Guest editorial

Editors' introduction productivity growth in India: issues and measurement

Why productivity

Productivity growth, driven by technological progress, plays a prime role in accelerating the economic growth, development and welfare of an economy. An improvement of technology shifts the frontier of production function and hence brings the opulence in the human life. Traditionally, it is assumed to affect only the long-run growth, but the random shocks of productivity growth can even influence short-run economic activities and business cycles. Fair understanding of the shocks of productivity growth and technological change working on the core macroeconomic variables is the key to stabilize the economy from short-run fluctuations. Moreover, the level of development of a typical underdeveloped economy depends on the size of the modern sector, which is determined by the size of productivity difference between the sectors. Because of the ability of increased production given same resources, the technology tends to reduce the marginal cost and unit price of goods and services and hence raises the welfare level. However, the productivity growth does not accelerate automatically, and the impact may not be welfare enhancing for every sector and section of individuals, especially for employment. The technological progress for increased productivity is a costly process. The innovation, better institution, finance and competitiveness are unanimously known as influencing factors to be affecting the growth of a typical economy. Of course, the working mechanism of these forces would be different from the developing world as compared to the one for the developed world. So, how these factors are working in an erstwhile developing economy such as India is yet to be understood clearly. Its favourable impact on labour market has been ambiguous, uncertain and controversial for a long time. This appears as an important area of concerns when most of the economies are experiencing slow economic growth in the recent time, specifically after the worldwide financial crisis. According to the traditional development theories, an economy grows along with the expansion of modern sector. Underdevelopment and unemployment are considered to be persisted in an economy when the modern sector is either growing at a slow rate and/or is unable to generate sufficient job opportunities for workable population. A larger section of working population in the developing world does not find employment in the formal sector and is forced to join in the traditional or informal sector for their survival. Therefore, better understanding of technological progress, its transmission mechanism and impact of various economic activities and agents is very important for policy-makers aiming for economic development.

Indian economy has gradually improved the growth rate during the past 70 years since independence. But, the development outcomes (e.g. poverty, informality, decent employment and inequality) seem not to have been influenced by the way growth has progressed. This special issue of *Indian Growth and Development Review* (*IGDR*) sets to bring a volume to highlight and draw a few experiences of productivity growth from Indian economy, especially when the growth of the economy has slugged a bit after financial crisis.

Indian growth and productivity: some issues

Theoretically, it is argued that the country which experiences productivity growth should grow at a faster rate compared to others. Because, both in the short- and long-run, productivity growth is what contributes to the welfare improvement, it is the only way to produce more at the same cost or effort. Let us try to understand the level of productivity

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growth experienced in practice. In an interesting study, Isaksson (2007) derives total factor productivity (TFP) growth based on data envelope analysis (DEA) and compares it for 112 countries for a span of 1960-2000. Overall, the world TFP growth has been static for the past 40 years, except a 3% recovery in the post oil crisis after 1980s. The recovery has been highly driven by innovation rise, especially from mid-1980s. In general, the productivity has grown at 0.32% during this period when the output has increased at 4.3% in the world. Obviously, this has been a bit higher in industrialized countries than the developing and less developed countries because of higher innovation level. The weighted average growth of TFP has been 0.26% for developing economies during the same period. It is noteworthy to mention that this has become a negative figure for less developed countries. However, Asia-Pacific has been the fastest-growing region in the world. Behind this rapid growth, it lays solid factor accumulation, in particular that of capital, while the contribution of TFP growth does not appear particularly important. Hence, one may be tempted to agree with Krugman (1994) and Young (1992) that the East Asian miracle may not be so miraculous after all. Because, the innovation has not contributed much in these countries. If the performance of four Asian tigers (Japan, South Korea, Hong Kong, Taiwan) has been taken out from others, the difference in TFP growth has been quite distinctive. TFP growth in this group of countries is higher than that of the industrialized group. Moreover, TFP growth contributed more than 30% to output growth. Judged by that yardstick, Krugman and Young thus may have been wrong. TFP growth is 46% faster in these four countries compared with the industrialized countries. Here innovation hovers around zero, while the catching-up process has taken place at a slower pace than for the region as a whole. TFP growth varies greatly across countries, but the best performers are Hong Kong (1.5% per year), Taiwan (1.2%) and Pakistan (1%). Many countries have performed very poorly in this area, for example, Bangladesh (−1.7%), Indonesia (−1.7%) and Nepal (−1.4%) during the same period.

As far as Indian performance is specifically concerned, it reveals a mixed scenario and does not show an encouraging picture. TFP has grown at 0.7% during 1960–2000 when output has increased at 4.97%, contributing 14% of output growth. According to a more recent study, undertaken by Li and Treichel (2012), TFP has maintained more than 1% growth since 1980 and is approaching towards 1.5% in 2010. It suggests that a substantial improvement has taken place in the productivity growth in the country. This is also true for China, Indonesia and other emerging economies.

Empirically, the productivity growth has been estimated by using various methods (both parametric and non-parametric approaches) in the Indian context. Often, the results derived using alternative methods and various databases generate contrasting results (Maiti, 2014). However, there has been a general trend of rising productivity growth until early 2010s. Moreover, a substantial improvement in the method of estimation over the year has been noticed, which acknowledges the importance of disaggregated and firm-level data use and dealt with endogenity issue, selection bias and market imperfections. According to Isaksson (2007), India has registered a decent productivity rise for a fairly longer period from 1960 to late 1990. Lall (1986) established a significant improvement of technological capabilities of firms that are exporting, by using expenditure on research and development to sales as the proxy for innovation. The study concentrated on engineering and chemical firms from India. After a while, Ahluwalia (1991) showed that the productivity growth was very slow before 1980, and it started rising thereafter. However, Puspangadan and Balakrishnan (1994) criticized it a lot because of the method applied to derive such result. They argued that the productivity growth was slower that the Ahluwalia estimate during 1980s, once the estimation applies double deflation method. According to them, if the productivity is being estimated by deflating respective prices (i.e. double deflation method), it would provide a

better and true estimate. The study undertaken by Ahluwalia (1991) applied the single deflation method, and hence the estimate provided therein was considered to be biased. But, these studies did not show any impact of trade reform because it appeared as a major structural change in early 1990s in the country. Understanding the implication of economic reform on the productivity growth has become important task since then. A number of studies found that the productivity surged in the manufacturing sector after 1980s in India (Unel, 2003; Ray, 2002; Balakrishnan *et al.*, 2006). In particular, Unel (2003) argues that the productivity has grown at a rate higher in the post-reform period than that in 1980s. Ray (2002) also found that the annual rate of productivity growth has been higher in the 1990s than that was during 1980s. The study, undertaken by Ray (2002), used a non-parametric linear programming technique to construct the Malmquist productivity index and decomposed it into various components. Kumar (2006) and Balakrishnan *et al.* (2006) found that the productivity has improved in the post-reform period. The improvement in both technical efficiency and technical progress, in response to competitiveness after economic reform, has played the responsible role behind the rise. Milner *et al.* (2007) used a range of methods to see the effect of liberalization at the two-digit manufacturing industry level and also found an increase in TFP growth on an average. And, this is also true for the majority of manufacturing industries. In such literature, a rise of competitiveness is directly and indirectly found to be the most influential factor behind the increase in productivity growth. According to Madsen *et al.* (2009), the productivity growth rate increased annually by 1.1 percentage points from 1960-1990 to 1991-2005 in India. Recent estimates indicate a marginal improvement in the productivity growth in the manufacturing industries during 2000s (Seghal and Sharma, 2010; Kathuria *et al.*, 2010).

On the other hand, there are other studies which do not find an encouraging figure of productivity growth in the post-reform period (Goldar, 2004 and Goldar and Kumari, 2003). The estimates of productivity growth reported by them indicate a drop in its rate in Indian industries during the post-reform period in contrast to the pre-reform period. And this happens during the period when the economy has grown consistently at a higher rate, particularly in the industrial sector which has never occurred in the history of Indian economy. Sub-optimal use of capacity and decreasing returns to technology seem to be identified as a few responsible factors noted in these literatures. Nevertheless, two issues have appeared as constrains in the recent years – one, the inability of the manufacturing sector to contribute substantially to the overall growth and the service sector-led growth acceleration during 1990s (Kumar and Sengupta, 2008; Eichengreen and Gupta, 2009). There are studies drawing upon sectoral perspectives, in particular the sub-sectors of manufacturing, that find evidence of factor accumulation rather than productivity growth in accounting for output growth (Das, 2004). There are some other studies which argued that the trade reform could be effective only when other institutional and infrastructural supports are provided (Besley and Burgess, 2004; Mitra *et al.*, 2012). If the labour market in the industry was flexible, the productivity growth would have been much better after reform.

In a recent study, Nin-Pratt *et al.* (2010) estimated productivity growth for China and India using non-parametric techniques and compared agricultural TFP growth and its components. The study shows that agricultural TFP growth started accelerating in China after 1979 and in India after 1974. Still, the Chinese agriculture clearly outperformed India in due course. Because, the agricultural growth in China has been benefited from more fundamental, institutional and policy reforms in agriculture than that in India. Manufacturing growth has helped to absorb surplus labour and has left a lower employment burden on the agriculture, creating incentives for capital investment and technical change.

This kept output per worker in agriculture growing at high rates. Using the growth accounting technique on India capital, labour, energy, materials and services (KLEMS) data set, which provides a detailed industry-level data, Das *et al.* (2018), however, did not find evidence of any steep productivity decline in India as was observed in many advanced countries. Labour productivity grew at an annual average rate of 6% per annum over the period 2001-2015 with a modest decline during the period 2012-2015. 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 included 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. While most of the studies mentioned here estimated productivity growth assuming perfect competition in the product and labour markets, Maiti (2013) showed the productivity growth is half of the previously mentioned estimates during 1998-2005, when the factor and product market distortions are controlled for. Whatever may be the case, the increased market competition after various reform measures were undertaken since early 1990s has depressed bargaining power of the labour market and that has, in turn, contributed to the productivity acceleration during 1980-2016 (Maiti, 2019).

While the productivity growth is broadly agreed to have been accelerated a bit, it is much lower in informal and unorganized sector than the formal and organized sector. Marjit and Maiti (2010) found that the productivity of the formal sector is at least three to five times higher than the informal sector. Lack of credit and access to stable market and infrastructure are some of the factors that limit the productivity improvement of the informal sector.

It is noteworthy to mention that the history of productivity debate in India has been highly influenced by the methodologies used in several studies. Three alternative methodologies are largely observed in the existing literature – growth accounting (production function approach), stochastic frontier and non-parametric DEA. While they have both advantages and disadvantages, applications of those methodologies are highly context-specific, and the results cannot be strictly compared between themselves.

Contribution of this volume

This special issue comprises ten articles empirically measuring productivity and productivity growth using various approaches in India. Indian economy, at aggregate level, has been experiencing acceleration in economic growth following macroeconomic reforms initiated in 1980s and 1990s. But, not much is known about how to have different industries fared in this growth story. Das *et al.* make an attempt to understand Indian growth dynamics from an industry perspective using KLEMS data set. An advantage of using the KLEMS data set is that it captures the industry dynamics involving industry-level information for understanding the aggregate growth. Using information for 27 industries for the period of 1980-2015, they examine the sources of aggregate GDP and trace them to the industry origin of aggregate GDP growth. For measuring productivity growth, they apply production possibility frontier framework. Their analysis reveals that though there is a huge variation in the growth rate of different sectors, the industries in market services such as post, telecommunication and business services experienced the highest growth. Note that the economic reforms were mostly confined to the manufacturing sector. Similarly, they find that the industries in service sector observed highest TFP growth.

Dua and Garg study the trend and determinants of labour productivity in various manufacturing and service sectors of developed and developing economies in Asia-Pacific region using information for the period of 1980-2014 and make a comparison thereof. The sectors included are manufacturing, distributive trade, transport and communication and financial intermediation services. They use panel unit root tests, panel co-integration and group-mean fully modified OLS approaches for identifying the determinants of the labour productivity in the region. Dua and Garg find that the labour is significantly associated with technological progress, capital deepening, human capital, trade openness, financial openness, productivity of the other sector and institutional quality in both developed and developing countries. Increased role of government is a significant determinant of labour productivity in manufacturing sector in the developing countries contrary to developed countries. Technological progress enhances labour productivity in developing countries in the post-reform era specifically.

One of the objectives of trade policy reforms initiated in the early 1990s was to raise productivity of Indian manufacturing sector, thereby making the Indian industry competitive. Goldar, Chawla and Behera make a comprehensive attempt to examine the impact of these reforms on Indian manufacturing firms using information for the period of 1990s and 2000s. They follow a two-step approach: in the first step, they measure the TFP of the firms and in the second step, they regress firms TFP on firm (company) characteristics and trade policy parameters such as nominal and effective tariff rates and quantitative restrictions on outputs and inputs. For measuring the TFP, they apply Levinsohn and Petrin (LP) approach that addresses the concerns of simultaneity and selection bias in the measuring of TFP. Goldar, Chawla and Behera differ from the earlier attempts on following two points:

(1) They take a good deal of care in the measurement of output and inputs and, hence, of TFP, which is obviously important for assessing correctly the impact of trade liberalization on productivity.

(2) They provide two estimates of TFP – one based on gross output function and the other based on value-added function that permits a richer analysis of the impact of trade liberalization on TFP in manufacturing firms.

They find that lowering tariff rates on imported manufactured goods raises TFP of Indian manufacturing firms. In deviation to the existing literature, they also find that output tariff cuts made a bigger contribution to TFP growth in Indian manufacturing than input tariff cuts. They also observe that improved access to imported intermediate inputs and acquisition of advanced technology help in raising the productivity of Indian corporates.

In the process of economic development and structural changes, the service sector accounts for more than 50% of the GDP, and the share of services in the manufacturing sector has been increasing over time. Impact of growing use of services in the manufacturing sector and its impact of the productivity of manufacturing sector is an under-researched area in Indian context, and Goldar's paper fills this void. Goldar examines the impact of service input intensity (split into manufacturing services purchased and other services) on the TFP of Indian manufacturing sector using plant-level information. Plant-level information has certain advantages over firm-level data (e.g. less measurement errors in inputs and outputs), and perhaps this is the first study in Indian context that uses plant-level data for measuring TFP. For measuring plant-level TFP, Goldar applies Levinsohn and Petrin (LP) approach and regresses the TFP estimates on service intensity along with other variables such as the share of information communication technology assets in total

fixed capital stock, the share of contract workers in total workers, the share of imported materials out of total materials used and plant size. He finds that the services' input and information and computer technology (ICT) intensity have a significant positive effect on productivity of Indian manufacturing firms' plants in India.

As stated above, there are various approaches for measuring TFP in the literature, and the results obtained using different approaches cannot be compared strictly. Singh and Sharma compare and analyse various productivity estimation techniques using production function framework. Among these approaches, they apply five approaches, namely, LP, Ackerberg, Caves and Frazer, Wooldridge and Mollisi and Rovigatti. They use plant-level information on inputs and outputs of 32 Indian industries for the period 2009-2015. They find that TFP estimates are sensitive to the approach followed in the measurement of TFP.

Arun Kummar and Paul measure TFP of Indian manufacturing sector using information of 27 industry groups for the period of 2008-2009 to 2015-2016 considering imperfection in product and inputs markets. Conventional measures of productivity growth assume that the production entities are operating in competitive markets and constant returns to scale. Arun Kummar and Paul's study makes an attempt to analyse the role of market imperfection in influencing the TFP of the Indian manufacturing sector, using the methodology offered by Maiti (2013). They also analyse the role of ICT and rising contractual employment in determining the TFP of the sector. The authors find that during the study period, the sector experienced higher TFP growth under market imperfection conditions in comparison to the conventional measures, such as Solow residual, indicating the role played by the imperfection in product and inputs markets. The study also observes that over the period, the wage share in output and bargaining power of Indian labour have been declining, thereby raising profitability and productivity of Indian industry.

Note that most of the above-stated studies, though using information for a wide range of industries of Indian manufacturing sector, have focussed on measurement and understanding the determinants of TFP in the manufacturing sector as a whole and at the national level. None of them have studied in detail a particular industry. Therefore, in this volume, we consider three studies that focus on particular important sectors of Indian economy, i.e. coal-based thermal power sector, pulp and paper and pharmaceutical. These sector-specific studies help in understanding the peculiarities of these sectors. We also consider the one that measures the TFP of major Indian states. This study is particularly useful as India is a diverse and huge country, the state-level measures of TFP highlight regional variation in the country.

Coal-based electricity generation accounts for about two-third of electricity generation in the country, and improving efficiency in this sector is good not only for improving standard of living of the people but also for helping in controlling the CO_2 emissions. Murty and Nagpal measure technical efficiency of Indian thermal power sector using the recent by-production approach for 48 thermal power plants over the period of 2003-2015. They use by-production approach to compute the output-based Färe–Grosskopf–Lovell efficiency index and its decomposition into productive and environmental efficiency indexes for the Indian thermal power plants. The first step in developing a methodology for measuring technical efficiency that discounts the performance of producing units for excessive generation of CO_2 emissions is the specification of a technology relative to whose efficient frontier technical efficiency will be measured. There is a positive association between generation of CO_2 emissions and electricity. The by-production approach decomposes the emission-generating technology into following:

- a standard neoclassical technology; and
- a sub-technology that relates uses of emission-causing inputs to emission generation considering the basic laws of thermodynamics.

The results reveal that productive efficiency is positively associated with the engineering concept of thermodynamic/energy efficiency and is also high for power plants with high operating availabilities reflecting better management and O&M practices. Both these factors are high for privately and centrally owned as opposed to state-owned power-generating companies.

Indian pulp and paper industry is characterized by high energy and water intensities and low productivity and low competitiveness. These characteristics of the industry are linked to the technology used by the firms in this industry. Moreover, the government is highly involved in the industry not just as a regulator but also as a buyer of its output and supplier of raw materials. Kathuria examines the role of government policy in affecting the growth of pulp and paper industry in the country. He also explores the role of embodied technologies in influencing the technical efficiency of the firms. Using time-series information of 66 years, Kathuria finds a structural break in the production trend of the industry in 1999. Note that the pulp and paper industry was delicenced in 1997; the delicencing could be the reason of the structural break. He uses stochastic production frontier approach for measuring technical efficiency of the industry using information of 166 manufacturing units in the year of 2011-2012. The study finds that embodied technological gap is not a significant determinant of technical efficiency of the firms; technical efficiency in the pulp and paper industry is influenced by the vintage, size, ownership and location.

Mahajan measures the impact of product patent regime on the TFP of pharmaceutical industry for the period from 2000-2001 to 2014-2015 using information of 141 ID&P firms. He uses Ray and Desli's Malmquist productivity index, a non-parametric measure, to measure the TFP of the industry. The index has been decomposed into several components such as catch-up effect, innovation effect and scale effect. The study finds that the industry experienced productivity change during the study period, but the impact of product patent regime on the productivity growth was not significant. Productivity growth in the Indian pharmaceutical industry has been governed by the catch-up and scale effects. Only large firms and those that are spending on research and development activities were able to harness the benefit of new patent regime in terms of productivity growth.

Misra measures TFP using macro information of 19 major Indian states pre- and post-global financial crisis period. He applies conventional growth-accounting approach for measuring the TFP growth. This attempt of measuring the TFP at state level is useful in the sense that in Indian context, this is highly under-researched area. The uniqueness of the study lies in the estimation of capital stock at the state level; he uses NSSO surveys to estimate state-level capital stock. The study finds that in the post-global financial crisis period, there is decline in the TFP growth at all-India level and 10 states also experience a declining trend in TFP growth. Using spatial Durbin model, the study observes positive spillover effect across states in the TFP growth. Misra finds that physical infrastructure such as irrigation facilities, road network and health infrastructure is positively associated with the state-level productivity growth. He could not find financial development as a significant determinant of productivity growth in Indian states.

Finally, note that all the papers selected for this special issue have gone through the usual process of peer review for *IGDR*. We were fortunate enough to get the support of a large number of capable referees. These referees provided excellent feedback and comments on these papers. We are highly grateful for their dedicated services and for ensuring that the submissions were of sufficient quality for publication. We would like to thank the editorial board of *IGDR*, especially Chetan Ghate and Prabal Roy Chaudhary, for giving us the opportunity to compile and edit this special issue. We are also thankful to Virginia and Lauren for their impeccable services at the various stages in the preparation of this issue.

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