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A STUDY ON THE IMPACT OF ARTIFICIAL INTELLIGENCE ON THE INDIAN ECONOMY

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Abstract

Artificial Intelligence (AI) is very evident in our daily lives and our economy, and it has had an impact on our environment in various ways. The competition to reap its benefits is growing worldwide, and world leaders - the US and Asia - are already taking action. From a technology capability perspective, artificial intelligence (AI) holds tremendous promise for India, to address some of the biggest challenges we face as a country. The adoption of AI across different sectors of the economy is found to have delivered positive returns by reducing risk, time and capital expended. It has enabled a range of innovation across different application sectors leading to massive economic and social benefits. Many people see AI as a way to improve productivity and economic development. It can improve process efficiency and greatly improve decision-making processes by examining large amounts of data. It can also lead to the creation of new products, services, markets, and sectors, leading to increased customer demand and new sources of revenue. Some are concerned that it could lead to the development of large corporations, institutions of wealth and knowledge - that would hurt the entire economy. It has the potential to widen the gap between developed and developing countries, as well as to increase the need for highly skilled workers while firing others; the latest trends can have a profound effect on the labor market. Experts also worry that inequality could worsen, reduce wages, and lower the tax base. The aim of this study was to learn how artificial intelligence is used in today's economy and what society thinks about its use.

Keywords: Artificial Intelligence, Digital Transformation, Industrial Revolution, Social Economic Environment.

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1. Introduction

Artificial intelligence (AI) is a disruptive technological development that, together with robotics, is changing the operating model in companies in each and every one of its basic functions (Choi & Ozkan, 2019). AI already has a significant impact on network marketing processes and

services, through the analysis of user behavior in networks and the creation of user profiles to which product and service offerings are oriented; It affects the production departments, managing maintenance in a predictive way, automating quality control and detecting anomalies in the production lines before problems occur; It influences the logistics processes, calculating efficient routes, recalculating new routes based on unexpected events and maintaining contact with the client and the logistics service provider in a fluid and automatic way; It has an influence on after-sales services, analyzing the opinion of customers about products and services, to assess their level of satisfaction and possible failures or improvements that may apply to products/services (Plastino & Purdy, 2018).

Living life to the tap of a screen or on the click of button was not something ordinary people had ever imagined. Yet, Artificial Intelligence (AI) today, shadows our day-to-day activities. AI applications spawn sectors of economic activity, governance and human interactions. From simple applications such as automatic generation of financial statements and tele-assistance for customer care to sophisticated applications such as medical diagnosis and self-driving cars, are all facilitated by AI (Smith, 2019). Even creative arts, a field known for human craftsmanship, have seen a proliferation of AI applications (Ghose, 2016). The Covid-19 pandemic, brought to fore, public good uses of AI, including its application in health, education, agriculture, transportation, law enforcement and judicial decision-making.

The omnipresence of AI makes it challenging to confine its application reach into a single definition. Accordingly, there are several definitions and impressions of what constitutes AI. For instance, the website of the Association for Advancement of Artificial Intelligence (AAAI) defines AI as “the scientific understanding of the mechanisms underlying thought and intelligent behavior and their embodiment in machines.” Russell and Norvig’s (2009) textbook titled “Artificial Intelligence: A Modern Approach” defines AI across four broad dimensions - thinking humanly, acting humanly, thinking rationally and acting rationally. A true artificially-intelligent system is understood to be one that can learn on its own, and can improve on past iterations, getting smarter and more aware, allowing it to enhance its capabilities and its knowledge (Adam, 2017).

The universe of AI comprises of logic-based tools, knowledge-based tools, probabilistic methods, machine learning, embodied intelligence, search and optimisation. Technology mapped

to these paradigms includes robotic process, automation, expert systems, machine learning, natural language processing, computer vision, speech etc. These technology forms vary in terms of processing capacity, the type of data used and more fundamentally the problem at hand (Taddy, 2018). While data fuels AI applications, algorithms are the engines.

The last couple of years have seen an explosion in AI activity. The adoption of AI across different business processes is found to have delivered positive returns by reducing risk, time and capital expended. It has catalysed technical improvements and enabled a range of innovation across different application sectors (Bresnahan et.al, 1995). While these impacts were not immediately visible, investments in intangible capital including organisational changes, re-skilling and training, have made AI enabled growth quite evident (Brynjolfsson et.al, 2017). At the country level, flurries of national policies on Artificial Intelligence (AI) have recognised the economic and social benefits of its application.

This paper builds on research from a report published by ICRIER in 2020 (Kathuria et.al, 2020), to provide estimates for the impact of AI on the total factor productivity (TFP) of Indian firms. We find that adoption of technology by Indian industry is largely concentrated within the top 10 percentile, firms that have a capacity to invest in both technology and skilled personnel. More specifically, current AI adoption in India is driven by large global technology conglomerates, select startups and Global Capability Centres (GCCs) located in India (Mehta et.al, 2020). Given the low-levels of digitization across the small and medium sized firms, the ICRIER report using data of almost 1500 Indian firms, presented relatively low impacts of AI on TFP, albeit positive. This report extracts from the older data set, a group of firms that belong to the top 500 firms listed in India's Bombay Stock Exchange to demonstrate the potential of AI adoption in the Indian industry.

With this background, section 2 will provide a snapshot of various AI applications and their adoption. The Section 3 will provide an estimate of AI on the Indian industry using a panel data regression of over 300 publicly listed firms belonging to the manufacturing and services sector in India. Section 4 will present case studies to explore the public good applications of AI technology in India and their potential for monetization. In highlighting the case studies, we will emphasize on the importance of data sharing. Section 5 concludes.

2. Benefits and Application of AI

The use of artificial intelligence is benefitting individuals, communities, industries and governments. AI applications that influence the daily lives of people and households include Siri, Cortana and Bixby, examples of virtual personal assistants that learn continuously about a user through daily engagement and provide personalized help on a number of tasks. Video Games are another example where the use of AI has revolutionized gaming experience for users. The game Middle Earth: Shadow of Mordor, launched in 2014, is designed to memorize patterns and characters, to help the user while playing the game. The shopping experience has also transformed with computer vision-based technologies churning 'just walk out' stores that do not have check-out counters (Reuters, 2018). These experiences are however common place only for the privileged sections of the society in India; for several others the opportunity to access these services are still a distant dream. Moreover, as users are becoming more and more dependent on technology for personal experiences, new behavioural and psychological concerns are being reported that need to be acknowledged and dealt with separately (Bartneck et.al, 2021).

Artificial Intelligence for Governance and Social Good

Applications falling in the category of AI for Good address a variety of developmental objectives including applications to diagnose cancer patients, support navigation for the blind, aid disaster relief efforts, etc. Though wide ranging, these applications are mostly small scale. Several pilot initiatives illustrate how the new and unexpected applications of AI can improve human lives. For instance, the UN global pulse deployed 'Neural Network Architectures', a form of AI, to detect shelter structures from satellite images at the time of multiple humanitarian crises in East Africa and the Middle East. The Indonesian Government deployed similar capabilities to develop a crisis analysis tool to enhance disaster management efforts. Precision Agriculture for Development (PAD) uses AI to provide personalised, low-cost, information through interactive voice response; Educate Girls uses machine learning techniques to target out-of- school girls; and the Center for Effective Global Action uses big data and machine learning methods to reduce gender gap in access to credit. GnoSys, a smartphone application developed for the deaf and mute, uses natural language processing, neural networks, and computer vision to translate gestures and sign language into speech. The app is expected to change the life of an estimated 18 million people in India who are hearing impaired. The report titled "Artificial Intelligence and

Life in 2030" provides several other such examples. Another important initiative in this area is Google DeepMind, working in partnership with clinicians, researchers and patients to solve real-world healthcare problems. The technology combines machine learning and systems neuroscience to build powerful general-purpose learning algorithms into neural networks that mimic the human brain (King, 2019). DeepMind and several other organisations have used deep learning to predict the structure of proteins associated with SARS-CoV-2, the virus that causes COVID-19 (OECD, 2020).

Artificial Intelligence for Industry

AI is at the centre of the ecosystem around Industry 4.07, optimizing the computerization of industry during the third technology revolution. The McKinsey Global Institute (2018)8 report provides a useful starting point to gauge the diffusion of AI across sectors and businesses. The report shows AI being highly relevant to automotive, banking, consumer goods, healthcare, insurance, pharmaceuticals, retail, telecommunications, transport and logistics sectors. Retail and e-commerce are one of the sectors where AI is deployed extensively. AI applications enhance consumer experiences with the use chatbots, powered by AI programs to respond to consumer queries. Banks are also demonstrating an appetite for AI. They use a range of applications to enhance consumer experience and increase the efficiency of their operations. For instance, using data from past payment patterns, AI applications can predict and prompt the user to their preferred mode of payment. In a completely different environment, AI based driver assistants are bringing massive changes to navigation and road safety. AI assistant can check blind zones, measure the exact distance to objects, and prevent road accidents.

Appen's 2020 State of AI and ML Report, on a cross-section of industries from around the world, found that 41 percent companies had adopted an AI strategy during the pandemic. Organisations invested in Ai driven automation to expedite remote working, enhance user and decrease costs. In fact, 75 percent organisations cited AI as critical to their success in 2020 (Appen, 2021), and many were already benefiting from its adoption. In India, the IDC Maturity Benchmark for Artificial Intelligence found that almost 25 percent organisations surveyed were in the AI practitioner stage, i.e., those beginning to align their AI strategy to that of the enterprise, while only 8.4 percent were in late stages of maturity (IDC, 2021).

The widespread application of AI has growth consequences leading to productivity gains in businesses and industries as well as increased consumer demand from customized products and services. The ability of an economy to adopt AI depends on its structural composition and the technological maturity of different industry sectors. While opportunities exist in most sectors and across business functions, digitised firms are more likely to adopt AI than their peers which lack technology infrastructure including skilled manpower. The section below provides an provides an estimate for the potential impact of AI on Indian industry using an understanding of AI as a general-purpose technology.

3. Estimating the Potential Impact of AI

For several decades now, growth economists have used technical changes to explain economic growth at the macro level (Abramovitz, 1956, Solow, 1957) and profits and market shares of firms at the micro level (Acemoglu, 2000). The Schumpetarian creative destruction explained the positive impact of new technologies and new industries on growth; bridging the gap between macro and micro economics (Schumpeter 1942). Technology is defined as the use of scientific knowledge for practical purposes or applications, whether in industry or in our everyday lives9. Technology can be of various types-mechanical, electronic, industrial, communications, medical, etc. The growth literature focuses on General Purpose Technologies (GPTs), a set of core technologies that have substantial and pervasive societal and economic effects. Some of the commonly cited "generic", or "general purpose" technologies are electricity, steam engines, semi-conductors and more recently information and communication technologies (ICT), which are all proven to have far reaching consequences on productivity gains. With the potential of profound impacts on the Indian economy AI is also considered by several economists as a GPT. Angrew Ng in 2015 stated "Just as electricity transformed almost everything a hundred years ago, today I actually have a hard time thinking of an industry that I don't think AI will transform in the next several years." While AI led innovation would have direct impacts on any given sector, it also has the capacity to inspire complementary innovations and spillover benefits in other sectors of the economy. AI applications demonstrate key characteristics of GPTs – pervasiveness, technological improvement and the ability to spawn innovation.

- Pervasiveness: A technology is classified as a GPT when the share of new capital associated with it, reaches a critical level and adoption is widespread across industries Cummins and Violante (2002, p. 245). As per a report by Gartner (2019), the number of businesses using AI has grown by 270 percent in the last four years. In a recent survey conducted by Congilytica10, over 40% respondents stated that they will implement AI in one or more identified patterns by 2025 and almost 90% responded that they will have some sort of in-progress AI implementation within the next 2 years.
- Technological Improvement: Bresnahan and Trajtenberg suggest that the efficiency of the GPTs improve over time. In the case of AI, from the 'Turing Test' to data driven machine learning techniques, there has been several seasons of technological advancements that AI has witnessed. For instance, from 1997 to 2017, while research on heuristic search and optimization, cognitive modeling, knowledge representation has declined, research on game theory, machine learning and natural language processing has witnessed a consistent rise.
- Ability of the GPT to spawn innovation: All GPTs support innovation. The adoption of AI has catalysed technical improvements and enabled a range of innovation across different application sectors (Bresnahan et.al, 1995). For instance, machine learning has improved the performance of labelling content on photos. With the decline in error rates from one per 30 frames to one per 30 million frames, self-driving cars have become a reality (Brynjolfsson et.al, 2017).

4. Data, AI and Economic Potential,

Even though the artificial technologies have existed for several decades, it is the explosion of data, the raw material for AI that has allowed it to advance at incredible speed. IDC predicts that world data will collectively grow to 175 Zettabytes by 2025. About a third of the data in the digital universe (more than 13,000 exabytes) has the potential to be used as Big Data if it is tagged and analyzed (Gantz.J et.al, 2012). resource, beating oil in the process (Humby, 2006). Economists have popularly pitched for data to be treated as a public good. The public good argument is based on non-rival and non-excludable principles, advocating its equitable use for the public at large. The lack of open access to quality data prevents it from being put to the best possible use. It also enables the formation of monopolies that tie people and enterprises into

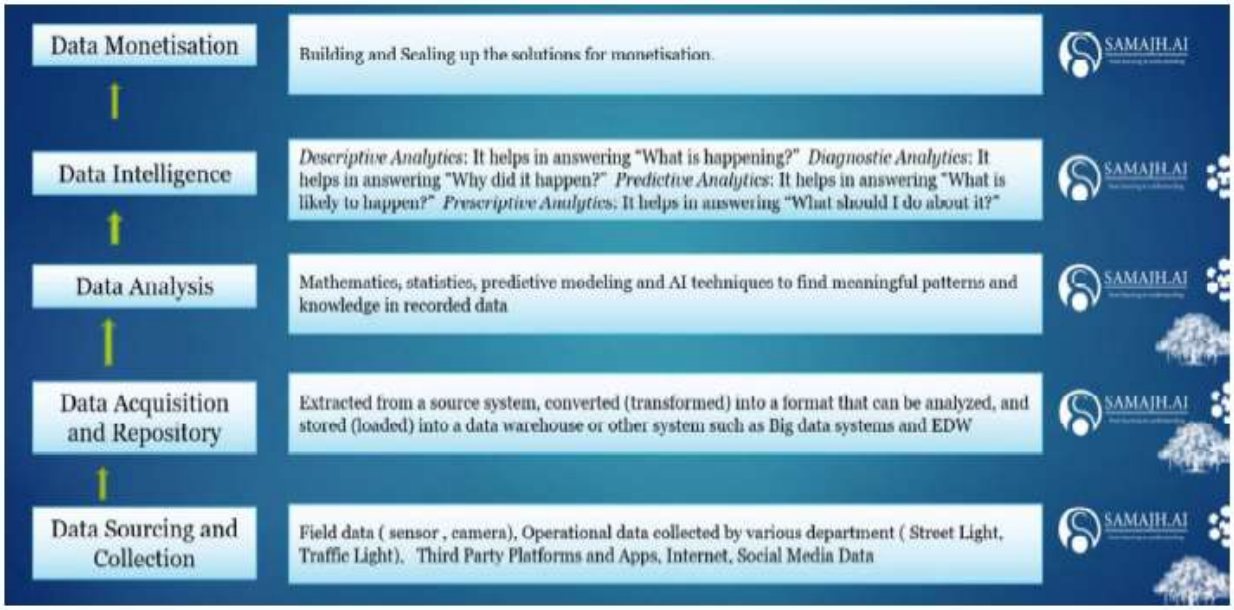
proprietary formats. To address this issue, countries have highlighted the importance of creating resilient open data infrastructure in their national policies. Governments have a fundamental role in setting up these institutions where data is made available as a public good. The International Open Data Charter (ODC) was launched with an understanding that good data was essential in achieving the sustainable development goals (SDGs). The Open Data Barometer defines open data as data which is available online, open-licensed, machine readable, available in bulk and free of charge. More than 50 percent countries covered in the barometer had an open data initiative in place. However, the latest report identifies some worrying trends which include a majority of data sets remaining closed to the public even in countries such as UK and USA which are open data leaders.

With the launch of data.gov.in in October 2012, India also embarked upon its journey of Open Government Data (OGD). As a part of the OGD movement, India has agreed to provide public access to government-owned data (along with its usage information) in machine-readable formats at no additional cost. However, India is yet to adopt the Open Data Charter. Also, the quality and range of data available on this platform can be significantly improved to feed into large scale AI applications that have proven to improve governance and generate revenue for governments in several other countries. For instance, Transport for London (TfL) releases a lot of data in an open format for developers to use, free of charge. The latest information suggests that more than 600 economies to the value of £14 million annually in gross value added and over 700 jobs (National Infrastructure Commission Report). According to a report on the Economic Impact of Open Data by the European Data Portal, the open data market size for EU is likely to be in the range of (European Data Portal, 2020).

The government in India is also sitting on a similar gold mine. Like most other countries it is the largest owner of all forms of data. Some of the case studies we present in the sub-sections below highlight the potential of government data, hitherto unutilized, to generate revenue for the government and add value to the Indian economy. This will address the post-covid fiscal strain as well as the unemployment challenge, the country is currently facing. In some positive news, the government is not only making its data available but finding institutions to collect data and build data foundations which will become the backbone of India AI economy.

The three initiatives illustrated below are India Urban Data Exchange (IUDX), Samajh.AI and AI Hub. In Figure 2 below we map the progress of these initiatives to the stages in the life-cycle of data. Open government data impacts the stages of data sourcing and collection as well as data acquisition and repository. Since these costs can otherwise be very high, OGD can fast track innovation, by making this available free of charge. Samajh.AI uses a combination of available government data as well as sources its own through the installation of cameras and has successfully monetized applications developed on the basis of this data. IUDX and AI Hub are working towards building data sets. While IUDX pulls in data from different governing bodies in a city to a centralized command and control system that are able to present some analytics to improve the efficiency of public services, AI Hub is investing in data collection from private sources as well as through its own devices and systems and is still at the sourcing and acquisition stage. Each of these initiatives highlight the role that open government data can actually play in creating applications for improved governance that can also become a ready source for government revenue.

Figure 2: Life-Cycle of Data



Source: https://online.hbs.edu/blog/post/data-life-cycle

4.1. Samajh. AI

This AI start-up uses computer vision and image processing technologies on publicly available data to improve regulatory compliance for the transportation sector. The company developed automated number plate recognition (ANPR) software that has the ability to read vehicle registration on number plates at the entry as well as exit points of a toll plaza. The wait-time at toll booths where the application was deployed was completely eliminated, from the 7-10 mins spent earlier at each toll booth. Moreover, data collected from these installed cameras on vehicle frequency, type and classification of vehicles, number of vehicles, etc. are now shared with concerned authorities that carry out repair and maintenance of road networks. The company also created an AI driven port audit system. With the help of cameras, the system accurately detected the number of containers being shipped out on a daily basis that was grossly underreported. This helped government revenue from each port to increase by almost 50 percent. A third AI application was developed to improve vehicular compliance to speed limits. The company reported that using human monitoring; only 1-2 percent of actual violators were being fined. The computer vision based AI application increased the number of violations that the authorities were able to detect and fine, increasing government revenue and improving traffic discipline.

4.2. India Urban Data Exchange (IUDX)

IUDX is an open-source software platform that is designed to facilitate secure and authenticated exchange of data amongst various city platforms and third party applications within a city. The platform intends to provide full control to data owners with a built-in accounting mechanism, forming the foundations of a data marketplace. IUDX envisages the use of this data to help citizens and the community benefit from innovative and cheaper applications and services (IUDX, 2018). The cities themselves can benefit from the reduction in development cost and faster development. Currently, there are ten cities under the IUDX umbrella-Agartala, Bengaluru, Bhopal, Bhubaneswar, Chennai, Faridabad, Pune, Surat, Vadodara, and Varanasi, each working on multiple use cases. There are 52 datasets across these cities and the exchange is actively engaged with industry partners in developing and implementing different use cases. In the bus occupancy use case, IUDX sources data from the Intelligent Transit Management System, Surat Money Open Loop Smart Card, QR code- -related real time data. All this data is

used to derive the actual time of bus arrival and the numbers of passengers on board in real time, helping citizens plan their travel. A recent report by the Ministry of Housing and Urban Affairs said that lakhs of commuters in Surat Smart City are now using a mobile app of IUDX that provides actual time of bus arrival and real time occupancy of seats (Urban Update, 2021). The platform has minimized waiting time for users and also enhanced commuter experience by enabling seat selection. It helps the city administration analyse 7935 daily trips and optimally schedule 840 buses. According to industry representatives, every percentage increase in ridership due to certainties in estimated time of arrival and occupancy data is expected to add 2.85 crore to revenue per year. Further, the fleet optimization based on occupancy data, if implemented, can reduce the operational expenses by 15 percent. This pilot in Surat exhibits promise for data-driven smart mobility in other cities of India.

4.3. I-Hub

I-Hub is the Technology Incubation Hub (TIH) at IIIT Hyderabad, funded by the Union Department of Science and Technology (DST) that focuses on building a data foundation. AI Hub aims to harness the volume and variety of data available in India that will become a valuable resource for AI developers and researchers all over the world. Some of the focus areas for the technology hub are mobility, healthcare, smart buildings, systems and other India specific research initiatives. So far, AI hub has started the process of data collection and curation for the healthcare and mobility sector. A few applications of research in mobility include driver assistance systems, road/ infrastructure mapping, road safety and resource optimization. The applications for the healthcare industry include diagnosis, prescription, success rate prediction etc. Each of these initiatives while in nascent stages, reflect the immense potential of high-quality organised data.

5. Concluding Remarks

Artificial Intelligence like any other general-purpose technology impacts entire economic systems. Its pervasiveness, innovational complementarities and dynamism has the potential to radically alter productivity gains for businesses with spillover benefits on the entire economy. This paper finds an unambiguous impact of AI on productivity of Indian firms. It also establishes adoption by relatively big firms in India and the potential impact AI can have on the industry as a whole. The econometric estimation finds a positive and significant relation between AI intensity

and total factor productivity growth. More precisely, a unit increase in AI intensity by Indian firms can lead to a 0.3% increase in TFP growth, on average. However, the long-term impact of AI on the Indian economy will depend on the quantum of investment in AI research, developing local capabilities of data engineers and building data sets and related governance practices. The paper also focuses on the lack of open access to quality data, which is a gold mine for AI-led innovation. There are several examples that demonstrate the role of public data in lowering consumer bills, improving governance and overall access to public services. Three case studies discussed in the paper highlight some of the current efforts of the Indian government and the private sector to carry forward the open government data initiative. While establishing the potential of this data, it also highlights the need to massively enhance the quality and range of open data sets. Strong public private partnerships and collaborations between government, industry and academia will be important to harness the value of data for innovative localised solutions. Finally, policy towards AI must also be accompanied with governance frameworks that enable its responsible use. Several governments recognize the risk of unethical data use and Black Box AI. Laws and regulations that encourage unbiased, reliable, open and inclusive data sharing will catalyze India's journey towards it AI potential.

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