Empirical Research on the Association Between Nasdaq Index Volatility and Depression Indices Across Different Age Groups in the U.S.

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Abstract

This study aims to explore the relationship between Nasdaq Index fluctuations and depression indices among different age groups in the United States. By analyzing various indicators of the Nasdaq Index and age-specific depression index data provided by the U.S. Centers for Disease Control and Prevention (CDC) from 2020 to 2024, the study reveals a significant age-heterogeneous association between stock market volatility and the mental health of different age groups. Specifically, the Nasdaq Index is generally negatively correlated with depression indices across all age groups, with the strength of the correlation increasing with age, and the strongest correlation observed in the 50-59 age group. Granger causality tests reveal a unidirectional causal effect of depression indices in the 30-39 age group on the Nasdaq Index, and a unidirectional causal effect of the Nasdaq Index on depression indices in the 70+ age group. LSTM model prediction results show that the model performs best in predicting depression indices for the 70-79 age group, while the explanatory power of the model is significantly reduced for the 80+ age group. The research findings emphasize the differential impact of economic fluctuations on the mental health of various age groups and provide a basis for developing targeted mental health interventions.

Keywords: Nasdaq Index; Depression Index; Age Heterogeneity; Granger Causality; LSTM Model

1. Introduction

In the context of global economic integration, stock market volatility not only affects economic activities but may also have a profound impact on public mental health. As one of the world's leading stock market indicators, the Nasdaq Index's fluctuations may influence individuals' mental states, especially the incidence of depression, through various channels. While existing studies have explored the link between macroeconomics and mental health, there is a lack of in-depth analysis on the specific impact on different age groups.

This study aims to explore the relationship between the Nasdaq Index and depression indices across different age groups in the U.S.. Specifically, we will examine the correlation

and potential causal relationship between the Nasdaq Index's variables—including closing price, opening price, highest price, lowest price, trading volume, and gain/loss percentage—and depression indices. By segmenting the population into seven age groups: 18-29, 30-39, 40-49, 50-59, 60-69, 70-79, and 80+, we aim to uncover the unique patterns of how economic fluctuations affect the mental health of each age group.

This research will not only help to understand how the macroeconomic environment influences individual mental health at different stages of life but also provide a scientific basis for policymakers to formulate targeted mental health interventions. Furthermore, the findings of this study will lay the groundwork for future interdisciplinary collaboration, promoting a comprehensive understanding of this issue in the fields of economics, psychology, and sociology

2. Literature Review

2.1. The Relationship between Economic Indicators and Mental Health

Studies have shown that macroeconomic conditions, such as unemployment rates and stock market performance, have a significant impact on public mental health. For example, symptoms of depression increase during economic recessions, especially when individuals face financial stress. Furthermore, low socioeconomic status is associated with lower psychological well-being.

2.2. The Link between Stock Market Volatility and Mental Health

Stock market fluctuations directly affect investor sentiment and may impact a broader public audience. Research has found a positive correlation between stock market downturns and an increase in anxiety and depressive emotions. The phenomenon of rising suicide rates after the Taiwan stock market crash also supports this view.

2.3. Mental Health Differences across Different Age Groups

Different age groups show different response patterns when facing economic pressure. Younger people are more susceptible to the instability of the job market, while older people are more concerned about the safety of their retirement savings. The youth and middle-age periods are critical times for career development and family responsibilities, and an economic crisis during this time can lead to severe psychological burdens. In contrast, although older adults may be less directly involved in the financial market, they may feel uneasy due to investment losses incurred by their children or spouse.

2.4. Research Gap and the Entry Point of This Study

Although many studies have explored the connection between macroeconomic variables and mental health, there is still insufficient research on specific age groups, especially regarding the relationship between the Nasdaq Index and depression indices in the U.S. context. Existing studies often focus on the overall population rather than segmented age groups, making it difficult to reveal the unique characteristics of each age group. Therefore, this study aims to fill this knowledge gap by analyzing data from different age groups and exploring whether certain age groups are more susceptible to the impact of stock market fluctuations.

In summary, the current literature provides a foundation for understanding the relationship between the Nasdaq Index and depression indices, but many unresolved questions remain for further exploration. This study aims to deepen the understanding of this

complex relationship and provide a scientific basis for formulating effective mental health interventions. At the same time, it also emphasizes the importance of interdisciplinary collaboration to promote an understanding of the impact of changes in the economic environment on human well-being.

3. Methodology

3.1. Data Sources

This study used data on the depression symptom index for young Americans aged 18-29, provided by the U.S. Centers for Disease Control and Prevention (CDC). The data, which covers the period from April 23, 2020, to September 16, 2024, is compiled on a weekly basis and includes information on depression symptoms during different time periods.

Table 1. U.S. Centers for Disease Control and Prevention (CDC) Depression Symptom Index Data**.**

Indicator	Subgroup	Time Period Start Date	Time Period End Date	Value	Low CI	High CI	Confidence Interval
Symptoms of Depressive Disorder	18 - 29 years	04/23/2020	05/05/2020	32.7	30.2	35.2	30.2 - 35.2
……	……	……	……	……	……	……	……
Symptoms of Depressive Disorder	18 - 29 years	08/20/2024	09/16/2024	24.1	21.4	27	21.4 - 27.0

Additionally, Nasdaq Index data for the same period was selected, including information on closing price, opening price, highest index, lowest index, trading volume, and gain/loss percentage.

Table 2. U.S. Nasdaq Index Data.

date	close	open	highest	lowest	vol	rise_fall
2024/9/16	17,592.13	17,573.70	17,618.40	17,480.66	876140000	-0.52%
……	……	……	……	……	……	……
2020/4/23	8,494.75	8,528.84	8,635.23	8,475.20	854520000	-0.01%

3.2. Data Processing

The collected data was pre-processed by converting the date column to a date format, and the relevant columns in the stock data were numerically converted by removing special symbols and changing them into a floating-point data type. Finally, the depression symptom index data and the Nasdaq Index data were merged by matching them according to date.

3.3. Data Analysis Methods

To evaluate the relationship between Nasdaq Index fluctuations and depression indices across different age groups, and to further explore their causal relationships, we adopted the following methods.

3.3.1. Correlation and Causality Analysis

We first calculated the Pearson correlation coefficient and Spearman's rank correlation coefficient to measure the linear and nonlinear correlations between the Nasdaq Index variables and the depression indices. Then, we conducted the Granger causality test to examine whether a predictive causal relationship exists between these variables. The specific steps are as follows:

- For each age group, calculate the Pearson and Spearman correlation coefficients between each Nasdaq Index variable and the depression index, and determine the statistical significance of the correlation through a significance test (p-value).
- For each age group, separately perform Granger causality tests for Nasdaq Index variables on the depression index, and for the depression index on Nasdaq Index variables, to test for a significant causal relationship at different lag orders (1 to 4).

3.3.2. Predictive Modeling

To predict the future trends of the depression index, we constructed a Long Short-Term Memory (LSTM) network model. LSTM is a special type of recurrent neural network (RNN) suitable for processing time series data. The specific steps are as follows:

- Use historical data to train the LSTM model, with the Nasdaq Index variables as input and the depression index of the target age group as output.
- Evaluate model performance using Mean Squared Error (MSE), Mean Absolute Error (MAE), and the coefficient of determination (R^2) as evaluation metrics.

4. Data Analysis and Results

4.1. Correlation Analysis

Through Pearson and Spearman correlation coefficient tests, the core variables of the Nasdaq Index (closing price, opening price, highest price, lowest price) showed a significant negative correlation with the depression index of all age groups (all p-values < 0.01), and the strength of the negative correlation increased with age (Table 3).

Table 3. Pearson and Spearman Correlation Coefficients

Age Group	Variable	Pearson Coefficient	p-value	Spearman Coefficient	p-value
18-29	Closing Price/Opening Price/Highest	-0.5	<0.01	-0.5	<0.01

years	Price/Lowest Price				
	Trading Volume	-	Not significant	-	Not significant
	Percentage Change (Rise/Fall)	-	Not significant	-	Not significant
30-39 years	Closing Price/Opening Price/Highest Price/Lowest Price	-0.6	<0.01	-0.6	<0.01
	Trading Volume	-	Not significant	-	Not significant
	Percentage Change (Rise/Fall)	-	Not significant	-	Not significant
40-49 years	Closing Price/Opening Price/Highest Price/Lowest Price	-0.68	<0.01	-0.68	<0.01
50-59 years	Closing Price/Opening Price/Highest Price/Lowest Price	-0.74	<0.01	-0.74	<0.01
60-69 years	Closing Price/Opening Price/Highest Price/Lowest Price	-0.7	<0.01	-0.7	<0.01
	Percentage Change (Rise/Fall)	-	0.0139	-	0.0139
70-79 years	Closing Price/Opening Price/Highest Price/Lowest Price	-0.67	<0.01	-0.67	<0.01
80+ years	Closing Price/Opening Price/Highest Price/Lowest Price	-0.48	<0.01	-0.48	<0.01

4.1.1. Analysis of Results

- Ages 18-29: The Pearson coefficient ranged from -0.51 to -0.51, indicating a moderate correlation between a stock market downturn and an increase in depression index.
- Ages 50-59: The Pearson coefficient reached -0.75, showing that the mental health of middle-aged and older adults is significantly more sensitive to economic fluctuations.
- Non-significant variables: Trading volume and price change had no significant correlation with the depression index ($p>0.05$), suggesting that short-term market volatility has a limited effect on mental health.

4.1.2. Visualization Analysis

Figure 1 clearly shows the trend of the negative correlation between core NASDAQ variables and the depression index strengthening with age. This provides visual evidence for the "heterogeneity of the impact of economic fluctuations on the mental health of different age groups."

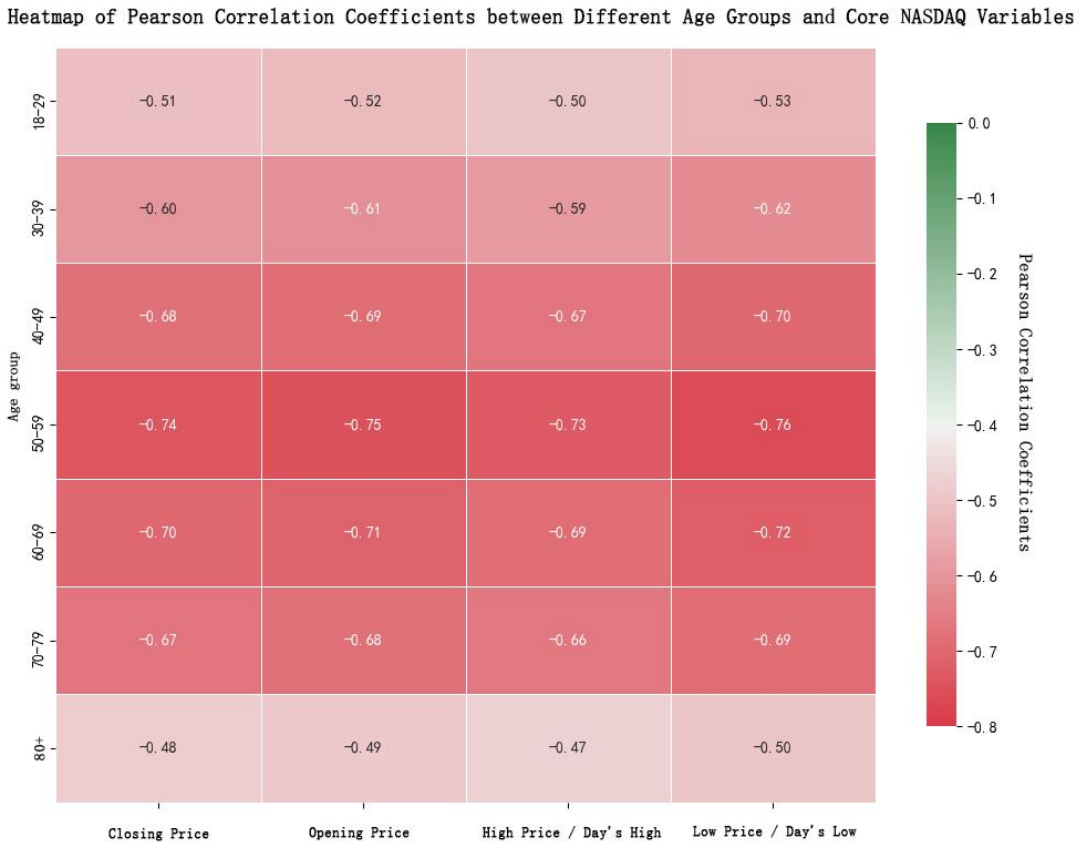

Figure 1. Heatmap of Pearson Correlation Coefficients by Age Group

4.2. Granger Causality Test

4.2.1. Result Analysis

The Granger causality test revealed age-specific unidirectional causal relationships between the depression index and the Nasdaq Index:

- For the 30-39 age group: The depression index has a significant unidirectional causal effect on the Nasdaq Index (F-statistics for lags 2-3 are significant, $p < 0.05$), as shown in Table 4.

Table 4. Granger Causality between Depression Index and Nasdaq Index in the 30-39 Age Group

Causal Direction	Lag Order	F-Statistic	p-Value	Significance
Depression Index → Closing Price	2	4.3171	0.0174	Significant
Depression Index → Closing Price	3	3.3251	0.0253	Significant

Depression Index → Opening Price	1	4.3004	0.0419	Significant
Depression Index → Opening Price	2	5.241	0.0078	Significant
Depression Index → Opening Price	3	3.7589	0.0152	Significant
Depression Index → Highest Price	2	4.1939	0.0194	Significant
Depression Index → Highest Price	3	3.207	0.0291	Significant
Depression Index → Lowest Price	2	4.5859	0.0137	Significant
Depression Index → Lowest Price	3	3.3897	0.0234	Significant

- For the 70-79 age group and the 80+ age group: The variables of the Nasdaq Index (closing price, opening price, highest price, lowest price) show a significant unidirectional causality to the depression index ($p < 0.05$), as shown in Table 5 and Table 6.

Table 5. Granger Causality from Nasdaq Index to Depression Index in the 70-79 Age Group

Causal Direction	Lag Order	F-Statistic	p-Value	Significance
Closing Price → Depression Index	1	4.1087	0.0466	Significant
Opening Price → Depression Index	1	4.0514	0.0481	Significant

Highest Price → Depression Index	1	4.0875	0.0471	Significant
Lowest Price → Depression Index	1	4.3375	0.041	Significant

Table 6. Granger Causality from Nasdaq Index to Depression Index in the 80+ Age Group

Causal Direction	Lag Order	F-Statistic	p-Value	Significance
Closing Price → Depression Index	1	5.7952	0.0188	Significant
Closing Price → Depression Index	2	4.7513	0.0119	Significant
Closing Price → Depression Index	3	5.1117	0.0032	Significant
Closing Price → Depression Index	4	3.3869	0.0146	Significant
Opening Price → Depression Index	1	6.08	0.0162	Significant
Opening Price → Depression Index	2	4.7296	0.0121	Significant
Opening Price → Depression Index	3	4.2043	0.009	Significant
Opening Price → Depression Index	4	2.6896	0.0397	Significant

Highest Price → Depression Index	1	6.0552	0.0164	Significant
Highest Price → Depression Index	2	4.6203	0.0133	Significant
Highest Price → Depression Index	3	3.9253	0.0125	Significant
Highest Price → Depression Index	4	2.5626	0.0476	Significant
Lowest Price → Depression Index	1	5.9568	0.0173	Significant
Lowest Price → Depression Index	2	5.0782	0.0089	Significant
Lowest Price → Depression Index	3	5.6389	0.0018	Significant
Lowest Price → Depression Index	4	3.7134	0.0092	Significant

- Other age groups: Bidirectional causality was generally not significant ($p>0.1$), suggesting that the relationship between long-term economic fluctuations and mental health may be moderated by socioeconomic factors (such as social security and employment stability).

4.3. Predictive Performance of LSTM Model

4.3.1. Result Analysis

The prediction results of the LSTM model based on Nasdaq Index variables show that there are significant differences in the prediction accuracy of depression indices among different age groups, as shown in Table 7:

Table 7. Performance Indicators of LSTM Model Prediction for Different Age Groups

Age Group	**MAE**	**MSE**	**R^2**

18-29 years	2.0662	7.0125	0.8197
30-39 years	1.6671	4.2689	0.7923
40-49 years	1.7548	4.8807	0.8041
50-59 years	1.9074	5.4595	0.7706
60-69 years	1.5286	3.3484	0.8363
70-79 years	0.8428	1.0532	0.9198
80+ years	2.2157	6.6041	0.224

- Ages 70-79: The model demonstrated the best predictive performance (R2=0.92, MAE=0.84), suggesting that the mental health of this group is strongly driven by economic variables.
- Ages 80+: The model's explanatory power significantly decreased (R2=0.22), implying that non-economic factors (such as physical health and social support) primarily drive the mental health of the very elderly population.
- Other age groups (18-69): The model showed moderate performance (R2=0.77－0.81), reflecting a mixed influence on their mental health from both economic and non-economic factors.

4.3.2 Visualization of Results

Figure 2 illustrates the performance of the LSTM model in predicting the depression index based on the NASDAQ index across different age groups. The model's predictive performance and explanatory power show a clear age-related difference. The prediction error is smaller and the explanatory power is better for the 70-79 age group, while the prediction error is large and explanatory power is weak for the 80+ age group.

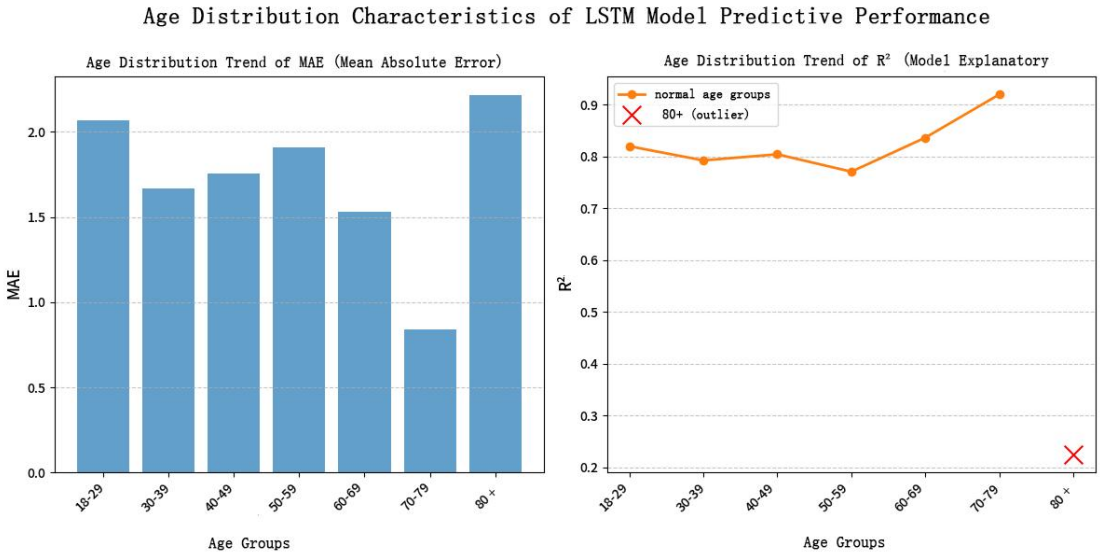

Figure 2: Age Distribution Trends of LSTM Model Predictive Error (MAE) and Explanatory Power (R^2)

The comparison chart of actual values and predicted values of depression index for the 70-79 age group predicted based on the Nasdaq Index is presented as Figure 4. As shown in Figure 3, the predicted values can well follow the changing trend of the actual values. At multiple nodes in the time series, the fluctuation patterns of the two are relatively consistent. For example, near the 4th sample point, the actual value shows a significant peak, and the predicted value also presents a sharp upward trend synchronously; around the 6th sample point, the small fluctuations of the actual value can also be reflected in the changes of the predicted value. Although there is a certain deviation between the two in some intervals, such as near the 2nd sample point, overall, the predicted values show certain effectiveness in reflecting the changing trend of the actual values.

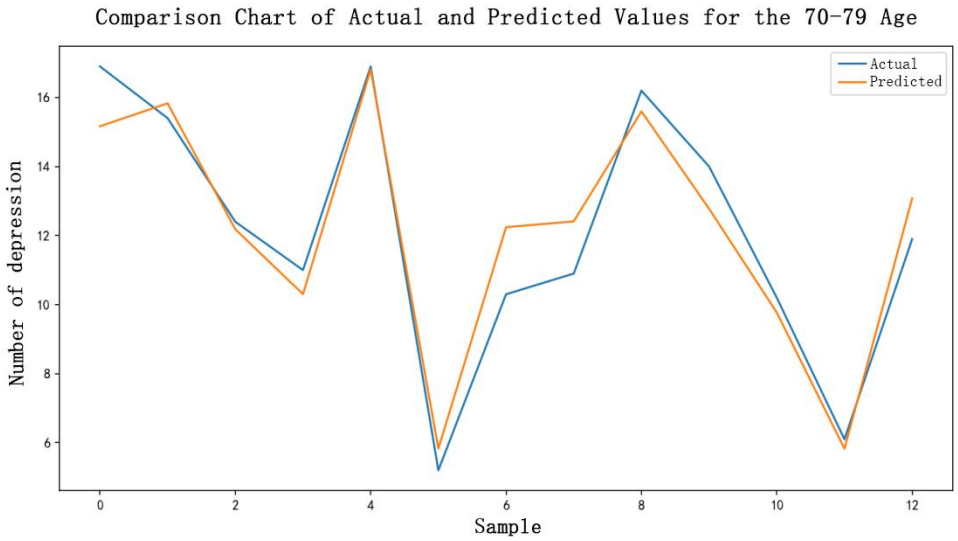

Figure 3: Comparison Chart of Actual and Predicted Values for the 70-79 Age Group

5. Discussion

5.1. Mechanisms of Age-Specific Correlation and Causality

This study reveals age heterogeneity in the relationship between the Nasdaq Index and depression index, with underlying mechanisms explainable from the following perspectives:

- Economic participation and financial stress**: The 50-59 age group exhibits the strongest negative correlation (Pearson coefficient of -0.74), potentially because individuals in this age bracket are in the late stage of their careers, hold more financial assets (such as retirement savings or investment portfolios), and are thus more sensitive to stock market fluctuations. A decline in the stock market may directly threaten their financial security and exacerbate psychological burdens. In contrast, the 80+ age group shows a weaker correlation (Pearson coefficient of -0.48), possibly due to their lower economic participation, with mental health being more influenced by physical conditions or social support.
- Differences in social roles and responsibilities**: The unidirectional causal relationship from the depression index to the Nasdaq Index in the 30-39 age group (e.g., significant F-values at specific lags) may be related to their peak period of career development and family responsibilities. Deteriorating mental health could reduce work efficiency or consumption capacity, indirectly affecting market confidence and forming a

"psychological-economic" feedback loop. For groups aged 70+, however, the direction of causality is reversed (stock market fluctuations affect mental health), likely because this population relies on fixed income or savings, and a stock market decline directly impacts their economic sense of security.

- Social security and risk buffering**: The weaker correlation between the depression index and the stock market in young and middle-aged groups (e.g., 18-29 years old, Pearson coefficient of -0.51) may be due to social security systems (such as unemployment insurance) or family support alleviating economic pressures. In contrast, social security for older adults (70-79 years old) is relatively limited, making the psychological impact of economic fluctuations more direct.

5.2. Socioeconomic Implications

Policy formulation should design interventions targeting the vulnerabilities of different age groups. For example, middle-aged and elderly populations require enhanced pension security and education on investment risks, while young people need attention to employment market stability and the supply of mental health services.

5.3. Causal Impact of Depression Index on the Nasdaq Index in the 30-39 Age Group

Granger causality tests indicate that the depression index of the 30-39 age group significantly affects the Nasdaq Index (e.g., significant F-values for the "close" variable at lags 2-3). Potential mechanisms include:

- Behavioral economics perspective: This group constitutes the main labor force and consumer base. Deteriorating mental health may lead to reduced productivity, consumption retrenchment, or risk aversion sentiment, thereby affecting market liquidity or corporate profit expectations.
- Transmission of psychological expectations: Depressive emotions may spread through social media or public opinion, triggering investors' pessimistic expectations about economic prospects and forming an "emotional contagion" effect.

5.4. Analysis of the Paradox between Correlation Coefficients and the Explanatory Power of the LSTM Model

5.4.1. The Paradox

For the 50-59 age group: Pearson/Spearman coefficients (-0.74) are significantly higher than those of the 70-79 age group (-0.67), yet the explanatory power of the LSTM model (R^2 = 0.77) is lower than that of the latter (R^2 = 0.92).

5.4.2. Potential Reasons

- Nonlinear relationships and model adaptability: LSTMs excel at capturing nonlinear dynamic features in time series. The mental health of the 70-79 age group may be more directly driven by long-term stock market trends (e.g., shrinking retirement savings), allowing the model to better fit both linear and nonlinear effects. In contrast, the 50-59 age group may be influenced by mixed factors (e.g., workplace stress, family debt), resulting in some nonlinear relationships not being fully reflected by Pearson coefficients.
- Data noise and confounding variables: The mental health of middle-aged populations may be disturbed by non-economic factors (e.g., health issues, children's education),

diluting the explanatory power of stock market variables. For older populations, reduced social activities make economic variables play a more dominant role.

6. Conclusions

This study indicates that there is a significant age-heterogeneous association between fluctuations in the Nasdaq Index and depression indices across different age groups in the United States. The specific conclusions are as follows:

6.1. Correlation Characteristics

The core variables of the Nasdaq Index (closing price, opening price, etc.) generally show a significant negative correlation with depression indices across all age groups, and the strength of the correlation increases with age. The 50-59 age group exhibits the strongest correlation (Pearson coefficient of -0.74), while the 80+ age group shows the weakest correlation (-0.48). Short-term fluctuation variables such as trading volume and percentage change (rise/fall) have no significant impact on mental health.

6.2. Direction of Causal Relationships

For the 30-39 age group: The depression index has a unidirectional causal effect on the Nasdaq Index, which may indirectly affect market confidence through the transmission of psychological expectations or the suppression of consumer behavior.

For groups aged 70 and above: Fluctuations in the Nasdaq Index significantly affect their depression indices, with the decline in economic security being the main driving factor.

For other age groups: The causal relationship is not significant, indicating that the association between long-term economic fluctuations and mental health may be regulated by mediating factors such as social security and employment stability.

6.3. Differences in Predictive Efficacy

The LSTM model shows that the predictive performance is optimal for the 70-79 age group ($R^2 = 0.92$), while the explanatory power for the 80+ age group decreases significantly ($R^2 = 0.22$), suggesting that the mental health of the very elderly is more dominated by non-economic factors (e.g., physical health, social support).

6.4. Socioeconomic Implications

Middle-aged and elderly populations need enhanced pension security and education on investment risks to mitigate the impact of stock market fluctuations on their mental health.

For young groups, attention should be paid to the stability of the job market and the supply of mental health services to reduce the indirect impact of economic pressure on psychology.

Policy design should focus on age specificity and formulate targeted intervention measures based on differences in economic participation and social security.

6.5. Research Limitations and Prospects

The data sources are limited to public databases and mental health surveys, which may not cover all confounding variables (such as household debt and physical health). Additionally, Granger causality tests indicate that the depression index of the 30-39 age group has an impact on the stock market, but this study lacks theoretical mechanisms from behavioral economics or psychology to fully explain this phenomenon. Future research needs to strengthen the logical argumentation for this reverse causality.

Future studies can introduce social psychological variables (such as social support and occupational stress) to improve the model's explanatory power, and expand the sample scope to verify cross-cultural universality.

This study provides empirical evidence for understanding the age-heterogeneous impact of economic fluctuations on mental health, emphasizing the necessity of interdisciplinary collaboration in policy formulation to balance changes in the economic environment and public mental health well-being.

7.Ethics and Data Compliance Statement

The data on the U.S. depression symptom index used in this study are derived from the public database of the U.S. Centers for Disease Control and Prevention (CDC), and the Nasdaq Index data are sourced from public financial data platforms such as Investing.com. All data are publicly available and do not involve personal privacy information or individually identifiable information, complying with relevant laws, regulations, and ethical requirements for data usage.

This study strictly adheres to data usage norms and is solely for academic research purposes. During data processing and analysis, no individuals were identified or tracked, ensuring data anonymity and the privacy security of participants. If subsequent research involves sensitive or personal data, it will be conducted in strict accordance with relevant ethical review procedures and data protection policies.

This study does not involve human experiments or animal experiments and thus does not require approval from an ethics committee.

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