Did Productivity Slowdown in the Emerging Economies?
Evidence from India in the Pre and Post Global Crisis Period

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Abstract

The global economy has seen downturn in productivity growth in the recent years. A less discussed aspect is the performance of emerging economies. This paper is an attempt to understand productivity dynamics in India, in the context of financial crisis, and global productivity slowdown. The present paper examines the labor productivity growth performance for the Indian economy for the period 2001-2015 and compares the pre global slowdown period with the post crisis period with an industry perspective. Using India KLEMS dataset, which provides detailed industry level data, and growth accounting technique, the sources of labor productivity for aggregate economy as well as disaggregated industrial sectors are analyzed. Our analysis did not find evidence of any steep productivity decline in India as was observed in many advanced countries. Labor productivity grew at an annual average rate of 6 per cent per annum over the period 2001-15 with a modest decline during the period 2012-15. Overall, the industries that performed well in terms of productivity in the pre-crisis period are manufacturing sectors and market services sectors with relatively large foreign content in their production. Other sectors that performed well include utilities, and market services in general. In the post-2012 period, however, productivity growth has declined substantially in sectors which are highly integrated to the global economy – i.e. those where the foreign content in production is high – both manufacturing and market services. With a compensating productivity gain in other manufacturing and market services sectors, where the foreign content is relatively less, overall productivity growth was somewhat maintained at the pre-crisis average. We observe a positive relationship between change in foreign content in domestic production and labor productivity growth, which warrants further investigation. Available evidence is suggestive of a decline in the change in foreign content across majority of sectors in the post crisis period, which might be having a productivity lowering impact in those industries.

KEY WORDS: Labor productivity, fragmentation of production, global financial crisis
JEL classification: D24; E24; G01; J24; O47

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1. Introduction

The global economy has seen downturn in productivity growth in the recent years. Indeed, the global financial crisis might have aggravated the productivity slowdown, but the decline started even before the onset of the crisis [OECD (2015),Van Ark and Jager (2017), and Erumban and van Ark (2018)]. Hence there emerged a debate on whether the world is seeing the end of massive productivity improvements. The discourse has centered on two views- (1) the importance of general purpose technologies – in particular electricity and information and communication technology (ICT) –, demography, education, inequality, globalization, environment and debt on understanding growth and productivity (See Gorden (2016), Brynjolfsson and McAfee (2011)) and (2) secular stagnation, where advanced economies are entering into a long-term productivity stagnation due to multiple factors [Summers (2014) versus Eichengreen (2015)]. A less discussed aspect is the role of emerging markets. Erumban and van Ark (2018) argue that a sizable part of the global productivity decline comes from emerging markets, which is partly a result of their success in the previous decades. The role of these economies in driving global trade and production fragmentation, facilitated by the accelerated use of information technology, has been massive in the 2000s, which has indeed translated into a much higher global productivity growth. It is imperative to understand the productivity dynamics in the emerging economies such as- China, India and Brazil in the context of global productivity slowdown as well as recovery of growth in the advanced economies.

This paper is an attempt to understand productivity dynamics in India, in the context of financial crisis, and global productivity slowdown. Two important questions arise when analyzing India's growth dynamics in the context of global slowdown. The first: how well integrated India was to the world economy before the crisis and the second: how did it perform subsequent to the slowdown. Share of exports in India's GDP increased from 7.13 percent in 1990 to 23.48 percent in 2008, while the share of imports rose from 8 percent to 29 percent in the same period. The trade share of GDP has declined since the financial crisis, reaching respectively to 18.7 percent in the case of exports and 21.8 percent for imports in 2017. The impact of the crisis on the export sector was evident as India's exports which had previously grown at nearly 20 percent between 2002 and 2008 plummeted to a negative 20.3 percent in 2009-10. Furthermore, it is now widely accepted that India witnessed a slowdown in GDP growth since 2008 after almost a decade of consistent high growth (2003-2008). However, there is less evidence on how labor productivity and its sources – total factor productivity and capital deepening – have moved after the global financial crisis. Several researchers have analyzed India's poor productivity levels, especially in manufacturing sector and highlight the roles of small scale production, low capital intensity and rigidity of labor markets as barriers to overcome for sustaining high productivity growth. In addition, despite being a pioneer in software services, evidence seem to suggest that Indian industries lags significantly behind in using information and communication technologies to boost their productivity [Erumban and Das (2016) and Erumban et al (2018)].

The present paper examines the labor productivity growth performance for the Indian economy for the period 2001-2015 and compares the pre global slowdown period (2001-2007) with the post crisis period (2008-2015) with an industry perspective. Using India KLEMS dataset, which provides detailed industry level data, and growth accounting technique we analyze the sources of labor productivity

for aggregate economy as well as disaggregated industrial sectors. This will help us understand how badly Indian industries are affected, or how well they are insulated from the global financial crisis. Further, the paper will examine analyze the factors that played a role in driving labor productivity growth in Indian industries pre-and post financial crisis.

The paper is structured as follows. We review the growth performance of India in the period and aftermath of global crisis in section 2. The sources of labor productivity growth including methodology and dataset are discussed in section 3. Section 4 analyzes the labor productivity growth in the broad sectors and Indian industries. Some analytical perspectives on observed productivity growth are presented in section5. The final section provides our summary and conclusions.

2. India's growth and productivity during the 21st century; A review of literature

The growth path of the Indian economy since 1950s has seen two sharp growth periods (mid 1980s and 2003-08) and this is by and large reflective of significant policy changes that have occurred through reforms in industrial policy, trade and exchange rate policy, fiscal and financial sector[1]. Two facts that remain core to India's growth are (1) The growth driver has been the services sector and (2) multifactor productivity have been low and observed growth has been driven by factor accumulation. Indian economy witnessed a period of robust and high economic growth during the period of 2000s with the peak of growth close to 9 per cent per annum during 2003-08. The onset of the global growth slowdown to the recession saw a slump in India's growth and it recovered by 2015 to around 5 per cent per annum. The growth slowdown saw a host of policy measures (both monetary as well as fiscal stimuli) put in place by the government of India to arrest the slide[2].

The growth performance of Indian economy for the period 2000-15 has seen period of high growth (2003-08). Beginning 2003, GDP growth rate increased and reached a high growth trajectory of 9% plus growth. India experienced 3 consecutive years of GDP growth rate in excess of 9% viz. 9.48% in 2005-06, 9.57% in 2006-07 and 9.32% in 2007-08. Economists have christened this growth period as India's "dream run" of high growth rate. The growth was financed via investment backed by a rise in domestic savings. Gross domestic savings increased to round 35 per cent of GDP and at the same time domestic investment rate also jumped to 36 per cent of GDP.[3] The growth boom triggered by demand side expansion however had some faulty dark spots (Nagraj (2008)). Five major issues were pointed which covered aspects like concentration around narrow industrial base (automobiles, telecoms), low infrastructure share vis a vis manufacturing as regards incremental investment; power and roads needed much improvements; share of construction in fixed investment declined and fall out of labor intensive sectors with regard to jobs. The growth slowdown as witnessed since 2010 were attributed to a host of factors. Acharya (2012), pointed out that the worsening of macroeconomic outcomes aided by unfavorable external factors. The fiscal deficit climbed to around 8 per cent and remained consistent at that rate, consumer price inflation showed double digit rates for food products and current account deficit also remained at more than 2 percent of GDP. This was

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[1] There has been many studies discussing various aspects of this growth process (Das et al (2016); Bhagwati and Panagariya (2013); Verma (2012); Balakrishnan (2012); Eichengreen, Gupta and Kumar (2010); Bosworth and Collins (2008); Panagariya (2008); Kochar et al (2006); Vaidyanathan and Krishna (2007)).
[2] Refer Rakesh Mohan and Munesh Kapur (2014)
[3] Refer Rakesh Mohan (2008)

followed by sharp falls in domestic savings and investment. Bosworth and Collins (2015) argued that wide range of issues- the rise of combined central and state deficit to around 7 percent, the acceleration of consumer price inflation to double digit in 2009; the surge in current account deficit after a decade of averaging less than 1 percent and widespread corruption questing governance were responsible for India's steep decline in growth. This assumes signifance given that the engagement with global trading system was low as is evident from low share of exports in world markets and the financial system being less dependent on foreign financial flows. In addition, the slowing down of the growth also puts questions on India's pace of economic reforms, particularly macroeconomic policies pursued with particular focus on subsidies and infrastructure bottlenecks.

An important question remains about can India revert the low growth trend and reestablish itself on the high growth trajectory post global financial crisis. Acharya (2012) points out that apart from corrective economic policies to curb both domestic and external macroeconomic imbalances, there should be strengthening of weakly designed and implemented programs in employment, education and food security. Mishra (2013) argues that potential growth in India continues to be high and needs boost in terms of structural reforms in a long term perspective and in short term caution is needed for loosening of monetary policy. Kapur and Mohan (2014) cite a host of policy measures which need attention- public savings, private corporate investment, capital account management and building infrastructure in order get back to high growth[4]. Bosworth and Collins (2015) attribute policies pertaining land transfer and power availability for medium size enterprises as core to the arresting the slide in growth.

While growth has seen a slide since the onset of global slowdown, productivity enhancement as a source of growth has remained a long standing challenge for India. Several studies have documented the productivity performance of the Indian economy since the advent of economic reforms since 1991-92, few have looked into the growth performance at a detailed disaggregate level. Das et al (2016) covered the different policy regimes from 1980-2011 and showed that a modest 1.2 percent TFP growth for the period. Two things stand out-(1) market services were the drivers of overall economic growth and (2) there was a turn- around in manufacturing TFP with a growth of more than 2 percent in 200s as against a negative growth in the 1990s. In another related study Goldar et al (2017) reveals that value added growth at the economy level accelerated significantly during 2003– 2014 by about 1.7 percentage points per annum to 7.2%, which was accompanied by accelerated total factor productivity (TFP) growth, acceleration by about 0.9 percentage points to 1.8% per year. The contribution of TFP growth to aggregate value added growth was much higher during 2003–2014 than that during 1980–2002. The share of Market Services sector in aggregate value added was on the rise, with a falling share of Agriculture. The rise of Asia in the new world order (Jorgenson and Vu (2015)) sees India as a major player in the world economy. A study examining the growth and productivity in 21st century India, Das et al (2018) argue that India entered a high growth phase beginning 2001 but that was delineated by two periods of pre and post global slowdown. The major findings were aggregate economy value added growth was driven by capital deepening, while in accounting for sources of overall industrial growth, intermediate inputs especially material inputs played a substantial role. While India continues to advance as an emerging economy through its growth and productivity performances, it is significant to note that While China grew 50 percent faster than India in terms of value added growth; it grew 25 percent slower when compared in terms

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[4] Inflation has emerged as a concern for policy makers as inflation rates has seen an upward rise since 2006 and remained at a around 9 level percent till 2013. The paper analyzes the dramatic decline in inflation, and quantifies the contribution of different factors in explaining the disinflation process.

of total factor productivity growth. Harry Wu et al (2017) comparing India and China observed that manufacturing for China contributed to more than 50 percent growth and services for India accounted for around 56 percent. The authors concluded that the impact of global financial crisis was more in case of China than India.

There remain enormous challenges to overcome if productivity enhancement is to lead India's future growth. Several aspects need attention – (a) the divide between formal and informal manufacturing with respect to productivity and efficiency shows a huge gap. The informal manufacturing is the largest job creator; however labor productivity remains lower than formal manufacturing. (b) The expansion in jobs seems to be through contract workers and there is evidence of wage differentials between the two categories- directly employed and employed via contractor. These points out to the long overdue of overhauling of labor market rigidities[5]. (c) Capital formation in the economy and the issues of investment in equipments and its role in growth needs to be addressed and finally, the social sectors particularly levels of education (primary versus secondary) and role of skilling remains major obstacles to overcome to realize the growth potential.

The above paragraphs showed India's growth and productivity for the periods of 2000s and it is evident that two distinct periods of growth were observable for the period 2000 onwards. From a high rate of growth India slumped to a low phase of growth amidst the global growth and productivity slowdown despite its exports and financial sectors not been too dependent on global growth. The question that we need to ask is if India is poised for a new phase of growth? The major structural reforms aimed at boosting the economy- goods and services tax and Insolvency and Bankruptcy Code Act 2017 were put in place. The former is aimed at formalization of the large informal economy and the latter attempts clean up of the financial sector particularly the non performing assets of the bank. Further reforms in speeding the use of digital payments, mobile banking as well as schemes to make affordable access to financial services (bank accounts, pensions, insurances) are expected to impact on growth and its distribution. These reforms are expected to have short term costs, but in the long run are expected to steer the growth process of the Indian economy. The OECD (2017) economic survey of Indian points recommends that   comprehensive tax reforms along with promotion of an active balanced regional development are important are realizing India's growth potential.

In conclusion India's long-term trend growth of GDP accelerated after 2001-02 and reached its peak in 2007-08, the gradual reform of 1990s and benign global growth before financial crisis of 2008-09 helped India's march to a higher growth levels. The growth experience of 21st century had two distinct phases- In phase I (2001-02 to 2007-08) India's growth moved in sync with world growth and enjoyed buoyant Global growth impetus. In phase II (2008-09 to 2015-16), India has gone through a cycle where domestic factors influenced more to the cyclical downturn, the cycle has started to revise in last few years. The government has made some strong policy directives at reforming the economy- goods and services tax (GST), bankruptcy law and financial inclusion and is expected to yield results in medium to long term. There still remains a path of long recovery with corrective and sustained policy reforms.

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[5] Singh et al (2017) point outs that Supreme Court led judicial interpretations of the law made it both easier for employers to fire contract labour (or at least they are not forced to give contract labour employed for perennial tasks regular labour status) and pay contract workers lower wages than those paid to regular workers. Also refer Goldar (2016).

3. Sources of labor Productivity Growth : Methodology and Dataset

In this section, we discuss the respective frameworks for computing productivity in the individual industries in Indian economy. The concept of labour productivity used in the present paper is defined as real value added per unit of labour input. Typically, the labour input is measured in terms of hours worked. However in the case of India, the data on hours worked are either not available or are of low quality and hence labour input is measured in terms of the number of persons.[6]

Measuring Productivity Growth for Individual Industries

Sectoral LP growth is measured using the standard growth accounting approach (see Jorgenson et al (2005)) using value added functions – using K and L only.

Let, $Z_j = g_j(K_j, L_j, T)$ (3.1)

be the value added production function , with Z_j as the quantity of value added in industry j.

We can compute TFP and factor contribution using a value added function as;
$$\Delta ln A_j^Z = \Delta ln Z_j - \bar{v}_{K,j}^Z \Delta ln K_j - \bar{v}_{L,j}^Z \Delta ln L_j \qquad (3.2)$$

where $\Delta ln A_j^Z$ is the growth rate of real value added and $\bar{v}_{K,j}^Z$ and $\bar{v}_{L,j}^Z$ are respectively the compensation shares of capital and labor in nominal value added, so that the sum of the two is unity, under constant returns to scale assumption.

Growth in industry value added can be decomposed into contribution of capital, labour and TFP.
$$\Delta ln Z_j = \bar{v}_{K,j}^Z \Delta ln K_j + \bar{v}_{L,j}^Z \Delta ln L_j + \Delta ln A_j^Z \qquad (3.3)$$
$$= v_{K,j}^Z \Delta ln K_j + v_{L,j}^Z \overline{\Delta ln N_j} + + v_{L,j}^Z \Delta ln LC_j + \Delta ln A_j^Z \qquad (3.4)$$

where N_j denotes number of persons employed in industry j and LC_j is a measure of labour composition in industry j.

Let labour productivity be defined as value added per person employed, $\mathit{z}_j = \frac{Z_j}{N_j}$ Let $k_j = \frac{K_j}{N_j}$ be capital intensity or capital input per person.

Then, $\Delta ln \mathit{z}_j = v_{K,j}^Z \Delta ln k_j + v_{L,j}^Z \Delta ln LC_j + \Delta ln A_j^Z$ (3.5)

The sources of labour productivity growth are change in capital intensity, change in labour composition and TFP growth, as shown in (3.5).

Aggregate Economy productivity growth and sectoral contributions

Aggregate economy growth is computed as the sum of sectoral growth rates weighted using their nominal share in aggregate economy value added. Using a Tornqvist index and defining aggregate economy value added growth as
$$\Delta ln Z = \sum_j \bar{v}_j^Z \Delta ln Z_j \qquad (3.6)$$

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[6] The number of persons employed in India refers to persons usually employed either in *principal* or in *subsidiary activities* for *major period of the year*.

where $\Delta \ln Z$ is the aggregate economy value added growth rate, $\bar{v}_j^Z$ is the nominal share of industry j in aggregate economy value added (averaged over current and previous years), and $\Delta \ln Z_j$ is the growth rate of value added in sector j.

Aggregate economy labor productivity is obtained as:

$$\Delta ln\left(\frac{Z}{N}\right) = \sum_j \bar{v}_j^Z \Delta ln_{3j} \tag{3.7}$$

Dataset and variables

The paper uses the India KLEMS dataset version 2017 for the estimation of labor productivity across various industry groups, broad sectors as well as the aggregate economy. The dataset is created using various statistical databases of the government of India. These include National Accounts Statistics (NAS), Input-Output (IO) tables, Annual Survey of Industries (ASI) and the National Sample Survey organization (NSSO) for unorganized manufacturing. The dataset is constructed in a manner that it is consistent with the official national accounts data of the government of India. The dataset is freely downloadable from the website of Reserve Bank of India (www.rbi.org). The present paper requires industry wise data on nominal and real value added, investment by asset type, number of employees and labor compensation by type of workers. The variable construction is described below.[7]

(1) **Gross Value added**: Gross value added of a sector is defined as the value of output less the value of its intermediate inputs. NAS provides estimates of Gross Domestic Product (GDP or gross value added) by industries at both current and constant prices since 1950. We use the data for the period 1980 to 2015 from the most recent National Accounts series (NAS 2017, NAS 2014 & Back series 2011). Using concordance between NAS classification and the 27 KLEMS industries GVA series for 1980-81 to 2015-16 have been constructed. For 7 manufacturing industries direct estimates of GVA were not available from NAS, estimates have been constructed by splitting the data for 6 NAS industries using additional information from ASI and NSSO unorganized manufacturing data. The major NSSO rounds for unorganized manufacturing used are 40th (1984-85), 45th (1989-90), 51st (1994-95), 56th (2000-01), 62nd (2005-06), 67th round (2011-12) and 73rd round (2015-16). 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.

(2) **Employment and labor composition**: Labour input is measured by combining data on labour persons and data on education. In the KLEMS framework it is desirable to estimate changes in labour composition by industries on the basis of age, gender and education. The source of human capital could be through investment in education, experience, training, etc. The contribution to output by each person also comes from this embodied capital and the reward (wages and earnings) to each person also includes the reward for investment in human capital. Therefore, it is essential to separate out these differences in labour to clearly understand the underlying differences in labour characteristics. The large scale Employment and Unemployment Surveys (EUS) by National Sample Survey Organization (NSSO) and the estimated population series based on the decennial population census are the main data sources for estimating the workforce by industry groups, as per the National Industrial

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[7] The India KLEMS Data Manual provides a detailed description of the construction of all the relevant variables. The manual is available at the website (www.rbi.org) and is also available by request from the authors.

Classification (NIC). The other data sources on employment are Economic Survey (for public enterprises), Annual Survey of Industries (ASI for organized manufacturing Industries) and Labour Beureu Surveys (available since 2009-10). Interpolated population is used for intervening years. 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[8] this seems to be the best measure to use given the data and hence we estimate the number of employed persons using UPSS definition.

We use number of workers estimated using UPSS assumption as our measure of employment, and our measure of labor input in any industry j (Lj) is computed as a Tornqvist volume index of persons worked by individual labour types '*l*' as follows:

$$\Delta \ln L_j = \sum_l \bar{v}^L_{l,j} \Delta \ln L_{l,j} \tag{3.8}$$

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

$$\bar{v}^L_{l,j} = \frac{P^L_{l,j} L_{l,j}}{\sum_l P^L_{l,j} L_{l,j}}$$

(3) **Capital services***:* As in the case of labour input, where workers differ in terms of skill and experience, capital also consists of different vintages and asset types. And these assets are not directly used in the production process, rather the service delivered by these assets are the inputs to the production. For the measurement of capital services we need capital stock estimates for detailed asset types and the shares of each of these assets in total capital remuneration. As in the case of labour input (3.8) we measure capital input K_j as a Tornqvist volume index of individual capital assets as follows:

$$\Delta \ln K_j = \sum_k \bar{v}^K_{k,j} \Delta \ln K_{k,j}$$

(3.9)

where $\Delta \ln K_j$ is the growth rate of aggregate capital services in any given industry j, $\Delta \ln K_{k,j}$ is the growth rate of capital stock in asset k (we distinguish between 4 types of capital assets; construction, machinery and transport equipment,) and the weights $\bar{v}^K_{k,j}$ 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 add to unity.

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[8] 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.

$$\bar{v}_{k,j}^K = \frac{P_{k,j}^K K_{k,j}}{\sum_k P_{k,j}^K K_{k,j}}$$

Where individual capital stocks K_K are estimated using standard Perpetual Inventory Method (PIM) with geometric depreciation rates ▯:

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

And the rental prices of capital $p_{k,j}^K$ are computed as

$$P_{k,t}^K = P_{k,t-1}^I i_t^* + \delta_k P_{k,t}^I$$

where p_k^I is the investment price of asset k, i^* is real external rate of return[9] δ_k is the assumed geometric depreciation rate of asset k. 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.

(4) **Labour Income Share**: Share of total compensation paid to all workers in any industry in Gross nominal value added in that industry is labour income share. *National Accounts Statistics* (NAS) of the CSO publishes the NDP series comprising of compensation of employees (CE), operating surplus (OS) and mixed income (MI) for the NAS industries. The income of the self-employed persons, i.e. mixed income (MI) is not separated into the labour component and capital component of the income. Therefore, to compute the labour income share out of value added, one has to take the sum of the compensation of employees and that part of the mixed income which are wages for labour. The computation of labour income share for the 27 study industries involves two steps. First, estimates of CE, OS and MI have to be obtained for each of the 27 study industries from the NAS data which are available only for the NAS sectors. For some industries under study, for instance (i) Agriculture, forestry & logging and fishing, (ii) Mining & Quarrying, (iii) Electricity, gas and water supply and (iv) Construction, the required data are readily available from NAS. For others, the estimates available in NAS have to be distributed across the study industries. In certain cases, the estimates of CE, OS and MI for a particular NAS sector have been distributed across constituent study industries proportionately in accordance with the gross value added in those industries. Second, the estimate of mixed income has to be split into labour income and capital income for each industry for each year (except for those industries for which the reported mixed income is zero, for instance, public administration).

4. Labor Productivity and it sources:

Productivity growth declined in the advanced economies in the period of global financial crisis (GDC) thereby making it very important to understand how productivity behaved and affected the emerging economies, particularly India[10]. In this context, the labor productivity growth for the

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[9] In the India-KLEMS database version 2017, we use an external rate of return. However, one can also use an internal rate of return, which will ensure complete consistency with NAS (see Jorgenson and Vu (2005)). This will be attempted in the future. See Erumban (2008) for a discussion on alternative approaches to the measurement of rental prices.

[10] Productivity growth has declined in advanced economies since the global financial crisis (GFC) and has remained weak ever since (Adler et al. (2017); OECD (2015)). Much attention in academic research has focused on whether the productivity slowdown reflects slowing innovation and technological diffusion (Andrews et al. (2016); Cette et al. (2016); Fernald (2015); Gordon (2017)), amid declining business dynamism (Decker et al. (2016); Haltiwanger et al. (2014). Further, Duval et al. (2017) accounts for the role of financial friction in explaining sharp and persistent productivity slowdown in advanced economies post 2008-09.

aggregate economy, broad sectors as well as disaggregated industrial sectors is outline below. The total period of study is divided into three sub periods- (i) pre global financial crisis (GFC):2001-02 to 2007-08 followed by (ii) the turbulent phase of the global financial crisis (GFC) 2008-09 to 2011-12 and (iii) after effect period of GFC (2012-13 to 2015-16) in order to understand the impact of GFC on India's productivity both in the pre and post GFC period.

Figure 1: Year to Year Growth in labor productivity for the period 2002-15: Aggregate economy.
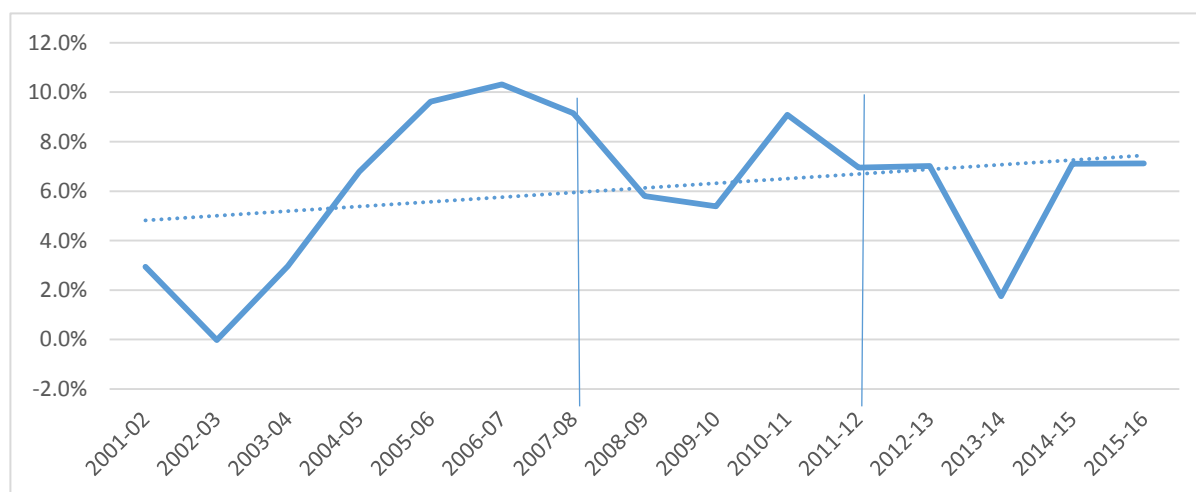

Table 1: Growth in labor productivity by periods: Aggregate economy.

	Pre Crisis period 2001-02 to 2007-08	Turbulent period 2008-09 to 2011-12	After effect period 2012-13 to 2015-16	Overall period 2001-02 to 2015-16
Economy	5.97	6.81	5.75	6.13

Source: Authors' calculation based on India KLEMS dataset version, 2017.

The time series plot of yearly labor productivity growth shows variations across the periods considered (Figure 1). Productivity growth improved steeply till about 2006-07, which is also considered the "High growth" phase of the Indian economy, where close to 10 percent overall growth was observed for successive years. Though there was a consistent decline after 2006-07, yet we observe several periods of rise in labor productivity even in the post GFC period-namely 2009-10 and 2013-14. For the overall period 2001-2005, growth in labor productivity remained at 6 per cent per annum. However, looking at the sub-periods, the average productivity growth during 2001-2007 was 5.97 percent, which increased to 6.28 percent during the post-crisis period. Even if we subdivide the post-crisis period into the two sub periods, the average productivity growth were 6.81 and 5.75 percent respectively for 2008-2012 and 2013-2015. Obviously, the decline in labor productivity growth in India is less pronounced compared to labor productivity growth decline in advanced economies.

From 2002-2007 period to 2011-2016 period, the mature economies' labor productivity growth eroded from 1.8 percent to 0.8 percent and the emerging market productivity growth from 4.8 percent 2.9 percent. In Table 1, we further provide the productivity trends in broad sectors of the economy.

Table 2: Labor productivity growth by periods and sectors

	2001-02 to 2007-08	2008-09 to 2011-12	2012-13 to 2015-16	2001-02 to 2015-16
Agriculture	2.71	5.44	3.92	3.76
Mining	0.59	1.38	11.62	3.74
Utilities	12.89	5.65	-3.09	6.70
Construction	0.94	-4.63	-7.07	-2.68
Manufacturing	6.78	8.17	5.62	6.84
High Foreign Content Manufacturing	8.47	6.94	3.01	6.61
High Foreign Content Manufacturing (excl. Petroleum)	6.61	6.54	3.39	5.73
Low Foreign Content Manufacturing	3.49	11.23	11.38	7.66
Market Services	7.62	7.04	7.53	7.44
High Foreign Content Market Services	12.96	14.36	4.49	11.07
Low Foreign Content Market services	5.16	4.15	8.57	5.80
Non Market Services	1.66	3.66	4.77	3.02
Economy	5.97	6.81	5.75	6.13

Source: Authors' calculation based on India KLEMS dataset version, 2017.

We classify the overall Indian economy into agriculture, mining, utilities, and construction. Further both manufacturing and services is sub-divided (A) High foreign (HF) content manufacturing and (B) low foreign (LF) content manufacturing and similarly services are separated into high and low foreign content specifications. The final sector comprises non market services. The HF services show the highest improvement in labor productivity for the overall period followed by utilities. Several startling facts emerge. Both HF as well as LF manufacturing sectors, register around 6 per cent per annum LP growth for the overall period, though LF manufacturing out performs HF manufacturing in the post GFC period. This may be partly explained with India's still low integration in value chains both in terms of exports and imports. Utilities (electricity, gas and water) perform well in the pre crisis period and this could be attributed to India's high GDP growth supported by domestic factors.

Table 3: Sources of Labor productivity Growth by sub periods- Broad sectors

	2001-02 to 2007-08				2008-09 to 2011-12				2012-13 to 2015-16			
	LP	LQ	KS	TFP	LP	LQ	KS	TFP	LP	LQ	KS	TFP
Agriculture	2.71	0.28	2.21	0.22	5.44	0.37	3.77	1.30	3.92	0.37	3.63	-0.08
Mining	0.59	0.83	5.73	-5.97	1.38	0.74	7.85	-7.21	11.62	0.69	6.34	4.59
Utilities	12.89	0.38	4.09	8.42	5.65	0.03	6.36	-0.74	-3.09	0.03	2.68	-5.79
Construction	0.94	0.29	2.50	-1.84	-4.63	0.23	0.49	-5.35	-7.07	0.23	-0.40	-6.91
High Foreign Content Manufacturing	8.47	0.16	3.50	4.81	6.94	0.23	3.95	2.77	3.01	0.28	3.99	-1.25
High Foreign Content Manufacturing (excl. Petroleum)	6.61	0.17	3.87	2.56	6.54	0.25	3.43	2.86	3.39	0.32	2.68	0.39
Low Foreign Content Manufacturing	3.49	0.31	3.46	-0.28	11.23	0.33	3.48	7.42	11.38	0.34	2.07	8.97
High Foreign Content Market Services	12.96	0.36	1.05	11.56	14.36	0.59	4.57	9.21	4.49	0.59	2.47	1.42
Low Foreign Content Market services	5.16	0.32	2.68	2.15	4.15	0.31	4.49	-0.64	8.57	0.31	5.41	2.85
Non Market Services	1.66	0.61	2.32	-1.27	3.66	0.51	1.84	1.31	4.77	0.51	2.11	2.15

Source: Authors' calculation based on India KLEMS dataset version, 2017.

Next we analyze the possible sources of observed growth in labor productivity. IT is evident that capital input is by far the significant contributor to LP growth across sectors. The contribution from labor though positive is minor except for two sectors-non market services and mining. To a large extent, these happen to be intensive in usage of labor. For manufacturing, both HF as well as LF has singnicant contribution from capital. As regards the contribution of multi factor productivity, we find that services has highest contribution from MFP and this is due to non market services has recorded high rates of MFP growth during the period of 2000s. LF manufacturing also shows presence of high MFP contribution to overall LP growth. We find that sources of observed LP growth shadows the sources of overall output growth in terms of contribution of capital a dominant input Vis avis MFP (see Das et al. (2016)).

**Figure 2: Capital Deepening by Sectors: 2001-15**
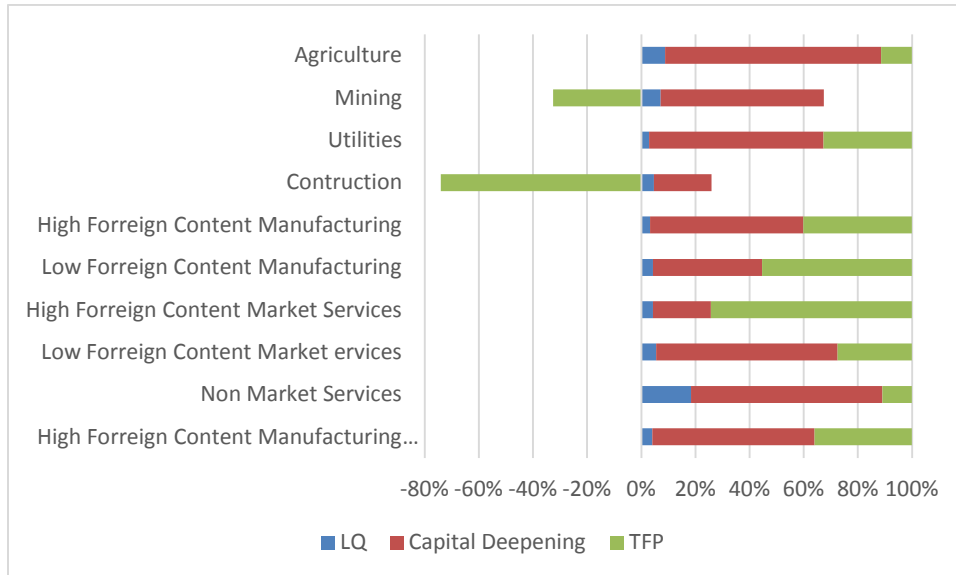
Source: Authors' calculation based on India KLEMS dataset version, 2017.

Capital deepening reflects the increasing capital-labor ratio usage. We find capital deepening as the major source of growth in labor productivity in most sectors. It shows large contribution for both utilities as well as high foreign content manufacturing in India. The large contribution of capital deepening in high foreign content manufacturing perhaps reflects higher rates of investment in manufacturing industries during the period. This also indicates greater substitution of capital for labor in the sectors where capital deepening has taken place. India's trade liberalization since 1991-92 reforms have reduced both levels of quantitative barriers and effective rates of protection and in turn allowed import of capital goods including second hand equipments and this has paved the way for a fall in relative price of capital Sen and Das (2016).

The pattern of labor productivity growth across industries is shown in the figure below. We compare the growth in period 1 (2001-02 to 2007-08) with post crisis period (2008-09 to 2015-16). It is significant to note that HF manufacturing industries have shown higher growth in labor productivity even during the crisis period and this is in contrast with the performance of manufacturing in advanced countries. We also find that most industries have by and large the same growth in labor productivity in the two periods thereby indicating no decline in productivity growth. Construction and health and education (non market services) seem to have suffered a worsening of performance.

Figure 3: Pre and Post global financial crisis labor productivity growth by sector
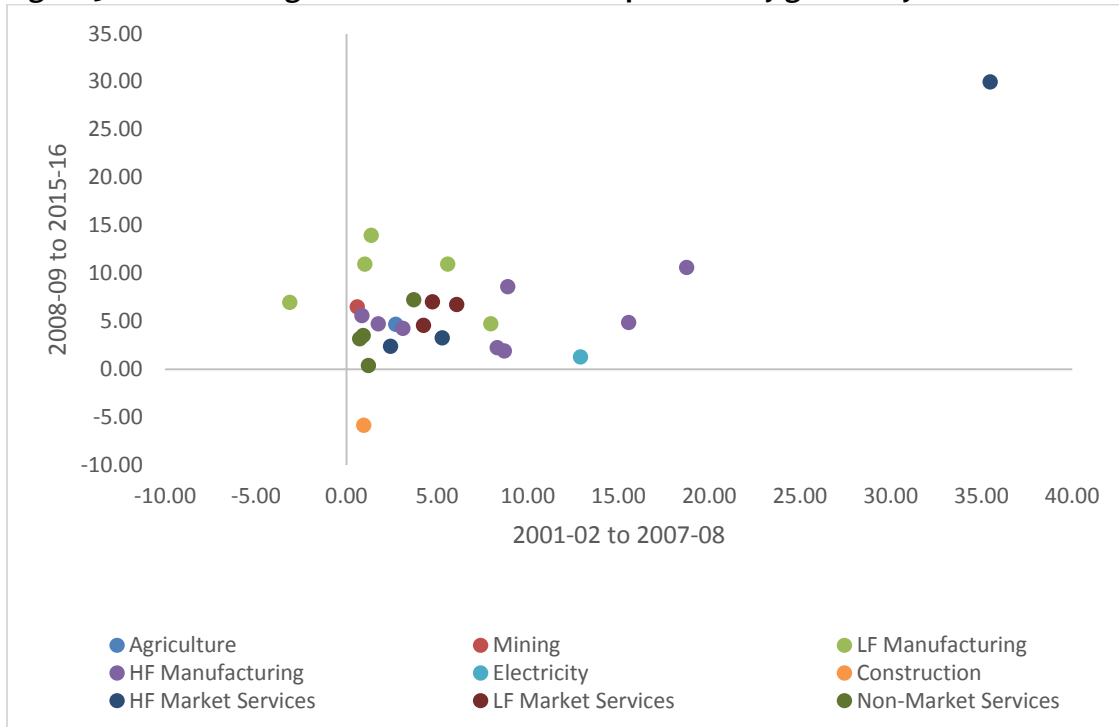
Source: Authors' calculation based on India KLEMS dataset version, 2017.

Figure 3 ranks the industries by their contribution to the aggregate labor productivity growth for the period 2001-15. Industries that make the largest contributions are telecom, petroleum and transport equipment. These large contributions in part reflect the large LP growth and also large share in value added. These 3 industries account for around 8 percent of combined value added share for the period and telecom, the largest single industry with VA share of 2 percent. When we look at the sub periods, we find that telecoms suffered a decline in contribution to aggregate LP growth in the last sub period and this is attributable to the steep decline in LP growth suffered by telecom industries subsequent to the global crisis. The negative contribution attributed to construction industry is partly due the overall low contribution in each of the sub periods.

Figure 4: Labor productivity growth by disaggregated industries: 2001 to 2015
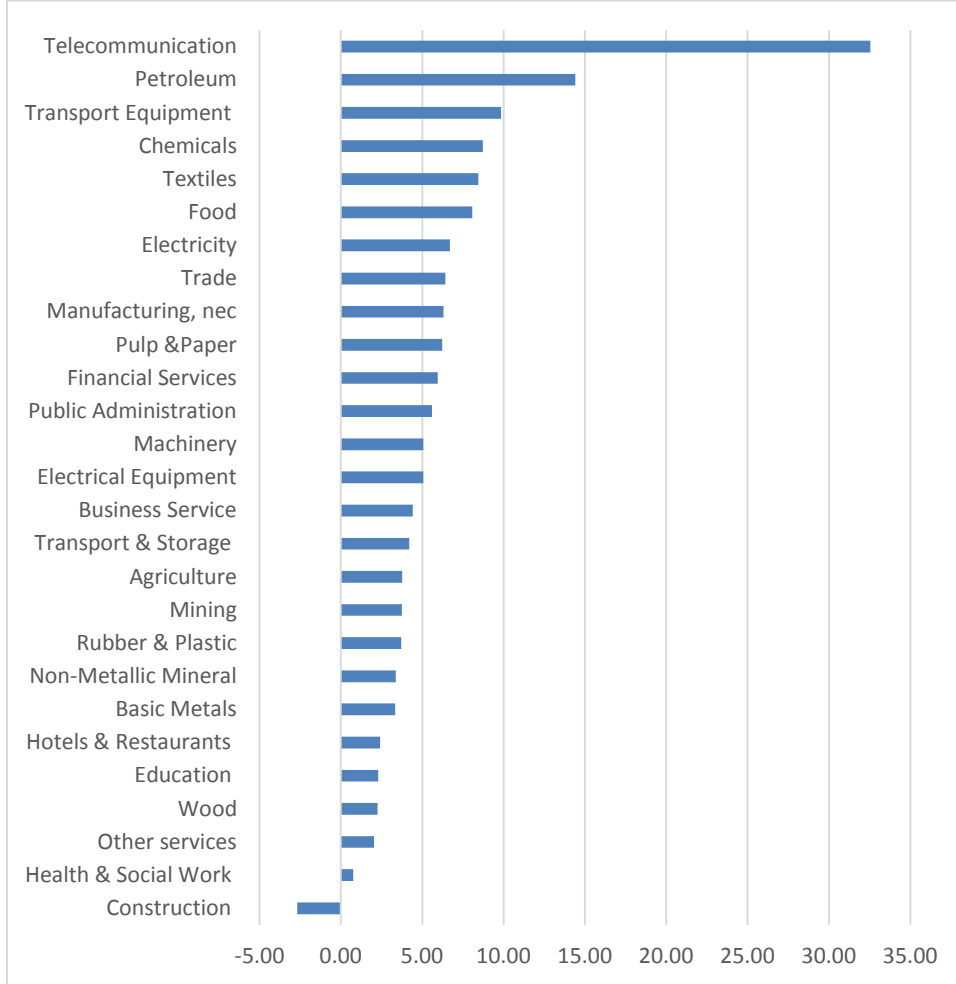
Source: Authors' calculation based on India KLEMS dataset version, 2017.

Lastly we compare productivity performance of the high foreign content industries of both manufacturing and services in order to understand the productivity dynamics of the industries which were more integrated with the rest of the world in the period of global financial crisis.

Table below provides a comparative assessment of services and manufacturing industries which are more integrated to the rest of world in terms of more foreign content. Majority of the manufacturing industries except machinery witnessed a decline in LP growth during the turbulent period 2008-11 and continued to decline. Two industries stand out- basic metals and transport equipment which improved their position in the immediate period 2012-15.Overall, HF content manufacturing averaged around 6 percent per annum for the period 2001-15 with petroleum, chemicals and transport equipment registering more than the average growth observed.

Table 4: High foreign content Manufacturing VS Services industries

	GVA Share (2001-02)	2001-02 to 2007-08	2008-09 to 2011-12	2012-13 to 2015-16	2001-02 to 2015-16
High Foreign Content Manufacturing	**11.49**	**5.83**	**6.50**	**5.88**	**6.02**
Petroleum	1.05	18.74	13.72	7.50	14.41
Chemicals	2.45	8.88	13.77	3.44	8.74
Rubber & Plastic	0.74	3.10	10.75	-2.24	3.72
Non-Metallic Mineral	1.21	0.84	10.76	0.43	3.38
Basic Metals	2.49	1.74	0.26	9.20	3.34
Machinery	1.13	8.30	7.64	-3.14	5.07
Electrical Equipment	0.98	8.69	4.90	-1.09	5.07
Transport Equipment	1.44	15.55	3.41	6.34	9.85
High Foreign Content Market Services	**8.09**	**12.69**	**15.82**	**5.90**	**11.71**
Hotels & Restaurants	0.96	2.42	-1.64	6.42	2.40
Transport & Storage	4.74	5.27	5.05	1.49	4.20
Telecommunication	2.39	35.47	47.94	12.01	32.54

Source: Authors' calculation based on India KLEMS dataset version, 2017.

Services on the other hand saw singnicant and large growth registered by telecoms for the first two periods and then a steep decline of over 35 percent in the third period. Hotels and Restaurant is the only sector to have seen an improvement in LP growth for the third period, whereas the other two showed sharp decline. HF market services maintained an average LP growth of more than 10 percent for the period and this is entirely due to the very high growth rates observed by telecoms.

Our analysis did not find evidence of any steep decline in LP growth in India as was observed in many advanced countries. LP grew at an annual average rate of 6 per cent per annum over the period 2001-15 with a modest decline during the period 2012-15. Across different sectors, we find that both HF market services and LF manufacturing were the groups that performed better in comparison to other sectors. Our decomposition of LP growth showed that capital is by far the most significant contributor to the observed growth and industry dynamics points to the maximum contribution to LP growth coming from telecom industry. The next section provides an analytical perspective on the observed productivity growth.

5. Productivity in pre and post global crisis and the trade dynamics

It appears from the above analysis that the global financial crisis has not affected productivity growth in India's aggregate economy; at least not to the extent it has impacted advanced economies. This is partly because the Indian economy has been relatively insulated from the global financial system. Indeed, since the opening of the Indian economy in the 1990s, the impact of

globalization has made its presence vivid in India's financial sector. Equity prices now rely not only on domestic factors but also several global factors. Yet the system still remains largely insulated from the global financial shocks, as India's banking sector remains largely nationalized, and less exposed to international competition. Yet, one would expect the economy, being part of the global trade system, to be affected through its trade relationship with the rest of the world. As is obvious from our results, the aggregate picture somewhat masks substantial differences across sectors, and the productivity slowdown in some of the sectors might be related to underlying trade dynamics in these sectors. While this section only attempts a descriptive analysis of sectoral productivity dynamics and global value chain participation, a more solid conclusion can be attained only using better econometric approach, which is in our future research agenda. We consider global value chain, as the international fragmentation of production has made it less relevant to use gross concepts of trade, while considering production, trade and productivity linkages between countries (Baldwin (2016), Timmer et al. (2014)).

It is evident from our results that labor productivity growth was low in agriculture and mining during the pre-crisis years but has in fact improved during the post-crisis years. At the same time, construction has lost productivity gain substantially, from nearly 1 percent growth in the pre-crisis period to more than 5 percent productivity contraction in the post-crisis. The gain in agricultural productivity and the loss in construction is primarily a reflection of structural transformation in Indian economy. Workers are moving largely from the agricultural sector to the construction sector, as most unskilled workers in the Indian economy are less compatible with the needs of the sectors which are growing rapidly. They end up in the services sector, which is still less skill intensive.

Two other important observations are the decline in labor productivity growth in manufacturing industries which uses foreign inputs heavily in their production. Excluding petroleum, on average productivity in the manufacturing sector with high foreign content declined from nearly 7 percent during the turbulent period (which was, in fact, acceleration from 5.6 percent in the pre-crisis years) to less than 3 percent. Similarly, services with high foreign input content lost productivity growth remarkably from 14 percent to 4.5 percent.

The trends in TFP also followed by and large that of the labor productivity growth. Whereas agriculture improved its TFP growth in the immediate years after the financial crisis, it did decelerate in the later years. Construction has registered consistent deceleration in TFP growth. As before, within manufacturing, we find notable loss in TFP growth in sectors which are highly exposed to foreign inputs. TFP growth declined from nearly 3 percent during the 2008-2011 period to just 0.4 percent during past 2011 years. During the same period, however, industries that use less foreign inputs did see a TFP improvement. A similar pattern is visible in the case of market services as well, with the loss in market services with a relatively larger amount of foreign inputs witnessing massive TFP losses, declining from 9.2 percent during the 2008-2011 period to just 1.4 percent afterward.

**Figure 5: Sectoral contribution to aggregate productivity growth**
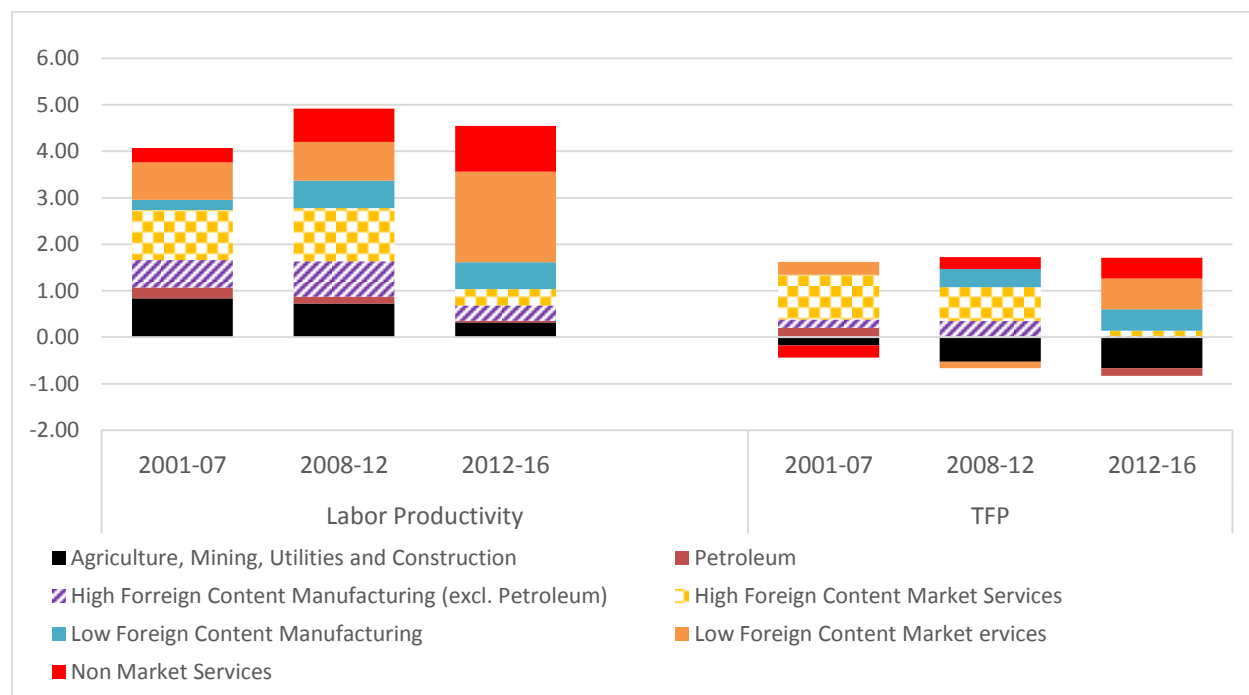
Source: Authors' calculation based on India KLEMS dataset version, 2017.

In Figure 5, we decompose the contribution of individual sectors to aggregate productivity growth. These contributions are calculated as the product of sectoral productivity growth and their relative size measured as their share in aggregate nominal GDP. Note that the sum of these sectors does not necessarily tally with the aggregate productivity measures, due to labor reallocation effects. As is evident from the Figure, a major part of the within-industry productivity slowdown in India's aggregate economy can be attributed to sectors which are largely integrated to the global economy. More prominently, the contribution of market services sector with high foreign content has declined in the post-crisis years, followed by manufacturing industries that have high imported input content. Indeed, the industry group that includes construction and mining, and petroleum has caused a severe drag on aggregate TFP growth, but that has been somewhat compensated by gains in low foreign content services and manufacturing.

Higher foreign content in domestic production is implicitly a measure of production fragmentation or the participation of global value chain. While the literature on the impact of GVC on productivity is still in infancy, it is being often argued that participation in GVC helps firms specialize in tasks where they are relatively more efficient. By easing access to high-quality varieties of imported inputs, GVC participation also helps firms restructure their production process to gain productivity improvement. Since the 2000s, the share of trade in intermediate goods in total trade has accelerated, suggesting the accelerated use of imported intermediate goods in production across the world. Earlier evidence points to such positive effects of the use of imported inputs in the production process, on productivity. In the post-liberalization India, the disappearance of tariff and non-tariff barriers helped

increased use of imported varieties, helping significant productivity improvement (Goldberg et al. (2010); Topalova and Khandelwal (2011)). Finally, participating in a global value chain also helps firms acquire advanced technology and knowledge spillover, which will help their productivity and quality upgrading.

Figure 6: Labor productivity growth and change in production fragmentation, pre-crisis years
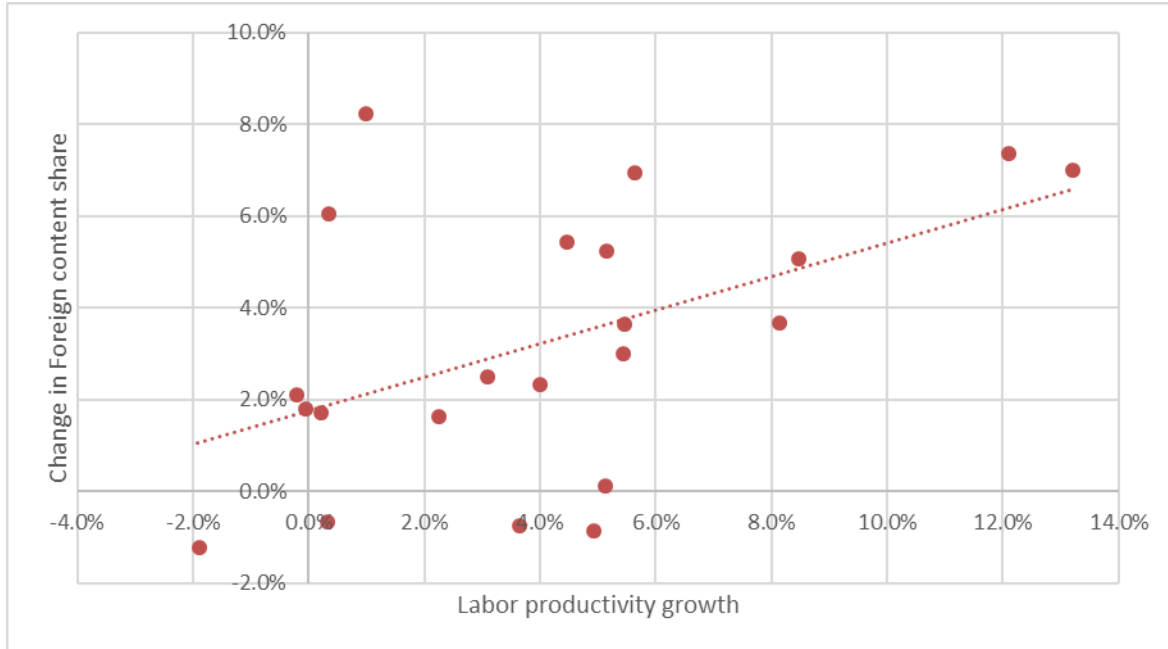

Note: each point is an industry's average productivity growth and change in foreign share.

Source: Author's calculation using WIOD and India KLEMS database

There has been a positive correlation between change in foreign content in domestic production and labor productivity growth (Figure 6). Industries that had a faster increase in foreign content also saw faster productivity growth. However, as can be seen from Figure 6, the foreign content growth has slowed substantially across all industries, causing to have larger productivity lowering impact on those industries where the relationship was solid. Most manufacturing industries which had relatively high presence of international production fragmentation in 2014, which includes Chemicals, rubber and plastics, basic metals, machinery, electrical equipment and transport equipment, have in fact witnessed a significant decline in the growth rate of production fragmentation, with some of them such as electrical equipment, machinery and transport equipment even seeing deceleration. Among the services sectors, business services, financial services, trade, and post and telecom all had declines in the fragmentation, following the global financial crisis, and the subsequent global trade slowdown.

Figure 7: Change in foreign content in domestic production (log changes) in market sectors
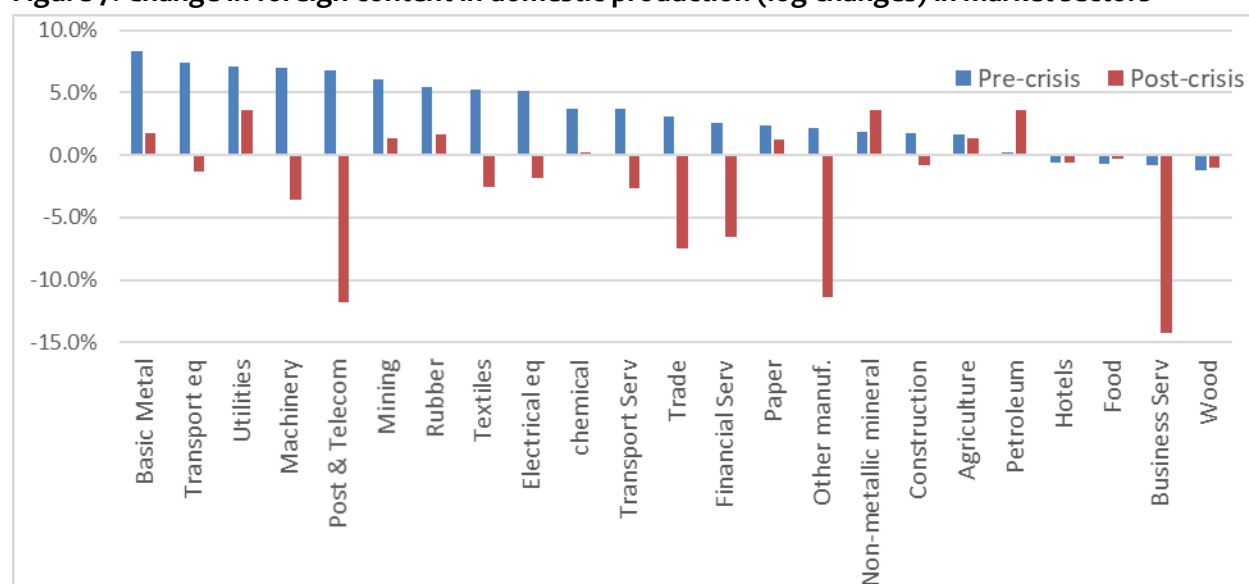
Source: Author's calculation using WIOD and India KLEMS database

According to data from the World Input-Output Database (WIOD), the nominal growth in foreign content in production has declined from 12 percent during the 2008-2011 period to -4 percent during 2012-2014. Obviously, the productivity gains from using better quality inputs might have declined. The decline in the pace of expansion in foreign content in domestic production in industries which were heavily using foreign inputs can imply the upgrading of domestic industries climbing up the value chain. In that case, however, one would expect these industries to gain in terms of faster productivity growth, which is not observed in our data. On the contrary, it might indicate that the decline in the use of imported intermediate inputs by domestic industries might have hampered their ability to produce using better quality inputs, thus hampering their productivity growth. Further, according to the World Bank data, the import of capital goods in the Indian economy as a whole has declined from 5.3 percent of GDP in 2008 to 3.6 percent in 2014. This has increased rapidly in the pre-crisis period from just 1.8 percent in 2000. Indeed, this further suggests that the post-crisis slowdown in global trade seem to have reduced the import intensity in India, leading to a decline in the productivity effects of using imported intermediate and capital goods. This issue, however, warrants further detailed examination.

6. Summary and conclusions

It has been widely reported that advanced economies suffered decline in productivity growth in recent times. Some had even started observing the downward trend in labor productivity even before the global crisis had set in. The observed performance of developing and emerging market economies in terms of productivity performance is not too well documented. This holds true for India. Therefore the present paper attempts to understand the productivity dynamics across sectors and disaggregated industries for India during the period 2001-2015 and undertakes a comparison of pre and post global crisis period. The labor productivity and its sources are computed using the neo classical growth accounting framework and the India KLEMS dataset. The India KLEMS dataset provide a comprehensive database of the Indian economy in terms of several broad sectors and disaggregated industries for around 30 years beginning 1980s. The present study covers the period

of 2000s until 2015 and divides it into three sub periods - the pre crisis period of 2001-07 and then the turbulent period 2008-2011 and after effect period of 2012-2015.

Our finding show that labor productivity grew at around six per cent per annum for the period 2001-2015 though there were sharp fluctuations on a yearly basis. The decline in labor productivity growth in India was less pronounced compared to labor productivity growth decline in advanced economies. The sectoral groups show that high foreign content services registered the highest growth in labor productivity for the period 2001-15 followed by utilities. Several important facts emerge- both low as well as high foreign content manufacturing sectors, registered around 6 per cent per annum growth for the overall period, though lower foreign content manufacturing out performs the other manufacturing group in the post GFC period. As regards the possible sources of observed growth in labor productivity, we find that capital input is by far the significant contributor to observed growth across sectors. At the disaggregated level, industries that make the largest contributions to aggregate labor productivity growth are telecom, petroleum and transport equipment. In conclusion, the study did not find evidence of any steep decline in productivity growth in India as was observed in many advanced countries.

The study does find the decline in labor productivity growth in manufacturing industries which uses foreign inputs heavily in their production. Excluding petroleum, on average productivity in the manufacturing sector with high foreign content declined from nearly 7 percent during the turbulent period to less than 3 percent. Similarly, services with high foreign input content lost productivity growth remarkably from 14 percent to 4.5 percent. The trends in TFP also followed by and large that of the labor productivity growth. Within manufacturing we observe notable loss in TFP growth in sectors which are highly exposed to foreign inputs. TFP growth declined from nearly 3 percent during the 2008-2011 period to just 0.4 percent during past 2011 years. During the same period, however, industries that use less foreign inputs did see a TFP improvement. A similar pattern is visible in the case of market services as well, with the loss in market services with a relatively larger amount of foreign inputs witnessing massive TFP losses, declining from 9.2 percent during the 2008-2011 period to just 1.4 percent afterward.

The decomposition of contribution of individual sectors to aggregate productivity growth shows that the contribution of market services sector with high foreign content has declined in the post-crisis years, followed by manufacturing industries that have high imported input content. Indeed, the industry group that includes construction and mining, and petroleum has caused a severe drag on aggregate TFP growth, but that has been somewhat compensated by gains in low foreign content services and manufacturing. Further, positive correlation is observed between change in foreign content in domestic production and labor productivity growth. The foreign content growth has slowed substantially across all industries, causing to have larger productivity lowering impact on those industries where the relationship was solid. Most manufacturing industries which had relatively high presence of international production fragmentation witnessed a significant decline in the growth rate of production fragmentation. Similarly the market oriented services sectors.

In conclusion, the global financial crisis has not affected productivity growth in India's aggregate economy; at least not to the extent it has impacted advanced economies. This, however, may not defy the general argument of Erumban and van Ark (2018) that the productivity loss in emerging markets was an important source of global slow down might still be valid. China constitutes a lion share of emerging markets in the global economy, which might be a driving force, yet the case of India does not fully support that argument. However, it is to be acknowledged that India could not

sustain the pace of its pre-crisis productivity growth, as several sectors, in particular, those which are largely integrated to the global value chain, lost steam in the post-crisis years. One would expect the economy, being part of the global trade system, to be affected through its trade relationship with the rest of the world. This needs a rigorous analysis using econometrics to examine India's productivity growth in post crisis scenario, which forms our future research agenda. Given the fact that India's past productivity growth has not been as spectacular as that of China in its fast-growth years, and the potential for India to grow is much larger as its productivity and per capita income levels are still relatively lower than that of China, the observed inertia in the pace of productivity growth in the post-crisis years is to be looked at carefully.

Appendix

Table A1: Indian Economy by industry groups

SL No	Industry code (ISIC rev4)	KLEMS Industry Description	Broad Sectors
1	AtB	Agriculture, Hunting, Forestry and Fishing	Agriculture
2	C	Mining and Quarrying	Mining
3	15t16	Food Products, Beverages and Tobacco	Low Foreign Content Manufacturing
4	17t19	Textiles, Textile Products, Leather and Footwear	
5	20	Wood and Products of wood	
6	21t22	Pulp, Paper, Paper products, Printing and Publishing	
7	23	Coke, Refined Petroleum Products and Nuclear fuel	High Foreign Content Manufacturing
8	24	Chemicals and Chemical Products	
9	25	Rubber and Plastic Products	
10	26	Other Non-Metallic Mineral Products	
11	27t28	Basic Metals and Fabricated Metal Products	
12	29	Machinery, nec.	
13	30t33	Electrical and Optical Equipment	
14	34t35	Transport Equipment	
15	36t37	Manufacturing, nec; recycling	Low Foreign Content Manufacturing
16	E	Electricity, Gas and Water Supply	Utilities
17	F	Construction	Construction
18	G	Trade	Low Foreign Content Market Services
19	H	Hotels and Restaurants	High Foreign Content Market Services
20	60t63	Transport and Storage	
21	64	Post and Telecommunication	
22	J	Financial Services	Low Foreign Content Market Services
23	71t74	Business Service	
24	L	Public Administration and Defence; Compulsory Social Security	Non Market Services
25	M	Education	
26	N	Health and Social Work	
27	70+O+P	Other services	

Chart A1: TFP growth by broad sectors-2001-02 to 2015-16
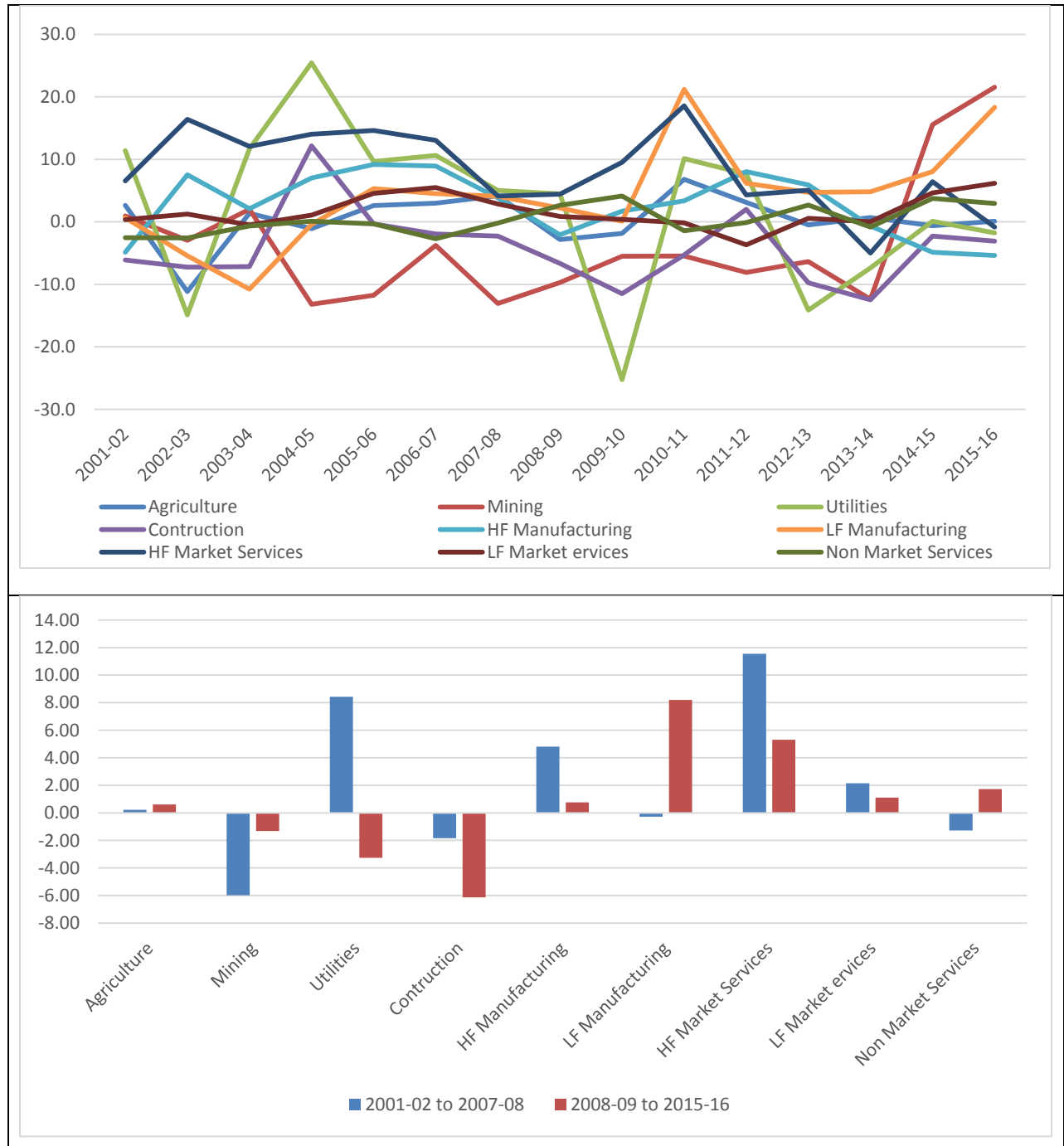
Source: Author's calculation using India KLEMS database

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