



Financial Markets Co-Movement between India and the US during the Turbulent Decade Ending with Covid-19

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ABSTRACT

In the backdrop of the events such as taper tantrum, demonetisation, Covid-19 etc, this paper examines whether financial markets in India are integrated with the overseas markets. The present study analyses the data on the stock index, government securities yield, corporate bond yield, treasury bond yield, commercial paper and certificates of deposit, etc, from 2010 onwards. The empirical result of the study indicates that, during the last decade, the Indian stock index, G-sec yield and corporate bond yield were having co-movement with their global counterparts. However, the co-movement was missing in case of the financial market segments such as Indian treasury bill, certificates of deposit (CD) and commercial paper (CP). Further, the co-movement of the Indian stock market with the US stock market increased during the bull phase of the Indian stock market, while co-movement of the Indian government securities market with the US security market increased during the phases when the Indian government security market witnessed higher yields. Further, the interaction between various markets in the domestic territory have remained intact despite the last decade being interspersed with taper tantrum, demonitisation and Covid -19.

JEL Classification: G10, G15 and G23

KEYWORDS: Financial markets, Co-integration, Quantile Regression

INTRODUCTION

The benefits of globalisation encouraged many economies to allow the foreign financial firms/industries to enter their domestic economy. Economies opened up their borders to the outside world through deregulation of the financial markets and scrapping of the fixed exchange rate system. The search for returns for the capital helped in the integration of the financial markets. The generation of many technological platforms also took the integration to new heights. These platforms put various investors in equal footing.

The committee to make Mumbai an international financial centre highlighted the characteristics of a vibrant financial system: (i) presence of highly liquid equity market, bond market, currency markets, along with derivatives products on these; (ii) activity of overseas firms; (iii) linkages of one financial segment with another segment; (iv) also equal playing field for domestic/overseas entities delivering financial services.

The search for higher return by the market participants brought out more and more market integration. The demand by various players for easy access to overseas markets forced the authorities to remove the barricades in front of them. The integration has happened between the markets in the

domestic territory, as well as between domestic markets and the international markets.

Various policy makers have voiced their opinion on the integration of the markets. Reddy (2003) highlighted that the integrated markets help the policy makers to transmit the price signals. Integrated markets also help in making the domestic market at par with the international standard. Mohan (2003) described how integrated markets help in promotion of savings, investment and finally economic growth. Trichet(2005) brought out that financial markets integration brings in competition between the market intermediaries, and enhances their efficiency. It is said that if markets are well-integrated, then transmission of monetary policy increases.

The financial integration brings in many benefits, but it is also associated with certain risks. The integration of the markets does not allow the domestic markets to remain immune to the global developments. There are many occurrences in the past that forced the policy makers to adjust their policy making tools to withstand the shocks emanating from the global developments. The pitfalls associated with the global financial market integration were witnessed during the episodes of South-East Asian crisis 1997, the Global financial crisis 2008 and the taper tantrum 2013.



The global financial crisis broke out with the collapse of the Lehman Brothers in the US on September 14, 2008. Many international financial institutions appeared on the verge of collapse. The doubt over the long-term viability of the US financial institutions brought strains crossing across markets segments and countries. Inter-institutional borrowing/lending activities virtually stopped. The major central banks in the world went on co-ordinated actions to address the strains in the global markets. The Indian markets did not remain immune to these. The Indian Rupee depreciated significantly against major currencies. The Indian financial markets also witnessed high volatility.

Another episode of volatility arose during the taper tantrum. The then US fed chairman's statement on taper of the bond purchases in May 2013 put the EMEs into major challenges. The deteriorating macroeconomic indicators of India raised the uncertainties and put the Indian economy in the 'fragile five' category. The Indian government securities market witnessed much capital outflow from the short-term segment. The Indian rupee witnessed almost a free fall. It forced the Reserve Bank of India to raise the interest rate as well as the daily required reserve level for Indian banks. FCNR(B) window was opened to address the volatility of the Rupee.

Recently Covid-19 originating in China affected the developed countries and their growth prospects. Along with these, the markets in the developed world crashed with the deterioration of the global growth outlook, and the Indian markets declined in tandem, though markets witnessed upturn later.

Integration brings access to overseas capital for a capital-starved economy. Market integration also takes market towards making it an international financial centre. However, it generates risks in the process. Information asymmetry generates financial instability (Mohan 2007). Capital flows are subject to sudden stops. For any country having low level of forex reserves, and current account deficit, it makes the external sector management very challenging. For example, Sri Lanka facing a balance payment crisis had to close down its stock exchange for five days recently just to safeguard its forex management. Any external development makes the domestic financial markets prone to getting affected by it. Volatility in foreign markets gets embedded into the domestic financial markets. In the external integration side, it is said the spill-over occurs at a very short notice. The famous macroeconomist late Rudiger Dornbush, described "***It took for ever and then it took a night***". This is how the gestation of a financial crisis happens.

However, financial market integration can be categorised into three types: domestic market integration, global market integration and regional financial market integration. USA ID(1998) identifies market integration as horizontal and

vertical. In horizontal integration, the domestic financial markets get integrated, while in vertical integration there is synchronous movements of the domestic markets with the international markets. Domestic market integration allows the financial market participants to go for portfolio diversification. Regional financial integration allows the participating country to strengthen the local best practices (BIS 2006).

Markets segments operate at different levels. Some segments' operation is confined to the domestic market while others operate at the international level. Money, G-sec and credit markets operate in the domestic territory of the country. But in foreign exchange market the operations occur at the international level.

Many of the economies started implementing various regulations to manage the functioning of the financial markets, particularly after the global crisis of 2008. In India, the government raised its huge borrowings from the market, this in turn has made the government securities market a large one. The huge borrowing programme is managed by issuance of government securities and treasury bills. The process is smoothly managed through the primary dealers of government securities. Similarly, for making the process of raising funds by the corporates easy, a well-developed corporate bond market is necessary. In India, this bond market is being developed in accordance with the measures recommended by the R.H. Patil committee.

Through the external integration of financial markets, the domestic companies get opportunity to raise funds from abroad. This makes the availability of funds for the well regarded companies very cheap. The Indian companies are also taking recourse to fund raising in the overseas markets through external commercial borrowings (ECBs) and from listing in the overseas markets. Introduction of international practices brought transparency and confidence in the minds of the investors. Foreign Portfolio investors (FPIs) have added to the integration process.

Market development by the government as well as the regulators are also part of the integration process. Without proper regulations, the market segments would not have been deep enough to carry the impulse of the policies. Making the call money market purely inter-bank and the creation of collateralised borrowing and lending obligation (CBLO) are done in these directions. The various segments achieved depth and started indicating the true pricing of the products. The frictional mismatches in the liquidity requirements of the market are addressed through the liquidity adjustment facility (LAF). The repo rate became the policy rate to send signal to the market about the cost of funds in the economy. All these have been made possible due to the pro-activeness of the Reserve Bank. The CP and CD are introduced to help in raising of funds by the corporates and banks, respectively, for short-term. FIIs can invest in these markets without breaching the limit set for them.

In the government securities auction process, the RBI was prohibited from participating, and in its place, the ways and means advances (WMA) was introduced. The statutory liquidity ratio (SLR) reduction in a gradual manner made the secondary market liquid. Various incentives were offered to widen the investor base. In the overall process, the government securities market got matured.

The forex market became first place where the external sector reform was initiated. The exchange rate was made market determined in 1993, and then current account convertibility was adopted in 1994. A series of reforms were initiated in the forex market to make the market more deep and liquid. Over time it was observed that the exchange rate in the non-deliverable forward (NDF) market is influencing the exchange rate in the domestic market. In the backdrop of it, currency futures and options were introduced to help the investors.

The SEBI was instituted in 1992 to usher in reform in the equity market. All listed companies were mandated to raise public shareholdings, and it also added to the depth of the market. The technological upgradation for order matching in trading came into operation. Various derivative products in the stock gave further boost to the capital market. In the NSE, the number of derivatives contract traded is highest in the world.

Literature says external integration forces a country to adopt financial discipline in its policies. Also it reduces information asymmetry between various stake holders. Further, International risk-sharing increases from the external integration of the economy. The competition from the market integration reduces the cost of funds and increases market efficiencies (Ayoso and Blanco, 1999).

The financial market integration occurs due to investors in various markets. The participants who invest in G-sec market generally get funded from the Call money market. The investors in the various segments are mostly same. The G-sec yield and the equity are also integrated as the rise in yield in US G-sec market generally forces the FIIs to sell in the Indian market and look for safe havens. These types of episodes were witnessed many times in the past. Further, the volatility in forex market gets spilled over to the equity market, and also in the reverse direction, at a very short interval.

The last decade (2010 to 2020) witnessed many spells of financial market turbulence. These spells came during the taper tantrum, demonetisation and Covid-19, etc. These were not normal times. Hence, it would be a prudent exercise to examine the presence of the financial market integration during this tumultuous period.

THE FINANCIAL MARKET INTEGRATION PROCESS IN INDIA

The command and control structure of Indian financial markets changed in the 1990s. Tough regulations were there

in the operations of the market participants. Banks were acting as captive investors of the government securities markets. The secondary markets were lacking depth. The equity market was lacking transparency. Forex operations were highly regulated. The removal of micro level regulations, free pricing of financial assets, transparency in operations were highly described in the speeches of past governors and deputy governors of RBI (Mohan 2004, 2006).

The market determined interest rate regime was created in place of the administered interest rate regime. The ceiling on the Call money rate was removed. Call money market was broadened with the inclusion of non-banks in it. However, the call money market was made purely bank-based with the removal of the non-banks on August 6, 2005. The administered exchange rate system was substituted by the market determined interest rate system.

In the money market, a new instrument, namely Collateralised Borrowing and Lending Obligation (CBLO), was operated. Over time, it emerged as the instrument having the highest volume in the money market. To give more avenues to banks for hedging interest rate risks, derivatives such as forward rate agreements (FRAs) and interest rate swaps (IRS) were made operational in 1999. Clearing Corporation of India (CCIL) was created, and made the counterparty for all trades in government security, forex and other instruments. Delivery versus payment system was also introduced. NDS-OM, NDS-Call were operationalised to bring in anonymous trading in the government security and Call money market. The introduction of Delivery-versus-Payment (DvP) mechanism, the negotiated Dealing system (NDS), NDS-OM, creation of CCIL helped in reduction of the counterparty risk in the system. It built confidence in the minds of the investors for more investment.

Capital account was liberalised gradually, and cautiously. Foreign banks were allowed to operate after liberalisation in the Indian territory. The Indian equity market was thrown open to the Foreign institutional investment, then government securities market was opened to the FIIs, but upto a limit.

The LAF helped in the liquidity management, and also in influencing the market behaviour. The liquidity availed from the LAF window of the RBI allows banks to address the liquidity requirements in the system, also to take position in the secondary market of the government securities. The forex market gets affected by the money market when the money market participants take positions in the forex market. In 2013 taper tantrum episode, restrictions were put in place by the RBI on the market participants in the deployment of funds in the forex market, to contain volatility in it.

The FIIs operate in government security, forex and equity markets, and their risk-on and risk-off sentiment affect these markets concurrently. The arrival of derivatives linked to

government security and forex market also spilled over to the primary market on multiple circumstances.

In the backdrop of the opening up of the economy, lot of reform measures were initiated. Some of the reform measures in the external sector are highlighted below.

- Capital account convertibility was allowed for non-residents.
- Foreign exchange management Act (FEMA) of 1999 came into operation in place of Foreign exchange regulation Act (FERA) of 1973.
- RBI gave considerable powers to authorised dealers for variety of activities.
- Many forex instruments were allowed in the market in the form of currency swaps and currency options.
- Many financial products such as cross-currency options, interest rate and currency swaps, caps/collars and forward rate agreements (FRAs) were introduced.
- Initiation of trading positions, borrowing and investment in foreign exchange market was permitted for the authorised dealers.
- Setting interest rate on non-resident deposits, using derivatives for asset-liability management, and setting overnight open position limit and gap limit, were decided to be left to the Banks.
- Forward cover and swap transactions made to be available to Indians and FIIs.
- Trading of exchange-traded derivative contracts was permitted to be undertaken by FII/NRIs.
- The option of opening of foreign currency accounts by foreign exchange earners was allowed. Further, opening of such accounts was permitted to the residents (up to US\$ 25000 remittance per year).
- Currency futures were allowed to be transacted in the stock exchanges.
- The foreign portfolio investment was allowed in government securities and state government securities(SGS), and corporate bonds, upto the limits set by RBI.
- Option of raising funds from the equity market was permitted to the public sector banks.

These measures caused the market participants (both foreign and domestic) to transact in various financial market segments both in India and outside India. In the process, the market integration is expanding day-by-day. There is also empirical evidence that in the stock market, the buying decisions of the traders get influenced by the level of volatility in the market. This behaviour in India is similar to the US (Acharya et al, 2022).

The chapter evolves as follows: Section II highlights the literature on market integration; Section III describes the evolution of the opening up of the markets and integration of these; Section IV analyses the empirical exercise, and some concluding observations are given in the last section.

LITERATURE REVIEW

There are many studies on the financial integration across the world. Some of these highlight how the domestic financial markets move in conjunction with the overseas markets. The essence of these is highlighted below.

Rajeb & Arfaoui (2016) is a paper that examines the level of co-movement of stock markets in emerging economies (in Asia and Latin America) with the stock markets in developed economies (USA and Japan) by looking at volatility spill-over during 1993 to 2010. With the help of GARCH methodology and quantile regression, the paper brought out the high interdependence between various stock markets. Proximity to the centre of the market plays its role in transmission of the volatility, so also the crisis periods. The coefficients from the upper and lower quantiles make the observation that the co-movement is higher during the bullish phase of the market. Another paper Karunanayake et al. (2010) examined the interdependence between stock markets, particularly with emphasis on Asian currency crisis period 1997 and global crisis in 2008, by applying MGARCH model on the stock indices of Australia, Singapore, the UK and the US. The empirical findings of this paper highlighted that stock returns were not affected by the crisis. But, both the financial crisis generated more volatility in the stock markets in all the four economies. The US stock market is the dominant one that influences the volatilities in other stock markets. It brought out that there is presence of significant cross volatilities in all the markets. Rigobon and Sack (2003) examined the effect of the US monetary policy on the stock market and interest rates in the US due to the heteroschedasticity in policy shocks. On the monetary policy date, the relationship between the policy rate and other asset prices changes. This finding can be utilised to examine the effect of monetary policy on asset prices. It shows that stock market is negatively affected by rise in interest rate. Further, market interest rates get affected positively by short-term rate, which is most visible on shorter maturities.

Ehrmann, Fratzscher and Rigobon (2005) showed the extent of transmission within various segments of the financial markets in the US, and also between markets in the US and the Euro area. Assets in one segment respond to changes in prices of assets in other segments, also get affected by international spill-overs. The study finds that the US market influences all the markets across the globe. While the US markets are responsible for 25 per cent of the changes in the European financial markets, the euro area accounts for less than 10 per cent of the changes in the US markets. The international propagation of shocks affects more in recession. But after the formation of European Monetary Union (EMU), there are

smaller international spill-over effects. Baele et al (2004) is a study on euro area and it quantifies the extent and evolution of financial integration in the common currency area. It sets a methodological framework with a precise definition to quantify the financial integration in the euro area. The paper assumes that the same rules apply across financial markets and financial instruments are equally open to all. It is built on two broad categories of measures. These directly examine the yield differences and investigate the changes in asset prices in any country with a well-devised benchmark yields/returns. The results were complemented with information derived from other quantity-based measures. The paper applied these on five markets: money market, government security market, corporate bond market, credit and equity markets. The result highlights that the level of integration varies in different markets. It finds that money market has achieved highest level of integration. Further, government securities market has attained high level of integration after the birth of Euro. Chakrabarti and Roll (2002) compared the stock markets in Asia with that in Europe, for the periods before and during the 1997 Asian currency crisis. The paper looks into the change in the co-movement at regional level, and whether it increases at the time of the crisis, generating contagion in the process. The volatility contagion was missing before the crisis, while it increased substantially after the crisis. The increase in the volatility spill-over measure is large in case of India than in Europe. Further, it is shown that scope for diversification was more in Asia before the onset of the crisis, it got changed after the crisis. Further, Baltzer, Cappiello, Santis and Manganelli (2008) is a study of financial integration in the new European Union economies, based on the framework of Baele et al. (2004). The constitution of the measures was limited by data availability, and low liquidity affecting the reliability of some of the measures. The empirical findings of the paper highlight that financial integration in the new EU member states is less than those of the euro area. The process of integration got into acceleration after joining the EU. Money and banking markets became increasingly integrated among themselves. In the government bond market, only large economies exhibited some integration. Further, equity markets are less integrated, even though they are increasingly affected by euro area shocks. Chan, Gup and Pan (2003) examined the relationships among the stock indices in eighteen stock markets with the application of unit root and co-integration tests during 1961-92. All the markets were analysed individually and collectively in regions for testing market efficiency. The study indicated that world equity markets are showing weak-form efficiency. Only a few significant co-integrating vectors existed over the past thirty years. The number of co-integrating vectors increased after the 1987 stock market crash, a phenomenon consistent with the contagion effect. Beckworth and Crowe (2007) has shown that the economic boom of the early-to-mid 2000s was a global phenomenon. There are factors ranging from opening up of the economies, technological gains and the ongoing liberalisation of the real economy that

are the reasons behind it; and however, it is also on account of the rapid expansion of the global liquidity. It is said that global saving glut was the reason behind the global liquidity boom. In a number of countries, such as China, the desired saving exceeded desired investment. That in turn brought in the current account deficit for US and Germany. The global liquidity boom is a reflection of the excess saving finding its way around the world. There is a different view that the US monetary policy is getting recycled back to the advanced economies via the dollar-pegged economies acquisition of the forex reserves. It has shown that bond yields increased by 100 basis points, between 2003 to 2004, in anticipation of ending of a loose monetary policy phase. It is seen that since its inception, the European Central Bank has operated its interest rate in sync with the Federal Reserve, just with a lag. Further, excessive easing or tightening by ECB was in sync with the Fed. For the Eurozone, up to 56 per cent of the short-term interest rate forecast error and upto about 40 per cent of the policy interest rate forecast error can be explained by US monetary policy shock. In a similar way, Chinese short-term rate followed the federal funds target rate with a lag. All these indicate that Federal Reserve of the US is appearing as the monetary superpower of the world.

There are some studies on integration of the financial markets in India. The gist of the findings of some of these are highlighted here. Bhoi and Dhal (1998) is one such study on financial market integration in India in the post-liberalisation period. The empirical findings of the paper highlights that many segments of the Indian financial market have achieved operational efficiency. The 91-day Treasury- Bill rate is likely to emerge as operational benchmark rate. The financial integration is visible at the short-end of the market, i.e., money market, credit market and government securities market. Indian stock market was found to be least integrated with the financial sector at that time. The movement of various interest rate in uniform directions is a positive sign of growing maturity of financial markets. There was lack of robustness in the integration of the domestic market with the global markets. This paper advocated for increasing the financial liberalisation at that time so that markets become mature and achieve more convergence. Mukherjee & Mishra (2008) paper has shown the co-movement of the Indian stock market with the stock markets of twelve other countries (developed and emerging Asian countries). The opening and closing indices have been taken to estimate the integration and volatility spill-over. The return spill-over is significantly present, with bi-directional causality, between these economies. Further, the Indian stock market gets influenced by the markets in Hong Kong, Korea, Singapore and Thailand, while the Indian stock market influences the markets in Pakistan and Sri Lanka. While there is instantaneous movement of information in these markets, some of the remaining information gets transmitted with the opening of the market next day. Jain and Bhanumurthy (2005) studied the financial integration in India. With the

use of multiple co-integration approach, it found that the call money rate has long-run co-movement with the LIBOR. It further showed that there is co-integration between domestic foreign exchange market with the LIBOR, which is not robust. The lack of robust relationship is attributed to the frequent forex intervention by the Reserve Bank of India to contain the exchange rate volatility. The government securities market in India are not co-integrated with the outside world as it was in nascent stage. This paper calls for policy measures to increase integration of financial markets so that the arbitrage advantage in some segments of the market is reduced. Overall, this paper tries to look into the co-integration between foreign exchange market and LIBOR. It does not appear to be a prudent exercise as LIBOR is the rate in the uncollateralised money market while foreign exchange market gives the Rupee-dollar exchange rate. These are not similar rates and looking for their cointegration is just like comparing apple with oranges. Saha and Chakrabarti (2011) examines interdependence between the stock market and the forex market, an issue that has caught the attention of the researchers, investors and policy makers, particularly after the global financial crisis. The contribution of the paper lies in bringing into focus the contagion of volatility during the financial crisis. By taking data of three exchange rates and four stock markets it explored the nature of volatility. The findings of the paper show that there is volatility spill-over, but the impact is not asymmetric between stock index to exchange rate and *vice versa*. Own market innovation has more influence than the cross-market innovation during both pre-crisis and crisis periods. However, both own and cross market innovations do not remain significant during the post-crisis period.

Mukherjee and Bose (2014) studied the co-movement of stock market in India with the stock markets in major economies in Asia and the USA. The paper has highlighted that the US operates as a leader and the information from the USA affects the Asian markets. While the US indices do not uniquely affect the financial integration in stock markets of Asia, Japan plays a uniquely influential part in the financial integration here. The US market also gets influenced by the movement of the Asian markets. The Indian stock index is influenced by the major stock indices in the US, Japan, Hong Kong, South Korea and Singapore. More importantly, Indian stock market has become powerful enough to influence the major stock markets in Asia. In the similar line, Panda, Panda, Nanda, Prasad (2021) examined the information bias and volatility spill-over among the 12 stock indices in the Asia-Pacific region. The study was carried out for the periods before the crisis, then after the crisis and for full sample period separately. The spill over was found to be higher after the crisis than in the period before the crisis. Negative shocks generate greater influence in comparison with the positive shocks. The impact of news is more in the China and HongKong stock markets than in the other stock markets. Cross-mean spill over effect is present among most

of the markets in the region except among Hong Kong-China, Japan-Hong Kong, Taiwan-Jakarta, and between Korea-New Zealand. The findings of this study give information to the portfolio manager for international portfolio diversification in the form of increasing exposure to the volatility receiver's countries while having portfolios with low risk appetite.

Sanati (2010) examined the financial integration of India's markets domestically and internationally after liberalisation. This paper showed that, as per trading value in equities/bonds, Indian capital market witnessed significant growth during 2001-2007 compared to developed countries like the US, the UK, Germany and Italy, and emerging economies like China, Korea and Brazil. It was evident from the high liquidity in the Indian capital market. Free flow of capital across economies and rising co-movement in the returns of the asset classes have brought out the inter-linkage among the various segments of the financial markets –domestic as well as international level. With the use of Johansen and Juselius co-integration test, it found that there was co-movement between the Indian money, capital and foreign exchange markets with high cointegration between short-term money and forex market. Law of one price is running in the Indian call money market rates. There was very weak cross-border cointegration for the Treasury-Bill and the 10-year government securities.

From the literature review, it is clear that many studies were conducted much earlier. There are studies where the empirical exercise was conducted taking inappropriate financial market indicators. The present article tries to study the relationship in a period characterised by high market turbulence. Further, it also looks into the international integration during rising/falling Indian markets.

STYLISTED FACTS

The success of Asian economies encouraged many economies in the world to open up further, though in India's case a balance of payment (BoP) crisis forced it to go for external sector reforms. In due course of time, many of these economies got more and more integrated externally. The table below gives the extent of integration, which is indicated by the external assets and liabilities to GDP ratio. The tables show that there has been a continuous rise in external integration. Even in the aftermath of global financial crisis 2008, there was no decline in the extent of external integration (Table 1). In India, the extent of integration is nowhere close to the advanced economies of the US or UK. In Asia, India, Pakistan and Bangladesh are least integrated while Japan, Malaysia, Thailand, Korea are more integrated.

In many economies, external liabilities outweigh the external assets (Tables 2&3). But, reverse is the case in China and Japan, where external assets outweigh the external liabilities. In some economies over the years, gross asset positions have risen continuously. Obstfeld 2005 says it is for risk sharing, and also it increases the possibility of counterparty failure.

	1970	1980	1990	2000	2010	2020
Bangladesh		24	45	39	41	45
China	0	0	36	68	113	103
India	18	17	29	41	71	91
Indonesia	36	35	70	122	78	103
Japan	22	28	108	98	186	369
Korea	0	60	31	70	133	212
Malaysia	59	74	99	158	236	276
Pakistan	34	37	47	57	61	67
Philippines	38	69	85	123	114	133
Srilanka	16	50	84	73	73	86
Thailand	33	38	66	133	165	229
UK	117	174	293	566	1293	1262
US	28	43	82	163	305	373

Source: Philip Lane database.

	1970	1980	1990	2000	2010	2020
Bangladesh		3	4	5	11	17
China	0	0	19	36	68	58
India	2	4	2	12	24	30
Indonesia	4	10	12	25	20	38
Japan	14	14	59	61	120	218
Korea	0	12	12	31	61	120
Malaysia	23	26	37	64	118	140
Pakistan	3	4	5	9	13	10
Philippines	5	18	16	34	48	63
Srilanka	2	11	18	14	17	13
Thailand	14	8	18	43	76	119
UK	61	89	145	284	642	618
US	17	24	39	74	143	152

Source: Philip Lane database.

	1970	1980	1990	2000	2010	2020
Bangladesh		22	40	34	30	28
China	0	0	17	32	45	44
India	16	12	27	29	47	61
Indonesia	31	24	57	97	58	65
Japan	8	13	49	37	66	151
Korea	0	48	19	39	72	92
Malaysia	36	48	62	94	118	136
Pakistan	31	34	42	48	48	56
Philippines	33	51	69	89	66	70
Srilanka	14	39	66	59	55	73
Thailand	19	30	48	90	89	110
UK	56	84	148	282	651	644
US	12	19	43	90	162	221

Source: Philip R. Lane Database, & Authors' Calculation.

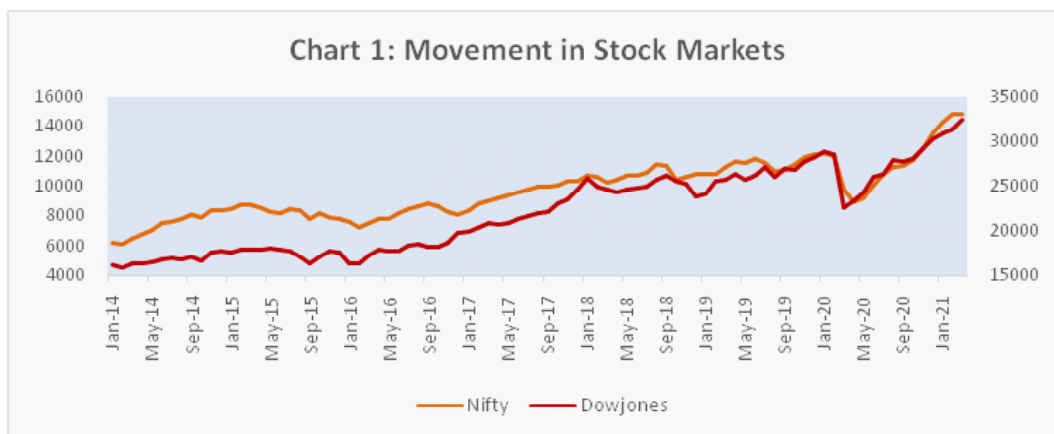
Market development captured the imagination of the policy makers, as a natural corollary to the opening of the economy to the overseas investors. Financial markets across all segments, i.e., money market, government securities market, equity market and corporate bond market, have grown significantly during the period 2011-2020 (Table 4).

Year	Money Market Turnover (Rs Crore)	Government Securities Market (Volume in Rs Crore) @	Foreign Exchange Market (Average Volume US\$ Million)	Equity Market (Cash Segment)		Equity Derivatives Turnover (Rupees Crore)		Corporate Bond Market (Volume in Rupees Crore)
				BSE	NSE	BSE	NSE	
1991-92	6579	112	-	45696	-	-	-	-
2001-02	40923	4,591	1496*	307592	1339510	1922	101925	-
2005-06	39997	3,340	5020	816074	1569558	9	4824250	-
2011-12	65327	13,482	20185	667498	2810893	808476	31349732	1009
2016-17	144557	63,987	27047	998261	5055913	6939	94370302	4668
2017-18	169109	42,329	27754	1082968	7234826	3263	164984859	5602
2018-19	190188	35,734	29246	775590	7949004	2250	237600705	4506
2019-20	221408	50,910	29863	660896	8998811	262268	344532892	6401
2020-21	305320	43,713	27742	690843	10922053	18077462	392478124	5942

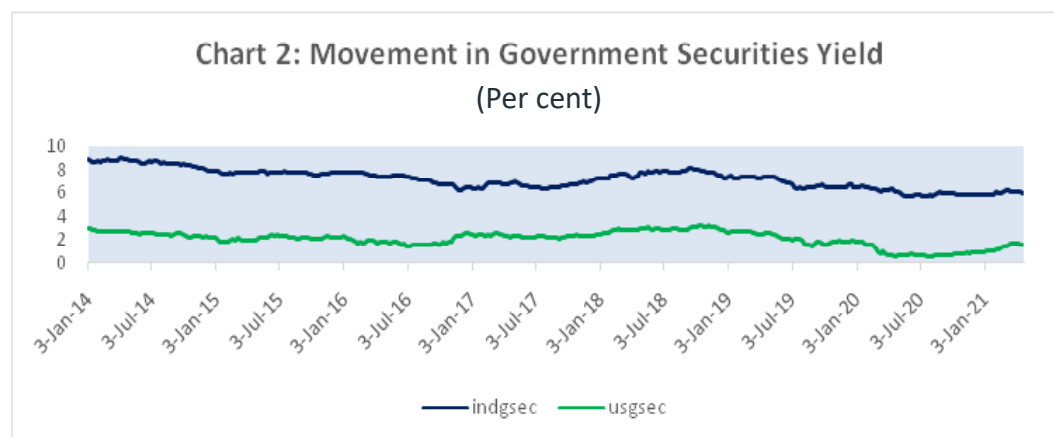
*2002-03.

Sources: RBI and CCIL.

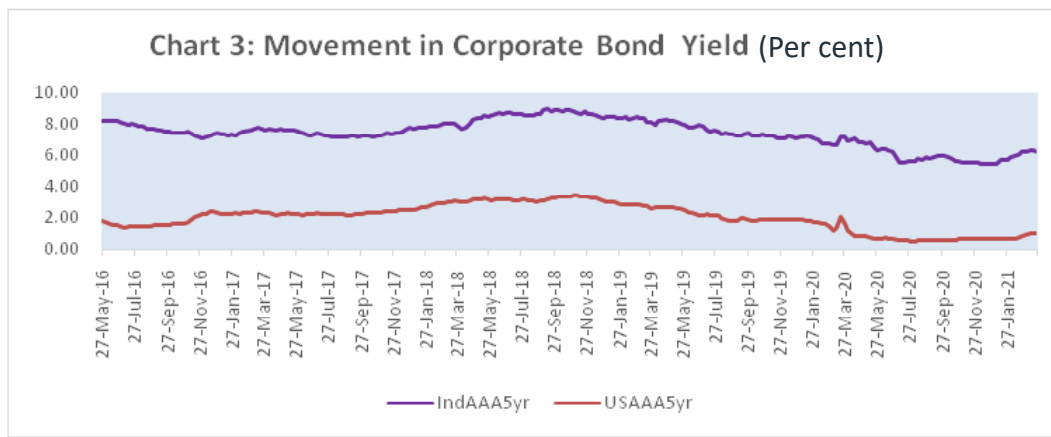
The charts given below (Charts 1, 2&3) highlight how the domestic financial market segments have moved along with their foreign counterparts. The movements of all these variables show the presence of a possible relationship between them. Hence, it needs to be examined in detail.



Source: Bloomberg.



Source: Bloomberg.



Source: Bloomberg.

DATA AND METHODOLOGY

The data was mostly taken for the long period starting after 2010. However, the quantile regression has been applied for the period starting 2014 to avoid the highly volatility phase of taper tantrum.

This paper follows the Johansen’s Co-integration Approach (1988, 1991) for examining the presence of co-integration. In a multivariate framework, with at least two integrated series, this examines the presence of co-integration. It looks for the linear combination which is most stationary while the Engle-Granger test looks for the stationary linear combination that has minimum variance (Alexander. C, 2008).

This operates through maximum likelihood method by testing a relationship in a vector error correction mechanism (VECM) having short-term and long-term relationships, particularly in a dynamic system.

This co-integration approach follows certain procedures: The stationarity of the data is checked by testing the presence of unit root, particularly by checking whether the data series is $I(0)$ or $I(1)$. For this, the Augmented Dicky Fuller (ADF) and Phillips Perron (PP) tests are applied to the data.

With confirmation of the fact that the series are of identical order, the Johansen’s Maximum Likelihood co-integrated test is run to check the presence of long-run relationship between the return of the two financial instruments.

If a set of g variables ($g \geq 2$) are $I(1)$ and are likely to be co-integrated, then a VAR with k lags can be written with these variables

$$X_t = \beta_1 X_{t-1} + \beta_2 X_{t-2} + \dots + \beta_k X_{t-k} + \varepsilon_t$$

A VECM can be generated from the above VAR equation for the application of the Johansen test

$$\Delta X_t = \Pi X_{t-k} + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \dots + \Gamma_{k-1} \Delta X_{t-(k-1)} + e_t$$

Where

$$\varepsilon_t = \begin{pmatrix} \varepsilon_{S,t} \\ \varepsilon_{F,t} \end{pmatrix} \sim N(0, \sigma_t^2)$$

$$\Pi = \left(\sum_{i=1}^k \beta_i \right) - I_g \text{ and } \Gamma_i = \left(\sum_{j=1}^i \beta_j \right) - I_g$$

Where X_t is the 2×1 vector of nifty and dow Jones, that are $I(1)$ and their first differenced series are $I(0)$; Δ denotes the first difference operator; Γ_i and Π are 2×2 coefficient matrices indicating the short-and long-run adjustment coefficients, respectively.

This VAR contains ‘ g ’ variables in the first differences on the LHS, and $k-1$ lags of the dependent variables (differences) on the (RHS), each with a Γ coefficient matrix attached to it. The Johansen test focuses on examining the Π matrix. Π is a long-run coefficient matrix, since in equilibrium, all the ΔX_{t-i} are expected to be zero, and bringing the error terms to their expected value of zero will have $\Pi X_{t-k} = 0$.

Third, the lag length selection is done from various lag length criteria.

Then, the co-integration between the two variables is identified from the rank of the Π matrix. The rank of a matrix is derived from the number of its characteristics roots (eigenvalues), which are non-zero.

Symbolically, eigenvalues are indicated by λ_i and are arranged in an ascending order. If λ_s are roots, these must be positive and less than one.

Likelihood ratio tests are used for identification of the co-integration between the two variables. The Trace test (λ_{trace}) is used to find out whether the number of co-integrating vectors are zero or one, and the Trace max test (λ_{max}) is used to check whether a single co-integrating equation is sufficient or two co-integrating equations are required. In Johansen’s approach, the two test statistics for estimating co-integration are as follows;

$$\lambda_{Trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i)$$

$$\lambda_{Max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$$

In which, r represents the rank of the co-integrating vector in the null hypothesis, T indicates the number of usable observations and $(\hat{\lambda}_i)$ is the value of the i^{th} ordered eigen values from the Π matrix (also called characteristic roots).

Eigenvalues associated with different co-integrating vector are known as eigenvectors.

The first test statistic (λ_{trace}) calculates the number of co-integrating vectors, which are less than or equal to r . Here, the null hypothesis is there is no co-integrating vector. When the null hypothesis is not rejected, it means there is no co-integrating vector. However, if null hypothesis is rejected, it indicates the presence of one or more co-integrating vector. The second test statistic (λ_{max}) works under the null hypothesis that the number of co-integrating vectors is r against $r+1$.

Johansen and Juselius (1990) gives the critical values of these statistics. The rank of Π is arrived at from the λ_{max} and λ_{trace} . When rank (Π) = 1, it indicates a single co-integrating vector and Π is factored as $\Pi = \alpha\beta$, where α and β are matrices. Using this factorization, β indicates the vector of co-integrating parameters and α indicates the vector of error correction coefficients that measures the speed of convergence to the long-run stable relationship.

The Vector Error Correction Model (VECM) technique helps in drawing relationship, when the $I(1)$ variables are present. Moreover, the Johansen (1988) procedure gives estimates of the co-integration that are more efficient than the Engel and Granger (1987) estimates (Gonzalo, 1994). Also, Johansen (1988) tests were found to be fairly robust in the presence of

non-normality (Cheung and Lai, 1993) and heteroscedasticity (Lien and Tse, 1999).

Data Sources

The data for the empirical exercise are taken from the RBI website (www.rbi.org.in), Bloomberg and Reuters. The data for the various segments of the financial markets such as Call money market rate, government securities yield, corporate bond yield, Nifty return have been used to see whether these are co-integrated with their respective counterparts of the overseas markets. For the overseas market, LIBOR, US G-sec yield, US corporate bond yield, US 3-month Treasury Bill rate, US CP & CD rate have been utilised. The data period starts from the January 2010 and ends in February 2022. It starts from January 2010 as the global crisis had ended by that time, and ends by February 2022 as third wave talk was going on in this period. However, the quantile regression analysis has been done for the period after taper tantrum to keep this extreme period of volatility out of the exercise.

EMPIRICAL FINDINGS

While going for examining any statistical relationship, the non-stationarity in the variable is tested. The classical regression model assumes that the variables are stationary. For calculating the stationarity, the presence of unit root is checked through the ADF/PP test. On most occasions, variables were non-stationary in levels but stationary in first difference. This satisfies the criteria for co-integration (Table 5).

Table 5. Unit Root Test Results

Variables	ADF Test Statistics			Philips-Perron Test		
	Without intercept	With intercept	With intercept and trend	Without intercept	With intercept	With intercept and trend
Nifty	0.98	0.98	0.47	0.99	0.98	0.54
Dow Jones	0.98	0.94	0.07	0.99	0.96	0.13
Indian G-sec	0.49	0.58	0.23	0.49	0.59	0.23
US G-sec	0.13	0.11	0.36	0.14	0.08	0.28
India CB	0.26	0.66	0.82	0.23	0.70	0.87
US CB	0.45	0.72	0.72	0.47	0.80	0.79
Call rate	0.59	0.55	0.05	0.55	0.59	0.05
Libor rate	0.27	0.64	0.93	0.70	0.31	0.96

Note: Mackinnon (1996) One-sided P-values.

After ascertaining that the variables are non-stationary, the co-integration between any two variables is tested through the Johansen and Juselius (1990) method. The co-integration analysis indicated the presence of relationship between the two variables in the long-run. However, the test for co-integration is influenced by the lag length. With the application of various lag length criteria, the appropriate lag length is selected. The maximum likelihood test and trace test throw the critical values. The presence of co-integration is checked, and then the co-integrating relationship is estimated. While the long-run relationship is established from the co-integrating relationship, error correction term gives

the speed of adjustment back to the equilibrium between the non-stationarity variables. The long-run relationship is established with the help of the error correction process, and at the same time error correction process allows for short-run dynamics.

This paper mainly focuses on exploring how the Indian financial markets co-move with the overseas financial markets. The domestic financial market integration has been examined in many papers extensively. The international integration has been attempted in some papers, and in many papers these are tried with wrong counterparts. This paper has tried all these in one place.



The test is carried out with the stock index, g-sec yield, corporate bond yield, other short-term money market instruments. The empirical findings are given below.

Co-integration Between Nifty and Dow Jones

Table 6. Johansen Cointegration Test result

Null Hypothesis	Alternative Hypothesis			10 % critical value
Unrestricted Co-integration Rank Test (Trace)		Eigen value	(λ_{trace}) Stat.	
$r = 0$	$r > 0$	0.02	12.88	13.42
$r \leq 1$	$r > 1$	6.59E-05	0.03	2.71
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)		Eigen value	(λ_{max}) Stat.	
$r = 0$	$r = 1$	0.02	12.83*	12.30
$r = 1$	$r = 2$	6.59E-05	0.04	2.71

Note: r indicates the number of co-integrating vectors.

* represent the significance at 10 percent level.

Long-run Relationship

Nifty = 0.48 Dow Jones - 826

For Nifty

Regressors	Coefficients	T-value
ECM(-1)	-0.03	-2.66
DNifty(-1)	0.18	3.71
DNifty(-2)	-0.02	-0.52
DDJ(-1)	0.05	2.47
DDJ(-2)	-0.001	-0.05
c	13.99	1.82

For Dow Jones

Regressors	Coefficients	T-value
ECM(-1)	0.011	0.50
DNifty(-1)	-0.09	-0.83
DNifty(-2)	-0.11	-1.11
DDJ(-1)	0.23	4.57
DDJ(-2)	-0.02	-0.37
c	35.6	2.18

The Johansen technique is applied to the Nifty and Dow Jones. The co-integrated relationship is indicated by the max test. Here, the error correction is occurring from the Nifty only (Table 6).

Co-integration Between India G-sec Yield and US G-sec Yield

Table 7. Johansen Cointegration Test result

Null Hypothesis	Alternative Hypothesis			10 % critical value
Unrestricted Co-integration Rank Test (Trace)		Eigen value	(λ_{trace}) Stat.	
$r = 0$	$r > 0$	0.02	15.21*	13.42
$r \leq 1$	$r > 1$	0.005	3.38*	2.70
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)		Eigen value	(λ_{max}) Stat.	
$r = 0$	$r = 1$	0.02	11.83	12.3
$r = 1$	$r = 2$	0.005	3.38*	2.70

Note: r indicates the number of co-integrating vectors.

* represent the significance at 10 percent level.

Long-run Relationship

$$\text{Indiagsec} = 2.04 \text{ US Gsec} + 3.03$$

For India gsec

Regressors	Coefficients	T-value
ECM(-1)	-0.007	-2.46
DIndgsec(-1)	0.19	4.70
DIndgsec(-2)	-0.08	-2.03
DUSgsec(-1)	-0.02	-0.49
DUSgsec(-2)	0.009	0.22
c	-0.001	-0.35

For US gsec

Regressors	Coefficients	T-value
ECM(-1)	0.005	1.93
DIndgsec(-1)	-0.011	-0.31
DIndgsec(-2)	0.029	0.76
DUSgsec(-1)	0.21	5.17
DUSgsec(-2)	-0.027	-0.67
c	-0.002	-0.64

The Johansen technique is applied to the Indian G-sec yield and the US G-sec yield. Both the trace and max tests show that there is presence of cointegration. Here the error correction mechanism is operating from the Indian G-sec yield only (Table 7).

Co-integration Between India Corporate Bond Yield and the US Corporate Bond Yield

Table 8. Johansen Cointegration Test result

Null Hypothesis	Alternative Hypothesis	Eigen value	(λ_{trace}) Stat.	10 % critical value
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
$r = 0$	$r > 0$	0.015	23.33*	15.49
$r \leq 1$	$r > 1$	0.00	1.21	3.84
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
$r = 0$	$r = 1$	0.015	22.12*	14.26
$r = 1$	$r = 2$	0.00	1.21	3.84

Note: r indicates the number of co-integrating vectors.

* represent the significance at 10 percent level.

Long-run Relationship

$$\text{India corporate bond} = 1.06 \text{ US corporate bond} + 5.73$$

For India corporate bond

Regressors	Coefficients	T-value
ECM(-1)	-0.01	-4.6
DIndcb(-1)	-0.03	-1.29
DIndcb(-2)	-0.05	-1.89
DUScb(-1)	0.17	4.14
DUScb(-2)	-0.02	-0.72
c	-0.001	-0.91



For US corporate bond

Regressors	Coefficients	T-value
ECM(-1)	0.001	0.65
DIndcb(-1)	0.027	1.56
DIndcb(-2)	0.018	1.05
DUScb(-1)	0.12	4.53
DUScb(-2)	0.17	6.33
c	-0.00	-0.20

To check the presence of cointegration the Johansen technique is applied to the Indian corporate bond yield and the US corporate bond yield. Both the trace and max tests show that cointegration exists between the two. However, the error correction mechanism is operating from the side of Indian corporate bond yield only (Table 8).

Co-integration Between India Call rate and the US Libor

Table 9. Johansen Cointegration Test result

Null Hypothesis	Alternative Hypothesis	Eigen value	(λ_{trace}) Stat.	10 % critical value
Unrestricted Co-integration Rank Test (Trace)				
$r = 0$	$r > 0$	0.005	4.98	15.5
$r \leq 1$	$r > 1$	0.003	1.61	3.84
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
$r = 0$	$r = 1$	0.006	3.37	14.26
$r = 1$	$r = 2$	0.003	1.61	3.84

Note: r indicates the number of co-integrating vectors.

* represent the significance at 10 percent level.

Co-integration Between India Treasury Bill and US Treasury Bill(3-month Maturity)

Table 10. Johansen Cointegration Test result

Null Hypothesis	Alternative Hypothesis	Eigen value	(λ_{trace}) Stat.	10 % critical value
Unrestricted Co-integration Rank Test (Trace)				
$r = 0$	$r > 0$	0.0098	7.38	13.42
$r \leq 1$	$r > 1$	0.0024	1.42	2.70
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
$r = 0$	$r = 1$	0.0098	5.96	12.29
$r = 1$	$r = 2$	0.0024	1.42	2.70

Note: r indicates the number of co-integrating vectors.

* represent the significance at 10 percent level.

Co-integration Between India CD and US CD (3-month)

Table 11. Johansen Cointegration Test result

Null Hypothesis	Alternative Hypothesis	Eigen value	(λ_{trace}) Stat.	10 % critical value
Unrestricted Co-integration Rank Test (Trace)				
$r = 0$	$r > 0$	0.004	3.53	13.42
$r \leq 1$	$r > 1$	0.002	0.88	2.7

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)		Eigen value	(λ_{max}) Stat.	
r = 0	r = 1	0.004	2.65	12.3
r = 1	r = 2	0.002	0.88	2.70

Note: r indicates the number of co-integrating vectors.

* represent the significance at 10 percent level.

Co-integration Between India CP and US CP (3-month)

Table 12. Johansen Cointegration Test result

Null Hypothesis	Alternative Hypothesis			10 % critical value
Unrestricted Co-integration Rank Test (Trace)		Eigen value	(λ_{trace}) Stat.	
r = 0	r > 0	0.009	4.13	13.4
r ≤ 1	r > 1	0.04	0.04	2.70
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)		Eigen value	(λ_{max}) Stat.	
r = 0	r = 1	0.008	4.09	12.29
r = 1	r = 2	8.44*10-5	0.04	2.71

Note: r indicates the number of co-integrating vectors.

* represent the significance at 10 percent level.

For finding the long-run relationship between the Call rate and US Libor, Indian TB rate and US T-Bill rate, India CD discount rate and US CD discount rate, India CP rate and US CP rate, the Johansen methodology was applied to these individual pairs. However, no co-integration was found in the relationships in any pair of variables (Tables 9,10,11 and 12).

The findings of the tests get influenced by the lag length selected. In the application of the co-integration technique here, the lag length criterion varies in case of different instruments. The empirical examination shows that there is co-integration between the Indian stock index and the US stock index. The Indian government securities yield and corporate bond yield are having long-run relationship with their counterparts in the USA. They adjust to their long-run stable relationship, faster also.

Taking the empirical assessment further to the forex market, it is said that the integration is studied through the application of the covered interest parity (CIP) and Uncovered Interest parity (UIP). The prevalence of CIP indicates that return from any financial market instrument in foreign market, covered in the forward market, is equal to the return to the same instrument in the domestic investment. It means interest rate differential and forward premium are matching with each other. The UIP says that the expected rate of return from financial instruments of two countries remain same despite the presence of exchange rate risk. However, in this paper, only CIP has been tested.

For the testing of the CIP, the forward premia has been regressed on the interest rate differential (ID) between India and the US. The equation arrived is given below:

$$\text{Forward Premia} = 1.96 + 0.64 \text{ ID}$$

$$(2.88) \quad (3.71)$$

$$R^2 = 0.48, R^2 (\text{adjusted}) = 0.47, DW = 0.84$$

Since serial correlation is there, AR term is incorporated in the above equation and the result is given below:

$$\text{Forward Premia} = 1.96 + 0.24 \text{ ID} + 0.63 \text{ Forward Premia} (-1)$$

$$(2.91) \quad (2.64) \quad (9.82)$$

$$R^2 = 0.70, R^2 (\text{adjusted}) = 0.69, DW = 1.94$$

The coefficient of the interest rate differential is significant, and hence it can be taken that CIP holds. The coefficient is very low and it may be due to the fact that lot of uncertainty has come due to demonetisation, GST implementation and the outbreak of Covid-19 etc.

QUANTILE REGRESSION ANALYSIS

While co-integration is applied for examining the long-run relationship, interdependence is studied through the application of correlation. While finding the interdependence between various economic indicators, correlation is applied in normal practice. However, this technique is criticised on many ways. This technique assumes symmetric liner relationships and does not distinguish between rising or falling markets, and between the large and small stock price movements. This type of situation can be analysed with the help of quantile regression technique. The result can also be utilised as a robustness check to the co-integration result in the previous section. It is another version of the least squares estimation technique applied to the conditional mean, where the different conditional quantile functions are estimated. It provides information on the average dependence as well as the upper and lower tail dependence (Rajeb and Arfaouit, 2016). This technique was used by these authors to study the extent of co-movement of the global stock exchanges. In the present paper, the same technique has been used to study the interdependence of various financial market instruments in India with the equivalent financial market instruments of the advanced economies, particularly the US.

In this exercise, first, the returns and the change in the yield are found to be stationary. The regression has been implemented on three quantiles (0.10, 0.50 and 0.90). These three quantiles reflect the extreme situations in the behaviour of the markets, particularly bearish movement, mean movement and bullish movement. Bootstrapping is applied to find out the standard errors here. However, in this analysis, the external stress has been taken as additional variable and its incorporation highlights the interdependence during stress period in the financial markets. This external stress variable is taken from the office of financial research of the US treasury department, which is said to be very good in tracking the systemic financial stress.

Quantile regression is run to show how the Indian stock market moves with the US stock market, when Indian stock market goes from lower quantile to upper quantiles. The independent variables are the US stock index return and the US financial market stress indicator. It could be seen from the first section of the Table 13 that in stock market the co-movement is more in case of a booming Indian stock market, *i.e.*, the co-movement increases as it moves from the lower quantiles to the upper quantiles. The Fisher test also rejects the null of equality between the coefficients derived for lower and upper quantiles, and it highlights that the coefficients are statistically different. Stress indicator is significant only when the stock market is at lower quantiles.

In government securities market, the yield and price of the security move in opposite directions. When the Government security's yield is at lower quantile it actually shows that price of the security is at higher quantile. The result in the second section of Table 13 shows that there is no interdependence when the yield is at lower quantile, reflecting that the co-movement between Indian government security market and its US counterpart stops when the price of the security remains high. However, the co-movement intensifies when the G-sec yield increases, at a stage when the securities are sold at lower price. The stress indicator is insignificant at every quantile, particularly in the movement of yield of the Indian government securities market. However, the explanatory power remains low in this exercise.

Similarly, in the corporate bond market, the yield and price move in opposite direction. The co-movement of Indian corporate bond (AAA rated) yield with the US corporate bond yield resembles that in government securities markets. The co-movement is significant for AA-rated corporate bond in any quantile. The stress indicator mostly remains insignificant in the corporate bond market.

In the case of call money market, Treasury Bill, certificates of deposit (CD), the interdependence is insignificant. This finding appears logically correct as these markets have various restrictions in the operation to the FIIs. The explanatory powers also remain low as indicated by very low pseudo R-square.

Overall, the interdependence is occurring in case of the stock markets, government securities markets and the corporate bond markets. It is also seen that the interdependence is highest in the stock market as seen in the higher coefficients. The interdependence of India and US stock markets are asymmetric as the coefficient increases with the higher quantile of the stock market.

Table 13. Quantile Regression Result (Dependent Variable : Indian Market Indicator)

Independent Variables	Q _{0.10}	Q _{0.5}	Q _{0.90}
STOCK MARKET			
US	0.61(0.00)	0.61(0.00)	0.72(0.00)
US Stress Index	-0.006(0.01)	-0.004(0.03)	0.0007(0.82)
Constant	-0.03(0.0)	-0.0006(0.75)	0.20(0.00)
Pseudo R ²	0.24	0.14	0.12

G-SEC			
US	0.14(0.35)	0.17(0.00)	0.36(0.01)
Stress Indicator	-0.02(0.23)	-0.002(0.52)	-0.01(0.63)
Constant	-0.11(0.00)	-0.005(0.29)	0.07(0.00)
Psudo R ²	0.01	0.03	0.06
CORPORATE BOND			
US (AAA 5yr)	0.09(0.71)	0.35(0.03)	0.43(0.01)
Stress Indicator	-0.02(0.34)	-0.01(0.08)	0.02(0.27)
Constant	-0.13(0.07)	-0.02(0.02)	0.12(0.0)
Psudo R ²	0.03	0.04	0.11
US (AA 5 yr)	0.92(0.00)	0.99(0.0)	0.9(0.0)
Stress Indicator	-0.007(0.25)	-0.0001(0.87)	0.001(0.63)
Constant	-0.03(0.00)	0.00(0.92)	0.03(0.00)
Psudo R ²	0.71	0.76	0.73
CALL RATE			
US	-0.29(0.71)	-0.11(0.42)	-0.16(0.85)
Stress Indicator	-0.11(0.25)	-0.007(0.71)	0.01(0.90)
Constant	-0.40(0.0)	-0.013(0.50)	0.27(0.00)
Psudo R ²	0.01	0.002	0.0013
Treasury Bills (90 day)			
US	-0.50(0.71)	-0.005(0.95)	1.11(0.56)
Stress Indicator	0.07(0.60)	-0.015(0.48)	-0.03(0.73)
Constant	-1.46(0.0)	-0.01(0.42)	1.37(0.00)
Psudo R ²	0.001	0.001	0.01
TB(1year)			
US	-0.50(0.69)	-0.002(0.98)	0.53(0.77)
Stress Indicator	0.05(0.54)	-0.02(0.17)	-0.05(0.53)
Constant	-1.46(0.00)	-0.017(0.15)	-1.42(0.00)
Psudo R ²	0.002	0.0009	0.002
CD (1m)			
US	-0.11(0.96)	0.05(0.90)	1.68(0.36)
Stress Indicator	-0.17(0.21)	-0.004(0.88)	0.085(0.49)
Constant	-1.51(0.00)	-0.012(0.72)	1.50(0.00)
Psudo R ²	0.007	0.0001	0.003

Notes:

1. In case of Commercial Paper, convergence is not achieved.
2. The figures in parentheses are P-values.

INTEGRATION OF DOMESTIC MARKETS IN INDIA

Examining the presence of integration of domestic markets in India during this turbulent period (2010 to 2020) is important as it is expected that the normal behaviour of the markets have been affected during these turbulent times. The domestic integration of markets with each other helps in understanding the extent of the monetary policy transmission to various sectors of the economy.

The existence of financial market integration during the turbulent times has been examined with the application of vector auto regression (VAR), instead of the usual technique such as correlation or granger causality. The impulse response generated from the VAR highlights many important findings (Annex Charts). The monetary policy rate (repo rate) is affecting many of the market segments. The policy rate affects the call money rate, g-sec yield, corporate bond yield, stock market and the exchange rate also. However, the corporate bond market is least affected by it. The call money rate is affecting the g-sec yield, corporate bond yield, stock market and the forex rate, with the impact being significant. The corporate bond yield is affecting the call money market, gsec yield, etc that indicates the activities of the corporates are having effect on other segments of the market. The essence is that the efforts undertaken by the government in developing the corporate bond market has started yielding benefits, and day-by-day more and more corporates are coming forward to issue bonds. In the process, it has achieved critical mass in the secondary market that its yield is affecting the rates prevailing in other segments of the financial markets. Further, it is seen that some segments affect each other, indicating that there is feedback from both sides, instead of one impacting the other only. The message from the whole exercise is that the dynamic interaction between various stake holders in the market have remained intact despite the last decade being interspersed with taper tantrum, European debt crisis, demonetisation and Covid-19 etc.

CONCLUSION

The external integration has followed a rising trend in many economies. In Asia, India, Pakistan and Bangladesh are comparatively less externally integrated while Japan, Malaysia, Thailand, Korea are more integrated. The extent of integration in many economies is nowhere close to the advanced economies of the US or UK. However, the external integration did not decline in the Asian economies, even in the aftermath of the global financial crisis 2008.

The findings from this paper say that Indian stock index, government securities market and corporate bond market were having co-movement with their counterparts in the US, during the last decade. There is absence of evidence on the integration of the treasury bill, call money, commercial paper or certificates of deposit with their respective counterparts in the US. It indicates that short-term money market instrument (with less than 365-days maturity), despite having grown in size over the years, are not yet integrated with the overseas markets.

The study also looked for the asymmetric co-movement of the Indian financial markets by applying the quantile regression technique. The empirical result says that the co-movement increases at the time of bullishness in the stock market. And, the co-movement intensify when the government securities market are in a phase of high yields. It may be

mentioned that on many occasions it is reported in financial newspapers that rising yield in the US is generating pressure on the Indian financial markets. The AAA-rated corporate bond market follows similar behaviour as the government securities market. However, the AA-rated corporate bond market is closely linked with the overseas ones. Rest of the financial market instruments such as certificates of deposit, commercial paper, treasury -bill do not show any sign of co-movement with their US counterparts in any stage of the market, which reflect the restrictions placed on the FIIs to operate in these market.

REFERENCES

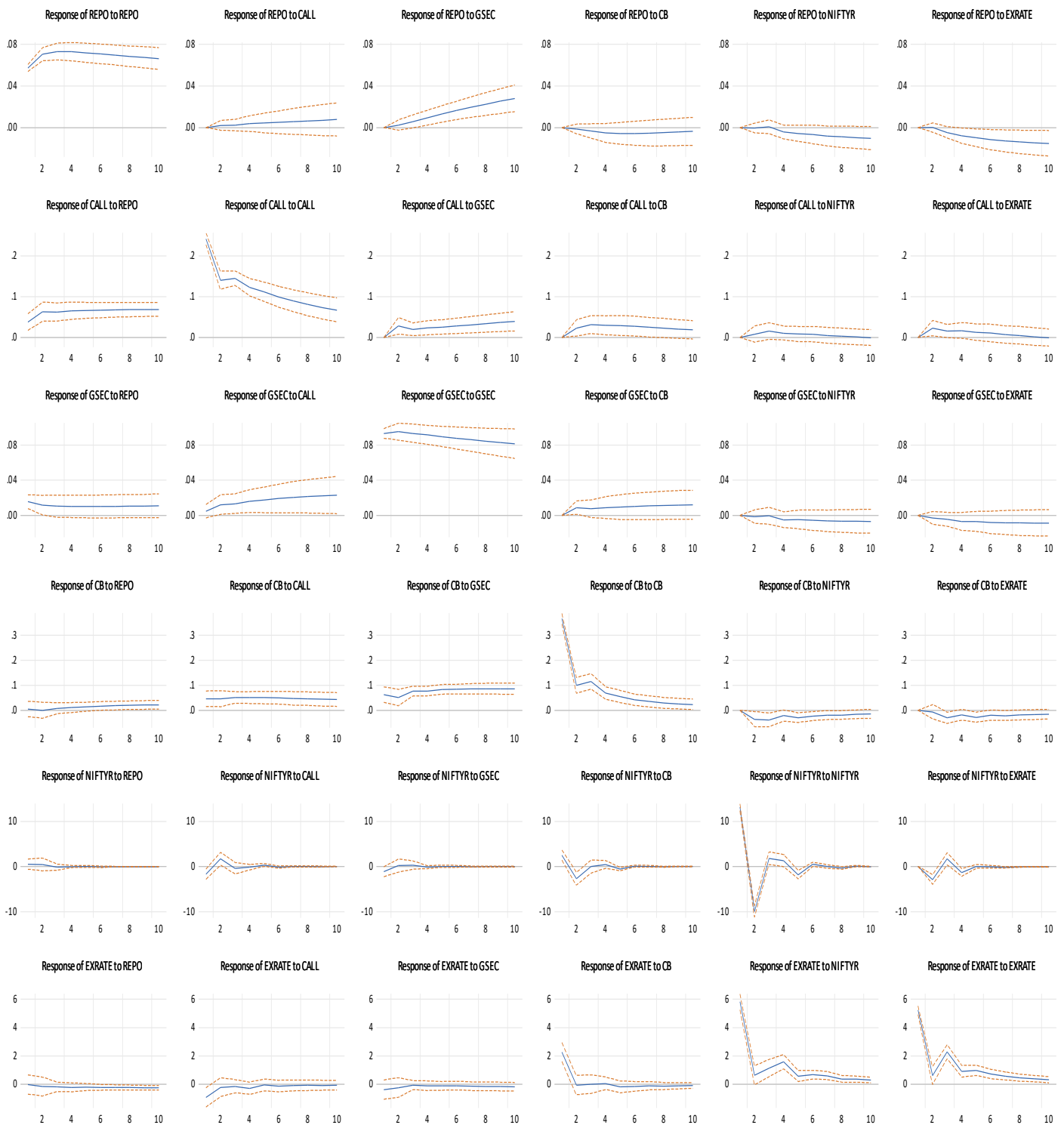
1. Acharya A., Salvi P. A. and Kumar S. (2017). Global Liquidity and Foreign Portfolio Flows to India: An Empirical Assessment, RBI Occasional Paper, Volume 38, No. 1&2
2. Acharya, A., Seet S. K. and Salvi P.A. (2022). Is Implied Volatility Index (VIX) a forward-looking Indicator of Stock Market Movements in India? RBI Working Paper, No. 13
3. Baltzer, M., Cappiello, L., Santis R. A. D. and Simon M. (2008). Measuring Financial Integration in New EU Member States. ECB Occasional Paper No. 81.
4. Beckworth, D. and Crowe, C. (2012). The Great Liquidity Boom and The Monetary Superpower Hypothesis, Boom and Bust Banking: the causes and cures of the Great Recession. -Oakland.
5. Ben, R. A. and Mongi, A. (2016). Financial market interdependencies: A quantile regression analysis of volatility Spillover, Research in International Business and Finance, Elsevier, vol. 36(C), pages 140-157.
6. Bhoi, B. K. and Dhal, S. C. (1997). Integration of Financial Markets in India: An empirical evaluation, RBI Occasional paper.
7. Bhunia, A. and Das, A.(2012). Financial Market Integration: Empirical Evidence from India and Select South Asian Countries. International Journal of Scientific & Engineering Research. Volume 3.
8. Chakrabarti, R. and Roll, R. (2001). East Asia and Europe During the 1997 Asian Collapse: A Clinical Study of a Financial Crisis. AFA, Atlanta Meetings.
9. Ehrmann, M., Fratzscher M. & Rigobon R. (2005). Stocks, Bonds, Money Markets and Exchange Rates: Measuring International Financial Transmission, NBER Working Paper No 11166.
10. Gray, C. (2013). Responding to a monetary superpower: investigating the behavioral Spillovers of US monetary policy, Atlantic Economic Journal, Vol 41(2), pp 173-84.

11. Guiso, L., Jappelli, T., Padula, M., Pagano, M.(2004). Financial market integration and economic growth in the EU, *Economic Policy*, Volume 19, Pages 524–577
12. Hoffman, B. and Takáts, E. (2015). *International Monetary Spillovers*, BIS Quarterly Review, September.
13. Jain, S. and Bhanumurthy, N.R.(2005). *Financial Markets Integration in India*, *Asia Pacific Development Journal*, Vol 12.
14. Joshi, P.(2011). *Market Integration and Efficiency of Indian stock markets: A study of NSE*, NSE Working Paper.
15. Karunanayake, I., Valadkhani, A., O'Brien, M.(2010). *Financial Crises and International Stock Market Volatility Transmission*. *Australian Economic Papers*, Vol 49, Issue 3.
16. Karunanayake, I., Valadkhani, A. (2010), *Modelling Australian stock market volatility: a multivariate GARCH approach*, Faculty of Business-Economics Working Papers No.211
17. Mukherjee, K.N. and Mishra R. K. (2010). *Stock Market Integration and Volatility Spillover: India and its Major Asian Counterparts*, *Research in International Business and Finance* 24(2):235-251
18. Mukherjee, P. and Bose, S. (2014). *Does the Stock market in India move with Asia? A multivariate Cointegration - Vector Autoregression Approach*”, *Emerging Market Finance and Trade*, 44(5).
19. Obstfeld, M. (2005). *Reflections upon Rereading “The Capital Myth”*, Jagdish Bhagwati 70th birthday celebrations, Columbia University
20. Obstfeld, M. (2015). *Trilemmas and trade-offs: Living with financial globalisation*, BIS Working Papers, no 480, January.
21. Panda, A.K., Panda P., Nanda S. and Parad A.(2021). *Information bias and its Spillover effect on return volatility: A study on stock markets in the Asia-Pacific region*, *Pacific-Basin Finance Journal*, Vol. 69
22. Panda, P.K. (2015). *Stock Market Integration: Evidence from India and Other Major World Stock Markets*, SSRN
23. *Report on Currency and Finance*, RBI, 2007
24. Rey, H. (2013). *Dilemma not Trilemma: the global financial cycle and monetary policy independence*, Paper presented at the 25th Federal Reserve Bank of Kansas City Annual Economic Policy Symposium, Jackson Hole, Wyoming, August.
25. Rigobon, R.& Sack, B. (2003). *Measuring the Reaction of Monetary Policy to the Stock Market*. *Quarterly Journal of Economics*, 118, 639-669.
26. Saha, S. and Chakrabarti, G. (2011). *Financial crisis and Financial market volatility Spillover*, *the International Journal of Applied Economics and Finances*, 5(3), 185-199
27. Sanati G., (2013). *Macro Impact of financial integration: An empirical study of Pre and Post liberalized India*, *Journal of Quantitative Economics*.
28. Sutherland, A. (1996). *Financial Market Integration and Macroeconomic Volatility*, *The Scandinavian Journal of Economics*, Vol. 98, No. 4, *Financial Liberalization and Macroeconomic Stability* (Dec., 1996), pp. 521-539 (19 pages)
29. United States Agency for International Development. (1998). *Financial Markets Development*. USAID Policy Paper.

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ANNEX

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.



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