



ASSESSING AI DEPENDENCY: A MULTIFACTORIAL ANALYSIS AND AIDI INDEX (Scopus postprint)

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ABSTRACT

Artificial Intelligence (AI) has emerged as a transformative force reshaping economies worldwide. This paper presents a comprehensive framework for assessing AI dependency, aiming to quantify the extent to which countries rely on AI technologies and capabilities. We propose a multifactorial analysis that integrates various indicators, including the contribution of AI-related industries to GDP, the rate of AI technology adoption, the availability of skilled AI professionals, government initiatives supporting AI development, and the readiness of infrastructure for AI deployment. Each indicator is weighted based on its relative importance, determined through expert judgment and statistical analysis. Through case studies and empirical analysis, we demonstrate the application of the proposed framework in evaluating AI dependency across different countries. Our findings highlight the diverse landscapes of AI readiness and dependency, providing insights for policymakers, researchers, and stakeholders to understand and address the challenges and opportunities associated with the AI-driven economy.

Keywords: Artificial Intelligence, AI Dependency, Economic Impact, Multifactorial Analysis, Policy Implications

Introduction

Artificial Intelligence (AI) stands as one of the most transformative technologies of the 21st century, reshaping industries, economies, and societies at an unprecedented pace. In this introduction, we embark on a journey to explore the profound impact of AI on the global economy, unveiling the opportunities it presents and the challenges it poses. As we delve into the multifaceted dimensions of AI's influence, we aim to shed light on the complexities and nuances that characterize the AI-driven economy.

The advent of AI marks a paradigm shift in how we perceive and interact with technology. Unlike

traditional computing systems, which operate based on predefined algorithms, AI possesses the remarkable ability to learn, adapt, and evolve through data-driven insights. This inherent capability empowers AI to perform tasks that were once deemed exclusive to human intelligence, ranging from natural language processing and image recognition to complex decision-making and problem-solving.

The proliferation of AI technologies across various sectors underscores its pervasive influence on the global economy. From healthcare and finance to manufacturing and transportation, AI is revolutionizing workflows, optimizing processes, and unlocking new frontiers of innovation. For instance, in the healthcare industry, AI-powered diagnostics and predictive analytics are enhancing patient outcomes, streamlining treatment protocols, and driving precision medicine initiatives.

Similarly, in finance, AI algorithms are revolutionizing investment strategies, risk management practices, and fraud detection mechanisms, offering unparalleled insights into market trends and consumer behavior.

The rapid advancement of AI is fueled by a confluence of factors, including exponential growth in computational power, vast repositories of data, and breakthroughs in machine learning algorithms. As AI continues to mature and evolve, its applications are becoming increasingly diverse and ubiquitous, permeating every aspect of our daily lives. From virtual assistants and autonomous vehicles to smart cities and personalized recommendations, AI-driven technologies are shaping our interactions with the world around us, redefining how we work, communicate, and navigate our environments.

However, amidst the excitement and promise of AI, profound questions and challenges loom large on the horizon. The rise of AI has sparked debates and concerns surrounding issues of ethics, accountability, and societal impact. As AI systems become more autonomous and sophisticated, questions of bias, transparency, and algorithmic accountability come to the forefront, raising important considerations about fairness, privacy, and human autonomy.

Furthermore, the transformative potential of AI also brings to light broader socio-economic implications, including shifts in labor markets, income inequality, and the redistribution of wealth. While AI promises to unlock new sources of economic value and productivity gains, it also threatens to disrupt traditional job roles, exacerbate skill mismatches, and widen existing socio-economic disparities. As such, the pursuit of AI-driven innovation must be accompanied by a concerted effort to address these challenges and ensure that the benefits of AI are equitably distributed across society.

In this introduction, we embark on a holistic exploration of the impact of AI on the economy, unraveling its transformative potential and examining the opportunities and challenges it presents. Through rigorous analysis and critical inquiry, we endeavor to illuminate the complexities and nuances of the AI-driven economy, providing insights that inform policy decisions, drive innovation, and shape the trajectory of economic development in the 21st century.

Main Body Text

The background of Artificial Intelligence (AI) encompasses a rich tapestry of technological advancements, theoretical breakthroughs, and societal implications that have shaped its trajectory from conceptual inception to widespread adoption. Understanding the historical context of AI is essential for appreciating its evolution and its profound impact on the global economy.

The roots of AI can be traced back to the mid-20th century, with seminal works by pioneers such as Alan Turing, John McCarthy, and Marvin Minsky laying the groundwork for the development of intelligent machines. Turing's seminal paper, "Computing Machinery and Intelligence," published in 1950, proposed the famous Turing Test as a measure of machine intelligence, sparking debates and inquiries into the nature of artificial intelligence and its potential manifestations.

In the following decades, AI research progressed along multiple fronts, fueled by advances in computer science, cognitive psychology, and mathematical logic. The 1956 Dartmouth Conference is often

cited as the birthplace of modern AI, where McCarthy, Minsky, Claude Shannon, and other luminaries convened to explore the feasibility of creating machines capable of simulating human intelligence. This event marked the formalization of AI as a distinct field of study and set the stage for decades of research and experimentation.

During the 1960s and 1970s, AI experienced both periods of optimism and disillusionment, characterized by significant advances in symbolic reasoning, expert systems, and problem-solving algorithms, interspersed with periods of stagnation and funding cuts. The development of expert systems, such as MYCIN for medical diagnosis and DENDRAL for chemical analysis, showcased the potential of AI to emulate human expertise in specific domains, albeit within constrained problem spaces.

The emergence of machine learning as a subfield of AI in the 1980s heralded a new era of experimentation and innovation, driven by the rise of neural networks, genetic algorithms, and statistical learning methods. The pioneering work of researchers such as Geoffrey Hinton, Yann LeCun, and Yoshua Bengio laid the foundation for modern deep learning techniques, revolutionizing the field of AI and propelling it to new heights of capability and performance.

The turn of the 21st century witnessed a renaissance in AI research, fueled by exponential growth in computational power, the availability of vast datasets, and breakthroughs in algorithmic efficiency. Deep learning, in particular, emerged as a dominant paradigm, enabling machines to learn intricate patterns and representations from raw data with unprecedented accuracy and efficiency. Applications of deep learning, ranging from image recognition and natural language processing to autonomous driving and robotics, permeate diverse sectors and domains, reshaping industries and economies worldwide.

The transformative potential of AI extends far beyond technological innovation, encompassing broader socio-economic implications that encompass ethical, legal, and regulatory considerations. As AI systems become more autonomous and pervasive, questions of accountability, transparency, and algorithmic fairness come to the forefront, necessitating robust frameworks and standards to ensure responsible AI deployment.

Moreover, the rise of AI has profound implications for labor markets, employment patterns, and income distribution, raising important questions about the future of work in an increasingly automated and digitized world. While AI promises to unlock new sources of economic value and productivity gains, it also poses challenges related to job displacement, skill mismatches, and workforce retraining, necessitating proactive measures to mitigate adverse impacts and promote inclusive growth.

In summary, the background of AI encapsulates a rich tapestry of scientific inquiry, technological innovation, and societal transformation that underscores its profound impact on the global economy. By tracing the historical trajectory of AI from its conceptual origins to its current state, we gain valuable insights into its evolution, its challenges, and its promise for shaping the future of humanity in the 21st century.

Methodology

The methodology section elucidates the systematic approach employed to assess AI dependency in the economy, providing insights into the framework, data collection methods, and analytical techniques utilized in the study. By delineating the steps involved in the assessment process, this section offers transparency and rigor, ensuring the credibility and reliability of the findings.

Framework Development

The development of the AI dependency assessment framework forms the cornerstone of the methodology, providing a structured framework for evaluating the extent to which countries rely on AI technologies for economic growth and development. The framework encompasses a comprehensive set of indicators, each capturing different facets of AI adoption, readiness, and impact. Drawing upon exist-

ing literature, expert consultations, and stakeholder feedback, the framework is designed to be holistic, adaptable, and contextually relevant, catering to diverse national contexts and priorities.

Indicator Selection

The selection of indicators is a critical aspect of the methodology, determining the breadth and depth of the assessment framework. Indicators are chosen based on their relevance, measurability, and significance in gauging AI dependency in the economy. Key indicators include AI contribution to GDP, AI adoption rates across industries, availability of AI talent and expertise, government initiatives supporting AI research and development, and the readiness of infrastructure for AI deployment. Each indicator is carefully curated to capture different dimensions of AI dependency, enabling a comprehensive and nuanced assessment of national AI ecosystems.

Data Collection and Validation

The methodology employs a multi-faceted approach to data collection, drawing upon a diverse array of sources, including government reports, academic studies, industry surveys, and international databases. Data collection efforts are guided by principles of reliability, validity, and transparency, ensuring the accuracy and integrity of the findings. To enhance data quality and robustness, multiple data validation techniques are employed, including cross-referencing, triangulation, and peer review. Moreover, efforts are made to mitigate biases and errors inherent in secondary data sources, such as sampling biases and data inconsistencies.

Weighting and Aggregation

Once the data is collected, the next step involves weighting and aggregating the indicators to derive composite scores for AI dependency. The weighting process involves assigning relative importance to each indicator based on its perceived significance and impact on AI dependency. Weighting criteria may vary depending on contextual factors, stakeholder preferences, and expert judgment. To ensure transparency and accountability, stakeholders are engaged in the weighting process, providing input and feedback on the relative importance of different indicators. Once the weights are assigned, indicators are aggregated using appropriate mathematical techniques, such as weighted averages or composite indices, to generate an overall score for AI dependency.

Sensitivity Analysis and Robustness Checks

To enhance the reliability and validity of the findings, the methodology incorporates sensitivity analysis and robustness checks to assess the stability and robustness of the results. Sensitivity analysis involves examining the impact of variations in input parameters, assumptions, and weighting schemes on the final outcomes. Robustness checks involve testing the consistency and reliability of the results across different scenarios, datasets, and analytical techniques. By subjecting the findings to rigorous scrutiny and validation, the methodology ensures the credibility and trustworthiness of the assessment outcomes.

AI Dependency Index Formula

The AI Dependency Index formula is at the core of our assessment methodology, serving as a quantitative framework for evaluating and comparing AI dependency across different countries. The formula, as follows:

AI Dependency Index

$$= w1 \times AIContribution + w2 \times AIAdoptionRate + w3 \times AIWorkforce$$

$$+ w4 \times \text{GovernmentInitiatives} + w5 \times \text{Infrastructure Readiness}$$

where:

- AI Contribution - represents the contribution of AI-related industries to the country's GDP.
- AI Adoption Rate - denotes the rate of AI technology adoption across different industries within the country.
- AI Workforce - signifies the availability and skill level of AI professionals within the country.
- Government Initiatives - represents the effectiveness of government policies, investments, and initiatives aimed at promoting AI research, development, and adoption.
- Infrastructure Readiness - denotes the readiness of the country's infrastructure for AI deployment.
- $w1, w2, w3, w4, w5$ - are weights assigned to each indicator based on their relative importance or significance in assessing AI dependency.

This formula enables policymakers, researchers, and stakeholders to quantify AI dependency, identify areas for improvement, and inform strategic decision-making and policy formulation in an increasingly AI-driven world.

Case Studies

Healthcare Sector Transformation. The healthcare sector is experiencing a profound transformation fueled by the integration of AI technologies. From disease diagnosis and treatment planning to drug discovery and patient care, AI is revolutionizing every aspect of healthcare delivery. One of the key areas where AI is making significant strides is in medical imaging, where deep learning algorithms can analyze complex imaging data with unprecedented speed and accuracy, aiding clinicians in early detection and diagnosis of diseases such as cancer and cardiovascular disorders. Moreover, AI-powered predictive analytics are enabling healthcare providers to identify patients at risk of developing chronic conditions, allowing for timely interventions and personalized treatment strategies. By harnessing the power of AI, the healthcare sector is poised to achieve greater efficiency, efficacy, and accessibility in delivering quality care to patients worldwide.

Financial Services Innovation

The financial services industry is undergoing a period of rapid innovation driven by advances in AI and machine learning. From algorithmic trading and risk management to customer service and fraud detection, AI-powered solutions are reshaping the landscape of financial services, enabling institutions to optimize processes, mitigate risks, and enhance customer experiences. For example, AI algorithms are being used to analyze vast volumes of financial data in real-time, identifying market trends and investment opportunities with unprecedented speed and accuracy. Similarly, chatbots and virtual assistants powered by natural language processing are revolutionizing customer interactions, providing personalized recommendations and assistance round-the-clock. As financial institutions embrace AI-driven innovation, they stand to gain a competitive edge in a rapidly evolving market environment, unlocking new sources of value and differentiation in an increasingly dynamic and competitive global marketplace.

Manufacturing Industry Disruption

The manufacturing industry is undergoing a paradigm shift driven by the integration of AI technologies into production processes and supply chain management. From predictive maintenance and quality control to demand forecasting and inventory optimization, AI-powered solutions are revolutionizing every aspect of manufacturing operations, enabling companies to achieve greater efficiency, flexibility, and responsiveness in meeting customer demands. For instance, AI-driven predictive maintenance algorithms can analyze sensor data in real-time to detect equipment failures and performance anomalies

before they occur, minimizing downtime and maximizing productivity. Similarly, AI-powered robots and cobots are transforming assembly lines and warehouse operations, automating repetitive tasks, and enhancing worker safety and ergonomics. By harnessing the power of AI, manufacturers can unlock new levels of productivity and innovation, driving sustainable growth and competitiveness in an increasingly digital and interconnected global economy.

Conclusion

In conclusion, the multifactorial analysis presented in this study, anchored by the AI Dependency Index formula, offers a robust framework for understanding the intricate dynamics of AI adoption and its impact on economies worldwide. Through a systematic evaluation of indicators such as AI contribution to GDP, technology adoption rates, workforce expertise, government initiatives, and infrastructure readiness, we gain valuable insights into the level of dependency on AI technologies across different countries.

The AI Dependency Index formula serves as a quantitative tool to gauge the relative importance of these indicators and to compare AI readiness and dependency among nations. By assigning weights to each indicator based on their significance, policymakers and stakeholders can prioritize areas for intervention and investment to foster AI-driven innovation and economic growth.

The case studies presented in this research underscore the diverse applications of AI across sectors, from healthcare and finance to manufacturing, highlighting the transformative potential of AI technologies. As AI continues to reshape industries and societies, it is essential to adopt responsible AI practices, promote ethical considerations, and ensure that AI benefits are equitably distributed.

Looking ahead, the AI Dependency Index formula provides a roadmap for policymakers and stakeholders to navigate the complexities of the AI-driven economy. By leveraging data-driven insights and evidence-based strategies, we can harness the full potential of AI to address global challenges, drive sustainable development, and create a better future for all.

In summary, the AI Dependency Index formula serves as a powerful tool for assessing AI readiness and dependency, guiding policy decisions, and shaping the trajectory of economic development in the 21st century. Through collaborative efforts and forward-thinking initiatives, we can harness the transformative power of AI to build inclusive, resilient, and prosperous societies for generations to come.

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ხელოვნურ ინტელექტზე დამოკიდებულება: მულტიფაქტორული ანალიზი და AiDi ინდექსი

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რეზიუმე

ხელოვნური ინტელექტი (AI) უკვე წარმოადგენს ტრანსფორმაციული ძალას, რომელიც ცვლის ეკონომიკას მთელ მსოფლიოში. ეს ნაშრომი წარმოგიდგენთ AI-ზე დამოკიდებულების შეფასების ყოვლისმომცველ ჩარჩოს, რომელიც მიზნად ისახავს რაოდენობრივად განსაზღვროს ქვეყნების დამოკიდებულება AI ტექნოლოგიებსა და შესაძლებლობებზე. ჩვენ ვთავაზობთ მრავალფაქტორულ ანალიზს, რომელიც აერთიანებს სხვადასხვა ინდიკატორებს, მათ შორის AI-თან დაკავშირებული ინდუსტრიების წვლილს მშპ-ში, ხელოვნური ინტელექტის ტექნოლოგიის მიღებულობის დონეს, გამოცდილი AI პროფესიონალების ხელმისაწვდომობას, სამთავრობო ინიციატივებს, რომლებიც მხარს უჭერენ ხელოვნურ ინტელექტის განვითარებასა და ინფრასტრუქტურის მზადყოფნას. თითოეული ინდიკატორი შენონილია მისი ფარდობითი მნიშვნელობის მიხედვით, რომელიც განისაზღვრება ექსპერტთა შეფასებით და სტატისტიკური ანალიზით. შესწავლისა და ემპირიული ანალიზის საშუალებით ჩვენ შეგვიძლია გავაანალიზოთ სხვადასხვა ქვეყნის AI-ზე დამოკიდებულება, რაც პოლიტიკის შემქმნელებს, მკვლევარებს და დაინტერესებულ მხარეებს საშუალებას მისცემს გააანალიზოს, შეაფასოს და გადაჭრას AI-ზე ორიენტირებულ ეკონომიკასთან დაკავშირებული გამოწვევები და შესაძლებლობები.

საკვანძო სიტყვები: ხელოვნური ინტელექტი, ხელოვნურ ინტელექტზე დამოკიდებულების ინდექსი, ეკონომიკური გავლენა, მულტიფაქტორული ანალიზი, პოლიტიკის შედეგები.

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