Estimating A Logistic Regression Model on The Role of Artificial Intelligence on Derivative Markets

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Abstract

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The study explored the role of Artificial intelligence on the stability, efficiency, depth, and access of derivative markets during the period 2009 to 2021. The study used mixed method research. Cross sectional data of 60 countries from North America, Latin America and the Caribbean, Western Europe, Eastern Europe, Middle East and North Africa, Sub-Sahara Africa, South and Central Asia, East Asia, and the Pacific. Simple random sampling was used to select the 60 countries according to their Government Artificial Intelligence Index. Logistic regression was applied on the cross-section data to determine the effect of Artificial Intelligence on derivative markets in terms of financial efficiency, financial depth, financial access, and financial stability. The proven role of Artificial Intelligence on derivative markets is to enhance financial inclusion and financial stability through the provision of derivative trading platforms. The results of the study showed that the use of Artificial intelligence on derivative markets is significantly and positively related to financial access as measured by the percentage of digital payments. Further, the test revealed that the use of Artificial Intelligence on derivative markets is significantly and negatively related to financial stability as measured by stock price volatility. The study showed that there was no effect on financial depth and efficiency arising from the use of Artificial Intelligence on derivative markets. The study recommended that governments should put in place adequate financial infrastructure as well as vibrant regulations prior to the use of Artificial Intelligence on the derivative markets to avoid systemic risk build ups.

Keywords: Artificial Intelligence, Derivative Markets, Financial Development, Government Artificial Intelligent Readiness Index, Logistic Regression

1.0 Introduction to the study

The study explored the role of Artificial Intelligent (AI) on Global Derivative markets. The global markets covered in the study comprise of sixty countries covering North America, Latin America, the Caribbean, Western Europe, Eastern Europe, Middle East, North Africa, South Asia, Central Asia, East Asia, and the Pacific.

1.1 Artificial Intelligent (AI)

Financial Stability Board [FSB, 2017] defined AI as a theory and development of computer systems able to perform tasks that traditionally had required human intelligence. According to the Organization for Economic Cooperation and Development [OECD, 2019] AI are regarded as machine-based systems with varying levels of autonomy that can

for a given set of human defined objectives, make recommendations, predictions or decisions using massive amounts of alternative data sources and data analytics referred to as big data.

1.1.1 Types of Artificial Intelligence

Futures Industry Association's Expo conference [FIA, 2023] deduced that artificial intelligence can be split into traditional machine learning termed discriminative AI and Generative AI. The role of discriminative AI was distinguished from that of generative AI in that discriminative AI looks for patterns and trends in the data it is trained on and makes predictions whilst generative AI are the models or algorithms that are used to create something new (Stanton, 2023). FIA [2023] declared at the Expo conference that generative AI gained a traction in the derivative markets as it is described as a big breakthrough in the power of AI and in the democratization of AI. Further the role of generative AI was seen as providing superpowers in personal productivity and product development [FIA, 2023].

1.1.1 Government Artificial Intelligence Readiness Index

The ambition of the index is to score governments according to their readiness to implement AI in the delivery of public services. 181 countries are ranked as AI readiness is regarded a global issue. The index is developed based on 39 indicators across 10 dimensions that make up 3 pillars comprising of the government pillar, technological sector pillar and the data and infrastructure pillar [Government AI Readiness Index, 2022].

The government pillar focuses on the strategic vision of how to develop and manage AI supported by appropriate governance and ethics. The technological sector pillar demands that the technological sector of any country should have high innovation capacity, underpinned by a business environment that supports entrepreneurship and good flow of research and development spending as well as good levels of human capital. Data and infrastructure pillar call for high quality of data availability to avoid bias and error and that the data should be a representative of the citizens in each country. The infrastructure pillar demands that appropriate infrastructure necessary to power AI should be put in place so that data potential can be realised [Government AI Readiness Index, 2022].

The index helps the government of any country to prepare for the adoption of AI in their services by having appropriate frameworks, capacities, resources, skills, and infrastructure in place to make good decision about AI [Government AI Readiness Index, 2022].

1.1.1 The role of Artificial Intelligence and Machine Learning

Financial Stability Board [FSB, 2017] identified the following purposes of artificial intelligence on the financial markets; sentiment indicators; trading signals; anti-money laundering (AML)/ combating financing terrorism (CFT) and fraud detection. Investment sentiment indicators are being developed through use of AI and sold to banks, high frequency trading traders, hedge funds and social trading and investment platforms. AI can be used to facilitate compliance with regulations, credit monitoring and risk mitigation purposes. AI can also be used to identify trading patterns and forecast trends [FSB, 2017].

In addition, the FSB [2017] identified the following as practical uses of AI in the financial markets; customer focused uses embracing client-facing chatbots, insurance and credit scoring; optimization of a bank's regulatory capital; derivatives margin optimization including value margin optimization; model risk management including back testing and model validation and stress testing; assess market impact of a given trade; asset management trading execution and portfolio management.

1.1 Statement of the Problem

Following the financial crisis of 2007/2008 derivatives were blamed for contributing towards the crisis. The period after the financial crisis has been characterised by revolution of artificial intelligence in all the global markets. The role of AI had been described as providing superpowers on the transformation of products and services relying on traditional economic and finance theory to systems currently being driven by deep learning smart finance. Most governments had been observed as not yet ready in the adoption of AI in their respective markets. Hence the study explored the role of artificial intelligence on derivative markets with respect to financial development.

1.3 Research Questions

1.3.1 Main Research Question

1. What is the role of Artificial Intelligent on Derivative markets?

1.3.2 Sub Research Questions

2.What are the risks of Artificial Intelligent (AI) on Derivative Markets?

1.4 Objectives of the study

The objective of the study is to examine.

1. The role of Artificial Intelligent on Derivative markets.

2. The risks of artificial Intelligent (AI) on Derivative Markets.

1.5 Research Hypothesis

1.5.1 Null Hypothesis

Derivative Market use of Artificial Intelligent (AI) is not significantly and positively related to financial development as measured by efficiency, depth, stability, and access.

1.5.2 Alternative Hypothesis

Derivative Market use of Artificial Intelligent (AI) is significantly and positively related to financial development as measured by efficiency, depth, stability, and access.

2. Literature Review

2.1 Empirical Review of Literature

2.1.1 The Role of Artificial Intelligent (AI) on Derivative Markets

Hajj and Hammoud (2023) acclaimed the use of Artificial Intelligence in algorithm trading, fraud detection, risk management, customer service and credit scoring. The study was based on convergent mixed method research design. The study was based on an online questionnaire survey of 144 questionnaires. The target population of the study was analysts, portfolio managers and traders. SPSS was used to produce descriptive statistics a multi regression equation was also deployed to examine the association between dependent and independent variables (ibid).

Mahalakshmi et al., (2022) alluded that artificial intelligence allows managers to concentrate on the strategic issues of the business rather than spending time on repetitive tasks. It is further reiterated that AI can be used for a wide range of activities ranging from credit lending, risk assessment, stock trading and risk assessment. The methodology of the study was based on qualitative research.

Longbing (2021) asserted that the advancement of Artificial Intelligence and Data Science (AIDS) resulted in the paradigm shift from conventional economy and finance that is based on economic and finance theories to a new era of smart finance driven by machine learning that involve deep data analysis and data driven evidence discovery that is combined with economic and finance theories.

Nobanee and Al-Blooshi (2020) proclaimed that the role of artificial intelligence around the world was for the detection of anomalies, establishment of optimal investment strategies and algorithmic trading. Furthermore, it is stressed that artificial intelligence was used in high frequency market trading through use of proprietary algorithmic programs that spontaneously integrate changing market dynamics and price levels. The study was based on systematic content analysis to evaluate related literature publications.

Further O' Halloran and Nowaczyk (2019) affirmed that artificial intelligence can be used as a robust approach to simulate the impact of financial regulations on systemic risk. Lin et al., (2022) demonstrated that derivatives strategies established by use of behavioural finance artificial intelligence deep neural network algorithms can yield positive results.

2.1.2 The risks of AI on Derivative Markets

Stiehl et al., (2021) conceptually illustrated that autonomous AI trading methods allowed for both old and new forms of market manipulation including emerging risks of algorithmic 'tacit collusion caused by the 'black box' nature of autonomous AI trading systems. The study was exploratory based on a financial market conduct perspective. It is reiterated that whenever the AI amounts to "black box" liability attribution rules are subverted and further existing enforcement mechanisms, including market surveillance mechanism can become outdated and increasingly leading to the inability to police those forms of market misconduct caused by AI algorithmic agents. It is further observed that algorithmic market abuse can go viral and spill over to the whole global financial system to the point of affecting the global systemic stability(ibid).

According to Ravikumar et al. (2021) AI and machine learning can give rise to embedded risk resulting from unfairly discrimination against certain individuals or groups of individuals in favour of others. It is further stressed that AI adoption can also raise concerns about data privacy and issues of financial stability(ibid). Furthermore Ravikumar et al. (2021) identified new unique cybersecurity threats such as novel threats in addition to the traditional cyber risks that are brought about by adoption of AI. Varona and Suarez (2020) alluded that AI could result in data biases or inaccurate or insufficient information and distrust for the technology.

The Financial Stability Board [FSB, 2017] asserted that the use of AI and machine learning to minimise margins and maximise expected return on capital may increase risks if the regulations are constraint thereby demanding tighter liquidity buffers, increased leveraged and faster maturity transformation than in cases when it had not been used for such optimization.

3. Research Methodology & Design

The methodology to be used for the study is the Mixed method Research (MMR) involving quantitative research as well as documentary review. Logistic regression was applied on the data obtained from the data base of the World Bank Financial Development Indicators covering the period from 2009 to 2021. The following logistic regression equation shall be used;

DMAI USEit = α + β1Made a digital payment + β2 Stock Market Capitalization to GDP % + β3Stock market turnover ratio + β4Stock price volatility + vit

Where it, is subscript for country derivative market artificial intelligence use in year t and takes a value of 1 if a country had a derivative market in the report for that year and is otherwise zero.

β1- Made a digital payment (% age 15+).

β2-Total value of all listed shares in a stock market

as a percentage of GDP.

β3-. Total value of shares traded during the period divided by the average market capitalization for the period.

β4- Stock price volatility is the average of the 360-day volatility of the national stock market index.

Vit- random error term

4. Data Analysis and Discussion of Research Findings

4.1 The role of Artificial Intelligent on Derivative Markets

The role of Artificial Intelligent (AI) on Derivative Markets is through the enhancement of risk management, algorithm trading, development of new derivative based approaches and development of Artificial Intelligent (AI) powered trading platforms (Frąckiewicz, 2023).

4.1.1 Enhancement of risk management

According to Frąckiewicz (2023) Artificial Intelligent (AI) allows investors to make more informed decisions when managing exposures to certain assets obviously leading to effective risk mitigation. This is enabled by Artificial Intelligent (AI) powered algorithms that can analyse huge amount of data that ultimately lead to an improvement in the prediction of market trends and identification of potential risks.

4.1.2 Improvement to Market Efficiency-Algorithm trading

Artificial Intelligent (AI) afforded the use of complex algorithms in the execution of derivative trades at high speeds in responds to changes in specific market conditions and market events. Further the integration of AI in derivative trading allows algorithms to learn from past data thereby adapting derivative strategies in real time resulting in better and spontaneous responds to changes in market conditions (Frąckiewicz, 2023).

4.1.3 Increased Customization of Derivative Products

AI enables customisation of derivative products thus tailoring the derivative products to the specific needs of the individual customers in terms of the client' s risk tolerance, investment goals and other preferences. In this regard AI offers a level of personalization that was never attained before in the derivative markets (Frąckiewicz, 2023).

4.1.4 Development of Artificial Intelligent (AI) Powered Derivative Trading Platforms

AI powered derivative platforms tend to bring greater transparency to the derivative markets as compared to the traditional over the counter (OTC) markets that were characterized with high degrees of obscurity. The lack of transparency in the traditional derivative markets contributed to the global financial crisis of 2007/2008, through market inefficiencies and market manipulation. The emerging AI-powered derivative platforms brings greater transparency to the derivative markets through use of advanced analytics providing valuable insights and real time pricing information on derivative products (Frąckiewicz, 2023).

Table 4.2 above shows the coefficients β1, β2, β3 and β4 of the panel regression equation that were used in this study. The dependent variable of the regression equation was Derivative Market use of artificial intelligence and took a value of 1 if the country had a derivative market and otherwise zero if a country had no derivative market. β1 relates to the percentage of respondents who reported using mobile money, a debit or credit card, or a mobile phone to make a payment from an account; or who report using the internet to pay bills or to buy something online or in a store in the past year. This included respondents who

Table 4.1 Descriptive Statistics for the role of Artificial Intelligence on derivative markets

Item	Mean	Median	Standard Deviation	Maximum	Minimum
Made a Digital Payment	59.35	65.52	31.77	99.48	5.36
Stock Price Volatility	18.51	16.80	9.16	65.35	4.02
Stock market Capitalization	69.80	59.10	55.63	322.71	4.59
Stock Market Turnover Ratio	49.97	28.33	66.26	480.29	0.093

Table 4.2 Estimating a logistic regression model on the role of Artificial Intelligence on derivative markets

	Logit regression	Logit regression	Logit regression
Constant	**Coefficient**	**Z-statistic**	**Prob.**
Made a Digital Payment (β1)	0.06	4.631	0.01
Stock Price Volatility (β4)	-0.02	-1.451	0.05
Stock market Capitalization (β2)	-0.0026	0.0054	0.6
Stock Market Turnover Ratio (β3)	-0.0023	0.0121	0.000

Level of significance @ 1%.

reported paying bills or sending remittances directly from a financial institution account or through a mobile money account in the past year.β2 relates to total value of all listed shares in a stock market as a percentage of GDP. β3 relates to total value of shares traded during the period divided by the average market capitalization for the period. β4 relates to Stock price volatility, the average of the 360-day volatility of the national stock market index (World Bank Group, 2022).

The results of testing the hypothesis revealed that derivative market use of artificial intelligence is significantly and positively related to financial access as measured by the percentage of digital payments made. This resonates with the findings of Financial Stability Board [FSB, 2017] that AI and Machine learning expand the investor base in the financial markets by reducing the barriers to entry for investors in both the retail and capital markets. The implication of this is that increased use of artificial intelligence through creation of derivative trading platforms increases the outreach of derivative markets. In addition, the results of the study revealed that derivative market use of artificial intelligence is significantly and negatively related to financial stability as measured by stock price volatility. This means that an increased use of artificial intelligence on derivative markets will result in stable financial systems that can easily contain contagion risks. This resonates with the findings of Financial Stability Board [FSB, 2017]. However, the study results showed that derivative market use of artificial intelligence has no effect on both derivative market depth and derivative market efficiency.

4.2 Conclusions and Recommendations

The evolution of AI and machine learning had brought with it financial access and stability gains in the global economy as proven by the study. However, as the global markets continued to be revolutionized by AI algorithmic trading new forms of market manipulation and deep learning trading risks emerge that may lead to the impairment of global financial systems if they are not carefully supervised and monitored.

4.2.1 Recommendations

In adoption of AI algorithmic trading policy makers are recommended to carefully rethink and promulgate robust AI social, legal and regulatory reforms that substantially reduce the risk of autonomous AI algorithmic trading risks through the mandating of the human in the loop regulatory option. Hence government needs to continuously monitor the adverse effect of autonomous AI algorithmic trading on their financial systems in view of global financial stability. Policy makers are advised to continuously prepare towards their readiness for the fully adoption of AI algorithmic trading through the provision of adequate strategic vision, financial infrastructure, and technological capabilities necessary to power AI deep learning effects on their local financial system.

Governments that have an adequate prudential oversight of AI and Machine learning can benefit from AI through the growth of new credit platform that directly connect lenders and borrowers thus reducing overreliance on bank loans, reducing bank leverage, and thereby achieving a more diversified risk sharing structure in the overall financial system [FSB, 2017].

Lastly policy makers need to continuously monitor and strengthen their prudential oversight in relation to new developments in artificial intelligence.

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