INVESTIGATING THE SCIENTIFIC FOCUS ON ARTIFICIAL INTELLIGENCE'S POTENTIAL IMPACT ON LABOR MARKET

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Abstract: *The pace of technological development, marked by its inexorable character, drives scientific research to continuously assess its economic impact. Research on the present and future effects materializes in an increasing volume of publications, the technological evolution bringing to the fore significant aspects of change, with increasingly evident accents of convergence towards the importance of researching the impact of technological evolution, especially artificial intelligence, on the labor market. Automation anxiety is the initial condition present in the labor market; the direction of technological development, and especially its direction, can influence the final impact. The widespread application of artificial intelligence, owing to its general applicability combined with the rapid advancement of specific technologies, sets the stage for significant economic and social transformation. Ongoing analysis of developmental stages and their potential impacts is essential to propose appropriate directing or regulatory measures. The purpose of this article is to capture the intensity and major concerns of the existing research on this topic at the global and national levels and to provide an overview and a recommendation for the selection of the literature for those who intend to research the relationship between technological development and the labor market. This article aims to identify the types of approach, the relevant topics, and the convergences towards possible clusters, along with the measurement of specific quantitative indicators: the number of publications per year, by authors, institutions, and countries. A bibliometric study was used as the research method. By analyzing the scientific literature based on quantitative indicators, this research captures the structure and dynamics of scientific research in this field. Measuring the impact and influence of scientific papers, identifying research trends, collaborative networks, and mapping clusters provide an overview of the evolution of the research field.*

Keywords: labor-market; employment; artificial-intelligence; technology.

JEL Classification: J01

1. Introduction

Major technological developments have radically changed the economic and social models of the times preceding them. The steam engine, electricity or information technology have revolutionized not only production models but also people's way of life. Anthropologist Ian Morris in his work "Why the West Rules – For Now" (Morris, 2011), tries to answer the question: what is the most remarkable development in human history? The applied criterion involves quantifying the impacts of

development on social progress, which can be defined as a group's capability to comprehend and manage its physical and intellectual state with the aim of enhancing its living conditions (Morris, 2011). The answer to this question was the steam engine. The steam engine generated the most radical social transformation in human history, paving the way for most co-inventions and technological developments that followed. Erik Brynjolfsson and Andrew McAfee(Brynjolfsson, 2014) call the period of the industrial revolution based on the steam engine *"first machine age,"* and that of artificial intelligence (AI), *"second machine age."* Since 1950, when Alan Turing (Turing, 1950) first associated the term intelligence with computational machines, to the present day, we observed rapid advancements in AI technology. This progress has been supported by an exponential increase in computing power, consistently surpassing Moore's law (Moore, 1965) of doubling the number of transistors on a microchip every two years, while the cost of computing is halved. The integration of deep neural networks, Monte Carlo tree-search techniques, and reinforcement learning has significantly advanced the capabilities of algorithms. In 2017, OpenAI launched the GPT-2 (Generative Pre-trained Transformer) model, with 1.5 billion parameters as a measure of the complexity of the system. GTP-3 was launched in 2020 with 175 billion parameters. The computing power of the model increased from two petaflops to ten billion petaflops. The GPT-4 model passed the Turing test, and the limits in terms of AI capabilities are being pushed to new extremes. The development of large language models (LLMs), including Llama by Meta, Gemini by Google, and Claude Sonnet by Anthropic, has prompted private companies to engage in a competitive technological race. This uncontrolled evolution of AI has generated continuous research into its effects on the economy. Technological predestination creates the premises for economic research, while history draws attention to the social costs incurred by those affected. Even if the contribution of technological developments to the increase in the standard of living and the formation of current societies with the democratic values that most of the population enjoys is undeniable, the imminence of a new technological wave requires the preparation of the necessary changes in advance. The analysis of the evolution of the relationship between capital and labor has been and is a continuous concern among economists, from Adam Smith (Smith, 1999) or Karl Marx (Marx, 1926) to contemporaries, such as Thomas Piketty (Piketty, 2017). Their study was based on the premise that labor and capital are antagonistic. Technological development can radically change positioning. The technology that augments labor, the capital that comes to ease human effort, to re-humanize labor, predicts a homeostatic state of natural balance. It depends on the direction of development of technology, in this case, artificial intelligence, which can follow the optimistic direction described above, or it can have a substitution effect on the dislocation of labor by capital. We are destined to grow, but the direction of development is not predetermined. This could be controlled during this phase. The analysis of the possible effects of a transformation similar to the industrial revolution is not only necessary, but also mandatory, in order to create the right economic and social models to avoid the price paid by humanity in the eighteenth century. The literature confirms that researchers are concerned about responding to this challenge, and the number of publications has increased from year to year. The exponential evolution of publications in recent years has led to the need to identify relevant publications and topics in the field of

AI's impact on the labor market. This article aims to identify the types of approach, the relevant topics, and the convergences towards possible clusters, along with the measurement of specific quantitative indicators: the number of publications per year, by authors, institutions, and countries.

2. Theoretical background

John Maynard Keynes (Keynes, 2010), in his 1930 essay *"Economic Possibilities for our Grandchildren,"* predicted a 15-hour workweek thanks to technological advances and increased productivity, leaving people more time for recreational activities and personal development. It is the most frequently used citation in articles that addresses the subject of literature on this topic, introducing the notion of technological unemployment with an optimistic future prediction. To classify the literature according to the authors, we defined two distinct categories. The first is that of authors coming from the practical sphere, applicability or development of AI, such as Mustafa Suleyman (DeepMind), Paul R. Daugherty (Accenture Research), H, James Wilson (Accenture Research), Mo Gawdat (Google X). The second category, which leads this effort, is that of scientific researchers, whose names and importance in the field are presented in the results of the present research. And there is dual focus on scientific and practical application, bridging the gap between groundbreaking research and real-world impact as Geoffrey Hinton (University of Toronto and Google Brain, awarded the Nobel Prize in Physics in 2024 for his work on theoretical and applied machine learning) and Sir Demis Hassabis (University College London and Google X, awarded the Nobel Prize in Chemistry in 2024 for his contribution on predicting protein structures using AI. The major difference in how the two categories are approached is the framing of the technology itself. Economists place less emphasis on the peculiarities of the technology, analyzing it as a generic technology, while engineers detail the differentiating and determining features of AI, such as hyper-evolution, asymmetric impact, increasing autonomy, and general usability. There are topics on which the positions are unanimous or at least mostly consensual. It concerns the imminence of the phenomenon, the magnitude of the impact, the transformative effect, the time-lag inherent to the implementation, the possible reactions of rejection from the directly affected factors, the increase in productivity, creative destruction, and the need for regulation. Positions diverge from the moment we approach the positioning of AI in future production processes, types of jobs affected, newly created jobs, technological unemployment or structural unemployment, polarization of the labor market, and inequality. Except for the option in which AI does not affect the labor market, the positions are between complementary, augmentative, and dislocating AI. The complementation of human capabilities in the labor market envisions harmonious collaboration between humans and AI, the latter eliminating repetitive tasks that do not offer job satisfaction, leaving room for creative and important processes, and rehumanizing both time and work. In 2024, Hassabis's research brought this scenario to fruition. By being augmented with AI, humans have developed the AlphaFold model, which is capable of predicting protein structures. The displacement of humans by AI or by technology due to AI also remains a possible scenario, taking up the fear formulated by Wassily Leontief in

1982 (Leontief, 1982), with the analogy between humans and horses, by diminishing their importance through technological progress. The most commonly used explanations for the effects of technology on the labor market are the skill-biased technical change theory SBTC (Acemoglu and Autor, 2011), the Autor-Levy-Murnane (Autor *et al.*, 2003) ALM hypothesis, and the routine-biased technological change RTBC (Autor *et al.*, 2003). According to SBTC, advanced technology requires skilled labor, generating additional demand for this category and decreasing demand for those with basic qualifications. The ALM hypothesis focuses on workplace tasks, grouping them into routine, easily automated, and non-routine tasks, and dividing them into manual and cognitive tasks. Routine-biased technological change suggests that technology replaces routine tasks but complements non-routine tasks. Based on these classifications, the hypothesis assumes polarization of the labor market due to the increased susceptibility to automation of mid-level jobs. Between the two poles, the hypothesis foresees a major wage inequality justified by the difference in productivity. In addition to the task-based approach, the need to continuously track the evolution of AI capabilities, whose limits are uncertain and unpredictable, is becoming increasingly evident. Indicators are introduced to track these developments, such as the AI Occupational Impact Measure, Machine Learning Index or AI Exposure Score.

3. Methodology

The methodology employed in this study was bibliometric. This approach provides the advantage of analyzing a large volume of publications through quantitative techniques, complementing traditional methods such as systematic literature reviews or meta-analyses that involve interpretive subjectivism. Upon establishing the research objectives outlined above, we proceeded with data collection. The data source utilized for the query was the Web of Science (WoS). The query was meticulously designed to focus on the topics of the publications, utilizing logical operators such as AND and OR to capture relevant works related to artificial intelligence and the labor market. The parameters of the query are crucial because they have a definitive impact on the database being analyzed; different parameters yield different results and conclusions. This highlights a fundamental critique of bibliometrics: the research outcomes are specific to the analyzed database, making their generalization to an entire research field unfounded or speculative. To capture the two domains, artificial intelligence and the labor market, we used the following query criterion applied on the topic (title, abstract, keywords) for the articles in the categories Economics OR Business OR Social Sciences Interdisciplinary OR Sociology, subsequently eliminating the purely technical subcategories: (artificial-intelligence OR automation OR computerization) AND (labor OR labor OR employment). The resulting database was processed using the Biblioshiny application, a bibliometric analysis application developed in the R programming language. The application of Biblioshiny enabled us to conduct a descriptive analysis of the database, facilitating the visualization of collaboration networks among authors or institutions, as well as the relationships between scientific concepts. This allowed us to analyze thematic networks, track the structure and evolution of

research topics, map citations and co-citations, and provide a comprehensive understanding of the influence and connections between various academic works.

4. Results

4.1. General analysis of the selected publications

As a result of the query, we obtained a database comprising 701 documents published in 339 distinct sources in the period 1989-2024, by 1587 authors, with an average co-author rate of 2.54 per document. The average growth rate of publications was 15.54%, and I analyze the dynamics of this growth in Figure 1.

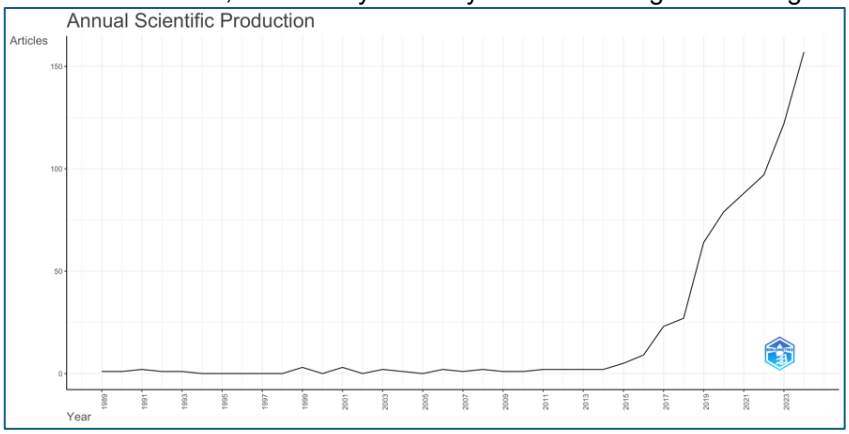

Figure 1: Annual Scientific Production
Source: Biblioshiny, database from WoS

The first publications on artificial intelligence collected on WoS were from 1977, but Alan Turing (Turing, 1950) associated the term intelligence with the computational machine as early as 1950, in the work entitled *"Computing Machinery and Intelligence."* The interdisciplinary approach, in this case AI and the labor market, although existing since 1989, followed a stagnant trajectory between 1989-2016, after which the average increase in scientific production was 34% per year. The trend was similar in terms of the number of citations, with an average annual increase of 54%, justified by the topicality of the subject and the growing number of publications.

4.2. Source analysis

The analysis of the sources aims not only to list the most frequent journals but also to evaluate the quality of the analyzed publications. To quantify this aspect, we also added the H-index to the list of the most frequent journals as a measure of scientific impact and productivity. Using the weighted arithmetic mean of the indices, we calculated the H-index of the analyzed database, with an H-index of 112. From top twenty most frequent present journals, half belongs to publisher Elsevier, journals like *Technological Forecasting and Social Change (H-Index 179), Technology in Society or Labour Economics (H-Index 88)*, but there are also journals from other high ranked publisher as Oxford University Press – *Industrial and Corporate Change (H-Index 127)*, Springer Nature – *Humanities and Social Sciences Communications*

(H-Index 35) and Taylor and Francis with *Journal of Economic Issues (H-Index 55)*. The list of the first ten most relevant sources is presented in Figure 2.

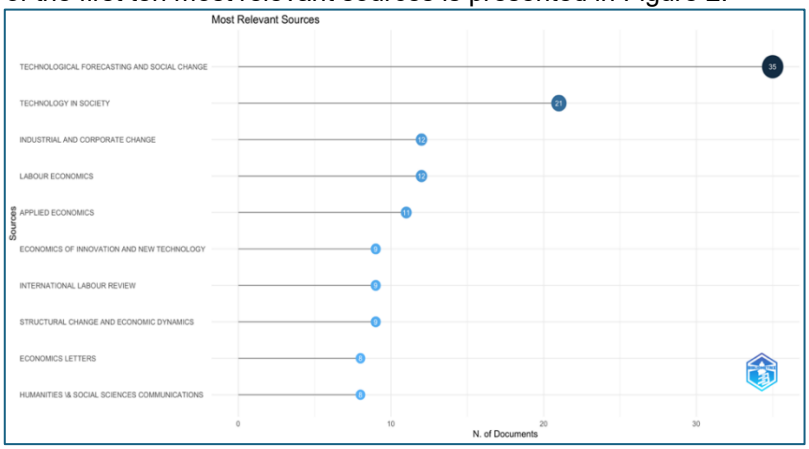

Figure 2: Most Relevant Sources
Source: Biblioshiny, database from WoS

The Romanian-relevant sources in our database are *Amfiteatru Economic (H-Index 30)* and *the Journal of Theoretical and Applied Electronic Commerce Research (H-Index 47)*.

4.3. Authors' analysis

For the analysis of the authors, we chose the three-field chart listed in Figure 3, which allows not only the quantitative identification of the authors with the most publications, but also their impact in terms of references and topics addressed.

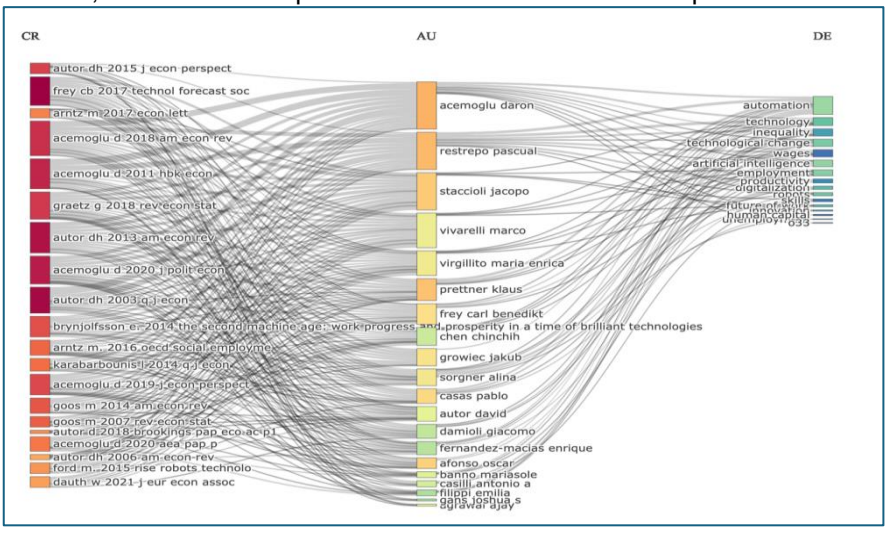

Figure 3: Most Relevant Autors
Source: Biblioshiny, database from WoS

The authors with the most publications are Daron Acemoglu (MIT), Pascual Restrepo (Yale University), Jacopo Staccioli (Catholic University of the Sacred Heart), Marco Vivarelli (Catholic University of the Sacred Heart), Virgillito Maria Enrica (Scuola Superiore Sant'Anna), Klaus Prettner (Vienna University of Economics and Business), Carl Benedikt Frey (University of Oxford), also present in the list of the most frequently used references, along with David Autor (MIT), Erik Brynjolfsson (Stanford University). Their common topics, in descending order of frequency, are automation, technology, inequality, technological change, wage level, artificial intelligence, employment, productivity, and topics that we analyze below. The 14 local publications came from 13 authors from 12 sources, including *Amfiteatru Economic (H-Index 30)* and *Journal of Theoretical and Applied Electronic Commerce Research (H-Index 47)* with two publications each; the most cited publications were *Pirosca Grigore Ioan, Serban-Oprescu George Laurențiu, Badea Liliana, Otoiu Adrian, Titan Emilia, and Paraschiv Dorel Mihai*. The common topics, in descending order of frequency, are *automation, technology, inequality, technological change, salary level, artificial intelligence, employment, productivity*, and subjects, which we examine in the following sections.

4.4. Content analysis

Although the analysis methods remain quantitative, content analysis manages to describe the major research directions in the analyzed articles based on the keywords used. In descending order of occurrence, the most frequently used keywords were employment, growth, future, jobs, technology, polarization, automation, robots, labor, and impact, as presented in Figure 4.

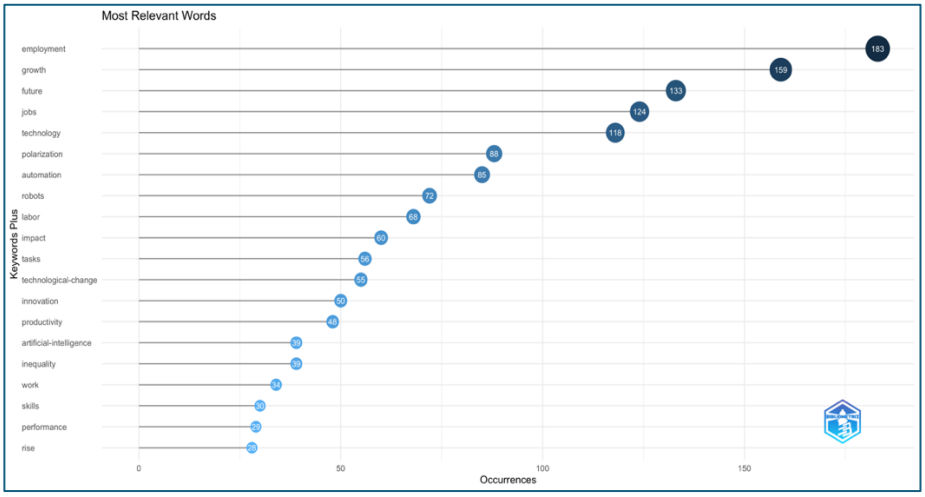

Figure 4: Most Relevant Words
Source: Biblioshiny, database from WoS

Of the top ten most frequently used terms, four (employment, jobs, polarization, work) refer to the labor market, one term is from the category of general economic concepts (growth), three refer to technology (technology, automation, robots), and

two terms refer to prospects (future, impact). The major concern is the future impact of automation and robotization on the labor market's employment rate and the possible polarization effect generated by imminent growth. It is worth mentioning the term productivity in 14th place, AI in 15th place, and inequality in 16th place. The identification of trend changes in topics shows that topics related to wages or the labor market remain constantly topical. The issue of the substitution effect remains behind as of 2022, when the pessimistic approach of a jobless future is considered unfounded. Referring to the past becomes irrelevant from the perspective of AI, and new topics have appeared, such as structural changes and economic growth correlated with technological evolution and automation.

4.5. Geographic analysis

More than half of the analyzed publications have as their country of origin, based on the authors' affiliation to one of five countries: the USA (17%), the Republic of China (12%), Germany (8%), Italy (7%), and the United Kingdom (7%). It is worth mentioning the growth rate of publications in the Republic of China, a dynamic that threatens the leading position of the US in this field, as presented in Figure 5.

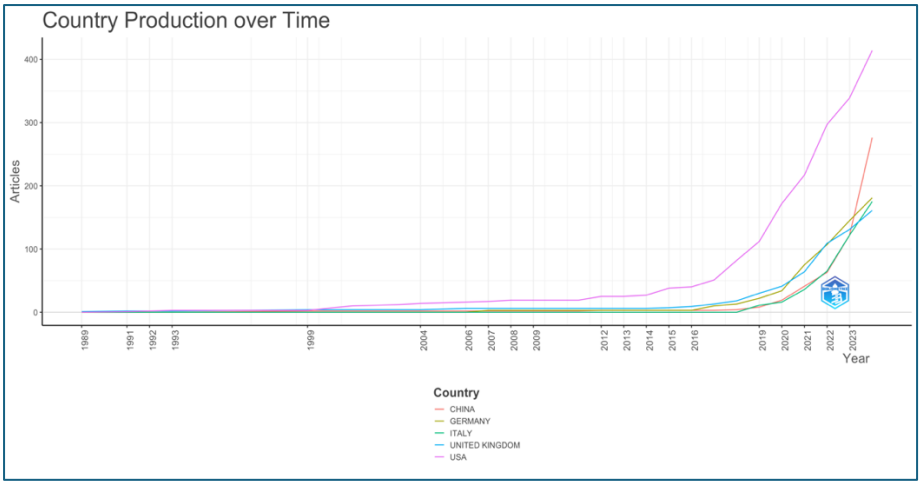

Figure 5: Country Production over Time
Source: Biblioshiny, database from WoS

This trend is not supported by the impact of publications as measured by the average number of citations per article. China with 9.2 citations per article, lags far behind the UK (71.1), the US (62.5), and Germany (20.7), a similar level to Italy with 9.2.

4.6. Cluster analysis

The relationships between the topics, represented by the keywords, were analyzed using co-occurrence diagrams, which allowed the identification of clusters, as presented in Figure 6.

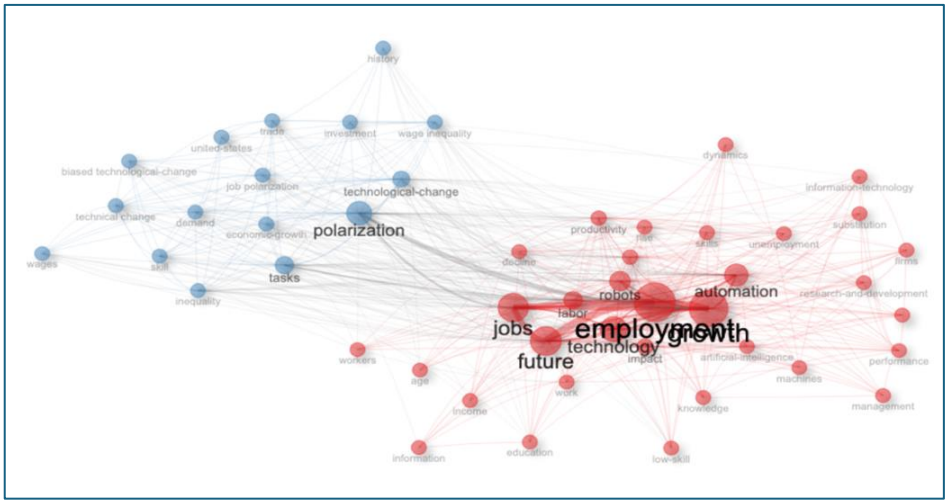

Figure 6: Clusters
Source: Biblioshiny, database from WoS

In such representations, keywords are grouped by research topic to form clusters. The application identified two clusters, one grouped around the words employment, future, technology, jobs, and the second, around the words polarization, tasks, technological-change. The first cluster focuses on the economic effects of technological evolution, whereas the second focuses on the social impact of these changes. The two primary clusters identify and delineate the main types of concerns regarding AI's impact on the labor market, primarily focusing on employment and polarization.

5. Conclusions

In this study, we aimed to identify scientific concerns regarding the impact of AI on the labor market using a bibliometric methodology. The study was able to identify the authors with a significant impact, the dominant journals in this field, the relevant topics and their evolution over time, and the existence of clusters. The comparable sizes of the two identified clusters highlight the importance of examining social impact. This necessitates directing future research towards specific recommendations for managing AI development, ensuring that it is steered towards areas that do not exacerbate labor market polarization or inequality. In his paper entitled *'Can We Survive Technology?'* Physicist John von Neumann (von Neumann, 1955) cautioned that the world was undersized and inadequately structured to cope with the technological progress. It is our responsibility and opportunity to expand it economically and socially and to reorganize it in order to leverage the benefits of technological progress. Humanity has its own limitations and is aware of them. However, as Acemoglu and Johnson highlighted in their book *"Power and Progress" (Acemoglu and Johnson, 2023)*, the direction of development of technologies is

neither predefined nor widespread prosperity. It is, as they stated *" an economic, social, and political choice."* (Acemoglu and Johnson, 2023, p.23)

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