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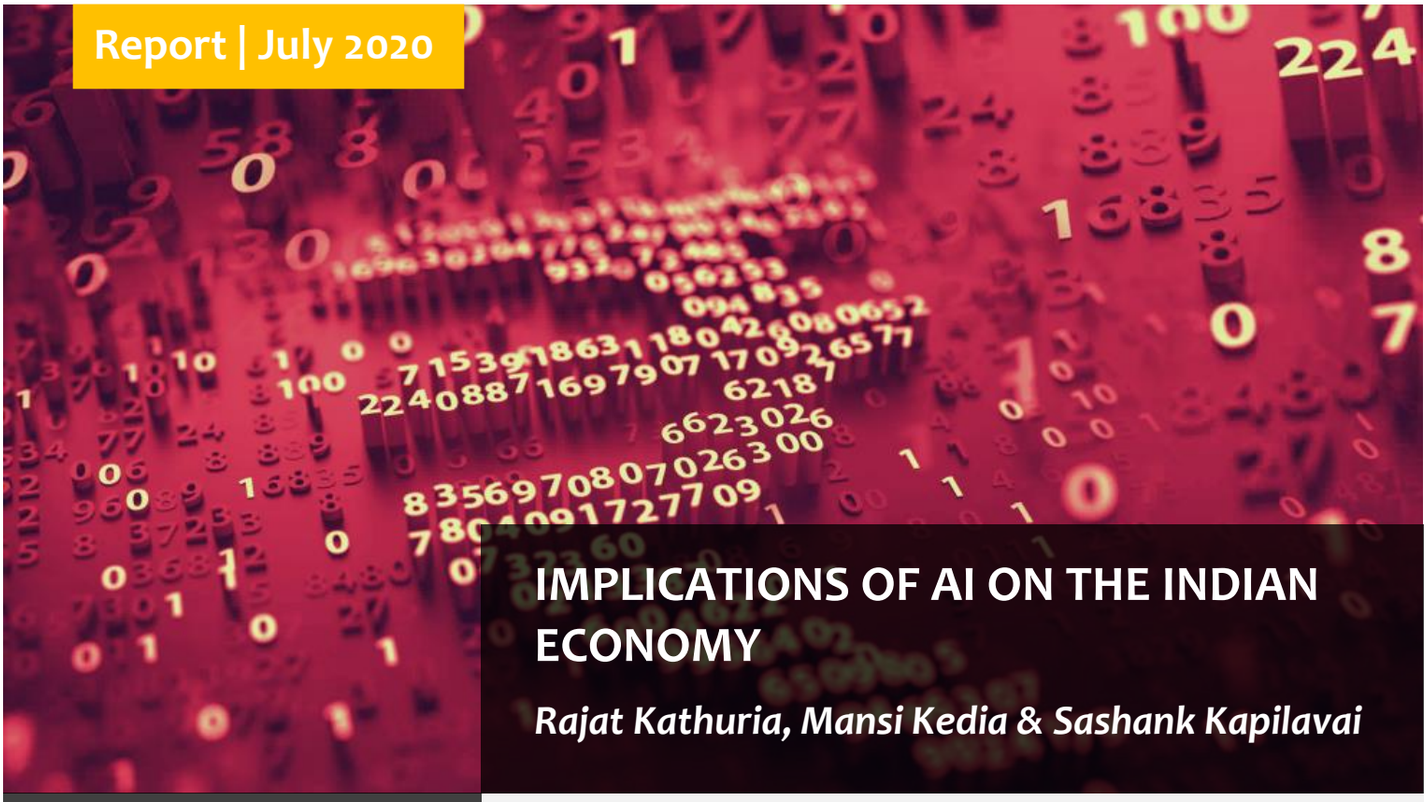

IMPLICATIONS OF AI ON THE INDIAN ECONOMY

Rajat Kathuria, Mansi Kedia & Sashank Kapilavai

Key Recommendations

- **Identify a Nodal Agency** within the government for development and diffusion of AI, the design and workings of which will be critical to push wide-scale AI adoption in India
- **Build Collaborative Frameworks** for engagement between governments, industry and academia to foster growth and promote innovative localised solutions.
- **Build an All Encompassing Data Strategy** to improve state capacity to provide AI-compatible publicly available data and encourage unbiased, reliable, safe and inclusive data sharing practices
- **Address India's Skill Gap in AI** to help build directly adaptable skills for the industry and facilitate recruitment of AI specialists
- **Address Governance Challenges in AI** to promote AI safety standards and guard against impacts of biased outcomes

EXECUTIVE SUMMARY

India's Artificial Intelligence (AI) moment is truly here and now. At a time when a diverse range of applications based on AI are being developed, pushing its frontier further into uncharted realms of business and society, Indian policy makers are contemplating and charting its potential for growth and social transformation. Our study attempts to understand the impacts of AI in India and trace the pathways that help realise it.

AI's transformational potential stems from its ability to lend itself to a diverse range of applications across a range of sectors. One can witness AI-based applications in manufacturing, transforming quality control, production lines, and supply chain management, and in services creating personalized product offerings and high-quality customer engagement. AI applications are also common in sectors such as agriculture that had taken a back seat in technological innovations in the post-industrial world. AI also demonstrates the potential to address developmental challenges by responding to societies' immediate demands for healthcare, education and expanding access to finance and banking.

The consequences of AI diffusion stem from AI's pervasiveness in society, its ability to trigger innovation, and its tendency to transform and evolve. These are typical characteristics of a class of technologies that can be found across history, the emergence and diffusion of which have enabled the wealth of nations. These are called General Purpose Technologies (GPT). Technologies such as steam engines, electricity, computers, semi-conductors, and more recently the internet, can all be considered as belonging to the GPT class of technologies. Our study is based on the understanding that the implications of AI can be best understood by viewing AI as a GPT.

Historically, the economic impacts of GPTs have not been immediate but follow after its diffusion in the economy over time, i.e. once scale is achieved. There are two reasons that explain this phenomenon: firstly, in early phases of technology diffusion, an economy diverts part of its resources from productive activities to costly activities aimed at enabling the GPT. For instance, organisations adopting

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computers must also invest in training employees or hire computer scientists, re-arrange production activities or organisational structures to accommodate computer driven work-flows, all of which are costly. Secondly, it is only after the GPT is diffused and widely used in the economy that the statistics measuring GDP start counting and fully measuring the GPT.

Empirical research on GPTs such as AI, including ours, throws up the challenge of measurement. Early estimates on the economic impact of AI should be interpreted with the caveat that data on AI's adoption is not fully available or not adequately reflected in the data used to compute economic growth, at least not yet. Measuring the economic impact of AI is also difficult because of the magnitude of indirect effects on productivity that GPTs trigger. It is therefore common that studies on GPTs, while attempting to estimate their economic impacts, also engage in in-depth case studies and historical analysis of its impacts.

In the absence of a direct measure of AI at the firm level, we extend the idea from other studies to use investment in software, databases and computer machinery as a proxy of AI. Although software and databases may not accurately measure the impacts of AI, it is perhaps the best proxy given the commonality of infrastructure and capabilities involved in the use and adoption of AI. AI algorithms are essentially software trained to analyse and predict data patterns with the aid of computer hardware, optimised for such use. This measure of AI also provides the potential of ICT using firms to adopt AI in the future.

We estimate our model using a panel data set of 1553 firms (including manufacturing and services) over the period 2007-08 to 2016-17. We use a fixed effects multivariate panel-data regression for the estimation of the model. We identify firm specific determinants of total factor productivity (TFP) growth of which AI as an efficiency enhancing GPT is one of the explanatory variables.

While the econometric estimation (Refer Box 1) provides adequate evidence for policy to support its wider adoption, we derive actionable measures based on an evaluation of firm capabilities, both for firms developing and using AI. We engaged in in-depth interviews with thirteen AI companies in India, most of them still young and small-scale. The companies are currently developing applications for ten different sectors including law enforcement, healthcare, banking and finance, agriculture and manufacturing. In terms of the AI used, we find machine learning and its subsets, deep learning, deep neural networks, convolutional neural networks, among others, featuring prominently across organisations building and providing AI-based services. Natural Language Processing, Speech Recognition, and Computer Vision are other AI-based technologies that also feature across several use cases.

We use the capability theory framework to illustrate how AI firms in India are currently building skills, organising and utilising research and resources needed to run and test AI applications. We also explore the capability of AI firms in India to form networks that finance and market their products and services that links the firm to the economy at large, and enables the diffusion of AI across the economy. We observe that at the root of all benefits stemming from AI-based applications is AI's ability to predict across a range of tasks. Examples of AI innovations across sectors find its positive impact on organisational efficiency that manifests in reduced time and costs, for various business processes, and enhanced quality control. There are also several interesting applications of AI in the social sector that impact a range of development and governance outcomes such as law enforcement, improvements in health and education, utilisation of natural resources, etc. Going by the nature of private and public interest in AI and the kinds of AI-based applications being developed, India is carving out a niche in the global ecosystem, deploying AI applications that focus on the social sector

The rise of AI however, comes with several statutory warnings. Firstly, recent advances in AI have raised concerns around the use of complex AI systems that are applied without revealing details of the data used to train the model or the algorithm design that forms the basis of predictions. Such applications run the risk of leading to unfair and /or incorrect decisions if they are used in contexts for

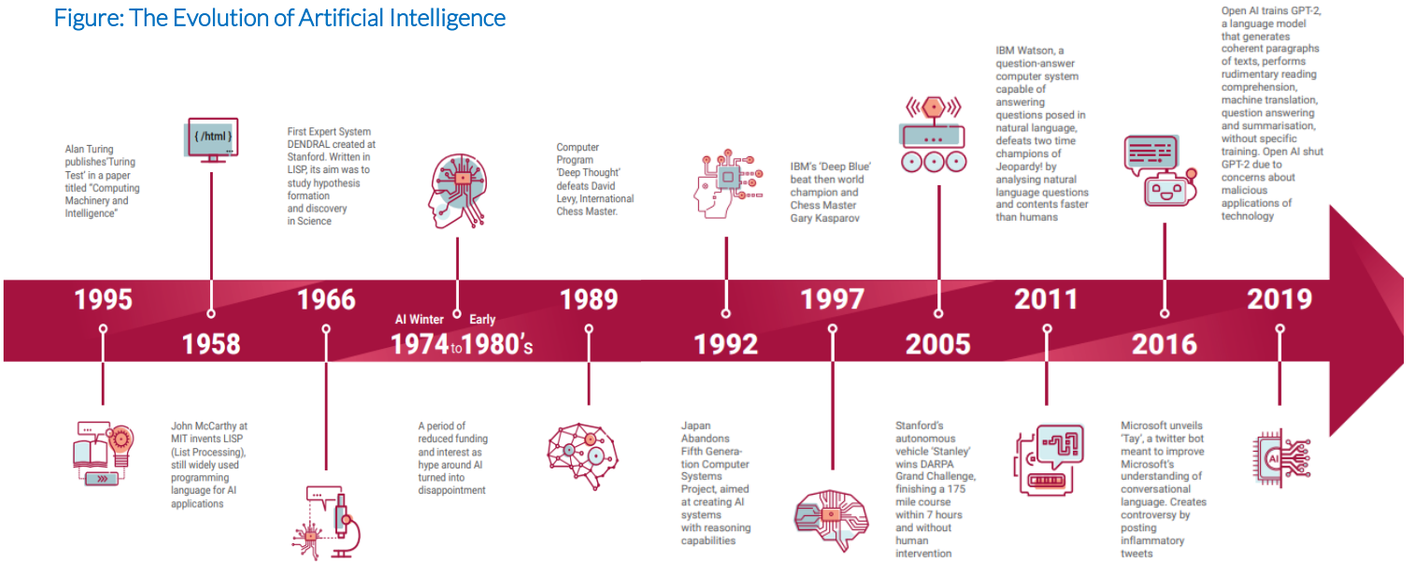
Box 1: Key Results from the Econometric Estimation

The results find a positive and significant relation between AI using firms and total factor productivity growth. In fact, given that the firm is an AI using firm, total factor productivity growth increases with increase in AI intensity. The estimate suggests that a unit increase in AI intensity will increase the TFP growth by 0.05%.

The growth co-efficient suggests that on average a unit increase in AI intensity, measured as the ratio of AI to total sales, can return USD 67.25 billion or 2.5% of GDP to the Indian economy in the immediate term.

The business as usual growth in AI investments is unlikely to increase current levels of AI intensity. In order to trigger a positive growth shock, AI intensities should be sharply increased. For example, the investment of Rs. 7000 crore approved by the Ministry of Finance towards an Artificial Intelligence program could increase AI investments at rates higher than the business as usual rates. This increase in investment will lead to an approximate 1.3 times increase in AI intensity, translating into spillover benefits of USD 85.77 billion for the Indian economy (3.2% of GDP).

Figure: The Evolution of Artificial Intelligence



Source: Adapted from Digital Intelligence Today

which they were not designed. Without careful upfront design and safety precautions, some AI systems may also be prone to error or breakdown when introduced to minor perturbations in data, representing situations that are beyond the scope of their training. Ongoing monitoring and fail-safe designs are therefore vital, especially in safety-critical systems such as self-driving cars, and military applications. Secondly, since AI by nature is labour substituting, immediate consequences of AI, take the form of inequality between labour and capital, and inequality within labor, i.e. between tasks with high and low skill content, raising contentious public policy concerns. However, the form this takes and the impact on human employment will depend on the manner in which organisations deploy AI tools and training.

These concerns raise questions on the role of the government and the nature of government policy that would enable the sustainable growth of the AI ecosystem in India. In our view, the government has an active role to play in creating institutions and providing public goods that enable an AI ecosystem, while also encouraging private actors to innovate and thrive.

The policy recommendations following from our analysis have been categorized into five broad themes. These themes include several actionable recommendations that are individually important to the implementation of a large-scale AI program and are summarized in below:

POLICY RECOMMENDATIONS

Identifying a Nodal Agency Within the Government for Development and Diffusion of AI, the design and workings of which will be critical to push wide-scale AI adoption in India

- Identify a nodal agency for coordinating all AI related activities in India.
- Nudge government departments to develop capabilities to adapt to AI-based governance mechanisms.
- Prioritise resources to build pockets of excellence for sectors that have already demonstrated positive economic and social impacts from AI.
- Offer government handholding to socially relevant applications.

Building Collaborative Frameworks for Engagement between Governments, Industry and Academia to foster growth and promote innovative localised solutions.

- Governments at the state and national level can directly foster growth among startups by inviting public-private partnerships and promoting innovative localized solutions.
- Cross-country collaborations catalyse the transfer and adoption of frontier technologies. Building on existing technologies can help promote AI-related capabilities in India, especially the hardware sector in which India is lagging behind.

Building an All Encompassing Data Strategy to improve state capacity to provide AI-compatible publicly available data and encourage unbiased, reliable, safe and inclusive data sharing practices

- Evaluate alternate data sharing models. Laws and regulations that encourage unbiased, reliable, safe, open and inclusive data sharing must be formulated for integration and dissemination of data.
- Examine the integration of public data that currently exists in silos and ensure compatibility for different uses.
- Enhance capacity of existing statistical agencies to collect and

process publicly available data for AI use.

- Evolve data.gov.in to become a national resource for Artificial Intelligence. Develop a generalised meta-data standard for data.gov.in to enable integration of resources including but not limited to data, tools, literature, etc.

Addressing India's Skill Gap in AI to help build directly adaptable skills for the industry and facilitate recruitment of AI specialists

- Focused collaborations at the sector level, engaging students with corporates, can help build directly adaptable skills for the industry.
- Revise the education curriculum, especially for technology institutes, to necessarily include a program on AI
- AI training should go beyond technology curricula to include social sciences, that contribute to the process of constructing the algorithm and conducting an algorithmic impact assessment.
- Explore a market place for skilled AI professionals to meet the immediate skill gap that AI startups currently face.
- Facilitate recruitment of technology specialists from other countries.

Addressing Governance Challenges in AI to promote AI safety standards and guard against impacts of biased outcomes

- Algorithmic Impact Assessments to be adopted by ethics councils

proposed to be set up at least at all Government funded research centres building AI for public use cases.

- Researchers from the public, private, and academic sectors should work together to outline basic workflows and standards of documentation for specific application contexts which would be sufficient to show due diligence in carrying out safety checks.
- Explore ways for India to enhance its participation in the AI standardisation process.
- Involve other specialists along with scientists in the process of AI design and application to check biases and their discriminatory impacts.

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