“IMPACT OF FOREIGN MARKET AND CURRENCY EXCHANGE RATE ON INDIAN IT STOCKS”

Research Paper

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Abstract

The Stock market plays a prominent role in every nation's economy, and it is no more dependent only upon national factors. With globalization, the world's economies have become increasingly interdependent. The national economies are integrated with international economies through trade, foreign direct investment, capital flow, and advancements in technologies. As a result, exalt studies analyzed the impact of the foreign stock exchange, currency exchange rate, and economic articles on the Indian stock market using the Granger causality and Co-integration test. Moreover, considering the majority vote of multiple deep-learning-based causality detection methods makes the strategy more concrete. Hence, this study analyses the impact of the foreign stock market, currency exchange rate, and economics articles on the Indian IT stock market using deep learning-based majority voting. The result of the study confirms that deep learning-based majority techniques uncovered the non-linear feature that impacts the Indian It stock market.

Keywords: Deep learning neural network, Artificial neural network, Causality detection, Long term short term memory, Gated Recurrent network, Stock price prediction, Foreign stock market

1. Introduction

A stock market is a network of markets and exchanges where publicly traded company shares are frequently bought, sold, and issued (CHEN, 2021). The stock market is an important part of every country's economy, and it is no longer solely determined by national factors. Globalization has increased the interdependence of the world's economies through Trade, foreign direct investment, capital flow, and technological advancement. As a result, changes in the international stock market have an impact on the domestic stock market, and India is no exception (Najmudin et al., 2019).

Currency exchange rates also affect Indian IT firms. Leading IT firms have various hedging policies in place, which is one of the most important factors in determining profit from falling rupees (Indian currency). The level of offshoring is another factor; more offshoring leads to excess profit from currency depreciation (BusinessToday, 2018). As a result, whenever the rupee (the Indian currency) falls in value relative to foreign currencies, these companies benefit, and vice versa.

1.1 Literature review

Furthermore, the stock market experiences short-term volatility (rise and fall) as a consequence of news articles. Positive news causes the stock market to rise, while negative news causes it to fall (Kwatra, 2018). Thus, the few research included global indices, currency exchange rates, historical stock prices, world news, and technical indicators to provide more consistent results that predict the rising and lowering trends of Indian IT stocks equally well (with 60% accuracy)(Sharma, 2020).

Moreover, Granger causality detection methods are frequently used to investigate the impact of foreign markets (foreign indices and currency exchange rates) and news articles (Kishor and Singh, 2017; Kumar, 2019). A Granger causality test determines whether one series of data can be used to

predict another (Granger, 1969). However, Granger causality is dependent on data stationarity. It also has trouble detecting causal relationships in multivariate time series with nonlinear dynamics. As a result of Granger causality's limitations, researchers are encouraged to think of a better alternative based on cutting-edge deep-learning networks. Thus, Sharma and Kiciman (2020), Rosoł, Młyńczak and Cybulski (2022), and Nauta, Bucur and Seifert (2019) proposed deep learning and machine learning-based causality methods that efficiently capture long-term dependencies between time-series and can work on non-linear datasets. Consequently, this study will examine the impact of foreign stock markets, currency exchange rates, and economic news articles on the Indian IT stock market using machine learning and deep learning techniques.

Recent studies have examined the impact of various factors on the Indian stock market, such as global stock market performance and currency exchange rates. Many of these studies, including Kumar (2019), Rao (2019), Samadder and Bhunia (2018), Manu and Menda (2017), and Kishor and Singh (2017), examined the impact of major country indices on the Indian stock market. However, only a few studies have looked into the impact of global IT indices on Indian IT stocks. Similarly, Hicham and Salah-Ddine (2021), Paramanik and Singhal (2020), Kumar, Ravi and Miglani (2020), and Biswas et al. (2020) investigated the impact of news article sentiment on the Indian stock market. However, only a few studies have examined the impact of named entities of economic articles on Indian IT stock.

Moreover, authors such as Bhattacharjee and Das (2020), Mohith and Sangeetha (2019), Anuradha (2018), and Manu and Bhaskar (2018) investigated the impact of currency volatility on the Indian stock market. The findings of these studies revealed that currency exchange rates have a significant impact on the Indian stock market.. Furthermore, the above-mentioned studies used the Granger causality test and the Johansen co-integration test to detect causality. The Granger causality test (Granger,1969) determines whether one series can be used to predict another, and the Johansen cointegration test identifies long and short-run integration among variables (Johansen, 1991). However, both of these techniques are limited in terms of non-linear data and a small sample size. Thus, Rosoł et al. (2022), Sharma et al. (2020), and Nauta et al. (2019) introduced deep-learning-based causality detection approaches to support non-linear data and efficiently discover the long-term and short-term integration between two or more time-series. Hence, this study analyzes the impact of foreign IT stock markets, currency exchange rates, and economic articles (named entities and sentiments) on the Indian IT stock market using deep-learning and machine-learning- based techniques.

2. Method

This was an exploratory study that followed the quantitative research principle. In addition, secondary data was used in the research to achieve the study's goal. The study's goal is to examine the impact of foreign IT indices, name entities, and sentiment features for economic articles and currency exchange rates on Indian IT stocks using deep-learning and machine-learning-based causality detection algorithms.

The proposed methodology will employ a framework to assess the impact of foreign IT indices, economic articles, and currency exchange rates on Indian IT stocks. The research has named this framework "causality analysis

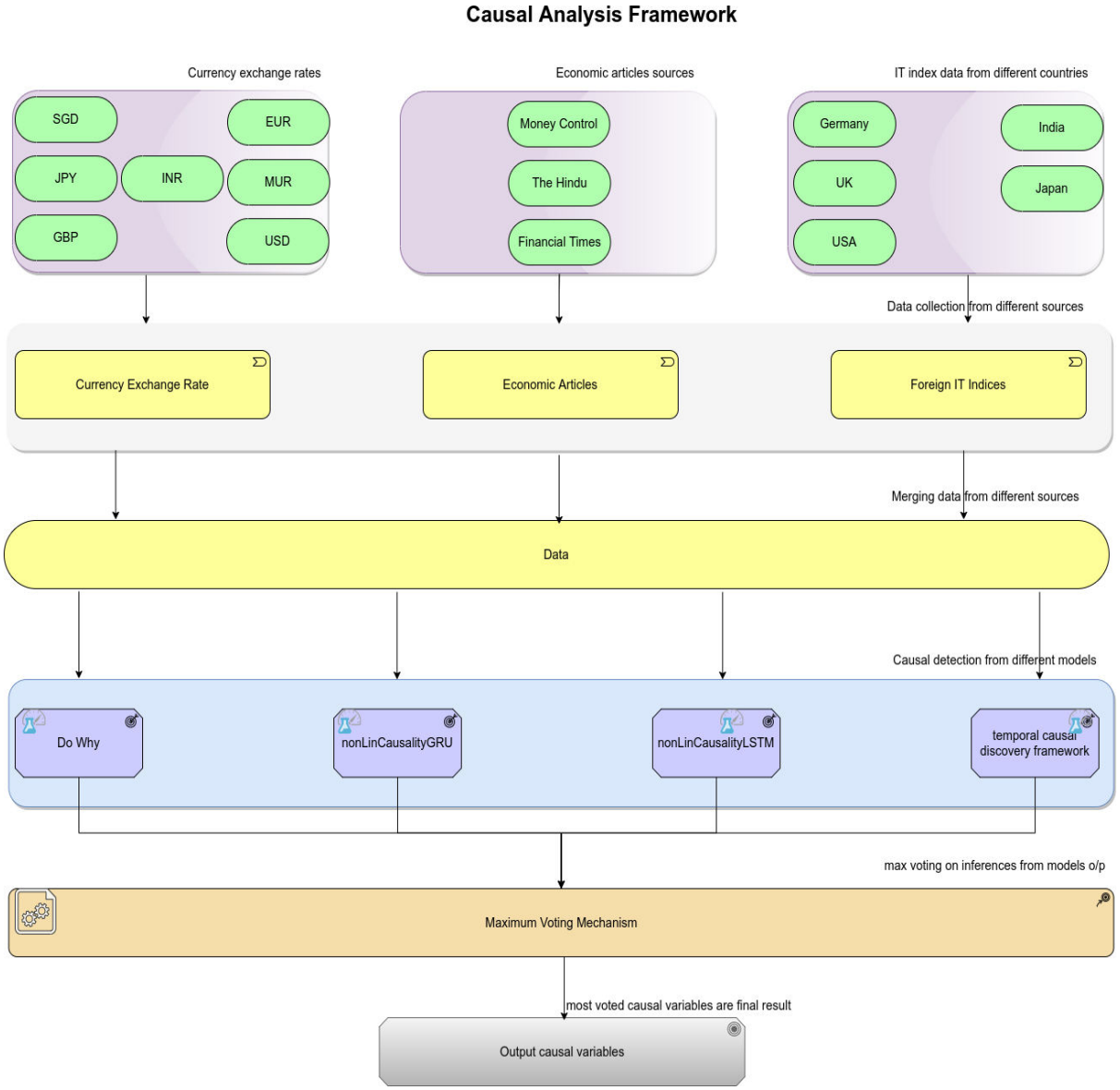

Figure 1. Causality analysis framework

The currency exchange rates considered for this research are shown in figure 1: Singapore (SGD), Japan (JPY), the United Kingdom (GBP), Germany (EUR), Mauritius (MUR), and the United States (USD). Similarly, economic articles are sourced from Money Control, The Hindu, and Financial Times, and foreign IT indices are sourced from Germany, the United Kingdom, the United States, France, and Japan. Following that, data from various sources is cleaned, pre-processed, and combined. The resulting data is then fed into four different causality detection algorithms, namely DoWhy (Sharma et al. (2020)), nonLinCausality GRU (Rosoł et al. (2022)), nonLinCausality LSTM (Rosoł et al. (2022)), and temporal causal discovery framework (Nauta et al. (2019)). Finally, each deep-learning causality detection algorithm's output is passed to the maximum voting mechanism layer.

2.1 Data collection and pre-processing

The study has collected quantitative data from Indian IT stocks, foreign IT indices, and currency exchange rates from secondary data sources from 01-January-2018 to 31- December-2021. Additionally, Named entities and sentiment features for economic articles were extracted from major

economic news sources such as Money Control, The Hindu, and financial times. Furthermore, the data source for all the variables is provided in the tables below.

2.1.1 The data source for foreign IT indices:

Country	IT Indices	Data Source
Germany	DAX Software (CXPSX)	https://www.investing.com
Japan	Tokyo SE TOPIX17 IT & Services Stock Price (ITSV17.T)	https://www.investing.com
India	Nifty IT (NIFTYIT)	https://www.investing.com
France	CAC Technology (FRTEC)	https://www.investing.com
USA	S&P 500 Information Technology (SPLRCT)	https://www.investing.com
UK	FTSE 350 Software & Computer Services (FTNMX101010)	https://www.investing.com

Table 1. The data source for foreign IT indices.

2.1.2 The data source for currency exchange rate:

Country	Exchange Rate	Data Source
Germany	EUR-INR	https://www.investing.com
France	EUR-INR	https://www.investing.com
Japan	JPY-INR	https://www.investing.com
Mauritius	MUR-INR	Google Finance
Singapore	SGD-INR	https://www.investing.com

UK	EUR-INR	https://www.investing.com
USA	USD-INR	https://www.investing.com

Table 2. The data source for the currency exchange rate.

2.1.3 The data source for economic articles:

Source Name	Data Source
The Hindu	www.thehindu.com/business/Economy/
Financial Times	www.ft.com
Money Control	www.moneycontrol.com/news/business/economy

Table 3. The data source for economic articles.

The research has considered the closing prices for foreign IT indices and the currency exchange rate. whereas named entities such as CARDINAL, DATE, EVENT, FAC, GPE, LANGUAGE, LAW, LOC, MONEY, NORP, ORDINAL, ORG, PERCENT, PERSON, PRODUCT, QUANTITY, TIME, WORK_OF_ART, and positive and negative sentiments were used as economic article representations. After collecting the above data points, the merge operation has been performed to get the data of interest. Thereafter, the null value imputation was then performed before standardizing the data across the mean value.

2.2 Deep learning models

For causality detection, the study used DoWhy (Sharma et al. (2020)), nonLinCausality GRU (Rosoł et al. (2022)), and nonLinCausality LSTM (Rosoł et al. (2022)), and the temporal causal discovery framework (Nauta et al. (2019)). Due to space constraints, this section only describes the nonLinCausality GRU.

2.2.1 NonLinCausality GRU

The NonLinCausality is a Python package that analyzes causality using deep learning methods.The package supports deep-learning methods including Long-Term Short- Term Memory (LSTM), Gated-Recurrent Unit (GRU), and MultiLayer Perceptron (MLP). However, this section only covers GRUs.

A gated recurrent unit (GRU) is a variant of a recurrent neural network (RNN). It intends to adjust neural network weights to solve the vanishing gradient problem. The GRU is different from the RNN in terms of supporting the gating mechanism for the hidden state. This gated mechanism manages the hidden state's update and resets operations.

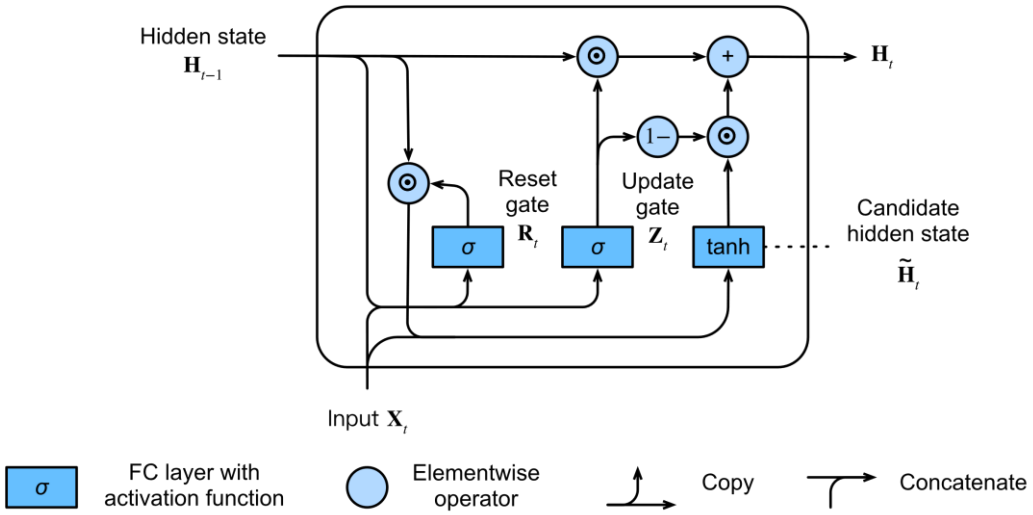

Figure 2. Gated recurrent Unit.

The update gate determines how much information should be "forgotten" and which new information from a particular point in time should be considered for further calculation. The calculation of the update gate is based upon the sigmoid function.

$$u^{(t)} = \sigma(b^u + x_t U^u + h_{t-1} W^u)$$

Equation 1.

U^u : weight for the input

W^u : weight for the previous cell output

b^u : Input bias

The reset gate, on the other hand, regulates the amount of information from the previous state that is used to compute the candidate state. The following expression describes the reset gate operation:

$$r^{(t)} = \sigma(b^r + x_t U^r + h_{t-1} W^r)$$

Equation 2.

U^r : weight for the input

W^r : weight for the previous cell output

b^r : Input bias

The candidate state is calculated using the reset gate's output. The candidate state is then used to compute the GRU cell state at a given time. The hyperbolic tangent function is used to compute the candidate state.

$$h^t = tanh(b^h + x_t U^h + r^t h_{t-1} W^h)$$

Equation 3.

U^h : weight for the input

W^h : weight for the previous cell output

b^h : Input bias

The value of state *h*t is being computed by using the value of the update gate. Following is the formulation of the same.

$$h^t = (1 - u^t)h^{t-1} + u^t h^t$$

Equation 4.

With the help of the reset gate and the update gate, the GRU networks can forget and remember the information for the successive time steps.

3. Results and Discussion

The study has collected results from DoWhy (Sharma et al. (2020)), nonLinCausality GRU (Rosoł et al. (2022)), nonLinCausality LSTM (Rosoł et al. (2022)), and the temporal causal discovery framework (Nauta et al. (2019)). However, the results of the temporal causal discovery framework (Nauta et al. (2019)) were not impressive. Hence, the study only analyzed DoWhy, nonLinCausality GRU, and nonLinCausality LSTM. The findings of the study used the most voted mechanism while considering the variables chosen by at least two algorithms. The chart below depicts the most important variables influencing the Indian IT stock market.

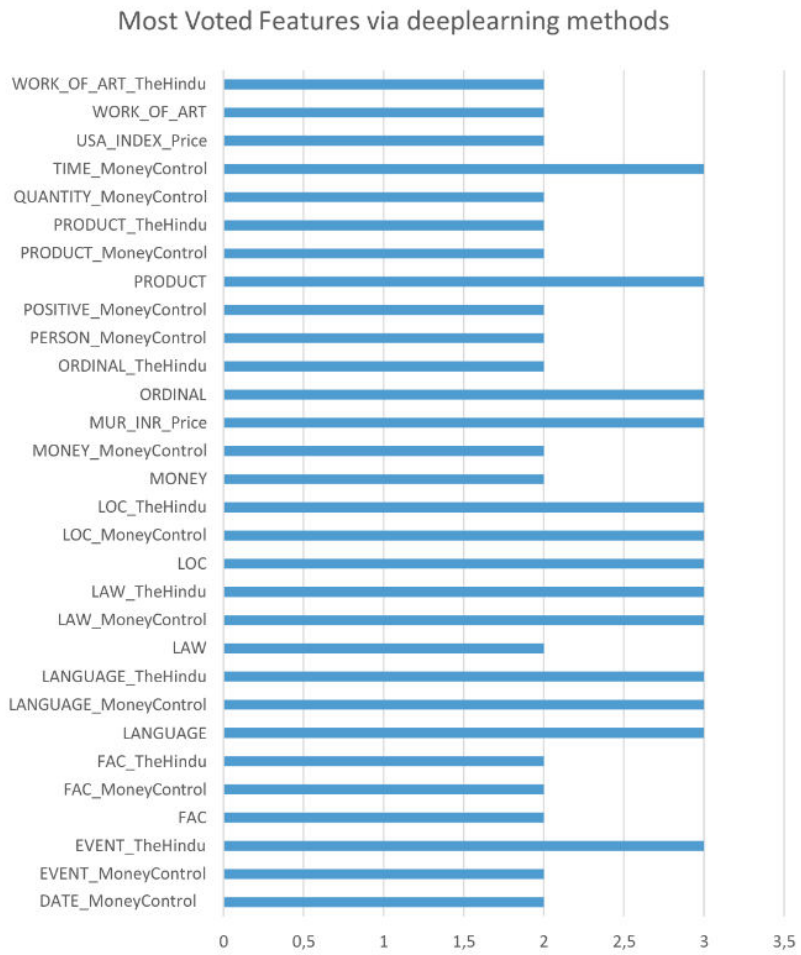

Figure 3. Most voted feature via deep-learning methods.

The research has also collected the result via the granger causality method and compared the results with the Majority voting-based deep-learning technique.

Features	Impact on the Indian IT stocks	
	Granger Causality	Majority Vote of DeepLearning Methods
FRANCE_INDEX_Price	Yes	No
USA_INDEX_Price	Yes	Yes
LANGUAGE_MoneyControl	Yes	Yes
LOC_MoneyControl	Yes	Yes
EVENT_TheHindu	Yes	Yes
FAC_TheHindu	Yes	Yes
LANGUAGE_TheHindu	Yes	Yes
LAW_TheHindu	Yes	Yes
LOC_TheHindu	Yes	Yes
WORK_OF_ART_TheHindu	Yes	Yes
FAC	Yes	Yes
LANGUAGE	Yes	Yes
LOC	Yes	Yes
ORDINAL	Yes	Yes
WORK_OF_ART	Yes	Yes
EUR_INR_Price	Yes	No
JPY_INR_Price	Yes	No
GBP_INR_Price	Yes	No
SGD_INR_Price	Yes	No
CARDINAL_TheHindu	Yes	No
ORDINAL_TheHindu	Yes	Yes
CARDINAL	Yes	No
EVENT	Yes	No
LAW	Yes	Yes
DATE_MoneyControl	No	Yes
EVENT_MoneyControl	No	Yes
FAC_MoneyControl	No	Yes
LAW_MoneyControl	No	Yes
MONEY	No	Yes
MONEY_MoneyControl	No	Yes
MUR_INR_Price	No	Yes
PERSON_MoneyControl	No	Yes
POSITIVE_MoneyControl	No	Yes
PRODUCT	No	Yes
PRODUCT_MoneyControl	No	Yes
PRODUCT_TheHindu	No	Yes

QUANTITY_MoneyControl	No	Yes
TIME_MoneyControl	No	Yes

Table 4. The data source for economic articles.

It has been discovered that a majority voting-based technique can uncover named entities and sentiments of economic articles that granger causality methods cannot. These variables are highlighted in yellow color. However, numerical variables such as France INDEX Price, EUR INR Price, JPY INR Price, GBP INR Price, SGD INR Price, CARDINAL TheHindu, CARDINAL, and EVENT have been captured by Granger Causality but not detected by deep-learning-based majority voting methods. As a result, the study can detect non-linear named entities and sentiments in economic articles using deep-learning methods with majority voting. Furthermore, traditional Granger causality methods are effective at detecting causality for linearly related variables.

4. Limitation and Future Work

This study only identified the variables influencing Indian IT stocks. Thus, the study is limited to the IT segment of the stock market. The causality framework proposed in this study, on the other hand, is easily replicable to the other segment of the stock market. Hence, the same concept for other sectors can be considered a possibility for future work.

5. Conclusion

The Prior research has primarily examined foreign market indices, currency exchange rates, and economic articles using Granger causality detection and the Johansen Co- integration Test. However, these methods are incapable of detecting causality in nonlinear datasets with small sample sizes. Thus, deep-learning techniques were used in this study to examine the impact of foreign IT stock markets, currency exchange rates, and economic articles. The study's findings show that deep-learning-based majority voting methods are effective at detecting causality on non-linear datasets, while traditional granger causality methods excel on linear variables.

Furthermore, the implication of the findings indicates that the correct identification of the most impactful factors would help portfolio managers to devise a profitable portfolio. and drive investors to make their fortune by investing smartly in the global stock exchange.

Appendix

Named Entity	Description
CARDINAL	Numerals do not fall into another entity
DATE	Absolute or relative dates
EVENT	Named battles,wars,sports,events etc.
FAC	Buildings, airports, highways, bridges, etc.
GPE	Countries, cities, states
LANGUAGE	Any Named language
LAW	Named documents made into laws
LOC	Non GPE locations, mountains, water bodies.
MONEY	Monetary value including units.
NORP	Nationalities or religious or political groups.
ORDINAL	First, second, etc.
ORG	Companies, agencies, institutions, etc.

PERCENT	Percentage, including %.
PERSON	People, including fictional.
PRODUCT	Objects, Vehicles, Foods, etc. (Not services)
QUANTITY	Measurement, as of weight or distance.
TIME	Time smaller than a day
WORK_OF_ART	Title of books, songs, etc.

Table 5. Appendix

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