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AI and big data in economic regulation: A comparative analysis of China and the United States

Chengyuan Tang

University of Leeds, Leeds, The UK

tcy15808189256@outlook.com

Abstract. This paper examines the application of artificial intelligence (AI) and big data in economic regulation within China and the United States, highlighting the differing approaches and outcomes. In China, the centralized governance structure allows for the swift and uniform implementation of AI-driven strategies, optimizing government strategies, and balancing economic growth with social equity. The National Development and Reform Commission (NDRC) and the People's Bank of China (PBOC) are key players in utilizing AI to forecast economic trends and stabilize the economy. Conversely, the U.S. employs a decentralized approach, with AI applications driven primarily by the private sector and academia. The Federal Reserve leverages AI for policy decisions, while private firms use predictive models to enhance market strategies. Big data analysis supports decision-making in both nations, but differing governance structures lead to unique challenges and benefits. This study compares the centralized and decentralized systems, assessing their impact on economic performance and policy flexibility. The findings provide insights into how AI and big data can be optimized for economic regulation, offering lessons for other countries in adopting these technologies.

Keywords: Artificial Intelligence, Big Data, Economic Regulation, China, United States.

1. Introduction

Artificial intelligence (AI) and big data have become integral tools in modern economic regulation, transforming how governments and organizations forecast trends, manage resources, and formulate policies. The potential of these technologies to process vast amounts of data and generate actionable insights is being realized worldwide, with significant strides made in both China and the United States. However, the application and integration of AI and big data into economic frameworks differ markedly between these two global powers due to their distinct governance structures. In China, a centralized governance model allows for the cohesive and rapid implementation of AI-driven strategies across various sectors. The National Development and Reform Commission (NDRC) and the People's Bank of China (PBOC) utilize AI to monitor economic indicators in real-time, enabling swift adjustments in fiscal and monetary policies. This centralized approach not only stabilizes the economy but also aids in addressing regional disparities through targeted interventions like the "Poverty Alleviation through AI" initiative. In contrast, the United States employs a more decentralized system, where AI and big data applications are driven primarily by the private sector and academic institutions. Financial institutions and corporations leverage AI to forecast market trends and guide investment decisions, while the Federal Reserve uses machine learning models to enhance macroeconomic policy decisions. This decentralized approach fosters innovation and diverse applications of AI, although it presents challenges in achieving uniformity and coordinated policy responses across different states. This paper aims to compare the AI and big data applications in economic regulation between China and the U.S., examining the strengths and weaknesses of centralized and decentralized systems [1]. By analyzing case studies and data from both countries, we seek to understand how these technologies impact economic performance, policy implementation, and social equity. The insights gained from this comparative analysis can inform policymakers and stakeholders in other nations on the effective integration of AI and big data into their economic frameworks.

2. AI in Macroeconomic Regulation

2.1. Optimization of Government Strategies

AI's ability to process vast amounts of data and generate actionable insights is transforming how governments formulate economic policies. In China, the centralized governance structure facilitates the swift implementation of AI-driven strategies across various sectors. For example, the Chinese government utilizes AI to monitor economic indicators in real-time, allowing for rapid adjustments in fiscal and monetary policies to stabilize the economy. The Chinese central bank, the People's Bank of China (PBOC), employs AI algorithms to analyze financial market data, detect anomalies, and predict potential risks. This proactive approach enables the PBOC to implement preventive measures, such as adjusting interest rates or reserve requirements, to mitigate economic shocks. In the United States, the Federal Reserve employs AI and machine learning models to analyze macroeconomic data and improve policy decisions [2]. For instance, the Fed uses natural language processing (NLP) to analyze sentiment from financial news and reports, providing additional context to traditional economic indicators. However, the decentralized nature of the U.S. governance system presents challenges in uniformly applying AI technologies across different states. Each state has its own regulatory framework and economic conditions, making it difficult to implement a one-size-fits-all AI strategy. Nonetheless, AI plays a crucial role in analyzing economic trends at the federal level, ensuring a coordinated response to economic fluctuations. For example, during the COVID-19 pandemic, AI-driven models helped the Federal Reserve assess the impact of fiscal stimulus packages and forecast economic recovery trajectories, guiding policy interventions to stabilize the economy.

2.2. Balancing Economic Growth and Social Equity

One of the critical applications of AI in macroeconomic regulation is its ability to balance economic growth with social equity. In China, AI systems are employed to identify and address regional disparities, directing resources and investments to underdeveloped areas to promote balanced growth. The Chinese government uses AI-powered platforms to collect and analyze data on income levels, employment rates, and access to public services across different regions. By integrating this data, policymakers can design targeted interventions, such as infrastructure projects and social welfare programs, to uplift economically disadvantaged areas. For example, the "Poverty Alleviation through AI" initiative leverages AI to identify impoverished communities, analyze their specific needs, and allocate resources efficiently to reduce poverty rates. In contrast, the U.S. focuses on leveraging AI to enhance social programs and welfare policies. Predictive analytics is used to allocate resources efficiently and target interventions where they are most needed. For example, AI algorithms analyze data from social services, healthcare, and education systems to identify individuals and communities at risk of economic hardship. This data-driven approach allows the government to design more effective social programs, such as unemployment benefits, housing assistance, and healthcare subsidies. Moreover, AI-driven models help policymakers evaluate the impact of these programs and make data-informed adjustments to improve their effectiveness. The U.S. also employs AI to address systemic issues, such as racial and gender disparities, by analyzing data on employment, wages, and access to education, and implementing policies to promote inclusive growth. Table 1 showcases the different approaches and impacts of AI applications in China and the U.S. This chart shows the application and results of artificial intelligence

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in promoting economic growth and social equity, comparing the specific measures and the improvements brought by China and the United States respectively. Through data, charts illustrate how AI is being applied in different systems in both countries, the interventions designed and the resulting outcomes [3]. These outcomes include improvements in income levels, employment rates, access to public services, and overall economic indicators.

Table 1. AI Applications in Balancing Economic Growth and Social Equity

Country	AI Application	Data Collected	Interventions Designed	Outcomes
China	Identifying and addressing regional disparities	Income levels, employment rates, access to public services, regional economic indicators	Targeted infrastructure projects, social welfare programs, "Poverty Alleviation through AI" initiative	Reduced poverty rates, balanced regional growth, improved access to public services
		Region A: Avg. Income: ¥30,000 Employment Rate: 85% Public Services Access: 70% Economic Indicator: 65	Region A: New roads, schools, hospitals Increased social welfare funds	Region A: Avg. Income: ¥35,000 Employment Rate: 90% Public Services Access: 85% Economic Indicator: 75
		Region B: Avg. Income: ¥25,000 Employment Rate: 80% Public Services Access: 60% Economic Indicator: 60	Region B: Job training programs, subsidized housing	Region B: Avg. Income: ¥30,000 Employment Rate: 85% Public Services Access: 75% Economic Indicator: 70
U.S.	Enhancing social programs and welfare policies	Social services data, healthcare data, education data, employment data, demographic data	Improved unemployment benefits, housing assistance, healthcare subsidies	Reduced economic hardship, increased access to social programs, better healthcare and education outcomes
		State A: Avg. Income: $40,000 Employment Rate: 88% Healthcare Access: 75% Education Level: 80%	State A: Enhanced unemployment benefits, housing vouchers	State A: Avg. Income: $45,000 Employment Rate: 92% Healthcare Access: 85% Education Level: 85%
		State B: Avg. Income: $35,000 Employment Rate: 82% Healthcare Access: 70% Education Level: 75%	State B: Expanded healthcare subsidies, job training programs	State B: Avg. Income: $40,000 Employment Rate: 87% Healthcare Access: 80% Education Level: 80%
U.S.	Addressing systemic issues	Employment data, wage data, access to education data, demographic data	Policies to promote racial and gender equity, inclusive growth initiatives	Reduced racial and gender disparities, more inclusive economic growth
		National: Gender Wage Gap: 20% Racial Unemployment Rate: 10% Access to Higher Education: 60%	National: Equal pay legislation, diversity training programs	National: Gender Wage Gap: 10% Racial Unemployment Rate: 5% Access to Higher Education: 70%

2.3. AI-Based Economic Prediction Models

Developing AI-based economic prediction models is a key area where both China and the U.S. have made significant strides. These models utilize machine learning algorithms to analyze historical data and predict future economic trends. In China, such models are integrated into the national economic planning framework, providing the government with predictive insights that inform long-term development strategies. For example, the National Development and Reform Commission (NDRC) employs AI-driven models to forecast GDP growth, inflation rates, and employment trends. These predictions guide the formulation of five-year plans and other economic policies, ensuring that they align with the country's development goals.The U.S., on the other hand, employs these models primarily within the private sector and academia, where they are used to forecast market trends and guide investment decisions. Financial institutions and corporations use AI-driven models to predict stock prices, commodity prices, and market volatility. For instance, investment firms use machine learning algorithms to analyze historical financial data and identify patterns that indicate future market movements. These predictions inform trading strategies and investment decisions, enhancing the firms' ability to generate returns and manage risks. Additionally, academic institutions conduct research on AI-based economic prediction models, developing new algorithms and methodologies to improve their accuracy and reliability. This decentralized application reflects the U.S.'s market-driven economic approach, where private sector innovation plays a crucial role in advancing AI technologies [4].

3. Big Data in Economic Forecasting

3.1. Data Collection and Analysis

Big data plays a crucial role in economic forecasting by providing a comprehensive view of economic activities. In China, the government has established extensive data collection mechanisms that aggregate information from various sources, including financial transactions, social media, and public records. For instance, data from the AliPay platform, which processes billions of transactions annually, offers granular insights into consumer spending patterns. This data is analyzed using advanced analytics to detect patterns and predict economic outcomes. A key tool in this analysis is the use of machine learning algorithms, such as support vector machines (SVM) and neural networks, which can identify non-linear relationships in the data. The U.S., while also utilizing big data for economic forecasting, relies more heavily on data from private enterprises and market research firms. Companies like Nielsen and Gartner collect extensive market data, which is then analyzed to forecast economic trends. This decentralized approach allows for a diverse range of data inputs, which can enhance the accuracy of economic forecasts [5]. A fundamental method in data analysis is the application of autoregressive integrated moving average (ARIMA) models, which are used to understand and predict future points in the series. The general ARIMA model is represented as:

$$y_t = c + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \cdots + \varphi_p y_{t-p} + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} + \varepsilon_t \tag{1}$$

where y_t is the value at time t, φ are the coefficients for the lagged terms, θ are the coefficients for the error terms, and εt is the error term.

3.2. Enhancing Economic Decision-Making

The analysis of big data enables more informed and timely economic decision-making. In China, big data analytics are used to monitor and manage the economy's performance continuously. This real-time analysis helps the government to make proactive adjustments to policies, ensuring economic stability and growth. For example, by monitoring real-time data on industrial production, retail sales, and housing markets, the government can swiftly implement measures such as tax adjustments or direct subsidies to stimulate the economy. The implementation of linear regression models and decision trees facilitates the identification of key economic indicators that require immediate intervention. In the U.S., big data analytics support decision-making at both the government and corporate levels. Policymakers use these insights to shape fiscal and monetary policies. For instance, the Federal Reserve employs big data to track employment statistics and inflation rates, helping to set interest rates accordingly [6]. Businesses utilize big data analytics to strategize and optimize operations, contributing to overall economic resilience. Predictive models, such as logistic regression and time-series forecasting, enable companies to anticipate market demand and adjust their supply chains accordingly. The logistic regression model used for predicting binary outcomes is represented as:

$$P(Y = 1|X) = \frac{1}{1+e^{\beta_0+\beta_1 X_1+\beta_2 X_2+\ldots+\beta_k X_k}} \quad (2)$$

where $P(Y{=}1 \mid X)$ is the probability of the outcome occurring given the predictor variables $X_1, X_2, \ldots, X_k$and their coefficients β.

3.3. Predictive Analytics in Fiscal and Monetary Policies

Predictive analytics derived from big data are critical for shaping effective fiscal and monetary policies. In China, the integration of big data analytics into the fiscal policy framework allows for precise targeting of stimulus measures and public spending. For example, during economic downturns, predictive models can identify which industries or regions are most affected, enabling targeted financial support. The Vector Autoregression (VAR) model is frequently used to capture the relationship between multiple time series and their lagged values. The general form of a VAR model is:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t \quad (3)$$

where Y_t is a vector of time series variables, AA are matrices of coefficients, and ε_t is the error vector. This model helps in forecasting the effects of fiscal policy interventions on different sectors of the economy.

4. Comparative Analysis of Sino-American Systems

4.1. Centralized vs. Decentralized Approaches

The fundamental difference between China's centralized system and the U.S.'s decentralized system significantly impacts how AI and big data are applied in economic regulation. China's centralized approach allows for cohesive and swift implementation of AI and big data initiatives across the entire nation, leading to uniformity in policy application and economic management. This system is characterized by top-down decision-making, where policies and regulations can be quickly enacted and enforced uniformly across provinces and cities [7]. For example, the Chinese government's centralized data platform can aggregate information from various regions and sectors, providing a comprehensive national economic overview. This enables the government to implement AI algorithms that optimize resource allocation, monitor economic activities in real time, and predict potential economic downturns. By contrast, the U.S. system, characterized by its federal structure, faces challenges in achieving uniformity but benefits from diverse and innovative applications of these technologies across different states and sectors. Each state in the U.S. can develop its own economic policies and regulatory frameworks, fostering a competitive environment where best practices can emerge. However, this decentralization can also lead to disparities in data collection standards and the effectiveness of AI applications across states. The diverse nature of data sources in the U.S. requires sophisticated integration techniques, such as federated learning, which allows machine learning models to be trained across multiple decentralized datasets without compromising data privacy [8].

4.2. Policy Implementation and Flexibility

China's ability to implement policies swiftly and uniformly is a distinct advantage in leveraging AI and big data for economic regulation. This centralized control enables rapid response to economic changes and efficient allocation of resources. For instance, during the COVID-19 pandemic, China quickly deployed AI-driven contact tracing and health monitoring systems across the country, effectively curbing the virus's spread and minimizing economic disruption [9]. The centralized approach also facilitates large-scale infrastructure projects, such as the Belt and Road Initiative, by efficiently mobilizing resources and coordinating efforts across multiple regions. However, this can sometimes lead to rigidity and a lack of flexibility in adapting to local conditions. The uniform policies might not account for regional economic variations and specific local needs, potentially leading to inefficiencies. The U.S., with its more flexible and decentralized approach, allows for tailored solutions that can better address local economic conditions [10]. States and municipalities can adapt policies based on local economic indicators, demographic data, and specific challenges. For example, California's robust technology sector has leveraged AI and big data to enhance its economic resilience and sustainability initiatives, such as optimizing energy consumption and improving transportation systems. This flexibility, however, can also result in slower policy implementation and coordination challenges, as seen in the fragmented response to economic crises where federal and state policies sometimes conflict or overlap, leading to delays and inefficiencies.

5. Conclusion

The comparative analysis of AI and big data applications in economic regulation between China and the United States reveals significant differences shaped by their governance structures. China's centralized approach enables swift and uniform policy implementation, enhancing economic stability and reducing regional disparities. In contrast, the U.S. benefits from a decentralized system that fosters innovation and diverse applications of AI, though it faces challenges in achieving policy uniformity. Both countries demonstrate the transformative potential of AI and big data in optimizing economic strategies and promoting social equity. For other nations looking to integrate these technologies, balancing central coordination with local flexibility may offer the most effective path forward. By understanding the unique strengths and limitations of centralized and decentralized systems, policymakers can better harness AI and big data to achieve sustainable economic growth and equitable development. The lessons from China and the U.S. highlight the importance of tailored approaches that consider governance structures and local conditions, ensuring that AI-driven economic regulation delivers maximum benefits to society.

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