The impact of artificial intelligence on economic development

Mohamed Ali Trabelsi
Department of Quantitative Methods, Faculty of Economic Sciences and Management of Tunis, University of Tunis El Manar, Tunis, Tunisia

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Abstract

Purpose – This paper reviews recent research on the expected economic effects of developing artificial intelligence (AI) through a survey of the latest publications, in particular papers and reports issued by academics, consulting companies and think tanks.

Design/methodology/approach – Our paper represents a point of view on AI and its impact on the global economy. It represents a descriptive analysis of the AI phenomenon.

Findings – AI represents a driver of productivity and economic growth. It can increase efficiency and significantly improve the decision-making process by analyzing large amounts of data, yet at the same time it creates equally serious risks of job market polarization, rising inequality, structural unemployment and the emergence of new undesirable industrial structures.

Practical implications – This paper presents itself as a building block for further research by introducing the two main factors in the production function (Cobb-Douglas): labor and capital. Indeed, Zeira (1998) and Aghion, Jones and Jones (2017) suggested that AI can stimulate growth by replacing labor, which is a limited resource, with capital, an unlimited resource, both for the production of goods, services and ideas.

Originality/value – Our study contributes to the previous literature and presents a descriptive analysis of the impact of AI on technological development, economic growth and employment.

Keywords Artificial intelligence, Economic growth, Employment, Automation, Digital labor

Paper type Literature review

1. Introduction

Artificial intelligence (AI) is increasingly present in our daily lives. It is the subject of a growing number of publications which have contributed to forging in public opinion a new "digital mythology" raising both hopes and fears. The progress of AI gives hope for a revival of consumption, a growth in productivity in most professions, better risk management, but at the same time gives rise to fears of the massive destruction of jobs in developed countries, a large retraining of skills, a widening of the digital divide within social structures (Bostrom, 2017; Mateu & Pluchart, 2019). Most observers, such as practitioners and academics, agree that AI is the lever of the "3rd transformation of economic history" after that of the industrial revolution of the 19th century and that of computing in the 20th century (Baldwin, 2019). In this regard, a study was carried out in November-December 2021 by the Ipsos group on

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19,504 individuals from 28 countries, aged between 16 and 74, on the impact of AI in several areas. Respondents indicated that, in the coming years, AI will have an impact of 35% on education, 33% on security, 32% on employment, 31% on shopping, 30% on transport, 27 on entertainment, 26% on the cost of living, 23% on income, 22% on the environment, 15% on food and 15% on personal relationships.

According to Zeira (1998), Hémous and Olsen (2014), Acemoglu and Restrepo (2016) and Aghion, Jones, and Jones (2017), AI can stimulate growth by replacing labor, which is a limited resource, with capital, an unlimited resource, both for the production of goods, services and ideas. On the other hand, AI can inhibit growth if combined with an unsuitable competition policy.

Recently, according to the new report from Goldman Sachs (March 26, 2023), up to 300 million jobs worldwide could be affected in the coming years. Indeed, this study shows that AI could automate 25% of the entire labor market. In more detail, economists at the American Investment Bank predict that AI is expected to replace humans in 46% of administrative tasks, 44% of legal jobs and 37% of architectural and engineering professions. Goldman Sachs says the effects are likely to be felt more in advanced economies than in emerging markets. The report states that the use of AI could also boost labor productivity growth and increase global gross domestic product (GDP) by 7% per year over a 10-year period.

AI is considered to be one of the driving forces behind the revolution in technologies, organizations and society at the start of the 21st century.

By harnessing the power of data analytics and algorithms, AI applications optimize service quality, help businesses identify and fight fake transactions and help better protect organizations from hackers as well as strengthening the fight against accounting fraud.

However, AI is increasingly affected by a crisis of confidence in its models and algorithms, sometimes considered to be "black boxes" and lacking robustness, although new advances that are taking advantage of the principles of "collective intelligence" (Servan Schreiber, 2018) are beginning to think about this vision.

In this paper, we provide a systematic review of the implications of AI on economic growth, on skills transformation, on technological revolution, on risk management, on consumption and on green economy. We aim to capture a general picture of the recent published statistics and reports from some consulting firms.

The paper is structured as follows: section 2 reviews the literature about the socio-economic impact of AI; section 3 presents AI across prospective and predictive visions; section 4 develops the implementation of AI in government. The final section concludes the paper.

2. Socio-economic impacts of AI: economic growth, skills, technological revolution, risk management, consumption and green economy

AI is a real revolution because it allows to create advanced technologies in a variety of fields. We can consider that the concept of AI was born in 1950, with the Turing test, which is a test designed by mathematician and cryptologist Alan Turing, aimed at measuring the ability of an AI to imitate a human conversation.

AI was then defined by Marvin Lee Minsky in 1956, as "the construction of computer programs that engage in tasks performed unsatisfactorily by human beings". This definition is used in most reports on AI and in particular in the "Villani report" (Villani, 2018).

AI covers an artificial rationality that optimizes the resolution of more or less complex problems, in a logical-deductive mode and in specific fields. It is part of cognitive science and the internet ecosystem, which also includes Internet of Things (IoT), big data, cloud computing and block chain. The dissemination of AI cannot be as inclusive and systematic as that of computers or the Internet, because AI covers a set of models and methods whose fields

and modes of application are heterogeneous. 3D image recognition is, for example, used to make medical diagnoses and to steer self-driving cars.

Recently, Yong, Zeshui, XinXin, and Marinko (2023) show that the proliferation of AI in the economy has been unprecedented. In particular, the advent of the post-pandemic era has intensified the reliance on and desire for AI for economic development.

AI today is segmented into two main streams. The first current is "symbolic AI" where the computer is programmed so that it can manipulate knowledge. The second consists of "machine learning" which covers advanced statistical models and in which we find in particular neural networks (Le Cun, 1987). The processing of big data is becoming one of the major techniques of AI because of the computing power of current computers.

A third wave is emerging which combines symbolic AI, machine learning and natural language, capable of merging knowledge of various origins and above all for which explanation and transparency are the main properties (Pearl & Mackenzie, 2018).

But while AI can solve complex problems, it cannot replace all forms of human intelligence, including intuition and emotion (Houdé, 2019). While AI has tangible effects on the real economy and the financial economy, it alone cannot alter the paradigms.

2.1 AI impact on economic growth

AI economy is essentially about data (Agrawal, Gans, & Goldfarb, 2016). The results of economics studies on AI are heterogeneous. The research methodologies applied to the AI ecosystem bear on either top-down (based on value creation hypotheses) or bottom-up (by consulting users and experts) type approaches.

Most relevant studies emphasize that AI has the potential to significantly impact economic growth in various ways. However, it is worth noting that the impact of AI on economic growth is not uniform across all sectors and regions. Some industries may experience more significant changes and growth, while others may face challenges or disruptions. Additionally, the successful adoption and integration of AI technologies need adequate infrastructure, data availability and supportive policies, which can vary across different economies.

In its 2017 study, the British consulting company PricewaterhouseCoopers (PwC) estimates the specific contribution of AI to global GDP at $15,700bn between 2018 and 2030, an increase of 14%. Value creation should be higher in Asia Pacific (26%) and North America (14.5%) than in Europe (9.9% to 11.5%) and developing countries. It would mainly lead to productivity gains (55%) and a recovery of consumption (45%) until 2030, but this ratio should be reversed beyond these benchmarks, because of an optimal productivity threshold.

According to the Stanford University report, "2023 AI index report", the countries that invested the most in AI during the 2013–2022 period are the United States of America, with an amount of 248.9bn dollars, followed by China, with $95.1bn. The data for the main countries is represented in the following Table 1. In 2022, the largest investments in AI were made in medicine and healthcare ($6.1bn), according to the same report.

On the other hand, and according to the latest study by the International Federation of Robotics, the number of operational robots in the Chinese manufacturing industry reached a ratio of 322 units per 10,000 employees in 2021, followed by the American industry with 274 units per 10,000 employees. China now ranks fifth in the world, behind South Korea (1,000 per 10,000 employees), Singapore (670), Japan (399) and Germany (397). Note that the global average is 141 units per 10,000 employees. The results are shown in Table 2.

The consulting company Accenture (2017) argues that AI could double the growth rates of twelve major Western countries by 2035. They explain this by the fact that automation, using AI, improves productivity.

Table 1.
Top 10 countries that have invested in AI

Countries	United States	China	Great Britain	Israel	Canada	India	Germany	France	South Korea	Singapore
Amount invested (billions of dollars) 2013–2022	248.9	95.1	18.2	10.8	8.8	7.7	7.0	6.6	5.6	4.7

Source(s): AI Index Report 2023

Table 2. Number of robots per 10,000 employees in the manufacturing industry in 2021

Countries	South Korea	Japan	Germany	China	Sweden	United States	Switzerland	Italy	Canada	France
Number of robots	1000	399	397	322	321	274	240	217	191	163

Source(s): International Federation of Robotics 2021

According to the Accenture company, the impact of AI-based technologies is expected to improve work efficiency by up to 40% in some countries. The company then calculated the impact of AI on the productivity of companies in each country. For France, the study estimates that companies will increase productivity by 20% because of AI and increase annual GDP growth from 1.7% to 2.9%. These results are represented in the following Figure 1.

According to the economist Philippe Aghion (2023), AI should however also have negative effects on economic growth, due to the brakes (or hidden costs) weighing on the development of AI. These obstacles are mainly of the following nature:

(1) **Technological:** some technologies have reached an insufficient stage of maturity to assess their economic benefits, such as the autonomous vehicle which is at an experimental stage or the quantum computer which is at an exploratory stage;

(2) **Legal:** protection of personal data, cybersecurity and the competitive environment of the AI ecosystem remain insufficiently regulated;

(3) **Socio-professional:** the effects of skills deficits and resistance to organizational change are difficult to measure;

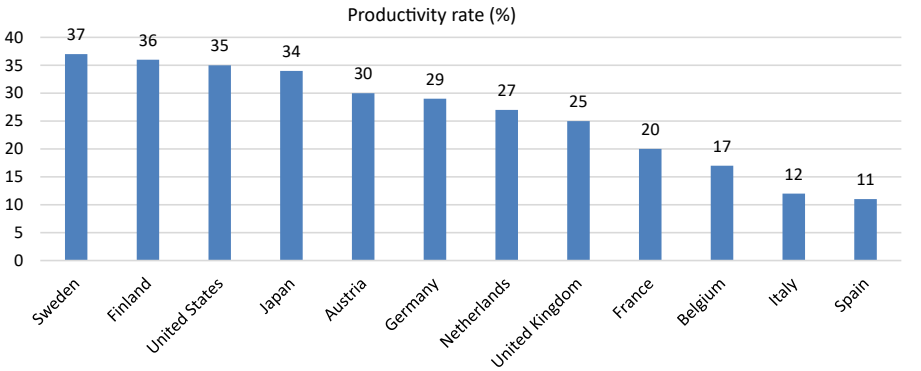
(4) **Organizational:** AI models in current business and government management systems are still insufficiently integrated;

(5) **Institutional:** public action on training (initial and continuous) in AI, in order to reduce the digital divide and promote the retraining of professions, is not equally promoted. It depends on the country and region.

The potential brakes can also be of a competitive nature. AI markets are controlled by "fringed oligopolies", with a few leaders in a situation of quasi-monopoly on their market segments (GAFAs – Google, Amazon, Facebook and Apple) and a galaxy of small players (start-ups). In order to conquer pioneering competitive advantages, the big players absorb or control the most innovative start-ups, thus strengthening their dominant positions and control of their markets. In fact, GAFA thus controlled more than two thirds of global internet traffic in 2018.

2.2 AI impact on skills transformation

AI has a significant impact on skills transformation, both in terms of the skills needed to work with AI technologies and the broader skills required in a world where AI is increasingly prevailing.



Source(s): Figure by author

Figure 1.
Business productivity

Studies on the mutation of skills caused by AI pointed to uncertain results. McKinsey Global Institute estimates that 90% of jobs will be transformed by AI. Only 1% of them could be fully automated, but 60% could be for at least a third of the tasks. The Institute drew up a list of the 25 key skills of an economy and projected their evolution by 2030. It believes that repetitive tasks in interaction with customers, standard manipulation, some administrative support functions, accounting, etc... are threatened, while manager, expert and technician activities (especially digital) should prosper.

The Boston Consulting Group estimates that 32% of companies in China have already adopted AI in their daily process, compared to 22% in the United States and 20% in France and Germany.

The OCED (2019) considers that the impact of AI on jobs and skills in developed countries should be profoundly different from one sector to another. The OCED (2019) rejects the hypothesis of "mass technological unemployment" and underlines the urgency of a partial and gradual retraining of agents exercising low-skilled robotic jobs towards "phygitalisable" jobs with higher skills. The jobs most affected would be those in large manufacturing, logistics, trade, banking and insurance. The OCED (2019) argues in favor of reducing the digital divide within populations, due to a better integration of AI into educational programs under educational technology "edtech".

Overall, AI drives a shift in the skill sets required for the workforce. While technical skills remain important, there is an increasing emphasis on complementary skills such as data literacy, critical thinking, collaboration, adaptability and ethical understanding.

2.3 AI impact on technological revolution

AI plays a central role in the ongoing technological revolution by fueling innovation, transforming industries and reshaping the way we live and work. AI is a real revolution because it allows you to go much further than the technologies already operating the complex tasks performed. Algorithms produced by AI are potentially more powerful than any computer program coded by a human. Studies (Agrawal, Gans, & Goldfarb, 2019; Yang, 2022) have shown that automation using AI improves productivity. In fact, its capabilities in innovation, automation, data analytics, customization and integration with emerging technologies are transforming industries and reshaping society.

It is in this regard that AI can be frightening because it evades the ability of total control by humans. The resulting ethical questions are numerous: if AI decides on the selection of candidates, how can we protect ourselves against discrimination? If the AI of an autonomous vehicle causes an accident, who is responsible?

2.4 AI impact on risk management

AI has a significant impact on risk management across various industries. By leveraging advanced algorithms and data analytics, AI enhances risk assessment, prediction and mitigation processes. It makes it possible to improve conventional risk management tools (scoring method, fraud detection, optimization of debt recovery strategies, rapid detection and interpretation of poor signals, construction of economic models, etc.) used by bankers, insurers, brokers, accountants, managers, etc. Some AI applications help to analyze and secure data flows made increasingly massive by new regulations imposed on companies. Some AI software can better protect organizations against hacking and strengthen the fight against accounting fraud. However, several observers (Bahuon & Pluchart, 2018) reveal that cybercrime and some accounting manipulations can be promoted by progress in AI. The combination of new technologies and the difficulty of complying with new regulations on the protection of personal data increase the criminal, financial, tax and social risks incurred by companies and their managers.

AI associated with blockchain technology helps create value by promoting risk management and the fight against fraud. It presents itself as a new trusted third party between an organization and its stakeholders (Leloup, 2017).

It is important to note that while AI enhances risk management, human expertise and judgment remain crucial. AI should be seen as a tool to support decision-making, with human oversight and interpretation. Effective risk management strategies should combine AI capabilities with human insights and domain knowledge to effectively address complex and evolving risks.

2.5 Effects of AI on consumption

AI's effects on consumption are reflected in enhanced customization, convenience, improved search and discovery, optimized pricing, predictive analytics, immersive experiences and increased security. It is also seen as a driver for creating new business models in many industries. The "Sizing the Prize" study published by the audit company PwC in 2017 identifies eight main sectors directly impacted by AI:

(1) **Health:** assistance with diagnosis enabled by data, identification of pandemics, diagnosis by imaging, prediction of diseases by the human genome, surgical robots, etc.

(2) **Automotive:** autonomous fleets for carpooling, smart cars and driver assistance, predictive and autonomous maintenance, etc.;

(3) **Financial services:** (banking and insurance): automation of customer relations and transactions (in particular thanks to robo-advisors), customized financial offers, detection of fraud and the fight against money laundering, etc. ;

(4) **Retailing:** customized product design, customer data list, automated inventory and delivery management, etc. ;

(5) **Communication and entertainment:** media archiving and research, content creation (films, music, etc.), personal assistants, etc.;

(6) **Manufacturing and production:** reinforced control and self-correction of processes, optimization of the supply chain and manufacturing, production on demand, etc.;

(7) **Energy:** smart meters, optimized networks and storage operations, smart infrastructure maintenance, etc.;

(8) **Logistics:** autonomous deliveries (by trucks, drones, etc.), traffic control and reduction of traffic jam, enhanced road safety, etc.

AI promotes the construction of increasingly complex digital product and service transaction platforms. The platform is the basic structure of the digital revolution (Rifkin, 2013). Intermediation via a platform makes it possible to reduce information asymmetries between the different parties.

2.6 Effects of AI on green economy

AI has the potential of significantly affecting the green economy by driving sustainability, resource efficiency and environmental stewardship.

Potential of AI can also be identified for different important sectors of a green transformation. AI applied to monitor and optimize energy consumption can support the integration of renewable energies in power grids.

Several studies have examined how AI affects green total factor productivity (GTFP). Peiya, Yu, and Xue (2022) and Yuxin, Hongjun, and Jihui (2022) showed that AI has a significant effect on total green factor productivity by using a nonlinear dynamic panel regression model in China. The authors have introduced the energy factor and the environmental pollution factor based on the nonlinear model used by Aghion, Akcigit, Cagé, and Kerr (2016) and Trabelsi (2023) to examine the relationships between AI and GTFP.

While AI offers significant opportunities for the green economy, it is important to consider potential challenges and risks, such as energy consumption by AI systems, data privacy concerns and unintended environmental consequences of AI deployment. Ensuring responsible and ethical use of AI is essential to fully harness its potential for driving sustainability and creating a greener economy because the environmental side effects are hard to ignore.

3. AI between prospective and predictive visions

AI can improve human decision-making processes by providing advanced analytics and predictive capabilities. With AI-powered tools, businesses and governments can make more informed decisions based on data-driven insights. This can lead to better resource allocation, improved risk management and optimized strategies, contributing to economic growth and competitiveness.

The main effect of machine intelligence will be to lower the cost of goods and services that rely on prediction. This matters because prediction is an input to a host of activities including transportation, agriculture, healthcare, energy manufacturing and retail.

An AI economy is an analytical economy. It uses both prospective and predictive perspectives (Vayre, 2016). Data from algorithms project futures that reflect realities based on big data about the past.

Prospective AI is valuable in scenarios where real-time decisions and responses are crucial, such as dynamic resource allocation, customer service interactions, or real-time monitoring and control systems. It focuses on immediate effectiveness and efficiency, reacting to the present circumstances.

Predictive AI aims to understand the underlying patterns and relationships within data to make informed projections about future outcomes. It uses machine learning algorithms to analyze large datasets, identify patterns and generate predictions or forecasts about future events or behaviors. It can be used for demand forecasting, financial projections, risk assessment and long-term resource planning.

It is important to note that prospective and predictive visions are not mutually exclusive. They can complement each other in many applications. Predictive insights can inform prospective decision-making by providing guidance and recommendations based on anticipated future outcomes. Similarly, prospective data generated from real-time interactions can be used to refine predictive models and improve their accuracy.

The validity of some predictive models is increasingly challenged due to certain methodological biases (Krivine, 2018) that affect algorithmic engineering. These biases make questionable the term "predictive", sometimes attributed to an insufficiently robust processing of legal databases (predictive justice), sales (predictive marketing), economic (predictive economy), financial (predictive finance). This is why algorithms are increasingly the subject of increased scrutiny by administrations, universities and consumer protection associations.

4. Governments and the implementation of AI in public services

The global interest in AI was spurred in large part by social distancing measures implemented in response to the coronavirus pandemic. National AI strategies, however,

remain concentrated in countries in the global north, showcasing a deep divide between developed and developing countries in global AI readiness.

According to the 2021 AI Readiness Index, nearly 40% of 160 countries have published or are drafting national AI strategies, indicating that AI is quickly becoming a top concern for world leaders. The USA tops the rankings, followed by Singapore in second place and the UK in third. East Asian countries showed particular strength, making up one quarter of the top 20 ranked countries.

The index, published yearly, ranks countries based on 42 indicators across three pillars: Government, Technology Sector and Data and Infrastructure.

(1) The ***Government*** dimension includes:

- **Vision** (indicators of which are: a National AI strategy);
- **Governance & Ethics** (indicators: data protection and privacy legislation, cybersecurity, national ethics framework, legal framework's adaptability to digital business models);
- **Digital Capacity** (indicators: Government promotion of investment in emerging technologies, information and communication technology (ICT) use and government efficiency, Online services, Trust in Government websites and apps);
- **Adaptability** (indicators: Effectiveness of government, Government's responsiveness to change and E-procurement capacity.

(2) The ***Technology Sector*** dimension includes:

- **Size** (indicators: Number of AI unicorns, CB Insights Number of non-AI technology unicorns, Market value of public technology companies, Value of trade in ICT services [per capita], Value of trade in ICT goods [per capita], Computer software spending);
- **Innovation Capacity** (indicators: Entrepreneurial culture, Business administrative requirements, R&D spending, Company investment in emerging technologies);
- **Human Capital** (Graduates in science, technology, engineering and math (STEM), Quality of engineering and technology higher education, Digital skills, GitHub commits, Knowledge-intensive employment and Research papers published in AI).

(3) The ***Data and Infrastructure*** dimension includes:

- **Infrastructure** (indicators: Telecommunications infrastructure, 5G infrastructure, Number of supercomputers, Internet bandwidth and Adoption of emerging technologies);
- **Data Availability** (indicators: Open government data, Open data policies, Statistical capacity, Mobile-cellular subscriptions and Households with Internet access at home);
- **Data Representativeness** (indicators: Gender gap in Internet access, Gender gap in mobile access, Cost of internet-enabled device relative to GDP per capita and Socio-economic gap in Internet usage).

The top 20 AI-ready governments worldwide 2022 are presented in the following Table 3.

Global Position	Countries/Regions	Overall Score	Government	Technology Sector	Data and infrastructure
1	United States of America	88.16	88.46	83.31	92.71
2	Singapore	82.46	94.88	66.69	85.80
3	United Kingdom	81.25	85.69	67.26	90.81
4	Finland	79.23	88.45	63.85	85.40
5	Netherlands	78.51	80.42	66.17	88.92
6	Sweden	78.16	80.76	67.37	86.36
7	Canada	77.73	84.36	63.75	85.08
8	Germany	77.26	78.04	67.68	86.07
9	Denmark	76.96	83.50	63.24	84.14
10	Republic of Korea	76.55	85.27	58.49	85.89
11	France	76.41	82.10	60.61	86.53
12	Japan	76.18	81.90	59.31	87.32
13	Norway	76.14	84.24	59.25	84.91
14	Australia	75.41	83.79	57.07	85.37
15	China	74.42	83.79	61.33	78.15
16	Luxembourg	73.37	82.67	50.66	86.80
17	Ireland	72.80	74.70	61.11	82.59
18	Taiwan, China	71.98	77.59	59.42	78.92
19	United Arab Emirates	71.60	79.41	53.33	82.05
20	Israel	70.01	64.64	65.87	79.52

Source(s): Government AI Readiness Index 2022, Oxford Insights (Rogerson, Hankins, Nettel, & Rahim, 2022)

Table 3. Top 20 AI readiness index

Deployment of AI by government is not without challenges. Implementation of AI in public services has the potential of increasing service efficiency and service quality for citizens (Misuraca, Barcevičius, & Codagnone, 2020). Thus, there is a dire need to spread awareness and develop AI expertise among government workers who must be ready for this new AI era. Governments should invest in building internal expertise by training their staff and hiring AI specialists. It should also mean providing existing workers with the training they need to manage AI systems in public services.

On the other hand, citizens and civil society organizations may call for mechanisms to hold governments accountable for the use of AI in public services. They may advocate for independent audits, regulatory frameworks and public participation in decision-making processes to ensure that AI systems are used responsibly and in the best interest of the public. Citizens and civil society organizations also may express concerns about the potential impact of AI on employment in public services.

By considering these perspectives, governments can ensure that the use of AI in public services aligns with the needs, values and expectations of citizens and civil society organizations. This inclusive approach can help build trust, address potential concerns and maximize the benefits of AI in public service delivery.

5. Conclusion

AI is seen by many as an engine of productivity and economic growth. It can increase the efficiency with which things are done and vastly improve the decision-making process by analyzing large amounts of data. It can also spawn the creation of new products and services, markets and industries, thereby boosting consumer demand and generating new revenue streams. However, AI may also have a highly disruptive effect on the economy and society. Some warn that it could lead to the creation of super firms that could have

detrimental effects on the wider economy. It may also widen the gap between developed and developing countries. On the other hand, there have been many debates about the dangers associated with the development and application of AI, especially ChatGPT.

The added value of AI mainly bears on effects on consumption, productivity gains and better risk management. These value creation levers vary according to the business (more or less automatable), but also time (duration of the technological cycles) and space (geographical areas).

It is important to note that the impact of AI on economic growth is not uniform across all sectors and regions. Access to AI technologies, digital infrastructure and AI skills can influence the extent to which countries and industries benefit from AI. Addressing ethical considerations, data privacy and ensuring inclusive access to AI benefits are also crucial for maximizing the positive impact of AI on economic growth. In this regard, Nguyen and Doytch (2022) found a positive and significant effect of total patents on economic growth for advanced economies, but the magnitude of the effect of the technology variable weakens for emerging economies.

On the other hand, absence of human reasoning in automated procedures can generate or amplify inequity, discrimination and racism.

Governments should collaborate with academia, industry experts and other stakeholders to leverage their expertise and experiences in AI implementation. Public-private partnerships can accelerate the development and deployment of AI solutions while ensuring alignment with public needs. Once AI systems are implemented, governments should continuously monitor their performance and evaluate their impact. Regular assessments help identify any issues or biases and allow for necessary adjustments and improvements.

This way, we can make sure these technologies reach their maximum potential while limiting any bad effects they might have on society.

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Corresponding author
Mohamed Ali Trabelsi can be contacted at: daly1704@yahoo.fr