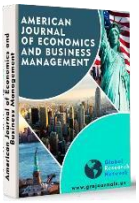

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Article

Ai Adoption in Macroeconomics and International Trade Issues Research: Mapping and Trends

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Abstract: Technologies in AI, namely Machine Learning (ML) and Neural Networks have begun to influence various economic fields such as macroeconomics and international trade. The shift from symbolic reasoning to more exploitative methods have paved new paths for the field to tread on, the most primed, perhaps, in economic analysis in the form of predictions and policies. The integration of AI into economics has been slow, working hand-in-hand with the developments of computational power and Big Data. The historical evolution of AI in economics has transitioned from expert systems to ML methods, which are now increasingly more about prediction and less about shape the world through optimal solutions by reusable patterns. However, whilst AI shows great potential, its take-up in economic research, particularly within the fields of macroeconomics and international trade, has lagged behind other fields such as the sciences. We have a very little understanding of how to better integrate AI with traditional economic mode of operation for more equity, effective decision making. Abstract Our approach in this study uses the scientometric methodology to examine the diffusion of AI methods adoption in macroeconomics and international trade. It gives theoretical perspectives on institutional roles, regional and academic structures driving this change, as well as empirical findings on changes made in the use of AI-augmented systems for doing economic modeling and planning. Advances in machine learning and associated concepts such as neural networks led to more promising applications of AI which started generating a lot of interest among other fields and these fields would start using these methods.

Keywords: Artificial Intelligence (AI), Macroeconomics, International Trade, Machine Learning, Scientometric Analysis, Economic Subfields

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1. Introduction

Artificial Intelligence (AI) has profoundly influenced many academic fields, including economics, especially in macroeconomics and international trade. The development of AI, rooted in philosophical and scientific advancements, began with early dreams of human-like machines, such as Leonardo da Vinci's robot knight and Vaucanson's duck. Landmark events, like the 1956 Dartmouth Project, marked the formal foundation of modern AI research [1]. This evolution mirrors broader developments in computer science and mathematics, which have shifted from symbolic reasoning to computational theories designed to solve complex problems more effectively.

In economics, AI introduces precision, especially in behavioral sciences. Pioneers like Herbert Simon used AI to model human decision-making, enhancing the rigor of economic theories [2]. Norbert Wiener's work on cybernetics laid the groundwork for applying

feedback systems to economics, helping economists model adaptive economic processes without making rigid assumptions about economic dynamics [3].

By the mid-20th century, economics aligned more with engineering through the application of quantitative methods. This shift was crucial for the integration of AI into economic analysis [4]. Paul Samuelson's emphasis on mathematical rigor set the stage for incorporating machine learning and neural networks in economic modeling. In the 21st century, the widespread availability of Big Data further solidified AI's role in economics, especially in macroeconomic forecasting and international trade analysis. These advancements are seen as crucial to enhancing decision-making in complex and dynamic economic environments. Recent advancements in Big Data, machine learning (ML), and deep learning (DL) have enabled economists to make more accurate predictions and models, sparking debates on whether AI can resolve complex economic problems as Friedrich Hayek had argued were unsolvable [5]. This debate highlights a central issue: while AI offers new ways to analyse economic data, it cannot replace the theoretical frameworks that underpin economic thinking. Economists must remain critical of how AI is used, ensuring that predictions and models do not overlook the human elements of decision-making.

However, AI still faces challenges in addressing economic complexity. Both Simon and Hayek pointed out that while AI can improve data collection and predictions, it cannot fully grasp the nuances of human behaviour or localized economic knowledge [6]. Economists must navigate the tension between applying engineering principles focused on efficiency and the broader, unpredictable nature of economics, which highlights a central issue: while AI offers new ways to analyse economic data, it cannot replace the theoretical frameworks that underpin economic thinking. Economists must remain critical of how AI is used, ensuring that predictions and models do not overlook the human elements of decision-making [7].

AI research has experienced periods of optimism and stagnation, known as "AI summers" and "winters." Despite setbacks in the 1970s and 1980s, the resurgence of AI in the 2000s, driven by advances in computational power and Big Data, has led to its widespread use in economics, particularly for prediction and classification [8].

This paper investigates the history and adoption of AI in economics through

a scientometric approach, focusing on its application in macroeconomics and international trade. The study provides empirical insights into how AI methods have been incorporated into these subfields, the key researchers and institutions involved, and the evolving role of AI in economic calculation and planning.

2. Materials and Methods

This study employs a bibliometric approach to analyse the use of AI in macroeconomics and international trade. Data were sourced from Scopus and EconPapers, focusing on AI-related articles in economics journals that aligned with specific JEL classification codes. Articles unrelated to these fields or with niche AI terms were excluded.

The study did not involve human subjects, focusing instead on bibliometric data such as institutional affiliations and author profiles. The Pybliometrics Python package was used to handle and process data from Scopus IDs and ISSNs. The analysis tracked AI methods (learning and non-learning-based) across time, regions, and subfields. It also examined the role of prestigious institutions in the diffusion of AI methods in economics [9]. A focus was placed on identifying key trends, geographical variations, and the influence of top-tier research institutions on AI adoption in economic research.

Additional qualitative analysis was conducted to understand the thematic evolution of AI research in these subfields. By analyzing the keywords and abstracts of relevant articles, the study identified shifts in research focus over time, such as the move from

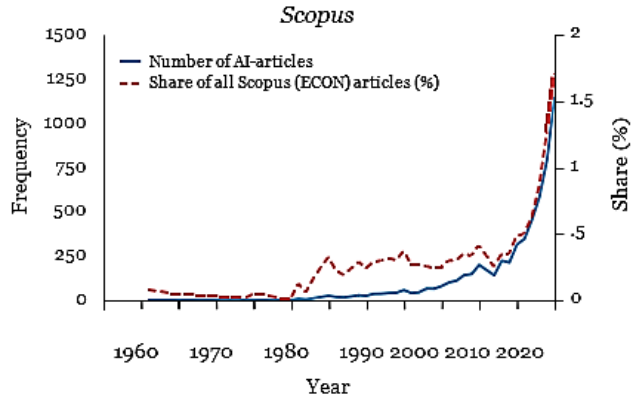
symbolic AI to machine learning. Co-occurrence analysis of JEL classification codes was used to track interdisciplinary research and collaboration, offering insights into how AI methods are being applied across various economic subfields. This provides a comprehensive overview of the integration and transformation of AI methodologies within macroeconomic and trade-related research.

3. Results

AI-related publications in economics have steadily increased since 1986, with a significant rise in the share of papers focused on AI, from 0.13% to 2.4% between 1986 and 2021 [10]. This upward trend is closely tied to the growing availability of computational resources and the increasing complexity of economic challenges, which demand more sophisticated tools for analysis. The early stages of AI in economics were marked by a focus on expert systems and symbolic reasoning, but over time, more flexible and adaptive methods, such as machine learning, gained prominence.

Machine learning and neural networks emerged as crucial tools in economic analysis during this period, particularly in macroeconomics and international trade [11]. Early symbolic AI methods struggled to handle complex economic systems, but connectionist models and Big Data have revitalized AI's role in the field [12]. Newer models enable economists to tackle issues like economic shocks, international trade agreements, and global supply chain disruptions with greater precision. For instance, AI algorithms are now used to simulate trade scenarios, optimizing agreements between countries based on a scope of *economic integration indicators*. This evolution illustrates the growing importance of AI in addressing both theoretical and practical challenges in countries economics integration.

Learning-based AI methods dominate AI research in economics. In *EconPapers*, 80.5% of AI-related papers between 2010 and 2020 focused on machine learning and deep learning, compared to 40%-55% in Scopus [13]. This suggests that recent advancements in AI have been primarily driven by AI-techniques, which offer a more adaptable and efficient approach to handling economic integration data value. The dominance of learning-based AI methods *highlights the importance* of prediction and pattern recognition in modern economic integration research, especially in macroeconomics and international trade with foreign nations (Fig 1).



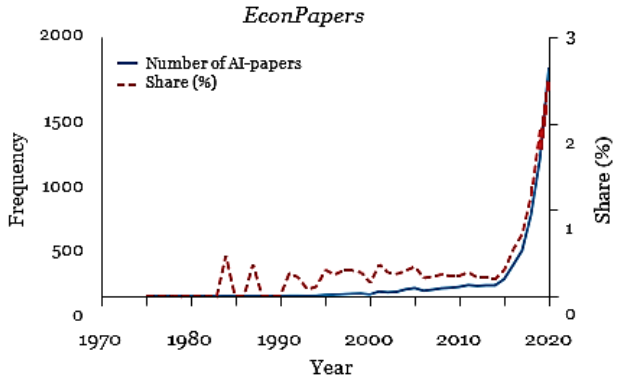


Fig. 1 Growth of AI-related economics papers in *Scopus* and *EconPapers* and relative (%) to overall number of economics papers over time (courtesy: Bickley, S.J., Chan, H.F. & Torgler, B. Artificial intelligence in the field of economics. Scientometrics 127, 2055–2084).

A smaller share of AI research in economics focuses on economic calculation and social planning, with the proportion of related papers remaining stable over the decades [14]. Ethical concerns regarding AI's role in economic decision-making have become more prominent in recent years, particularly as machine learning models are increasingly used for public policy and social planning. Issues such as data privacy, algorithmic bias, and the transparency of AI systems are critical for ensuring that AI contributes to equitable and responsible economic outcomes [15].

4. DISCUSSION

AI's application in macroeconomics and international trade has expanded, but its adoption remains slower compared to other economic subfields like environmental economics. Machine learning offers promising tools for enhancing policy-making and predictive accuracy, but traditional econometric methods still dominate in these fields [16]. The slower uptake in macroeconomics and international trade may be due to the complexity of modeling large-scale economic systems, where AI's advantages are not yet fully realized. However, the potential for AI to revolutionize these fields remains significant, particularly as more sophisticated models are developed.

The study also found underutilization of AI in financial economics and macroeconomic policy research, areas where AI could offer substantial benefits in handling complex data. The historical reliance on traditional econometrics may have hindered the adoption of AI in these areas, but growing market complexities suggest a need for AI tools [17]. AI ability to process and analyse massive datasets will likely lead to its wider adoption in these fields, especially as policymakers seek more accurate and timely insights into global economic trends.

AI has proven valuable in predicting economic trends and addressing global economic dynamics, but its full potential remains unrealized, particularly in areas *requiring ethical oversight and localized knowledge*. However, concerns over data privacy and the possibility of algorithmic bias must be addressed to ensure that AI's benefits are shared equitably. Future research should focus on developing transparent and ethical AI models that respect data privacy while providing accurate and actionable economic insights.

Additionally, the study revealed that AI's role in economic calculation and social planning is often limited by philosophical and ethical debates. While AI can improve the efficiency of economic models, it cannot fully replace human judgment in decision-making processes. Policymakers must carefully balance the use of AI in economic planning, ensuring that its implementation does not exacerbate existing inequalities or undermine democratic processes. These concerns are particularly relevant in the context of international trade, where AI-driven models could influence negotiations and agreements with far-reaching consequences

5. Conclusion

AI's integration into macroeconomics and international trade is still developing. While AI has the potential to transform economic analysis, it also poses challenges, particularly in addressing ethical concerns. Future research should focus on integrating AI with traditional methods, improving its role in forecasting and policy-making, and exploring its application in international trade negotiations and economic shocks. By understanding the limitations and strengths of AI, economists can leverage these tools to enhance both theoretical and practical insights into complex economic phenomena.

Interdisciplinary collaboration will be essential for ensuring AI's ethical use in these fields. Additionally, the cultural and institutional factors influencing AI adoption across regions should be further explored to facilitate broader implementation. Future research could also investigate how AI might help resolve longstanding economic issues, such as predicting financial crises or optimizing trade agreements. As AI tools become more sophisticated, their application in macroeconomics and international trade may evolve, offering new opportunities for innovation in economic theory and practice.

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