Activation of Artificial Intelligence Technology Capacities in Expanding Economic Strategies and National Macroeconomic Policies with a Piloting Approach

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Abstract
The present study aimed to activate the technological capacities of artificial intelligence in expanding economic strategies and national macroeconomic policies. This research, conducted with a piloting approach to improve the research process through identifying weaknesses, refining tools and methods, and preventing issues that may arise on a larger scale, is applied in terms of its purpose and qualitative in nature, using a data-driven and exploratory approach. It was carried out in two phases. In the first phase, the participants were experts from the industrial and academic sectors (managers of knowledge-based companies in the field of information technology and university professors with a Ph.D. in economics and technology). These participants were selected using purposive sampling based on the principle of theoretical saturation, and 18 individuals were chosen as the sample. The data collection tool was semi-structured and in-depth interviews with participants. Initially, the data obtained from the interviews were implemented based on the systematic approach of Strauss and Corbin, and analyzed in three stages: open coding, axial coding, and selective coding. The validity and analyses conducted were confirmed by the interviewees. In the second phase, the results of the analysis (from phase one) were formulated into a questionnaire and distributed in three rounds using the Delphi method among 42 managers (from startups, organizations, and governmental institutions). In the first round of Delphi, the questionnaire was distributed among 15 experts, and after calculating the Kendall's concordance coefficient of 0.564, 25 components were eliminated. In the second and third rounds of Delphi, the questionnaire was distributed among 15 and 12 individuals, respectively. Since the significance level for all components was less than 5%, no components were eliminated in the second and third rounds, and the Kendall's concordance coefficient was calculated as 0.600 and 0.788, respectively, indicating strong consensus among the members. Finally, the research model was developed with 6 main categories and 55 subcategories.

Keywords: *Artificial Intelligence Technology, Economic Strategies, Macroeconomic Policies, Piloting Approach*.
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1. Introduction

With the expansion of globalization, the new economy is now steering society toward progress and prosperity. Whenever a new technology emerges, the shift from an agricultural and industrial economy to a knowledge-based economy can occur. Thus, knowledge and information play a crucial and effective role, as it allows for the transition from the idea of the survival of the fittest to the survival of the fastest. Therefore, knowledge and information technology complement capital and have become a key factor for economic growth and macro-level policy-making [1].

In this context, knowledge has always played a significant role in human life, and in the modern world, its importance has increased remarkably [2]. Knowledge and information have become the primary wealth of organizations in all countries, and industrial nations are increasingly seeking to use this wealth in decision-making processes regarding macro-political and economic policies in today's dynamic global environment [3]. Information and communication technology is one of the essential tools for expanding political and economic activities and accelerating economic growth [4].

Today, the use of information systems, particularly artificial intelligence systems, has gained greater importance. It is evident that advanced and emerging technologies have played an undeniable role in the increasing development of technological transformations across all industries. Most countries that have succeeded in achieving superior technologies have been able to convert ideas and knowledge into practical and profitable products through appropriate policies and strategies [5].

In recent years, artificial intelligence has demonstrated impressive applications in various economic and commercial sectors [5]. Artificial intelligence is indeed the driving force behind economic development [2], leading to fundamental changes in structure, production processes, and the quantity and quality of consumption [6]. Therefore, the impact of artificial intelligence growth on the economy—both in the real sector and in production, as well as in market analysis and economic analysis at the micro level—is undeniable [7].

In general, artificial intelligence functions as the ability to process and convert data into information for purposeful behavior. With the rapid development of technology and the elimination of human-centered organizations, it transforms organizations and companies, activating innovation management within them [5].

Investments in artificial intelligence have seen significant growth globally in recent years, largely due to the recognition of its capabilities and the introduction of serious applications for it, particularly during the pandemic, which created an opportunity for more effective use of this technology. It is expected that by 2030, the global economy will grow by $20 trillion with the help of artificial intelligence, and the Middle East will see a $320 billion increase in its regional economy. Furthermore, it is predicted that artificial intelligence will have a prominent position in Iran within the next five years, as the government and private sector have expressed interest in investing in this area. With a large pool of young and talented human resources, this forecast seems to be very close to reality. Therefore, by 2031, the Islamic Republic of Iran will position itself among the top 10 countries globally in artificial intelligence, utilizing the ethical capabilities of artificial intelligence and relying on its internal capabilities and skilled, creative experts. This will help boost economic growth and increase social welfare. In this vision, economic factors and macro-policies of the government are of special significance [3, 8].

The issue of artificial intelligence is a new topic in both foreign and domestic research. However, a review of studies conducted inside and outside the country reveals that insufficient research has been done on the activation of artificial intelligence capacity in expanding economic strategies and macro-policies. For example, Tolan et al. (2023) have examined the impact of artificial intelligence on employment in society, designing an analytical framework to assess the impact of AI on employment and ranking AI-related jobs, thus enhancing awareness and insight for individuals entering the labor market [9]. Qin et al. (2023) focused on artificial intelligence and examined its impact on economic growth [2]. In a different study, Miller (2019) focused on social sciences and explained artificial intelligence, suggesting that AI could be developed based on research in fields such as the philosophy of psychology and social psychology [10]. In another noteworthy study, Kath (2018) examined AI governance frameworks in technical, ethical, and legal dimensions, addressing the challenges and opportunities related to these three aspects. He argues that the significant effects of AI on banking, social welfare, and human rights indicate the widespread adoption of AI and, in other words, AI governance, which requires consideration for evaluating the fairness and transparency of this governance [11]. Sharifzadeh et al. (2024) emphasize that

substantial investment in AI by developed nations has led to competitive advantages in macro-political strategies, contributing to economic improvements and research advancements. They argue that focusing on AI technologies in various political, economic, and social spheres could significantly strengthen the Islamic Republic of Iran's regional and global standing [3]. Similarly, Mousavi et al. (2021) demonstrate that deep learning models, especially those combining recurrent and fully connected networks, enable more accurate economic predictions, reducing risks and uncertainties while improving policy decisions at the macroeconomic level [12]. Vaghfi and Darabi (2020) validate the use of AI algorithms, such as decision trees, in predicting financial distress within the industrial and mining sectors, showing superior performance over other methods like Bayesian classification and support vector machines [13]. Additionally, Atashbar and Shi (2023) suggest that deep reinforcement learning (DRL) models can optimize macroeconomic decisions, with potential improvements through the inclusion of additional variables [14]. Novikov et al. (2022) highlight the role of DevOps techniques in integrating AI for the successful coordination of development and operational teams, further advancing digital economy initiatives [15]. Lastly, Reis et al. (2020) argue that AI-driven decision support systems can enhance political decision-making processes, with significant implications for policy development at local, regional, and national levels in the European Union [16]. These studies collectively underline the transformative impact of AI on both economic and political strategies, positioning it as a key tool for future policy development and economic forecasting.

The importance of science and technology policies in achieving the 20-year national document and the 1404 vision is not hidden from political and social scholars. Undoubtedly, the promotion of knowledge and technology production paves the way for the country's progress toward the political system's higher objectives [17]. In this regard, this research project aims to explore the activation of artificial intelligence capacities in expanding economic strategies and macro-policies through a pilot approach. The use of artificial intelligence can have significant positive impacts on the country's economy by improving efficiency and productivity, leading to cost and time savings. As artificial intelligence gains prominence in Iran, new industries and job opportunities will emerge, ultimately enhancing the quality of life for citizens. This could lead to economic growth through foreign investment and the introduction of new technologies. The project aims to fully identify the issue through pilot testing, utilizing artificial intelligence's capabilities in Iran. This research will be conducted simultaneously at two locations: startups and knowledge-based companies and various government organizations and institutions (Ministry of Economic Affairs and Finance, Ministry of Cooperatives, Labor and Social Welfare, Ministry of Industry, Mine and Trade, Plan and Budget Organization, Ministry of Cultural Heritage, Tourism and Handicrafts, Ministry of Health, Ministry of Agriculture, Ministry of Communications and Information Technology, and Ministry of Oil).

2. Methodology

In this study, a combination of three methods—piloting, grounded theory, and Delphi—was used. The piloting method, or preliminary study, is a research technique conducted to evaluate and prepare the tools, methods, and processes for the main research. The aim of this method is to improve the research process by identifying weaknesses, refining tools and methods, and preventing issues that may arise on a larger scale. Piloting research serves as a key phase in scientific investigations, strengthening the link between theory and practice and enhancing the quality of the final main study. The grounded theory method is designed to generate theory based on empirical data. In this method, data are collected through observation or interviews, and analysis is performed inductively. The Delphi method is a decision-making and forecasting technique designed based on collecting expert opinions in multiple rounds. Therefore, combining these three methods can help researchers achieve more comprehensive and accurate results.

Thus, this research, with a piloting approach, is classified as applied research in terms of its objective. In terms of execution, it is categorized as qualitative research (grounded theory and Delphi) and exploratory in nature. This is because, during the piloting phase, the researcher tested the data collection tools and then used grounded theory to extract new theories from the collected data. Finally, Delphi was used for validating the developed theories and achieving consensus regarding the research findings.

The statistical population of this research consists of two groups. The first group of participants includes experts from the industry and academia (managers of knowledge-based companies in the information technology sector and university professors holding PhDs in economics and technology). A total of 18 participants were selected using

theoretical sampling and purposive sampling based on the principle of theoretical saturation. In the second group, the panel members included 42 experts and managers from startups and managers of organizations and government institutions. These participants were selected based on their educational background and work experience in the fields of economics and technology.

The data collection tool in the first phase of the research was semi-structured and in-depth interviews with participants, which were conducted with open-ended questions and lasted between 30 to 105 minutes. Sometimes, the interviews were repeated to share preliminary findings, complete, refine, and adjust the data. With the participants' consent, these interviews were recorded so that, upon reviewing the conversations, a more accurate analysis and examination of the participants' views could be conducted. After each interview, the analysis and coding of the data were carried out. Based on the analysis of each interview, the research questions were refined, and the direction of the research was determined. Quick note-taking during each interview and detailed analytical notes on each concept derived from the data helped the researcher to overcome many ambiguities that arose during the research. In the second phase of the research, the data collection tool was a researcher-made questionnaire, and the Delphi method was used to collect the necessary information. This questionnaire was designed and developed based on the analysis and coding of the expert interviews in the first phase of the research. The questionnaire consisted of two sections (closed and open) and a total of 56 questionnaires were distributed in three rounds: 20 questionnaires in the first and second rounds, and 16 in the third round. The questionnaires were distributed in person and electronically among the managers of startups and government organization leaders who were informed and briefed by phone or in person. After one to three weeks, follow-up was initiated to collect responses, and after four contact attempts (on average), 42 usable questionnaires were received and analyzed.

In the first part of the research, data analysis was based on the systematic approach of Strauss and Corbin (2008), using open coding, axial coding, and selective coding. Concepts and categories were generated, and the systematic relationship between categories was identified. Initially, all statements obtained from the participant interviews were transcribed and important elements were extracted through several reviews. The data were categorized separately for each participant. In this study, the unit of analysis was the paragraph, meaning after eliminating irrelevant statements, the information was categorized into several paragraphs. In the next phase, the concepts derived from the statements were extracted and coded. Initially, appropriate codes were assigned to various sections of the data, and finally, these codes were grouped into categories (open coding). In the subsequent phase, the researcher moved away from open coding and examined the relationship between each category and its subcategories. In this phase, the researcher placed the main category at the center and connected other categories to it (axial coding). Finally, the researcher, after reviewing the open and axial coding, reflected on the main phenomenon and the relationship of each cluster of open categories. The researcher also considered the emerging category clusters and finalized the main category block, which itself contained several components. In the end, by consolidating and explaining the relationships between the categories, the process of reaching a theory and stating its causes was completed.

For data analysis in the second qualitative part of the research, the Delphi technique and Kendall’s coefficient of concordance were used. The necessary data for the Delphi method were obtained through semi-structured and in-depth interviews with participants in the first phase of the research, organized into a researcher-made questionnaire. Based on the subject, the required expertise was determined, and Delphi panel members were identified and selected in three rounds using non-probability sampling methods. After determining the panel members, the Delphi method was conducted in three rounds. In designing the Delphi questionnaire for this research, two scales were used: 1) the degree of congruence of the components with the dimension, and 2) the degree of importance of the component for commercialization, to gather expert opinions. In this section, each respondent had to choose an option between 1 and 10 for both scales. The questionnaires for each round were distributed and collected both in person and electronically (via email, WhatsApp, and Telegram). Then, in each of the three rounds of the Delphi method among 42 managers from startups and government organizations, Kendall’s coefficient of concordance was used to determine the degree of agreement among the panel members.

The results of the three rounds of the Delphi method show that the Kendall’s coefficient of concordance for the panel members’ responses regarding the degree of congruence of the components with the dimension and the importance of the factors for commercialization were calculated according to Table 1. All values were significant in the second and third rounds. Since the level of consensus among the members did

not show significant growth across the three rounds, the Delphi rounds were concluded.

Table 1. Kendall's Coefficient of Concordance Calculation for the Three Rounds of Delphi

Round	Number of Participants	Kendall's Coefficient	Significance Level
First	15	0.564	0.006
Second	15	0.600	0.001
Third	12	0.788	0.001

3. Findings

In response to the research question (What is the appropriate model for activating the capacities of artificial intelligence technology in expanding economic strategies and macro-level policymaking using a pilot approach?), the qualitative data collected from the semi-structured interviews with research participants (experts and scholars from the industry and academia) were analyzed using open, axial, and selective coding. The summary of the findings obtained from the three stages of coding is presented in Table 2:

Table 2. Dimensions, Categories, and Statements Derived from Kendall's Coefficient of Concordance

Dimensions	Categories	Statements
Causal Conditions	Technological Infrastructure Factors	- Access to high-speed internet - Advanced hardware and software - High-capacity data centers and strong processing capabilities
	Financial Investment Factors	- Allocation of public and private budgets to AI projects - Support for startups and knowledge-based companies
	Specialized Human Resources Factors	- Training data scientists, machine learning engineers, and AI specialists - Transfer of knowledge and technology from developed countries
	Legal and Regulatory Support Factors	- Establishing clear legal frameworks for the use of AI - Addressing legal and ethical barriers to the use of this technology
Contextual Conditions	Cultural and Social Factors	- Acceptance of AI in society - Promoting digital literacy and public trust in new technologies
	Government Policy Factors	- Formulating national strategies for AI development - Use of AI in public sectors such as health, education, and security
	Macroeconomic and Financial Sustainability Factors	- Impact of economic conditions on resource allocation to technology projects - Financial sustainability of companies and industries in adopting new technologies
	Industrial and Commercial Structure Factors	- Readiness of industries to adopt AI technology - Impact of this technology on employment and economic productivity
Strategies	Investment Strategy	- Supporting startups and new companies - Providing financial incentives and tax exemptions for AI-related businesses
	Educational and Human Resource Development Strategy	- Specialized training programs - Enhancing digital literacy
	Technological Strategies	- Developing digital infrastructure - Localization of technology
	International Partnership Strategies	- Scientific and research collaborations - Technological competition and diplomacy
Core Phenomenon	Governance and Policy Factors	- Regulation and supportive policies - Formulating clear laws for AI use - Supportive policies for AI-related businesses - Ensuring transparency in algorithm usage - Identifying and managing the security and economic risks of AI - Preventing potential harms such as unemployment caused by automation
	Environmental and International Factors	- Role of AI in strengthening the competitive position of countries - Impact of trade policies and sanctions on technological development - Formation of regional and global alliances for AI development - Knowledge and technology exchange with advanced countries
Intervening Conditions	Structural Factors	- Level of economic development - Status of digital infrastructure - Organizational readiness

	Social and Cultural Factors	- Cultural and social acceptance of technology - Level of digital literacy - Resistance to change
	Political and Governmental Factors	- Political stability - Bureaucratic challenges - Legal and regulatory support
Outcomes	Economic Outcomes	- Increased productivity - Sustainable economic growth - Transformation of the labor market
	Social Outcomes	- Improved quality of life - Reduced inequalities - Enhanced public trust
	Technological Outcomes	- Progress in innovation - Enhanced digital security
	Political Outcomes	- Strengthened national power - Enhanced technological diplomacy

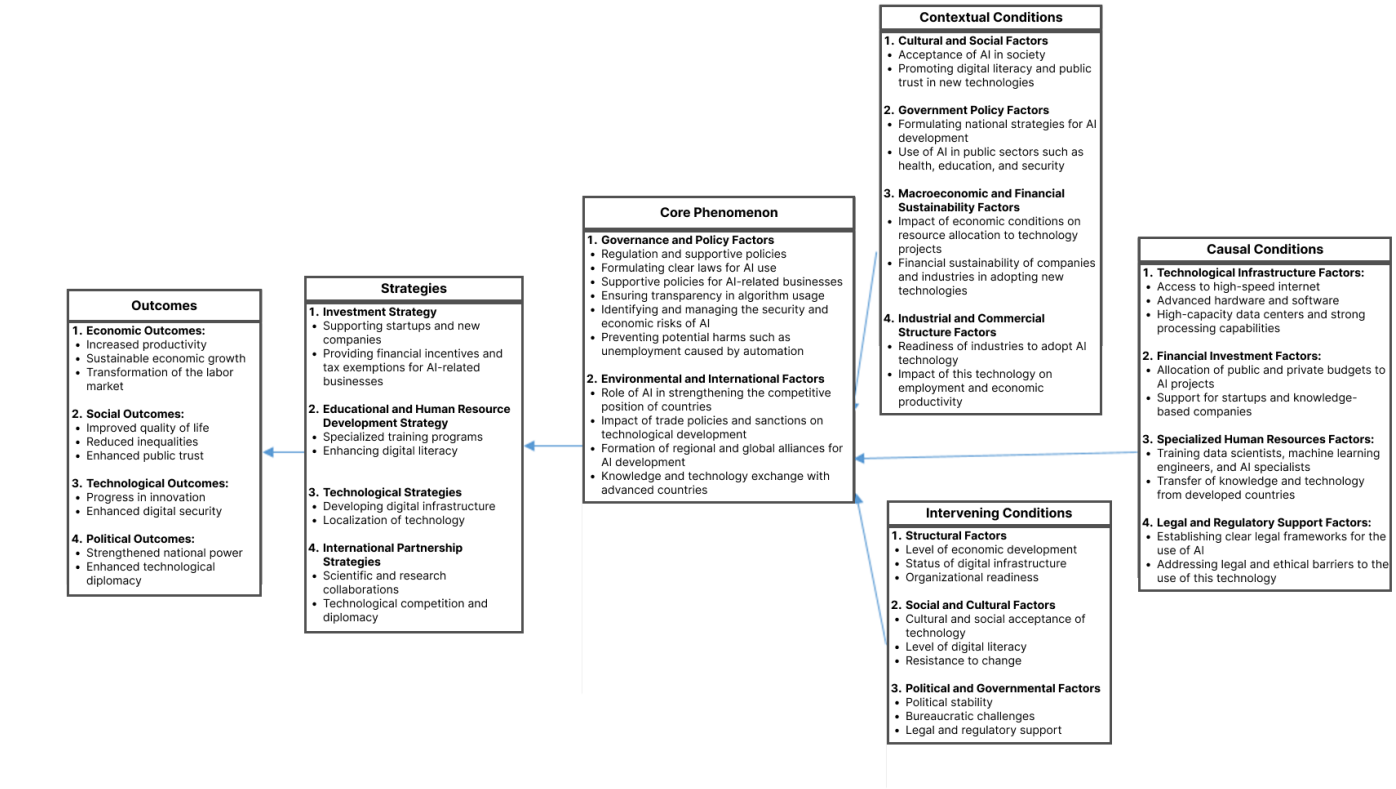

Figure 1. Conceptual Model of the Study

4. Discussion and Conclusion

The findings of this study underscore the significant potential of artificial intelligence (AI) technologies in transforming macroeconomic strategies and policy-making across various domains. The results revealed several key dimensions influencing the activation of AI capabilities in national economic strategies, including infrastructural factors, human capital, legal support, and organizational readiness. Specifically, the study highlights that the integration of AI into economic policy can enhance decision-making processes, reduce uncertainties, and drive economic growth. The study's findings align with existing literature, confirming the crucial role of AI in both political and economic spheres, as well as its potential to offer competitive advantages to countries focusing on technological advancements.

Sharifzadeh et al. (2024) found that large-scale investment in AI by developed countries has enabled them to achieve a competitive advantage in macro-political policies, leading to improved economic conditions and fostering research and development [3]. This aligns with our study's findings, where the presence of advanced

technological infrastructure and financial investments in AI-related projects was shown to significantly contribute to the economic and political advancement of a nation. The research suggests that developing countries, including Iran, can benefit greatly from integrating AI into national policy-making, particularly in fostering economic development and international standing. The study's emphasis on the importance of investing in advanced technological infrastructures mirrors the findings of previous studies, such as those by Mousavi et al. (2021), who showed how AI technologies could predict large-scale economic changes with high accuracy, thus aiding policymakers in making informed decisions to navigate economic uncertainties [12].

Moreover, Mousavi et al. (2021) illustrated that deep learning models, particularly those combining recurrent and fully connected networks, offer substantial benefits in predicting economic outcomes [12]. Our study mirrors this by showing how AI-based approaches help policymakers navigate large-scale risks and uncertainties, providing a clearer path toward efficient economic strategies. The ability of AI to synthesize and analyze vast amounts of data was a crucial factor in mitigating risks in policy-making. Vaghfi and Darabi (2020) also found that AI algorithms, particularly decision trees, are highly effective in predicting financial distress in sectors like industry and mining [13]. The findings of the present study further support this, as AI algorithms were found to be instrumental in predicting and managing financial crises, highlighting the intersection between AI technologies and financial stability.

The study also corroborates the conclusions of Atashbar and Shi (2023), who demonstrated the effectiveness of deep reinforcement learning (DRL) models in optimizing macroeconomic decisions [14]. Our findings further support the idea that AI technologies, particularly those employing DRL models, have the capacity to enhance policy-making by incorporating real-time data and improving decision-making processes. The use of such advanced AI models in policy-making would significantly contribute to better handling macroeconomic issues such as inflation, unemployment, and trade imbalances. At the same time, Novikov et al. (2022) provided valuable insights into the role of DevOps techniques in facilitating AI adoption in digital economy initiatives. Their research highlighted the importance of team integration and collaboration in ensuring the successful deployment of AI technologies [15]. The findings of our study align with this perspective, emphasizing the need for organizational readiness and a conducive work environment for the successful implementation of AI solutions in national economic policies.

In summary, the findings of this study are consistent with existing literature on AI's role in economic forecasting and policy-making, reinforcing the idea that AI technologies hold transformative potential in shaping both economic and political landscapes. By aligning the results with previous studies, we see a clear pattern of AI facilitating better decision-making, optimizing economic strategies, and enhancing national competitiveness. The integration of AI in policy-making, as highlighted by several studies, offers a significant opportunity for countries to better manage their economies and address global challenges more effectively.

Despite the promising results, this study has several limitations that need to be acknowledged. One of the primary limitations is the focus on a specific context, which may limit the generalizability of the findings. The study primarily centered on AI's potential in macroeconomic policies in Iran, and while the results can offer insights for other developing countries, caution should be taken when applying them to different geopolitical contexts. Economic structures, political environments, and technological infrastructures can vary significantly from one country to another, which may influence the applicability of the findings in other regions or nations.

Another limitation is the reliance on qualitative data, specifically from semi-structured interviews with experts in the field. Although this approach allows for in-depth insights into the perspectives of key stakeholders, it may introduce a level of subjectivity that could affect the consistency and validity of the findings. The perceptions of a relatively small group of experts may not fully represent the broader population of policymakers, economists, or AI specialists. Additionally, the study did not incorporate quantitative data or empirical testing to validate the findings, which would have enhanced the robustness of the conclusions.

Furthermore, the study focused primarily on the benefits of AI in macroeconomic policy-making but did not fully explore the potential challenges and risks associated with the integration of AI into these processes. While AI offers significant advantages, it also presents several ethical, legal, and security concerns, such as the risk of bias in AI algorithms, data privacy issues, and the potential for job displacement due to automation. Future research should address these concerns in more detail to provide a balanced perspective on the role of AI in economic policy.

Future research could build on this study by exploring the broader applications of AI in economic policy across

different sectors. While this study focused on the role of AI in macroeconomic decision-making, it would be valuable to examine how AI can be applied to specific areas such as healthcare, education, and environmental policy. Researchers could explore the impact of AI on policy decisions at the microeconomic level, including how AI influences individual business practices and the decision-making of SMEs (small and medium-sized enterprises).

Additionally, future studies should investigate the challenges and risks associated with AI integration in economic policy-making. While AI offers numerous benefits, such as improved decision-making and enhanced predictive capabilities, there are significant ethical, legal, and technical challenges that need to be addressed. For instance, AI systems are susceptible to bias, and there are concerns about the transparency of AI decision-making processes. Examining these challenges will help policymakers develop strategies to mitigate potential risks and ensure the responsible use of AI in economic governance.

Furthermore, longitudinal studies could be conducted to assess the long-term effects of AI implementation on national economic performance. Most of the existing studies on AI in economic policy focus on short-term outcomes, but there is limited research on how AI technologies impact economic performance over extended periods. By tracking the effects of AI-driven policies over time, researchers could provide a more comprehensive understanding of the long-term benefits and drawbacks of AI adoption in economic governance.

Given the findings of this study, there are several practical implications for policymakers and practitioners involved in the development and implementation of AI technologies in economic policy. First, it is essential to invest in the development of robust technological infrastructures to support AI adoption. This includes ensuring access to high-speed internet, developing data centers with strong processing capabilities, and providing adequate hardware and software resources. Moreover, fostering a skilled workforce through specialized education and training programs will be critical in ensuring that there is a sufficient pool of AI experts to guide the implementation of AI in policy-making.

In addition to technological and human resources, policymakers must also create a conducive legal and regulatory environment for AI adoption. This involves developing clear, transparent regulations that address ethical concerns related to AI, such as data privacy, bias, and algorithmic transparency. Furthermore, governments should focus on creating incentives for businesses to invest in AI technologies, particularly for small and medium-sized enterprises (SMEs) that may lack the resources to implement AI on their own. Financial support in the form of grants, tax breaks, and low-interest loans could help stimulate AI adoption in various sectors of the economy.

Finally, to successfully integrate AI into economic policy, there is a need for collaboration between different stakeholders, including government agencies, industry leaders, and academic institutions. Cross-sector partnerships will help ensure that AI technologies are developed and deployed in a way that aligns with national economic goals. Collaborative efforts can also facilitate the exchange of knowledge and expertise, accelerating the adoption of AI and maximizing its potential benefits in policy-making. By fostering a culture of collaboration and knowledge-sharing, governments can ensure that AI technologies are harnessed effectively for the advancement of national economic strategies.

Authors' Contributions

Authors equally contributed to this article.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

All procedures performed in this study were under the ethical standards.

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