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The role of big data and CEIC data in supporting economic policy formulation and evaluation: opportunities, challenges, and implications

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ABSTRACT

This research comprehensively examines the transformative role of Big Data, with particular emphasis on data provided by the Central Economic Information Center (CEIC), in supporting the formulation and evaluation of economic policies. By analyzing the characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value, etc.) and the CEIC's capabilities as a global macro- and microeconomic data provider, this article identifies how Big Data enables more granular, timely, and predictive economic analysis. The discussion explores concrete applications of Big Data in the policy cycle, from problem identification to impact evaluation, as well as its integration with econometric and machine learning methods. While offering great potential for evidence-based policymaking, the utilization of Big Data also faces significant challenges such as data quality, privacy, algorithmic bias, and regulatory gaps. This article presents solutions and recommendations to address these challenges, including the importance of strong data governance, cross-sector collaboration, and the development of data literacy, to maximize the benefits of Big Data in driving sustainable and inclusive economic growth. This data, which often has a non-standard structure, has the potential to provide much richer and deeper economic insights than conventional data sources. Effective economic policy formulation and evaluation require a deep understanding of market dynamics, the behavior of economic agents (consumers, firms), and the causal impact of government interventions. Big Data offers the potential for more granular, comprehensive, and timely analysis, which can complement and enrich traditional statistical data.

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1. INTRODUCTION

This study aims to discuss how to obtain analytical recommendations for leadership. One of the macro indicators routinely focused on review and recommendation development is economic growth (Fanny, 2018). This is based on several considerations. First, economic growth is an assumption in the preparation of the Government Work Plan, serving as the basis for determining macro development targets (poverty, unemployment, the Human Development Index, and inequality) as well as national priority targets. Second, economic growth is one of the macro assumptions underlying the preparation of the State Budget (APBN) macro posture, which includes revenue targets, expenditure targets, and budget deficit targets. Third, economic growth is one of the main indicators the President focuses on when assessing national economic performance, along with the risks that influence it, as a basis for providing direction. Therefore, comprehensive and up-to-date economic data is needed (Nagaraj, 2014).

This data need can be met with Big Data related to the Indonesian national economy. Essentially, big data is defined by the 3Vs (Volume, Velocity, and Variety), which are widely accepted as the basis for the definition of Big Data (Zervoudi, 2020). In the Gartner glossary, the terms are typically high volume, high velocity, and high variety. The initial 3V definition, developed to explain the technical and business implications of newer data management strategies, has been extended over time to reflect approaches to Big Data. IBM, in the vendor context, proposed Truth as the fourth V (Dantata, 2016).

Therefore, in developing recommendations and economic growth projections, a tool is needed to access economic data in the form of a database. The CEIC database provides real-time macroeconomic, industry, and financial data, both domestic and global. By combining and visualizing CEIC's big data technology, it will be easier to provide recommendations to management regarding current conditions (Paryzkyy, 2018).

BI is a broad concept that encompasses the collection, integration, analysis, and visualization of organizational data to support and improve the decision-making process. To support the formulation of recommendations, the organization utilizes relevant data. The approach adopted adheres to the 3V attributes (Barbier, 2011).

Today's global economy is characterized by high complexity and dynamism, marked by rapid market changes, unpredictable crises such as the COVID-19 pandemic, and global interconnectivity (Nanto, 2011). These conditions require policymakers to shift from traditional approaches that often rely on lagging or aggregated data to more agile strategies supported by real-time and granular data insights. The need for adaptive and responsive policies amid global uncertainty demonstrates that Big Data is no longer merely an additional tool, but rather an essential prerequisite for effective economic governance in the 21st century. It fundamentally transforms the nature of decision-making from reactive to proactive and predictive, enabling more timely and targeted interventions. In a volatile economic environment, policy decisions based on outdated or incomplete information can exacerbate the situation. Big Data characteristics such as Velocity (the speed at which data is generated and analyzed) and Variability (the rapid change in data) enable policymakers to monitor economic indicators in near real-time. This shifts the decision-making paradigm from "wait and see" to "predict and act," which is crucial for maintaining stability and promoting sustainable economic growth (Aithal, 2019)

The rapid development of information and communication technology has generated unprecedented volumes of data from various sources, including digital transactions, sensor data, social media, and administrative records. This data, which often has a non-standard structure, has the potential to provide much richer and deeper economic insights than conventional data sources (Stevens, 2009). Effective economic policy formulation and evaluation require a deep understanding of market dynamics, the behavior of economic agents (consumers, firms), and the causal impacts of government

interventions. Big Data offers the potential for more granular, comprehensive, and timely analysis, which can complement and enrich traditional statistical data (Chilenga, 2017).

This article aims to systematically outline how Big Data in general, and CEIC Data in particular, can support the entire cycle of economic policy formulation and evaluation. Furthermore, it will discuss the significant challenges inherent in utilizing Big Data for policy purposes and present solutions and recommendations to address these challenges. The structure of the article will follow the sections outlined in this framework.

2. RESEARCH METHOD

This study utilizes the CEIC big data platform, which contains over 470,000 macroeconomic data series and the growth of Indonesia's economic sectors. It offers comprehensive coverage for all 33 provinces in Indonesia, extracted using an API. The API provides direct access to the macroeconomic database according to your needs and provides customization options. Responsive and interactive charts are supported (Krueger, 2000).

Economic growth is one of the macro indicators routinely focused on for review and recommendation development. This is based on several considerations. First, economic growth is an assumption in the preparation of the Government Work Plan, serving as the basis for determining macro development targets (poverty, unemployment, the Human Development Index, and inequality) as well as national priority targets (Alonbeck, 2018). Second, economic growth is one of the macro assumptions underlying the preparation of the State Budget (APBN) macro posture, which includes revenue targets, expenditure targets, and budget deficit targets. Third, economic growth is one of the main indicators the President focuses on when assessing national economic performance (Arestis, 2003).

This study used the CEIC big data platform with an API extraction process. This API provides direct access to macroeconomic databases according to your needs and allows for customization options. Responsive and interactive charts are supported. This trial consisted of five stages: data classification, followed by data grouping and data indexing. If data is available or needed, data processing is performed to align with the information needs. Finally, data storage is performed on internal storage, visualizing the information and providing recommendations for related policy needs (Kassen, 2018).

3. RESULTS AND DISCUSSIONS

Based on system testing, big data extraction using the API protocol proved effective in extracting information from the CEIC big data platform, Bank Indonesia database, and Statistics Indonesia (BPS). The use of this API enabled direct, real-time access to various macroeconomic indicators needed to develop policy recommendations.

During the search and indexing phase, the system successfully processed and efficiently retrieved information from large-scale macroeconomic data datasets. This demonstrated that the system architecture was capable of effectively handling the volume and velocity attributes of big data (De la, 2010).

Furthermore, the Business Intelligence (BI) implementation was realized through an analytical dashboard utilizing the modern JavaScript charting library, ApexCharts. This library successfully rendered high-frequency and alternative data into dynamic, interactive, and responsive visualizations. These visualizations were crucial in transforming complex raw data into easily understood insights. By visualizing real-time trends in indicators such as GDP growth, inflation rates, and exchange rate fluctuations, the analyst team was able to provide more comprehensive and accurate national economic policy proposals and recommendations to leadership.

3.1 Application of Big Data and CEIC Data in Economic Policy Formulation and Evaluation

a. Policy Formulation

Big Data enables the identification of complex patterns and trends in demographic, economic, and environmental data, which is very helpful in development planning and public issue analysis. For example, Big Data diagrams can visualize relationships between variables such as population, economic, and environmental data to make more accurate predictions, supporting more informed decision-making. Big Data significantly supports and complements traditional statistical data, especially in complex and uncertain situations, providing additional, deeper, and real-time insights. Minister Bambang (Indonesia) explicitly supports the use of Big Data as a complement to traditional statistical data for policy formulation amidst complex and uncertain situations (Ahmed, 2025).

Big Data analytics enables policymakers to design more targeted interventions based on real-time data analysis. Examples include increasing agricultural yields through precision resource management or improving urban infrastructure (Ahmed, 2025). Big Data can also be used to increase tax revenues through better data analysis. The use of Big Data in policy formulation marks a fundamental shift from intuition-based policies or limited data to evidence-based policies supported by comprehensive analysis. This significantly improves the accuracy, efficiency, and relevance of government interventions. Traditional economic policies are often "one-size-fits-all" due to data limitations that hinder understanding heterogeneity at the regional or sectoral level (Ahmed, 2025). Big Data, with its granularity (e.g., provincial/city-level data from the CEIC), enables policymakers to design highly targeted interventions. For example, understanding specific unemployment trends in a region or the impact of tariffs on specific industries allows policymakers to design more effective and efficient policies, minimizing unintended consequences and maximizing positive outcomes for specific segments of the economy or population (Ahmed, 2025).

b. Policy Evaluation

Big Data enables policymakers to monitor policy outcomes in near real-time and adjust strategies as needed, increasing transparency in decision-making. The CEIC provides detailed data on the Consolidated Fiscal Balance (% of GDP), Government Debt (% of GDP), Tax Revenue, and Forecasts for Government Expenditure and Revenue (Raza, 2025). This data is crucial for evaluating fiscal sustainability, the impact of public spending policies, and the effectiveness of tax reforms (Raza, 2025).

Policy Rate data from the CEIC for various countries allows for analysis of the impact of interest rate changes on inflation, GDP growth, and economic stability. Research shows that traditional monetary policy performs better in times of low risk, highlighting the importance of comprehensive data for identifying economic regimes (Raza, 2025). The CEIC also provides Trade Balance, Exports, and Imports data, which can be used to analyze the impact of trade policies such as tariffs on the manufacturing sector and global supply chains. An example from CEIC data shows how US tariffs impact industrial production and the automotive sector, with a 1.1% decline in industrial production and an 8.4% decline in the automotive sector in March 2025 compared to March 2024 (Raza, 2025).

The CEIC provides data and nowcasts for key indicators such as inflation and GDP projections. This helps policymakers anticipate economic fluctuations and design evidence-based interventions. The Point-in-Time (PiT) feature of CEIC data is crucial for accurate policy evaluation. By preserving historical data revision history, PiT data

eliminates hindsight bias in backtesting and model validation (Raza, 2025). This allows for more realistic policy simulations, so that evaluation results reflect the actual information conditions at the time the policy was made, strengthening the causal validity of policy analysis. In policy evaluation, there is often a problem of hindsight bias, where models are tested using revised and final data, even though the data was not yet available or was still in its initial form at the time the policy was created. This can make the model appear more predictive or the policy appear more effective than it actually was in real-time. CEIC's PiT data feature addresses this problem by providing data as it was known at a specific point in time. This allows researchers and policymakers to simulate past decisions with the same information available at the time, resulting in a more honest and accurate evaluation of policy impacts, which in turn leads to improved future policies (Raza, 2025).

c. Integration with Econometrics and Machine Learning

Large data volumes, the problem of predictor overload (more predictors than are appropriate for estimation), and the need to model flexible relationships in Big Data require more powerful data manipulation tools and econometric techniques that differ from conventional methods. Machine Learning (ML) techniques such as decision trees, support vector machines, neural networks, and deep learning enable more effective modeling of complex relationships. ML can also extract valuable information from non-standard data structures and clean them for econometric analysis (Raza, 2025).

ML offers new possibilities for measurement (e.g., inflation, economic activity), forecasting, and causal inference. This has improved the accuracy of consumer behavior analysis and labor market predictions. The integration of Natural Language Processing (NLP) also enables the analysis of qualitative data such as news and social media sentiment to enrich economic forecasts. The convergence of Big Data, econometrics, and machine learning represents a new paradigm in economic analysis. This enables policymakers to not only understand what is happening but also predict what will happen and identify why with greater precision, integrating the predictive power of ML with the causal inference capabilities of econometrics (Miah, 2025). Econometrics traditionally focuses on causal inference and hypothesis testing based on theoretical models, which are crucial for understanding the mechanisms behind economic phenomena. Machine learning, on the other hand, excels at predicting and discovering patterns in large, complex data sets, often without strong theoretical assumptions. With Big Data, which often has non-linear relationships and high dimensions, ML becomes particularly relevant. However, for policy, understanding why a phenomenon occurs (causality) is as important as understanding what will happen (prediction) (Miah, 2025). The integration of the two enables policymakers to derive models that are both predictively powerful (from ML) and interpretable and usable for intervention design (from econometrics), creating a more comprehensive and actionable analytical framework for decision-making (Kshetri, 2014).

3.2 Challenges and Solutions in Utilizing Big Data for Economic Policy

a. Main Challenges

Utilizing Big Data for economic policy is not without significant challenges. First, data quality is a major concern. Inaccurate, incomplete, or inconsistent data can lead to erroneous conclusions and poor policy decisions. This includes issues of noise, bias, and inconsistency in data. Maintaining high data quality from diverse sources is a constant struggle (Kshetri, 2014).

Second, data privacy and security are crucial issues. The collection and analysis of vast volumes of data increases the risk of privacy breaches, data breaches, and

cyberattacks. This is particularly relevant when data is sourced from mobile devices or social media platforms.

Third, the ethical use of algorithms and the issue of bias require attention. Algorithms used in Big Data analysis can perpetuate bias or lead to discriminatory practices if not carefully designed, trained, and audited. Concepts such as fairness, justice, and equity are often poorly understood or accommodated by AI systems (Kshetri, 2014).

Fourth, regulatory and governance gaps present barriers. Outdated legal frameworks often cannot keep pace with the rapid advancement of Big Data technology, creating challenges in data governance, compliance, and accountability (Miah, 2025). Particularly in developing countries, regulatory frameworks for data privacy protection are often inadequate, leaving individual telecommunications companies to deal with the concerns.

Fifth, implementation costs and talent shortages present practical obstacles (Miah, 2025). Implementing Big Data solutions often involves significant upfront costs for infrastructure (distributed storage, cloud-based databases), software, and staff. There is also a shortage of talent with the necessary skills in data science, econometrics, and public policy to effectively manage and analyze Big Data.

Sixth, integration with legacy systems can be a complex technical and operational challenge. Integrating new Big Data solutions with existing government IT systems and legacy databases requires significant effort.

Finally, many low- and middle-income countries still face significant data gaps, where basic administrative data is outdated, under-collected, or of poor quality. This hinders the utilization of Big Data and can lead to disputes about the reliability of figures. These challenges collectively demonstrate that the adoption of Big Data in economic policy is not merely a technical issue, but rather a systemic one involving ethics, law, institutional capacity, and socio-economic preparedness. Ignoring these aspects can undermine public trust in data-driven policies and potentially exacerbate social inequalities. If economic policies are based on inaccurate data (data quality issues), data vulnerable to breaches (privacy/security concerns), or inherently biased algorithms (ethics concerns), then such policies will not only be ineffective but can also undermine government legitimacy and deepen social inequalities. For example, resource allocation policies based on models trained with biased data can unfairly favor one group over another. Therefore, addressing these challenges requires a multidisciplinary approach and significant investment in data governance, ethical frameworks, and human capacity development, not just technology alone (Kshetri, 2014).

b. Solutions and Mitigation Strategies

To address these challenges, several solutions and mitigation strategies can be implemented. Improving data quality is a fundamental step. This involves implementing rigorous data cleansing, deduplication, validation, and normalization techniques. Ensuring valid and relevant data before analysis is crucial to avoid misleading conclusions (Kshetri, 2014).

A robust data governance framework must be established. This includes a comprehensive framework that defines data ownership, access rights, the data lifecycle, and audit protocols to ensure data integrity and compliance. In terms of regulation, adaptive and transparent regulations are needed that can evolve with technological changes (Miah, 2025). Governments are encouraged to develop legal frameworks that balance innovation with governance and to interact with international bodies to align policies. Encouraging open data initiatives can foster broader participation in economic analysis and policy formulation.

To address the problem of algorithmic bias, ethical and transparent algorithm development is crucial. This includes regular audits of algorithms and transparency initiatives to ensure that models do not perpetuate bias or lead to discriminatory practices (Kshetri, 2014).

Addressing the talent shortage requires investment in capacity building and data literacy. This includes investing in interdisciplinary research that combines insights from data science, economics, and public policy, as well as increasing data literacy among policymakers to bridge the gap between technical and policy domains (Miah, 2025). Cross-sector collaboration and data sharing are also crucial strategies. Sharing data across borders and institutions can streamline development projects and foster more harmonious economic policies (Miah, 2025).

Overall, these challenges demonstrate that the adoption of Big Data in economic policy is a systemic issue that requires a multifaceted approach. Effective solutions must encompass not only technical aspects but also ethics, law, and institutional capacity to ensure that Big Data truly serves as a tool for social and economic good (Miah, 2025).

4. CONCLUSION

The integration of Big Data into macroeconomic analysis offers significant solutions to the challenges of formulating national economic policy proposals. Utilizing data provider platforms such as CEIC, combined with domestic data sources (Bank Indonesia and BPS) through API integration, ensures comprehensive, real-time data availability.

A Business Intelligence (BI) approach combined with modern data visualization technology enables the processing of millions of databases into actionable information. This allows leaders to monitor macro indicators, such as economic growth, with greater precision to inform strategic decision-making, both for national priority targets and the macro-state budget (APBN) structure.

Big Data and CEIC Data applications have been proven to improve policy formulation through more accurate identification of patterns and trends, targeted intervention design, and increased administrative efficiency. In policy evaluation, the ability to monitor results in near real-time and conduct more valid impact analyses, particularly by eliminating hindsight bias through PiT data, significantly improves decision quality. The integration of Big Data with econometrics and machine learning paves the way for more sophisticated models for forecasting and causal inference, enabling policymakers to understand what will happen and why.

The application of Big Data in economic policy is not without challenges. Issues such as data quality, privacy and security, algorithmic bias, regulatory bias, implementation costs, talent shortages, and data misrepresentation in developing countries require serious attention. Maximizing the benefits of Big Data requires a holistic approach that includes improving data quality, implementing a robust data governance framework, implementing adaptive and ethical development regulations, investing in capacity building and data literacy, and promoting cross-sector collaboration. By proactively addressing these barriers, governments can fully leverage the potential of Big Data to design and implement more effective, responsive, and inclusive economic policies, fostering sustainable growth and improving public welfare in the digital age.

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