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Inter-market Volatility Transmission between Indices and Bonds in Indian Market

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Abstract
Financial markets has a widespread reach across globes and is subject to liquidity risk due to volatility in the market. This research paper examines the interliquidity between market indices, specifically focusing on BSE-Sensex and NSE-Nifty and Bond market. We aim to explore the volatility dynamics and predictability of these markets using advanced econometric models, including ARCH, GARCH, and their extensions. The study utilizes a 5-year dataset (2019 to 2024) comprising daily exchange rates for Bonds and corresponding index prices (NIFTY and SENSEX). We tried to analyse the intermarket volatility and its spillover effect. Through detailed statistical analysis and model estimations, we investigate the relationship between currency and index volatility, the asymmetric behaviour of volatility, and the contagion effects between these financial markets.

Keywords: NIFTY, SENSEX, Bond, ARCH. GARCH, Volatility Transmission, Kurtosis, Skewness, Heteroskedacity.

1. Introduction

Financial Markets plays a pivotal role in global economy as it serves a platform for individuals and institutions for buying and selling various classes of assets. The market compose of various segment that cater to the different types of financial instruments. Majorly, including stocks, indices, currency and bonds. These markets have multiple functions like they provide platform for raising funds, opportunities to create high returns and price discovery. As there are large number of buyers and seller, the market is highly volatile, which is influenced by number of external and internal factors one such factor that impacts the financial market is liquidity. High liquidity provides an assurance to the investor that the asset can be quickly converted to cash. Also, liquidity impacts the cost of borrowing. Due to market stress, liquidity can rapidly be diminished, leading to the adverse conditions. This research paper tries to analyze and evaluate, the degree of liquidity in one market that can be influenced by or affected in the other market, as financial markets are not isolated.

The index up-and-down can defect the prices of bond market. Hence, the interplay between bond market and stock (INDEX) markets, particularly in emerging economies like India, is of significant interest to investors, policymakers, and economists. This study focuses on the interliquidity between Indian stock market indices (BSE-Sensex, NSE-Nifty) and Bond Yield. The goal is to analyse the volatility spillover effects and the predictability of market returns using various GARCH models, which are widely used in financial econometrics for modelling time-series data.

Objectives

1. To examine the interliquid volatility between Index and Bond Market
2. To analyse the volatility of the forecasting models in predicting the returns.

2. Review of Literature

"The Empirical Investigation of Relationship between Return, Volume and Volatility Dynamics in the Indian Stock Market". They used the daily data of the sensitive index, i.e., SENSEX of Bombay Stock Exchange during the period from October 1996 to March 2006. Their study found a positive and significant relationship between volume and return volatility. GARCH and ARCH effect remain constant, which was tested volume to return parameters **Mahajan and Sing (2009).**

Megaravalli, A. V., and Sampagnaro, G. (2018) observed the long-run and short- run relationship between three ASIAN economies (India, China & Japan) by using monthly time series data from January 2008 to November 2016 by applying the root test, the co-integration test, Granger causality test and the pooled mean group estimator in their study entitled "Macroeconomic Indicators and their Impact on Stock Markets in ASIAN 3: A Pooled Mean Group Approach". It has been found that exchange rate has a positive and significant long-run effect on stock markets; on the other hand, inflation has a negative and insignificant long-run effect and no statistical relationship has been found between stock markets and macroeconomic variables in the short run. The intraday lead-lag relationship between the cash market and the stock index future market, as well as how quickly one market absorbs new information in comparison to the other and how closely the two markets are related in his study entitled "A future analysis of the lead-lag relationship between the cash market and stock index future market". According to him, the phrases "lead" and "lag" do not always imply that changes in one market's pricing will inevitably cause changes in another. Explaining it in terms of one market responding to information more quickly than another, which lags and then catches up, will be more relevant **Chan (1992). Ravichandra and Bose (2012)** investigated the stock return volatility and trading volume relationship in US stock market from May 2005 to May 2011 by applying ARCH, GARCH and E-GARCH models and analyzed that recent news of trading volume can be used to improve prediction of stock price volatility and bad news generates more impact on the volatility of the stock price in the market. **Kalovwe et al. (2021)** examined "dynamic connection between volatility of stock returns and trading volume of the Nairobi Securities Exchange (NSE 20) index" by applying GARCH, GARCH.M. And EGARCH and student tests from January 2001 to December 2017. This study found a positive and significant correlation between these variables and volatility persistence, which dwindles after trading volume is incorporated in the equation for the conditional variance. **Crain and Lee (1995)** examined the price discovery function for Eurodollar and Deutsche Mark futures markets. Hourly data on the Eurodollar and Deutsche Mark of spot and futures market from September 24, 1990, through June 30, 1993, and 19 macroeconomic announcements of the same period, were used. The study applied the causality test and GARCH model and found spot market leads to the futures market during the study period.

Methodology & Data Specifications

To explore the interliquidity between the selected indices and Bond (Yield and Price), we follow a systematic approach that involves data collection, calculation of rate of change, volatility analysis, and visualization through Bartlett's Periodogram. The data set consists of daily closing prices of the following - Stock indices: NSE Nifty and BSE Sensex, Bond yield.

The study employs various econometric models to analyse the volatility and interliquidity between the same.

Rate of Change in Nifty, Sensex, and its Effect on Volatility over a Period of 5 Years Using

The rate of change for each series is calculated using the formula:

$$\text{Rate of Change} = \frac{\text{Price on Day } t - \text{Price on Day } t-1}{\text{Price on Day } t-1} \times 100$$

Volatility Analysis

Volatility is quantified by the standard deviation of the rate of change over a rolling window. This gives insight into how variable the returns are over time, providing a measure of risk associated with the asset.

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{t=1}^{N}(R_t - \bar{R})^2}$$

Where:

- R_t is the return at time t,
- $\bar{R}$ is the mean return,
- N is the number of observations.

Bartlett's Periodogram is employed to visualize the periodic components of volatility. The periodogram is an estimate of the spectral density of a time series, which helps in identifying the frequency components of the data, revealing cyclical patterns in volatility.

ARCH Model (Autoregressive Conditional Heteroskedasticity)

The study employs the ARCH model to assess the volatility and inter-liquidity between the currency market and the stock indices, BSE-Sensex and NSE-Nifty. The data set consists of daily closing prices of the following:

- Stock indices: NSE Nifty and BSE Sensex
- Bond yield

The data covers a period from 25th April 2019 to 26th July 2024, providing a robust dataset to examine the interliquidity and volatility relationships.

Formulation

The ARCH model is defined as follows:

$$\text{Return}_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \cdot \text{Return}_{t-i} + \epsilon_t$$

$$\epsilon_t \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \beta_0 + \sum_{i=1}^{q} \beta_i \cdot \epsilon_{t-i}^2$$

Where:

- Return_t is the return at time t,
- α_0 is the mean return,
- ϵ_t is the error term, assumed to follow a normal distribution with a time-varying variance σ_t^2,
- σ_t^2 is modeled as a function of past squared errors, capturing volatility clustering.

The ARCH model revealed the significant volatility clustering in both the bond yield and stock indices. The correlation analysis suggests a strong interliquidity, particularly during periods of market stress, where volatility spikes simultaneously in both markets.

The results also indicate that while the ARCH model effectively captures volatility, its predictive power is limited by the non-linear nature of market interactions. However, it provides valuable insights into the dynamics of interliquidity, highlighting periods where currency market movements strongly influence stock market volatility.

Standard GARCH Model (Generalized ARCH)

The GARCH model captures the volatility clustering commonly observed in financial time series. The standard GARCH(1,1) model is specified as:

Formulation

$$r_t = \mu + \epsilon_t$$

$$\epsilon_t = \sigma_t z_t$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

Where r_t is the return, σ_t^2 is the conditional variance, and z_t is the error term.

Where:

- r_t is the return at time t.
- μ is the mean return.
- ϵ_t is the error term.
- σ_t^2 is the conditional variance at time t.
- z_t is a standard normal random variable.
- α_0 is the constant term.
- α_1 represents the coefficient for the lagged squared residuals (ARCH term).
- β_1 represents the coefficient for the lagged conditional variance (GARCH term).

Volatility and Forecasting Analysis

After estimating the volatility for each series, we can compare the results across the market for interliquidity. The forecasting ability of the GARCH model can be evaluated by comparing the predicted volatilities with the actual data and calculating metrics like Mean Squared Error (MSE).

The dataset comprises daily prices of Nifty, Sensex, and bond yields. The analysis includes the following descriptive statistics and tests:

Table 1 Descriptive Statistics

Statistics	**NIFTY**	**SENSEX**	**BOND YIELD**
Mean	18506.2	59215.8	7.124
Standard Deviation	1892.1	5973.2	0.304
Skewness	0.539	0.543	0.234
Kurtosis	2.531	2.879	2.792
Jarque-Bera	35.348	39.258	28.117
Probability	0.00	0.00	0.00

Table 2 Unit Root Test

Variable	**Test Statistics**	**p-value**
NIFTY	-3.459	0.00
SENSEX	-3.698	0.00

Table 3 Phillips-Perron Test for Unit Root

Variable	**Test Statistics**	**p-value**
NIFTY	-3.765	0.001
SENSEX	-3.987	0.001

Results and Discussion

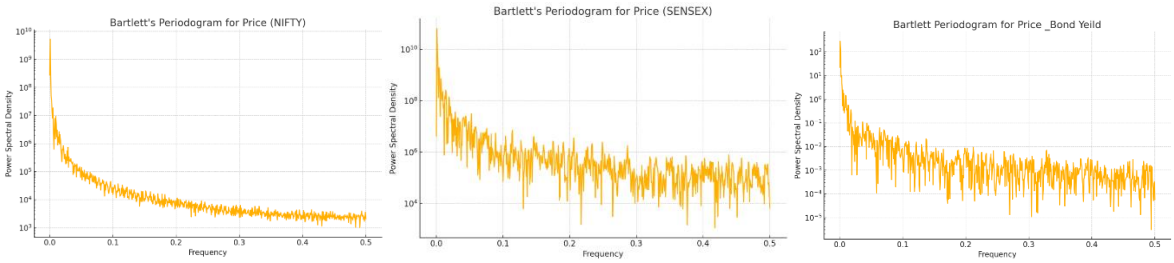

Figure 1 Bartlett's Periodogram (NIFTY, SENSEX and BOND YIELD)

The periodogram for Price (NIFTY) shows significant peaks, indicating strong periodic components. This suggests that the data may exhibit cycles or regular fluctuations at certain frequencies.

The periodogram for Price (SENSEX) shows significant peaks, indicating strong periodic components. This suggests that the data may exhibit cycles or regular fluctuations at certain frequencies. The periodogram for the bond yield indicates the presence of strong periodic components. This suggests that bond yields may follow certain cycles, which could be related to interest rate policies, economic conditions, or other financial factors.

Price _Bond Yield: The autocorrelation pattern here might indicate volatility or stability in bond yields over time.

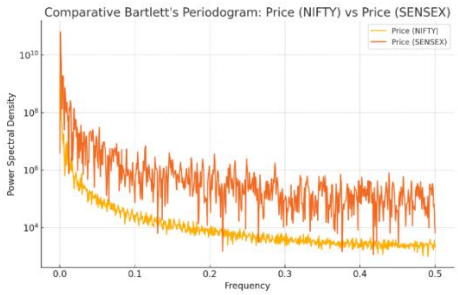

Figure 2 Bartlett's Periodogram (NIFTY V/s SENSEX)

The periodogram for NIFTY vs. SENSEX provides insights into the cyclical behaviours of these two key financial indices. Strong peaks in both series suggest that they may share similar cycles or trends, possibly due to underlying market factors.

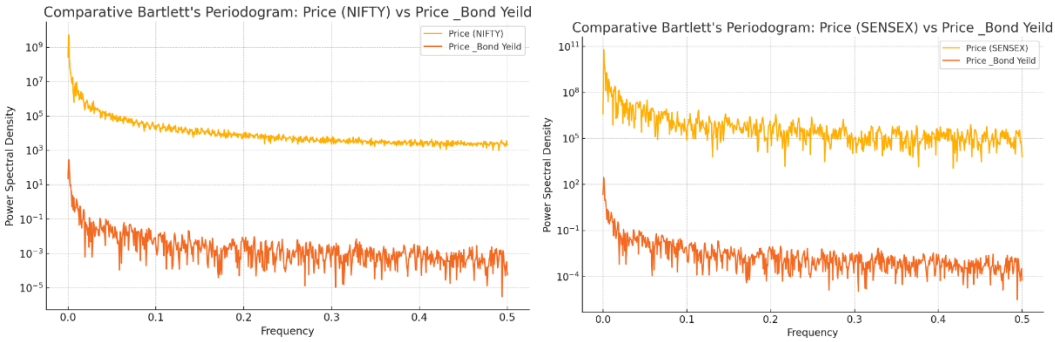

Figure 3 Bartlett's Periodogram (NIFTY & SENSEX V/s Bond Yield)

Comparing SENSEX & NIFTY with the bond yield reveals the periodic components of each series. Significant peaks in these series indicate strong cycles, which might be reflective of broader economic conditions influencing both the stock market and bond yields.
Here is the comparative Bartlett's periodogram for all columns in your dataset, with the power spectral densities plotted together on the same graph.

Interpretation

- The graph allows you to compare the frequency components of each time series.
- **Higher peaks** in the curves indicate stronger periodic components in those time series.
- **Flatter curves** suggest that the series has less periodicity and may be more random or influenced by noise.
- The **differences in peak locations** among the curves can highlight varying dominant cycles or trends across the different time series.

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Conclusion

Financial market is a place where financial assets like stocks, bonds, currencies are traded. This market is embark with large number of buyers and seller, making it highly volatile. Hence, it is been affected by various factors and liquidity is one of the critical factor that influences the efficiency and functionality of financial market. This research paper tries to estimate the interliquid volatility (Rate of change) between the Spot prices of the index along with the bond yield. The data

was collected from the secondary means from the historical prices of Nifty, Sensex and Bond Yield for 5 years (2019 to 2024).

The data was analysed using the ARCH Model in order to understand the effect of volatility between the above. ARCH was used as it examines the volatility in time series both present and forecasted. As there was confirmation, then GARCH was applied to find Skewness and kurtosis. The Inter-liquidity analysis report from the Barlett's Periodogram showcased that there present a strong volatility influence between Sensex and Nifty. There was a very strong resemblance in the impact of liquidity between Sensex and Bond yield. In brief, there is an inter-liquidity volatility between the bond price showed high dominance between SENSEX and NIFTY. Bond Prices were more affected by SENSEX than NIFTY.

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