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RESEARCH NOTE

# Impact of ICT Usage on Productivity of Unorganised Manufacturing Enterprises in India

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## Abstract

The boom of ICT which started during late 1990s in the USA has now spread to the whole world and is not only altering the way the production process is carried out but also enhanced productivity levels of the enterprises. India's growth is largely ICT-led growth as witnessed in the case of services sector; however, for the growth of the manufacturing sector, ICT diffusion is required which is in lieu of the fact that at the global level, the manufacturing sector is witnessing an increased share of ICT enabled vis-a-vis core production activities. The large firms have largely succeeded in terms of adoption of ICT infrastructure, but difficulties lie with the small firms which have been comparatively slower in this process over the period of time. In this context, this paper attempts to assess the extent of ICT diffusion across small enterprises and the impact of ICT usage on firm and labour productivity, based on unit-level data from 67th (2010–2011) and 73rd (2015–2016) rounds of NSSO. The findings reveal that ICT usage is not only beneficial for the large firms but also beneficial for the smaller firms alike, which calls for a prompt policy action towards their upgradation in this regard.

**Keywords** ICT-led growth · ICT diffusion · Total factor productivity · Labour productivity · Unorganised manufacturing

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## 1 Introduction and Rationale of the Study

The world economy is undergoing a structural change driven by the globalisation of business on the one hand and by the revolution in information and communication technology on the other (Shepard 1997). The New Economy is the superior economic structure that has arisen is expected to arise as an outcome of these two forces. The production systems today are undergoing a massive transformation in terms of changes in the infrastructure at workplace as they are largely getting embedded into the framework of ICT, i.e. information and communication technology and leading towards the 'New Economy' Age.[1] The boom of ICT which started during late 1990s in the USA has now spread to the whole world and is not only altering the way the production process is carried out but also enhancing the productivity levels of the enterprises.

At the macro-level, various studies like Ahmed et al. (2004) and Waverman et al. (2005) have shown significant and positive impact on GDP from investment in ICT-based infrastructure in both developing as well as developed countries. ICTs help expand economic opportunity by enabling people to enhance their knowledge and skills, identify, apply and qualify for better-paying jobs, manage their own businesses efficiently and tap into broader markets for their goods and services. This phenomenon will only continue to grow especially in the emerging markets for the following reasons: (1) with everyday expansion of technological capabilities and innovation, costs of operation will continue to fall, thereby increasing the share of income for the users of ICT-enabled services, (2) as ICTs become cheaper and more powerful, their usage in low-income groups will grow exponentially as they have now become the source of enhanced productivity levels and (3) with the expansion of economic activities resting on the premises of ICT-based infrastructure a large chunk of the micro-entrepreneurial section of the business community is likely to enter the formal economy where they would be visibly and legally operating.[2]

[1] The term 'New Economy' is generally used to refer to the increased use of ICT in industries which have given a whole new shape and context to the production structure and processes being carried out today. Cohen et al. (2000) point out, the ongoing transformation of our economy has been given many names: a 'post-industrial society', an 'information society', an 'innovation economy', a 'knowledge economy', a 'network economy', a 'digital economy', a 'weightless economy', and an 'e-economy'. This basically got thrust by three major developments: (1) technological breakthrough in the mid-1990s in the semiconductor manufacturing industry (Jorgenson 2001), (2) increase in network computing due to the rapid diffusion of a widespread information infrastructure—the Internet and (3) labour productivity appears to have picked up in the United States in the mid-1990s.

[2] At present, the Informal Economy is normally identified as a Shadow Economy which escapes the net of visibility of the authorised public and legal institutions leading it to connote the ways of living in two forms—first is the Survival economy (where people have very meagre or just enough incomes to survive and to save on the costs of operation in the formal economy, they usually tend to hide or rather escape the net of identification of the formal system of operation) and Second is in the form of Black economy (where all sorts of illegal activities are undertaken not only by low but also affluent income groups). The increased ICT usage among low income groups (where primarily self-employed people constitute the majority section of the population) would definitely help to bring the Survivalist form of Informal Economy into the Formal Economy by reducing their costs of operation and mitigate the operation of Black Economy to a great extent although complete non-operation of the latter cannot be ruled out owing to the malicious activities being confronted by the users of ICT in everyday life.

The positive impact of ICT investment on enhanced productivity levels of the enterprises has been substantiated by several studies using various micro- and macro-firm-level data like Brynjolfsson and Hitt (2002), Doms et al. (1997), Bresnahan et al. (2002), Gordon (2003) and Nickell and Van Reenen (2000) in case of USA and Europe, Motohashi (2005) in case of China, Baily and Lawrence (2001), Stiroh (2001) and Jorgenson and Stiroh (2000) in case of USA, Commander and Svejnar (2011) in case of Brazil, Joseph and Abraham (2007) and Sharma and Singh (2013) and Singh (2014) in case of India, Falk (2004) in case of EU (comprising 4 nations Germany, France, Italy and UK), Indjikian and Siegel (2005) in case of developed and developing countries. Amidst these studies, a consensus exists especially among those which have been conducted on developing countries do report that there have been large variations in reaping the productivity gains from enhanced usage of ICT between the developed and developing countries, where developed countries are able to achieve scalable heights in their productivity levels owing to access to advanced and technical knowhow and sound institutional systems in place while developing countries lag way behind due to the lack of such factors.

Not only in the case of firm productivity but also in enhancing labour productivity, there are studies which have shown a positive impact. Some of the studies conducted on both developed and developing countries like Krueger (1993), Doms et al. (1997), Aghion et al. (1999) and Caroli and Van Reenen (2001) in case of British, French and US firms, and others like Bresnahan et al. (2002) and Pohjola (2002) have shown that ICT revolution has introduced and intensified (in the later stages of growth) 'skill-biased' technological inequalities in terms of both factor income share, i.e. wages and labour productivity. However, this ICT-induced inequality is being considered imperative to root out persistent vicious cycles of poverty and underdevelopment (Romer 1993) in the Third World countries which are lagging behind in the pace of growth and a ray of hope towards this direction is shown by the spillovers from developed to developing countries (Mohnen 2001) and the adoption of ICT-induced production mechanisms by the latter themselves (UNDP 1999; World Bank 1999).

However, a voice of contrast also appears in studies like Oliner and Sichel (1994), Morrison (1997), Berndt et al. (1992) and Parsons et al. (1993) where they negated the gains accruing to the firms on account of enhanced ICT usage. But this was visible primarily in the earlier stages of the ICT boom in 1990s, while the latter half as evidenced in the above section provides a 'firm' link on the potential benefits of the enhanced ICT usage.

The studies conducted so far in this domain of study point to certain stylised observations and phenomenon which is being witnessed in the current phase of economic growth not only in India but around the world and that is significantly impacting the way business activity is being carried out today.

First, the emergence of global production networks involves a system of production and trading of goods and services across different regional blocks of the world (Baldwin and Lopez-Gonzalez 2013) which primarily rests on the premises of an efficient and sound infrastructure of ICT-enabled services. This has repercussions on the growth of manufacturing enterprises in two ways: (1) enhanced levels of productivity of the enterprises and reduction in costs of operation in various dimensions

by the increased rate of usage of ICT-enabled services in carrying out the production process and (2) diffusion of technological knowledge in two dimensions—from high-income countries to low-income countries [also referred to as Technology Gap Theory[3] pioneered by Abramovitz (1986), Fagerberg (1987) and Verspagen (1991)] and from large firms to small firms[4] resulting into their gradual upgradation in terms of standard of living (UNIDO 2015). Thus, the overall growth of the manufacturing sector would become increasingly dependent on the share of ICT-enabled services vis-à-vis the total share of production activities carried out by them.

Second, so far various studies have pointed out that the benefits of ICT usage have been largely reaped by large enterprises as compared to small enterprises and even if small enterprises have been able to do so (either in sound and good quality or poor an deteoriated infrastructure), they constitute those enterprises which incur a substantial amount of investment in plant and machinery and commonly termed as small and medium enterprises (SMEs) (firm size identified by the level of investment in P&M). Thus, in this process the 'process' of knowledge diffusion seems to be bypassing the unorganised manufacturing sector (firm size identified by the number of workers) which constitutes a large part of the overall manufacturing sector. This raises an important question that in lieu of growing unorganised sector can the growth of the economy be dependent only on the large enterprises which are already much equipped and sailing well through ICT-induced infrastructure or is there a need to assess the current status of infrastructure and step it up in the small enterprises in the manner as the bigger enterprises are doing in terms of ICT usage.

Third, the whole discussion above comes up in the light of the fact that the current era is witnessing a paradigm change in moving towards 'digitisation' owing to the thrust given by the policy makers in the Indian context and recently witnessed, in the discourses of demonetisation and launching of GST nationwide, the premises of successful operation of which would be very much resting on the access to and possession of sound and adequate ICT infrastructure by the large and small enterprises alike.

Thus, having understood the potential gains arising out of the usage of ICT, this paper is an attempt to (1) understand the extent of ICT diffusion by examining the share of small enterprises in terms of ICT usage and (2) impact of ICT usage on firm and labour productivity at all-India and disaggregated levels across unorganised manufacturing enterprises in the country. The paper is organised into the following sections—Sect. 2 discusses the conceptual framework, methodology and data

[3] The Technological Gap Theory considers technological knowledge as the core engine of development. It focuses on how economic development is fuelled by the international diffusion of technical knowledge, the development of capabilities by economic actors who adopt that knowledge and the institutions that facilitate that adoption.

[4] The patterns of trade today have intensified the process of Subcontracting or Outsourcing (integration of a parent firm with the subcontracted firm to carry out the functions as specified by the parent firm (Lazerson 1990) which exists embedded within a single or multiple Value Chains operating across the globe. The parent (large) firms are usually the lead firms located in high income countries while the subcontractor or supplier firms (usually small in size) are located in the low income countries, the interaction between which enables the process of 'transfer of knowledge'.

used in the current study, Sect. 3 brings out the findings and discussions, and finally Sect. 4 concludes the paper.

## 2 Conceptual Framework, Data Source and Methodology

### 2.1 Concept of ICT Diffusion

Information and communication technology is both an output from the ICT producing industries which refers to the term ICT Growth[5] and an input into the ICT-using industries which is referred to as ICT diffusion.[6] In the current study, the emphasis would be to assess the impact of ICT on ICT-using industries, i.e. ICT diffusion. India has majorly benefitted from ICT growth through a series of institutional innovations and export oriented policy measures (Joseph 2002) while considerably lacked in terms of harnessing ICT for enhanced efficiency and productivity growth. The studies so far conducted show that ICT-induced productivity and growth still remain a phenomenon of the developed (OECD) countries and that the developing countries are yet to catch up (Joseph 2002) which has also resulted in the 'international digital divide' substantiated by studies conducted by UNDP (1999) and OECD (2000). For the purpose of the current study, the term 'Usage' of ICT-based infrastructure has been identified by the use of computers in the day-to-day business operations performed by the enterprises.[7]

### 2.2 Data Source and Methodology

The present study uses 67th (2010–2011) and 73rd (2015–2016) rounds of NSSO unit-level data to examine the impact of ICT usage on the productivity of small enterprises which is probably the first of its kind as the earlier studies conducted in the Indian context, namely Joseph and Abraham (2007), Sharma and Singh (2013) and Singh (2014) are based on ASI data which assess the impact of ICT usage on productivity of large enterprises in India. The classifying criterion for Own Account Manufacturing Enterprises (OAMEs) and Establishments (hereafter ESTBs) is followed as per the NSSO definition.

[5] It refers to the contribution in output, employment, export earning, etc., resulting from the production of ICT related goods and services that are limited to just one segment of the economy (Kraemer and Dedrick 2001).

[6] It refers to IT induced development through enhanced productivity, competitiveness, growth and human welfare resulting from the use of this technology by different sectors of the economy and society (Joseph 2002).

[7] This indicator has been borrowed from OECD (2009) indicators of measuring the Information Society. As far as the use of Internet is concerned, it is assumed that the enterprises which are duly equipped with the 'Computers' would also be working on Internet as well for their daily business operations. Also since the proportion of Computer using enterprises is already very small so adding more specifications to it has been avoided so as to make the sample size relevant to produce significant results.

### 2.2.1 Analysis at Disaggregated Levels

(a) State-Level

The state-level analysis has been done on the basis of The RaghuramRajan Committee Report (2013)[8] which has classified the states into three categories—least developed, less developed and relatively developed. According to the Committee Report, an (under)development index has been instituted to identify the status of development of states. If the score on the index is 0.6 and above, then those states are termed as 'least developed', if it lies between 0.4 and 0.6, then the states are termed as 'less developed', and if the score is below 0.4, then the states are considered to be 'relatively developed'. Among the major states which are classified as 'least developed' are Assam, Bihar, Madhya Pradesh, Orissa, Rajasthan and Uttar Pradesh; the 'less developed' states are Andhra Pradesh, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka and West Bengal, and those that are classified as 'relatively developed' are Kerala, Maharashtra, Punjab and Tamil Nadu.

(b) Industry-Level

The estimates at the industry level are derived by classifying the industries as high tech, medium tech and low tech as identified by OECD (2005)[9] and harmonising it with NIC-2008 classification at two-digit level. The term 'tech' used in these classifications does not strictly conform to the ICT usage but takes into account the share of R&D expenditure as a percentage of the gross output. Thus, an attempt is being made to understand the nature of ICT usage in differently classified tech industries in the manufacturing sector.

- Low-tech industries comprise of manufacture of food products and beverages, manufacture of tobacco products, manufacture of textiles, manufacture of wearing apparel, dressing and dyeing of fur, tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear, manufacture of wood and products of wood and cork except furniture, manufacture of paper and paper products, publishing, printing and reproduction of recorded media and manufacture of furniture.
- Medium tech comprises of manufacture of coke, refined petroleum products and nuclear fuel, manufacture of rubber and plastic products, manufacture of other non-metallic mineral products, manufacture of basic metals and manufacture of fabricated metal products except machinery and equipment.
- High-tech industries are classified as manufacture of chemicals and chemical products, manufacture of machinery and equipment, manufacture of electrical machinery and apparatus, manufacture of radio, television and communication equipment and apparatus, manufacture of medical, precision and opti-

[8] For detailed description Refer to-GOI (2013): "Report of the Committee for Evolving a Composite Development Index of States", Ministry of Finance, New Delhi.

[9] For more details, refer to Annexure in UNIDO (2015).

cal instruments, manufacture of motor vehicles, trailers and semi-trailers and manufacture of other transport equipment.

#### 2.2.2 Estimation of Labour and Firm Productivity

For measuring labour productivity, the indicator partial factor productivity (gross value added per worker) has been estimated, while for measuring firm productivity, total factor productivity has been estimated through Malmquist productivity index (MPI). It measures the productivity changes along with time variations and is decomposed into changes in scale efficiency and technical efficiency. A data envelope analysis technique which is based on linear programming is used to construct the Malmquist productivity index at all-India level (for ICT-using and non-ICT-using enterprises) and at disaggregated levels (by type of enterprise, type of industries, sector, states and asset quintile).

The linear programming (LP) technique has two benefits over the econometric method in measuring TFPG (Grosskopf 1986). First, it analyses the condition to the 'best' performing technology quite than 'average' performed technology as computed by econometric studies. Second, it 'does not require the specification of an *ad hoc* functional form or error structure'. In this procedure, the LP technique allows revival of various efficiency and productivity measures in a simply quantifiable manner. Following the Fare et al. (1994), the output-oriented MPI is as follows:

$$M_0\left(x^{t+1}, y^{t+1}, x^t, y^t\right) = \left[\frac{D_0^t\left(x^{t+1}, y^{t+1}\right)}{D_0^t(x^t, y^t)} * \frac{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_0^{t+1}(x^t, y^t)}\right]^{\frac{1}{2}}$$

A value of $M_0$ greater than one indicates positive TFPG from period t to $t + 1$ and vice versa. In this study, we deflate gross value added, and fixed asset, by overall WPI, and index of machine and machinery tools, respectively, at 2011–2012 base.

As a limitation of the study, it may be noted that the share of ICT-using enterprises is very minimal in the total unorganised manufacturing enterprises, which means that sample size may be rendered as insufficient and thus not strongly comparable with non-ICT enterprises as far as the proportion of the both the categories in the overall unorganised sector is concerned.

## 3 Findings and Discussion

### 3.1 Share of Enterprises Operating on ICT Infrastructure

Table 1 shows the distribution of ICT-using enterprises across all-India, state-wise and industry-wise. When we look sectoral-wise, we find a very high share of enterprises operating on ICT-based infrastructure in urban areas as compared to rural areas, but what is worth noticing is that within the rural areas, over the period of time the share of smaller enterprises (OAMEs) switching over to adoption of ICT usage has grown considerably indicative of a positive attitude of the

smaller enterprises towards recognising the benefits of using ICT usage and gradually adopting it, while it would be worth pondering why there has been a decline in the share of ESTBs which are operational on ICT-based infrastructure over the period of time at Pan-India level.

At the Regional level, in the rural areas, for OAMEs while the share for least developed states and relatively developed states has considerably increased, the opposite is being observed in case of less developed states. The same pattern is observed in the case of ESTBs also but the decline has been lesser as compared to the OAMEs. This unexplained feature occurring in case of less developed sates seems to be very much unusual given the fact that these states are the ones which are growing faster than the other category of states, especially as echoed in case of Gujarat. So it would be worth examining in the further studies what is exactly happening in this category of states. In the urban areas, in case of OAMEs, the share of ICT-based enterprises has grown considerably only in case of relatively developed states while falling for least developed and almost stagnant for less developed states, while in case of ESTBs less developed states have shown a massive increase in the share of ICT-based enterprises as compared to the other two categories of states. It is again a very uncommon feature where urban landscape is not able to provide the adequate support to the small enterprises towards their orientation to go ICT-based operations except in two instances which also is in contradiction to the nature of growth experienced in rural areas, where over the period of time there has been a considerable rise in the share of ICT-based enterprises, both the categories (OAMEs and ESTBs) taken together.

While moving on to the industry-wise dimension, we observe that in the rural areas, when we consider the case of OAMEs, across the industries, it is observed that low-tech industries comprise a very high share of ICT-based enterprises which has only grown over the period of time as compared to the other two categories of industries—medium tech and high tech. This trend is observed probably because of two reasons—(1) there is a very huge share of small labour intensive and traditional industries in the rural areas which are generally classified as OAMEs and (2) the subcontracting practices from the bigger formal as well as informal firms might have led to the upgradation of small firms in terms of increased usage of ICT-based operations to keep up with the pace and requirements of the parent firms. While in case of ESTBs, growth of ICT-based enterprises has been registered only in case of medium-tech industries so it would be worthwhile to examine further, what characteristics of ESTBs are enabling for a positive growth for the medium-tech industries, while regressive for the other two categories, namely low and high tech. In the urban areas, in case of OAMEs, it is very obvious that the share of high-tech industries is high as compared to the low-tech industries, but such a small share of medium-tech industries which are functional on ICT-based infrastructure is again a very unusual feature. Not only this over the period of time, we also witness a regressive trend in the share of ICT-based industries in case of high-tech industries which is again worth exploring as against the considerable increase in the share of low-tech industries. However, when we observe the share of ESTBs, the case is just the opposite which seems to be very obvious also.

**Table 1** Distribution of ICT-using enterprises at all-India and disaggregated levels

| Year | 2010–2011 | | | | | | 2015–2016 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sector | Rural | | Urban | | All | | Rural | | Urban | | All | |
| Type of enterprises | O | E | O | E | O | E | O | E | O | E | O | E |
| All-India | 15.92 | 12.16 | 84.08 | 87.84 | 15.03 | 84.74 | 19.48 | 6.93 | 80.52 | 93.07 | 18.76 | 81.24 |
| State-wise | | | | | | | | | | | | |
| Least dev | 46.99 | 11.94 | 34.8 | 14.78 | 36.87 | 14.47 | 59.21 | 14.49 | 17.96 | 10.61 | 26.51 | 10.89 |
| Less dev | 41.23 | 48.77 | 28.87 | 39.25 | 30.97 | 40.29 | 20.96 | 32.41 | 26.16 | 54.86 | 25.08 | 53.24 |
| Rel dev | 11.78 | 39.28 | 36.33 | 45.97 | 32.16 | 45.24 | 19.83 | 53.1 | 55.89 | 34.54 | 48.41 | 35.88 |
| Industry-wise | | | | | | | | | | | | |
| Low tech | 89.67 | 52.05 | 77.78 | 60.92 | 79.81 | 59.95 | 93.81 | 49.6 | 83.69 | 53.35 | 85.69 | 53.11 |
| Medium tech | 8.08 | 16.37 | 2.4 | 15.53 | 3.37 | 15.63 | 6.38 | 27.77 | 4.46 | 15.77 | 3.65 | 16.54 |
| High tech | 2.26 | 31.58 | 19.82 | 23.54 | 16.82 | 24.42 | 5.81 | 22.63 | 11.86 | 30.88 | 10.66 | 30.35 |

*Source*: calculations done by the authors based on 67th (2010–2011) and 73rd (2015–2016) rounds of NSSO Notations used O-OAMEs; E-ESTBs

**Table 2** Labour productivity in ICT and non-ICT enterprises at all-India level

| Sector | Rural | | | Urban | | | All | | |
|---|---|---|---|---|---|---|---|---|---|
| Type of enterprise | OAMEs | ESTBs | All | OAMEs | ESTBs | All | OAMEs | ESTBs | All |
| 2010–2011 | | | | | | | | | |
| ICT | 57,807 | 118,307 | 106,922 | 82,575 | 130,159 | 123,267 | 78,631 | 128,718 | 121,187 |
| Non-ICT | 26,517 | 57,589 | 29,467 | 41,063 | 84,067 | 51,417 | 31,809 | 74,362 | 38,365 |
| 2015–2016 | | | | | | | | | |
| ICT | 70,453 | 180,369 | 137,112 | 122,908 | 201,051 | 188,042 | 112,690 | 199,618 | 183,314 |
| Non-ICT | 36,542 | 81,793 | 40,113 | 61,378 | 114,507 | 72,648 | 45,833 | 103,140 | 53,496 |

*Source*: calculations done by the authors based on 67th (2010–2011) and 73rd (2015–2016) rounds of NSSO

Overall, it is observed that it is in general the case of OAMEs where we find that the share of ICT-based enterprises has increased over the period of time which goes against the conventional understanding, which should have actually happened in case of ESTBs. Is it the case that more and more ESTBs are fragmenting and coming under the classification of OAMEs or OAMEs are more inclined towards their association with big parent firms (subcontracting practices) that is enabling them (in fact it is becoming a basic requirement) to upgrade in terms of their ICT-based infrastructure which is reflective of their enhanced share of ICT-based operation over the period of time is a matter of further exploration.

### 3.2 Labour Productivity in ICT-Using Enterprises

Labour productivity has a direct impact on the share of wages earned by the workers in the informal sector, and if it is more skill-led (as essentially ICT usage involves a certain level of Technical Proficiency on the part of the workers), then it has a greater potential for the upward spiralling of wages and thereby raising the living standards of the workers. In this context, Table 2 shows the estimates of labour productivity (gross value added per worker) for ICT and non-ICT enterprises, while Table 3 further dissects labour productivity by industrial classification within the ICT-using enterprises which tries to capture the differentials in labour productivity across different technology-based industries.

A general observation is that at the all-India level, labour productivity for ICT-using enterprises is higher as compared to non-ICT enterprises for all categories over the period of time giving an indication that probably ICT usage by the enterprises is leading to a higher labour productivity in such enterprises (Table 2). However, going through the second line of observation, we find that labour productivity has increased over the period of time for both ICT and non-ICT-using industries so a casual observation would definitely signify that there are other factors also apart from ICT usage due to which labour productivity has increased but when we examine closely then we find that the differentials are very large for ICT as compared to non-ICT enterprises. This signals that the role of gradual adoption of ICT

**Table 3** Labour productivity by type of industry within ICT-using industries

| Sector | Rural | | | Urban | | | All | | |
|---|---|---|---|---|---|---|---|---|---|
| Type of enterprise | OAMEs | ESTBs | All | OAMEs | ESTBs | All | OAMEs | ESTBs | All |
| 2010–2011 | | | | | | | | | |
| Low tech | 54,624 | 118,039 | 97,681 | 85,161 | 126,569 | 119,418 | 79,298 | 125,759 | 116,955 |
| Medium tech | 72,252 | 130,736 | 123,762 | 186,659 | 125,786 | 127,285 | 139,796 | 126,353 | 126,843 |
| High tech | 68,648 | 96,325 | 95,792 | 106,584 | 149,431 | 144,247 | 105,714 | 141,924 | 138,017 |
| 2015–2016 | | | | | | | | | |
| Low tech | 64,349 | 113,741 | 85,058 | 117,349 | 157,831 | 148,069 | 105,854 | 155,197 | 141,570 |
| Medium tech | 258,142 | 201,526 | 202,084 | 148,582 | 193,839 | 191,388 | 150,830 | 194,664 | 192,491 |
| High tech | 102,731 | 248,237 | 225,203 | 186,639 | 264,639 | 259,009 | 177,574 | 263,856 | 257,240 |

*Source*: calculations done by the authors based on 67th (2010–2011) and 73rd (2015–2016) rounds of NSSO

infrastructure over the period of time cannot be ruled out altogether as a cause for increased labour productivity and more so in case of enterprises (both OAMEs and ESTBs) in the rural areas which in itself entails the welfare effects for the workers living in rural areas and engaged in small business operations (Table 2).

In rural areas within the ICT-using enterprises, across both the type of enterprises there has been an increasing trend and more pronounced in case of medium-tech and high-tech industries except for the case of ESTBs in low-tech industries where it has declined. This again is observed as a contradictory phenomenon as against the OAMEs in the same category of industries. In case of urban areas, except for medium-tech industries in both the categories (OAMEs and ESTBs), labour productivity has increased over the period of time. When we compare labour productivity in rural and urban areas, we find that an increase in the labour productivity is more pronounced in the rural areas as compared to urban areas (as in the above case), especially in the medium- and high-tech industries, so an increase in employment opportunities in such industries would be more gainful for labour as compared to low-tech industries (Table 3).

### 3.3 Firm Productivity (TFPG) in ICT-Using Enterprises

Table 4 shows the TFPG estimates for ICT and non-ICT enterprises at all-India level and within the ICT-using enterprises how has firm productivity varied over the period of time across various disaggregated levels. When we observe TFPG across ICT and non-ICT enterprises, we find a higher level of productivity growth for ICT-based enterprises[10] which is also indicated by the higher level of technical efficiency

[10] Though TFPG in case of ICT-based enterprises seems to be higher than non-ICT enterprises, it can be noted that the difference does not seem to be very substantial hence may not lead to any significant conclusion on the impact of ICT usage on firm productivity. However, it needs to be recognised that the ICT-

**Table 4** Firm productivity (TFPG) for ICT and non-ICT enterprises and impact of ICT usage at various disaggregated levels from (2010–2011) to (2015–2016)

| Indicator | Scale efficiency | Technical efficiency | TFPG (MPI) |
|---|---|---|---|
| ICT | 1.02 | 1.30 | 1.33 |
| Non-ICT | 1.01 | 1.12 | 1.13 |
| *Within ICT-using enterprises* | | | |
| Type of enterprises | | | |
| OAE | 1.59 | 1.14 | 1.82 |
| ESST | 1.02 | 1.13 | 1.15 |
| By sector | | | |
| Rural | 1.04 | 1.38 | 1.43 |
| Urban | 1.01 | 1.10 | 1.11 |
| Industry-wise | | | |
| L tech | 0.91 | 1.13 | 1.03 |
| M tech | 1.09 | 1.14 | 1.24 |
| H tech | 1.00 | 1.17 | 1.17 |
| State-wise | | | |
| Least developed | 0.91 | 1.13 | 1.03 |
| Less developed | 1.09 | 1.14 | 1.24 |
| Relatively developed | 1.02 | 1.17 | 1.19 |
| By asset quintile | | | |
| Q1 (lowest quintile) | 1.03 | 1.27 | 1.31 |
| Q2 | 0.84 | 1.09 | 0.91 |
| Q3 | 1.05 | 1.14 | 1.20 |
| Q4 (highest quintile) | 1.03 | 1.10 | 1.13 |

*Source* calculations done by the authors based on 67th (2010–2011) and 73rd (2015–2016) rounds of NSSO

achieved by such enterprises. Within the ICT-using enterprises, ICT usage has benefited OAMEs more than the ESTBs and that too in the rural areas, medium- and high-tech industries, enterprises located in the less developed and relatively developed states and enterprises falling under the lowest asset quintile[11] pointing towards the fact apart from benefitting large enterprises (large firms in general and ESTBs in

Footnote 10 (continued)
based enterprises comprise just a miniscule fraction of the total unorganized manufacturing enterprises as compared to non-ICT enterprises and even a small incremental value indicates that impact of ICT usage on firm productivity cannot be ignored altogether and may lead towards the development of such policy initiatives which would benefit the firms at large in the coming years of industrial growth wherein digitization is supposed to play a key role.

[11] Asset Quintiles are worked out by considering investment of an enterprise in Fixed Assets, i.e. machines and machinery tools. It is normally understood that the enterprises which have greater levels of investment would be more inclined towards adoption of ICT-based infrastructure, but the estimates have pointed otherwise giving an indication that enterprises are incurring investment towards adoption of ICT-based infrastructure irrespective of the Asset Quintile they fall into.

case of current study), ICT usage has also impacted the productivity in small enterprises over the period of time.

## 4 Concluding Remarks

With an inevitable usage of ICT as one of the key factors driving growth of the industry worldwide today, the current study attempted to (1) explore the extent of ICT diffusion and (2) assess the impact of ICT usage on productivity levels (both firm and labour) across unorganised manufacturing enterprises in India. Following are the key conclusions that can be derived from the findings drawn above:

1. Even though there has been widespread expansion of digital services and ICT-based infrastructure across even the remotest corners of India, small enterprises are yet to catch up vis-a-vis medium and large firms in terms of adoption of ICT-based infrastructure so as to be able to reap out the benefits of digitisation in the operation of day-to-day business activities as they just constitute a miniscule fraction of the total unorganised manufacturing enterprises (as reported by NSSO in its 73rd round). Thus, it can be concluded that ICT diffusion has still not taken place largely wherein ICT usage is primarily being used as an 'input' and has become the key strategy for the growth of the manufacturing industries in general.
2. As against the general understanding, within the ICT-using enterprises, it is the smaller bunch of enterprises (OAMEs) as against ESTBs which constitute a majority share in terms of ICT adoption which are largely located in rural areas and classified as low-tech industries. This might be probably due to the fact ESTBs might be undergoing fragmentation and adding to the already existing chunk of smaller enterprises on the one hand and increased subcontracting practices by the larger parent firms which require small firms to be upgraded at least in terms of basic requirements of being able to cater to them in which ICT adoption plays a key role.
3. As regards, labour productivity though we cannot explicitly say an increase in labour productivity is due to ICT usage, but the huge differentials in labour productivity across ICT and non-ICT enterprises certainly point out to the fact that ICT usage has a potential for increasing labour productivity and thereby remuneration levels over the period of time. This is also in consonance with the wage gap of skilled and unskilled labour (in terms of digital literacy and proficiency) which may result into inequalities of income for the two categories of labour over the period of time due to technological upgradation (here it refers to ICT usage).
4. When it comes to impact of ICT usage on firm productivity, TFPG estimates (over a period of last 5 years) reveal that though the difference in productivity of ICT and non-ICT enterprises is not very significant as such the fact that it is incrementally higher for ICT-using enterprises as compared to non-ICT enterprises cannot be ignored altogether in framing a policy having a proactive attitude towards ICT adoption by the enterprises. When we dissect it further across various disaggregated levels, we find that ICT usage does have a positive impact on the productivity of large enterprises, it is even more beneficial for smaller enterprises.

Thus, an overall policy perspective would be to lay thrust on the adoption of ICT infrastructure and aim to bring a larger section of the unorganised manufacturing sector within the ambit of ICT-based enterprises by provision of adequate technical, financial and infrastructural support to the small enterprises.

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