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DOES ARTIFICIAL INTELLIGENCE HAVE AN IMPACT ON MONETARY POLICY EFFECTIVENESS IN INDONESIA?

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Abstract

The study empirically investigates the implications of AI Readiness, Broad Money, and political stability for monetary policy effectiveness, as measured by a composite index. The study uses robust fixed-effect panel data estimation techniques to analyse data from 19 OIC member countries between 2019 and 2023, with a focus on Indonesia. The results show that AI readiness and political stability have a substantial positive impact on monetary policy effectiveness in Indonesia, whereas Broad Money has a significant adverse impact. These findings offer relevant policy implications for AI transformation in the financial sector, particularly for effective monetary policy. These findings establish a relationship between the quest for high-quality institutions, defined by the readiness of AI implementation, political stability, and stable broad money. The study adds to a recent body of literature on the impact of AI and other variables on the efficiency of monetary policy.

Keywords: *monetary policy effectiveness, ai readiness, composite index, panel data analysis, digital transformation*

I. INTRODUCTION

In recent decades, digitalisation has become integral to every aspect of our existence. This is the first instance in human history when digital technology has become pervasive, consciously or unconsciously. This has also transformed the functioning of economic activity. All activities, from banking transactions to taxi hiring, are conducted via digital technology.[1] This is anticipated to affect the broader economy.[2] Artificial Intelligence (AI) is a testament to contemporary technical growth. Driven by technological advances such as AI,

[1] Ali, Mohsin Ali et al., "Digitalisation and Economies of OIC Countries," *Bulletin of Monetary Economics and Banking* 27, no. 0 (2024): 155-170.

[2] Chris Warhush and Wil Hunt, "The Digitalisation of Future Work and Employment: Possible Impact and Policy Responses," *JRC Working Papers Series on Labour, Education and Technology* 05 (2019): 57–73, https://hdl.handle.net/10419/205265.

cloud computing, and improved cybersecurity, this paradigm has ushered in an unparalleled period of innovation and transformation.[3]

Monetary policy implementation is a complicated process. It is ironically both forward-looking and facing an uncertain future.[4] A wide variety of tools, such as interest rate manipulation, aggregate spending, loans, foreign exchange rates, and changing asset values, may be used to implement monetary policy.[5]

A new wave of technological innovation, often referred to as fintech, is driving transformation across the banking industry. The extensive use of novel technology presents advantages as well as hazards. Technology may enhance efficiency in the financial system, deliver superior, more tailored goods and services, and promote financial inclusion in emerging nations. Nonetheless, poorly planned adoption of some technologies may also pose hazards by undermining competitiveness, public trust, monetary policy implementation, and economic prosperity.[6]

The global financial landscape is undergoing a profound transformation due to rapid growth in the digital economy. This has presented both unparalleled difficulties and opportunities for conventional monetary policy implementation.[7] In the past few years, the rapid emergence of new financial instruments, including electronic payment methods, digital currencies, and digital lending platforms, has sparked significant debate among scholars and lawmakers about the efficacy of monetary regulation. The discussion results from the convergence of technological advancements and innovative financial practices.[8] The emergence of economic decentralisation and a digital economy has cast doubt on these channels, as conventional monetary policy predominantly affects the real economy through mechanisms such as interest rates, credit, and asset valuation. Currently, digital innovation offers a multitude of novel methods and opportunities for the implementation of monetary regulation, particularly the advent of central bank digital currencies (CBDCs).[9]

A central bank's ability to disseminate information, mirror economic trends, and respond to economic shocks may be significantly affected by a

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[3] Bhargav Reddy Piduru, "Navigating Digital Transformation: Impacts on Inflation and the Job Market." *International Journal of Engineering and Technology Research (IJETR)* 8, no. 1 (2023): 1-10.

[4] Kajleen Kaur et al., "Effectiveness of Monetary Policy in Controlling Inflation." Journal of Business Thought 5 (2015): 59-70.

[5] Ascarya, "Transmission Channel and Effectiveness of Dual Monetary Policy in Indonesia," *Bulletin of Monetary Economics and Banking* 14, no. 3 (2012): 269-98.

[6] Dong He et al., "Fintech and Financial Services: Initial Considerations." *International Monetary Fund Staff Discussion Notes* 5 (2017) 49.

[7] Haoyu Wang, "Transformation of Monetary Policy Transmission Mechanisms in the Digital Economy Era," *Modern Economy* 15, no. 12 (2024). 1254–64. https://doi.org/10.4236/me.2024.1512065.

[8] He et al., "Fintech and Financial Services."

[9] Wang, "Transformation,"

nation's willingness to adopt AI technology. Monetary parameters, particularly the money supply—the quantity of currency in circulation—remain a crucial indicator of the impact of monetary regulations on inflation rates, economic growth, and monetary stability. Aside from finance and technological factors, political stability is a crucial predictor of the efficacy of financial regulation. The stability in politics scale measures the extent to which a nation's political situation facilitates or impedes the implementation of its economic strategies. In contrast to political instability, which may erode public trust and hinder the implementation of monetary policy, political stability can give central banks greater confidence in formulating policy.

The novel aspect of this study is its simultaneous examination of the effectiveness of monetary policy across several variables that have been less thoroughly investigated in the existing literature, including AI readiness, broad money growth, and political stability. Prior research has exclusively concentrated on the impact of macroeconomic indicators, whereas this investigation integrates the influence of technological capacity and institutions on monetary outcomes. This study provides new insights into how developing countries can align digital transformation with monetary stability, focusing on Organisation of Islamic Cooperation member countries from 2019 to 2023.

The paper aims to analyse the influence of broad money, political stability, and AI readiness on the effectiveness of monetary policy, with a particular emphasis on Indonesia and the OIC member states. This study investigates the extent to which these variables contribute to the accomplishment of the objectives of monetary regulation in managing inflation as well as ensuring stability in finance by analysing panel data from 2019 to 2023. Policymakers, central banks, and financial institutions, particularly those in regions where AI adoption is still in its infancy, can derive significant insights from the results.

II. LITERATURE REVIEW

II.A. The efficacy of monetary policies

The efficacy of monetary policy has recently attracted significant scholarly attention as countries seek to enhance the overall effectiveness of their economic approach. The significance of financial regulations' efficacy increased due to the need to assess which financial institutions, in both emerging and affluent nations, may have a substantial and systematic influence on global demand through monetary policies. In this context, a policy is deemed efficient if it can influence a specified objective with the desired method and intensity.[10]

[10] Vera Fiador et al., "Monetary Policy Effectiveness in Africa: The Role of Financial Development and Institutional Quality," *Journal of Financial Regulation and Compliance* 30, no. 3 (2022): 335–52, https://doi.org/10.1108/JFRC-03-2021-0024.

Historical assessments of monetary policy efficacy have primarily focused on identifying the predominant traditional financial policy tools within specific economic contexts, often neglecting key determinants, such as monetary growth and the quality of institutions.[11] The efficiency of monetary policy is apparent in established countries;[12] however, this is not the case for emerging economies. In wealthier countries, influencing the money supply through interest rate adjustments is considered more effective, whereas the financial institution approach is regarded as more functional in emerging economies.[13] The financial institution lending approach is viewed as an effective monetary policy conduit in developing economies due to these countries' significant reliance on banks and the absence of alternative structures, such as bond and stock markets, where alternative methods of transmission may prove successful.

II.B. Artificial Intelligence and Monetary Policy

The initial work, now widely recognised as coining the term "artificial intelligence," was published by Warren and Pitts in 1943. The three primary sources they employed were Turing's theory of computability, Russell and Whitehead's formal explication of propositional logic, and a comprehension of the physiology and fundamental function of neurons in the brain. In recent years, economists have conducted a more thorough examination of AI's revolutionary potential.[14] AI patents have a substantial, beneficial, and long-term influence on economic performance. The AI Government Readiness Index was developed by Oxford Insights to assess governments' preparedness to integrate AI into public service delivery. This index evaluates readiness across three primary pillars: governance, which assesses policy frameworks and leadership; the technology sector, which evaluates innovation capacity and technological resources; and data and infrastructure, which emphasises the availability and accessibility of data and digital infrastructure essential for AI implementation.[15]

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[11] Fiador et al., "Monetary Policy Effectiveness."

[12] Prachi Mishra and Peter Montiel, "How Effective is Monetary Transmission in Low-Income Countries? A Survey of the Empirical Evidence," *IMF Working Papers* 12, no. 143 (2012): 1-48, https://doi.org/10.5089/9781475504064.001.

[13] Mishra and Montiel, "How Effective."

[14] Wulan Kurniasari et al., "Navigating Economic Growth: The Roles of AI Readiness, Trade Openness, Inflation, and Unemployment in ASEAN-7," Proceedings of the 7th International Conference of Economics, Business, and Entrepreneurship, ICEBE 2024, Malaysia, 2024. https://doi.org/10.4108/eai.4-9-2024.2353717.

[15] Kurniasari et al., "Navigating Economic Growth."

AI-driven text mining methods, often referred to as natural language processing (NLP), have emerged as a powerful big data tool for extracting valuable insights from vast volumes of text-based reports.[16] Presently, there's a limited quantity of empirical investigations that employ text mining techniques to evaluate the readability, effectiveness of communication strategies, and sentiments expressed in financial institutions' press releases, reports on the state of the economy, the banking industry, and digital platforms;[17] The effectiveness of central banks' communication with the general public, investors, and financial markets is a determining factor in their transparency and credibility.[18]

AI is beginning to revolutionise the way central banks set monetary policy through reinforcement learning (RL) and machine learning. RL models can design interest rate policies that are more adaptable and flexible than traditional linear methods, such as the Taylor Rule.[19] The neutral policy rate can be more accurately estimated by AI, which can respond immediately to changes in the broader economy. It also enables policies to be compatible with emerging financial technologies, including decentralised finance (DeFi) and CBDC. Central banks, particularly those in Europe, have employed AI and big data to analyse economic indicators, monitor systemic risks, and make more informed decisions.[20]

Nevertheless, AI is merely a supplement and not a substitute for human decision-making, as it is both challenging to comprehend and raises social concerns. Kahyaoğlu emphasised in 2021 that AI is altering the instruments used for policymaking, as well as the way central banks are set up and perform their functions in the digital age.[21] In this regard, AI is a significant contributor to the increasing flexibility and data-driven nature of monetary policy; however, the ultimate decisions remain in human hands.

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[16] Francis Mawuli Abude et al., "Developing Artificial Intelligence-Powered Monetary Policy Communication Indicators for Macroeconomic Inquiries in Ghana," *Communicare: Journal for Communication Studies in Africa* 43, no. 1 (2024): 14–35, https://doi.org/10.36615/jcsa.v43i1.2779.

[17] Luca Barbaglia et al., "Sentiment Analysis of Economic Text: A Lexicon-Based Approach," *SSRN Electronic Journal*, (2022). https://doi.org/10.2139/ssrn.4106936; Bach et al., "Text Mining for Big Data Analysis in Financial Sector: A Literature Review," *Sustainability (Switzerland)* 11, no. 5 (2019). https://doi.org/10.3390/su11051277.

[18] Namig Naghdaliyev, "Central Banks' Communication in the Post-Crisis Period," *SSRN Electronic Journal* (2011): 1–2.

[19] Mariam Dundua and Otar Gorgodze, "Application of Artificial Intelligence for Monetary Policy-Making," *National Bank of Georgia Working Papers* 2, 2022.

[20] Sudeep Marwaha et al., "Application of Artificial Intelligence and Machine Learning in Agriculture," in *Translating Physiological Tools to Augment Crop Breeding*, eds. Sudeep Marwaha et al. (Springer, 2023), 441–57. https://doi.org/10.1007/978-981-19-7498-4_21.

[21] Ramazan Ekinci, "The Impact on Digitalisation on Financial Sector Performance," in *The Impact of Artificial Intelligence on Governance, Economics and Finance, Volume I*, (ed.) S. Bozkuş Kahyaoğlu (Springer, 2021).

II.C. Broad Money Growth and Monetary Policy

The significance of money in every economy is derived from its diverse characteristics and requirements. A central bank's expansive monetary policy will reduce interest rates by increasing the money supply. As a result, the duration of cash flow and loan operations will be extended. Therefore, it is anticipated that investment will increase, resulting in a rise in gross production. Consequently, a positive correlation between the supply of money and economic growth has been established.[22] The Eurosystem has specified three aggregates: narrow (M1), intermediate (M2), and broad (M3).

The money supply, often known as M1, consists of both fiat currency and liquid assets that may be exchanged for other forms of currency or used for electronic payments.[23] Deposits having initial maturities of up to two years and redeemable with up to three months' notice are included in M2, or intermediate money. There may be limitations, such as prior notice, delays, fines, or fees, on converting these deposits into narrow money components. The money supply (M2) is the sum of all deposits (not just cash and overnight deposits) that are tracked and studied.[24] Broad money, or M3, consists of M2 plus marketable instruments issued by the MFI sector, such as buyback agreements, MMF shares/units, and MMF. These instruments are less affected by substitution among different types of liquid assets than more limited definitions of money, due to their high liquidity and price certainty, which makes them near substitutes for deposits.[25]

Monetary policy is often measured by broad money. As in Ansari's research, broad money is one component of financial policy analysis.[26] Furthermore, broad money serves as an indicator for financial policy in research related to aggregate macroeconomic variables against shocks on monetary policy in Pakistan.[27] Broad money is also used as a variable to find the impact on GDP for Nigeria.[28] It was found that causality flows from broad money to GDP.[29]

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[22] Md. Arfanuzzaman, "The Long-Run Dynamic Relationship between Broad Money Supply and the GDP of Bangladesh: A VECM Approach," *Developing Country Studies* 4, no. 14 (2014): 167–79.

[23] European Central Bank, "Manual on MFI Balance Sheet Statistics," accessed February 2012, 156.

[24] *Ibid.*

[25] *Ibid.*

[26] M.I. Ansari, and S.M. Ahmed, "Does Money Matter? Evidence from Vector Error – Correction for Mexico," *The Journal of Developing Areas* 41, no. 1 (2007): 185-202, https://www.jstor.org/stable/40376166.

[27] Abdul Rashid and Zainab Jehan, "The Response of Macroeconomic Aggregates to Monetary Policy Shocks in Pakistan," *Journal of Financial Economic Policy* 6, no. 4 (2014): 314–30, https://doi.org/10.1108/JFEP-04-2013-0016.

[28] Hussain Mohammed Ershad and Haque Mahfuzul, "Empirical Analysis of the Relationship between Money Supply and Per Capita GDP Growth Rate in Bangladesh," *Journal of Advances in Economics and Finance* 2, no. 1 (2017): 54–66, https://doi.org/10.22606/jaef.2017.21005.

[29] Arfanuzzaman, "The Long-Run Dynamic."

II.D. Political Stability Index and Monetary Policy Effectiveness

Macroeconomic stability and monetary policy performance may be adversely affected by an environment with inadequate political stability.[30] De Mendonça and Da Silva Veiga[31] have suggested that financial institutions' dedication to controlling inflation can be enhanced by strengthening political stability, which, in turn, facilitates alignment of inflation projections with their objectives. Furthermore, the efficacy and development of financial intermediation are facilitated by globalisation, a factor determined by political stability. Consequently, financial markets can convert savings into investment and growth.[32] Furthermore, economic development is stimulated by globalisation, which encourages innovation and efficient production while allowing countries to leverage their distinct strengths and expertise.[33] Political stability is one indicator of globalisation. Therefore, economic globalisation and financial openness can promote macroeconomic stability and improve monetary policy efficiency.[34]

Political stability, the expansion of the money supply, and the adoption of technologies like AI are among the variables that affect the effectiveness of monetary policy, according to the research. According to an earlier study, the influence of money varies widely across nations, depending on their monetary policy and financial structures, and its link to inflation and economic development is complex. Furthermore, a favourable environment for successful monetary policy largely depends on political stability, particularly in nations that rely heavily on government involvement. AI readiness is increasingly recognised as a potential factor that could enhance the effectiveness of financial regulation amid digitalisations. However, further research is needed to fully understand its implications. Thus, this research aims to close a gap in the literature by examining how political stability, money supply expansion,

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[30] Ari Aisen and Francisco Jose Veiga, "Does Political Instability Lead to Higher Inflation? A Panel Data Analysis." *Journal of Money, Credit and Banking* 38, no. 5 (2006): 1379–89. https://www.jstor.org/stable/3839011.

[31] Helder Ferreira de Mendonça and Igor da Silva Veiga, "A Note on Openness and Inflation Targeting: Implications for the Unpleasant Fiscal Arithmetic," *Macroeconomic Dynamics* 18, no. 5 (2014): 1187–1207. https://doi.org/10.1017/S1365100512000752.

[32] Niels Hermes, and Robert Lensink, "Does Financial Liberalisation Influence Saving, Investment and Economic Growth? Evidence from 25 Emerging Market Economies, 1973-96," in *Financial Development, Institutions, Growth and Poverty Reduction*, eds. Basudeb Guha-Khasnobis and George Mavrotas (Springer, 2008), 164-18.

[33] Niklas Potrafke, "The Evidence on Globalisation," *World Economy* 38, no. 3 (2015): 509–52, https://doi.org/10.1111/twec.12174.

[34] Helder Ferreira de Mendonça and Natalia Cunha Nascimento, "Monetary Policy Efficiency and Macroeconomic Stability: Do Financial Openness and Economic Globalisation Matter?" *The North American Journal of Economics and Finance* 53, (2020): 1–20, https://doi.org/10.1016/j.najef.2018.10.018.

and AI readiness affect the efficacy of monetary policy globally, and more specifically in Indonesia and the OIC nations.

III. RESEARCH METHODOLOGY

The efficacy of monetary regulations, which is built by a composite index of three variables, namely interest rates, exchange rates, and Inflation, is examined in this study using a quantitative approach to test the effect of AI readiness, exchange rates, and political stability in Indonesia. The panel data in this analysis cover 19 OIC-affiliated countries for the years 2019-2023. Due to data limitations, our investigation relies on nineteen countries, although we initially included all OIC member countries. Albania, Algeria, Azerbaijan, Bangladesh, Brunei Darussalam, Egypt, Gambia, Guyana, Indonesia, Jordan, Kuwait, Kyrgyz Republic, Malaysia, Maldives, Mozambique, Nigeria, Qatar, Sierra Leone, and Uzbekistan are the countries examined in this investigation, which will later focus on Indonesia. Data are sourced from the World Bank - World Development Indicators and Oxford Insights - Government AI Readiness Index for the years 2019 to 2023. Stata 18.5 software was used to conduct panel data analysis.

III.A. Composite Index

By integrating three economic indicators, inflation, interest rates, and exchange rates. This study employs Principal Components Analysis (PCA) to evaluate the effectiveness of monetary policy. The PCA method, a fundamental technique in contemporary data analysis, is well-suited across various disciplines of science and is appropriate to the construction of this composite index. The objective of PCA is to find the most significant foundation for re-expressing specific metadata. The new base was able to address latent structures within the set of data and eradicate confusion. Reducing dimensions, data encryption, extraction of traits, and data visualising are among the numerous applications. The advantage of the composite index is that the regression equation is calculated by directly entering the key variables into the regression analysis, allowing one to determine whether the composite measure performs better than the individual variables. The composite index performs better, but the results are unsatisfactory. The composite index, which encapsulates the combined information content, more appropriately captures the intricacy of the phenomena. It also provides greater freedom and reduces the number of variables.[35]

[35] K. V. Bhanu Murthy and Anjala Kalsie, "Measurement of International Currency Crises: A Panel Data Approach Using Composite Indices," *Vikalpa* 38, no. 4 (2013): 13–36, https://doi.org/10.1177/0256090920130402.

PCA Formula:

$$MPE = \sum_{i=1}^{n} w_i z_i$$

III.B. Panel Data Analysis

A cross-sectional variable is a panel data variable, which is a collection of observations taken over a given period.[36] The collection of data is symmetrical, with the same quantity of insight for each participant, and it combines both cross-sectional and time-series aspects. Diverse observation counts indicate an unbalanced data set.[37] Panel data are employed in microeconomic research due to their efficacy, degrees of freedom, reduced collinearity, diversity, and informativeness.[38] Regression and time-series analyses, which are based on repeated-measures models, are among the possibilities.[39] Panel data analysis enables the identification and quantification of enhanced effects that are not visible in time-series or cross-sectional data itself.[40] In contrast to pure cross-sectional or time-series analyses, these models provide greater clarity, reduced collinearity, and greater freedom and efficiency. Random-, fixed-, and covariance-effect estimators are employed in statistical panel data models.

Fixed Effect Model:

$$Y_{it} = a_i + \sum_{k=1}^{k} \beta_k X_{kit} + u_{it}, \qquad i = 1, \ldots, N,$$

Random Effect Model:

$$y_{it} = \sum_{k=1}^{k} \beta_k x_{kit} + (a_i + u_{it}), \qquad i = 1, \ldots, N,\ t = 1, \ldots, T$$

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[36] Seung C. Ahn and Hyungsik Roger Moon, "Large-N and Large-T Properties of Panel Data Estimators and the Hausman Test," *SSRN Electronic Journal*, 2005, https://doi.org/10.2139/ssrn.283252.

[37] Jeffrey M. Wooldridge, *Introductory Econometrics: A Modern Approach. South-Western, 1999.*

[38] R. Carter Hill et al., *Principles of Econometrics, 3rd Ed,* (Wiley, 2008).

[39] Edward W. Frees, *Longitudinal and Panel Data Analysis and Applications in the Social Sciences* (Cambridge University Press, 2004).

[40] Damodar N. Gujarati and Dawn C. Porter, *Basic Econometrics* (*McGraw-Hill Education,* 2009).

The subjects are differentiated by index i, which ranges from 1 to N. The quantity of subjects is denoted as N. The index t distinguishes the observation periods from 1 to T for each subject. The variable k represents the quantity of explanatory (independent) variables.

IV. RESULTS AND DISCUSSION

IV.A. Principal Component Analysis for Monetary Policy Effectiveness

IV.A.1. Statistical descriptive data

According to this analysis, the dynamics of the economic variables under investigation are remarkably diverse. A substantial standard deviation of 602.47 is correlated with a mean rate of inflation of 68.59, suggesting significant variability in the statistics. Deflation is indicated by the smallest inflation rate of -2.54, while hyperinflation is indicated by the maximum rate of 5878 in the dataset. The level of economic and political stability is one of many factors that influence inflation rates, which vary among the subject countries.[41] Furthermore, inflation results also fluctuated during the 2019-2023 global COVID-19 pandemic.[42] The lowest interest rate is 3.44, and the highest is 28, illustrating a considerable variance in monetary policy. The exchange rate averages 1378, with a substantial standard deviation of 3917.23, indicating significant volatility in the foreign exchange market. The lowest exchange rate is 0.30, and the highest is 15236.88, signifying substantial fluctuations in currency values over the observation period. These indicators reveal considerable economic instability, defined by significant volatility in inflation and exchange rates, although interest rates exhibit relative stability, albeit with notable fluctuations. This is influenced by several factors, including the COVID-19 crisis that occurred during the data collection period.[43] Below is a table that contains the detailed results of the descriptive statistics.

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[41] Ahmad Nailul Hikam et al., "Economic Growth in OIC Countries: The Role of Political Stability," *Economics Development Analysis Journal* 13, no. 1 (2024): 125–39.

[42] Olivier Armantier et al., "How Economic Crises Affect Inflation Beliefs: Evidence from the Covid-19 Pandemic,"
Journal of Economic Behavior and Organisation 189 (2021): 443–69, https://doi.org/10.1016/j.jebo.2021.04.036.

[43] O. Makarov and S. Arzhevitin, "Coordination of Monetary and Fiscal Policies During Crisis," *Financial and Credit Activity Problems of Theory and Practice* 6, no. 41 (2022): 17–31, https://doi.org/10.18371/fcaptp.v6i41.251384.

Table 1.
Statistical Descriptive Result (Composite Index Variables)

Variable	Obs.	Mean	Std. dev.	Min	Max
Inflation	95	68.58639	602.4723	-2.540315	5878
Interest Rate	95	11.73181	6.264011	3.444106	28
Exchange Rate	95	1377.997	3917.228	0.3016431	15236.88

IV.A.2. Principal Component Analysis (PCA) result

Of the 95 observations that were analysed, three primary components (Comp1, Comp2, and Comp3) account for 100% of the total variance in the data. With an eigenvalue of 1.412, Comp1 accounts for approximately 47.07% of the data's total variance. Thus, it is the most critical element of the investigation. A component with an eigenvalue greater than 1 is capable of accounting for a greater proportion of the variance than the original variability of a singular variable. 0.863 is the eigenvalue of Comp2, which explains 28.76% of the total variance. This component remains significant and provides supplementary explanations for data variability, despite being smaller than Comp1. Comp3 has an eigenvalue of 0.725 and explains 24.16% of the total variance. This component furnishes the explanation of data variability that Comp1 and Comp2 do not address. Eigenvalues and the proportion of variance of each variable are presented in the table below.

Table 2.
Eigenvalues and Proportion of Variance

Component	Eigenvalue	Proportion of Variance	Cumulative Variance
Comp1	1.41214	0.4707	0.4707
Comp2	.862932	0.2876	0.7584
Comp3	.724927	0.2416	1.0000

Table 3 illustrates the extent to which variables contribute to macroeconomic instability. The combined effects of inflation, exchange rates, and interest rates as indicators of instability are reflected in Comp1. The dynamic dimension of monetary policy is reflected in Comp2, which contrasts fluctuations in inflation and exchange rates with interest rate adjustments. Inflation has a detrimental effect on Comp3, which has the maximum positive loading. The interest rate contributes the least, suggesting that inflation and exchange rates are in opposing relationships. While Comp1 is the most prominent component, contributing nearly half of the total variance in the data, Comp2 and Comp3 offer additional perspectives on the dynamics of monetary policy and the relationship between inflation and the currency exchange rate. In total, these three components account for 100% of the data's variance.

Table 3.
PCA Loadings Result

Component	Comp1	Comp2	Comp3
Inflation	0.6191	-0.2907	-0.7295
Interest Rate	0.5013	0.8614	0.0822
Exchange Rate	0.6045	-0.4166	0.6790

IV.B. Panel Regression Analysis

IV.B.1. Model Specification

The analysis is furthered by utilising panel data after the composite index is used to determine the index value for the efficacy of the monetary policies. The model is as follows:

$$MPE_{it} = \beta_0 + \beta_1 AI_{it} + \beta_2 BM_{it} + \beta_3 PS_{it} + u_{it}$$

Where the explained variable in this research is the effectiveness of monetary policy (MPE), the independent parameters in this study are AI readiness (AIR), broad money growth (BM), and the political stability index. Both the fixed effects and random effects models are the most frequently employed linear statistical panel data analysis models. In this study, we aim to examine the relationship between monetary policy effectiveness, AIR, and other independent variables.

Fixed Effect Model:

$$MPE_{it} = a_i + \beta_1 AIR_{it} + \beta_2 BM_{it} + \beta_3 PS_{it} + u_{it}$$

Random Effect Model:

$$MPE_{it} = \beta_1 AIR_{it} + \beta_2 BM_{it} + \beta_3 PS_{it} + (a_i + u_{it})$$

The country number is represented by i, the year by t, and the fixed effects' error term is denoted by u. where ($a_i + u_{it}$) is the Random Effects Model composite error term.

IV.B.2. Statistical descriptive

Table 4.
Statistical Descriptive of Panel Data Analysis

Variable	Mean	Std. dev.	Min	Max	Obs.
MPE	3.92e-10	1.188335	-.9431612	8.402386	95
AIR	34.62744	18.19692	1.344043	68.70723	95
BM	11.82939	9.39961	-7.349572	41.74421	95
PS	6.503326	4.489133	.1	19.837	95

The test results show substantial variation across OIC countries in the monetary policy effectiveness variable. The average MPE of 3.92e-10 and standard deviation of 1.188335 indicate that the effectiveness of monetary policy for OIC nations varies widely, with the highest MPE of 8.402386 indicating effective economic policy and the lowest MPE of -0.9431612 indicating ineffective monetary policy. Likewise, the AIR variable shows considerable variation, with a median of 34.62744 and a standard deviation of 18.19692. The maximum value of AIR is 68.70723, and the minimum is 1.344043. This shows that there are differences across countries in readiness to adopt AI technology. Although the regression results for countries are not significant between AI and MPE, there is substantial variation between the two variables, suggesting that each country faces unique challenges and opportunities in technology adoption and monetary policy. The average BM is 11.82939, with a standard deviation of 9.39961. This metric indicates the expansion of the money supply. The money supply growth of certain countries was reduced, while others experienced a substantial expansion, as evidenced by the BM values, which range from -7.349572 to 41.74421.

In conclusion, the Political Stability Index (PS) has a mean of 6.503326 and a standard deviation of 4.489133. The political stability of the countries observed is represented by the PS values, which range from 0.1 to 19.837. The findings of the subsequent analysis in this research may be influenced by the substantial variation in all variables, as indicated by these descriptive statistics.

These are the outcomes of the panel regression tests with fixed-effects, pooled ordinary least squares, and random-effects models.

Table 5.
Regression Results for OIC Countries

MPE		Pooled OLS	FE	RE
AIR	Coefficient	-.0003586	.0030097	.0014988
	Std. error	.0064425	.0042946	.0042816
	P-value	0.956	0.486	0.726
BM	Coefficient	.035913	-.0194531	-.0067275
	Std. error	.0125344	.0120551	.0113994
	P-value	0.005	0.111	0.555
PS	Coefficient	-.0431128	-.1194189	-.0612243
	Std. error	.0262116	.1038703	.0465484
	P-value	0.103	0.254	0.188

Several tests were conducted to ascertain the optimal model from the results of the three aforementioned models, including the Lagrange Multiplier Test (LM Test) and the Hausman Test. The LM Test is used to test whether the variance of each country's influence is zero, thereby verifying the null hypothesis. According to the Hausman test, the model with fixed effects is optimal, as the chi-square probability value is 0.0000. Consequently, H0 is denied, and H1 is accepted. Therefore, a preset paradigm was implemented in this investigation.

IV.B.3. Diagnostic Test Results

Diagnostic tests for autocorrelation, heteroscedasticity, and multicollinearity were implemented. The regression model did not exhibit substantial multicollinearity, as evidenced by a VIF of 1.01. Additionally, the study's findings indicated that there was no multicollinearity. Based on this value, the independent variables in a model exhibit a relatively low degree of interdependence and do not exert an inordinate influence on one another. Consequently, the regression model employed is stable, and the coefficient estimates can be interpreted adequately. This demonstrates that the variables used in the study are relatively independent, thereby eliminating the possibility of significant multicollinearity-induced distortions in the analysis. The study's results also indicated heteroscedasticity, as evidenced by the probability value of 0.0000. This suggests that variance is not constant. The probability of 0.0647, which is marginally above the general significance level of 0.05, was found in the autocorrelation test results. This indicates that the model contains no first-order autocorrelation.

A heteroscedasticity issue was identified. As a result, the researcher implemented robust standard errors in the model estimation to resolve this issue. Although the assumption of homoscedasticity is not satisfied, this method enabled the researcher to derive statistical inferences that are more

precise and dependable. The following are the regression results of the fixed effect model with robust standard errors:

Table 6.
Robust Fixed Effect Regression Results

MPE	Coefficient	Robust std. error	P-value
AIR	.0030097	.0049433	0.550
BM	-.0194531	.0205056	0.355
PS	-.1194189	.1048987	0.270

The findings of the fixed effect with robust standard error regression for OIC countries in this study indicate that AIR, BM, and PS do not significantly affect MPE where the P-value results are > 0.05. In addition, the R-squared within value (0.0469) shows that these variables only explain 4.69% of the variation in MPE, while rho (ϱ of 0.757) indicates that 75.7% of the error variation comes from differences between countries. Furthermore, this study focuses on Indonesia to analyse the effect of AIR, BM, and PS on MPE. The following are the results of panel data regression with a focus on Indonesia.

Table 7.
Regression Result of Indonesia

MPE	Coefficient	P-value	Result
AIR	.0003532	0.046	Significant
BM	-.0200928	0.007	Significant
PS	.15939939	0.011	Significant

According to the regression results for Indonesia, MPE is statistically significantly influenced by all independent variables, including AIR, BM, and PS, at a significance level of 5%. Where the AI variable has a positive coefficient of 0.0003532 (p-value = 0.046), suggesting that the effectiveness of Indonesia's monetary is positively impacted by an increase in AI technology preparedness. This conclusion is consistent with Abude's research, which found that AI is beneficial for developing indicators grounded in monetary policy.[44] In addition, the utilisation of AI can serve as an efficient instrument for anticipating and monitoring macroeconomic developments. Furthermore, AI-based models are better able to manage inflation and respond to economic disruptions.[45] AI has proven more effective at predicting inflation in Nigeria. AI

[44] Abude et al., "Developing."
[45] Dundua and Gorgodze, "Application of Artificial Intelligence."

can also help predict exchange rate fluctuations and provide more appropriate policy recommendations to maintain price stability.[46]

AI is also considered to accelerate transactions and money circulation in digital banking, which can affect inflation.[47] AI can enhance financial stability by assisting banks in more effectively managing interest rate risk by accurately predicting its movements.[48] Additionally, the monetary authority can manage fluctuations in the economic cycle by implementing data-driven monetary policy when utilising AI.[49] In conclusion, the effectiveness of monetary policy in Indonesia is significantly affected by AI.

In contrast, the BM variable has a negative coefficient of -0.0200928 (p-value = 0.007), implying that the effectiveness of monetary policy decreases as the broad money supply increases in Indonesia. This is supported by the finding that the amount of cash supplies also has a substantial adverse effect on monetary policy in Africa.[50] It was found that increasing the money supply reduces the need for funding, thereby decreasing the cost of borrowing.[51] This suggests that excessive money growth can reduce the efficiency of monetary policies. It has been demonstrated that inflation, bank loans, and deposits are all influenced by broad money.[52] Furthermore, inflation is more effectively addressed through a monetary policy that is based on broad money.[53]

The Political Stability Index (PS) variable has a positive coefficient of 0.1593993 (p-value = 0.011), indicating that political stability significantly enhances the efficiency of monetary policies in Indonesia. This is consistent with the research by de Mendonça and Nascimento, which finds that political stability is a critical factor in enhancing monetary policy effectiveness.[54] Additionally, increased political stability can reduce the risk of inflation.[55]

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[46] Nwanhele Udo Noble Aguwamba Rowland Chidi. "Artificial Intelligence Solutions for Economic Resilience: Addressing Inflation, Food Scarcity, and Insecurity in Nigeria." Paper presented at the Academic Staff Union of Polytechnics 1st International Hybrid Conference at ASUP Solidarity Complex, Federal Polytechnic, Nekede, June 18-21, 2024.

[47] Piduru, "Navigating Digital Transformation."

[48] Enes Koçoşlu and Filiz Ersöz, "The Application of Data Mining Application with Machine Learning Algorithms to Manage Interest Rate Risk," *Business & Management Studies: An International Journal* 10, no. 4 (2022): 1545–64. https://doi.org/10.15295/bmij.v10i4.2162.

[49] Ekinci, "The Impact on Digitalisation."

[50] Fiador et al., "Monetary Policy Effectiveness."

[51] Benoit Mojon, "Financial Structure and the Interest Rate Channel of ECB Monetary Policy," *European Central Bank Working Papers*, no. 40 (2000).

[52] Ahmad AlHarbi et al., "Money Supply, Banking and Economic Growth: A Cross Country Analysis," *International Journal of Economics and Financial Issues* 14, no. 2 (2024): 234–42, https://doi.org/10.32479/ijefi.15749.

[53] Rashid and Jehan, "The Response of Macroeconomic Aggregates."

[54] de Mendonça and Nascimento, "Monetary Policy Efficiency."

[55] Fiador et al., "Monetary Policy Effectiveness."

Macroeconomic stability and monetary policy performance may be adversely affected by an environment with inadequate political stability.[56] In addition, countries with lower political pressure risk perform better in monetary policy.[57] High political instability is consistent with high inflation.[58] Other evidence was found across North Africa and the Middle East, where the political system is unstable, and instability has been shown to increase inflation volatility significantly.[59] In Argentina, political instability was found to affect economic expansion. This indirectly affects the macroeconomic variable of inflation.[60] It can be concluded that the political stability index affects the efficiency of monetary policy. The higher the value of political stability in Indonesia, the more effective the monetary policy is.

The model is described as having an R-squared value of 0.9999, which accounts for almost 100% of the variance in MPE for Indonesia, and a minimal Root MSE of 0.00115, reflecting a high degree of model precision. These results affirm that AIR, BM, and PS are critical determinants affecting the efficiency of monetary policies in Indonesia. The policy ramifications of these findings necessitate enhancing AI technological preparedness, ensuring political stability, and judiciously managing the expansion of the money supply to bolster the efficacy of monetary policy. The regression results demonstrate robust predictive potential; however, they should be interpreted with prudence. The high R-squared value may suggest overfitting, suggesting that although AIR, BM, and PS account for nearly all the variation in the efficacy of monetary policy, additional external variables may also be at play. The analysis could be refined by incorporating alternative indicators, such as financial market depth, central bank independence, and international trade dynamics, in future research.

V. CONCLUSION

This study examines the roles of AI preparedness, broad money (M2) growth, and political stability in the effectiveness of monetary policy, as measured using the composite index PCA method, focusing on Indonesia. We selected

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[56] Aisen and Veiga, "Does Political Instability Lead."

[57] de Mendonça and Nascimento, "Monetary Policy Efficiency."

[58] Aisen and Veiga, "Does Political Instability Lead."

[59] Ghanayem Afnan et al., "The Impact of Political Instability on Inflation Volatility: The Case of the Middle East and North Africa Region," *Cogent Economics and Finance* 11, no. 1 (2023), https://doi.org/10.1080/23322039.2023.2213016.

[60] Nauro F. Campos et al., "Two to Tangle: Financial Development, Political Instability and Economic Growth in Argentina," *Journal of Banking and Finance* 36, no. 1 (2012): 290–304, https://doi.org/10.1016/j.jbankfin.2011.07.011.

OIC countries as our sample and collected data for the period 2019-2023. The period 2019-2023 was selected for analysis due to the limited data available for OIC countries, facilitating a more contextually relevant examination. 19 OIC countries were selected in this study due to data limitations. Panel data analysis is used in this study, in which, after processing data for OIC countries, the analysis focuses on Indonesia. This study found that AI Readiness exerts a significant, beneficial influence on the efficiency of the monetary system practised in Indonesia. This means that as Indonesia's readiness to adopt AI, as measured by the AI Readiness index, improves, the efficacy of monetary policy in Indonesia increases. Likewise, political stability in Indonesia has a substantial positive impact. This means that when the value of political stability in Indonesia, as determined by the index of political stability, increases, it also increases the efficiency of Indonesia's monetary regulations. As for the money growth variable, it shows a significant adverse effect, indicating that when broad money increases, the effectiveness of monetary policy in Indonesia decreases. When money circulation increases in Indonesia, monetary policy becomes less effective. This study also found differences in results between OIC countries and the focus country, Indonesia. Where, in OIC countries, the regression results show the opposite of the results for Indonesia. The AI Readiness, Broad Money, and Political Stability Index variables do not have a significant effect. This means that other indicators, which have a higher or stronger influence on the efficacy of monetary policies in OIC countries, are not examined in this study. This could be due to differences across OIC countries, including economic status, geography, and so on. In addition, it was found that 0.9999, or almost 100%, of the variation in the efficiency of monetary policy in Indonesia can be explained by AI readiness, broad money growth, and the political stability index, with a minimum Root MSE of 0.00115 indicating a high level of model precision.

The limitations of this study should be considered: the monetary policy effectiveness index, built from a composite of inflation indicators, interest rates, and exchange rates, may not capture all aspects of each OIC country's economy, society, and politics, which have their own characteristics, especially in Indonesia. To better reflect regional differences and increase the robustness of the findings, further research should include additional indicators over a longer period.

In addition, the differing results between OIC and Indonesia suggest that country-specific factors influence monetary policy efficiency. Variables need to be examined more carefully for future research related to structural and institutional differences between Indonesia and the OIC. Another weakness is that using five-year panel data may not be sufficient to capture more relevant long-term trends. Therefore, a high R-squared value may indicate overfitting,

suggesting that although AI Readiness, Broad Money Growth, and Political Stability account for almost all the variation in monetary policy efficacy, additional external variables may also be at play.

The practical implications of these findings include the importance of AI in developing the efficiency of monetary policies. The findings showing a positive association between AI readiness and the effectiveness of monetary regulations indicate that financial system collaboration, supported by digital transformation in the form of AI, can improve economic resilience and policy response. so that policymakers must prioritise the promotion and development of AI readiness in Indonesia's financial institutions by ensuring the necessary regulatory framework is in place to reduce risks and threats. In addition to providing valuable insights, this study underscores the importance of continuous adaptation in the monetary policy framework to respond to the acceleration of technological progress. In addition, the alignment between increased AI readiness and political stability in Indonesia is an important indicator and should be pursued. The analysis should be refined by incorporating alternative indicators, such as financial market depth, central bank independence, and international trade dynamics, in future research.

In the future, Indonesian authorities need to strengthen the legislative framework supporting the use of AI and encourage the establishment of research institutes in the financial industry focused on artificial intelligence. To investigate the structural disparities among OIC nations, it is advised that more studies be conducted. Additionally, the long-term link between the adoption of AI and the effectiveness of monetary policy should be tested by adding a greater number of macroeconomic and social factors.

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