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Integrated Spillover Effect of Cross-Listed Stock Markets on the Indian Equity Market

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Abstract

The increased integration due to cross-listing leads to the volatility spillover effect on the domestic market posing from the cross-listed global indices viz., Nifty 50 from India, Luxx 100 from Luxembourg, NASDAQ from the US, and FTSE_Aim 100 from the UK. Johansen Co-integration test is applied to check the level of integration, which is further checked by multivariate granger causality showing the causality pattern among the indices. GARCH (1,1) model is applied to examine the volatility spillover effect on the Indian Stock Market. The findings suggest that the series are co-integrated with one vector 'v,' which is confirmed by the Trace and Max-Eigen Test. The Multivariate Granger Causality test confirms the bivariate causal pattern between India and US markets, implying the dual effect. In contrast, the Luxembourg market is relatively exogenous, which gives investors an opportunity for portfolio diversification. ARCH term is significant in the GARCH (1,1) model showing that the past innovation in the time series leads to the present fluctuation in the Indian stock market. Also, the results show a significant spillover effect from the US and UK markets. Thus, this will assist the investors that by concentrating on the movement of these markets, they can take specific actions regarding portfolio management.

Keywords: Volatility modeling; Johansen Co-integration Test; Multivariate Granger Causality Test; Indian Stock Market

Introduction

Cross-listing of tradable assets in the form of ADRs and GDRs is considered a critical factor responsible for increasing integration among the stock markets' - (Rodríguez & Toledo, 2015). The cross-listing of assets creates a secondary market for raising capital from the firms. It lowers the cost of equity capital as the cost of capital is low in the developed stock markets rather than in the developing market (Errunza, Vihang R., Miller, 2016). The cross-listing of assets results in a volatility spillover effect from these foreign stock markets to the Indian Stock Market. In light of this hypothesis, it is crucial to model the volatility spillover effect emanating from foreign markets, as the phenomenon poses certain challenges to investors and managers for properly managing global portfolios, as extreme events in one region of the country can affect the pricing movement of the Indian stock market.

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Finally, stock market integration is vital to issuers and investors since it helps channel money and increase the savings and investments needed for economic growth. By permitting diversification across several assets, a well-integrated equities market lowers the cost of capital, boosting investment and economic development. As investment in developing stock markets has increased over a period, the issue of integration has acquired even more support, particularly in Asian countries (Tunis El Manar, 2019). As a result, the focus has turned to examine the linkages between untapped Asian and African markets in connection with the developed markets (Bhaduri & Samuel, 2009). As a result, the present study's objectives are as follows:

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RO1: To examine the integration of the Indian Stock Market with cross-listed markets.
RO2: To analyse the causality pattern of the Indian Stock Market with cross-listed markets.

RO3: To analyse the volatility spillover effect on the Indian Stock Market from cross-listed markets.

Literature Review

Stock Market Integration

Stock market integration is an old phenomenon that exists among the stock markets of the country due to various reasons and several studies, including research (Chan et al., 1997; Goyal & Mtttal, 2018; Gulzar et al., 2019; Lobo, 2005; Schöllhammer & Sand, 1987; Srikanth & Aparna, 2012) which focuses on the integration among the stock market. The most prominent work (Seth and Sharma, 2015) applied the Johansen Co-integration test to examine the integration between 13 world markets and found that the markets are correlated and integrated into the long run and interpreted that the portfolio diversification will be insignificant. –(Agoraki et al., 2019), Their paper applied the VAR framework to the US, UK, Germany, and Japan monthly data from Jan 1980- May 2019. It supported the partial cointegration among the stock markets, due to which identifying the market for portfolio diversification is possible. (Gulzar et al., 2019) applied the VECM and GARCH-BEKK model for integration and conditional volatility and found long-term cointegration among the US and emerging markets. The literature regarding integration concentrates on no cointegration or partial cointegration. Thus, it gives the following hypothesis of the study.

H0: There is no integration between the Indian stock market and other cross-listed markets.

Multivariate Granger Causality

The Granger Causality test is applied to examine whether the causality pattern exists among the variables (Ray, 2012). The studies of "'(Guru-Gharana et al., 2021; Panda et al., 2019; Singh, 2014) focus on the causality pattern of stock price movement with other variables like foreign market indices, interest rate, industrial production, interest rate, and exchange rate. —(Nyasha & Odhiambo, 2015) in his study investigated the dynamic causal relationship between the stock market development and growth in South Africa for the period 1980-2012. Their study indicates unidirectional casual flow from financial development and growth. (Demirer et al., 2019) applied the bivariate and multivariate nonlinear causality test for examining the stock market return and market volatility with excess return and found that informational dispersion exists among the forecasted market return. Thus, it gives the formulation of the following hypothesis for the study.

H0: A does not Granger causes B.

Volatility Spillover

The earlier literature of (Baele, 2005) examined the volatility spillover of European Union and US stock markets on 13 emerging equity markets and found that the spillover shocks arising from US and EU are increasing substantially. They also found the contagion effect on local European equity markets. (Su, 2010) GARCH and EGARCH models were applied to analyse long-term volatility in the Chinese market before and throughout the period. Their findings suggest that the GARCH model is better at modeling volatility than the EGACRH model. (Bonilla & Sepúlveda, 2011) applied the GARCH model in the index of 13 emerging markets, found evidence of the ARCH effect, and suggested that the GARCH model is significant for evaluating the spillover effect and modeling the economic policy. (Jebran & Iqbal, 2016) applied the EGARCH model between the Asian countries of Pakistan, India, Sri Lanka, China, Hong Kong, and Japan, considering the period between January 1999 to January 2014, and found that there is a unidirectional transmission of volatility from the foreign market to the Indian Stock Market. Thus, the above discussion results in the following hypothesis for the study.

H0: There is no Volatility Spillover effect on the Indian Stock Market from cross-listed foreign markets.

Methodology

The study focuses on the three different yet essential phenomena arising from cross-listing. The first part focuses on the stock market integration and recovery arising out of cross-listing, the second part concentrates on the causality pattern among the indices, and the third part focuses on the spillover effect arising from those stock indices where the assets are being cross-listed. In this, the first step is to check the stationarity of the series.

The stock market series must follow the stationarity at the first difference or level, which is estimated to hold the long-term relationship. It is also required for the classical regression model that all the selected dependent and independent variable needs to be stationary. If the chosen series are non-stationary, then the outcome obtained from the analysis is spurious. For this, the ADF and PP tests are applied to check the stationarity of the series.

The ADF test is based on the following regression:

$$Dx_t = a_0 + a_1 x_{t-1} + \sum_{j=1}^{m} b_j Dx_{t-j} + v_t \tag{1}$$

The Phillip and Perron (PP) test is based on the following regression:

$$y_t = b_0 + b_1 y_{t-1} + u_t \tag{2}$$

Data

The present study focused on the daily return of the four stock indices, calculated from the stock price indices of four countries, including India, the US, the UK, and Luxembourg. Major stock market indices are taken to represent each country. Thus, the data is comprised of Nifty (India), NASDAQ(USA), FTSE_AIM100(UK), and LUXX100(Luxembourg) indices to represent each country. The stock market indices are strong indicators, and their return movements exhibit the market's direction (Onali, 2020). Considering the purpose of the study to examine the spillover effect among the Indian stock market and the cross-listed markets, data is most suitable for the analysis. The stock market indices data is taken from the Bloomberg terminal, and all the price indices are changed into return series to avoid the currency exchange problem. Daily data is used because daily data gives a detail about the nature of the movement. The returns were calculated using the formula:

$$R_t = log(P_0/P(-1))*100 \tag{3}$$

The Cointegration test_follows the procedure of Johansen and Juselius (1991). This test is suited for cointegration because of its consistency and accurate result. The test includes a cointegration equation based on the measured likelihood estimation techniques for a vector autoregression and a likelihood ratio that looks for the variable's association. The Johansen test constitutes two tests, i.e., the trace and max-eigenvalue test. Assuming that r is the rank of Π, which represents the number of vectors for the cointegration equation. For the trace test, the rank of the matrix Π is r0. The null hypothesis for the test(Π) is r0, whereas, for the max-eigen test, the null hypothesis is (Π) = r0 + 1. The equation for the Trace test statistic is:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{g} \ln(1-\lambda_i) \qquad (4)$$

The Maximum Eigenvalue test is:

$$\lambda_{max}(r, r+1) = -T \ln(1-\lambda_{r+1}) \qquad (5)$$

Granger causality

Granger causality analysis depicts the bivariate relationship between the variable x_t casual for the variable y_t, given the past and present value information for forecasting the y_t. The framework for x_t and y_t process for the variable is given as:

$$\begin{pmatrix} x_t \\ y_t \end{pmatrix} = \sum_{i=1}^{p} \begin{vmatrix} \alpha_{11,i} & \alpha_{12,i} \\ \alpha_{21,1} & \alpha_{22,i} \end{vmatrix} \begin{pmatrix} x1, t-i \\ y1, t-i \end{pmatrix} + \mu_t \qquad (6)$$

The GARCH (1, 1) Model

Bollerslev and Taylor (1986) contributed to the development of the GARCH model. The conditional variance is permitted for being reliant on its own prior delays by the model. Such that the simplest GARCH (1,1) specification is used to start off the conditional variances.

$$Y_t = X_t'\theta + \varepsilon_t \qquad (7)$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad (8)$$

The equation for the mean, which is shown above, is expressed in terms of exogenous variables and also includes the error component. The one-period forward forecasting variation based on previous evidence is referred to as the conditional variance, and it is represented by the notation σ2t. The equation for conditional volatility has been provided.

The (1, 1) within the GARCH (1, 1) model indicates the inclusion of a first-order exponential smoothing GARCH term and its first-order moving average ARCH term. The conditional variance equation in an ordinary ARCH model, often known as a GARCH specification, contains no lag forecast errors (0, 1).

These squared errors consequently exhibit heteroskedastic ARMA (1,1) structure. The AR process in the ARMA controls the persistence of the period of volatility shocks. The root is quite near to unity across many practical contexts, which causes disruptions to dissipate gradually.

Data Analysis and Interpretation

Stationarity Test

H0: There is a presence of unit root in the time series

Table 1: First Differences

Index	Augmented Dickey-Fuller	Phillip and Perron
Nifty	-18.62645(0.0000)	-51.03980(0.0001
NASDAQ	-16.57(0.000)	-60.28092(0.0001)
Luxembourg	-51.90420(0.0001)	-51.9067(0.0001)
FTSE	-46.72204(0.0001)	-46.71602(0.0001)

The obtained results suggest that all the indices representing their respective stock market are non-stationary series in their natural order; the ADF and PP tests confirm the non-stationarity of the series at level, with deterministic trends including both intercept and time trend. In Table 1, it is visible that the series became stationary on the first differences. Therefore, the selected stock market series are first-order integrated or follow the I (1) process.

Table 2: Lag Order Selection Criteria

Criteria	1	2	5
AIC	45.4027	45.3738	45.3746*
SC	45.4475*	45.4521	45.4406
HQ	45.4199	45.4021*	45.4406

**Indicates the lag order selected by the criteria*

Table 3:VEC Lag Exclusion Wald Test

Lag	Nifty	NASDAQ	FTSE	Luxx
2	7.344(0.0079)	11.38(0.0049)	14.17(0.0067)	9.834(0.0433)

The appropriate specification for the standard lag length is required for the analysis. On the basis of AIC, SC, and HQ criteria, the appropriate lag length is selected. In this regard, AIC shows a lag of 5; on the other hand, SC shows a lag of 1, and the HQ criterion shows a lag of 2. Further, we also confirm the lag length with the Wald test, which ensures a lag of 2. For the high frequency of data, the low order lags are preferred bearing the informational efficiency of the stock markets (Schöllhammer & Sand, 1987). Thus, our analysis is based on the lag of 2 days as mentioned in table 2-3, selected for the Co-integration analysis involving daily stock prices based on the HQ criterion.

Cointegration Test

Table 4: Trace Test

Hypothesised Number of Co-integrating equations	Trace Statistics	0.05 Critical Value	Probability	Significance at 5% level
At most 1	38.12	29.79	0.0044	Yes

Table 5: Max-Eigen Test

Hypothesised Number of Co-integrating equations	Max-Eigenvalue Statistic	0.05 Critical Value	Probability	Significance at 5% level
At most 1	24.81	21.13	0.0144	Yes

The study's empirical results from the Johansen cointegration test involving four stock markets chosen are summarised in Tables 4-5. The trace test shows the one co-integrating equations at a 5% level. This implies the existence of two linear relationships between the variables, which compel these indices to have a connection during the sample period, despite possible short-term deviations from equilibrium values. To confirm the Trace test result, the Max-Eigen Test result is also shown in the below table. The eigenvalue test also confirms the presence of one co-integrating vector of linear combination during this period.

Multivariate Granger Causality Test

For checking the short-run causality among the co-integrated series, the Granger causality test is applied, which helps in specifying the direction of causality among the selected markets. Figure 1 presents applying the pairwise granger causality model on these four stock indices. It shows the hypotheses of these four stock indices in pairs. The most integrated market is NASDAQ which Granger causes Luxx and FTSE and have a bidirectional relationship with Nifty. Luxx does not Granger causes any of the other indices.

Figure 1: Pairwise Granger Causality Test

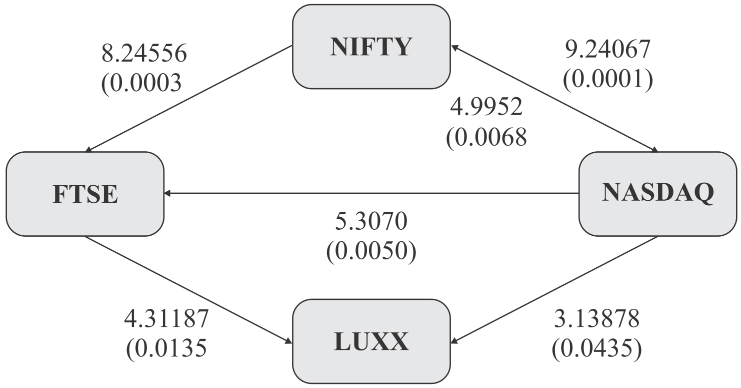

Table 6. GARCH (1,1)

Dependent Variable: NIFTY
Sample Adjusted: January 01, 2011, to December 31, 2021
Convergence achieved after 50 iterations
Method: ML-ARCH- Normal Distribution (BFGS/Marquardt steps)

Equation used:

GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1) + C(7)*RLUXX + C(8)*RFTSE + C(9)*RNASDAQ

Table 6 demonstrates that the constant C is significant at 1% in the mean equation, just as the p-value is significant and the ARCH is significant at 1% in the GARCH model,

demonstrating how the volatility risk is influenced by its historical residual components.

Variable	Coefficient	Standard Error	Z-statistics	P-Value
C	0.021327	0.004497	4.742961	0.0000
Variance Equation				
ARCH (1)	0.082569	0.007157	11.53677	0.0000
GARCH (1)	0.899024	0.009739	92.31616	0.0000
RLUXX	-0.010197	0.006164	-1.541886	0.1231
RFTSE	0.009066	0.009171	6.345823	0.0034
RNASDAQ	-0.010042	0.009806	8.457634	0.0002

Additionally, GARCH (1) is crucial because it suggests that the historical volatility of an index's return is essential and affects the volatility of that index's return today, indicating that these indexes are a source of volatility transmission toward the Indian stock market.

Discussion

Cross-listing of assets on international stock exchanges is increasing market integration as more and more assets are listed there. The current study examined the relationship between the Indian stock market and other international stock markets, including those in the US, the UK, and Luxembourg, where assets are cross-listed as ADR/GDRs. The Johansen Co-integration Test established that the series are integrated with one vector. The short-term equilibrium effect is shown by the paired Granger causality test, which is subsequently checked by the GARCH model for volatility spillover. Unit roots for all the indices have been checked, and after ensuring the series at I(1), the Johansen cointegration test gives the result of two co-integrating vectors. The Causality relationship demonstrates that India and the United States have a bidirectional link and presents the US as the most influential market influencing India and other markets. The result is consistent with the previous studies (Bhaduri & Samuel, 2009; Gulzar et al., 2019; Zhang, 2009). NASDAQ, which Granger causes Luxx and FTSE, has a bidirectional relationship with Nifty, and Luxx does not Granger causes any of the other indices.

Furthermore, the volatility spillover on the Indian Stock market is checked through the GARCH(1,1) model, which reflects that the past innovation influences the present return of the index as the ARCH term is significant, which is consistent with the latest studies (Akdag et al., 2020; Baek et al., 2020; Bonilla & Sepúlveda, 2011). Also, the Indian Stock Market is influenced by the movement of the US stock market and the UK stock market, showing the spillover effect from cross-listing is significant,

Managerial Implications

Foreign institutional investors (FIIs) and retail investments have made cross-border movement possible, resulting in the liberalisation of financial markets. It also helped the individual investors diversify their portfolios as developed country markets get saturated if they go outside these conventional investment paths and toward the developing financial markets. It allows them to go beyond traditional avenues and invest in global assets of ADRs and GDRs. The study also demonstrates that the stock markets are not entirely interconnected, which helps investors find an exogenous market. In the study, the Luxembourg market comes out to be relatively exogenous with no impact from the world market. The finding that there was significant volatility spillover between these markets shows that information is transferred across markets and that the two markets are interconnected. Investors can predict the behavior of one market using data from another market based on these discoveries. This idea is supported by the present analysis, which demonstrates the US market's dominance. Therefore, it is possible to take decisive action to stop global shocks by concentrating on the movement in the US market. Additionally, the connection between the two markets throughout the sample period shows that there is, at the very least, unidirectional causality between the two variables. As a result, financial managers might learn more important lessons about overseeing their portfolios.

Conclusion

The present study addresses the exciting question of integration and volatility spillover of financial markets and tries to fill the gap in the literature that does not capture both aspects. The cross-listing of assets in the form of ADRs and GDRs poses the spillover effect and results in financial market integration. But in the study, it is found that the short-term impact is quite significant among the countries. The conclusion that the cross-listing of ADRs poses a significant volatility effect over the Indian market and imposes a dominating position of the US market in the world financial market can be reached because the Luxembourg market is not significant in any of the models that contribute to this conclusion. In each scenario, the unidirectional relationship between the model and the US market was shown to have significant importance.

Direction for Future Research

Investment decisions are critical, and the right market and diversification portfolio is essential. While going for investing, it is advised to go for a holistic view rather than just integration and spillover. Thus, it gives the direction for future research in which other variables can be included, like macroeconomic factors, investments in the bond market, and the latest innovations like cryptocurrency.

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