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India's Tryst with Robotisation: Opportunities, Challenges, and Policy Implications

Introduction

The impact of robots on the future of work, enterprises, and trade has been a much-talked-about issue in the academic and policy discourse in recent years. The rise of robots, over the past decade, enabled by convergences in technologies like machine learning (ML), energy storage systems, the internet of things (IoT), additive engineering, etc. is fast changing the face of global manufacturing. With the growing cost-effectiveness and efficiency of robots, firms in both developed and emerging economies have been automating the production lines to boost productivity and competitiveness. According to the international federation of robotics (IFR), the average robot density in manufacturing industries has risen from an average of 60 units in 2015 to 113 units per 10000 employees in 2021 globally (IFR 2021). Today, Western Europe and Scandinavia are among the highly automated regions in the world followed by countries in North America and South-East Asia. While China has emerged as the largest users of industrial robots with one of every three industrial robots in the world being installed by Chinese firms, the emerging economies of Brazil, India, and South Africa have been somewhat slow in catching up to the robotic revolution (IFR 2020; MIT Technology Review 2018).

In the contemporary context, the use of robots has also been accentuated in the wake of events like the 2008 global financial crisis (GFC) and the ongoing COVID-19 pandemic. The 2008 crisis gave an unexpected push to robotisation as firms in industrialised economies struggled to cope with growing imbalances in revenue and labour wage ratios and the lowering of interest rates (Muro *et al.* 2020; Marin 2020). The disruptions in global supply chains in the aftermath of the 2008 financial crisis coupled with rising labour costs in countries like China led many North American and European firms to re-shore industrial production and to leverage robots as cost-effective solutions for enhancing productivity and sustaining their competitive advantages (De Backer

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et al. 2016). The ongoing COVID-19 pandemic is similarly regarded as an "automation forcing event" which is driving firms' to accelerate robotisation amidst constraints of physical distancing, and a reduced number of workers during lockdowns (Salisbury 2020).

The use of robots and ICT-led automation technologies nevertheless triggered a volley of concerns about their impact on enterprises and the industrial workforce. A widely cited study by Frey and Osborne (2013), for instance, estimated that around 47 per cent of jobs in the United States are likely to be taken away by robots and digital technologies. A world bank study in 2016 similarly estimated that the use of robotics and smart manufacturing techniques would result in the automation of about 1.8 billion jobs in both industrialised and developing countries (World Bank 2016). More importantly, robotisation is widely seen as inducing premature de-industrialisation in developing countries as robots are allowing firms in developed countries to exploit cost-efficiencies and enable re-shoring of industrial production. Such de-industrialisation would, in turn, puts pressure on the services sector to provide more jobs, which might stagnate wages and stymie the overall development in much of the southern world (UNCTAD 2016; 2017).

Robot-led automation, therefore, presents a peculiar challenge for emerging economies where balancing productivity with equitable growth have become prime concerns for innovation and industrial policies (UNCTAD 2021). This policy brief seeks to critically examine the extent to which the adoption of robots in India affects industrial labour and probe various opportunities and challenges for policymaking in this area. Emerging economies, like India, are unique in terms of their catching-up trajectories, and adoption of new technologies is a highly context-specific (or path-dependent) process involving a range of economic, and policy considerations that shape firm's technological choices (Li and Georghiou 2015; Lall 1992). Understanding the impact of robots on the future of work, therefore, requires focusing on India's unique policy context and the adoption of robots across various industrial sectors. In the first part, this policy brief maps the extant debate on the impact of robotisation on the future of jobs, and captures key insights from major studies published on robotisation. In the second part, we map the current status of robotisation and attempt to account for sectoral differences in the adoption of robots. Although the current pace of robot-led automation in India is insufficient to investigate the 'technological unemployment' hypothesis, this brief sheds light on key issues that merit attention for not only boosting robotisation but also stimulating India's nascent robotic innovation system.

Rise of Robots and Future of Work: Mapping the Debate

The rise of robots has given push to a flourishing debate and studies on its impact on the future of work. Although this brief does not intend to present an exhaustive review of the vast scholarly literature emerged in recent years, in this section, it reviews some of the major studies, and present stylised facts on the impact of robots on the future of jobs and wages. At the outset, it is pertinent to note that there is a considerable lack of consensus on how robots might affect the future of work. On one hand, the policy discussions have focussed on vast economic possibilities that robots can generate in terms of improving productivity levels, and replacement of tasks that are considered to be dangerous for human beings to perform (Thiel 2014; Oxford Economics 2020). Analyses in this stream mainly contend that every new technological wave has led to high rates of employment,

wages, and economic growth while rendering obsolete certain existing categories of jobs (Tyson and Lund 2017; Verhofstadt 2017). With each 'technological wave' replacing older technologies with newer ones, the process of 'creative destruction' has served to create a safer occupational environment for workers and generated more value for society (Schumpeter 1943).

Setting aside concerns surrounding the downward pressure on wages induced by the use of robots, Nobel Laureate economist Edmund Phelps notes that such impacts would only be 'short-term', and going forward, there will be a significant increase in profit rates of firms, which would yield newer investments and a recovery in the wages (Phelps 2020). Furthermore, Phelps point out that robots are not just "additive" but also task "multiplicative" which will enhance the productivity levels of the workforce and "need not result in any prolonged recession of aggregate employment and wages". The fear of job losses due to robotisation, according to Phelps is largely "misplaced", since most jobs include a combination of routine and non-routine tasks, which cannot possibly be automated (Phelps 2020). Atkinson (2014), a leading proponent of industrial robots, contends that robots bring significant productivity gains and carries with it net positive gains for employment and the labour market (Atkinson 2014). Pointing to the positive impacts of robots on employment, Dahlin (2019) shows that robots not only generates more value for human labour by reducing strenuous physical labour but also bring higher compensation for workers skilled enough to work in and around robotic systems. More importantly, a recent report from *The Economist* sought to reject 'technological unemployment' concerns as 'Luddite Fallacy', and that the alarms of a jobless future are mostly false and overblown (The Economist 2021).

The robots skeptics, on the other hand, perceive automation of factories and work-stations as structurally distinct from earlier waves of technological change and regard automation technologies as inherently labour-substituting. The 'labour substituting' impacts of robots are reckoned to have adverse impacts on developing countries that would reduce the total number of jobs for unskilled and semi-skilled workers in the economy.[1]

A study by Frey and Osborne (2013), as mentioned earlier, showed that around 47 per cent of total US employment will be at the risk of automation. Similarly, the International Labour Organization (ILO) research conducted by Chang and Huynh (2016) warned that 56 per cent of total employment in Cambodia, Indonesia, the Philippines, Thailand, and Vietnam is "at high risk of displacement due to technology over the next decade or two". Taking into account the heterogeneity of tasks involved in a given occupation, the studies have shown somewhat lessened impacts of robots and automation on jobs. Focussing on tasks instead of jobs that can be automated, a study by Arntz, Gregory, and Zierahn (2016) published by OECD shown that only 9 per cent of jobs on average across 21 OECD countries are at the risk of automation.

Using the task-based approach, Nedelkoska and Quintini (2018) estimated the impacts of robots in 32 countries and showed that, on average, 14 per cent of jobs carries high risks of automation, while another 32 per cent of jobs could experience marked changes in their task composition as a result of technology adoption. A study by McKenzie & Company (2017) similarly noted that robot-led automation would adversely impact low-skilled workers, especially in developing countries. Schlogl and Sumner (2020) contend that the risks of impoverishment posed by automation technologies to low-skilled workers calls for a set of welfare-inducing measures like social security schemes, etc. to curb societal unrest. Prominent figures like Nobel Laureate economist Robert J. Shillermakes and Microsoft CEO Bill Gates reiterated the

[1] See, Schlogl and Sumner (2020). This study analyses in detail the skill-biased nature of AI & robotic technologies and its impact on workers in developed as well as developing countries.

concerns surrounding the impact of robots in their pleas to impose robot "tax" to stem wage inequities resulting from robot-led automation (Shiller 2017). The rationale for the robots tax, and other interventions mainly arises from the need to protect labour rights by adjusting the policy regimes to cope with the adverse impact of robots rather than arresting their diffusion through policy barriers.[2]

Apart from their impact on the future of work, the training and re-skilling of workers too have emerged as important concerns with studies highlighting certain occupations/tasks that can be automated due to the introduction of robots on the shopfloors. Since re-skilling would be essential to improve the re-employability of workers, Delong (2014) and Groff (2018) have called for launching new programmes to train the workers for robotised shop-floors (Delong 2014; Groff 2018). Such measures, Delong (2019) argues would help to nurture job growth sustainably, and ensure that technological change occurs without causing any social upheaval. In sum, the robotisation debate remains largely inconclusive with experts divided over both quantitative and qualitative impacts of robots on labour. Mattos *et al.* (2020) contend that quantitative estimation of job/tasks displacement is mainly derived from 'technological feasibilities', i.e. job/tasks that can be automated within a given industrial set-up; and that such feasibilities need not necessarily result in actual automation of tasks/jobs since technological adoption in developing countries is contingent upon a range of economic and policy-related factors. In view of the fact that technological feasibilities and profiling of jobs/tasks vary across industries and countries, understanding the impact of robots on future of work needs to take into account the determinants of 'technology adoption' that shape firms choices in pursuing automation. Accordingly, in the next section, we map the sectoral distribution of robots in India and issues concerning technological adoption and identify issues for policy consideration.

Current Status of Robotisation in India

a) Sectoral Distribution

Notwithstanding the significance of robots for enhancing productivity and competitiveness of firms, the pace of robotisation in India has remained much slower compared to economies in the Eastern and South-East Asian region (Ahaskar 2018). The size of India's industrial robot market remains very small with about 26000 operational robots in the year 2020 (IFR 2020). With only four industrial robots per 10,000 employees in the manufacturing industry, the robot density in India is also one of the lowest. According to the International Federation of Robotics (IFR 2021), a total of 4,112 new industrial robots were installed in India in the year 2020 showing 12 per cent growth from the previous year in robot installation. The IFR data shows that three industries, viz. the metal, electrical and electronics, and automotive, together account for about 80 per cent of the entire operational stock of industrial robots in India. The automotive industry, in particular, accounts for over 55 per cent of total robots installed in the country with around 100 robots per 10,000 workers. The high rates of robotisation in the automotive sector is mainly due to widespread adoption of robots by subsidiaries of multinational companies which started embraced robotisation nearly two decades ago (Philip 2015).

The Indian affiliates of global automotive firms thus secured an early lead in terms of deploying industrial robots compared to other industries. Moreover, OEMs/MNCs increasingly require a local supply of standard automotive parts, which are fabricated using precision robotics. For such reasons, the use of industrial robots in the Indian automotive sector is higher compared to the general

[2] See, Nahavandi (2019) for discussion on human-centric approach to technological adoption and labour-friendly policy measures such as 'robot tax'.

industry (Miglani and Ray 2018). The robot density of the automotive sector in India nevertheless remains far behind the Asian giants like China and South Korea where about 732 and 2,589 units of robots are installed per 10,000 employees respectively. Also, the automotive sector in India accounts for only 10 per cent of the country's overall manufacturing employment (PwC 2019). The demand for robots has increased in the general industry comprising rubber, plastics, metal industry, and the electrical/electronics (IFR 2019). A growing number of firms in electronics, food and packaging, education, and the banking sectors are also investing in robotic systems to enhance operational efficiency.

Notwithstanding the strong potential for robotisation in India's general industries, sectors like rubber, leather, FMCG, etc. have shown continued reliance on established and tested production tools instead of switching to automation by robotic systems (Ibid). In the wake of the COVID19 pandemic, the robots have reportedly found a more prominent role in many industries. During lockdowns, the warehousing industry reported growing use of robots to perform tasks like sorting, lifting and arranging heavy packages and goods (Gupta 2020). Similarly, the demand for co-bots or collaborative robots too has increased in the wake of the COVID 19 pandemic as co-bots help to enhance and complement human efforts rather than replacing human labour from the shop-floors (Ramesh 2020). Augmenting human productivity, efficiency, and safety gains are among the key benefits that firms seek to exploit from the deployment of industrial robots, and the COVID19 pandemic has reportedly served to increase the use of robots in certain industries.

b) Adoption of Robots: Issues & Constraints

The sectoral distribution of robots outlined in the previous section shows that capital-intensive industries like automobile manufacturing account for the largest share of industrial robots installed in the country (Philip 2015). Consequently, the employment potential of the automotive sector is likely to decline in the coming years. Following automotive, the textile and apparel industry represents a major employment-intensive sector where robot-led automation poses a serious concern for the labour force. The automation of processes like spinning, splicing, etc. and the growing pace of automation with the declining cost of robots would significantly limit the overall employment potential of this industry (Kumar 2019). This trend is already evident as leading Indian textile firms like Raymond have announced that robots would replace around 10,000 workers in the next three years (TNN 2016). The adoption of robots in the garment/textile industry however is not without a problem. The high cost of imported robots and challenges involved in their installation, operation and maintenance on the factory floors are critical issues for many Indian textile firms. A study by Vashisht & Rani (2019) reported that textile firms are often reluctant to adopt technologies like American Sewbot (robots) for automating clothes-making process. Warehousing and logistics is another industry where the adoption of robots is seen as a 'gamechanger' to achieve cost reduction and economies of scale (Kamali 2019). The idea of a smart warehouse pioneered by leading e-commerce giants is mainly aimed at deploying smart and heavy-duty robots to replace unskilled human labour and improve the efficiencies of warehousing operations.[3]

Except for the e-commerce industry, a large number of warehouses in India under entities like national food corporation, railways, local agriculture markets (mandi system) in rural and semi-urban areas continue to rely on human labour. In labour-intensive industries such as plastics, rubber, leather and footwear, paper, the adoption of robots too has been limited irrespective of the immense scope for automating several jobs/

[3] Following e-commerce giant Amazon, many domestic and multinational e-commerce firms viz Walmart, Alibaba, Flipkart are developing smart warehouses using robots.

tasks in these industries (Mani 2019). The pace of robotisation has also been quite slow in a large number of small and medium-sized firms in India. Also, contrary to automotive manufacturers in the organised sector, a large number of component manufacturers which operate in the semi-organised sector are yet to automate production, and continue to rely on manual labour to perform various production activities (Sabnavis and Kansara 2017; Soni and Subramanya 2020). Among other, the high capital cost of robots, dependence on foreign (licensed) technologies, poor infrastructure, lack of skilled manpower, etc. largely explain the slow adoption of robots across the aforementioned industries. The informant interviews with industry and robot experts (scientists) revealed valuable insights into firms choices in adopting industrial robots.

First, the limited availability of knowledge resources pose a serious barrier for robotisation in MSMEs, and India's 'general' manufacturing industries. Except for foreign subsidiary firms, a large number of Indian firms lack in-house technological resources to learn and assimilate robots imported from foreign suppliers. Being the technology recipients, the adoption, assimilation, and integration of robots often suffer from lack of knowledge about the use of these technologies. The limited learning and technological capacities of firms significantly limit their choice to adopt industrial robots coupled with high import cost, and concurrent challenges like import duties, limited credit facilities, and so on. The non-availability of technological resources like skilled manpower also puts Indian firms at a serious disadvantage vis-a-vis the foreign firms which can hire experts from international markets. Recent studies by UNIDO (2019) corroborate these dynamics and point to the absence of a 'level-playing field' for developing country firms, and their acute dependence on external technological resources. Similarly, the 'access, equity, and inclusion' (AEI) framework pioneered by Chaturvedi et al. (2015) regards access to technologies between and within countries as an essential value.

Although India has witnessed a rapid growth of start-ups in the robotic and automation sector in recent years, the market share of these firms remains much low. Notwithstanding their efforts to replicate and adapt foreign technological systems to the needs of local market, the Indian robotic firms face serious competition from foreign entities in both the industrial and service category of robots. The foreign firms are highly cost competitive as they source fabricated robot assemblies from factories located outside of India and source only peripherals from the local market, whereas Indian firms are forced to import both core and peripheral components from abroad which significantly adds to the cost of robots.[4] As a result, subsidiaries of foreign firms continue to dominate the Indian market for robots and obstruct the growth of the domestic robot industry. It is thus essential that government supports the growth of the domestic robotic industry, and enable it become competitive vis-à-vis foreign firms to deliver affordable and sophisticated robotic systems and to improve their adoption across industry sectors.

Second, as noted in ILO (2020) study, the high cost of operation and maintenance of robots and availability of skilled labour are crucial factors that shape the firm's decision to automate production (ILO 2020). The creation of robotised shop-floors not only involves large initial investments but also the uncertainty surrounding the decline in the average unit cost of production post-robotisation (Ibid). Such uncertainties are particularly pronounced for Indian firms as they lack a workforce possessing the necessary skills, and competence to work with advanced manufacturing technologies like robots (see Kumar 2021). In addition, the lower levels of digital penetration and

[4] The leading foreign subsidiaries in India include firms like ABB India, Gudel, Kuka robots, etc.

the poor state of infrastructure including low optic fibre connectivity continue to work against the rapid diffusion of industrial robots and digitalisation in India.[5] The Indian industry associations have frequently drawn attention to wide-ranging infrastructural bottlenecks including lack of high-speed internet to power outages that affect the performance of robots which, in turn, affect the overall pace of robotisation in the country (CII 2020). On account of such constraints, human labour has so far remained central to general industries, and robots are being introduced mainly in assistive and collaborative roles (Ahaskar, 2020). As argued by Gentili *et al.* (2020) in their seminal piece that robotisation processes are "industry- and country-sensitive", it is pertinent to note that low robot density in India coupled with an abundant supply of low-cost labour implies that the prediction of job losses in the Indian scenario is unlikely to become true in the near term future.

c. Nascent Indigenous Innovation System

As noted in the preceding paragraphs, a fairly nascent state of India's domestic innovation system for robots has affected the diffusion of robots in the country. The R&D and innovation ecosystem for robotics in India led by technical institutions such as the IITs, defence R&D labs, and private enterprises has remained much smaller and yet to fully exploit the opportunity presented by the available domestic demand. The R&D for robots in the private sector is led by a handful of start-ups and large firms like TAL Manufacturing Solutions, a wholly-owned subsidiary of Tata Motors. In recent years, the fledgeling start-up ecosystem has shown significant willingness to capture the large domestic market and launched innovative products including both industrial and service robots. Well-known start-ups like Sastra Robotics, Gridbots, Skilancer Solar, Systemantics, and GreyOrange Robotics are pushing the innovation frontier by launching both production and service category robots.[6] Similarly, firms like TAL are developing multi-purpose industrial robots for the automotive sector which represents high demand for robots in the country (D'Monte 2019). In addition, the start-ups are focussing on the development of peripherals including components, spares, and software solutions for large MNCs.[7]

The market share of local firms in robots however remains much smaller as they compete with foreign subsidiaries possessing high levels of innovation and technological capabilities. For the Indian robotic industry to become competitive in the production of industrial and service robots, it is imperative to rapidly augment their innovation capabilities, expedite learning, and acquire comprehensive knowledge resources. The availability of low-cost robots and services can go a long way in deepening robotisation in India and enable both small and big firms to increase their productivity. India's nascent ecosystem can benefit from the articulation of a holistic national policy, and setting standards for the robotic sector, and also hold consultations with technology adopting firms something which countries like China have done proactively to promote their domestic robotic industry.[8] The indigenous robotic innovations can benefit from not only tapping the demand for industrial robots but also enable the adoption of robots in areas likes food & agro-industries, warehousing, and various public utility services. Similarly, extending tax benefits to companies investing in robots as capital goods could increase the adoption of robots as well as promote higher R&D in robotic-driven technologies. Such incentives could also attract foreign robotic manufactures to enter India and make the country a regional robotic R&D and production hub.

In the defence sector, the Department of Defence Research & Development Organisation (DRDO) has launched a national robotic mission to replace humans with robot soldiers on the battlefield (PIB

5 Discussion with technical expert on robots.

6 Manufactures and supplies robots to retail giants Flipkart and Pepperfry (Livemint, 2014).

7 Discussion with industry expert.

8 Input from the industry representative.

2020; Raja Simhan 2017). Under the Digital India mission, the government has so far allocated about INR 3,073 crore to further research in Robotics, Artificial Intelligence (AI) and the Internet of Things (IoT) (TNN 2018). Similarly, a national programme on AI has been set up by NITI Aayog at IIT Chennai with a focus on robotics for enhancing industrial productivity and automating tasks that considered risky for workers (IANS 2018). Under the flagship Clean India Mission, the government has outlined the need to leverage robotic solutions to replace humans performing tasks like manual scavenging, cleaning of underground sewer pipes, etc. (Bora 2019). For the rapid development of India's domestic robotic industry, it is imperative to strengthen the fledgeling innovation system and address deficits in infrastructure, R&D, and knowledge production and augment advanced maintenance and repair services (Ejiaku 2014).

Implication for Policymaking

Since the publication of the World Banks' 2016 World Development Report which predicted that about two-thirds of Indian jobs are at a high risk of automation to a wave of robotisation and digital technologies, it is worthwhile to underline that the diffusion of industrial robots in India has not shown any significant growth pattern. As noted in the previous section, in India the adoption of robots in labour-intensive sectors like agriculture, food, metal, garments and textiles, leather industries, etc. has been rather slow, and only capital-intensive sectors like automobile have been able to deepen the automation using robotic systems. The analysis in this brief suggests that despite the vast potential for using robots in many Indian industries, the pace of robot adoption is affected by factors like relative costs, and infrastructure deficits. In particular, the limited availability of low-cost indigenous technologies, and lack of skilled manpower prevent Indian firms from catching up to the technology frontier, and increases their dependence on foreign knowledge and technological resources.

To compete globally in robotics, the Indian industry has to transform its manufacturing to global standards, which demands accelerated use of robotics and precision manufacturing. Only then, the Indian industry can meet the national demand for quality products, minimise its dependence on technology imports. As in the case of the transport industry, it would result in the emergence of ancillary industries in the informal sector and would result in large scale jobs for our unskilled and semiskilled workers. Fostering the rapid adoption of robots, therefore, presents three-fold implication for policymaking in India. Since automation is going to be a slow and gradual process in India, it would be worthwhile for Indian policymakers to focus on supply-side measures aimed at preparing the emerging workforce to acquire skills required for automation technologies. This requires reorienting the existing education, training, and skill development institutions to equip human resource for the future needs of industry. With the right skills and competence, the emerging workforce can immensely benefit from technological adoption rather than being substituted by the unfolding technological changes.

Second, the policy measures can focus on a range of demand and supply-side interventions which can give a major boost to indigenous robotic innovation system. In particular, the start-up ecosystem needs special support which can be extended from the aggregation of public sector demand for service robots under national missions like 'Clean India', 'Healthy India', etc. Similarly, the government can also coordinate the demand for robots in both public and private

sector through demand for robots.[9] Similarly, the R&D efforts in both public and private R&D institutions, and universities can be strengthened through effective coordination, university-industry partnerships which can meet the technical requirements of small, medium and large enterprises.

Third, in addition to enhancing the productivity and competitiveness of firms, policy efforts should also be directed towards making occupations safer and healthier through the use of robots. It is well-known that robots were originally developed to handle hazardous materials and to save humans from exposure to harmful chemicals, nuclear waste, etc. The robots need to be supported in areas like deep mining, construction to minimise fatalities.[10] Over the years, the productive uses of robots have revolutionised manufacturing, and resulted in the production of clones, with the help of AI, etc. Through concerted efforts and incentives, the use of robots, R&D and innovation can be enhanced significantly.

It is important to note that the robotic ecosystem in India is flourishing without any government policy and the market is quickly diversifying in various uses and applications of robots. Given that robotics in India is in the early stages of development, the government need to support the adoption of robots and industrial innovation to enhance productivity, competitiveness, and job creation. The low levels of robot density in India per unit of employment indicate that robotisation would present very limited 'labour-displacing effects' in the near future. Also, a 'countervailing trend' may be in the offing in which the anxieties about job losses are likely to be offset by a slow pace of robotisation by firms in the short to medium term. The Indian policymakers need to closely monitor its impact on the industrial workforce and undertake appropriate measures to mitigate any adverse impacts on industrial labour. Lastly, with the integration of digital technology with robotics systems through artificial intelligence (AI) and the Internet of Things (IoT), the issues of privacy and data protection need close monitoring, together with the concerns surrounding externally triggered cyber-attacks, which can paralyse critical production lines. The Southern countries, in particular, have to look at closer collaboration, and pitch for technology transfer and availability of development finance for safe and responsible use of robots.

Conclusion

The aforesaid analysis mainly suggests that estimating the impact of robots on the workforce requires taking into account various costs and benefits of robotisation and not just the jobs/tasks that can be automated. The concerns surrounding job losses projected based on jobs/tasks that can be automated are likely to go off the mark as the pace of technological adoption in emerging economies is going to be determined by a range of economic and policy considerations. Instead, the current trend of robotisation requires Indian policymakers to focus on how robotisation would impact the qualitative aspects of jobs in the country in the medium to long run. Given the slow pace of robot adoption, it is pertinent for policy interventions in India to focus on not only improving the quality of education, training, and skill development. Since current technological advances are putting higher demand for knowledge and skills on labour markets, revamping the university/education system presents a key priority for Indian policymakers. Lastly, fostering indigenous robot technologies and innovation ecosystem is vital to promote rapid adoption and diffusion of robotics and attendant technologies in the country. The ongoing robot revolution denies the level-playing field to firms in the global south given their dependence on technology and skilled manpower in developed countries. Fostering robotisation in the Southern World, therefore, calls for greater synergy

[9] For more on demand aggregation see, Edler 2008.

[10] Inputs received from technical expert on robot.

and push to North-South collaboration for not only transferring critical technologies, but also to make available development finance to ensure safe and responsible use of robots.

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