

Long-Run Equilibrium and Short-Run Asymmetry in Selected Stock Markets

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Abstract - This study examines the dynamic nature of financial integration among four major equity markets, the United States, China, Russia and India over the period from January 2010 to January 2026 using daily closing data. The study investigates both long-run equilibrium relationships and short-run adjustment dynamics by employing unit root test, Johansen cointegration test and Vector Error Correction Model. The study confirms that all indices are integrated of order one, satisfying the precondition for cointegration analysis. Johansen trace statistics reveal the presence of two cointegrating long-run relationships, indicating strong long-term financial integration among the selected markets. However, short-term dynamics remain limited and asymmetric. The error correction mechanism suggests that only the US market exhibits significant adjustment toward long term equilibrium, implying dominant role in restoring equilibrium within the system. Correlation analysis further indicates weak short-term interdependence, preserving partial diversification benefits. Overall, the results highlight a horizon-dependent and hierarchical structure of global financial integration, where long term convergence coexists with asymmetric short-term dynamics.

Key words: Financial Integration, Johansen Cointegration, Short-term Interdependence, Vector Error Correction, Portfolio Diversification

I. INTRODUCTION

Over the past decades financial liberalisation, technological development, geopolitical realignments and cross border capital mobility have all contributed to a significant change in the structure of global capital markets. Scholarly interest in the dynamics of global stock market integration has been rekindled by the financial shock, cycles of monetary tightening in developed nations, sanction policies and the expanding involvement of emerging markets. According to recent empirical research, global equity markets maintain varied short-term adjustment dynamics while displaying increasing long-run

interdependence (Alam et al., 2023; Rizvi et al., 2023). According to the recent studies, financial integration neither uniform nor static but as per traditional diversification theory, imperfect correlations increase portfolio efficiency (Markowitz, 1952). However, more recent research suggests that correlations become more intense during times of global stress, which could lessen the benefits of diversification (Singh & Kumar, 2024). The necessity for dynamic econometric modelling techniques is further supported by the persistence of non-normal return distributions and volatility clustering, which continue to define equity markets (Abedin & Tang, 2023). Cointegration techniques have been widely used to study long-term equilibrium linkages among markets. As per recent research, capital flow integration, financial openness and macroeconomic synchronisation are causing global markets to share more stochastic patterns (Zhu et al., 2024; Li & Gu, 2025). These advancements align with the theoretical underpinnings of cointegration, which were developed by Engle and Granger (1987) and further upon by Johansen (1988) using multivariate framework. However, current study also shows that developed markets are primarily responsible for transmitting and correcting shocks, making adjustment toward long-run equilibrium often asymmetric (Shahbaz et al., 2022; Sami & Naveed, 2024).

Few studies concurrently analyse the US, China, Russia and India in a single paradigm that encompasses both short-term interdependence and long-term equilibrium relationships, despite the expanding body of literature on global integration. These economies reflect a range of institutional structures, financial development stages and geopolitical inclinations. The financial system of Russia has undergone fundamental changes as a result of sanctions and geopolitical tensions, China

and India are rapidly developing economies and the United States continues to be the primary node in the global financial cycle. Given these structural heterogeneities it is still unclear whether integration across these markets is symmetric, hierarchical or horizon-dependent. In order to address this gap, the current study uses descriptive statistics, correlation analysis, unit root testing, Johansen cointegration analysis and Vector Error Correction modelling to empirically examine the dynamic nature of financial integration among these four equity markets. The analysis adds to current discussion over whether global financial integration is complete or if it is still asymmetrically organised across developed and developing nations by distinguishing between short-run interactions and long-run equilibrium.

II. LITERATURE REVIEW

International portfolio diversification has its roots in Modern Portfolio Theory, which holds that by combining assets with imperfect correlations, investors can lower unsystematic risk (Harry Markowitz, 1952). However, this potential benefit is contingent upon low cross-market correlations continuing to exist. There is growing discussion about whether diversification benefits are sustainable as global capital markets get more integrated. Early empirical study questioned the notion that stock returns are regularly distributed. Mandelbrot (1963) and Fama (1965) showed that asset returns show clustering volatility, fat tails and leptokurtosis. Simple correlation analysis is insufficient to assess integration because of the persistent shocks and nonlinear dynamics that these stylised facts indicate affect financial markets. The empirical examination of financial relationships was greatly advanced by the ideas of cointegration. Non-stationary time series may have a stable long-term equilibrium relationship, as demonstrated by Engle and Granger (1987). Johansen (1988) extended this paradigm by creating a multivariate maximum likelihood method that could find several cointegrating vectors. The basis for contemporary financial integration research was established by these methodological advancements. Increasing long-term co-movement among developed markets was shown by previous empirical research. The benefit of long-term diversification may be diminishing according to the discovery of shared stochastic trends among major developed stock markets Kasa (1992). Time-varying integration was later documented by Bekaert & Harvey (1995)

especially during the period of financial liberalisation. According to recent research, Strong long-term equilibrium relationships are seen in developed markets, particularly in times of global stress. Evidence from the post-COVID era suggests regime-dependent integration, with correlations peaking during crises and reducing during the stable periods. The idea that integration is dynamic rather than constant is supported by this. Emerging economies are becoming more vulnerable to international capital flows as a result of financial liberalisation. However, the integration of developed and emerging markets is frequently uneven. According to global financial cycle hypothesis by Rey (2013), capital flows and asset price movements are shaped globally by global liquidity conditions which are primarily impacted by developed nations. As per this concept, developed markets dominate hierarchical financial integration. According to current empirical study (Alam et al., 2023; Rizvi et al., 2023; Singh & Kumar, 2024), short-term dynamics are still diverse even if developing markets are gradually cointegrating with developed markets. According to these research, emerging markets are often show slower rates of adjustment toward long-term equilibrium as compared to developed markets. Additionally, studies on G-20 and BRICS economies show that long-term integration has strengthened the following significant world events like pandemic and cycles of monetary tightening. Nonetheless, uneven short-term spillovers point to partial integration. During the time of stability, correlation-based study frequently reveals weak contemporaneous correlations between geographically separated markets, maintaining the short-term benefits of diversification. However, at the time of crisis, correlation increases dramatically, which lowers portfolio efficiency. Ardia et al., 2024; Ali & Manel, 2025 showed, diversification gains are horizon-dependent and regime -sensitive. Short-term investors may profit from weak correlations, while long-term investors experience diminishing benefits as a result of equilibrium convergence. One or more long-run equilibrium relationships among global markets are often found in Johansen-based cointegration investigation. However, asymmetric error correction dynamics are frequently revealed by VECM estimations. Developed markets typically display statistically substantial adjustment coefficients, suggesting a leading role in restoring equilibrium while emerging markets exhibit poor

short-run responsiveness. This uneven adjustment hypothesis is supported by recent research that suggests global financial integration is hierarchical rather than uniform (Alam et al., 2023; Sami & Naveed, 2024). Emerging markets react passively to shocks, whereas developed markets take the lead in communicating and correcting them. Concern about systematic risk and contagion are raised by the deepening of long-term integration. According to IMF (2023), more cross-border connections intensify shock transmission mechanisms, especially from advanced to emerging countries. In similar vein, studies from the Bank for International Settlements (2024) emphasises how crucial regulatory collaboration and macroprudential coordination are in a global financial system. The argument that integration increases systematic vulnerability and necessitates enhanced institutional resilience and cross-border surveillance measures is supported by these policy-oriented studies.

2.1 Research Gap

There are still a number of gaps despite earlier research showing global stock market integration. First, very few study simultaneously looks at the US, China, Russia and India under a single empirical framework despite their strategic significance and structural heterogeneity. Second, while many research concentrate on either long-term cointegration or short-term spillovers, they usually use a through Johansen-VECM technique based on Engel and Johansen's paradigm to integrate both dynamics. Third, the problem of asymmetric adjustment is still not well understood in this particular market arrangement, especially the leading role of developed markets in re-establishing equilibrium as proposed by Rey (2013). In order to fulfil these gaps, this paper examines the asymmetric adjustment dynamics, long term equilibrium relationship and short-term Interdependence of these four major equity markets in a modern global setting.

2.2 Research Objectives

The aim of the current study is to investigate how the stock markets in the US, China, Russia and India are becoming more and more integrated financially. Specifically, the objectives are:

1. To investigate the existence of long-run equilibrium relationships among these selected stock markets.

2. To assess short-run adjustment dynamics and asymmetric equilibrium correction mechanisms among these selected stock markets.

III. DATA AND METHODOLOGY

3.1 Data

Four major equity markets, the S&P 500 (United States), SSE Composite Index (China), MOEX Russia Index (Russia) and NSE Nifty Index (India), representing developed and developing economies are examined in this study for their dynamic integration. These indices represent broad market fluctuations and act as benchmark indicators for their respective national stock markets. The analysis relies on daily closing price data that was gathered during the study period from January 2010 to January 2026. Short-term market interactions and volatility dynamics are better captured by daily frequency data than by lower-frequency observations. To stabilise variance and assess changes in relative terms, all price series are converted into natural logarithm.

3.2 Unit Root Test

Determining the order of integration of each series is important before looking at long-term relationships. The null hypothesis of the unit root is tested by using Augmented Dickey-Fuller test. The specifications for the ADF regression are as follows:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{i=1}^p \delta_i \Delta Y_{t-i} + \varepsilon_t$$

Where t is the deterministic time trend, ε_t is the white noise error term and Δ represents the first difference operator. According to null hypothesis, there is a unit root (non-stationary) since $\gamma=0$. The series is deemed stationary in the event that the null hypothesis is rejected. Cointegration analysis only takes into account if variables are integrated in the same order, usually I (1).

3.3 Johansen Cointegration Test

The Johansen cointegration technique, created by Johansen in 1988 is used to investigate whether long-term equilibrium relationships exist among the variables. Based on VAR framework cointegration equation can be as follows:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t$$

Where Π captures the long-term relationship, Γ_i represents short term adjustment coefficients. The number of cointegrating vectors (r) is determined by the rank of matrix. Cointegration happens when the rank r is greater than zero but less than the total number of variables. The Johansen techniques calculate the number of cointegration relationship using the trace and maximum eigen statistics.

3.4 Vector Error Correction Model

The vector error correction model is expected to account for both short-term dynamics and long-term equilibrium adjustments once cointegration has been verified. An error correction term obtained from cointegration equation is incorporated into VECM:

$$\Delta Y_t = \alpha(ECT_{t-1}) + \sum_{i=1}^{k-1} \beta_i \Delta Y_{t-i} + \varepsilon_t$$

Where, ECT_{t-1} represents lagged error correction term, α measures the speed of adjustments towards long-run equilibrium. System stability is confirmed when deviations from equilibrium are corrected over

time, as indicated by a negative and statistically significant of α coefficient. The immediate dynamic interactions between the variables are explained by the short-term coefficients of the differenced variables.

IV. ANALYSIS AND FINDINGS

4.1 Normality Analysis

The descriptive statistics of logarithmic stock price indices are shown in table 1. According to it, the NSE had comparatively higher average index value over the study period with having highest mean value followed by USA, China and Russia. In terms of volatility, USA have the biggest standard deviations, indicating higher variability than China which seems to be more stable. Skewness statistic exhibits modest asymmetry, China has a negative skewness whereas USA, Russia and India have a slight positive skewness. Kurtosis values for all indices are lower than the benchmark value of three, indicating platykurtic distributions with thinner tails than the normal distribution.

Table 1: Descriptive Statistics

	LNPS&P	LNPSSE	LNPMOEX	LNPNSE
Mean	7.866	7.986	7.663	9.248
Median	7.862	8.021	7.678	9.221
St. Deviation	0.510	0.177	0.319	0.513
Skewness	0.057	-0.428	0.133	0.239
Kurtosis	1.960	2.865	1.821	1.844
Jarque-Bera	184.3030	122.3881	244.6442	260.1303
Probability	0.000	0.000	0.000	0.000

Additionally, as the Jarque-Bera test statistics are very significant for all series, the null hypothesis of normality is rejected. This suggest that the log-transformed stock price series deviate from the normal distribution, as is often case with financial time series data.

4.2 Co-Movement Analysis

The result of correlation matrix show that the stock markets of USA, China, Russia and India have weak positive relationship with one another. A modest degree of linear relationship between the indices is suggested by the correlation coefficients. The S&P and NSE have the strongest correlation which is significant. Likewise, extremely weak and statistically insignificant relationship is observed between the SSE and MOEX index.

Table2: Corelation Analysis

	LNPS&P	LNPSSE	LNPMOEX	LNPNSE
LNPS&P	0.2435 (1.000)			
LNPSSE	0.0499 (0.5703)	0.031 (1.000)		
LNPMOEX	0.1336 (0.8581)	0.034 (0.6109)	0.099 (1.000)	
LNPNSE	0.2458 (0.9807)	0.053 (0.5938)	0.134 (0.838)	0.258 (1.000)

The short-term linear correlation among these markets appear to be statistically insignificant, as indicated by the low correlation values observed in all most all pairs. According to recent empirical studies on global and emerging equities market integration, short-term correlation between developed and emerging markets often remains modest despite growing financial globalisation (Bouri et al., 2022; Tiwari et al., 2023). This suggests that there may be chances for international portfolio diversification due to the minimal short-term movement among the chosen makers.

4.3 Stationarity Analysis

The findings of ADF unit root test for the S&P, SSE, IMOEX and NSE stock indices at both level and first difference are shown in table 3. At level the computed t-statistics for the all indexes are higher than the critical value in absolute term. Since the absolute ADF test statistics are higher than the critical value thus, the null hypothesis of presence of unit root is not rejected. So, the fact that all stock indices are non-stationary at level implied the existence of stochastic trends in their price series.

Table 3. ADF Unit Root Test Result

Stock Index	At level			First Difference		
	t-stat value	c-value	Remarks	t-stat value	c-value	Remarks
S&P	-0.9826	-2.8620	NS	-13.7034	-2.8620	S
SSE	-2.6260	-2.8620	NS	-11.5525	-2.8620	S
IMOEX	-1.0812	-2.8620	NS	-12.4153	-2.8620	S
NSE	-1.1858	-2.8620	NS	-17.8682	-2.8620	S

NS: Non-stationary; S: Stationary

However, after taking the first difference the ADF test statistics become highly negative for all the indices. At the significance level absolute values of test statistics are greater than the critical values. Therefore, the null hypothesis of unit root is rejected for all the indices at the first difference. Following first differencing, all four stock indices become stationary which is confirmed by this result. Thus, the variables are integrated of order one i.e. $I(1)$. As a result, the requirement for using cointegration approaches like Johansen Cointegration test or Vector Error Correction model is satisfied, even though the individual stock indices show non-stationarity behaviour in their level. By using multivariate cointegration analysis any long-term equilibrium relationship can be investigated, as shown by the presence of $I(1)$ variables.

4.4 Long Run Relationship

The Johansen Cointegration test was used with the optimum lag length chosen using the AIC, FPE and LR criteria after it was determined that all stock indices are integrated of order one $I(1)$. Since trace statistics are greater than critical values at 5 per cent level of significance, the trace statistic is statistically significant, rejecting the null hypothesis of no cointegration ($r=0$) and at most one cointegration ($r \leq 1$). At the significance level, the trace statistics is somewhat lower than critical value and negligible, hence the null hypothesis that there are no more than two cointegrating equations ($r \leq 2$) cannot be rejected. As a result, two long-term cointegration relationships among the stock indices are indicated by the trace test.

Table 4: Johansen Cointegration Test Result

Trace Test Results				
No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob**
None*	0.007092	60.01560	47.85613	0.0024
At most 1*	0.004327	32.27201	29.79707	0.0254
At most 2	0.002487	15.36856	15.49471	0.0522
At most 3*	0.001451	5.661094	3.841465	0.0173
Max Eigenvalue Test Results				
No. of CE(s)	Eigenvalue	MaxEigen Statistic	0.05 Critical Value	Prob**
None*	0.007092	27.74359	27.58434	0.0477
At most 1	0.004327	16.90345	21.13162	0.1766

At most 2	0.002487	9.707464	14.26460	0.2319
At most 3*	0.001451	5.661094	3.841465	0.0173

On the other hand, the maximum eigenvalue test rejects the null hypothesis that there is no cointegration ($r = 0$) because at the significance level the test result is significant and higher than the critical value. It indicates significance at $r \leq 3$ but fails to reject the null hypothesis at $r \leq 1$ and $r < 2$. This erratic pattern implies that the system under investigation of maximum eigen value test findings is relatively less stable.

In empirical finance literature, the trace test is typically chosen over the maximum eigen statistic due to its greater robustness and ability to identify multiple cointegration vectors in multivariate systems (Johansen, 1988). It is less susceptible to small sample distortions than the maximum eigen value test and examines the joint hypothesis of the number of cointegrating relationships. As a result, this study mainly uses the trace test result to draw the conclusion that the chosen stock markets have two long-term cointegrating relationships. Cointegration shows that the indices have long-term financial integration and share long-term

equilibrium relationships even though the indices are individually non-stationary, which supports the estimation of VECM to account for both short-term adjustments and long-term dynamics.

4.5 Short Run Dynamics:

The error correction model derived from VECM was used to analyse the short-run dynamics. The rate at which deviations from the long run equilibrium are corrected throughout each period is captured by the coefficient of the error correction term (ECT) (Granger, 1987; Johansen, 1988). Negative and statistically significant ECT confirmed both the presence of short-term changes toward equilibrium and the existence of a stable long-term relationship. The error correction term is statistically significant ($t = -4.98$) and negative (-0.0189) for $D(LNPS\&P)$, suggesting a stable long-term relationship and confirming that dispersion from equilibrium is corrected over time. As per the magnitude, adjustment of short-run disequilibrium for each period is roughly 1.89 %.

Table 5: Vector Error Correction Mechanism

Dependent Variable	ECT Coefficient	t Stat	Interpretation
D(LNPS&P)	-0.0189	-4.98	Significant
D(LNPSSE)	-0.00058	-0.22	Not Significant
D(LNPMOEX)	-0.000227	-1.12	Not Significant
D(LNPNSE)	0.01097	1.43	Not Significant

On the other hand, for $D(LNPSSE)$, $D(LNPMOEX)$ and $D(LNPNSE)$ the ECT coefficients are statistically insignificant, suggesting that there are no notable short-term changes toward the long-term equilibrium in these markets. As a result, the S&P index seems to be the main vector for short-run causality, while the other markets exhibit little to no short-term adjustment speed, consistence with findings from recent international market integration studies (Alam et al., 2023; Singh & Kumar, 2024), Asymmetric adjustment dynamics has been implied, in which the markets don't share the burden of restoring equilibrium evenly. Thus, short-term integration seems limited and market specific, even though long term integration is present.

V. CONCLUSION

This study empirically demonstrates the nature and dynamic nature of financial integration among the S&P, SSE, MOEX and NSE. Normality test, Correlation analysis, unit root test, Johansen cointegration and vector error correction modelling all are integrated in this work to provide a thorough evaluation of both short-term interactions and long-term equilibrium linkages among these markets. The descriptive statistics support the generalised facts of financial markets, which are defined by non-normal distribution and volatility persistence, by confirming that all series deviate from normality (Fama, 1965; Mandelbrot, 1963). Limited short-term interdependence is suggested by the correlation analysis, which shows weak contemporaneous correlation among these markets. This suggests that

these markets do not show significant synchronised changes over the short term, protecting the potential benefits of diversifying international portfolio (Markowitz, 1952). On the other hand, the unit root and Johansen cointegration results offer a different long-term view. Even though all of the indices are integrated of order one and non-stationary at level, the existence of two statistically significant cointegrating vector validates long-term equilibrium relationship among these markets. According to this findings, global macroeconomic fundamentals, capital flows and structural economic linkages gradually align market movements over time, supporting the interdependence hypothesis of financial markets (Granger, 1987; Johansen, 1988). Therefore, even when there aren't any significant short-term co-movements, the markets have similar long-term stochastic trends. The VECM findings also show asymmetric patterns of adjustment. Only in the S&P equation is the error correction term negative and statistically significant, suggesting that the US market is a major player in re-establishing long-term equilibrium. Conversely, there is no statistically significant short-run adjustment in the Chinese, Russian and Indian markets, indicating that disequilibrium corrections are not evenly distributed across ma

rkets. Such asymmetric adjustment patterns are consistent with the recent studies documenting heterogeneous speeds of convergence between developed and emerging markets (Alam et al., 2023; Singh & Kumar, 2024). Although emerging countries exhibit comparatively passive short-term reactions, this asymmetric burden of adjustment suggests that developed markets may have greater influence in the global system. With strong long-term convergence and weak short-term integration, the results collectively point to a pattern of incomplete financial integration. This dual structure of integration adds to the body of literature by showing that market integration is asymmetric and horizon-dependent across economies with varying degree of institutional development and maturity of markets.

The findings have significant ramifications for policy implication. The weak short-run correlations suggest that the advantages of diversification are still present for foreign investors with shorter investment horizons. However, the presence of long-run cointegration implies that equilibrium convergence may cause these advantages to

diminish with time. Thus, horizon-specific risk management frameworks and dynamic rebalancing should be incorporated into portfolio strategies (Ardia et al., 2024; Ali & Manel, 2025).

The evidence of long-term integration highlights the growing interdependence of global capital markets and the possibility of cross-border shock transmission for financial regulators and policymakers. The predominant adjustment role of US market suggests that disruptions from developed economies may have systemic effects on emerging markets. As a result, developing market authorities ought to improve institutional resilience to external volatility, broaden the financial markets and strengthen macroprudential surveillance (IMF,2023). In an interconnected financial architecture, more information exchange and international regulatory cooperation are necessary reduce the risk of contagion.

In conclusion, by emphasising the presence of strong long-run equilibrium linkages and uneven short-run dynamics, this study contributes to our understanding of global stock market integration. By showing that integration is uniform nor immediate but rather develops through gradual equilibrium adjustments driven by fundamental market hierarchy, the results add to the broader discussion on financial globalisation.

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