry in aggregate value added. For the entire time period 1980-2008, the average growth rate of value added was slightly below 6 percent per annum. Out of this, almost 1.3 percent point was due to trade and distributive services. This sector, which accounted for almost 1/5th of the aggregate growth, is followed by other market services, and consumer and intermediate goods manufacturing. Together, these three sectors contributed more than half of the observed aggregate growth (Table 2). Agriculture contributed 0.8 percent points out of 5.9 percent aggregate growth, consisting of almost 14 percent, due to the fact that it has contributed almost a quarter of nominal value added during the period (see Table 3).Among the 8 sub-sectors, it is the

[12] A caveat may be added, however. As described in our data section, the capital input in our data exclude land, due to the absence of any information on investment in land in the National Accounts. Since our data keeps complete consistency with National Accounts, and the information on investment in land is scarce, we do not have this as a distinct asset type in our calculations. However, we admit that land may be an important factor that drives agricultural productivity, and the exclusion of the same may have important consequences for our results. This will be taken into account in the future.

[13] Note, however, that the aggregate has been arrived at using data on growth rates and value added share in detailed 26 industries, as reported in Appendix Table 1. A detailed picture of industry contribution to aggregate value added growth is also provided in Appendix Figure 1.

capital goods producing sector that contributed least to the aggregate economic growth. However, it is a tiny sector that contributed about 3 percent of aggregate value added.

During the early 1980s agriculture was the largest contributor, accounting for almost 1/5th of the aggregate growth, followed respectively by trade and distributive services and consumer and intermediate goods. These three sectors accounted for 2.76 percent point (almost 55 percent) of aggregate growth. In addition, both market and non-market services contributed substantially (respectively 0.72 and 0.56 percent points) to the aggregate growth during this period. The relative position of these sectors remained almost the same during the mid 1980s, a period that witnessed partial liberalization and pro-business reforms in India. However, the overall growth has increased by 0.8 percentage point which was reflected in an improvement in the growth contribution of other goods production and market and non-market services. In general, there has been an improvement in the contributions of consumer and intermediate manufacturing and services sectors during the partial reform period, while agriculture and capital goods sector did not witness any substantial gain. During the transition period, the economy witnessed a decline in aggregate valued added growth, by almost 0.68 percentage points, say from 5.86 percent to 5.18 percent. Interestingly this decline is observed across the board, except in three sectors. While trade and distributive services improved their growth contributions by about 0.26 percent points, consumer and intermediate goods sector and financial services witnessed a slight improvement. All other sectors have witnessed a decline in their contribution. In terms of relative contributions, agriculture has shown a substantial decline (Figure 1), while trade, other market services and consumer and intermediate goods has improved their relative positions.

The average value added growth has witnessed a revival during the first 5 years of post-1995 period. The economy grew at an annual average growth rate of 5.80 percent, registering an increase of 0.62 point from the previous period. This was primarily due to a remarkable increase in the contribution of non-market services. Out of 0.62 percent point increase, 0.57 percent point was due to non-market services, leading to an improvement of its contribution from a mere 0.44 percent point during 1990-1995 to 1.01 percent point during 1995-2000. Consequently, its relative contribution has improved from about 8 percent during the transition period to 17 percent during 1995-2000 (Figure 1), which is reflected in a decline in goods manufacturing (both consumer & intermediate and investment

goods). In the subsequent period, which is the period of spectacular growth in Indian economy, there has been a rapid increase in economic growth. During 2000-05 period, the economy grew at about 6.8 percent per annum, registering an increase of about 1 percent in the growth rate from previous period. Out of this 6.8 percent annual average growth rate, about 4 percent point is accounted by 3 sectors, say, trade and distributive services, other market services and other goods production. These three sectors accounted for an increase of 1.17 percent point from the previous period. However, this increase was not fully reflected in the aggregate economic growth rate which increased only by about 1 percent point from previous period. There has been a decline in the growth contribution of agriculture and non-market services. Agricultural sector faced a drastic decline in its contribution, partly due to the declining share of this sector in the overall economy. A comparable picture is seen in the last period, where also we observe a spectacular increase in the aggregate economic growth. However, a notable element of this growth is the increase in the contribution of financial services. The overall growth has increased from 6.75 percent to 8.02 percent. Out of this 1.27 percent point increase in growth rate, 0.35 percent point was due to financial services. Other sectors that have contributed to this high growth are consumer and intermediate goods, other non-market services and market services. The only sector that contributed negatively is the investment goods sector.

Thus, over the period, the Indian economy has witnessed significant gain in its aggregate economic growth, particularly after the post-reform period. Only during the transition period, the aggregate value added growth has shown a declining trend compared to the previous period. Certainly, the economic reforms have made clear impact on aggregate economic growth. We observe that this growth has been predominantly driven by two sectors, trade and distributive services and other market services. Throughout the period, one sector that has witnessed an increasing contribution is financial services. Agriculture is clearly losing its importance as a contributor to aggregate economic growth. In what follows we examine whether the observed surge in the aggregate growth was driven by factor accumulation or productivity.

4.2 Contribution of inputs and productivity to aggregate value added growth

The lower panel of Table 2 also provides the standard growth accounting results, where the aggregate value added growth is decomposed into the contributions of capital and labor inputs and multifactor productivity growth (MFPG). This has been done using equation (4), where the aggregate value added

growth is a weighted average of industry growth value added growth rates and capital and labor input growth rates are calculated from aggregate capital and labor input obtained by simply aggregating across industries. The Table provides the relative contribution of aggregate capital services, total employees, labor composition and aggregate MFPG to the aggregate value added growth rate. The contribution of capital is divided into equipment and non-equipment capital, as equipment capital is often argued to be a major growth enhancing input (De long and Summers, 1991). The results are in conformity with the largest growth enhancing role of capital input, in particular that of equipment capital.[14] During the entire period, aggregate capital accounted for 3.34 percentages out of 5.90 percent aggregate growth. Within this 3.34, only 1 percentage point was due to non-equipment capital, while the rest is due to equipment capital. Obviously, Indian economy has been accumulating machinery to achieve a faster economic growth. Labor input contributed 1.54 percentage point, with almost half of it coming from labor quality (about 0.70 percent point), and MFPG was 1.02 percent.

In the first half of the 1980s, the aggregate MFPG was about 1 percent, while the contribution of capital was 2.33 and of labor was about 1.75. During this period the contribution of labor input was higher than that of the equipment capital. Employment growth has contributed more than 1 percent point in the total of 5.06 percent growth rate. However, the picture changed substantially during the partial reform period, during which equipment capital contributed almost 2.1 out of 5.9 percent growth, while the contribution of labor was 1.8. While the contribution of employment remained the same, the capital contribution increased from the previous period. The contribution of labor quality changes has helped improve the average contribution of labor input, which may be a reflection of the increasing share of high-skilled workers in the labor force. MFPG has improved substantially, by about 0.7 percentage point during this period. Economic reforms in the mid 1980s may have helped firms use the market principles better and thereby improve their efficiency in using inputs in the production process. During the transition period, however, the decline in the aggregate growth was predominantly driven by a decline in MFPG. While the contribution of equipment capital increased and that of non-equipment capital, employment and labor quality declined marginally, MFPG has declined from 1.16 percent during the 1980-1985 period to 0.33 percent during 1985-1990.

[14] It would be interesting to decompose the contribution of equipment capital into ICT and non ICT, as ICT is often argued to have a larger growth enhancing effect. However, due to many data limitations this version of the paper does not include such a distinction, which may be incorporated at a later stage.

In the post-1995 period, the economy picked up again, along with a substantial increase in the contribution of MFPG. While MFPG increased from 0.33 to 1.24, the contribution of capital increased from 3.18 to 3.34 and the contribution of both employment and labor composition declined. During 2000-2005 period, however, labor input contribution increased again, from 1.22 during 1995-2000 to 1.77 percent point, mainly due to an increase in employment contribution from 0.64 to 1.12. MFPG remained almost the same as 1.2 percentage. During the last three years of our study, MFPG has improved by almost 0.54 percentage point. However, most of the aggregate value added growth was due to a spectacular increase in capital input. Though equipment capital dominated, non-equipment capital also registered an increase in its growth contribution. Even more striking feature of this period is that of a decline in the contribution of employment.

The picture that emerges from the above analysis is that of a dominant role of factor accumulation in achieving economic growth in India. In particular, the Indian economy has been able to achieve a faster growth by means of capital accumulation. This is in line with the conclusions made by many previous studies in the context of East Asia (World Bank, 1993; Krugman, 1994; Young 1995), world economic growth (Jorgenson and Vu, 2005) and the United Sates (Jorgenson et al, 2012). Almost all these studies have observed a larger role for capital accumulation in driving aggregate economic growth in individual economies than assimilation.[15] However, a remarkable feature of measured MFPG in Indian economy is that of an improving trend, particularly after the economic reforms has been initiated. The contribution of labor input has been diminishing or stagnant over time.

4.3 Contribution of capital deepening and productivity to aggregate labor productivity growth

In Table 4, we present the decomposition of labor productivity growth, measured as the difference between the growth rates of aggregate value added and aggregate employment, into the contributions of capital accumulation, labor quality and MFPG (equation 9). The aggregate labor productivity has been growing substantially over time, averaging around 4.2 percent for the entire period. It has increased from a mere 3 percent during 1980-1985 to about 4.4 percent during the 2000-2005. It has further accelerated to 8.04 percent during the last three years in our analysis, which is however, partly

[15] It may be noted, however, that in the context of cross-country analysis, studies have observed that the differences in economic growth across countries is driven primarily by differences in productivity rather than accumulation (Erumban, 2008)

due to the loss of employment during this period. While the aggregate value added grew at 8.02 percent during this period, the labor productivity grew at 8.04 percent indicating a decline in employment by 0.014 percent. Nevertheless, in general, except during the transition period, the Indian economy has witnessed an increase in aggregate labor productivity growth over years. Throughout the period, more than half of the labor productivity has been due to increased capital deepening. This has particularly pronounced during and after the early 1990s. While the equipment capital deepening dominated throughout, the non-equipment capital also expanded significantly after 1995. This may reflect the expansion of the service sector growth, which requires an expansion of office buildings. The contributions of both equipment and non-equipment capital deepening have been particularly pronounced during the last three years, partly due to the declining employment growth. While the relative contribution of MFPG was quite high during the 1980s (out of 3.08 percent growth in the first half of 1980s, 0.99 percent point or 32 percent was due to MFPG, and in the second half out of 3.9 percent, 1.16 percent point, or 30 percent was due to MFPG), it has declined substantially during the transition period. It declined from 1.16 to 0.33, which was about 10 percent of 3.27 percent aggregate labor productivity growth. MFPG contribution has improved again in the post reform period. On average it contributed about a quarter of aggregate labor productivity growth.

4.4 Industry origins of aggregate MFPG

So far our results are based on aggregation based on production possibility frontier. Comparisons of these aggregate estimates with that of direct aggregation across industries will help us understand the resource reallocation effects (see methodology section). In this section, we present the results based on direct aggregation across industries, which is the least restrictive approach as explained by Jorgenson et al (2012).

In Table 5, we examine the aggregate re-allocation effects by comparing the aggregate production possibility frontier and the direct aggregation methods. In the top panel of the table, we have the value added growth rates from the two methods. The difference between the two is the value added reallocation, which reflects failure of the assumption that all industries face the same value added price (Jorgenson et al, 2012). For the whole period, the reallocation effect is very tiny, say 0.06 percent points. There are large differences across sub periods, however. While value added in aggregate PPF

grew faster than the aggregate production function during the 1980-2000 period, the picture has overturned after 2000. The relatively larger and positive reallocation term after 2000 may suggest that industries with decreasing relative prices were growing faster. As argued by Jorgenson et al (2012) in the case of the US, this may be a reflection of consumers and investors responding to changing price signals altering their consumption and investment decisions. A detailed look at the data shows that the industries that are growing relatively faster after 2000 include post and telecom, transport equipment, electrical and optical equipment, financial service, food and beverages, and trade. Most of these sectors are subject to substantial technological change and fierce competition that may lead to a decline in prices. This is particularly so, in telecom services, financial services and electrical and optical equipment sector. For instance, the relative price (value added price relative to aggregate GDP deflator) in post and telecom declined by almost 15 percent, while that of financial service by about 3.5 per cent during this period.

The lower panel provides the decomposition of aggregate MFPG into Domar weighted industry MFPG measured using gross output function, and capital and labor reallocation terms (equation 14).[16] The main observation that comes out from the table is that the measured MFPG is primarily a reflection of MFPG in the underlying industries, or the within industry productivity change is significantly reflected in aggregate MFPG. The reallocation effect between industries is quite small.

For the entire period, the non-market services and trade and distributive services have been the largest MFPG enhancing sectors. However, one may raise the question on what MFPG in non-market services would mean, as they hardly follow any market principles. Also agriculture, due to its large share in value added in the early years, show a larger impact on MFPG. This, however, has declined substantially over years. During the period 1980-1985, non-market services, followed by agriculture and trade and distributive services were the largest productivity contributing sectors. Together the productivity of these sectors was larger than the aggregate productivity. The aggregate productivity was driven down by other goods production, consumer and intermediate manufacturing, other market services and the capital reallocation effect. The mid 1980s seems to be a period of productivity gain across the board. Only consumer and intermediate goods manufacturing has shown a negative

[16] Das and Kalita (2011) have presented Domar weighted aggregate MFPG for organized manufacturing sector in India, and shows that the estimates are lower than traditionally shown aggregate MFPG numbers. We show that such differences are primarily due to resource re-allocation across sectors.

contribution, whereas there was no productivity gain in investment goods sector. All other sectors contributed positively to aggregate MFPG, with non-market services, agriculture and trade being the dominant contributors. The observed increase in MFPG during 1985-90 over the previous period was mainly due to an increase the productivity contribution from other goods production, while all other sectors registered a declining or stagnant contribution during this period in comparison with the previous period. During the first half of the 1990s, aggregate MFPG has declined, due to declining productivity contributions from almost all segments of the economy, except from trade and distributive services and other market services. In addition, financial services, which had a positive contribution in the previous period, also registered a negative contribution, leading to a further decline in the aggregate MFPG. During the second half of the 1990s, however, the economy had a productivity revival. This was achieved mainly because of the remarkable increase in the contribution of financial services, non-market services and other market services. Thus, this productivity surge was mainly driven by the service sector. Non-market services along with trade and distributive services and financial services accounted for about 1.09 percentage point (about 90 percent) of 1.24 per cent aggregate MFPG during this period. Compared to 1995-2000, during the period 2000-2005, the aggregate MFPG witnessed a decline. This was primarily due to a declining contribution from non-market services, and a negative contribution from agriculture. Sectors, investment goods manufacturing, consumer and intermediate goods manufacturing and other market services improved their contributions, compared to the previous period. Also, the relative importance of trade and distributive services as the largest contributor to aggregate MFPG remained, while that of financial services and non-market services has increased further. In the last period, apart from non-market services, consumer and intermediate goods manufacturing and financial services also improved their contributions to aggregate MFPG over the previous period. More importantly, we observe a massive increase in the relative share of financial services, which remained to be the single largest contributor to the aggregate MFPG (0.6 percentage point out of 1.72 percent), followed by consumer and intermediate goods manufacturing and non-market services. The contribution of trade and distributive services to aggregate MFPG has almost been nil during this period.

As mentioned before, the quantitative magnitude of the reallocation effect is quite marginal on average. However, there is substantial difference over the different sub-periods. For instance, the reallocation effect was decisive in driving the aggregate productivity down during 1980-1985 period.

The effect of reallocation on aggregate MFPG during this period was to pull down productivity by almost 0.3 percentage points. Reallocation term was positive only after 2000, while it was almost zero during the transition period and was negative during all other periods. When looked at the reallocation effects of capital and labor separately, we see that, in general, the capital reallocation term is negative, indicating that capital is moving to the wrong direction, say from more productive to less productive sectors. Only exceptions to this are during the crisis period and during 2000-2005, when there was a positive capital reallocation. This may indicate that in all the periods capital grew relatively slowly in industries with high capital services prices, leading to a negative capital reallocation. Labor on the other hand, shows a positive reallocation term, indicating a movement of labor from less productive to more productive sectors. This is also in accordance with the recent findings in McMillan and Rodrik (2011) and de Vries et al (2012).[17] As is shown in Figure 2, employment share of agriculture is declining over time, while that of fast growing sectors such as trade, financial services, other market services and non-market services has been increasing. Employment share in consumer and intermediate manufacturing has been stagnant and often going down.

An important observation which is evident from the above analysis is that of an eroding importance of agricultural sector in driving aggregate MFPG. The relative importance of agriculture started declining since the mid 1980s and had continued to decline in the subsequent periods. Also we see substantial fluctuations in the contribution of other goods production, which includes mining, utilities and construction, and investment goods manufacturing. In general, lower productivity contribution is observed from consumer and investment goods manufacturing sectors. Trade and distributive services remains to have one of the largest contributors to the aggregate MFPG, except during the last three years. The importance of financial services and other market services is increasing substantially over time. Though the financial sector experienced a major setback during the crisis period, it has regained its contribution to aggregate growth in the subsequent periods, ensuring an important role in enhancing aggregate productivity. The capital reallocation effect is negative in most of the periods, and is substantial during the 1980s. In contrast, labor reallocation is positive in general, though relatively smaller in magnitude as compared to capital reallocation.

[17] However, de Vries et al (2012) who study the structural transformation and its effect on growth in BRIC countries, also suggest that such a growth enhancing labor reallocation disappears, once accounted for the dualism in the Indian economy. When a distinction is made between formal and informal manufacturing sectors, the labor reallocation term is almost zero.

4.5 The pattern of aggregate MFPG – a detailed analysis

The analysis in this paper uses very detailed industry level data on inputs and output, in deriving measures of productivity. The results, however, discussed so far are summarizations of many disaggregate industry details into a handful of industries, in order to provide an insightful discussion and for ease of analysis. However, while doing so, we use an approach that relaxes many restrictive assumptions underlying aggregate productivity measurement, followed in many previous studies. Such an exercise may still miss important heterogeneity within the chosen industry groups (see Timmer et al, 2011). At the same time, presenting detailed industry level results (as in Appendix Figure 1) would be tedious for readers and may not help provide a meaningful interpretation for the observed aggregate productivity growth. To get a more detailed picture of the pattern of productivity growth with meaningful interpretation, we use the Harberger diagram (Harberger, 1998; Timmer et al, 2011). The Harberger diagram is more like a Lorenz curve that provide how unequal the distribution of income is. In a similar fashion, the Harberger diagram plots the cumulative contribution of individual industries to aggregate growth, against the cumulative share of these industries in aggregate value added. Such a graph will provide us a summary of how widespread or localized are the the productivity growth and changes in growth are within an economy. If growth is widely spread across industries (or growth takes place in many industries, thereby reflecting in aggregate economy) it is called as *yeast-like* growth, and if the aggregate growth is driven only by the positive growth of a few industries, it is called *mushroom-like* growth process.

In Figure 3, we provide the Harberger diagram for the entire period and in Figure 4, the same is presented for the six sub-periods. Note that the MFPG presented in these graphs are the Domar weighted aggregate and therefore does not include the reallocation term. On the *x axis* of the graph, we have cumulative industry value added share, and on the *y axis* we have cumulative MFPG contribution. The green horizontal line shows the measured aggregate Domar weighted MFPG. For the full period of 1980-2008, the aggregate MFP growth is more *yeast-like*, with many industry showing positive MFPG contribution, that adds up to about 1.2 percentages. The industries that contribute positively to aggregate MFPG account for almost 80 percent of value added.

The picture has been substantially different in different sub-periods. During the 1980-1985 period, we see a more *mushroom-like* picture, with many industries contributing negatively to aggregate

MFPG. While the positively contributing sectors' MFPG adds up to about 2 percent and account for about 75 percent of value added, the growth reducing effect of the remaining sectors was sufficient enough to bring down the aggregate MFPG significantly to about 1.3 percent. During the second half of the 1980s, the picture is much more even, and is more *yeast-like*. Many industries contribute positively, and these positive contributing sectors account for almost 85 percent of value added. The growth reducing effect of the remaining sectors is smaller compared to the previous period. 1990-95 is clearly a mushroom-like process. Even though industries that contribute about 70 percent of value added had positive productivity contribution, the negative effect of remaining industries was large enough to pull down aggregate MFPG from about 1 percent to a mere 0.3 percent . In the post 1995 period, in general the growth pattern is more of mushroom-like. Only during the 1995-2000 period, we see a relatively lower growth reducing effect. During this period, clearly there are more industries contributing positively and they account for about 85 percent of value added. Their productivity adds up to 1.7 percent. However, there are also many industries that contribute negatively, leading to a decline of MFPG to about 1.3 percent. During the first five years of 2000s, even though the positive growth contribution adds up to 1.6 percentage, which comes from industries that account for about 60 percent of value added, growth reducing effect of negatively contributing sectors was substantially large that the aggregate growth dropped to less than 1 percent. During the last three years, we see many industries with positive contribution to aggregate growth, but the declining productivity in the negatively contributing sectors are too large, making a larger quantitative effect on aggregate MFPG. The aggregate MFPG dropped from 2 percent, when only positively contributing industries where included, to about 1.2 percent, due to the declining sectors.

Thus the Harberger diagram provides us a mixed pattern of economic growth in India. Overall, it is difficult to say whether Indian economy had a *mushroom-like* or *yeast-like* growth pattern. Clearly the growth was not broad-based throughout the period. While it was so in some periods, the same does not hold throughout. On average many industries contributed positively to aggregate growth. However, often the negatively contributing sectors had a larger effect in terms of their quantitative magnitude, leading to a substantial drop in the aggregate MFPG.

5 Summary and concluding remarks

This paper is an attempt to document the evolution or India's aggregate productivity and its industry origins since 1980s. Since the period after 1980 has been subject to significant economic reforms in India, we examine the industry origins of aggregate economic growth and productivity by dividing the entire period 1980-2008 into 6 sub-periods, each roughly covering different phases of economic reforms in India. As is already known, the Indian economy has shown a significant growth performance after the introduction of economic reforms in the late 1980s and in particular after the early 1990s. Clearly, the aggregate value added and labor productivity grew faster in the late 1980s and during the period after 1995. More importantly the aggregate growth has been substantially high after 2000, which is clearly an indication of the effect of economic reforms in the 1990s.

The observed aggregate growth is primarily due to capital accumulation. Equipment capital deepening has contributed substantially to aggregate economic growth and labor productivity growth. There have been some differences across different periods, though. For instance, during the early 1980s labor contribution was much higher than that of the contribution from equipment capital. Also during the mid 1980s, improvement in labor quality, or the increase of high-skilled workers' share in aggregate employment, has helped improve the contribution of labor input to aggregate value added and labor productivity growth. Even though capital deepening was the dominant contributor to aggregate growth MFPG has been substantial in deciding the trends in aggregate growth. In particular, after the reform process, MFPG has improved substantially, leading to a higher aggregate growth. MFPG has contributed about a quarter of aggregate labor productivity growth in the post reform period. Also during the transition period, i.e. 1990-95 period, the observed decline in aggregate growth is predominantly due to a decline in MFPG. Thus, it appears that economic reforms in the mid 1980s and early 1990s have helped Indian economy follow the market principles better and thereby gain better productivity. Labor quality and employment does not seem to be moving in the same direction as the aggregate growth.

However, in general the observed productivity growth in the post-reform period is not broad based. Rather it is more mushroom-like, as there are many industries that contributed negatively to aggregate productivity growth. If the pattern of productivity was more broad-based the aggregate productivity gain would have been much larger. While some industries lost their relative importance as contributor

to aggregate productivity, some industries emerged as important contributors. For instance, our analysis on the industry origins of aggregate value added and productivity growth suggests that while the agricultural sector was still dominant and important in the early 1980s, it has lost its significance as a contributor to aggregate growth and productivity over time. This, nevertheless, does not suggest that this sector has lost its significance as an employment provider in Indian economy. It still remains as one of the major employment providers in the Indian economy. However, its relative share has eroded substantially over time, and it appears that job share in service sector, in particular, trade and distributive services, financial services and non-market services are improving. Apart from the observed decline in productivity contribution of agriculture, we also see that the productivity contribution from manufacturing has been almost stagnant over years, while there has been remarkable increase in financial services, non-market services, other market services and trade and distributive services. It may be noted that the economic reforms in India has not focused much on the agricultural sector, rather they were primarily on the manufacturing sector. The service sector revolution seems to be a spin-off of the manufacturing reforms. There is definitely a momentum in the sectoral productivity, which is driven by service sector. There is a clear sign of increase in the importance of market services, financial services and trade and distributive services both in terms of value added share and their contributions to value added and productivity growth after the late 1990s. However, one may question the meaning of productivity decline or improvement in the non-market services, which does not follow the market principles. The improvement in market services, however, might indicate the effect of information and communication technology, which needs further analysis. Since the production of ICT is heavily concentrated in the advanced countries, where evidences also suggest the effect of ICT on manufacturing sector through ICT producing sectors, India seems to have benefitted more in ICT using sectors, which is predominantly the service sector. However, to make such a strong conclusion we need further detailed analysis. It appears that it would be useful to make a distinction between ICT using and non-ICT using industries while examining the contributions, which will be explored in the future.

Another important finding of our study is that the labor reallocation effect is generally positive and larger, suggesting a movement of labor from low productive to high productive sectors. However the capital reallocation is negative, suggesting that the misallocation of capital might be a factor that pulls down aggregate productivity in Indian economy. From a pure methodological perspective, the

observed reallocation term, which quite small in some periods, while substantial in some other, may suggest that simple aggregation across industries may not provide a true picture of the aggregate growth in an economy like India, which is still subject to much resource misallocation.

Certainly, the economic reform process that started lightly in the late 1980s and more widely during the early 1990s has made a clear impact on aggregate economic and productivity growth, though the effect of the same has not been broad-based. The reform process that has sustained in the subsequent periods may have helped the Schumpeterian creative destruction process (Schumpeter, 1942) in Indian economy. It might have led to significant churning in the market, by replacing many inefficient firms, and also old capital by new, which may have reflected in faster capital accumulation. The continued growth of market service sector, including financial services, and their productivity, along with the declining employment share in agriculture might also indicate the importance of improving the quality of labor force, as the sectors that are expanding quickly are those which requires relatively more skilled labor force.

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Tables and Graphs

TABLE 1 Industry aggregation, and corresponding ISIC codes

sl Nr.	Industry Aggregate	ISIC	Industry description
1	Agriculture	AtB	Agriculture, hunting and fishing
2	Other goods production	C+E+F	Mining and Quarrying + Electricity, Gas and Water Supply + Construction
3	Consumer & intermediate goods manufacturing	15to28+36 to37	Manufacturing, excluding machinery, electrical and transport equipment
4	investment goods manufacturing	29t35	Machinery, nec. + Electrical and Optical Equipment + Transport Equipment
5	Trade and distribution	G+60t63	Wholesale and Retail trade + Transport and Storage
6	Finance services	J	Financial Services
7	Other market services	H+64+K+ O+P	Hotels and Restaurants, Post and Telecommunication and all other market Services
8	Non-market services	L+M+N	Public Administration and Defense + Compulsory Social Security + Education + Health and Social Work

Note: A detailed industry classification consisting of all 26 industries considered in the analysis are given in Appendix Table 1

TABLE 2 Industry origins of value added growth, and input and MFPG contribution to aggregate growth

		Pre-reform period			Post-reform period		
	1980-2008	**1980-1985**	**1985-1990**	**1990-1995**	**1995-2000**	**2000-2005**	**2005-2008**
Value Added	**5.90**	**5.06**	**5.86**	**5.18**	**5.80**	**6.75**	**8.02**
Industry contribution							
Agriculture	0.80	1.05	1.06	0.67	0.79	0.56	0.60
Other goods production	0.63	0.43	0.77	0.47	0.57	0.88	0.91
Consumer & intermediate goods manufacturing	0.86	0.81	0.86	0.87	0.68	0.79	1.29
investment goods manufacturing	0.22	0.26	0.26	0.23	0.08	0.30	0.21
Trade and distribution	1.26	0.90	0.96	1.22	1.22	1.78	1.80
Finance services	0.47	0.32	0.38	0.43	0.46	0.53	0.88
Other market services	0.98	0.72	0.87	0.86	0.98	1.28	1.56
Non-market services	0.68	0.56	0.72	0.44	1.01	0.62	0.76
Input and MFPG contribution							
Capital input	3.34	2.33	2.89	3.18	3.34	3.80	5.54
Equipment Capital	2.34	1.44	2.10	2.49	2.38	2.44	3.94
Non-equipment capital	1.00	0.88	0.79	0.70	0.96	1.36	1.60
Labor input	1.54	1.75	1.80	1.67	1.22	1.77	0.77
Employment	0.84	1.03	1.03	0.95	0.64	1.12	-0.01
Labor composition	0.70	0.72	0.78	0.72	0.57	0.65	0.78
Aggregate MFPG	1.02	0.99	1.16	0.33	1.24	1.18	1.72

Note: Industry contributions are measured as share weighted growth rate of each industry group. Input and MFPG contributions are using standard growth accounting.

Source**:** Authors' calculation using National Accounts Statistics (NAS), Central Statistical Organization (CSO), India

TABLE3 Industry shares in aggregate nominal value added, averaged across years

Industry	1980-2008	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2008
Agriculture	26.8	33.4	29.9	28.6	25.7	21.1	18.5
Other goods production	10.4	9.0	9.9	10.1	10.3	11.3	12.5
Consumer & intermediate goods manufacturing	13.0	13.2	12.9	13.1	13.2	12.6	12.9
investment goods manufacturing	3.3	3.5	3.6	3.4	3.1	2.9	3.4
Trade and distribution	18.3	15.7	16.9	17.4	18.7	20.5	21.8
Finance services	4.7	3.3	3.6	4.6	5.5	5.9	5.6
Other market services	13.1	12.8	12.9	12.6	12.4	13.8	14.6
Non-market services	10.5	9.1	10.2	10.1	11.1	11.9	10.8
Total	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

Source**:** Authors' calculation using National Accounts Statistics (NAS), Central Statistical Organization (CSO), India

TABLE 4 Decomposition of aggregate labor productivity, Aggregate production possibility frontier

		Pre-reform period			Post-reform period		
	1980-2008	**1980-1985**	**1985-1990**	**1990-1995**	**1995-2000**	**2000-2005**	**2005-2008**
Average Labor Productivity	**4.21**	**3.09**	**3.89**	**3.27**	**4.48**	**4.40**	**8.04**
Input and MFPG contribution							
Capital deepening	2.48	1.38	1.95	2.22	2.67	2.57	5.54
Equipment Capital	1.88	1.05	1.67	1.96	1.98	1.70	3.94
Non-equipment capital	0.60	0.34	0.28	0.26	0.68	0.87	1.60
Labor composition	0.70	0.72	0.78	0.72	0.57	0.65	0.78
Aggregate MFPG	1.02	0.99	1.16	0.33	1.24	1.18	1.72

Notes: All growth rates are average of annual log differences, expressed in percentages. Aggregates may not add up, due to rounding

Source**:** Authors' calculation using National Accounts Statistics (NAS), Central Statistical Organization (CSO), India

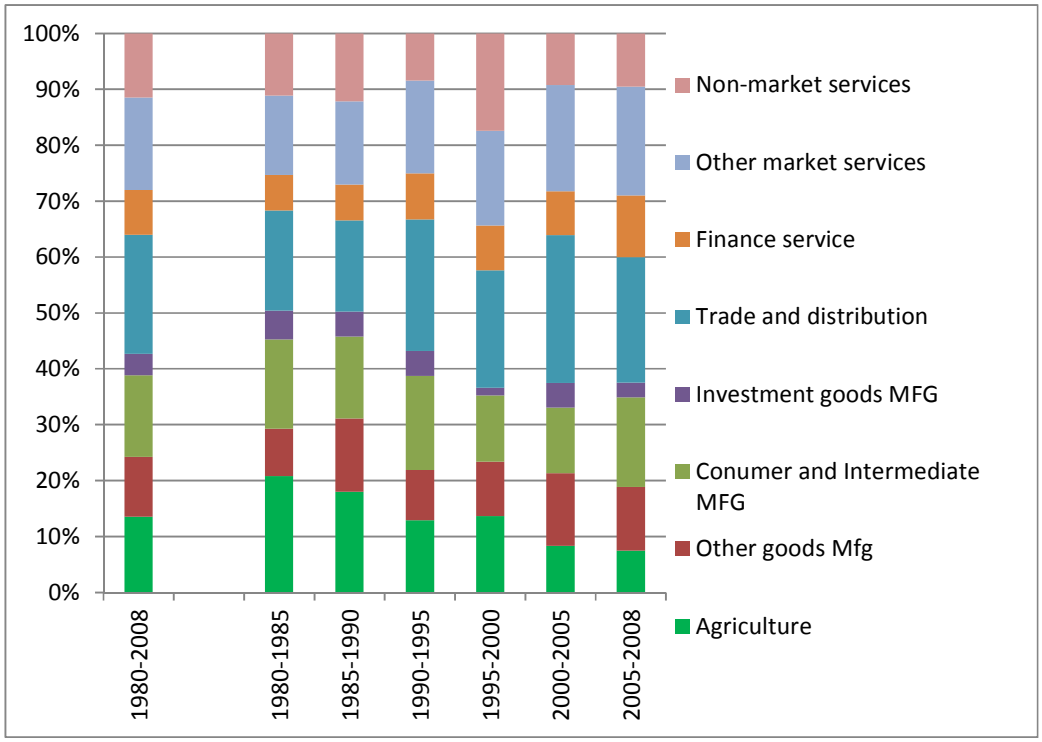
TABLE 5 Aggregate reallocation effects

		Pre-reform period			Post-reform period		
	1980-2008	**1980-1985**	**1985-1990**	**1990-1995**	**1995-2000**	**2000-2005**	**2005-2008**
Aggregate production possibility frontier vs. Aggregate production function							
Aggregate production function VA	5.96	4.78	5.70	5.08	5.77	6.88	8.65
Aggregate PPF VA	5.90	5.06	5.86	5.18	5.80	6.75	8.02
Reallocation of VA	0.06	-0.29	-0.17	-0.10	-0.02	0.13	0.63
Aggregate Production Possibility frontier vs. Direct aggregation across industries							
Aggregate MFPG	1.02	0.99	1.16	0.33	1.24	1.18	1.72
Domar-Weighted MFPG	1.00	1.33	1.35	0.34	1.27	0.89	1.21
Agriculture	0.18	0.53	0.49	0.11	0.15	-0.19	0.09
Other goods production	-0.06	-0.35	0.12	0.04	0.09	0.01	-0.37
Consumer & intermediate	-0.01	-0.06	-0.06	-0.12	-0.13	0.04	0.37
Goods manufacturing investment goods manufacturing	0.00	0.10	0.00	-0.02	-0.10	0.10	-0.15
Trade and distribution	0.27	0.32	0.17	0.36	0.28	0.31	0.00
Finance services	0.10	0.06	0.02	-0.30	0.22	0.35	0.60
Other market services	0.10	-0.03	0.00	0.06	0.17	0.33	0.30
Non-market services	0.43	0.75	0.61	0.20	0.60	-0.04	0.38
Reallocation of capital input	-0.07	-0.32	-0.26	0.04	-0.06	0.13	-0.11
Reallocation of labor input	0.12	0.03	0.10	-0.04	0.05	0.15	0.67

Notes: All growth rates are average of annual log differences, expressed in percentages. Aggregates may not add up, due to rounding

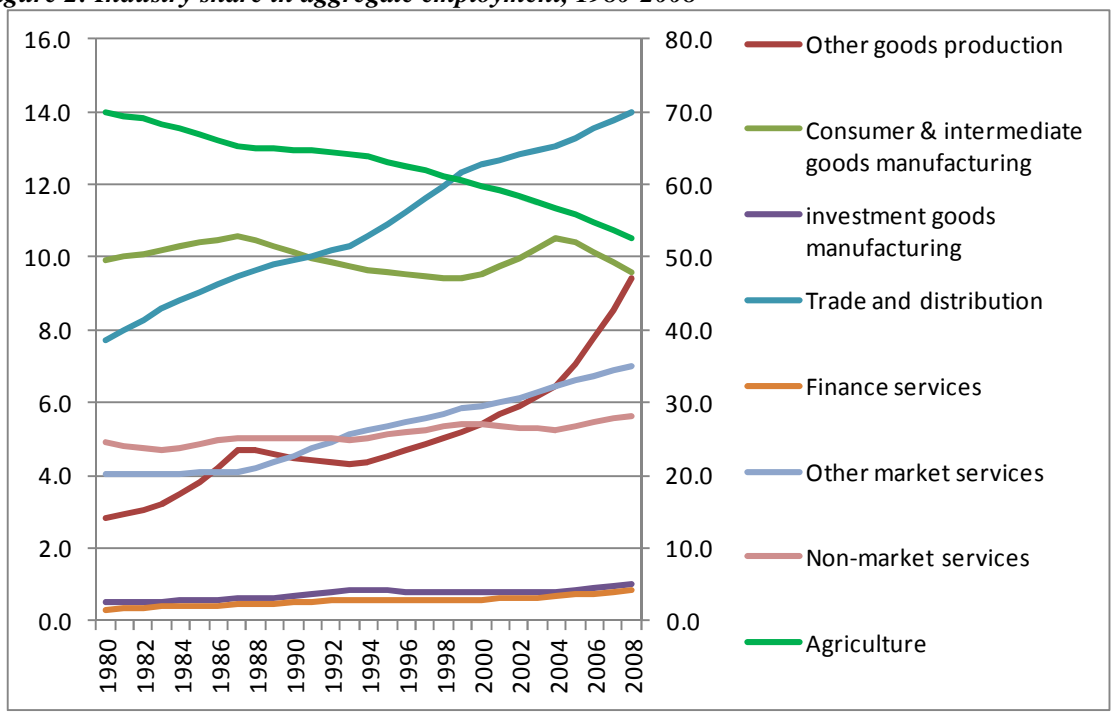
Source**:** Authors' calculation using National Accounts Statistics (NAS), Central Statistical Organization (CSO), India

Figure 1: Industry contribution to aggregate value added growth (per cent)



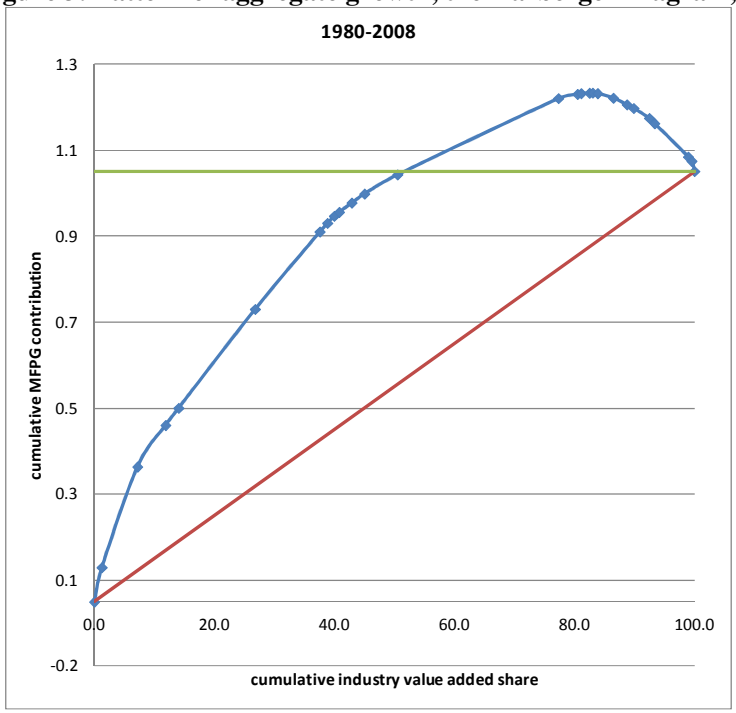
Source**:** Authors' calculation using National Accounts Statistics (NAS), Central Statistical Organization (CSO), India

Figure 2: Industry share in aggregate employment, 1980-2008



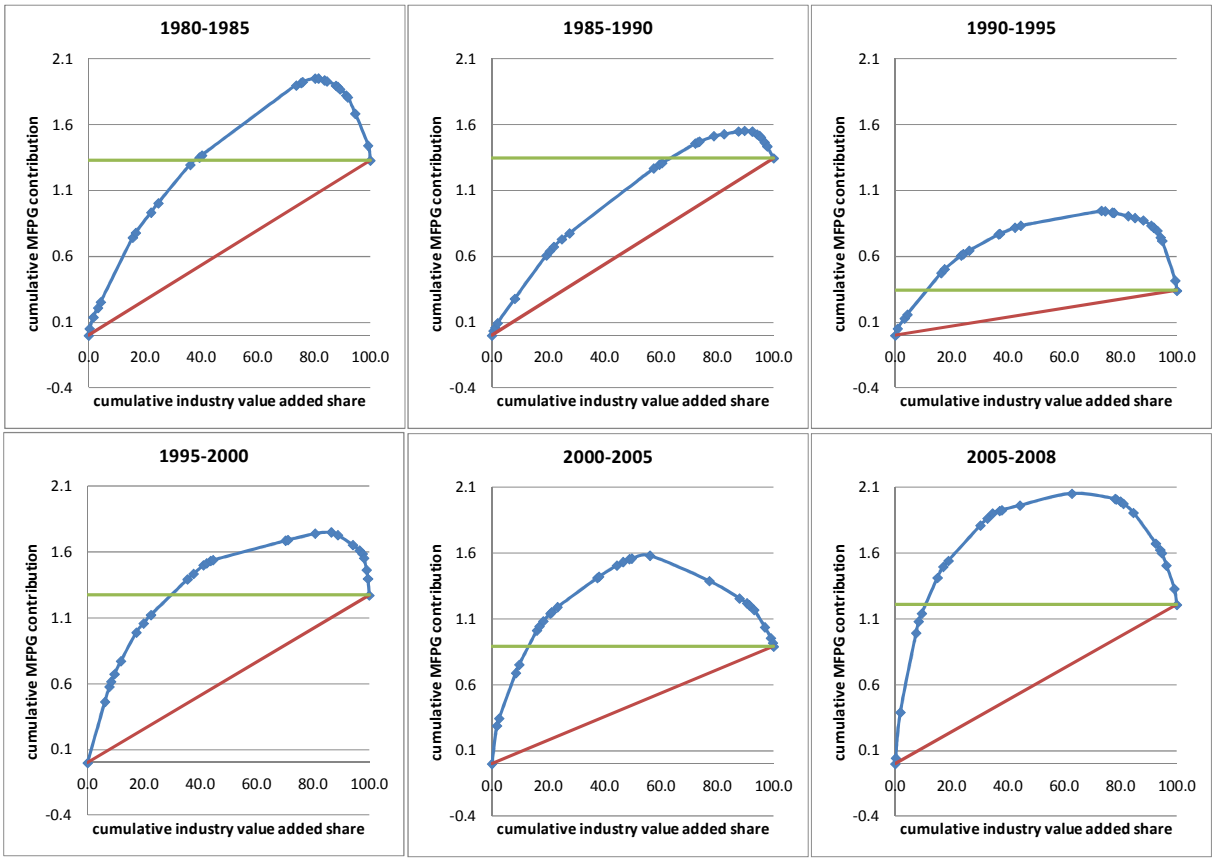
Note: Due to large share of agriculture, to get a better picture of the movement, it is depicted on the secondary axis.

Figure 3: Pattern of aggregate growth, the Harberger Diagram, 1980-2008



Notes: The green line is the observed aggregate Domar weighted MFPG

Figure 4: Pattern of aggregate growth, the Harberger Diagram, sub-periods

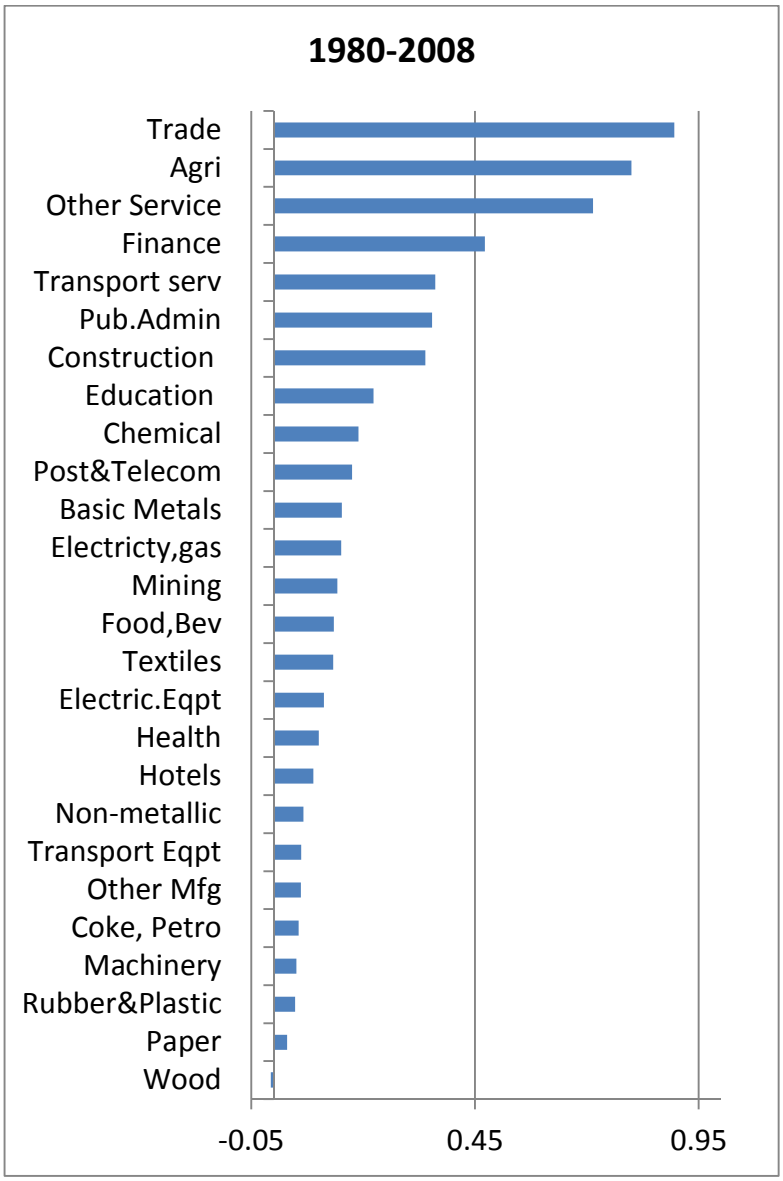


Notes: The green line is the observed aggregate Domar weighted MFPG

APPENDIX TABLE 1: AVERAGE ANNUAL GROWTH RATES OF VALUE ADDED BY INDUSTRIES

Industry	ISIC	1980-2008	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2008
Agriculture, Hunting, Forestry and Fishing	AtB	3.0	3.1	3.5	2.3	3.1	2.7	3.2
Mining and Quarrying	C	5.5	6.7	9.5	4.0	3.6	4.5	4.0
Food Products, Beverages and Tobacco	15t16	6.4	7.0	5.8	6.0	5.3	5.3	10.3
Textiles, Textile Products, Leather and Footwear	17t19	5.1	3.3	4.7	5.3	6.2	5.2	6.7
Wood and Products of Wood (20)	20	-1.4	-5.6	-1.2	2.1	-4.4	-8.9	17.3
Pulp, Paper, Paper Products, Printing and Publishing	21t22	5.5	6.1	9.3	3.6	-0.8	9.4	5.5
Coke, Refined Petroleum Products and Nuclear Fuel	23	9.2	17.3	13.6	7.6	-4.3	11.7	9.4
Chemicals and Chemical Products	24	9.0	9.6	9.8	10.4	6.4	8.1	10.2
Rubber and Plastic Products	25	8.1	7.1	13.1	2.8	14.4	3.9	7.2
Other Non-Metallic Mineral Products	26	7.9	9.3	8.2	5.3	7.6	3.6	16.7
Basic Metals and Fabricated Metal Products	27t28	6.7	5.2	5.3	7.9	4.7	7.1	12.1
Machinery, nec.	29	4.5	6.8	4.0	4.2	0.3	6.4	6.1
Electrical and Optical Equipment	30t33	8.8	9.6	10.3	5.7	6.7	11.6	8.8
Transport Equipment	34t35	7.0	6.1	7.1	12.3	0.0	12.4	1.9
Manufacturing, nec; recycling	36t37	7.2	12.5	4.7	8.0	5.4	5.5	6.6
Electricity, Gas and Water Supply	E	7.0	8.0	8.5	7.7	5.4	5.1	7.2
Construction	F	6.0	2.4	6.5	3.4	6.4	10.0	8.4
Trade	G	7.0	5.8	5.7	7.3	6.7	8.8	8.5
Hotels and Restaurants	H	8.0	5.0	7.2	8.3	9.8	9.7	7.5
Transport and Storage	60t63	6.6	5.7	5.6	6.3	6.1	8.5	7.6
Post and Telecommunication	64	14.0	5.5	6.2	12.9	18.1	22.1	22.6
Financial Services	J	10.1	9.8	10.4	9.2	8.5	9.0	15.8
Public Administration and Defence; Compulsory Social Security	L	6.0	6.1	6.5	3.5	8.4	3.5	9.2
Education	M	7.0	6.0	7.7	5.5	10.0	6.7	5.7
Health and Social Work	N	7.3	7.2	8.1	5.6	9.8	8.6	2.7
Other Services	K+O+P	6.6	5.6	6.7	6.0	6.0	7.1	9.4

Appendix Figure 1a: Industry contribution to value added growth, 1980-2008



Appendix Figure 1b: Industry contribution to value added growth, sub-periods