DOMESTIC FINANCIAL MARKET INTEGRATION:

A STUDY ON INTER- LINKAGE AMONGST INDIAN MONEY, CAPITAL AND FOREIGN EXCHANGE MARKET

By

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A Thesis

Submitted to the

University of North Bengal

in partial fulfilment of the

requirements for the degree of

Doctor of Philosophy in Commerce

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February, 2022

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CERTIFICATE

It is certified that the work contained in the thesis titled "**DOMESTIC FINANCIAL MARKET INTEGRATION: A STUDY ON INTER-LINKAGE AMONGST INDIAN MONEY, CAPITAL AND FOREIGN EXCHANGE MARKET"** by Debashree Dey has been carried out under our supervision and that this work has not been submitted elsewhere for a degree.

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DECLARATION

I declare that the thesis entitled "**DOMESTIC FINANCIAL MARKET INTEGRATION: A STUDY ON INTER- LINKAGE AMONGST INDIAN MONEY, CAPITAL AND FOREIGN EXCHANGE MARKET**" has been prepared by me under the supervision of former professor Hirak Ray and professor Samirendra Nath Dhar, Department of Commerce, University of North Bengal. No part of this thesis has formed the basis for the award of any degree or fellowship previously.

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Document Information

Analyzed document	Debashree Dey_Commerce.pdf (D123772072)
Submitted	2021-12-29T10:13:00.0000000
Submitted by	University of North Bengal
Submitter email	nbuplg@nbu.ac.in
Similarity	1%
Analysis address	nbuplg.nbu@analysis.urkund.com

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I. Dedication

I dedicate the thesis to the lovely memory of my grandparents Lt. Mahendra Ch. Dey, Lt. Priotama Dey, Lt. Pratap Ch. Kar and Lt. Bani Bala Kar

II. Acknowledgement

At first, I bow down to my esteemed teachers Prof. Hirak Ray and Prof. Samirendra Nath Dhar for their active help and encouragement to complete the thesis with utmost perfection. They are truly outliers in my life. I, also take the opportunity to express my sincere gratitude to their better halves as well for their invaluable encouragement.

I am really indebted to my father Mr. Amalendu Dey, mother Mrs. Sabita Dey, sister Mrs. Jayashree Dey, brother-in-law Mr. Sudipta Bose , niece Miss. Jithisha Bose and to Mr. Arunangshu Kar (WBA&AS) for their unconditional and invaluable support.

I am grateful to my departmental teachers and staffs for their inspiration and magnanimity.

I would specially mention the name of my senior scholars, Dr. Tamojit Roy, (Assistant Professor, Coochbehar college, Coochbehar), Mr. Avijit Lahiri (Assistant Professor, St. Joseph, College, Darjeeling), Mr. Joy Sarkar (Assistant Professor, Department of Commerce, University of North Bengal) and Mr. Raj Das(Asst. Prof., CE, University of North Bengal) for their active support.

I am thankful to all the staffs of the registrar branch and Grantha Bhaban who always extend their helping hands to tide over the problems when I really need their help. All of them have always been a huge source of morale booster and inspiration for me.

III. Abstract

There is endless debate on globalization, free economy and integration of markets. Followers of McKinnon (1973) and Shaw(1973) forcefully argue and advocate that ‘ this is the only game in the town ‘(Obstfeld 1994, Mohan 2005,Trichet 2005, Lane et al., 2006). Again, scholars like Agenor (2001), warns the world about the evils of financial integration. Despite the debate on boons and evils of integration, now almost all economies are following the ‘free regime' and obviously India cannot live in isolation and started to pursue the ‘free economic policies' from 1991 and attempts to reap the benefits of globalization. The central Bank of India, accordingly, sets the objectives of reform of the financial sector. Reddy (1999, 2005), former governor of the Reserve Bank of India, argued and prescribed that more and more policy reforms are necessary to converge the domestic markets. Integration of domestic markets not only help to reap the benefits of liberalisation across the domestic and international financial sectors but also help to increase the efficiency, integrity and competitiveness of all the sectors —be it real or financial and the outcome of which ultimately be translated to the overall development of the economy.

The issue of domestic integration has escaped adequate attention of the scholars. Majority of the studies investigated the stock, foreign exchange and money market as secondary or auxiliary issue and a few have investigated the domestic financial markets as the only or primary issue. Studies in the context of India are rare. The use of low frequency data, variety of methodologies, incomplete searching, absence of report on the presence of the variables in the co-integration space, etc, and the fractured findings suggest that there is the scope for further research to unveil the intricate relationship amongst the Indian money, foreign exchange and stock market. The primary objective of this study is to investigate whether Indian domestic financial markets are integrated and would remain integrated in future or not. In pursuing the objectives and considering a time period from 1st January, 2008 to 31st

December, 2018, the daily data of the stock, foreign exchange and money market are collected and used in this study.

This study transformed all the select time series process under the scrutiny by taking natural logarithm and estimated the entire tests with log-level data. The stationarity tests suggest that all the variables representing the markets are significantly integrated to order one. With the I(1) time series process we assessed the relationship of the markets based on the methodology suggested by Johansen, (1991,95) and Johansen, and Juselius, (1990). Results of the test significantly suggest the presence of one co-integrating relation and the deterministic term as, there is 'a linear trend at level, and intercept with no trend' which is very common and expected in the studies in finance and economics. Results of the test show the presence of significant long-term stable relationship amongst the markets and all the markets are found to be significantly present in the core of the co - integration space. There is no serial or autocorrelation at and up to the optimum lag order and also found stability of the system. The coefficients of error correction terms are statistically significant and according to the absolute figures, the speed of adjustment of the money market is relatively higher followed by stock and foreign exchange market. Levels of co-integrating relation of the Indian domestic financial markets found in this study do not disappoint the policy planners as it is marked by ups and downs around the critical levels of 95 percent. All these findings suggest strong long-term stable link between the markets.

Results of the Granger causality tests point to bi-directional causality in between the stock and foreign exchange and unidirectional from foreign exchange market to call money market. The pair wise Granger causality run in both direction between the markets. In other words, the past values of all the markets grossly influence the future values of all the markets. The findings of the forecast error variance decomposition analysis indicate that the foreign exchange market followed by stock market will remain flexible over the future period of 50

days and steps are needed to make the money market more vibrant and flexible. The results of the impulse response analysis show that the markets transmit shock to other markets and responses to the shocks nearing to zero at or up to 50th day of our study indicating all the markets under study would remain integrated, at least, to the future horizon of the study.

The results derived and observations made by the study should be accepted with caution due to the inevitable bias and technical limitations of statistical and econometric tools used. In this study, the modified information criteria in the selection of the optimum lag order are not used, the cases of fractional integration, if any, also not considered when testing the order of integration of the time series process. There is enough scope to use alternative tools and techniques to improve the outcome of these types of studies and the matter is left to scholars to study in future.

In investigation, linear co-integrating relationship is assumed. Theoretically, the relation among the markets may well take the nonlinear form. This possibility is not investigated by this study.

One of the primary objectives of this study is to investigate whether there is any co-integration among the domestic markets or not, but to investigate the probable reasons for co-integration or no integration is beyond the purview of this study, hence, it is left for future studies.

In this analysis ‘narrow base' but highly traded segment of the Bombay Stock Exchange that is S & P BSE SENSEX 30 is used. Future studies considering broad base index is welcome. Real rates in place of nominal rates, basket of currencies or more currencies in place of single currency rates, forward rate instead of spot, Yield on Treasury bills in place of call rates can be used to study the relationship in future.

IV. Preface

The debate on globalization, free economy and integration of markets seems not to die out in recent future. Followers of McKinnon(1973) and Shaw(1973) forcefully advocate that this is the only game in the town, but, this economic proposition is not free from limitations and evils. Despite the debate on boons and evils of integration, now almost all economies are following the ‘free economic policies' and obviously India cannot live in isolation and miss the benefits of globalization. The central Bank of India, accordingly, sets the objectives of reform of the financial sector and prescribed several policy measures necessary to converge the domestic markets also. Integration of domestic markets not only help to reap the benefits of liberalisation across the domestic and international financial sectors but also help to increase the efficiency, integrity and competitiveness of all the sectors —be it real or financial and the outcome of which ultimately be translated to the overall development of the economy.

In the new era, Indian financial markets appeared as the major player of the Indian financial system. In the free-regime, after initiating a good number of policy measures by the Indian authorities to integrate the segments of financial markets, emphasizing the capital (especially stock market which is considered by this study to represent capital market), money and foreign exchange market, many questions were appearing in my mind when I was a student of post-graduate classes of finance. Is there any short-term or long-term stable relationship amongst the segments of Indian domestic financial market? Do the past values of the Indian domestic markets influence the future values of other markets? Can we have some fair amount of information about the future movement of one market by observing the activities of other market or markets? Are the Indian domestic markets rigid?

I have searched the literature on financial integration and found that the issue of domestic integration has escaped adequate attention of the scholars. Majority of the studies investigated the stock, foreign exchange and money market as secondary or auxiliary issue and a few have investigated the domestic financial markets as the only or primary issue. Moreover, studies in the context of India are rare. Majority of them used monthly data to assess the activities and status of the very liquid market segments. The use of a variety of methodologies, incomplete searching, and the fractured findings attracted me to research on the issue to unveil the intricate relationship amongst the Indian money, exchange and stock market. Now I got the scope to research on the issue and hope that the findings of my study would help a lot to our policy planners in the matters of overall management of liquidity in our economy. My research findings suggest a stable long term relation between Stock market, Money market and Foreign exchange markets. They are co-integrated but the flexibility of the Stock market and Money market are relatively less than the Foreign exchange market.

At the bottom, the entire study is presented within five chapters: the 1st chapter of this thesis introduces domestic integration, major steps taken by the government to converge stock, money and foreign exchange market and a brief theoretical relation amongst the markets under the study. Chapter II outlines the objective, research questions and hypotheses along with the survey of literature. Methodology used in this study is described in chapter III. Domestic integration and other hypotheses of the study are assessed by econometric tools in chapter IV. The last chapter, i.e., chapter V concludes the study with summary, gap and further scope of the study.

During my research work, two papers titled: Indian Money and Equity Market: Are They Entwined? (with H.Ray and J.Sarkar), Asset Prices and Short-term Interest Rates: An

Experience from the Indian Stock and Money Market (with H.Ray and J.Sarkar) are published in national and international journals and presented a paper titled Domestic integration: An empirical investigation of the select segments of Indian money market (with H. Ray and J. Sarkar) in the seminar organized by the Department of Commerce, University of North Bengal on the 28th and 29th March, 2019.

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Introduction

CHAPTER-1

1.1 Prologue:

In an economy domestic financial market integration, in general, implies horizontal linkage of the segments of financial market (RCF 2005-06). It allows market participants to realize similar rates of returns after allowing for risk and tenor in different segments of financial market. In a completely integrated market system, savers, investors and intermediaries face common and 'market-segment-specific' risks but price only the common risk as the completely integrated segments act as one entity and the 'specific market-segment' risk turned to a minuscule risk, if not eliminated. Scholars argue that, integration of the segments and the consequent reduced opportunities for arbitrage are essential for stabilizing the flow of funds to different segments of the financial market quickly and efficiently (Obstfeld 1994, Mohan 2005). It is posited to be an important aspect for healthy and balanced growth for all the segments of the financial system. Domestic integration is likely to inspire and increase the efficiency of the financial intermediaries. Hence, greater efficiency stimulates the demand for funds and financial services which ultimately results into an increased size of market that delivers more growth to both the developed and developing economies (see, Trichet 2005, Lane et al., 2003). Influenced heavily by the forceful arguments of**,** especially, the neoclassical theorists, peer domestic pressure groups and residents in an economy as a whole, policy planners of several economies all over the globe have experimented several policy measures either to integrate the financial markets—internationally and domestically or to increase the degrees of integration and reap the benefits which is mostly argued as the ultimate outcome of globalization. Over the past few decades, spurred by deregulation, globalization and advances in information technology, financial markets all over the world have witnessed growing integration within as well as across boundaries, (see Ray et al., 2009, Prasad et al., 2003, Stulz, 1981).

In India, one of the important objectives of the economic reforms that has initiated in early 1990's is to integrate the various segments of the financial market by transforming the structure of markets, reducing arbitrage opportunities, acquiring more and more efficiency in market operation of intermediaries and increasing efficacy of monetary policy in the economy (Reddy, 1999, 2005). Efficient allocation of funds across the financial segments and uniformity in the pricing of various financial instruments through greater inter-linkages of financial markets has been one of the basic objectives of the Indian new economic policy and the recent monetary policies are also following the same philosophy. Scholars advocate that, integration not only allows the government machinery to transmit key price signals, but also promotes domestic savings and investments. In turn, these create opportunities for the financial sector of a nation to emerge as a financial hub at the regional or the international level. Integrated financial markets enhance equal access to financial services for the public as well as for companies, and institutions by innovative and cost-effective intermediation, informational efficiency, and market discipline (see Mohan, 2005). Indian central bank also agrees that the administered cross-market and cross-border movement of funds and transactions is the key component for the market segmentation in India. In presence of such restrictions, growing market orientation of an economy demands greater integration of markets for enhancing the effectiveness of policies and for facilitating better functioning of markets (RCF, 2000). India's domestic financial market comprises the money market, the credit market, the government securities market, the equity market, the corporate debt market and the foreign exchange market. Hence, development of economy through financial system and specifically the financial markets can occur in its true sense only if they are well-integrated, because it is only then that the monetary policy impulses are effectively transmitted to the entire economy leading to usher better economic development (see Mohan, 2007).

Globally, changes in the operating framework of monetary policy with a shift in emphasis from quantitative controls to price-based instruments like, the short-term policy interest rate brought about changes in the term structure of interest rates and are expected to be instrumental to integrate various segments of the domestic financial market. The market integration process of both the developing and emerging economies has strengthened more by following the prudential regulations in line with international best practices and by enabling competitive pricing of products (see Feldstein and Horioka 1980, Feldstein, 1983, Haque and Montiel, 1990). Moreover, transmission of monetary policy becomes smooth and quick only when the impact of policy intervention at one end of the market gets quickly transmitted to the entire spectrum of the market. Thus, domestic market integration plays an important role in signaling the interest rate (Vasudevan and Menon 1978). Scholars also argues that, development and integration of financial markets is required for the purpose of not only realising the hidden saving potential and effective monetary policy, but also for expanding the economy's role and participation in the process of globalisation and regional integration. With growing openness, global factors come to play a greater role in domestic policy formulation, leading to greater financial market integration (Reddy, 2005).

It is worthwhile to mention that there are several significant evils of integration within the segments of domestic financial markets and the national markets with the world markets. Taking the clues from Agenor (2001), such potential threats may include destabilizing impacts of high degree of capital flows-- inward, outward and cross-segment-- that may hamper and exacerbate pre-existing domestic gaps and distortions; lack of access to finance by some economic organisms either totally or when they actually need the funds most; the loss of macroeconomic stability; adverse impacts of the pro-cyclical nature of short-term capital flows especially the foreign portfolio investment liabilities ,and the risk of abrupt reversals of the flows that ultimately results in to herding and contagion effects, and like.

1.2. Major Steps taken by the Government of India to Integrate Capital Market[1], Foreign Exchange Market and Money Market:

Integration is a process by which markets become unified so that participants in one market have friction less access to other markets. In the absence of formal and informational barriers, risk-adjusted returns on assets of the same duration in each segment of the integrated market should almost equal and comparable to one another. Return differentials across markets could force investors to shift their portfolio to avail the opportunity left by arbitrage, if any, which ultimately brings an overall equality of returns across markets. Accordingly in cross-border unrestricted movement of capital, it is highly expected that adjusted returns on financial instruments of different countries should be equal when the returns are expressed in any single currency.

In Indian financial system, till the early 1990s, administered structure of interest rates, restrictions on various market participants - including banks, financial institutions and corporates are very common phenomena and that practically discouraged them to execute the desired volume of transactions they could do in the money, forex and capital markets. Administrative limits on the transactions between the residents and the non-residents also affected the volume of transaction in the markets. All these lead to disintegrated financial markets and less economic development. The process of economic reform that started in the early 1990s has attempted to create the environment for better integration of the markets. The gradual approach to reforms in India, which is nicely coined by Atul Kohli (1995), as one step forward and two step backward policy, strives to attain a balance between the goals of financial stability and integrated and efficient markets(RCF, 2000). The gradual approach, although criticized by many, but ushered the benefits to the economy by helping to escape the ill-effects of the great Asian crisis of 1997. Learning from the crisis, the government has

taken more steps to develop various segments of the financial market with the objective to increase the levels of their integration and efficiency. These steps essentially covered the money market, the securities market and the foreign exchange market. Initiatives are taken to introduce new instruments, institutions and practices to (i) widen the participant base, (ii) improve information base for all participants,(iii) create greater transparency, (iv) encourage good market practices, (v) introduce efficient settlement mechanisms, (vi) rationalise tax structures, (vii) create better infrastructure to facilitate faster transactions and (viii) lower the costs of transaction in each and every financial market. A brief and quick look to some major steps taken by the Government in:

1.2.1. Money Market:

Reforms in the money market included permission for entry of additional participants in the inter-bank call money market, and steps to develop a term-money market – particularly exemption of inter-bank liabilities from Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR) stipulations and introduction of new instruments. The Reserve Bank started repos, both on auction and fixed interest rate basis for liquidity management. Since June 5, 2000, the newly introduced Liquidity Adjustment Facility (LAF) has been effectively used to influence short- term rates by modulating day-to-day liquidity conditions. The transition to LAF provided a mechanism for liquidity management through a combination of repos, export credit refinance and collaterised lending facilities. In an environment where banks are undertaking non- bank activities and Direct Foreign Investments (DFIs) are planning to undertake banking functions, a more homogenous set of players are allowed in the call money market with the expectation to facilitate introduction of longer and variable term repos. A well developed repo market is also essential to make the call money market purely inter-bank. The Reserve bank of India (RBI) has introduced Collateral Borrowing and

Lending Obligations(CBLO) market for the DFIs and based on the realised effectiveness of the repo market, the call money market is made completely a inter-bank market.

1.2.2. Capital Market:

Activating Securities and Exchange Board of India(SEBI), setting up of depositories, clearing corporations or houses and introduction of on-line trading in all stock exchanges, dematerialization (31st March,1998), etc., have helped a lot to increase the efficiency of the capital market. Rolling settlement is made mandatory in the exchanges where trading in dematerialized securities was available since January 15, 1998. Brokers were permitted to warehouse trades for firm orders of the Institutional clients. The SEBI appointed a committee under the chairmanship of Shri G. P. Gupta (1998), to study the concept of market making and to revive the institution of market maker. SEBI appointed Chandratre Committee (1997) on delisting of securities which recommend exchanges to collect listing fees from the companies for three year period in advance. Besides, the companies opting for voluntary delisting should mandatorily provide an exit route to investors by offering buy-back facility to them. These recommendations were accepted and suitable directions were issued to the stock exchanges and delisting norms are tightened. All publicly issued debt instruments, regardless of the period of maturity, are presently required to be rated by credit rating agencies. All listed companies are also required to publish unaudited financial results on a quarterly basis. Book building process is introduced. With a view to enhancing transparency in corporate affairs, SEBI accepted the recommendations of the Committee on Corporate Governance,1999 (Chairman: Shri K.M. Birla) and the listing norms have been modified to reflect a code of corporate governance. With a view to detecting market manipulations, SEBI regularly monitors market movements and oversees the activities of the stock exchanges. Along with other measures, these steps in the capital market have helped to move a step forward in achieving the golden goal of ‘free flow' of information across the investors

irrespective to their stake, protecting investors, especially, small investors and in reducing the transaction costs in the stock markets.

1.2.3. Foreign Exchange Market:

In integrating Indian markets with international markets and carry the benefits to domestic arena, recommendations of the Report of the High Level Committee on Balance of Payments , 1993,(Chairman: Dr. C. Rangarajan) and the Report of the Expert Group on Foreign Exchange Markets (Chairman: Shri O.P. Sodhani,1994) are grossly accepted by the government. The Rangarajan committee report recommended, inter alia, liberalisation of current account transactions, compositional shifts in capital flows, that is, away from debt in favour of non debt, strict regulation of external commercial borrowings (ECBs), particularly of shorter maturities, and measures to discourage volatile elements in the inflows from non-resident Indians (NRIs). Against the background of the gradual liberalisation of current account transactions, a transition to the market determined exchange rate on March 1, 1993 was achieved through a successful experimentation with a dual exchange rate system under the Liberalised Exchange Rate Management System (LERMS) for one year beginning with March 1992. In October 1993, banks were permitted to rediscount export bills abroad at rates linked to international rates. Introduction of Post Shipment Export Credit in Foreign Currency (PCFC), in November 1993, enabled Indian merchants to access funds at internationally competitive rates. In October 1996, authorised dealers (ADs) were permitted to use foreign currency note receipts (FCNR -B) funds to lend to their resident partners for meeting their foreign exchange as well as rupee needs. Based on the recommendations of the Sodhani Committee (1994), several measures were instituted to deepen and widen the forex market. ADs were permitted in April 1997 to borrow from their overseas offices/correspondents as well as to invest funds in overseas money market instruments up to US $ 10 million. In October 1997, this limit was raised to 15 per cent of Tier I capital of the

banks. The uniform limit of Rs. 15 crore on the overnight positions of the ADs was removed with effect from January 4, 1996 and banks were allowed to operate on the limits fixed by their management and vetted by the Reserve Bank. The Aggregate Gap Limit (AGL), which was previously not to exceed US $ 100 million or six times the net owned funds of a bank, was left to be fixed by the individual banks since April 1996, depending upon their foreign exchange operations, risk taking capacity, balance sheet size and other relevant parameters subject to approval by the Reserve Bank.

In India, liberalisation of capital account is considered as a process and not as a single event. In the process of capital account convertibility (CAC), the initial reform measures were directed towards current account convertibility leading to the acceptance of Article VIII of the Articles of Agreement of the IMF in August 1994. For operationalising CAC in India, a clear distinction was made between inflows and outflows with asymmetrical treatment between inflows (less restricted), outflows associated with inflows (free) and other outflows (more restricted). Differential restrictions were also applied to residents versus non-residents and to individuals versus corporate entities and financial institutions. A combination of direct and market based instruments of control was used for meeting the requirements of a prudent approach to the management of the capital account. The policy of ensuring a well diversified capital account with rising share of non-debt liabilities and low percentage of short-term debt in total debt liabilities was reflected in India's policies of foreign direct investment, portfolio investment and external commercial borrowings. Quantitative annual ceilings on ECB along with maturity and end-use restrictions broadly shaped the ECB policy. FDI was encouraged through a liberal but dual route - a progressively expanding automatic route and a case-by-case route. Portfolio investments were restricted to select players, particularly approved institutional investors and the NRIs. Short-term capital gains were taxed at a higher rate than longer term capital gains. Indian companies were also permitted to access international

markets through GDRs/ADRs, subject to the prescribed guidelines. Foreign investment in the form of Indian joint ventures abroad was also permitted through both automatic and case-by-case routes.

The Committee on Capital Account Convertibility, 1997, (Chairman: Shri. S.S. Tarapore) which submitted its Report in 1997 highlighted the benefits of a more open capital account but at the same time cautioned that CAC could pose tremendous pressures on the financial system. To ensure a more stable transition to CAC, the Report recommended certain signposts and pre- conditions of which the three crucial ones relate to fiscal consolidation, mandated inflation rate and strengthened financial system. Keeping in view the recommendations of the Report, India has over the years liberalised certain transactions in its capital account. Vastly altered and liberal policy environment for the external sector is reflected in the Foreign Exchange Management Act, 1999 (FEMA), which replaced the earlier Foreign Exchange Regulation Act, 1973 (FERA). The new Act sets out its objective as facilitating external trade and payment and promoting the orderly development and maintenance of foreign exchange market in India.

1.3. A Brief Review of Relationship between Capital Market, Foreign Exchange and Money Market:

1.3.1. Stock and Foreign Exchange market:

The dynamic relationship between stock prices and exchange rates is aptly explained by ‘flow’ and ‘stock’ oriented models. The flow oriented model emphasizes on the trade balance and advocates that changes in exchange rates affect international competitiveness and trade balances, and in the process influence real income and output (Dornbush and Fisher 1980). The followers of stock oriented model focuses on demand and supply of financial instruments, especially stock and bonds and posit that changes in stock prices affect output

through wealth and investment decisions which ultimately influences money demand and exchange rates (Gavin 1989, Mishkin 2001, Dimitrova 2005).The ‘stock-oriented‘ models of exchange rates view the rate as equating the supply of and demand for assets like stock and bonds and unlike the former one emphasize the role of capital accounts in determining exchange rate dynamics. Since the values of financial assets are determined by the present values of their future cash flows, scholars argue that, expectations of relative currency values play a considerable role in their price movements, especially for internationally held financial assets. Thus, changes in stock price may affect or be affected by exchange rate dynamics (Branson 1983, Frankel 1983, Yang and Doong 2004).

In empirical analysis, scholars found contradictory relations. Aggarwal (1981) found U.S stock prices are positively correlated with the ‘trade weighted‘ dollars. But, Soenen and Hennigar (1988) have found a strong negative correlation between U.S stock prices and ‘fifteen currency-weighted value’ of the dollar. Ma and Kao (1990) have provided some possible explanations for these contradictory evidences. Their study, based on six industrially developed economies, suggests that the currency appreciation has a negative effect on the stock market of export dominant economies and boosts the stock market of import- dominant economies.

According to Ajayi and Mougoue (1996) an increase in stock prices causes the currency to depreciate. They argued that, a rising stock market is an indicator of an expanding economy which goes together with higher inflation expectations. Foreign investors discount this signal negatively and their demand for the currency of the economy with a booming stock market falls and it depreciates. Again, Granger, Huang and Yang (2000) argued that, in the markets with high capital mobility, it is the capital flows and not the trade flows that determine the daily demand for currency. A decline in stock prices makes foreign investors sell the financial assets they hold in the respective currencies and that result in the depreciation of

currency. Hence, they posit that currency will depreciate if stock market declines, and the stock prices are expected to react ambiguously to exchange rates as depreciation of currency could either rise or lower the value of a company depending on whether the company mainly imports or exports.

In literature, there is no unanimity among researchers regarding the form the relationship (positive or negative) (Mok 1993, Mukharjee and Naka 1995, Abdalla and Murinde 1997, Chang et, al (2000), Chiang et al 2010, Nieh and Lee 2001, Dimitrova 2005, Rudiger, and Stanley.(1980), Machado et al,2017, Santana et al. 2018, Noriller and Silva,(2019), Bernardelli and Castro,(2020).

1.3.2. Stock and Money Market:

The relation between stock market and money market is debated by the scholars discretely for more than a century (see White, 1910). Majority of the scholars agreed that equity prices certainly and strongly react to monetary policy impulses. It is widely argued and attested that an increase in short term interest rate raises the 'discount value' and lowers the demand for goods and services resulting a decline in equity prices (Bernanke and Kutner, 2004, Ehrmann, Fratzscher and Rigbn, 2009).

According to Tobin (1969), if the equity prices increases then economic units can raise more funds by issuing smaller number of shares which ultimately increases the investment and output and lowers the interest rates. Modigliani (1971) posited that a permanent increase in the security prices results in increase in the individual's wealth holdings leading to higher permanent income. Hence, on the occasions of rise in equity prices, consumers will be able to readjust upwards their consumption level which finally, influence demand and interest rates. Several scholars, in the line of Tobin (1969), observed and advocated that, if the price of equity shares increases then the companies can afford to offer more collaterals and lift more

funds which mostly put an upward pressure on the demand for the funds. Hence, rise in the equity prices triggers an expansion of the economy and influences the interest rates conditional to the availability of funds (Barnanke and Gertler,1989, Kiyotaki and Moore, 1997).

Short term interest rate and its impact on asset prices are marred by endless debate without any objective answer. The advocates of Keynesian theory argue in favour of low interest to encourage more consumption and increase in demand in the economy. This increase in demand promotes investment and growth of the economy by influencing economic activities including the asset market. On the other hand, neo-liberalists reject Keynesian view and suggest that rise in real interest rate helps to accumulate more savings and create more funds which ultimately are available in the economy for investment, and hence, the equilibrium rate of investment and efficiency of firms will finally increase (Fry, 1978 and Agarwal, 2004).

1.3.3. Foreign Exchange and Money Market:

Money market is essentially a market which in intertwined with the liquidity of the economy via economic activities. Hence, higher short- term interest rates signals tight economy i.e. dearth of capital. To balance the short – term liquidity for the sake of overall growth and development of, especially under developed or developed economies, the policy planners or economic planners may utilise the option of foreign capital by removing the obstacles for the inflow of capital. ‘Fisher Effect’ also demonstrate that capital would flow from low real interest bearing nations to a higher one. Thus increase in interest rates, assuming a slow growth in inflation, attracts foreign capital resulting an appreciation of the domestic currency, and one can expect a indirect relation ,that is, inverse relation between domestic currency and foreign currency or direct relation between foreign currency and domestic currency and money market rate represented by (CR) rates.

1.4. Conclusion:

To reap the benefits of globalization and integration of international financial markets, integration of the domestic segments of financial markets and the consequent reduced opportunities for arbitrage are must. Domestic integration helps in stabilizing the flow of funds to different segments of the financial market quickly and efficiently resulting a balanced growth in economy. The government of India has also initiated several important measures in each of the critical segments of the Indian financial market expecting enhanced informational sensitivity and competitive efficiency of the markets. Despite the restrictions that still exist on specific cross-market transactions and the general policy of discouraging speculation, it is claimed by the government that domestic markets have shown some signs of increased integration (RCF,2000). This study, like some other earlier studies, attempted humbly to examine domestic integration objectively with the robust and state of art tools from time series analysis.

Note:1. This study considered the highly active segment i.e, stock market to represent capital market.

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CHAPTER-2

Review of Literature, Scope and Plan of the Study

CHAPTER-2

2.1 Introduction:

In the literature of financial integration quest of the scholars to investigate the issues on integration of international financial markets is found more than the domestic financial integration leading to a big gap in both the theoretical and empirical literature on integration of financial markets. In fact, the literature on domestic financial integration is in its infancy.

The quantitative analysis of integration of domestic financial markets dates back to Gordon de Brouwer's (1995) study of changing relationship between non- traded and traded financial instruments, especially between money market and institutional interest rates under the regulated and free-market regimes. Considering the importance of competition, financial liberalization and permanency of money market interest rate shocks, the author positively argued in favour of integration of money market which ultimately signals broader and more fundamental financial integration. His sample countries consisted of eight Western Pacific economies, namely, Australia, Hong-Kong, Indonesia, Malaysia, Philippines, Singapore, Taiwan and Thailand along with Canada, Japan and United States of America. He attempted to develop a model to assess the structural and dynamic relation between money market rates and deposit and lending rates based on banks' assets (reserves and loans) and liabilities (money market borrowings, deposits and equity) along with the (i) probability of payment of loan interest, (ii) default in loan principal, and (iii) monopoly of banks in the lines suggested by Lowe (1995). In sum, the author assessed the integration of domestic financial markets by estimating the relation between (i) money market rates and deposit rates and (ii) money market rates and loan rates over a period of 20 years, dividing the entire period in four sub-periods. The study considered monthly data for all the rates collected from various sources available in the economies under the study. Call and overnight borrowing rates were

considered to represent money market rates and CD rates for some countries to surrogate the deposit rates. He had reported (i) non-stationarity in all the monthly rates at level, (ii) strong positive and statistically significant correlation between Call and CD rates, and (iii) the presence of integration amongst the rates under the study. The author also found that correlation and integration were more robust in developed countries like Canada, Japan and United States of America.

Various policy prescriptions of financial reform were undertaken by the Government of India in the 'free – regime'. She implemented the major suggestions initially recommended by Chakraborty Committee (1985) followed by Vaghul Working Group (1987), the Narashimham Committee (1991), M. Narashimham Committee (1997), and many other committees. The major suggestions of the committees were to integrate the various segments of the financial markets so as to achieve a higher level of efficiency and elimination or reduction of arbitrage opportunity, if exists, in the financial markets. To assess the state of integration of the markets after implementation of the recommendations of above mentioned committees, Bhoi and Dhal(1998) attempted to empirically evaluate the level of convergence of Indian financial markets. The authors, firstly, searched the reference rates of the markets on the basis of the descriptive statistics, tested the stationarity of the variables under their study and then conducted the Granger causality test with the qualified reference rates. In their unit root test based on the methodology suggested by Phillips-Perron(1998), they found all the rates save call rate are non-stationary. In the context of call rates, they considered a three-month moving average of the same which turned out to be a non-stationary one, hence, included the three-month moving average rate (call money rate 3) in their main frame of the study. In estimating the relationship, they argued that the causal relationship and the size of long-run elasticity are important facts for any meaningful study of integration of different segments of the financial market. The set of variables, finally, under their study included the

rates of call money (CMR), certificates of deposits (CDR), commercial paper (CPR), deposits (DRT), lending (LRT), 91-day Treasury bill (G91), 364-day Treasury bill (G364), and return on capital (RE) consisting of capital gains and dividend yields, price-earning ratio (PERN) of 100-scrip National Index, 3- month forward premium (FRWD3), 6-month forward premium (FRWD6) of the US dollar and the US Treasury bill rate (USTB). The paper examined the monthly rates/returns covering 60 months from April 1993 to March 1998 only. The study reported a bi-directional causality between call and foreign exchange market (forward premia), between money (91-day Treasury bill rate) and foreign exchange market (forward premia). But at a higher level of significance, they found no causal link between capital market, money and credit market and no integration in capital and call money markets. In the context of only the money market rates, their bi-variate cointegration test results indicates that (i) that commercial paper rate and call money rate 3, (ii) certificate of deposits rates and call money rate 3, and (iii) commercial paper rate and certificate of deposits rates were integrated. In the multivariate analysis, considering the performance of the variable 91-day Treasury bill rate, they posited that Treasury bills market is the prime mover of the money market rates. Their attempt to find convergence of various financial markets yielded mixed results and the integration of domestic and overseas financial markets was not robust.

Jena et al.(2004) conducted a similar study to examine the impact of the policy and institutional reforms in India on narrowing down the inter market divergence empirically and attempted to provide some lights on the domestic market integration in India. They argued that in the post-independence but pre-reform period the Indian financial institutions and markets were under ‘control regime’ causing the financial system to remain in a highly segmented and inefficient state. They considered seven variables -- call money rate (CMR), certificate of deposit rate (CDR), commercial paper rate (CPR), 91-day Treasury bill rate (TB-91), prime lending rate (PLR), 3-months forward premium (FRWD), and price earnings

ratio of 100 scrips BSE index (PER). The variables under their study covered five markets viz. money market, credit market, capital market, government securities market and foreign exchange market for the purpose of testing the market integration hypothesis. The authors used monthly data spanning from March 1993 to March 2002 and found all the variables were integrated at order one at level excepting call rate. Like Bhoi and Dhal (1998), they also considered a three-month moving average of the call rates which turned out to be a non-stationary one. The study reported the presence of causality amongst the short-term interest rates but no causality between short and long term rates. Money market and foreign exchange market had shown high degree of integration between them. They found a lower degree of integration between money market, government securities market and credit market and positive relation amongst call, exchange, treasury bills and stock market. Amongst the money market instruments, they reported a long term stable and positive relation between the three-month moving average of call rate and 91-days Treasury bills but no integration between (i) certificate of deposit rate (CDR) and 91-days Treasury bills and (ii) commercial paper rate (CPR) and 91-days Treasury bills. However, on the basis of the results of both the correlation matrix and the cointegration test, they observed that there seemed to be no long-run relationship between the capital market and other short-term markets. Finally the authors suggested that while the reform process had helped in removing institutional bottlenecks to the free flow of capital across various segments of Indian financial market; the event had not yet been translated into complete integration among them. After closely scrutinising the paper it is found that: (i) 'Impulse Response Accounting' which is considered as a vital tool to identify the status of integration of the markets are not explored, (ii)which market(s) is(are) in the cointegration space is not tested and reported, (iii) the authors have not considered the three-month moving average of the call rate for their study when selecting the reference rate (Table-1of their article) and, last but not the final one (iv) the markets under their

consideration are highly liquid markets and are expected to react fast on the arrival of news, hence, monthly data of the call rates which is again averaged (3-month moving average) loses some, may be vital, information . Gross information is expected not to represent and infer information about the activities of the market properly. Despite their best efforts, without resolving and giving a clear and meaningful direction towards the integration of Indian money market, the study itself raised the issue to be researched further.

Sanati (2010) assumed that the increasing gross flow of capital across borders and increasing correlation among different asset returns of major financial markets in the last couple of years , inter linkage across different segments of financial, domestic as well as international, markets has increased. To test the domestic integration she considered returns of call, treasury bills-91days and treasury bills-364 days to represent money market, log of BSE indices and 10-year yield on Government securities to represent capital market and foreign exchange rates from spot, one, three and six-month's forward markets to represent foreign exchange market. The author considered the monthly data and started with the correlation technique dividing the total sample period (1993 – 2007) into two- from 1993 to 2000 and from 2001 to 2007. She found contradictory results of correlation amongst the variables for the periods especially in the context of (i) exchange rates and all the other variables and(ii) stock market and yield on 91 days treasury bills. The results were not surprising as the author conducted the study on the basis of almost low frequency data covering a period under the Information Technology-Knowledge boom. She then investigated the same on the basis of the methodology provided by Johansen and Juselius (1990,1994) for co-integration test in both the multi-variate and bi-variate framework. The author claimed co-movement among the domestic money, capital and foreign exchange markets with strong co-movement between the short-term money and foreign exchange markets. The cross-country analysis, in terms of the short-term inter-bank rate, showed convergence of two different clusters of countries with

Canada, Germany, India, and the UK figuring as common members in both the clusters. Also, her stochastic time series analysis showed that the Law of One Price (LOOP) held good for Indian call money market rates. The findings based on the 91 day Treasury Bill rate and the 10-year government bond yield revealed very weak cross-border co-integration.

Kumari and Mahakud (2012) investigated the relationship between stock prices, exchange rate and demand for money in the post-liberalisation period in India using monthly data from 1996:1 to 2010:8. The test results disclosed the presence of more than two co-integrating vector for each money demand specification. They also found that money demand function was sensitive to inflation, stock prices and economic activity. Unidirectional causality was reported flowing from stock prices and exchange rate to demand for money function.

Paramati and Gupta (2013) investigated the relationship between call money rates, exchange rates and stock returns of India using monthly data for the time span of April 1992 to March 2011. The variables under their consideration are call money rates (monthly weighted average), exchange rates (monthly US Dollar average against Indian rupee), monthly closing price indices of BSE SENSEX 30 and NSE-S&P CNX Nifty. They reported that call money rates are I(0) and exchange rates and the stock returns are I(1) at log-level. Result from Granger causality test evidences bidirectional relationship between call money rates and exchange rates and virtually no causation at less than five percent level of significance. To explore lead-lag interaction among the variables, VAR model is used and the results suggest no evidence of lead-lag causation from stock returns to call money and exchange rates.

Capital flows and propagation of information between financial markets gradually increasing within and across economies due to the continuous development of the global economy, the economic globalization and deepening of financial liberalization. Thus, linkage between various segments of the domestic financial markets is visible and increasingly significant

when openness and marketization of financial market of an economy moves faster. In the context of China, Yu and Liao (2017), attempted to measure the mean spillover effect and volatility spillover effect using daily data for the period June, 2000 to December 2016, taking stock, money (represented by call rates) and foreign exchange market. They used VAR (7)-GARCH (1,1)- BEKK model. The results of the mean spill over test show yields of foreign exchange market influences the stock prices but stock market has no influence on foreign exchange market and asymmetrical bidirectional mean spill over between stock and money market and money and foreign exchange market. The results of the volatility spillover tests show bidirectional spillover of the volatility from foreign exchange market to money market and unidirectional from stock market to money market and money market to foreign exchange market .

Abbas et al, (2017) examined the relationship between stock market (KSE-100), money market (M2 and 180 days T-bill rate), and foreign exchange market (ER: PKR/USD) in Pakistan. They used monthly data covering the period from 2000:M1 to 2015:M12. The study investigated long-run equilibrium relationship among three financial markets on the basis of the Johansen and Juselius cointegration tests, Granger causality in vector error correction model (VECM) framework and pair wise Granger causality tests. They found all the variables under their study are I(1), one cointegrating relation in trace test and no integration in lamda –max test. They claimed existence of the long-term significant relationship among stock market , money market and foreign exchange market and no significant relation in the two sub-periods studied. They also reported positive relation between stock and money market and negative relation between stock and treasury bills and exchange rates. It is very interesting to note that they found positive relation with one component of the money market and negative in another. In pair wise causality , they found unidirectional causality flows from treasury bills to stock and money supply, foreign exchange to money supply and

treasury bills and no causal relation between stock and both the money supply and foreign exchange. In VECM set up, causality flows from treasury bills, money supply and foreign exchange to stock market. According to the CUSUM test , they found no structural break in their system studied. The major problems with their paper are, (i) how they selected the optimum lag- order is not clear, (ii) significance of the variables in the cointegrating space is not reported, (iii) non-reporting or estimating the impulse response analysis to attest the results of granger causality test quantitatively, and (iv) absence of variance decomposition analysis to assess the future flexibility and integration among the markets.

Integration of domestic financial markets is not a well examined issue in the literature of financial integration. In this context, one can get a fair idea about the relationship amongst the markets from the empirical analyses of some scholars who have studied the relationship among the variables representing domestic financial markets in a different perspective, considering several other macroeconomic or financial variables along with the market variables. Bhattacharya and Mukherjee (2003) investigated the nature of the causal relationship between stock prices and macroeconomic aggregates of the foreign sector in India. Using monthly data for the period 1990-91 to 2000-01, they suggested that demand for money affects interest rate. Chakraborty (2012) examined whether there is any evidence of fiscal deficit determining interest rate in India, by using the high frequency macro data of financially deregulated regime from the period of 2006-07 to 2011. Quite contrary to the debates in the policy circles, using the asymmetric vector autoregressive model, they found that increase in fiscal deficit does not cause the rise in interest rates. The long-term and short-term interest rates were studied to determine the occurrence of financial crowding out, but fiscal deficit did not appear to be causing both short and long term rates. Jain and Bhanumurthy *(*2005) examined the issue of integration of financial markets in India in the post-1991 period by using monthly data of call money rates, 91 day Treasury Bill rates,

Indian Rupee/US dollar exchange rates, and the London Inter Bank Offered Rate (LIBOR).The study found a strong integration of the domestic call money market with the LIBOR and a long-term co-movement, although not robust, between domestic foreign exchange market and LIBOR. They suggested that, more policy measures are necessary to increase integration of financial markets which would help in reducing the arbitrage advantage in some specific segment of the Indian financial markets. Rowe et al,(1986),studied the term structure of the interest rates based on the expectation theory and found positive and statistically significant relation amongst T-Bills yields, CD, CP and Call rates(represented by LIBOR).

Machado et al, (2017), examined the relationship between index of Brazilian Stock Exchange i.e, Ibovespa and interest rates , exchange rate, long term economic activity, money supply and imports. They used monthly data from the period January , 1999 to June , 2017 and used Markov- Switching model. They found that the interest rate and exchange rate are positively related with the stock market index and there was no significant relation between Ibovespa and inflation.

Bernardelli and Castro,(2020) examined the relationship between Brazilian stock market and Selic ,that is , short run interest , exports, GDP, exchange as a percentage of GDP, index of Dow Jones for the period of January,2003 to March, 2019. They have used monthly data and according to the ADF and PP test ,they found Brazilian stock index Ibovespa ,GDP and exchange rate are I(0) and , Dow Jones index are I(1). They used OLS method and found negative relation between stock market and exchange rates and short run interests and positive relation with the GDP.

There are other studies also which have been done in these areas however, for the sake of brevity, other research works which have been done in this area is given in a synoptic manner

depicting the relationship amongst the variables representing domestic financial markets below:

Table – 2.1

Synoptic View Depicting the Relationship Amongst the Variables Representing Domestic Financial Markets

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
1. Stievers and Sun (2002)	Stock and bond market of United States	1988- 2000	Correlation, GARCH and regime shifting model	Stock and bond returns tend to move substantially together during periods of lower stock market uncertainty and exhibit little relation or even a negative relation during periods of high stock market uncertainty
2. Muhammad and Rasheed (2002)	Stock and Exchange market of India, Pakistan, SriLanka and Bangladesh	1994 - 2000	Cointegration and error correction model	Stock prices and exchange rates are unrelated (at least in the short run)
3. Kasman (2003)	Stock prices and Exchange rate of Turkey	1990 - 2002	Johansen's cointegration and Granger non- causality	Long run stable relationship exists between stock indices

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
			test	and exchange rate but causality flowed only from exchange rate to industry sector index.
4. Nath and Samanta(2003)	Stock prices and Exchange rate of India	1993 - 2002	Granger Causality and Multivariate Cointegration test	Returns in foreign exchange and stock market are not inter-related
5. Phylaktis and Ravazzolo (2005)	Stock prices and exchange rates of HongKong, Malaysia, Singapore, Thailand and Philippines.	1980 - 1998	Cointegration methodology and multivariate Granger Causality test	Close association between stock and foreign exchange markets.
6.Wong et al., (2005)	Stock indices of Singapore and the United States	1982 - 2002	Cointegration tests, and fractional testing methodology and Granger causality.	Changes in Singapore's stock prices in general formed a long run equilibrium relationship with interest rate and M1 but the same was not applicable in the case of the United States.

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
7. Acikalin et al., (2008)	Stock exchange market returns, production levels, interest rates, foreign exchange rates and current account deficits of Turkey	1991 - 2006	Cointegration tests, a vector error correction model and causality tests	Stock price index is cointegrated with production, exchange rate, interest rate and current account balance — which provides a direct long-run equilibrium relationship.
8. Ray (2008)	Exchange rates, stock market index, foreign institutional investments, index of industrial production and money supply (M3).	1995 - 2007	Co- integration test and Granger causality test.	In the long-run, the exchange rates were found to be positively related to stock prices and money supply; negatively related with output and foreign institutional investments.
9. Banerje and Adhikary (2009)	Exchange rate between Bangladesh Taka and U.S. Dollar	1983 - 2006	Unit root test and co-integrating test	A long-run equilibrium relationship existed among the variables

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				and flowing from interest rate and exchange rate changes to stock market returns in Bangladesh.
10.Aliyu (2009)	Stock prices and exchange rate in Nigeria	2001- 2008	Co –integration and Granger Causality test	Existence of long run equilibrium relationship between the stock prices and exchange rate.
11. Rahman and Uddin (2009)	Nominal exchange rates of US dollar, euro, Japanese yen, pound sterling and monthly values of Dhaka Stock Exchange.	2003- 2008	Co –integration and Granger Causality test	No cointegrating relationship between stock prices and exchange rates. However stock prices Granger cause exchange rates of US dollar and Japanese yen but there is no two way causal relationship between stock prices and

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				exchange rates of euro and pound sterling.
12.Ooi.et al., (2009)	Exchange rate and stock prices of Thailand and Malaysia	1993- 2003	Unit root test, co- integration test, Causality test and Variance decomposition test.	Granger causality is unidirectional. Causal relationship from stock prices to exchange either within country or across countries for the case of Thailand and Malaysia
13. Khrawish et al.,(2010)	Interest rate and stock market capitalization rate in Amman	1999 - 2008	Time series analysis and regression analysis.	Significant and positive relationship was found between government prevailing interest rate (R) and stock market capitalization rate (S). Moreover it was seen that government development stock rate (D)

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				exerted negative influence on (S);significant and negative relationship between(R) and (D)
14.Alagidede et.al.,(2011).	Stock markets and foreign exchange markets in Australia, Canada, Japan, Switzerland, and UK	1992 - 2005	Unit root and co – integration test , Granger causality test and Non-parametric causality test.	No long run relationship between foreign exchange markets and stock markets; Causal linkage from exchange rate to stock prices in Canada, Switzerland, and UK.
15. Kutty (2010)	Stock price and Exchange rate in Mexico	1989 - 2006	Unit root test, co – integration test and granger causality test.	Short run relationship found between stock prices and exchange rates. Granger causality tests revealed that stock prices lead exchange rates in the short run, and

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				there was no long run relationship between these two financial variables
16. Islami (2011)	Foreign exchange market and stock exchange market of Ireland, Portugal, Spain, Greece, Poland, Czech Republic, Slovenia, and Hungary	1998 - 2000	Unit root test, co – integration test and granger causality test.	Significant links exist between the stock market index and foreign exchange rate for five countries, where for Poland both long term and short-term links exist.
17. Gurgul and Lach (2012)	Exchange rate and stock market rate of Switzerland and Poland	2001 - 2008	Linear and Non –Linear Granger Causality test.	Strong linear causal relationship in the direction from stock market to exchange rate for Switzerland as well as existence of strong causal influence of stock market

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				returns on fluctuations of exchange rate in both countries
18. Gulati and Kakhani (2012)	Indian stock indices and INR-USD exchange rate	2004- 2012	Granger Causality test and Correlation Method	No relationship between SENSEX and foreign exchange rate (INR/$) as well as no relationship between Nifty 50 and foreign exchange rate (INR/$).
19. Malarvizhi and Jaya (2012)	Exchange rate and the value of S&P CNX NIFTY Index.	2001 - 2011	Unit root test, co – integration test and granger causality test.	No cointegration vector between nifty and exchange rate. bidirectional causal relationship between exchange rate and nifty.
20. Pallegedara (2012)	Share price index of Colombo Stock Exchange and the Sri Lanka interbank offer rate.	2004 - 2011	Unit root test, Johansen cointegration method, vector error correction	Unit root tests result concluded that both stock market performance

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
			model, granger causality test and the impulse response analysis.	and interest rate variables were non stationary and order of integration of I(1). The results of the Johansen cointegration test indicated a long run cointegration movement between stock market performance and short term interest rate. However the estimation of VECM model, revealed negative long run relationship between stock market returns and short term interest rate . However, results of the Granger causality test indicated no

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				short run causal relationship between stock market returns and interest rate. IRF analysis revealed permanent negative impact on stock market performance as a result of a shock to the short term interest rate.
21. Addo and Sunzuoye (2013)	Treasury bill rate, interest rate and stock market return of Ghana stock exchange.	1995 - 2011	Time series , coinintegration test, multiple regression model	Weak negative relationship between interest rate and stock market returns and a weak negative relationship between Treasury bill rate and stock market returns as well.
22. Ali et. al,(2013)	Stock prices and exchange rate of Brazil, Russia, India	2003 - 2010	Stationarity test and Tada Yamamoto	In pre-crisis period, Russia and India

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
	and China		Causality test.	showed uni-directional relation moving from stock market to exchange market, whereas, Brazil showed bidirectional and no relation was found in China. During crisis period, Brazil and India showed unidirectional relation running from stock prices to exchange rates. However, Russia evidenced the bidirectional relation and china showed no relationship. In post crisis period, no changes in the results of China

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				and Brazil and Russia revealed stability in the relationship during crisis and post-crisis.
23. Tavakoli and Dadashi (2013)	Stock and exchange markets in Iran and South Korea.	2002 - 2012	(MGARCH) BEKK method	Bidirectional relationship between two markets in South Korean economy and only a unidirectional relationship from exchange market to stock market in Iranian economy.
24. Lee and Zhao (2014)	Stock market prices and exchange rates in China	2002 - 2012	Unit root test, Co-integration test, vector error correction estimates,block exogeneity Wald test, impulse responses, variance decomposition technique and	Existense of long-run causality from exchange rates to stock prices in Chinese stock markets. The short-run causality from Japanese yen and Korean won exchange

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
			structural break test	rates to Chinese stock prices exists.
25.Aamd and Dg (2014)	Exchange rate and stock market returns in Sri Lanka.	2003 - 2012	Unit root test, Granger Causality test and regression analysis	One-way causality which is stock return does Granger Cause exchange rate but exchange rate does not Granger Cause stock returns. However regression analysis showed no relationship between exchange rate and stock returns.
26. Odoyo et al.(2014)	Stock prices and exchange rates in Kenya	2012 - 2013	Regression analysis	Strong, positive correlation between Foreign Exchange Rates represented by the Kenyan shilling to the US Dollar and the Stock price index as

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				provided by the Nairobi securities exchange 20-share Index.
27. Paul and Uriam (2014)	Stock and foreign exchange market of Fiji	2010 - 2012	Unit root test, co – integration test and granger causality test.	There is cointegration and therefore long term trend relations found between FJ dollar / US dollar, and the market capitalization index of Fiji.
28. Aikaterini (2014)	Stock prices and exchange rates in US and Asian markets.	2004 - 2014	Cointegration test and granger causality test.	Unidirectional causal relationship from Nikkei to dollar-japanese yen in the short run whereas positive relationship between stock price and exchange rates in the long run. However consumer price index in Japan

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				seems to have a significant negative effect in stock price and as a result a change in the one variable will cause a negative change on the other.
29. Ray and Sarkar(2014)	Index of Industrial Production (IIP), Whole Sale Price Index(WPI), Money Supply (M3), Yields on 91-day Treasury Bills (YTB), Yields on Long-term (10-year) Government Bonds (YLGB), Competitiveness of Domestic Currency measured by the price of one US $ expressed in terms of Rupee (EX) and the BSE SENSEX 30(Index) to represent Stock market prices	1991 – 2008	Unit root test, co – integration test and granger causality test.	Indian Stock Market leads the economic activities and the core determinants of the asset market are the markets itself, IIP,money supply and exchange market.

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
30. Abbas et al, (2017)	Stock(KSE-100), 180-day treasury bills,money supply and foreign exchange rate (PKR/USD)	2000-2015	Unit root test, co – integration test and granger causality test,	They found the variables under their study are I(1), one cointegration relation in trace test and no integration in lamda-max test. They found long term significant relationship among stock,money and forex market, no significant relation in the two sub-periodsstudied, reported positive relation between stock and treasury bills and exchange rates, unidirectional causality flows from treasury bills to stock and money

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				supply and treasury bills and no casual relation between stock and both the money supply and stock exchange. In the VECM set up , causality flows from treasury bills , money supply and foreign exchange to stock market. There was no structural break.
31.Machado et al,(2017)	Ibovespa and interest , exchange rate, long term economic activity, money supply and imports	January,1999 to Jun,2017	CUSUM-test Markov-Switching Model	The interest rate and exchange rate are positively related with the stock market and no significant relation between Ibovespa and inflation

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
32.Yu and Liao (2017)	Stock, Money and Foreign Exchange market of Chaina	Daily data from June, 2000 to December, 2016	VAR (7)-GARCH (1,1)-BEKK model	The results of the mean spill over test shows yields of foreign exchange market influences the stock price but stock price has no influence on foreign exchange market, and asymmetrical bidirectional mean spill over between stock and money and foreign exchange market. The results of the volatility spill over test show bidirectional spill over of the volatility from foreign exchange market to money market

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				and money market to foreign exchange market.
33.Gopinathan and Durai(2019)	BSE SENSEX, IIP,WPI,Broad Money, Indian Rupee-Dollar exchange Rate	04-1994 to07-2018	Engle-Granger,Phillips-Ouliaris(1990) and Johansn – Juselius(1990,1994) test cointegration and non-linear conitegration with ACE(Alternating Conditional Expectation) transformed data	Strong non-linear cointegration found between stock market and macro variablesincludin the broad money.
34. Bernardelli and Castro, (2020)	Between Brazilian stock market and Selic ,that is , short run interest , exports, GDP, exchange as a percentage of GDP, index of Dow Jones.	January,2003 to March, 2019	Regression	They found Brazilian stock index, Ibovespa, GDP and exchange rate are I(0) but Dow Jones index are I(1) by ADF and PP test.They found negative

Authors/Study	Variables/Markets	Data Period	Methodology	Findings
				relation between stock market and exchange rates and short run interest, and, positive relation with GDP.
35. Shahoo and Satpathy(2020)	Iflation rate, interest rates, GDP, per capita GDP, SENSEX, Dow Jones indicices of India and USA.	2015to2019, annual data	Correlation,regression, t-test and ANOVA test	All the maco variables in India and USA are significantly related
36.Gharana, Rahman and Islam (2021)	Interest rates(bond) Stock market, Money supply,Forex market (Yen/US Dollaro)f Japan	September 1974 to February, 2017,monthly data	Toda-Yamamoto(1995) and Dolado-Lutkepohl(1996), multivariate Granger causality tests	They found bidirectional causality between IIP and stock market, Unidirectional between interest to stock market and stock market to money supply but no causality between stock and foreign exchange markets.

2.2. Research Gaps:

In essence, the literature illuminates that the issue of domestic integration is a debatable issue which must be settled on the basis of robust and objective investigation. The studies on Indian markets used, mostly, the monthly data to assess the activities and status of the very liquid market segments. Scholars argue that, instead of a strong long- term and stable view, the estimations based on the monthly data provide a short-run insight (Dimitrova, 2005) .The use of a variety of methodologies, incomplete searching ,absence of report on the presence of the variables in the co-integration space, lack of attestation of the Granger causality results by Innovation Accounting, following the rule of majority without reporting the unit root or stationarity test results, etc., and the fractured findings suggest that there is enough scope for further research to unveil the intricate relationship amongst the Indian call money, exchange and stock market. Findings of further studies might be helpful for policy planners in the overall monitoring and management of the liquidity in the economy.

2.3. Objectives of the Study:

In the new era, Indian financial markets appeared as the major player of the Indian financial system. In the free-regime, after initiating a good number of policy measures by the Indian authorities to integrate the segments of financial markets, especially the capital, money and foreign exchange market, the objectives of the study is simply to assess how far the segments are integrated. Very specifically, the objectives are:

i) To assess the relationship amongst the capital, money and foreign exchange market ,

ii) To assess the influence, if any , of the past values of the sample domestic markets on the future values of other markets under the study, and

iii) To assess the future flexibility of the sample Indian domestic markets under the study.

2.4. Research Questions:

According to the objectives of the research the present study attempts to find the answer to the following questions:

i) Is there any short-term or long-term stable relationship amongst the Indian capital, money and foreign exchange market ?

ii) Do the past values of the Indian domestic markets, under the study, influence the future values of other markets?

iii) Are the sample Indian domestic markets rigid, that is, can they explain or explained by other markets of this study?

2.5. Hypotheses:

Hypotheses of this study are:

(A). H_0 : Indian domestic markets namely, stock, money and foreign exchange markets, are not integrated.

(B) H_0 : Past values of none of the Indian domestic markets under the study influence the future values of other markets.

(C) H_0 : All the sample domestic markets would remain rigid over the future period of time.

2.6. Methodology:

For the empirical methodology, this study would follow the statistical and econometric tools that are robust and widely used in the literature.

2.7. Data and Time Period:

Primary focus of the present study is to evaluate the nature of relation, if any, of the Indian major financial markets, like, Stock, Foreign and Money market. For this empirical investigation about the link amongst the markets, this study used secondary data collected from the official publications and websites of the Reserve Bank of India, Bombay Stock Exchange, etc. Precisely, the data used in the study are S&P BSE SENSEX 30 Indices (to represent capital market), Call money rates(CR) (to represent money market) and Rupee-Dollar nominal spot exchange rates (FX) (to represent foreign exchange market). In reviewing the literature, it is found that most of the earlier studies used the monthly data but the estimations based on the monthly data provide nothing but a short-run insight (Dimitrova, 2005). Hence, in this study used the high frequency data like the daily one at level. Although normal econometric practice is to take the first difference of the level data of the series but the problem in first differencing is that the technique imposes too many unit roots which virtually filters out the important information regarding long term relationship (see Eun and Shim 1989). Moreover, all the markets under our study are very sensitive and on a slightest hunch of instability in one market may lead to transfer of the funds to other markets including the overseas markets creating an overall problem in liquidity management in and across the markets in the economy.

Earlier researchers on market integration showed their positive preference for the period ranging from 5-10 years (Bhoi and Dhal,1998, Jena et al.,2004 Sanati ,2010, Bhattacharya and Mukherjee ,2003, Tavakoli and Dadashi ,2013, Lee and Zhao ,2014, Aamd and Dg ,2014, Odoyo. et al.,2014,). The reason behind is that any result based on longer horizon has little relevance in this type of finance research because of the degree of co-integration of financial markets changes over time (Karolyi and Scultz 1996,). Hence, this study also

investigated the link considering a time period of approximately 11 recent years ranging from 1st January, 2008 to 31st December, 2018 and used the daily data at log level.

2.8. Significance of the Research:

This empirical study is expected to be significant in providing an objective understanding of the inter-linkage amongst the Indian capital, money and foreign exchange market. Furthermore, it can be valuable in the hands of the policy planners and the Government in overall monitoring and management of the liquidity in the economy.

2.9. Plan of the Study:

The entire study is presented within five chapters below:

Chapter - 1: Introduction

Chapter – 2: Review of literature, Scope and Plan of study

Chapter–3: Methodology Used: A Brief Discussion

Chapter – 4: Cointegration of the Capital Market, Foreign Exchange Market and Money Market.

Chapter – 5: Summary of Findings, Limitations and Scope of Further Studies

2.10. Summary and Conclusion:

Till date, the literature on domestic financial integration is in its infancy. The studies so far surveyed illuminates that the issue of domestic integration is a debatable issue and the fractured findings suggest that there is enough scope for further research to unveil the intricate relationship amongst the Indian call money, exchange and stock market. The issue deserves serious attention of the researchers and must be settled on the basis of robust and objective investigation. The objectives of the study are : i) to assess the relationship amongst

the capital, money and foreign exchange market, ii) to assess the influence, if any , of the past values of the sample domestic markets on the future values of other markets under the study, and iii) to assess the future flexibility of the sample Indian domestic markets under the study. On the basis of the objectives, this study framed three hypotheses to attain the objectives. The hypotheses are:(i) Indian domestic markets namely, stock, money and foreign exchange markets, are not integrated, (ii) Past values of none of the Indian domestic markets under the study influence the future values of other markets, and (iii) All the sample domestic markets would remain rigid over the future period of time. Considering a time period of approximately 11 years ranging from 1st January, 2008 to 31st December, 2018, the daily data are collected for this study. The 1st chapter of this thesis introduces domestic integration, major steps taken by the government to converge stock, money and foreign exchange market and a brief theoretical relation amongst the markets under the study. Chapter 2, that is this chapter, outlines the objective, research questions and hypotheses along with the survey of literature. Empirical methodologies which are widely used and popular in the literature and used in this study are described in Chapter 3. Domestic integration and other hypotheses of the study are assessed by econometric tools in Chapter 4. The last chapter, i.e., Chapter 5 concludes the study with summary of findings, limitations and scope of further studies.

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CHAPTER-3

METHODOLOGY USED: A BRIEF DISCUSSION

CHAPTER-3

3.1. Introduction:

This research followed that methodology of measurement of integration which is popular, simple and widely used in the finance literature. In empirical analysis, the degree of integration is largely addressed and measured by co-integration, that is, co variation or co movement of the variables (Maddala and Kim 2004, Chen 2012, Ray and Sarkar 2014). The literature of integration of domestic markets is in infancy. Hence, for the methodology to measure integration, the study consulted heavily the literature on financial integration, more specifically, international integration of the asset markets. Till date, in the empirical literature on financial integration, the most popular and widely used methodology to measure the degree of integration is co-integration. In the past, considerable gap existed between the economic theorists who had much to say about equilibrium but relatively less to say about dynamic relation and econometrician whose models more concentrated on the short run dynamics disregarding the long run equilibrium has been bridged by the concept of cointegration. In addition to allowing the data to determine the short run dynamics, cointegration suggests that models can be significantly improved by including long run equilibrium conditions guided by finance or economic theory. Subsequently, the generic existence of the long run relationship should be tested using the appropriate techniques to eliminate the risk of spurious inferences. The literature on cointegration has improved a lot by the inclusion of methods of dynamic econometric modelling of economic and financial time series and nowadays cointegration is considered as a very important and valuable methodology in empirical studies in finance and economics (Dolado et. al, 2003).

It is observed that, almost always non stationary and trending variables are involved in the empirical studies under finance and macroeconomics (Nelson and Plosser 1982, Phylaktis

and Ravazzolos 2002, Greene,2003). To avoid spurious and non-standard conclusions, scholars suggest that the best way to handle such series is to use differencing and other transformation like seasonal adjustments etc, and reduce the variables to stationary processes and then analyse the resulting series as VARs (suggested 1st by Sims, 1980) or the methodology recommended by Box- Jenkins (1970)(see Maddala and Kim, 2004).

3.2. Demerits of VAR and Box-Jenkins (1970) Methodology:

VAR methodology is very popular for some of its merits but a good number of scholars heavily criticized and pointed to several pre-conditions (which cannot be fulfilled in the real world condition) and disadvantages of VAR methodology like , (i) a very high number of parameters to be estimated , e.g., if any researcher considers k- variables and q- lags for each variable then $k+qk^2$ parameters, which might be a huge number, is to be estimated by the researcher (Schlegel 1985, Brooks 2014), (ii) a good command over the economic or financial theory and proper institutional knowledge is required to solve the identification problem which cannot be solved by VAR (Stock and Watson, 2001), (iii) the results are mostly sensitive to the choice of the optimum lag order and the ordering of the variables in estimation (Mida, 2013), (iv) the problems of multicolinearity often arise due to the fact that a lot of economic time series are correlated with their own past values, hence, increasing the number of variables and lags which might cause multicollinearity and in practice, the unrestricted VAR model gives very erratic estimates because of the multicolinarity of the explanatory variables (Maddala and Kim 2004, Schegel 1985,) (v)VARs are a-theoretical (Brooks,2014),(vi) only stationary variables are estimated in VAR, and (vii) a measurement errors or misspecification of the model will induce unexplained information left in the disturbance term turning interpretation more difficult (Hendry 1995).

Again, Box–Jenkins (1970) methodology is one of the most popular methodologies for analysis of time- series data. It is widely used by the scholars as they can estimate any type of series, stationary or non- stationary, with or without seasonality. Furthermore, it is very popular as it has well documented computer programmes (Maddala and Kim 2004). Despite its popularity, it has some limitations also. Differencing and transformations of the data at level force to the analyst to lose some important signals or information in forecasting. Autocorrelation of residuals can produce common factors, especially, in over fitted models, which makes estimation difficult and the statistical tests ill behaved (Pelgrin, 2011). Scholars also point to several other limitations of the methodology for using in financial economics like, i) it requires a long- series, ii) is useful for short – run but not long-run analysis, iii) usually financial time series data contains asymmetries, sudden breaks at irregular intervals and periods of high and low volatility which cannot be captured adequately by the ARMA process as that violates the assumption of constant variance of the ARMA methodology (Petrica et al 2016) , and (v) in general, financial time series reveals more complex structures than those by ARMA process, hence, against more complex approaches, it, at the best, can be considered as a starting point (Rachev et al 2007, Bellgard and Goldsmith 1999, Kon 1984, Maddala and Kim 2004).

The recent research and growing literature in macro econometrics has shown that there are more interesting and appropriate ways, to analyse financial time series and trending variables (Green, 2003). Cointegration and its related technique – error correction is now widely researched and used as they are concerned with methods of estimation that preserve the information about both form of covariation (see Green 2003, Engels and Granger,1987, Hamilton 1994, Watson 1994).

3.3.1. Cointegration:

Cointegration is a concept whereby time series have a fixed relationship in the long-run (Brooks,2014).It was introduced by Granger(1981). In simple language, let us consider two variables y_t and x_t which are integrated at order one or I(1). Then, y_t and x_t are said to be cointegrated if there exists a β such that $y_t - \beta_1 x_t$ is stationary or I (0). That is, estimation of the regression equation $y_t = \beta x_t + u_t$ or $u_t = y_t - \beta x_t$, where u_t is the error term, will not produce spurious results. Because, an important property of non- stationary variables, integrated of order one is that, there can be linear combination of these variables which are stationary or (I(0)). And, y_t and x_t do not drift too far apart from each other in the long-run or can drift together at roughly the same rate and might be stable around a fixed mean over time (Greene , 2003). This implies that those time serieses are moving stochastically together towards some long-run relationship, and the vector [1 - β] or any multiple of it is a cointegrating vector , that is, the set of parameters that describe the relationship between two or more time series [Engle and Granger 1987, Greene,2003, Brooks, 2014]. Scholars suggest, in such a case, one can clearly distinguish between a long – run equilibrium relationship among the variables y_t and x_t, that is, the manner in which the two variables drift upward together and the short run dynamics depicting the relationship between deviations of y_t from its long – run trend and deviation of x_t from its long – run trend. In this situation, obviously differencing the data is not required to avoid spurious inferences; rather, it would be counterproductive as it would obscure the long-run relationship between the time series (Greene, 2003).

3.3.2. CRDW Test:

There are several methodologies to test co- integration. The most simple and quick test of cointegration is the Cointegrating Regression Durbin-Watson test (CRDW- Test, Gujarati,

2004). Under this method, in a bi-variate setting, one has to estimate the assumed cointegrating equation like:

$$y_t = \beta_1 + \beta_2 x_t + u_t. \quad \text{Eq (1)}$$

and estimate the Durbin-Watson test statistics (1950,1951) for the first order auto-correlation. Under the null hypothesis that y_t is a random walk and $\beta_2 = 0$, so there is no co-integration and $\hat{u}_t$ becomes a random walk with theoretical first order autocorrealtion equal to unity. If the computed value of '*d*' is more than the critical value, then the equation (1) is identified as cointegrating equation. The critical value of '*d*' is provided by Sargan and Bhargava (1983). Although, the method is very simple, but it suffers from two major problems – (i) it is very sensitive to the assumption of dependant variable be a true random walk and (ii) the critical values of the test statistic are not consistent if the number of regressors increases over the sample size (Sjo,2019,). The use of the test in empirical studies is, therefore, extremely limited (Sjo,2019).

3.3.3 Engle-Granger Test:

In the literature of finance and economics, till date, two methods gained popularity and are widely used in the empirical studies (Chen,2012) and one of them is suggested by Engle and Granger (1987). It is a two-step procedure to test cointegration. In the first step, they suggested to estimate the so called cointegrating regression, basically in bi- variate nature but can be extended to multivariate one:

$$y_t = \beta_1 + \beta_2 x_t + u_t \quad \text{Eq(2)}$$

where, y_t and x_t are the variables and in the regression, the assumption is that, all variables are integrated at order one, i.e. I(1) at level and might cointegrate to form a stationary relationship so that the residual term $\hat{u}_t = y_t - \beta_1 - \beta_2 x_t$ is stationary or I (0).

In the second step, Engle and Granger (1987) suggested to test for a unit root in the residual process of the equation (2) above. DF (Dicky and Fuller, 1979) or ADF (Said and Dicky,1984) tests can be used to ascertain the stationarity. As the estimated u_t are based on the estimated cointegrating parameter, β_2 , the DF (Dicky and Fuller, 1979) and ADF (Said and Dicky,1984) critical significance values are not appropriate because the unit root test is now applied to a derived variable-- the estimated residual from a regression (Sjo, 2019). The new set of critical values is provided by Engle and Granger (1987).If the null hypothesis of unit root is rejected, then the residuals are identified as the stationary one and the regression equation as the cointegrating equation. More specifically, the variable y_t is then said to be cointegrated with $x_{t.}$ Hence, it is posited that, the equation (2) represents the assumed economically meaningful or understandable steady state or equilibrium relationship among the variables. Moreover, according to the properties of super converge, the estimated parameters are representing correct estimates of the long-run steady state parameters and the residuals at lag one can be used as an error correction term in the error correction model(Sjo, 2019).

Despite the simplicity, easy to perform and popularity of the procedure, the Engle – Granger (1987) two step cointegration methodology suffers from many limitations like, (i) the estimated standard errors of this 'procedure' are, in general, useless when the variables are cointegtrated, hence, using standard distribution no inference is possible, (ii) asymptotically, the test procedure is independent of the arrangement of the variables in the regression equation but choosing a variable in the left hand side of the regression equation, the cointegrating vector is normalised around that variable which means that normalization corresponds to some long-run economic relationship. Scholars disagree to this proposition as this is not true in limited samples; normalisation matters and makes an economic sense and plays a vital role in economic interpretation (Ng and Perron 1995) , (iii) as the test involves

an ADF test (Said and Dicky,1984) in the second step, all the limitations of ADF test is valid in this cointegration test also, especially, the selection of lag order for the augmentation is a very critical factor, (iv) the test is based on the assumption of one cointegrating vector and, as such, very useful in the model with two variables. Even so, if two variables cointegrate then adding a third integrated variable will not change the results of the test, because, if the third variable do not belong to the cointegrating vector, ordinary least square (OLS) estimation will simply put its parameters to zero leaving error process unchanged (Sjo, 2019) and (v) the test assumes a common factor in the dynamics of the system but the common factor restriction is a severe restriction since all the short – run dynamics is forced to the residual process(Sjo, 2019). Counting the limitations, Maddala and Kim (2004) strongly opposes to use the test procedure in empirical analysis.

This study, in assessing the integration of domestic markets, involves more than two variables; hence, there is a possibility of having more than one cointegrating vector. In simple language, the variables in the model might form several equilibrium relationships governing the joint evolution of all the variables as, in general, for n number of variables one can have up to (n-1) cointegrating vectors. So, a test procedure is required which captures more than one cointegrating relationship in the model. The widely used, popular and superior test for cointegration is the test suggested by Johansen and Juselius (1990) and Johansen (1991, 1995).

3.3.4. Johansen and Juselius Methodology:

Johansen and Juselius (1990), Johansen (1991,1995) procedure is essentially a process to estimate cointegrating vector based on the maximum likelihood ratio (LR) statistics λ_{max} and λ_{trace}(Johansen 1991, 1995). The method is based on the VAR model estimation

(Kozhan,2010). Accordingly, one has to start with a simple VAR representation (See Maddala and Kim, 2004) :

$$A_k(L)y_t = \mu_0 + \varepsilon_t \text{. ..... Eq.(3)}$$

and, following Engle and Ganger (1987),under some regulatory conditions and using difference operator Δ (i.e. Δ = 1-L or L = 1-Δ), he can write the cointegrating process, y_t , in VECM ,below:

$$\Delta y_t = \mu_0 + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \Pi y_{t-1} + \varphi D_t + \varepsilon_t \text{ . ..... Eq.(4)}$$

where, μ_0 is unrestricted constant component, D_t may include deterministic regressors like, trend and (seasonal) dummy variables, k equals to number of lags, y_t is a p×1 vector and p is the number of variables. The variables are integrated of order 'd' i.e. $\{y_t\} \sim I(d)$, Γ and Π are the coefficient-matrices representing short and long term impacts, respectively and ε_t is residual vector assumed to be independent and identically distributed as multi-normal distribution with mean zero and variance Ω. Johansen (1991, 1995) decomposed Π in two matrices α and β, where, α represents the effect of each cointegrating vector on the $\Delta y_{p,t}$ variables, that is, the loading vector and β,the cointegrating vector. Both α and β are p×r matrices where, $r < p$ such that $\Pi = \alpha\beta'$.

It is worthy to note here that, the numbers of conintegrating vectors are equal to the number of stationary relationship in the Π matrix. Again, the rank of Π matrix determines the number of independent rows in Π matrix which further identifies the number of cointegrating vectors. The rank 'r' of the Π matrix is identified by the number of significant eigenvalues found in the estimated Π of the equation (4). Each significant eigenvalue depicts a stationary relation and reduced rank in Π matrix, i.e., 0<r< p indicates that there exists

cointegrating relation amongst the variables under the study. Here, rank equal to zero indicates that all the variables are non-stationary and rank equals to ‘p’ indicates that all the variables are stationary (Sjo, 2019). Hence, for the presence of cointrgration, the rank ‘r’ must lie between zero and number of variables p.

Johansen and Jusellius (1990) suggested two methods or two test statistics to identify the cointegrating equation. The first one is the maximum eigenvalue statistics $(\lambda_{\max})$ which consists of ordering the largest eigenvalue is descending order and testify whether they are significantly different from zero (Abbas, et.al., 2017). The ‘ $\lambda_{\max}$test’ tests the null hypothesis of ‘r’ cointegrating vector against the hypothesis that there are r+1cointegrating vectors (Maddala and Kim, 2004). The likelihood ratio (LR) test stastistic is:

$$\lambda_{\max} = -T\ln(1-\hat{\lambda}_{r+1}) \quad \text{Eq.(5)}$$

The second one, named ‘trace test’, tests the hypothesis that there at most ‘r’ conintegrating vector and the LR test statistic is:

$$\lambda_{trace} = -T\sum_{i=r+1}^{p}\ln\left(1-\hat{\lambda}_i\right) \quad \text{Eq. (6)}$$

It has been found that the trace test performs better that the $\lambda_{\max}$test as (i) the λ_{trace}statistic takes into account all (p-r) of the smallest eigenvalues, (ii) it can be adjusted for degrees of freedom, and (iii) it tends to have more power than $\lambda_{\max}$statistic. Hence, in empirical analysis and if there be any contradiction in results between $\lambda_{\max}$and λ_{trace} tests, scholars including Johansen and Jusellius (1990) advocate to use λ_{trace} statistic (see, Kasa, 1992, Serletis and King, 1997, Lutkepohl et.al., 2001, Sjo, 2019). We, throughout our thesis, used the ‘trace test’ statistic to identify cointegrating rank over and above the $\lambda_{\max}$ statistic.

The tests for determining the number of cointegrating vectors are nested. Hence, the tests are performed by starting from the hypothesis of zero cointegrating vectors. In simple words, $H_{0,1}$: 0, i.e., zero conintegrating vector is tested against the alternative $H_{a,1}$: 1 i.e., at most one cointegrating vector. If $H_{0,1}$ is rejected, then the next test is $H_{0,2}$: 1, i.e, one cointegrating vector against $H_{a,2}$: 2, i.e., at most two cointegrating vectors, and so on.

The LR test statistic for identifying cointegration varies according to the assumptions made on the deterministic trends, i.e., of constants and trends in the model. Five deterministic trend assumptions are suggested by Johansen (1995) and the models to estimate are below (see Sjo, 2019):

1. Assumption I (Model 1): Here, the assumption is- 'there is no deterministic trend in the data and no intercept or trend in the cointegrating equation.' That is, the constant is assumed to be zero $(\mu_0 = 0)$ for both the first differenced equations and cointegrating vectors. The estimated model for the p - dimensional vector of variables y_t is:

$$\Delta y_t = \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \alpha\beta' y_{t-1} + \varphi D_t + \varepsilon_t \text{ ..... Eq (7)}$$

2. Assumption II (Model 2): Here, the assumption is- 'there is no deterministic trend in the data at level and an intercept but no trend present in the cointegrating space of the variables.' That is, μ_0 is assumed to be zero but allows for constant in cointegrating vector. The model to estimate is :

$$\Delta y_t = \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \alpha[\beta', \beta_0][y_{t-1}, 1] + \varphi D_t + \varepsilon_t \text{ ..... Eq. (8)}$$

3. Assumption III (Model 3): Here, the assumption is- 'there is a linear trend in the data at level and intercept with no trend is present in the cointegrating space of the variables.' In

other words, μ_0 is left unrestricted which actually lead to the inclusion of both deterministic trend in the y_t's and constant in the cointegrating vector. The model to estimate is :

$$\Delta y_t = \mu_0 + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \alpha\beta' y_{t-1} + \varphi D_t + \varepsilon_t \quad \text{Eq. (9)}$$

4. Assumption IV (Model 4): Here, the assumption is- 'there is a linear trend in the data at level and both intercept and trend is present in the cointegrating space of the variables.' That is, it is assumed to allow for constants and deterministic trends in the cointegrating vectors. The model to estimate is :

$$\Delta y_t = \mu_0 + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \alpha[\beta', \beta_{1,} \beta_0]' [y_{t-1}, t, 1] + \varphi D_t + \varepsilon_t \quad \text{Eq. (10)}$$

5.Assumption V (Model 5): Here, it is assumed to allow for a quadratic trend in data (y_t's) and both an intercept and trend in the cointegrating equation.' That is, least restricted situation and the model to estimate is :

$$\Delta y_t = \mu_0 + \mu_{1t} + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \alpha[\beta', \beta_{1,} \beta_0]' [y_{t-1}, t, 1] y_{t-1} + \varphi D_t + \varepsilon_t \quad \text{Eq. (11)}$$

Selection of the appropriate deterministic trend from all the five alternative models ,Model 1 is the most restrictive one and carries a very little or no sense from the viewpoint of economics and finance. Because, in social issues, it is very impractical to assume that all the variables in the cointegrating space have the same mean. Similarly, in the case of Model 5, the assumption of the presence of quadratic trends in levels of the variables is also almost unrealistic in economics and finance. It may provide a good fit but will produce dubious out-of sample forecasts (Lada, 2007 and Sjo, 2019). Model 2, 3 and 4 are most relevant in empirical studies and out of the five models, Model 3 is advocated as the basic model and is widely chosen and used in empirical studies (Lada, 2007, Sjo, 2019, Sharma and

Wangbangpo, 2002). Johansen (1995) suggested to estimate all the models and to perform reduced rank test across the models to determine the most appropriate one. In this study only the Models 2, 3 and 4 are estimated . The search procedure starts from the most restricted to least restricted model and the deterministic component is then determined where the null hypothesis is not rejected for the first time. The technique of the search procedure is explained below, considering number variables is three (p=3) and models under search are only 2, 3 and 4.

Table-3.1

Testing Deterministic Trends

Null Hypothesis $H_0 : r$	**No. of common trends (unit roots)** $p-r$	**Model 2**	**Model 3**	**Model 4**
0	3	$\lambda_{trace2,0} \rightarrow$	$\lambda_{trace3,0} \rightarrow$	$\lambda_{trace4,0}$
1	2	$\lambda_{trace2,1} \rightarrow$	$\lambda_{trace3,1} \rightarrow$	$\lambda_{trace4,1}$
2	1	$\lambda_{trace2,2} \rightarrow$	$\lambda_{trace3,2} \rightarrow$	$\lambda_{trace4,2}$
3	0	$\lambda_{trace2,3} \rightarrow$	$\lambda_{trace3,3} \rightarrow$	$\lambda_{trace4,3}$

Note: 1.r = number of cointegrating vector

2.p = number of variables

3.p-r = number of common trends (unit roots)

4. $\lambda_{tracei,j}$ = estimated trace statistics where i represents Model (i=2,3 and 4) and j represents the number of the significant eigenvalues (j=1,2,...,p)

5. $\rightarrow$ = direction of the search procedure

The search procedure starts from row one of the Table 1,i.e., testing Model 2 for cointegrating rank 'r' equals to zero. If the $\lambda_{trace2,0}$ is rejected, then scholars have to test r= 0 for Model 3, and so on. Now, in the event that all three models reject the assumptions of zero cointegrating vector in favour of at least one cointegrating vector, the scholar has to move to the second row where the null hypothesis is r= 1, and so on. When for the first time the

estimated eigenvalue cannot reject the null hypothesis, then, the researchers have to end the search procedure because looking at the test statistics beyond this point might be misleading (Sjo, 2019). Let, $\lambda_{trace3,3}$ cannot reject the null, then it points to the fact that there exists three cointegrating vectors and the Model 3 is the better model for describing the system under study. Although, at the top of the issue, it is the logic of economics or finance and the objective of the researcher which finally guides the scholar to select the best model (Maddala and Kim, 2004).

Johansen and Jesulius (1990) observed that the first cointegrating vector corresponding to the highest eigenvalue in most related with the stationary part of the model and are very useful in explaining the empirical results. Moreover, the coefficients of the first cointegrating vector seem to possess the signs consistent with the a priori hypothesis of the researchers (Sharma, and Wangbangpo 2002). Accordingly, after normalising the target variable to 'one', the long-run relationship amongst the variables corresponding to the highest eigenvalue at optimum lag order with the estimated cointegrating rank is reported in our thesis.

3.4. Error Correction Model (ECM):

Error Correction Model (ECM) sometimes considered as the model to assess the speed of adjustment towards equilibrium and preserves the information about the short-run form of covariance (Green, 2003). In essence, the short-run dynamics or speed of adjustment towards equilibrium depicts the relationship between deviation of y_t from its long-run trend and x_t from its own long-run trend. They are expressed by the error correction term of the model below (Green, 2003,Johansen, 1991):

$$\Delta y_t = \alpha_0 + \alpha_1 ECT_{t-1} + \sum_{i=1}^{k} \alpha_{2i} \Delta y_{t-i} + \sum_{i=0}^{k} \alpha_{3i} \Delta x_{t-i} + \varepsilon_t \quad \text{Eq (12)}$$

where, Δ is the first difference operator, y_t and x_t are the variables, k is the number of variables, α_1 is the error correction coefficient and ε_t, as usual, are stationary random process with mean zero and constant variance. Along with the long-term relationship, this analysis also reported the 'adjustment coefficients' with short-run dynamics also.

It is observed that Johansen and Jesulius (1990) procedure only identifies the number of stationary vectors amongst the variables under the study and the cointegrating vectors are not unique save the cointegrating space (Sjo, 2019 and Neusser, 2016). Despite some suitable transformations of the cointegrating vectors on some basis, it is often very difficult to interpret the vectors on the line of economic and financial theories. Empirical researchers are interested to relate the state and direction of variables with theories, willing to know which variables are affected by the vectors and the significance of β 's in the cointegrating relation. In simple words, researchers are interested to know which variables are in the cointegrating space and which are not in the long-run equilibrium relationship/relationships. The significance of β 's in the cointegrating relation is estimated by the likelihood ratio test statistic below (Neusser, 2016, Boswijk and Doornik, 2003):

$$LR(H_0 / H_r) = T \sum_{j=1}^{r} \ln \frac{1-\tilde{\lambda}_j}{1-\hat{\lambda}_j} \quad \text{.....Eq(13)}$$

where, λ_j 's are the eigenvalues ($\tilde{\lambda}_j$ = estimate of the eigenvalues for the restricted estimator, $\hat{\lambda}_j$ = unrestricted estimates of eigenvalues), r is the cointegrating rank, n's are the number of variables, j's are cointegrating ranks such that j = 1,2,...,r, s denotes sub-space in the cointegrating vectors such that $r \leq s \leq n$. The test statistic is asymptotically distributed as a Chi-square distribution with r(n– s) degrees of freedom (Neusser, 2016). Similarly, it is possible to test the hypothesis on α 's ; and the joint hypothesis on α 's and β 's with s(n–

r) degrees of freedom (Neusser, 2016). We, in our thesis, tested the β 's with the null as 'do not belong to the cointegrating relationship' by excluding variables one by one from the long-run relationship (Wangbangpo and Sharma, 2002, Morin,2006).

The popular and widely used tests like, portmanteau (Box and Pierce, 1970, Ljung-Box, 1978) or LM tests are performed on the residuals to assess the presence of serial correlation in residuals considering 'no serial correlation' up to the lag order '*h*' in the residuals as null.

3.5. Stationary process:

In empirical analysis, application of the Johansen and Juselius (1990) and Johansen (1991,1995) methodology requires pre-testing of (i) stationarity/ non- stationarity of the series including the order of integration, and (ii) the optimum lag order of the VAR process on which it is modelled.

Determining a time series whether stationary or not is very crucial as the stationarity or otherwise of a series can strongly influence its behaviour and properties (Brooks,2014). If the mean and variance of a time series change over time, then it is impossible to generate results from regression model for a specific time period to a different or future time period. Hence , for any meaningful statistical inferences, pre-testing the stationarity of the time series is necessary (Balarezo 2010).

In the literature of time series analysis and econometrics, the concept of weakly stationary or the covariance stationary process is widely discussed and used in empirical finance and economics. The strict form of stationarity which is defined by all the four moments of distribution practically indicates that the distribution of the realised values of the time points in a time series $\{Y_t, t=0, \pm1, \ldots\}$ remains the same as time progresses. It indicates that the probability that a value of the series falls within a particular interval is same now as at any

time in the past and future also (Brooks 2014, Brockwell and Davis,2016). Simply , if all the moments, namely mean, variance, skewness and kurtosis, of a time series are time invariant, then the series is said to be a strictly stationary process(Balarezo,2010, Brockwell and Davis,2016, Commandeur and Koopman, 2007). Some scholars argue that the strict form of statioarity has very little practical application and are rarely observed in practice (Tong 1990, Greene, 2003,Balarezo,2010, Brooks,2014,Herranz, 2017). Moreover, according to Brockwell and Davis(2016), it is easy to check if a time series { Y_t ,t=0, ±1,….} is strictly stationary and $EY^2 < \infty$ for all t, then{ Y_t ,t=0, ±1,….} is also weakly stationary. Again, if a distribution is normal, then weakly stationary also implies strictly stationary because a normal distribution is fully explained by its first two moments (Balarezo,2010). Thus this study used the concept of weakly stationary or covariance stationary process to mean 'stationarity'.

A stochastic process { Y_t } is said to be weakly stationary if its mean and variance are constant over time and the value of the covariance between two time periods depends only on the distance or gap or lag between two time periods and not the actual time at which the covariance is computed (Gujarati, 2003, Greene, 2003). That is,

$$\text{Mean} : E(Y_t) = \mu \quad \text{Eq(14)}$$

$$\text{Variance} : var(Y_t) = E(Y_t - \mu)^2 = \sigma^2 < \alpha \quad \text{Eq(15)}$$

$$\text{Covariance} : cov(Y_{t1}, Y_{t2}) = E[(Y_{t1}-\mu)(Y_{t2}-\mu)] = \gamma_{t1-t2}, \forall t_1, t_2 \quad \text{Eq(16)}$$

Weakly or covariance stationary will tend to return to its mean and fluctuations around this mean, measured by its variance, will have a broadly constant amplitude (Cuthbertson, Hall and Taylor,1995, Gujarati2003, Brooks,2014, Balarezo,2010). In other words, for a autoregressive process of order one (AR(1)) like:

$$Y_{t=} \alpha+\rho Y_{t-1} +u_t \text{.....} Eq(17)$$

is said to be stationary only if the following three conditions are satisfied,

Condition 1: Constant and finite mean: This can be expressed as:

$$E(Y_t) = \frac{\alpha}{(1-\rho)} \text{ .....} Eq(18)$$

Condition 2: Constant and finite variance : This condition can be expressed as,

$$var (Y_t)= = \frac{\sigma^2}{(1-\rho^2)} \text{ .....} Eq(19)$$

Condition 3: Constant and finite covariance: The covariance of the time series,

Eg (17), for its own lead and lag values, i.e., autocovariance, is constant over time and can be expressed as,

$$Cov (Y_t , Y_{t-s}) = = \frac{\rho^s.\sigma^2}{1-\rho^2} \text{ .....} Eq(20)$$

where, s is the distance between the periods.

The above three conditions that defines stationarity are satisfied only if $|\rho|<1$. In the case where $|\rho|>1$, which is, although , a rarity in the economic or finance series, implies that the series is explosive. That is, the future values of the series will not return back to mean values but will, instead, diverge at a faster pace. If $|\rho|=1$, then it is the case that the mean reverting level is undefined as all the denominations in the above three conditions will turn to zero. In this particular case, i.e., $|\rho|=1$, the time series is not covariance stationary and exhibits what is called a 'unit root' (Maddala and Kim 2004, Brooks 2014, Balarezo,2010).

It is worthy to note that, autocovariances are not a particularly useful measure of the relationship between Y_t and its previous values. Scholars suggest to use a more convenient

measure by transforming or standardizing, that is, normalizing the autocovariance. The normalization by variance i.e., dividing the autocovariance by variance, researchers get autocorrelation which is more convenient to use (Maddala and Kim,2004, Brook 2014).

3.6. Non-stationary process:

The opposite of stationary time series process is non–stationary process. The time series process which does not satisfy the stationarity conditions stated in the equations14, 15, and 16, that is, which has a structure of time varying mean or time varying variance or both is coined in the literature of econometrics as non – stationary time series process. In applied finance and economics, scholars mostly encounter with the non – stationary time series process and the simple example of which is the random walk model (RWM) (Gujarati, 2003, Greene, 2003). A vital feature of these types of series is the persistence of random shock, that is, the impact of a particular shock does not die away and hence have an infinite memory (Patterson, 2000). Random walk model (RWM) also falls under the unit root process (Gujarati, 2003). A series follows a unit root process if it is non – stationary and becomes stationary by taking first difference (Brooks, 2014). RWM is a specific case of a more general class of stochastic process known in the literature as integrated process. Series with random walk components are called integrated because they are the integrals of weakly stationary components in the series (Aoki, 1990). If a non – stationary time series becomes stationary after its first difference, then that time series is termed as integrated of order one, and denoted by I (1). In general, if a non – stationary time series has to be differentiated ‘d’ times to make it stationary, then the time series is said to be integrated of order ‘ d’ and denoted by I (d). Thus, if a time series is stationary at level, that is, the series does not require any differencing, it is said to be integrated of order zero, and denoted by I (0) (Gujarati, 2003, Greene, 2003).

Scholars observed that an I (1) series at level form will grow constantly and wander about with no tendency to revert back to a fixed mean. Macroeconomic and financial flows and stocks which relate to population size are mostly I(1) process (Patterson 2000, Greene, 2003, Gujarati, 2003).

Correct identification of the process of a time series whether stationary or non – stationary is heavily researched and debated by the scholars and the issue is so challenging that it seems to never die out. The basic literature on the issue dates back to the works of Mann and Wald (1943) and Rubin (1950) (Greene , 2003). But the huge attention of a large number of scholars is drawn after the seminal paper of Nelson and Plosser (1982) who observed that almost all the macro economic variables in US are I(1). Interestingly, hundreds of studies, both theoretical and empirical on unit roots in finance and economics appeared only in 1980s (Greene, 2003).

3.7. Estimation of the Stationary or Non-stationary Process:

3.7.1 (Unit-root Test):

There are basically, three approaches to identify stationarity or non – stationarity i.e. the order of integration of a time series process: (i) graphical inspection or analysis, (ii) observation of the sample autocorrelation and partial autocorrelation functions (Box and Jenkins,1976) and (iii) formal statistical tests. The eye ball estimation of the sample time series is the simplest method. It compares the plot of the time series under study with the time series of first and second differences and concludes. It may be an effective procedure for an efficient and experienced scholar but is very subjective one. Under the second method, if the plot of the autocorrelation function (ACF) is slowly decreasing, roughly at a linear rate, and the first value of the partial autocorrelation function (PACF) is very high, then the series under consideration is identified as non – stationary one. The differencing value, i.e., the

value of ‘ d’ then identify the series as I(1) or I(2), etc. This approach is also widely used but suffers from the risk of over – differencing (Gujarati, 2003). Hence, scholars suggest that it is better to approach the identification problem formally using appropriate statistical tests (Maddala and Kim, 2004, Altrova and Fedorova, 2016).

The area of research of the ‘unit-root test’ is vast and one can find several formal statistical tests are recommended and are in use in empirical studies to identify the correct order of integration. Amongst the battery of tests, the most popular and widely used tests are Dickey Fuller’s test (DF tests) (Dickey and Fuller,1979), Augmented Dickey Fuller test (ADF – test) (Said and Dickey,1984), Phillips –Perron test (PP –test) (Phillips and Perron 1988), KPSS test (Kwiatkowski, Phillips, Schmidt and Sin, 1992) and a bit less frequently used but strongly recommended ADF – GLS test (Elliot, Rothenberg and Stock,1996) and NGP test (Ng and Perron,1995,2001). It is worthy to note here that, almost all the tests suffer from ‘low power’ and virtually a uniformly powerful test does not exist. The choice of an appropriate one largely depends upon the intuition of the analyst which certainly is a subjective judgement (Schwert,1989, Dufour and King,1991, Altrova and Fedorova, 2016). Some scholars strongly argue to reject the use of DF, ADF, PP and KPSS tests and recommended the modified tests like ADF – GLS and NGP tests (Dufour and King 1991, Maddala and Kim, 2004). Altrova and Fedorova (2016), for a time series of long length (i.e. at least of 500 observations) and positive values of the autoregressive parameter AR(1), recommended to use ADF, ADF – GLS and NGP tests. Moreover, Greene (2003), strongly suggests the practioners to use ADF-test.

In this thesis, to avoid the risk of identifying incorrect order of integration of the time series under the study and also keeping in mind the recommendations of the eminent scholars like, Maddala and Kim,2004, Altrova and Fedorova, 2016 and many others, used ADF test, ADF – GLS test and NGP test.

3.7. 2. Augmented Dickey Fuller Test (ADF-test):

The augmented Dickey Fuller test is the modified test procedure of the original Dickey – Fuller test (Dickey and Fuller, 1979). It is observed that many financial time series have more complicated dynamic structure than the simple AR (1) model. Hence, Said and Dickey, 1984, introduced augmented components to the basic DF test (Dickey and Fuller, 1979) to accommodate general autoregressive moving average i.e., ARMA (p,q) models with unknown orders. The augmented components are incorporated to soak the disturbances and make the residuals free from autocorrelation. The new or modified test is based on estimating the test regression:

$$y_t = D_t + \varphi y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \varepsilon_t \quad \text{.....Eq (21)}$$

where, D_t is a vector of deterministic terms, may be constant, trend, etc, and p is the lagged difference terms or optimum lag order. Δy_{t-i} are used to approximate the ARMA structure of the errors and the value of p is set in such a way that error ε_t is serially uncorrelated. Here, the null hypothesis is Y_t is I(1) against the alternative hypothesis I(0).

An alternative formulation of the test is:

$$\Delta y_t = D_t + \pi y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \varepsilon_t \quad \text{.....Eq (22)}$$

Where, $\pi = \varphi - 1$. Under the null hypothesis Δy_t is I(0) which means to test $\pi = 0$. This equation (22) is used in practice for testing the significance of the coefficient Y_{t-1}.

The ADF t-statistics and normalised bias statistics are based on the least square estimate of equation (21) and are:

$$ADF_t = t_{\varphi = 1} = \frac{\hat{\emptyset} - 1}{SE(\emptyset)} \quad \text{.....Eq (23)}$$

$$ADF_n = \frac{T(\hat{\emptyset}-1)}{1-\gamma 1-\cdots-\gamma p} \quad \text{.....Eq(24)}$$

The limiting distribution of the test statistic is identical with the distribution of DF test (Dickey and Fuller, 1979) and for $T \to \infty$is tabulated by Dickey (1976) and MacKinnon (1991).

3.7.3. Augmented Dickey Fuller–Generalised Least Square (ADF–GLS) test:

This test is also known as ERS-test (Elliot, Rothenberg and Stock, 1996) and is recommended by modifying the ADF test. Before the unit root test, ERS test uses the de-trending transformation that primarily removes trend from time series. The constant in the model:

$$y_t = \beta_0 + \emptyset y_{t-1} + \varepsilon t \text{.....Eq(25)}$$

is estimated by using generalised least square method with the transformation (Altrova and Feorova, 2016):

$\check{y} = y_1$,$\check{y} = y_t - \rho y_{t-1}$, t=2,……., T

$x_1 = 1$, $x_t = 1 - \rho$, t = 2, ……,T .....Eq (26)

where, $\rho = 1 + \bar{C} / T$ and $\bar{C}$ = (-)7. The constant is estimated based on the equation:

$$\check{y} = \beta_0 x_t + e_t \text{ .....Eq (27)}$$

The parameter is estimated with the help of least square method and is used to remove constant from the time series y_t. The trend, especially the linear trend, is estimated by generalised least square method by transforming the equation (27) by :

$Z_1 = 1$, $Z_t = t - \rho (t - 1)$,

where, $\rho = 1 + \bar{C} / T$ and$\bar{C}$ = (-)13.5. The estimates of the parameters are computed by:

$$\check{y} = \beta_0 x_t + \beta_1 z_t + \varepsilon t \quad \text{Eq(28)}$$

and the estimated parameters $\tilde{\beta}_0$ and $\tilde{\beta}_1$ are then used to remove constant and a trend from the series y_t :

$$y_t^* = y_t - (\tilde{\beta}_0 + \tilde{\beta}_t) \quad \text{Eq (29)}$$

After transformation, ADF test is applied on the transformed time series y^*_t and the test statistic is obtained by the equation:

$$\Delta y_t^* = \beta_0 + \emptyset y^*_{t-1} + \sum_{i=1}^{p} \gamma i \, \Delta y^*_{t-I} + \varepsilon t \quad \text{Eq (30)}$$

The critical values are provided by Elliot, Rothenberg and Stock, (1996). It is worthwhile to note here that, the value of $\bar{C}$ for constant = (-)7 and for linear trend (-) 13.5 was deduced for $\propto$= 0.05 by Elliot, Rothenberg and Stock (1996) based on power envelop, and for given T, the tests are optimal at the 50% power.

3.7.4. Ng – Perron test (NGP test):

Ng and Perron (1995,2001) recommended the test by modifying Phillips – Perron test (Phillips and Perron, 1988) with the detrended data y^*_t , (equation ,29), obtained from the ADF – GLS test. Their basic equation is (Maddala and Kim, 2004):

$$y_t = D_t + \emptyset y_{t-1} + \sum_{i=1}^{p} \gamma i \Delta y_{t-I} + \varepsilon t \quad \text{Eq(31)}$$

and the test statistic z of the P P–test (Phillip and Perron, 1988) are modified to the form below (Altrova and Fedorova, 2016):

$$\bar{M}\bar{Z}_{\emptyset} = (T^{-1} y^*_t - S^2_{AR}) (2T^{-2} \sum_{t=1}^{T} y^*_{t-1})^{-1} \quad \text{Eq (32)}$$

$$\bar{M}\bar{S}\bar{B} = (T^{-2} \sum_{1=1}^{T} \frac{y*t-I}{S^2_{AR}})^{1/2} \quad \text{Eq(33)}$$

Here , MSB is the modified Sargan – Bhargava test (Sargan and Bhargava, 1983) and for I(0) series, MSB is related to the P P- test by (Maddala and Kim, 2004):

$$\overline{M}\overline{Z}_T = \overline{M}\overline{Z}_{\emptyset} \,.\, \overline{M}\overline{S}\overline{B} \quad \text{.....Eq (34)}$$

Here, $S^2_{AR} = (\sum_{t=p+1}^{T} \varepsilon_t^2)\,((T - K)(1 - \sum_{i=1}^{P} \hat{\beta}_i)^2)^{-1}$, $\emptyset$ = auto regressive parameter, y^*_t is the transformed time series and p is the optimum lag order.

3.8. Optimum lag-order:

The unit-root tests discussed above are, for their power, very sensitive to the lag orders. Scholars recommend several ways to select the optimum lag order but most of them are inappropriate save some modified information criteria (Maddala and Kim, 2003).

The optimum lag order used in this study is derived by 'information criteria' like:

3.8.1. Akaike Information Criterion which is defined as (Akaike1974) :

$$AIC = e^{2k/n}(\Sigma\, \hat{u}_i^2)/n \quad \text{.....Eq(35)}$$

where $\hat{u}_i$ is the estimated error terms from the regression equation involving the time series. The minimum of the criterion serves as the guide to select the optimum lag range.

3.8.2. Schwartz Information Criterion which is defined as (Schwarz 1978) :

$$SIC = n^{k/n}(\Sigma\, \hat{u}_i^2)/n \quad \text{.....Eq(36)}$$

where $\hat{u}_i$ is the estimated error terms from the regression equation involving two macrovariables. Like the AIC, here also, the minimum of the criterion serves as the guide to select the optimum lag range.

3.8.3.Final Prediction Error Criterion (FPE) which is generally described in a Error Correction Model as (Hsiao, 1979, 1981):

$$FPE\ \Delta y_t(n, m) = \frac{(N+n+m+1)\ \Sigma\ (\Delta y_t - \Delta \hat{y}t)^2}{(N-n-m-1)/N} \quad \text{Eq(37)}$$

where, n and m are the number of lags in the dependent (explained) and independent (unexplained) variables respectively; N is the number of observations. To obtain the optimum lag, one has to determine the minimum FPE Δy_t by running the regression equations involving the dependent and independent variables under question (Wong, et al, 2004).

3.8.4. Hannan-Quinn Information Criterion (HQC) which is defined as (Hannan-Quinn,1979):

$$HQC = -2\ l(\hat{a}) + 2k \log \log n \quad \text{Eq(38)}$$

where, l(â) represents the minimum log likelihood as a function of the vector of parameter estimates (â), and k denotes the number of independently adjusted parameters within the model.

It is noteworthy here that, none of these criteria is necessarily statistically superior to others (Gujarati, 2003, Maddala and Kim, 2003). Scholars like, Diebold (2001), Stock (1994), however, recommend SIC to be applied. But cautionary approach guided the analysis to explore all the criteria stated above for selecting the optimum lag order.

3.9. Structural Stability:

Literature on structural instability or structural break in time series is vast, expanding and full of contesting but not converging recommendations on issues like known break point, unknown break point, single and multiple break points, gradualism, priors and pre-testing bias, application on linear or nonlinear, finite and infinite time series process, etc. According to Maddala and Kim (2004), more research works needs to be done to compare the methods

suggested by scholars to determine the structural instability. Some of the recommendations of the researches summarised by him are: (i) it is more important to determine the number and location of the break point(s) than only identifying that there is structural change, (ii) problem of consistent estimation still exists, although, the matter is examined nicely by Bai and Perron(1998), (iii) there is no need to search over the entire time period of observations, because, there are always some prior information about the major break dates, like , war, mammoth changes in economic policies etc, (iv) despite several good works, consensus is not arrived on the use of Bayesian or Classical approach to search the break points and (v) more attention of the scholars is required to the 'gradual structural changes' as the shift from one regime to the another one is never sudden. Interestingly, may be due to gradualism, Agarwal and Ghosh (2015), found no break in Indian economy during the period 1960 to 2013, especially in per capita GDP, agriculture and manufacturing sector save the service sector in 2003. Some scholars argue that the breaks for small magnitude have no impact in forecasting. Ignoring rather than modelling small breaks may lead to more accurate forecasts (Stock and Watson 1996, Pesran and Timmermann 2005, Boot and Pick,2017). Against this backdrop, we, in this thesis, used two popular and widely used methodology(i) CUSUM test suggested by Brown,Durbin and Evans,(1975) and (ii) Quandt-Andrews breakpoint test suggested by Quandt(1958,1960), Andrews (1993) and (iii) Andrews and Ploberger (1994).

3.9. 1. CUSUM- test:

Brown, Durbin and Evans (1975) suggested a test of structural break, popularly known as CUSUM- test, based primarily on the model's ability to predict correctly the observation or observations actually outside the range of the observations used to estimate it. According to Greene,2003, the test is in the right direction to detect the timing of the change which is unknown. It is based on the cumulated sum of the recursive residuals and the test statistic recommended is:

$$W_t = \sum_{r=K+1}^{t} w_r / \hat{\sigma} \quad \text{.....Eq(39)}$$

where,

$\hat{\sigma}^2 = (T-K-1)^{-1} = \sum_{r=K+1}^{T} (w_r - w)^2$, and

$w = (T - K)^{-1} \sum_{r=K+1}^{T} w_r$

or, $\hat{\sigma}$ is the standard deviation of the recursive residuals w_t. Under the null hypothesis, w_t has mean zero and variance approximately equal to the number of residuals being summed, because each term has variance 1 and they are independent (Greene, 2003).

Assessment of the divergence from the ‘ zero line’, one has to study the behaviour of w_t by plotting w_t against t. Confidence bounds of the cumulated sum are obtained by plotting the two lines that connect the points $[K, \pm a (T - K)^{1/2}]$ and $[T, \pm 3a(T-K)^{1/2}]$, where ‘a’ is the parameter whose value depends on the value of significance level α. The null hypothesis of there is no structural change is rejected if w_t goes outside the area bounded by two critical lines.

3.9.2. Quandt-Andrews Breakpoint test:

Quandt’s log- likelihood ratio technique (Quandt 1958,1960), is appropriate when the regression relationship changes suddenly from one constant relationship to another constant relationship (see Brown, Durbin and Evans,1975). The idea behind Quandt-Andrews Breakpoint test is that a single Chow break point test(1960,1983) is performed at every observation between two dates T_1 and T_2.The k statistics from those Chow tests (1960,1983) are then summarised to one test statistic for a test against the null hypothesis of no break points (Diebold and Chen, 1996, Brooks, 2014).

Let ,the unknown break point be , t=r, the first constant regression relationship be specified by $\beta^{(1)}$, σ_1^2 and the second one by $\beta^{(2)}$ and σ_2^2 , then for each r from r=K+1 to

r = T – (K+1), the plot is

$$\lambda_r = \log_{10}\left(\frac{\max\ likeli\ hoodobservationsgivenbyH\ \ 0}{\max\ likeli\ hoodobse\ rvationsgivenbyH\ \ 1}\right)$$

where, H_1 is the alternative hypothesis, i.e. the observations in the time segment (1, …, r) and the segment (r+1,……..,T) come from two different regressions. This form is the standard likelihood ratio statistics for taking decision on the null and alternative hypothesis. However,

$$\lambda_r = \tfrac{1}{2}\, r \log \hat{\sigma}_1^{\,2} + \tfrac{1}{2}\,(T - r)\log \hat{\sigma}_2^{\,2} - \tfrac{1}{2}\, T \log \hat{\sigma}^{\,2} \quad \text{.....Eq (40)}$$

where, $\hat{\sigma}_1^{\,2}$, $\hat{\sigma}_2^{\,2}$, and σ^2 are the ratios of the residual sums of squares to number of observations when the regression is fitted to first r observations, the remaining (T – r) observations and the whole set of observations , respectively. When the value of r at which λ_r achieve minimum, at that point shift from one constant relationship to another occurs. The test for the distribution on the minimum of λ_r is given by Andrews (1993).

Andrews (1993) modified the Quandt's test and suggested three supremum tests.

Let , the null of the structural stability of AR(1) process be:

$$y_t = \rho y_{t-i} + e_t,\ t=1,\ldots\ldots,T \quad \text{.....Eq (41)}$$

(no break or restricted model)

The H_1, one – time break, be:

$$\text{Model 1: } y_t = \rho_1 y_{t-1} + \epsilon_t,\ t = 1,\ldots\ldots\ldots r \text{.....Eq (42)}$$

$$\text{Model 2: } y_t = \rho_1 y_{t-1} + \epsilon_t,\ t = (r_{+1},\ldots\ldots\ldots,T) \text{.....Eq (43)}$$

(sub–sample or unrestricted model)

Then, the tests are:

$$Sup\ W = max_{\pi} T \left(\frac{\hat{\epsilon}'_t \hat{\epsilon_t} - \hat{\epsilon}'_1 \hat{\epsilon_1} - \hat{\epsilon}'_2 \hat{\epsilon_2}}{\hat{\epsilon}'_1 \hat{\epsilon_1} + \hat{\epsilon}'_2 \hat{\epsilon_2}} \right)$$

$$Sup\ LM = max_{\pi} T \left(\frac{\hat{\epsilon}' \hat{\epsilon} - \hat{\epsilon}'_1 \hat{\epsilon_1} - \hat{\epsilon}'_2 \hat{\epsilon_2}}{\hat{\epsilon}' \hat{\epsilon}} \right)$$

$$Sup\ LR = max_{\pi} T \left(\frac{\hat{\epsilon}' \hat{\epsilon}}{\hat{\epsilon}'_1 \hat{\epsilon_1} + \hat{\epsilon}'_2 \hat{\epsilon_2}} \right)$$

where , $\hat{\epsilon}$ is the T x 1 vector of OLS residuals from the restricted model, $\hat{\epsilon}_1$ is the r x 1 vector of OLS residuals from the sub-sample 1 model, $\hat{\epsilon}_2$ is the (T - r)*1 vector of OLS residuals from the sub-sample 2 model, and Π= r/T. The standard procedure suggested by Andrews (1993) is to impose Πϵ(0.15,0.85); although , it may vary according to the need of the analyst (Diebold and Chen, 1996). Break date estimate obtained by the OLS for all time series does not depend upon the variation of trimming (Jouini and Boutahar, 2005).

Andrews and Ploberger (1994) developed tests with stronger optimality properties than those of Andrews (1993) (Maddala and Kim, 2004). Using the notations used by Maddala and Kim (2004), let, $T_1<m<T_2$ be the range within which structural break occurs. Let , W^* be the Wald statistics for a break at t=m, then,

$$\text{Sup W}=\max_{T_1<m<T_2} W^*, \quad \text{Eq(44)}$$

The test statistics suggested by Andrews and Ploberger (1994) are:

$$\text{ExpW} = l_n \left[\frac{1}{T_2-T_1+1} \sum_{m=T_1}^{T_2} exp(w \frac{*1}{2}) \right] \quad \text{Eq(45)}$$

$$\text{AveW}=\frac{1}{T_2-T_1+1} \sum_{m=T_1}^{T_2} W^* \quad \text{Eq(46)}$$

They showed that, under some regulatory conditions, the asymptotic distribution of the test statistics are given by the functions of the Wiener process, i.e. like a continuous random walk defined on interval (0,1), and are the same for LM and LR statistics:

$$\text{Sup W} = \max_{\pi_1 < m < \pi_2} Q(\tau) \text{ , ... Eq(47)}$$

$$\text{ExpW} = l_n \left[\frac{1}{\pi_{2-\pi_1}} \int_{\pi_1}^{\pi_2} \exp(Q(\tau)/2) \, d\tau \ldots \text{ ..... Eq(48)} \right.$$

$$\text{Ave W} = \frac{1}{\pi_{2-\pi_1}} \int_{\pi_1}^{\pi_2} Q(\tau) \, d\tau \ldots \text{ ..... Eq(49)}$$

where, $\Pi_1 = T_1/T$, $\Pi_2 = T_2/T$, and $Q(\tau) = \frac{(w(\tau) - \tau W(1))' (W(\tau) - \tau W(1))}{\tau(1-\tau)}$

and W is a vector of K independent Wiener process. If τ is known, then this is a Chi – square (K) (see Maddala and Kim,2004). Hansen (1997) provided the table to consult and compare the probability values.

3.10. Seasonality Test

Recent philosophy in the time series analysis is to allow the data to speak for themselves, hence, in empirical analysis it is suggested to avoid maximum modifications of the raw data (see Maddala and Kim,2004. Neuesser, 2016, Brockwell and Davis, 2016) .

Removal of the trend and seasonal components are required to get stationary residuals. According to Brockwell and Davis (2016), to achieve this goal it may sometimes be necessary to apply a preliminary transformation to the data. There are several ways in which trend and seasonality can be removed , some involving estimating the components and subtracting them from the data, and others depending on differencing the data, i.e., replacing the original series {X} by {Y, := X, – X-d} for some positive integer d. Whichever method is used, the aim is to produce a stationary series, whose values in general referred to as

residuals. Again, if the magnitude of the fluctuations appears to grow roughly linearly with the level of the series, then the transformed series {In X_1, ..., In Xn} will have fluctuations of more constant magnitude.

The magnitude of the fluctuations in the time series under this study appeared to go roughly linearly with the level of the series. Thus, following Brockwell and Davis, 2016, this analysis has taken log of the original series at level to transform the series to eliminate the trend and seasonality.

3.11. Causalty Test:

This study used Granger (1969, 1981, 1988) causality test to assess which of the markets under our study have statistically significant influence on the future values of each of the markets in the system. Considering only two variables eg, Y_t and X_t, the test involves estimating the equations below:

$$\Delta Y_t = \alpha_0 + aEC_{t-1} + \sum_{i=1}^{k} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta X_{t-i} + \epsilon_t^y \quad \text{.....Eq(50)}$$

$$\Delta X_t = \beta_0 + bEC_{t-1} + \sum_{i=1}^{k} \beta_{1i} \Delta X_{t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta Y_{t-i} + \epsilon_t^X \quad \text{.....Eq(51)}$$

where, EC_{t-1} is the error correction term obtained from the co- integrating vector and α_i , β_i (i=1, ……,k), a and b are parameters to be estimated, k is the optimum lag order in the system, ϵ^x , ϵ^y are stationary random process with mean zero and constant variance (Wangbangpo, and Sharma, 2002).

According to Granger (1998), a VECM provides two ways to detect causality: (i) the significance of the lagged error term coefficients which are tested by t- statistics, and (ii) the joint significance of the lags of each variable tested by F–statistics. Simply, X_t Granger cause $Y_t$if ‘a’ is significant or α_{2i} are jointly significant i.e. $H_0 : \alpha_{21} = \alpha_{22} = \ldots\ldots\ldots\ldots\ldots\ldots = \alpha_{2k} = 0$

is rejected. In other words, if Y_t Granger cause X_t, then lags of Y_t should be significant in the equation for X_t. If this is the only outcome not the vice versa, then it is said that there is unidirectional causality running from Y_t to X_t. If the case is vice versa, i.e. both sets of lags and both EC_{t-1} coefficients are significant, then it is said that there exists a bi-directional causality between Y_t and X_t . If Y_t cause X_t and not vice versa, then it is said that the variable Y_t is strongly exogenous. If neither set of lags are statistically significant in the equation of the other variable, it is said that Y_t and X_t are independent (Brooks, 2014).

3.12. Impulse Response Analysis:

In a VAR model, all variables depend on each other and on the reaction of the system to a shock, only limited information can be obtained by the estimates of individual coefficients. Moreover, it is very difficult to directly understand and interpret the dynamic interactions between variables as VAR is composed of many coefficients. Impulse response function can be used here to trace out the responses of the dependent variable to the structural shocks of each of the variables, even, related to economic or financial model over time (Neusser, 2016). In response analysis, if the responses subside quickly towards zero, then it is said that transmission between the variables in VAR are relatively efficient (Roca and Tularam,2011). In Granger causality (1987,1988) one can find the reaction qualitatively but it fails to give any quantitative idea about the effects for the periods in future or the sign of the relationship or how long the effects require to take place. In impulse response function (IRF), the dynamic relationships between variables are captured(Brooks, 2014). Let us consider the VAR model below (Lutkepohl, 2007):

$$Y_t = \mu + \sum_{i=1}^{p} \emptyset_i Y_{t-i} + \epsilon_t \text{ , } t= 1,2,3\ldots\ldots\ldots\ldots\ldots,T \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq(52)}$$

where, y_t = (SX´,FX´,CR´)´is a three block vector (m x 1) in our study, where SX is a vector of stock market indices, FX is a vector of foreign exchange rate (Rs/$), and CR is a vector of

money market variable, $\emptyset_i$ are fixed m x m coefficient matrices, $\in_t = (\in_{lt}, \ldots\ldots\ldots, \in_{mt})'$ is a Ganssian white noise process with $E(\in_t) = 0$, $E(\in_t \in'_t) = \Sigma_\epsilon$, $E(\in_t \in_s) = 0$, for $t \neq s$ and Σ_ϵ is the covariance matrix of the error terms.

The infinite moving average process (MA) of the model (Eq,52) under the stability condition is:

$$y_t = C + \sum_{i=0}^{\propto} A_i \in_{t-i} \quad \text{.....Eq(53)}$$

The coefficient matrices can be obtained from the recursive formula:

$$A_i = \sum_{j=1}^{i} A_{i-j}\, \varphi_j,\ i = 1,2,3, \quad \text{.....Eq(54)}$$

where $A_0 = I_m$ and $\varphi_j = 0$ for j>p. The constant term $e = (I_m - A_1 - \ldots\ldots\ldots\ldots - A_p)^{-1}\mu$, and the μ is the mean of the process.

Impulse response function of a ‘ one standard deviation’ shock to the i th variable in y_t, on jth variable in y_{t+m} is given by:

$$\Psi_{ji}(n) = e'_j A_n P_{ei},\ n = 0,1,2, \quad \text{.....Eq(55)}$$

where, e_i is a column selection vector with unity as the ith element and zeroes otherwise, P is lower triangular matrix obtained by decomposing the covariance matrix Σ_ϵ using the Cholesky method so that $PP' = \Sigma_\epsilon$ (Serwa and Wdowinski, 2016).

Impulse response analysis and its outcome depend on the ordering of the variables under study. Impulse response function (IRF) computed using Cholesky decomposition is highly sensitive to the ordering of the variables and on the covariance matrix Σ_ϵ, too. Pesaran and Shin (1998) and Koop, Pesaran and Potter (1996) suggested a method of estimation known as Generalised Impulse Response Function which, authors claimed, can avoid the problems of ordering of the variables. But, according to Kim (2012), Generalised Impulse Response

Function (GIRF) treats all the shock of the variables as if they were ordered first in a VAR. Moreover, GIRF generates responses that are larger and more frequently statistically significant than ordinary IRF. Hence, using generalised impulse response function may result in misleading inferences caused by their extreme identification schemes (Kim, 2012). We, in this study, used ordinary impulse response function using Cholesky (see Lutkepohl,2007) decomposition.

3.13. Variance decomposition Analysis:

In examining the dynamics of VAR system, Variance Decompositions give the proportion of the movements in the dependent variables that are due to their 'own shocks' and against shocks to other variables in the system. A shock to the i th variable not only affect the variable, it also transmits the shock to all other variable through the dynamic structure of VAR. Variance decomposition computes how much of the h-step ahead forecast error variance of a given variable is explained by shocks to each explanatory variable for h = 1,2,3……, the horizon (h) chosen by the analyst.

According to Sims (2011), the forecast error of a variable at time t is the change in the variable that could not have been forecast between t-1 and t. This is primarily because of the realisation of the structural shocks in the system, ε_t . Using the notations of Sims (2011), for a n variable system, the total forecast error variance of a variable i at horizon h is:

$$\Omega_i (h) = \Sigma^h_{k=0} \Sigma^n_{j=1} C_{i,j} (k)^2 \quad \text{Eq(56)}$$

where, C(L) = A $(L)^{-1}$B to be the matrix polynomial of structural moving average coefficients, A $(L)^{-1}$ is the inverted AR process, K = 0,1,2,……..h, h = horizon of the study for shocks and A (L) is a matrix of lag polynomial.

Quantification of the shock in explaining the variation in each variable in the system amounts to the fraction or proportion of the forecast error variance of each variable due to each shock at each horizon (Sims, 2011). The forecast error variance of variable i due to shock j at horizon h is:

$$\omega_{ij}\,(h) = \sum_{k=0}^{h} C_{i,j}\,(k)^2 \ldots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq (57)}$$

Then the fraction of the forecast error variance of variable i due to shock j at horizon h is the above equation (57) divided by the total error variance in equation (56), is:

$$\Phi_{i,j}\,(h) = \frac{\omega i,j\ (h)}{\Omega i\,(h)} = \frac{forecasterrorvarianceofivariable}{totalforecasterrorvariance}$$

$$= \frac{Equation\ 57}{Equation\ 56} = \frac{\sum_{k=0}^{h} Ci,j\ (k)2}{\sum_{k=0}^{h}\sum_{j=1}^{n} C_{i,j}\,(k)2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq(58)}$$

here, it is assumed that the shocks have unit variance and are uncorrelated.

3.14. Summary:

In sum, in measuring the integration of domestic financial markets and to test the hypothesis under this study, this research used the mythology, step by step, recommended by the eminent scholars of econometrics and statistics below:

Step 1: This study transformed the series by taking natural logarithm at level data to eliminate the seasonality, if any, of the time series data used in the study (Brockwell and Davis, 2016, Gopinathan and Durai,2019)

Step 2: To identify the order of integration of the time series, ADF (Said and Dickey, 1984,), ADF-GLS (Elliot, Rothenberg and Stock, 1996) and Ng-Perron tests (Ng and Perron, 1995, 2001) tests are used.

Step 3: The optimum leg order of the VAR process is identified by the information criteria, namely, AIC (Akaike1974), BIC (Schwarz 1978), HQC **(**Hannan, and Quinn 1979) and FPE (Hsiao 1979, 1981).

Step 4: To test the first null hypothesis of this study i.e., Indian domestic markets namely stock, money and foreign exchange market are not integrated, the study used the process recommended by Johansen and Juselius (1990) and Johansen (1991,1995) . In this process this study also attempted to identify the number of cointegrating rank, if any, deterministic trend ,long-run equilibrium relationship, short-run dynamics and also attempted to identify the markets which are in the co integrating space , the structural stability of the model etc., with the methodologies suggested by the scholars.

Step 5: To test the second null hypothesis, that is, past values of none of the Indian domestic markets, under the study , influence the future values of other markets , this study attempted to apply the test suggested by Granger(1969,1981,1988) .

Step 6: The 3rd null hypothesis ,that is, all the sample domestic markets would remain rigid over the future periods of time, is tested with the help of impulse response analysis and forecast error variance decomposition analysis.

The time series literature is growing very fast hence the recommended mythologies used in this thesis are obviously not free from limitations.

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CHAPTER-4

Cointegration of the Capital Market, Foreign Exchange Market and Money Market.

CHAPTER-4

4.1. Introduction:

Integration of the various financial market-segments in an economy and the consequent reduced opportunities for arbitrage are essential for stabilizing the flow of funds to different segments of the financial market promptly and efficiently causing overall development of the economy (Obstfeld 1994, Mohan 2005). It is an important aspect for healthy and balanced growth of all the components of the financial system. Domestic integration is likely to inspire and increase the efficiency of the financial intermediaries, hence, greater efficiency stimulates the demand for funds and financial services which ultimately results into an increased size of market which delivers more growth for both the developed and developing economies (see, Trichet 2005, Lane et al., 2003).In 1980's, Policy planners of several economies all over the globe are influenced heavily by these forceful arguments of neoclassical theorists. In addition to that, pressure from the peer domestic groups and people as a whole almost forced the governments of several countries to adopt several dynamic policies including free economic policies to increase the levels of integration of domestic financial markets so that they can ultimately reap the benefits of international integration and globalisation. As a result, , inspired by deregulation and advances in information technology over the past few decades, financial markets all over the world have witnessed growing integration within as well as across boundaries (see Ray et al., 2009, Prasad et al., 2003 Stulz, 1981).

It is found that, gradually, there are changes in the operating framework of monetary policy all over the world and a shift in emphasis from quantitative controls to price-based instruments like the short-term policy interest rates which brought about changes in the term

structure of interest rates and are expected to be instrumental to integrate various segments of the domestic financial market. The market integration process, both in the developing and emerging economies , has strengthened more by following the prudential regulations in line with international best practices and by enabling competitive pricing of products (see Feldstein and Horioka 1980; Feldstein 1983; and Haque 1990). Moreover, transmission of monetary policy impulses becomes smooth and quick only when the impact of policy intervention at one end of the market gets quickly transmitted to the entire spectrum of the markets in an economy (Vasudevan and Menon 1978). Thus, domestic market integration also plays an important role in signalling the interest rate. In India an important objective of the economic reforms is to integrate the various segments of the financial market for bringing about a transformation in the structure of markets, reducing arbitrage opportunities, achieving higher level of efficiency in market operation of intermediaries and increasing efficacy of monetary policy in the economy (Reddy, 1999, 2005). Efficient allocation of funds across the financial sector and uniformity in the pricing of various financial products through greater inter-linkages of financial markets has been the basic emphasis of the Indian new economic policy followed by the recent monetary policies (see Mohan, 2005).

This thesis attempted to assess the integration of the major segments of Indian domestic financial market considering only the Capital, Foreign exchange and Money market. Considering a time period of approximately 11 years ranging from 1st January, 2008 to 31st December, 2018 and used daily data at log level.

It is worthwhile to mention that there are several significant evils of financial market integration. Taking the clues from Agenor (2001), such potential threats in domestic integration may include destabilizing impacts of high degree of capital flows-- inward, outward and cross-segment-- that may hamper and exacerbate pre-existing domestic gaps and

distortions; lack of access to finance by some economic organisms either totally or when they actually need the funds most; the loss of macroeconomic stability; adverse impacts of the pro-cyclical nature of short-term capital flows especially the foreign portfolio investment liabilities ,and the risk of abrupt reversals of the flows that ultimately results in to herding and contagion effects.

4.2. Estimations and Findings:

4.2.1. Seasonality:

Firstly, all the time series process under our study are transformed taking natural logarithm to avoid the problems of seasonality and trend (Brockwell and Davis, 2016 , Gopinathan and Durai,2019). Throughout the thesis, in all computations and estimations, this log-level data are used.

4.2.2. Identification of the Order of Integration:

This study examined the stationarity of each series on the basis of the widely used methodology prescribed by Said and Dickey(1984),(Augmented Dicky-Fuller (ADF) test), Elliott, Rothenberg and Stock (1996) (DF-GLS test) and Ng and Perron (1995, 2001)(Ng-Perron test)with ‘constant’, and ‘constant and trend'. The results of the tests are presented in Table-4.1(a) Table-4.1(b) and Table-4.1(c). It is observed that all the time series under the study are statistically significantly non-stationary at log- level and stationary at first difference at five percent level of significance. Only lnCR has unit root, with constant, at 10 percent level of significance under ADF-GLS test. This is a common problem encountered by several scholars in empirical analysis (see Al-Sharkas, 2004, Humpe and McMillan, 2005, Ray, 2008, Ray, et al, 2009). This study proceeded to the next phases of estimations considering all the variables under this study, with constant and constant and trend, as I(1).

Table-4.1(a):

ADF Test for Unit Root

Variables	With Constant			With Constant and Trend		
	Lag Order (SIC)	t-statistic	p-value	Lag Order (SIC)	t-statistic	p-value
LNCR	21	-1.727570	0.4172	21	-1.802000	0.7038
ΔLNCR	20	-14.10393	0.0000*	20	-14.10138	0.0000*
LNSX	1	-0.648475	0.8573	15	-3.259659	0.0733
ΔLNSX	0	-48.79559	0.0001*	0	-48.80947	0.0000*
LNFX	0	-1.582992	0.4912	0	-2.349890	0.4061
ΔLNFX	0	-51.88637	0.0001*	0	-51.88899	0.0000*

Note: 1) Δ is the first difference operator.

2) *Indicates rejection of null hypothesis at one percent level of significance.

Table-4.1(b):

DF-GLS Test for Unit Root

Variables	With Constant				With Constant and Trend			
	Lag Order (SIC)	t-statistic	CriticalValue		Lag Order (SIC)	t-statistic	CriticalValue	
			1% Level	5% Level			1% Level	5% Level
LNCR	21	-1.722982	-2.565819	-1.940941	21	-1.726091	-3.48000	-2.89000
ΔLNCR	27	-0.524794***	-2.585821	-1.940941	5	-9.073307*	-3.48000	-2.89000
LNSX	1	-0.542729	-2.565813	-1.940940	1	-1.368698	-3.48000	-2.89000
ΔLNSX	16	-4.752915*	-2.565818	-1.940941	8	-12.38228*	-3.48000	-2.89000
LNFX	0	-1.227171	-2.565812	-1.940940	0	-1.753842*	-3.48000	-2.89000
ΔLNFX	0	-51.89341*	-2.565813	-1.940940	0	-51.71653*	-3.48000	-2.89000

Note: 1) Δ is the first difference operator.

2) *Indicates rejection of null hypothesis at one percent level of significance

3) ***Indicates rejection of null hypothesis at ten percent level of significance

Table-4.1(c):
Ng-Perron Test for Unit Root
Observed Test Statistics

Variables	With Constant					With Constant and Trend				
	Lag@	MZa	MZt	MSB	MPT	Lag@	MZa	MZt	MSB	MPT
LNCR	21	-5.88852	-1.7152	0.2918	4.1628	21	-5.9125	-1.7170	0.2904	15.409
ΔLNCR	5	-25.3477*	-3.54211*	0.1397*	1.0271*	5	-51.180*	-5.0552*	0.0987*	1.7974*
LNSX	1	-1.29206	-0.5435	0.4206	12.468	1	-4.0056	-1.3687	0.3416	22.215
ΔLNSX	16	-13.5825**	-2.5935*	0.1909*	1.8533**	8	-153.43*	-8.7584*	0.0570*	0.5952*
LNFX	0	0.86297	1.22788	1.4228	130.64	0	-6.5667	-1.7519	0.2668	13.917
ΔLNFX	0	-1359.47*	-26.070*	0.0191*	0.0188*	0	-1359.4*	-26.070*	0.0191*	0.0680*

Critical Values^

Level	With Constant				With Constant and Trend			
	MZa	MZt	MSB	MPT	MZa	MZt	MSB	MPT
1%	-13.8000	-2.58000	0.17400	1.78000	-23.8000	-3.42000	0.14300	4.03000
5%	-8.10000	-1.98000	0.23300	3.17000	-17.3000	-2.91000	0.16800	5.48000
10%	-5.70000	-1.62000	0.27500	4.45000	-14.2000	-2.62000	0.18500	6.67000

Note: 1) Δ is the first difference operator; 2) @ Indicates lag order based on SIC; 3) ^ critical values (see Ng-Perron (2001,); 4) *Rejects the Null at one cent level of significance; 5) **Rejects the Null at five cent level of significance.

4.2.3. Estimation of the Optimum or Maximum Lag-Order:

In this step, the optimum lag order was searched and selected by using the information criteria like: Akaike Information Criterion (AIC) (Akaike1974), Schwarz Information Criterion (BIC) (Schwarz 1978), Hannan-Quinn InformationCriterion (HQC) (Hannan, and Quinn 1979) and Final Prediction Error Criterion (FPE) (Hsiao 1979, 1981) in a VAR framework. Results of the tests suggest ten lag order under all the methods as the optimum one save BIC (see Table 4.2). Thus, ten-order lag length throughout our subsequent empirical analyses is used.

TABLE-4.2

Maximum Lag Order at log level

(Searched up to 10 lag order)

Variables: lnSX, lnFX, lnCR

Lags	loglik	FPE	AIC	BIC	HQC
0	1005.943	9.58e-05	-0.739906	-0.733372	-0.737544
1	21344.93	2.94e-11	-15.73805	-15.71192	-15.72860
2	21613.77	2.42e-11	-15.92975	-15.88401	-15.91321
3	21695.28	2.30e-11	-15.98324	-15.91790	-15.95962
4	21763.70	2.20e-11	-16.02707	-15.94212	-15.99636
5	21825.82	2.11e-11	-16.06626	-15.96171*	-16.02846
6	21840.74	2.10e-11	-16.07063	-15.94647	-16.02574
7	21848.12	2.11e-11	-16.06944	-15.92568	-16.01746
8	21868.07	2.09e-11	-16.07752	-15.91415	-16.01845
9	21906.40	2.05e-11	-16.09915	-15.91618	-16.03300
10	21932.80	2.02e-11*	-16.11199*	-15.90942	-16.03875*

Note :

1. ***** indicate the minimized values of the information criteria,

2. VAR Optimum Lag Order obtained : FPE = 10, AIC = 10, BIC = 5, HQC = 10

4.2.4. Identification of co-integrating vectors and the deterministic component:

The number of significant co-integrating vectors and the deterministic component present in the cointegrating space are investigated simultaneously by using the maximum likelihood based λ- max and λ- trace statistics suggested by Johansen (1991,1995) and Johansen and Juselius (1990,1994). They proposed a 'Trace test' for determining the cointegrating rank 'r' such that:

$$\lambda_{trace} = -T \sum_{i=r+1}^{k} \ln\left(1 - \hat{\lambda}_i\right) \quad \text{.....Eq(59)}$$

and a likelihood ratio test to assess whether there is a maximum number of cointegrating vectors against r+1 such that:

$$\lambda_{\max} = -T\ln(1-\hat{\lambda}_{r+1}) \text{ ..... Eq (60)}$$

with critical values given in Johansen(1995).

Here, in this research three models are estimated to ascertain the deterministic component present in the cointegrating space of the variables. The models tested are: i) where there is 'no data trend at level, and intercept with no trend' is present in the cointegrating space of the variables (Model-1), ii) where there is 'a linear trend at level, and intercept with no trend' is present in the cointegrating space of the variables (Model-2), and iii) where there is 'a linear trend at level, and intercept with trend' is present in the cointegrating space of the variables (Model-3). The search procedure runs from the most restricted form to the least restricted one.

TABLE-4.3 (a)

Deterministic Component and the Rank in the Cointegrating Relationship

Null	Model-1			Model-2			Model-3		
	Eigen value	**Trace Statistic**	**5% Critical Value**	**Eigen value**	**Trace Statistic**	**5% Critical value**	**Eigen value**	**Trace Statistic**	**5% Critical Value**
r = 0	0.013568	60.37858*	35.19275	0.013406	51.69623*	29.79707	0.015410	63.93724*	42.91525
r = 1	0.005513	23.35808*	20.26184	0.005467	15.11898	15.49471	0.005658	21.85034	25.87211
r = 2	0.003086	8.375554	9.164546	9.67E-05	0.261948	3.841466	0.002386	6.472561	12.51798

Note : 1 ***** denotes rejection of the null hypothesis at 5% level

TABLE-4.3(b)

Deterministic Component and the Rank in the Cointegrating Relationship

Null	Model-1			Model-2			Model-3		
	Eigen value	λ max Statistic	5% Critical Value	Eigen value	λ max Statistic	5% Critical Value	Eigen value	λ max Statistic	5% Critical Value
r = 0	0.013568	37.02050*	22.29962	0.013406	36.57726*	21.13162	0.015410	42.08689*	25.82321
r = 1	0.005513	14.98252	15.89210	0.005467	14.85703*	14.26460	0.005658	15.37778	19.38704
r = 2	0.003086	8.375554	9.164546	9.67E-05	0.261948	3.841466	0.002386	6.472561	12.51798

Note.1 ***** denotes rejection of the null hypothesis at 5% level

According to the trace statistic, the investigation found two cointegrating vectors under Model-1, one each under Model-2 and 3. Again, according to the λ_{max} statistic, one cointegrating vector under Model-1, two under Model-2 and one under Model- 3 are observed . Scholars recommended to use the results from λ_{trace} statistic because it takes into account all (n-r) of the smallest eigenvalues and tends to have more power than the λ_{max} statistic (Kasa,1992, Serlatis and King,1997, Wangbangpo and Sharma, 2002). Above all, in the cases where a conflict between these two test statistics occurs, Johansen and Juselius (1990) suggested to use the λ_{trace} statistic. The suggestions of the scholars in this study are followed and in this three-variable system, the analysis found the deterministic term as Model-2, that is,'there is a linear trend at level, and intercept with no trend' is present in the cointegrating space of the variables. Two cointegrating rank (trace Test) is found to be statistically significant in the cointegrating relationships (see Table-4.3 a and 4.3 b).

4.2.5. The Long-run Relationship:

In pursuing the objective of this study it is hypothesized to estimate the model in the linear form below:

$$SX_t = (FX_t, CR_t)' \quad \text{..... Eq. (61)}$$

where, SX_t represents the S&P BSE SENSEX 30 of Mumbai Stock Exchange, FX_t represents the the rupee-dollar spot rates (nominal values) and CR_t represents the daily Weighted Average Rates for borrowing and lending at the Indian Call Money Market. This thesis attempted to estimate the relationship following the methodology recommended by Johansen and Juselius (1990, 1994).

Johansen and Juselius (1990, 1994) have noted that the first cointegrating vector corresponding to the highest eigenvalue is most correlated with the stationarity part of the model; hence the study has followed his recommendation to report the cointegrating relations. After normalizing the stock market indices (lnSX) to one, the long-term relationship amongst the markets corresponding to the highest eigenvalue at the optimum lag order with one cointegrating rank is (see Eq. 62):

$$\ln SX = 1.617614 + 2.220882 \ln FX - 0.314294 \ln CR \quad \text{Eq(62)}$$

SE	(0.24808)	(0.14611)
t-statistic	[-8.95227]	[2.15108]

The findings of this study are consistent with the macroeconomic theories and the empirical works of many scholars in the literature of financial economics (see Wangbangpo, and Sharma ,2002 **(**in Indonesia and Malaysia; FX in Singapore and Thailand), Ajayi, and Mougoue,1996, Chancharoenchai, and Mathur ,2005, Dimitrova, 2005,Mukharjee, and Naka,1995, Ma, and Kao,1990, Badhani, 2006, Nath, Samanta,2003, Bilson, et.al.,(2001) Brailsford, 2001,Pethe, and Karnik, 2000, Kumari and Mahakud2012, Jena et al 2004, Yang et al, 2005,Ray,2008,Ray and Sarkar,2014)).

The most interesting result of this study is the positive relationship amongst foreign exchange market and money market. It possibly points to more imports by India from stronger-currency countries resulting to trade deficits if not backed by enough exports. This finally leads to

depreciation of the domestic currency and rise in import bills, increase in cost of production of the import oriented companies and finally increase interest like call rates, if the imports are totally financed by bank (Dimitrova,2005). Since 1993, the declared policy of the Government of India is to follow the free-float regime and the period under the study witnessed almost rare intervention by the central bank leaving the market to determine the rate. This may also be one of the possible reasons for the positive relationship. Again, rise in call money market rate virtually supports the arguments that higher the call rates higher is the expectation for all the short-term interest rates to increase further. Supporters of the 'Expectation theory' of term structure of interest rates, posit that , subject to some restrictions, the current higher short-term rate and the expectation for future rise in the rates lead to the expectation and realisation of higher long-term rates which may be translated to higher inflation and depreciation of the domestic currency. Higher interest rates also mean higher demand of capital in the economy. Expectation for inflation discourages the overseas investors and more capital out flow leads to more depreciation of the domestic currency cannot be denied. Similar are the finding of the studies by Wangbangpo and Sharma, 2002, for Philippines, and Ray and Sarkar, 2014, for India.

The neo-liberalists theorized and forcefully argue that higher interest rate (equilibrium) attracts more savings thus investment grows which allows investors to earn more return in the stock market but the high interest rates finally depreciates the domestic currency. The positive relationship between capital and foreign exchange market is observed by many scholars in the context of different economies **(** see Swartz,1989 Aamd, & Dg,(2014), Bhattacharya & Mukherjee, (2003), Granger, et al. 2000, Ajayi and Mougoue ,1996, Soenen and Hennigar ,1988, Wu, 2000, Tsai, 2012, Joshi,2015, Machado, et al.2017, Santana, et al. ,2018,Noriller, and Silva, 2019) . It seems natural especially for the developing and import oriented economies as more the out flows of capital to import modern and advanced

technologies, more would be the depreciation in the domestic currencies. Moreover, in the markets with high capital mobility, it is the capital flows and not the trade flows that determine the daily demand for currency (Granger et al,2000).

The negative relationship between the short term interest rates and stock market is very much consistent to the finance and economic theories and is reported by many scholars like, Bulmash and Trivoli (1991) in the case of the United States, Wangbangpo and Sharma (2002) for Philippines, Singapore and Thailand, Adjasi, *et al.* (2008) for Ghana, Mukherjee and Naka,1995, and Maysami and Koh (2000) for Japan , Chancharoenchai, Lu, and Mathur (2005) for south east Asian countries, Bernardelli,et al.,2020 for Brazil,also Noriller, and Silva, 2019, for Brazil.

4.2.6. Test of Autocorrelation in Residuals:

The portmanteau test and the LM test results on the residuals of the co-integrating equation indicate the presence of no autocorrelation up to and at lag ten (see Table-4.4a and b).

Table: 4.4(a)

Results of Portmanteau Test to Detect Autocorrelation

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	Degrees of freedom
1	0.343551	NA*	0.343678	NA*	NA*
2	0.792971	NA*	0.793430	NA*	NA*
3	1.133009	NA*	1.133844	NA*	NA*
4	1.657371	NA*	1.658981	NA*	NA*
5	2.574300	NA*	2.577604	NA*	NA*
6	2.704740	NA*	2.708333	NA*	NA*
7	3.346104	NA*	3.351358	NA*	NA*
8	5.942957	NA*	5.955896	NA*	NA*
9	8.750969	NA*	8.773262	NA*	NA*
10	16.63190	0.3413	16.68338	0.3381	15

Table:4.4(b)

Results of Residual Serial Autocorrelation LM Test

Lags	LM-Stat	Chi-square Probabilities, 9 df.
1	33.50438	0.0001
2	29.26501	0.0006
3	29.15937	0.0006
4	18.02561	0.0349
5	22.44867	0.0076
6	4.962583	0.8376
7	10.07934	0.3441
8	43.85370	0.0000
9	38.82674	0.0000
10	8.620682	0.4730

4.2.7. Signifiance of the Markets in Cointegrating Equation:

As proposed by Johansen (1991), this study has tested the significance of the capital market, foreign exchange market and call money market individually by the likelihood ratio (LR) test. It is observed that all the markets are statistically significant and lies in the core of the co-integration space (see Table-4.5). The stock and foreign exchange market are statistically significant at one percent level and the call money market is at ten percent level of significance (see Table 4.5). According to econometricians, the dependent variable of the cointegrating equation must be in the cointegrating space (Brooks,2014, Greene,2003). Our study also confirms the theory and the stock market is statistically significantly present in the cointegrating space.

Table—4.5

Markets in the Cointegrating Space

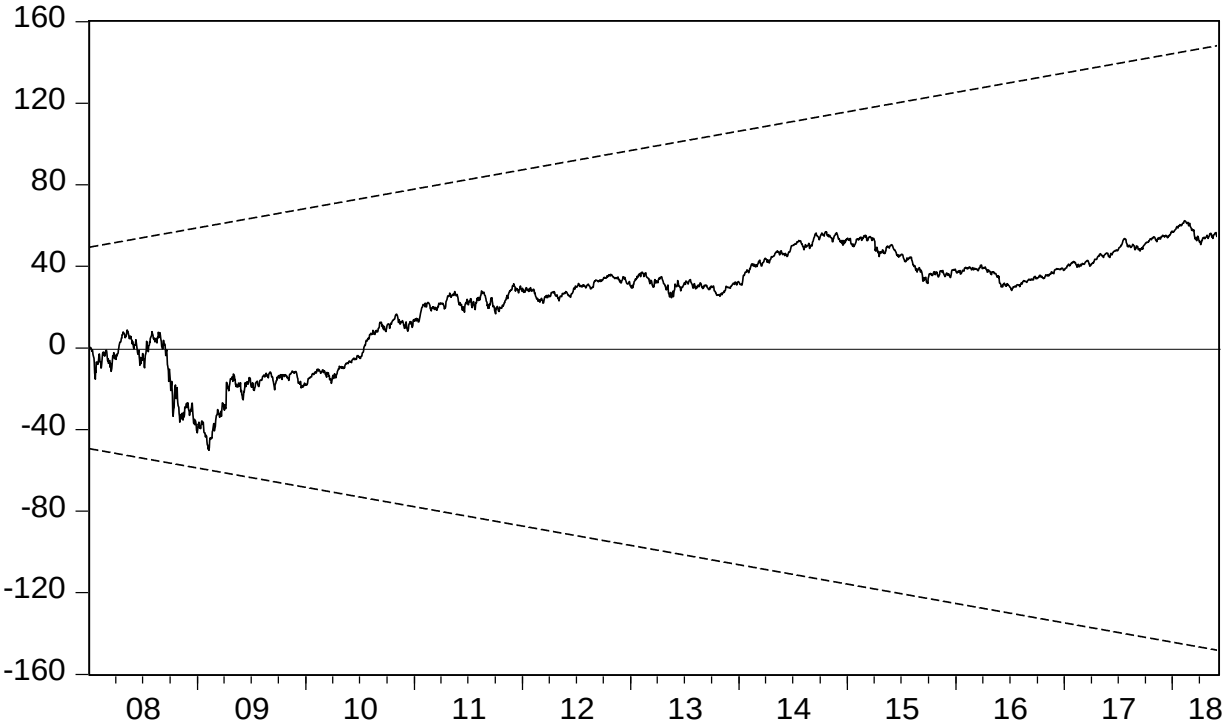
Variables/Markets Restricted	LR Statistic	p-value
Stock Market (lnSX)	16.88030	0.000040
Foreign Exchange Market (lnFX)	21.13997	0.000004
Money Market (lnCR)	2.839265	0.091986

4.2.8. Structural Stability or Break Point Test:

Firstly, this study estimated the CUSUM test and the results are plotted in the Figure-1 below. The results of the CUSUM test depict that, within the time period of our study, there is no break point at five percent level of significance. This result is partially supported by the study of Agarwal and Ghosh, 2015, who found no break points in Indian economy within the time period of 1960 to 2013. Next, tested the structural stability of our model with the process recommended by Quandt(1960)-Andews(1993) and Andrews and Ploberger (1994) is tested. The results are shown in Table-4.6 below:

Figure -4.1

Plot of the CUSUM Test for Identifying Break Point/Points



Note: 1. --------indicates-CUSUM PLOT

2. ……indicates Significance level-95 per cent

Table-4.6

Results of Structural Stability Test for Break Point (15% trimmed data)

(Quandt-Andews Test, Probabilities estimated by Hansen's (1997) method)

Statistic	Value	Probability
Maximum LR F-statistic (6/09/2010)	2.249090	0.7244
Maximum Wald F-statistic (6/09/2010)	2.249090	0.7244
Exp LR F-statistic	0.297212	0.6470
Exp Wald F-statistic	0.297212	0.6470
Ave LR F-statistic	0.499500	0.6463
Ave Wald F-statistic	0.499500	0.6463

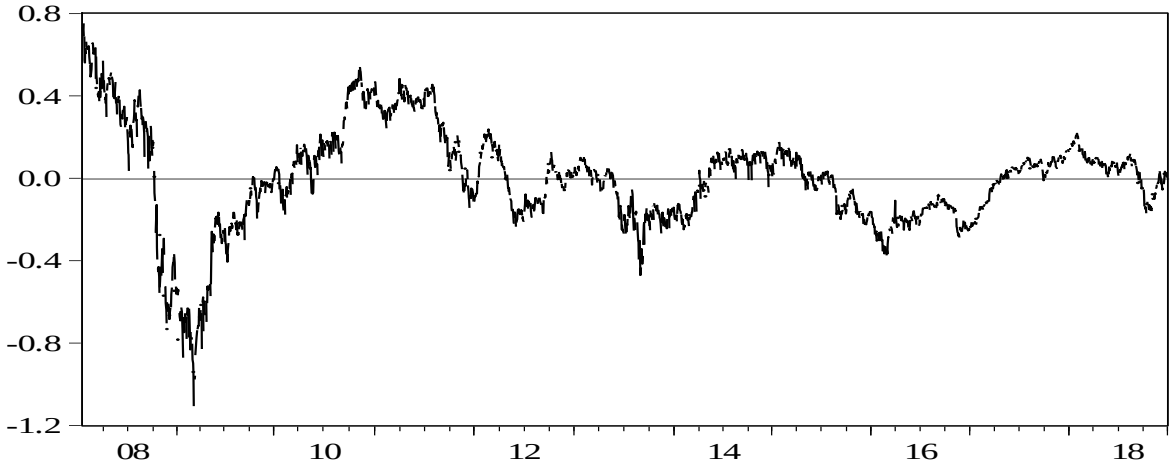
According to the Quandt(1960)-Andews(1993) and Andrews and Ploberger (1994) test there is no structural instability in the long term equilibrium equation is found. Several studies, in the context of India found no break point within the period 1950 to 2013 save 2003 (see Agarwal and Ghosh, 2015, Agarwal, Mitra and Whalley,2015,). Joshi (2015), by applying CUSUM and CUSUM square test found no structural break up to 2014, their end period of study. Counting all the results of our tests, i.e., the results of CUSUM test, the Exp LR F-statistic, Ave LR F-statistic and Ave Wald F-statistic, Maximum LR F-statistic, Maximum Wald F-statistic and Exp Wald F-statistic no break point is found. Hence, the study proceeded to the next phase considering the results suggesting that there is no structural instability.

4.2.9. Levels of Cointegrating Relation:

The figure below (Figure-2), depicts the levels of integration of Stock, Foreign Exchange Market and Money market. According to the plot of the values, this study found fluctuations in the levels of integration of the markets in the period under the study. According to Karolyi and Scultz, 1996, the degree of co-integration of financial markets changes over time which is supported by our finding.

Figure-4.2

Levels of Cointegrating Relation of the Indian Select Domestic Financial Markets (2008-2018)



4.3. The Short-Run Dynamic Behaviour:

In this study, all the error correction terms found statistically significant at 'at least' five percent level of significance (see Table-4.7). The ECM posited to be a force affecting the integrated variables to return to their long-run equilibrium relation when they deviate from it and thus the longer the deviation; greater would be force tending to correct the deviation (Banerjee, et al, 1993). According to the absolute figures, it is found that the speed of adjustment of the call market is relatively higher followed by stock and foreign exchange market. In simple words, the Indian money market is found to be more capable to discount the signals and try to return to equilibrium position relatively more quickly than the equity and foreign exchange markets. It is probably due to the fact that, the Indian money market is very compact and closely participated one. Expectedly, each and every participant in the Indian call money market has the access to information relatively more than the participants of other markets. They can react faster than the participants of the other markets. The results obtained indicate that there is enough scope for further development of the domestic stock and foreign exchange market. In fact, a large number of retail buyers and sellers in domestic segment of the Indian foreign exchange market have little or no role to cast any impact on the market. Similar problems are also faced by the retail investors in Indian stock market.

Table—4.7

Error Correction Terms or Speed of Adjustment of the Markets

Markets	**EC_{t-1}**	**Standard Error**	**t-statistis**
Stock	-0.005870	0.00109	-5.38773 *
Foreign Exchange	0.001023	0.00039	2.59704**
Money (Call)	0.012309	0.00551	2.23283**

Note:1. * means sigficant at 1 percent level and ** means sigficant at 5 percent level.

4.4. The Causal Relationship:

This analysis has estimated the Granger (Engle and Granger 1987) causal relationship between the markets within the framework of vector error correction model. The results are presented in the Table-4.8 a and Table-4.8 b. Results of Granger-Causality/ Wald Exogeneity Test are shown in the Table-4.8 a. and Pair wise Granger Causality test results in the Table-4.8 b. There is bi-directional causal relationship that flows from the stock to call money and foreign exchange market at one percent level of significance and a unidirectional causal relationship from foreign exchange market to call money market only (see Table-4.8 a). That is , the past values of the markets can influence the future values of the all markets under study save , partially call money which fails to influence only foreign exchange market, but foreign exchange market can influence the future values of call market . The results of pair wise Granger causality flows bi-directionally amongst all the markets (see the Table-4.8 b). The presence of feedback causal relation amongst the Indian markets fits well in the literature of' globalization and liberalization that advocates the convergence of the segments of domestic financial markets within and across the economies. The results grossly attest the findings of the co-integration analysis and undoubtedly the past values of the Indian domestic markets influence the future values of the other domestic markets under this study.

TABLE – 4.8(a)

Results of the Test for Granger-Causality/ Wald Exogeneity

Dependent Variable	Excluded Variable (Chi-square value and in parenthesis p-value)			EC_{t-1} (t-statistic)
	ΔlnSX	ΔlnFX	ΔlnCR	
ΔlnSX	--	32.73952 (.0001)*	61.28285 (0.0000)*	-0.005870 (-5.38773)*
ΔlnFX	143.2347 (0.0000)*	--	28.82004 (0.0007)*	0.001023 (2.59704)**
ΔlnCR	65.07632 (0.0000)*	12.70996 (0.1762)	--	0.012309 (2.23283)**

Note:1. * sigficant at 1 percent level , 2. ** sigficant at 5 percent level

Table- 4.8(b)

Results of the Pair wise Granger Causality (Optimum Lag Order Ten)

Null Hypothesis:	Observation	F-Statistic	Probability.
LNFX does not Granger Cause LNSX	2711	4.13729	1.E-05*
LNSX does not Granger Cause LNFX	2711	15.4991	2.E-27*
LNCR does not Granger Cause LNSX	2711	5.46655	4.E-08*
LNSX does not Granger Cause LNCR	2711	7.69118	3.E-12*
LNCR does not Granger Cause LNFX	2711	4.24592	7.E-06*
LNFX does not Granger Cause LNCR	2711	1.96430	0.0333**

Note:1. * sigficant at 1 percent level

2. ** sigficant at 5 percent level

4.5.The Innovation Accounting:

4.5.1. Forecast Error Variance Decomposition:

Forecast Error Variance Decomposition Analysis is carried out by this study for a future period of 50 days for 'one standard deviation' innovation in markets under our study. One co-integrating rank and the optimum lag order and the Choleski ordering (Lutkepohl, 2007) of the variables like stock market first then foreign exchange market and money market are used. Results are shown in Figure-4.3 and Table-4.9 a, b ,and c.

Figure-4.3

Results of the Variance Decomposition

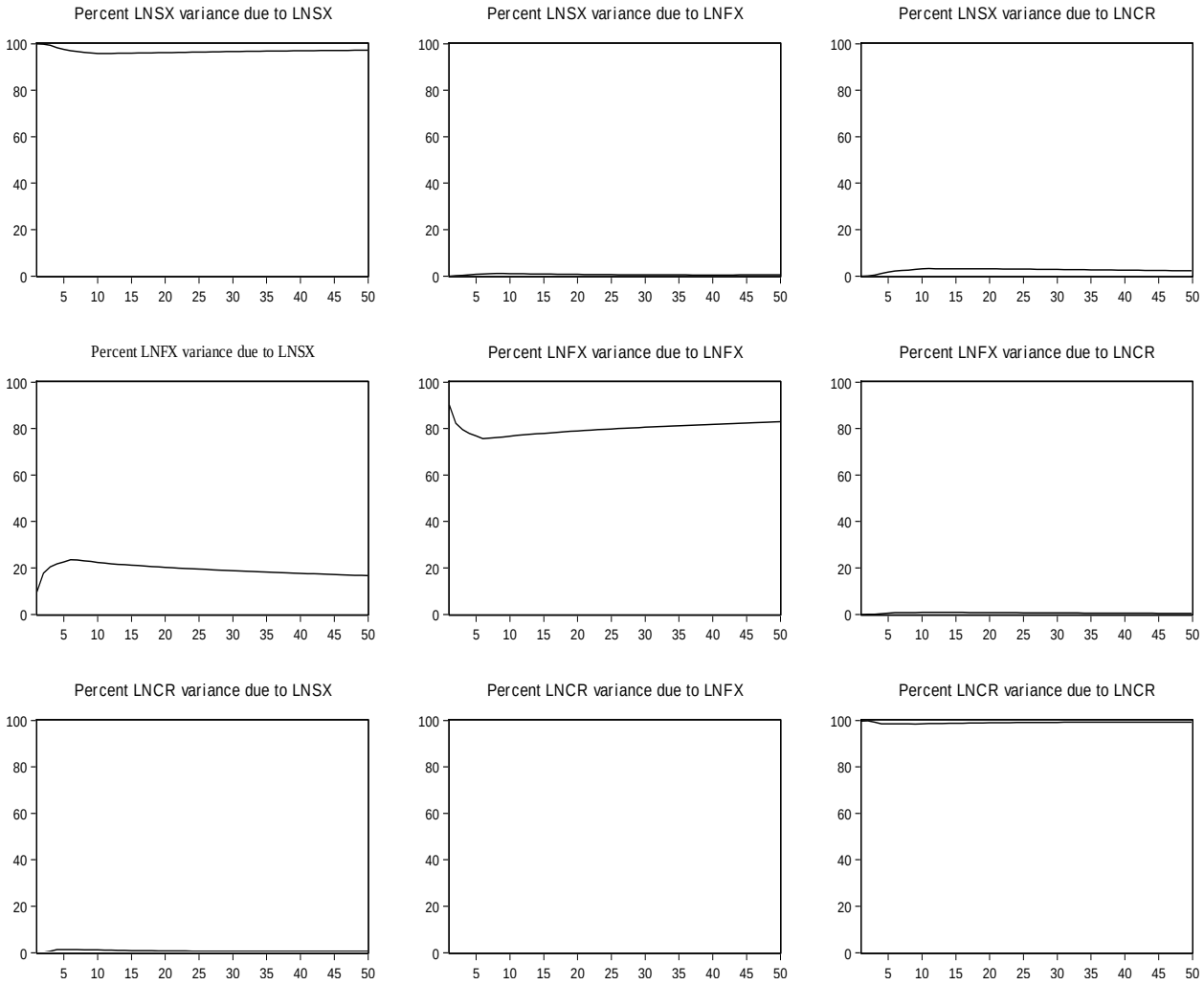


Table-4.9 a
Variance Decomposition
(Variance Decomposition of LnSX)

Period	S.E.	LnSX	LnFX	LnCR
1	0.013660	100.0000	0.000000	0.000000
2	0.019762	99.82230	0.147300	0.030397
3	0.024206	99.29784	0.293865	0.408300
4	0.027935	98.26553	0.567241	1.167229
5	0.030906	97.53940	0.725696	1.734905
6	0.033394	96.98046	0.871008	2.148528
7	0.035506	96.58415	1.003255	2.412591
8	0.037659	96.23073	1.179100	2.590169
9	0.039939	95.99788	1.127422	2.874694
10	0.042132	95.78617	1.052398	3.161430
11	0.044085	95.81078	1.004097	3.185123
12	0.045883	95.86157	0.965004	3.173428
13	0.047576	95.91252	0.927890	3.159589
14	0.049176	95.94935	0.896181	3.154472
15	0.050677	95.97816	0.868964	3.152881
16	0.052104	96.01890	0.842402	3.138701
17	0.053495	96.06314	0.811307	3.125557
18	0.054848	96.10384	0.778357	3.117802
19	0.056151	96.13654	0.748768	3.114688
20	0.057398	96.17185	0.721781	3.106370
21	0.058592	96.21590	0.696383	3.087722
22	0.059739	96.26237	0.672203	3.065429
23	0.060846	96.30895	0.649449	3.041602
24	0.061919	96.35530	0.628077	3.016624
25	0.062958	96.40236	0.607943	2.989694
26	0.063964	96.45020	0.589052	2.960748
27	0.064940	96.49689	0.571486	2.931627
28	0.065886	96.54166	0.555249	2.903094
29	0.066803	96.58502	0.540302	2.874679
30	0.067693	96.62774	0.526659	2.845596
40	0.075374	96.99393	0.461878	2.544193
50	0.081392	97.20772	0.529127	2.263148

Table-4.9(b)
Variance Decomposition
(Variance Decomposition of LnFX)

Period	S.E.	LnSX	LnFX	LnCR
1	0.004940	9.724117	90.27588	0.000000
2	0.007056	17.76295	82.20111	0.035945
3	0.008548	20.47528	79.48344	0.041282
4	0.009867	21.80354	77.88633	0.310136
5	0.011164	22.59095	76.84884	0.560208
6	0.012385	23.54931	75.70484	0.745845
7	0.013529	23.39776	75.83494	0.767308
8	0.014574	23.10791	76.15574	0.736348
9	0.015539	22.82082	76.37377	0.805417
10	0.016465	22.36720	76.72079	0.912017
11	0.017330	22.05559	77.01360	0.930813
12	0.018134	21.77554	77.32037	0.904086
13	0.018900	21.55121	77.57073	0.878057
14	0.019635	21.39331	77.73704	0.869649
15	0.020343	21.21820	77.91719	0.864612
16	0.021023	20.99802	78.15466	0.847317
17	0.021669	20.78553	78.38974	0.824725
18	0.022290	20.59217	78.60255	0.805281
19	0.022893	20.41274	78.79456	0.792702
20	0.023477	20.24185	78.97673	0.781418
21	0.024042	20.07605	79.15748	0.766471
22	0.024586	19.91897	79.33068	0.750348
23	0.025114	19.77105	79.49370	0.735257
24	0.025628	19.62635	79.65238	0.721274
25	0.026128	19.48238	79.81058	0.707046
26	0.026615	19.34140	79.96654	0.692059
27	0.027087	19.20525	80.11760	0.677144
28	0.027548	19.07373	80.26327	0.662993
29	0.027997	18.94540	80.40509	0.649504
30	0.028436	18.81918	80.54464	0.636183
40	0.032326	17.66721	81.81507	0.517723
50	0.035538	16.65100	82.91849	0.430505

Table-4.9(c)
Variance Decomposition
(Variance Decomposition of LnCR)

Period	S.E.	LnSX	LnFX	LnCR
1	0.069113	0.274218	0.000637	99.72515
2	0.075727	0.232204	0.003497	99.76430
3	0.080839	0.706180	0.032315	99.26151
4	0.084555	1.406610	0.095378	98.49801
5	0.087280	1.331026	0.121979	98.54699
6	0.091631	1.361701	0.159187	98.47911
7	0.093741	1.306151	0.152109	98.54174
8	0.095052	1.272674	0.148215	98.57911
9	0.096477	1.238878	0.300575	98.46055
10	0.098705	1.183597	0.314400	98.50200
11	0.101888	1.111448	0.302309	98.58624
12	0.104400	1.068228	0.287947	98.64383
13	0.106823	1.029027	0.280819	98.69015
14	0.109326	0.985177	0.294531	98.72029
15	0.111941	0.940360	0.293346	98.76629
16	0.114523	0.899614	0.283252	98.81713
17	0.116722	0.866334	0.274849	98.85882
18	0.118726	0.837946	0.271892	98.89016
19	0.120760	0.810774	0.270699	98.91853
20	0.122885	0.785304	0.264814	98.94988
21	0.125008	0.761362	0.257527	98.98111
22	0.127044	0.738883	0.250940	99.01018
23	0.129065	0.717981	0.245531	99.03649
24	0.131125	0.698801	0.240107	99.06109
25	0.133205	0.681707	0.233764	99.08453
26	0.135246	0.666228	0.227358	99.10641
27	0.137218	0.652261	0.221413	99.12633
28	0.139156	0.640075	0.215871	99.14405
29	0.141091	0.629781	0.210404	99.15981
30	0.143015	0.621168	0.204949	99.17388
40	0.161339	0.597721	0.161974	99.24030
50	0.178466	0.671582	0.142148	99.1862

The study found, the forecast error variance of stock market is explained by itself almost completely (variation ranges from 100 to 95.7 percent) leaving a marginal scope to the other markets to explain the stock market. Similar results are found in the call money market. It is found to be very marginally explained by the stock market. Only the Foreign exchange market is found to be flexible enough as it can explain itself to the extent of 90 to 75.7

percent and the rest is almost explained by the stock market, (23.54 percent) with an increasing note and call market by one percent.

4.5.2.Impulse Response Analysis

Impulse Response Analysis provides a quantitative idea about the potential responses of the markets against the innovations on themselves and the others over the future period of time. The impulse response of the system is the path whereby the variable, after consuming the shock, returns to the equilibrium position (Greene 2003). The responses to innovations are likely to be sensitive to the ordering of the variables. Following the suggestions of Lutkepohl(2007) and Lutkepohl and Reimers (1992), the variables are arranged as stock market first, followed by foreign exchange market and money market. There is no major logic behind this order save the relative reform measures, till date, initiated by the government of India to make the markets flexible, converging and integrated one. The Impulse Response Analysis is carried on for a horizon of 10 weeks or 50 days and Studentised Hall Bootstrap confidence interval set at 95% level (see Hall 1992).This anlysis has estimated the responses of one market to ‘one standard deviation shock’ of the other markets with the observed co-integrating rank, i.e., one and the optimum lag order. The results of the study are shown in the Figure – 4.4 and Table-4.10 a, b, and c.

Figure – 4.4

Response to Non-factorized One Standard Deviation Innovations

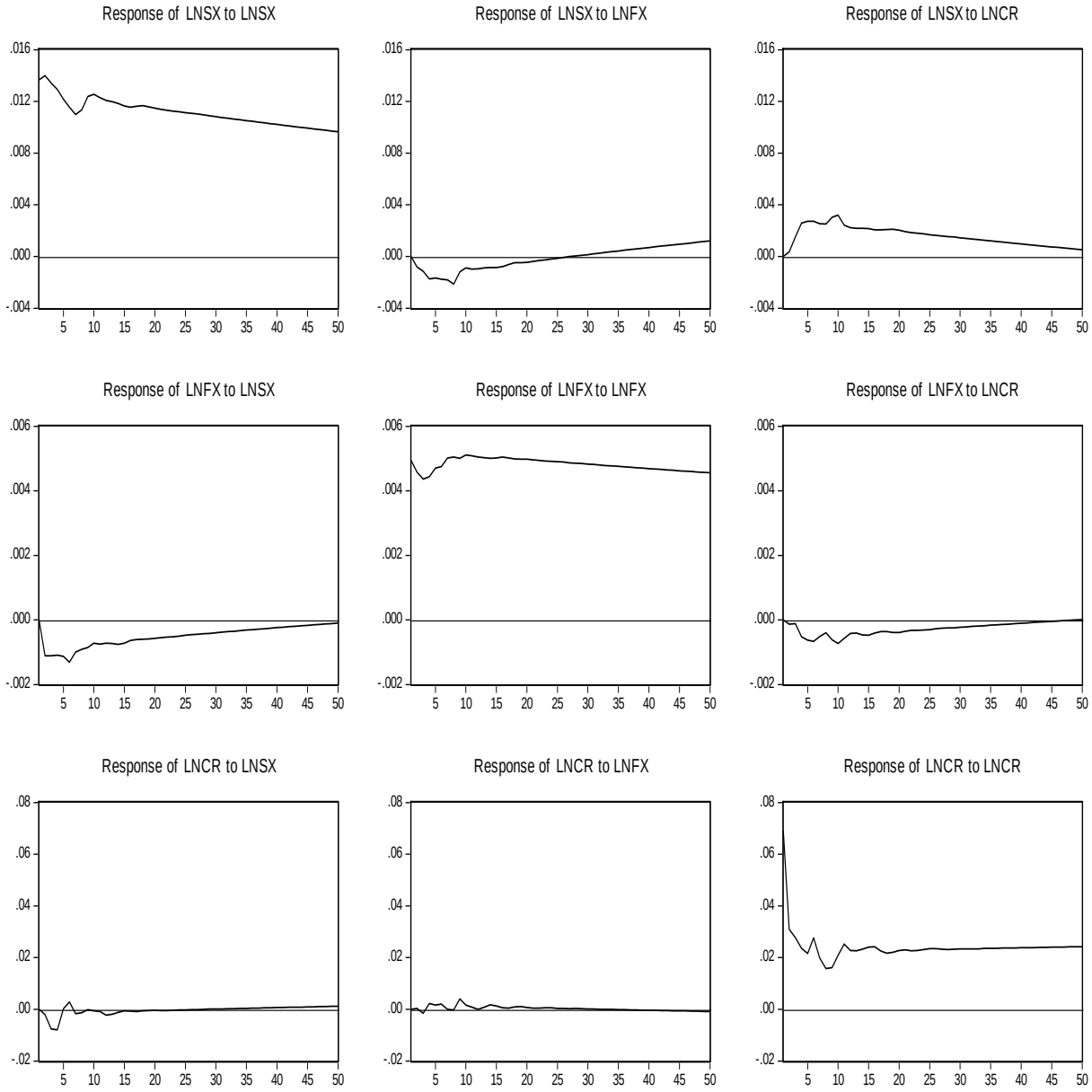


Table- 4.10(a)

Response of LnSX to the Shocks of Markets

Period	LnSX	LnFX	LnCR
1	0.013660	0.000000	0.000000
2	0.013990	-0.000799	0.000345
3	0.013423	-0.001131	0.001510
4	0.012925	-0.001738	0.002595
5	0.012173	-0.001673	0.002736
6	0.011547	-0.001762	0.002722
7	0.010971	-0.001810	0.002544
8	0.011333	-0.002131	0.002517
9	0.012376	-0.001190	0.003024
10	0.012555	-0.000887	0.003208
11	0.012292	-0.000967	0.002408
12	0.012079	-0.000948	0.002218
13	0.011976	-0.000878	0.002173
14	0.011836	-0.000867	0.002186
15	0.011643	-0.000850	0.002168
16	0.011560	-0.000789	0.002062
17	0.011625	-0.000626	0.002060
18	0.011661	-0.000474	0.002088
19	0.011575	-0.000467	0.002103
20	0.011475	-0.000441	0.002037
21	0.011386	-0.000381	0.001916
22	0.011310	-0.000307	0.001846
23	0.011240	-0.000252	0.001794
24	0.011184	-0.000203	0.001748
25	0.011131	-0.000141	0.001689
26	0.011079	-6.88E-05	0.001626
27	0.011018	-4.15E-06	0.001582
28	0.010950	4.67E-05	0.001548
29	0.010881	9.56E-05	0.001508
30	0.010813	0.000150	0.001454
40	0.010215	0.000694	0.000970
50	0.009653	0.001200	0.000525

Table-4.10(b)

Response of LnFX to the Shocks of Markets

Period	LnSX	LnFX	LnCR
1	0.000000	0.004940	0.000000
2	-0.001110	0.004575	-0.000134
3	-0.001108	0.004360	-0.000111
4	-0.001093	0.004436	-0.000522
5	-0.001133	0.004702	-0.000630
6	-0.001307	0.004750	-0.000669
7	-0.000999	0.005012	-0.000511
8	-0.000908	0.005043	-0.000400
9	-0.000859	0.005011	-0.000618
10	-0.000720	0.005113	-0.000727
11	-0.000753	0.005084	-0.000569
12	-0.000721	0.005044	-0.000422
13	-0.000729	0.005028	-0.000405
14	-0.000759	0.005009	-0.000466
15	-0.000718	0.005021	-0.000475
16	-0.000640	0.005043	-0.000409
17	-0.000608	0.005012	-0.000358
18	-0.000597	0.004988	-0.000359
19	-0.000586	0.004983	-0.000392
20	-0.000570	0.004978	-0.000391
21	-0.000548	0.004963	-0.000351
22	-0.000533	0.004939	-0.000325
23	-0.000521	0.004919	-0.000319
24	-0.000503	0.004912	-0.000317
25	-0.000480	0.004905	-0.000300
26	-0.000460	0.004889	-0.000274
27	-0.000445	0.004869	-0.000258
28	-0.000431	0.004853	-0.000251
29	-0.000416	0.004841	-0.000245
30	-0.000398	0.004829	-0.000231
40	-0.000241	0.004688	-0.000104
50	-9.54E-05	0.004557	1.12E-05

Table-4.10(c)

Response of LnCR to the Shocks of Markets

Period	LnSX	LnFX	LnCR
1	0.000000	0.000000	0.069113
2	-0.001979	0.000352	0.030987
3	-0.007658	-0.001529	0.027710
4	-0.007920	0.002221	0.023599
5	0.000278	0.001598	0.021592
6	0.002789	0.002051	0.027632
7	-0.001712	-2.24E-05	0.019796
8	-0.001343	-0.000207	0.015743
9	-0.000174	0.003977	0.016084
10	-0.000615	0.001659	0.020819
11	-0.000800	0.000846	0.025288
12	-0.002225	-2.70E-05	0.022771
13	-0.001933	0.000795	0.022617
14	-0.001224	0.001809	0.023219
15	-0.000580	0.001249	0.024053
16	-0.000690	0.000594	0.024201
17	-0.000819	0.000513	0.022576
18	-0.000555	0.000930	0.021728
19	-0.000477	0.001070	0.022071
20	-0.000383	0.000693	0.022767
21	-0.000430	0.000470	0.022959
22	-0.000511	0.000475	0.022673
23	-0.000419	0.000603	0.022764
24	-0.000286	0.000590	0.023166
25	-0.000203	0.000402	0.023460
26	-0.000187	0.000285	0.023418
27	-0.000154	0.000275	0.023187
28	-5.63E-05	0.000292	0.023148
29	4.79E-05	0.000240	0.023287
30	0.000114	0.000134	0.023378
40	0.000655	-0.000373	0.023810
50	0.001188	-0.000850	0.024223

It is found that, response of stock market due to the shock from (i) itself, shows a positive but decreasing trend up to seven days, then a rise up to 12 days and then decreasing continuously, (ii) foreign exchange market, the stock market responses with the negative but decreasing trend up to 8 days then increasing and crosses that zero line on 30th day then very slowly increasing, and (iii) the call money market, the stock market shows initial positive and increasing response up to 10 days then decreasing and nearing to zero at the 50th day . Response of foreign exchange market due to shock from (i) stock market, shows the negative and decreasing tendency up to eight days then increasing to reach almost zero, (ii) foreign exchange market, shows a positive but decreasing trend up to three days then slightly increases and again starts decreasing from 9th day to 0.004557 at 50th day, and (iii) call money market, shows decreasing tendency up to sixth day then with some ups and downs it is almost zero at 50th day of our future horizon of study. Response of call money market due to the shock from (i) stock market, shows negative and decreasing tendency, and with some ups and downs it remains around the zero, (ii) foreign exchange market, shows initial positive shock then almost flat and nearing to zero, and (iii) call money market, shows sharp fall but positive up to 5th day then remains positive and flat (0.024) up to the 50th day.

According to Roca and Tularam (2011), if the response subsides quickly towards zero then it is said that transmission between the variables (in our case markets) are relatively efficient. Our results show that the markets transmit shock to other markets and responses to the shocks nearing to zero at or up to 50th day of our study indicating all the markets under study will remain integrated at least to the future horizon of 50 days.

In sum, the findings of the Response Accounting suggest a moderate empirical evidence for the gradual integration and efficiency of all the domestic Indian financial markets under the study for the future period of 50 days.

4.6. Summary and Conclusion:

Integration of the segments of domestic financial markets is necessary to reap the benefits of so called 'Globalisation' and international integration of financial markets. Government of India has implemented several reform measures to converge the domestic markets across segments and economies. In assessing the integration of domestic market segments, this study considered major three financial markets –the stock, foreign exchange and money market. In empirical literature it is found that mostly these markets are conventionally or widely scrutinized by the scholars.

In the first step all the time series process under our study are transformed taking natural logarithm and estimated the entire tests with log-level data. The stationarity tests suggest that all the variables representing the markets are significantly integrated to order one (I(1)). With the I(1) time series process this investigation assessed the relationship of the markets based on the methodology suggested by Johansen and Juselius (1990, 1994). Results of the trace test significantly suggest the presence of cointegrating relation and the deterministic term as Model-2, where there is 'a linear trend at level, and intercept with no trend' is present in the cointegrating space of the variables. Results of the cointegration test show the presence of significant long-term stable relationship amongst the markets and all the markets are found to be significantly present in the core of the co - integration space. There is no serial or autocorrelation at and up to the optimum lag order of ten found and used in this study. On the basis of the results of all the tests performed to study the stability of the system, the results obtained are firmly pointing to the stability of the system. The coefficients of error correction terms are statistically significant and according to the absolute figures, the speed of adjustment of the money market is relatively higher followed by stock and foreign exchange

market. Levels of cointegrating relation of the Indian domestic financial markets found in this study do not disappoint the policy planners as it is marked by ups and downs around the critical levels of 95 percent.

Results of the Granger causality test points to the fact that there is bi-directional causality in between the stock and foreign exchange market and unidirectional from foreign exchange market to call money market . In other words, the past values of all the markets grossly influence the future values of all the markets.

The findings of the forecast error variance decomposition analysis indicate that the foreign exchange market followed by stock market would remain flexible over the future period of 50 days and more steps are needed to make the money market more flexible. Our results show that the markets transmit shock to other markets and responses to the shocks nearing to zero at or up to 50th day of our study indicate that all the markets under study will remain integrated at least to the future horizon of 50 days.

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CHAPTER-5

Summary of Findings, Limitations and Scope of Further

CHAPTER—5

5.1 Summary of Findings:

There are endless debates on globalization, free economy and integration of markets. Followers of McKinnon(1973) and Shaw(1973) forcefully argue and advocate that this is the only game in the town (see, Obstfeld 1994, Mohan 2005,Trichet 2005, Lane et al., 2003). Again, scholars like Agenor (2001) , warned the world about the evils of financial integration. Despite the debate on boons and evils of integration, now almost all economies are following the ‘free economic policies' and obviously India cannot live in isolation and started to pursue the ‘free economic policies' from 1992 and attempts to reap the benefits of globalization . The central Bank of India, accordingly, sets the objectives of reform of the financial sector . Reddy (1999,2005) , former governor of the Reserve Bank of India, argued and prescribed that more and more policy reforms are necessary to converge the domestic markets. Integration of domestic markets not only help to reap the benefits of liberalisation across the domestic and international financial sectors but also help to increase the efficiency, integrity and competitiveness of all the sectors —be it real or financial and the outcome of which ultimately be translated to the overall development of the economy.

After searching the literature on financial integration it is observed that the issue of domestic integration has escaped adequate attention of the scholars. Majority of the studies investigated the stock, foreign exchange and money market as secondary or auxiliary issue and a few have investigated the domestic financial markets as the only or primary issue. Moreover, studies in the context of India are rare. Majority of them used monthly data to assess the activities and status of the very liquid market segments. The use of a variety of methodologies, incomplete searching, absence of report on the presence of the variables in the co-integration space, lack of attestation of the Granger causality results by Innovation

Accounting, no proper reporting of the unit root or stationarity test results, etc., and the fractured findings suggest that there is the scope for further research to unveil the intricate relationship amongst the Indian money, exchange and stock market. The primary objective of this study is to investigate whether Indian domestic financial markets are integrated and would remain integrated in future or not. In pursuing the objectives the thesis hypothesised that (i) Indian domestic markets namely, stock, money and foreign exchange market, are not integrated, (ii) past values of none of the Indian domestic markets under the study influence the future values of other markets, and (iii) all the sample domestic markets would remain rigid over the future period of time. Considering a time period of approximately 11 years ranging from 1st January, 2008 to 31st December, 2018, the daily data are collected and used in this study. Government of India has implemented several reform measures to converge the domestic markets across segments . In assessing the integration of domestic market segments, this study considered the major three financial markets –the stock, foreign exchange and money market. In empirical literature it is found that mostly these markets are conventionally and widely scrutinized by the scholars.

This analysis has transformed all the time series process under the study taking natural logarithm and estimated the entire tests with log-level data. The stationarity tests suggest that all the variables representing the markets are significantly integrated to order one. With the I(1) time series process this analysis assessed the relationship of the markets based on the methodology suggested by Johansen, (1991,1995) and Johansen, and Juselius, (1990). Results of the test significantly suggest the presence of cointegrating relation and the deterministic term- a linear trend at level, and intercept with no trend is present in the cointegrating space of the variables which is very common and expected in the studies in finance and economics. Results of the test reveal the presence of significant long-term stable relationship amongst the markets and all the markets are found to be significantly present in

the core of the co - integration space. There is no serial or autocorrelation in the residuals of the cointegrating equation at and up to the optimum lag order of ten. On the basis of the results of all the tests to study the stability of the system, it is found that the results are pointing to the stability of the system. The coefficients of error correction terms are statistically significant and according to the absolute figures, the speed of adjustment of the money market is relatively higher followed by stock and foreign exchange market. Levels of cointegrating relation of the Indian domestic financial markets found in this study do not disappoint the policy planners as it is marked by ups and downs around the critical levels of 95 percent. All these findings reject the first null hypothesis and suggest strong long-term link between the markets.

Results of the Granger causality test (Engel and Granger,1987), in VECM framework, points to the fact that there is bi-directional causality in between the stock and foreign exchange and unidirectional from foreign exchange market to call money market . The pair wise Granger causality run in both direction between the markets. In other words, the past values of all the markets grossly influence the future values of all the markets and reject the second null hypothesis of the study.

The forecast error variance of stock market is found explained by itself almost completely (variation ranges from 100 to 95.7 percent) leaving a marginal scope to the other markets to explain the stock market. Similar results are found in the call money market. It is found to be very marginally explained by the stock market. Only the Foreign exchange market is found to be flexible enough as it can explain itself to the extent of 90 to 75.7 percent and the rest is almost explained by the stock market, (23.54 percent) with an increasing note and call market by one percent. The findings of the forecast error variance decomposition analysis indicate that the foreign exchange market followed by stock market would remain flexible over the

future period of 50 days and more steps are needed to make the money market more vibrant and flexible.

It is found that, response of stock market due to the shock from (i) itself, shows a decreasing trend up to seven days and after 12th day decreasing continuously, (ii) foreign exchange market, the stock market responses with a decreasing trend up to 8 days then increasing and crosses that zero line on 30th day then very slowly increasing but stays around zero line, and (iii) the call money market, the stock market shows initial increasing response up to 10 days then decreasing and nearing to zero at the 50th day. Response of foreign exchange market due to shock from (i) stock market, shows decreasing tendency up to eight days then increasing to reach almost zero, (ii) foreign exchange market, shows decreasing trend up to three days then slightly increases and again tends to zero after 9th day and (iii) call money market, shows decreasing tendency up to sixth day then with some ups and downs it is almost zero at the future horizon of study. Response of call money market due to the shock from (i) stock market, shows initial decreasing tendency, and with some ups and downs it remains around the zero, (ii) foreign exchange market, shows almost flat and nearing to zero, and (iii) call money market, shows sharp fall but positive up to 5th day then remains positive and flat (0.024) up to the 50th day.

In sum, the results of the impulse response analysis show that the markets transmit shock to other markets and responses to the shocks nearing to zero at or up to 50th day of our study indicating all the markets under the study are efficient in transmitting and absorbing the impulses of each other and would remain integrated, at least, up to the future horizon of the study. The results of both the tests reject the third hypothesis and the Indian domestic markets under the study will remain flexible in the near future.

5.2. Policy Implications:

Monitoring and management of liquidity in an economy is a complex task if not difficult. Hence, an objective understanding of the relationship amongst the primary financial markets like capital, foreign exchange and money market, the three pillars of development and growth of any economy, is essential. The policy planners of India would certainly want to know the status of the fixed or equilibrium relationship, if any, amongst the domestic markets. They expect and accordingly would frame policies, so that the markets do not drift too far apart from each other in the long run, rather would expect that the markets can drift together at roughly the same rate and might be stable around fixed mean over time. The findings of this study suggest some policy measures that should be undertaken by the policy planners in India to improve the cointegration amongst capital , foreign exchange and money market, below:

1. Although all the markets under the study are significantly cointegrated but according to the results of short term period (error correction terms) some more measures should be taken to narrow down the gap between the equilibrium state and the position that are enjoyed especially by the money market and stock market during the period under the study.

2. After objective investigation, adequate policy measures should be taken to widen the period of fluctuations in the levels of cointegration amongst the markets.

3. It is observed that the past and current position of money market failed to influence and predict the foreign exchange market. It indicates that, keeping all other findings of this investigation in mind, the link between these two markets is, a bit, weak. Probably the less preference of the global foreign direct investments and the erratic movement of foreign portfolio investments may have produced the results. Hence, more care should

be taken to monitor and manage the foreign capital - both foreign direct investments and foreign institutional investments.

4. Some more reform measures like total capital account convertibility in real sense, more effective use of a single rate to represent the base rate of the economy, are required.

5. According to the observations of this study, stock and money markets are a bit less flexible to react to news of the markets and the economy. Hence, more reform measures and more monitoring are warranted.

In sum, the findings of the study indicate that the overall policy measures are in the right direction, needing only some fine adjustments to tune up more to integrate the Indian domestic financial markets like capital, money, and foreign exchange market which are examined in this study.

5.3. Limitations and Scope of Further Studies:

The results derived and observations made by the study should be accepted with caution due to the inevitable bias and technical limitations of statistical and econometric tools used. Refinements in the observations of empirical studies largely depend on the advancement of statistics and econometrics. This study has not used the modified information criteria in the selection of the optimum lag order of the VAR process. The cases of fractional integration (Wong, et al,2005), if any, are also not considered when testing the order of integration of the time series process and cointegration under the study. There is enough scope to use alternative tools and techniques to improve the outcome of these type of studies and the matter is left to scholars to study in future.

In investigating the link and long run stable relationship, the thesis assumed linear cointegrating relationship. Theoretically, the relation among the markets may well take the

nonlinear form. This possibility is not investigated by this study and can be taken up for further research. The outcome of the study assuming nonlinear form may strongly support integration among the domestic markets or may reject it.

One of the primary objectives of our study is to investigate whether there is any cointegration among the domestic markets or not, but investigation of the probable reasons for cointegration or no integration is beyond the purview of this study, hence, it is left for future studies.

This thesis has not considered yields on Treasury bills instead of call rates to represent the money market. Yield on Treasury bills, especially 91-day Treasury bills, is widely used in the studies of finance and economics. In fact, some scholars have used it but given less attention on the issue. Yield on treasury bill can be used to represent money market in investigating the integration among the domestic markets.

‘Narrow base' but highly traded segment of the Bombay Stock Exchange that is S&P BSE SENSEX 30 is used in the study. This study welcome future studies considering broad base index from the Bombay Stock Exchange or the National Stock Exchange. Similar is the case with foreign exchange market. Real rates in place of nominal rates, basket of currencies or more currencies in place of single currency rates (that is, rupee dollar), forward rate instead of spot rate can be used to study the relationship in future.

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Publications during Research

1. Ray, H., Sarkar, J., & Dey, D. (2017). Domestic Integration: An Empirical Investigation of the Select Segments of Indian Money Market. *International Research Journal of Management and Commerce*, *4*(10), 390-416.

2. Ray, H., Sarkar, J., & Dey, D. (2021). Indian Money and Equity Market: Are They Entwined?. *Modern Economy*, *12*, 516-533.

International Research Journal of Management and Commerce
ISSN: (2348-9766)
Impact Factor- 5.564, Volume 4, Issue 10, October 2017
Website- www.aarf.asia, **Email** : editor@aarf.asia , editoraarf@gmail.com

DOMESTIC INTEGRATION: AN EMPIRICAL INVESTIGATION OF THE SELECT SEGMENTS OF INDIAN MONEY MARKET

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ABSTRACT

In the literature of 'financial integration', cointegration of domestic markets, especially the segments of money market has escaped adequate attention of the researchers. The issue is vital as the absence of integration at the 'base level', like the money market, may deny the economy from the benefits of domestic, regional and international integration of financial markets. This paper attempts to investigate empirically the issue in the context of the select segments of Indian money market on the basis of fortnightly data covering the period from January, 2008 to July, 2016. This study found that, at the log-level, all the variables representing the segments of money market are integrated to the order of one, mutually 'Granger cause' each other except the treasury- bills by the call money market, and enjoy a long run statistically significant relationship save the certificate of deposits market. The call and the treasury- bills market are found to be the prime linkers of the segments where the call money market is more efficient and flexible than the treasury- bills market. Hence, more attention of the Indian policy planners is warranted on the treasury-bills market to make the segment less compartmentalized.

Key Words: Integration of financial markets, Call money market, Treasury-bills market,

Commercial Paper market, Certificate of deposits market, Cointegration, Causality, Impulse Response Analysis, Forecast Error Variance Decomposition Analysis

JEL Code: E 44, G 1,

I. Introduction

Money market is defined as a market for short-term funds with maturities ranging from overnight to one year and includes financial instruments that are considered to be close substitutes of money and, as such, the market is widely considered as the most liquid one in the financial system. It plays a key role in banks' liquidity management and act as the primary link in the transmission of monetary policy impulses to real economy by designing the appropriate instruments and arranging players for liquidity trading. Across the countries, financial institutions prefer to manage their immediate liquidity through money market instruments for financing short-term monetary requirements of various sectors of the economy. Money market instruments with their embedded benefits are indispensible tools for development and growth of an economy, hence, they have to be carefully crafted to play desired roles in the successful implementation of various economic policy measures. The market provides an equilibrating mechanism for demand and supply of short term funds in consistence with the overall monetary policy targeting 'economy-specific-objectives' for development. It is a good option in the hands of economic policy planners to influence both the quantum and cost of liquidity in the financial system and the 'saving- investment' behaviour of all the economic organisms in the economy.

Monitory policy decisions and executions are heavily influenced by the expectation about its future impact on the cost and flow of funds – the aspect which is well discussed and debated by several scholars (Morgenstern 1959, Lutz 1967, Fama 1984, Mankiw and Summers 1984, Ray 2015). Despite several theoretical criticisms and empirical evidences, researchers forcefully posit that expectations about the short-term interest rates shape the returns of the long-term instruments of an economy (Lutz 1967, Brouwer 1995, Oh 1998, Bhoi and Dhal 1998, Bhole 2006). Following the prescriptions of the scholars, economic policy planners in general, adopt a strategy to exert direct influence on short-term interest rates as the central banks have limited control over long-term interest rates. Changes in the short-term policy rates provide signals to financial markets whereby different segments of the financial system are expected to respond by adjusting their rates of return on various financial

instruments depending on the sensitivity of the instruments and the efficacy of the transmission mechanism. Again, the 'efficacy of the transmission mechanism' largely depends on the status—whether integrated or segmented-- of the market segments. Extreme volatility in the segments of the money market can increase the problems of moral hazard with banks expecting the central bank not to function as the lender of last resort but to function as the first one (Mankiw and Summers 1984, Oh 1998, Mohan 2007, Ray,2015). Kang (2001), while studying the behavior of interest rates in the context of Korea, argued for a 'policy' to reduce the risk of economic uncertainty caused by 'big short-term and long-term interest rate differentials'. In a sense, he advocated 'integration' of 'liquid-financial-markets' as a measure to reduce the adverse effects of economic uncertainty resulting from the 'rate differentials'. Hence, integrated money market turns to be an essential condition for the stability of returns of the financial instruments and smooth transmission of monetary objectives of an economy which ultimately augment her development and growth.

Furthermore, it is well documented in the literature of finance that, in free-regime where the primary agenda is the 'frictionless movement of capital' , inter and intra-integrated financial markets of an economy can play an important role to attract the 'foreign capital'. If the markets are segmented, which is a very common feature of the underdeveloped and emerging economies, then it may distort the levels and structure of the interest rates which in turn discourages the 'capital to flow in' mainly due to the uncertainty about the returns. How quickly and effectively the monetary policy actions influences the spectrum of returns—is a big issue to select the investment destinations by the 'smart investors' across the globe **(** Agénor 2003, Kim and Roger 1995, Siklos and Ng 2001 and Darrat and Benkato 2003). Against this backdrop, this paper attempts to investigate the status of the Indian money market considering some select money market segments. In simple words, the primary objective of this paper is to investigate, empirically, the nature, magnitude and direction of the relationship, if any, amongst the segments of the Indian money market. The remaining part of the paper is organized as follows: an epigrammatic review of the previous studies in this context is described in the Section II. Data and time period of study are detailed in the Section III. Empirical methodology and findings are presented in the Section IV and, finally, the Section V concludes the paper.

II. Survey of Literature

In the literature of 'financial integration' quest of the scholars to investigate the issues on 'international integration' is found more than the 'domestic integration'. Surprisingly, the

issue of the integration of the segments of money market has escaped the adequate attention of the researchers, till date. Some major excerpts of relevant studies of the scholars, grossly on the integration of money market, are appended below.

Brouwer (1995) extensively examined the relation between money market and institutional interest rates under the regulated and free-market regimes considering a sample of eight Western Pacific Economies along with some developed economies like, Canada, Japan and United States of America. He admitted the importance of competition, financial liberalization and permanency of money market interest rate shocks in analyzing the changing relationship between money market and institutional interest rates. The author positively argued in favour of integration of money market which ultimately signals for broader and more fundamental financial integration. He basically attempted to develop a model to assess the structural and dynamic relation between 'money market rates' and 'deposit and lending rates' based on banks' assets (reserves and loans) and liabilities (money market borrowings, deposits and equity) along with the (i) probability of payment of loan interest, (ii) default in loan principal, and (iii) monopoly of banks, in the lines suggested by Lowe (1995). The author assessed the integration of domestic financial markets by estimating the relation between (i) money market rates and deposit rates and (ii) money market rates and loan rates, on the basis of monthly data spanning over a period of 20 years and dividing the entire period in four sub-periods. Call and overnight borrowing rates are considered to represent money market rates and CD rates for some countries to surrogate the deposit rates. The study found that: (i) non-stationarity in all the monthly rates, (ii) strong positive and statistically significant correlation between Call and CD rates, and (iii) presence of integration amongst the rates under their study. The author concluded that correlation and integration of the rates were robust only in developed countries.

Bhoi and Dhal (1998) empirically evaluated the 'convergence of Indian financial markets' in the post-liberalisation period. In the free regime, various packages of financial reforms were undertaken by the Government of India following the suggestions initially made by Chakraborty Committee (1985) followed by Vaghul Committee (1987) and the Narashimham Committee (1991). The primary but common recommendations of the committees were to integrate the various segments of the financial markets to achieve a higher level of efficiency which ultimately help to eliminate or reduce the arbitrage opportunities across the financial markets. To assess the state of integration, the authors, firstly, searched the reference rates of the markets on the basis of the descriptive statistics,

tested the stationarity of the variables under their study and then conducted the Granger causality test with the 'qualified' reference rates. In their unit root test based on the methodology suggested by Phillips-Perron (1988) only, they found that all the rates save call rate are non-stationary. In the context of call rates, they considered a three-month moving average of the same which turned out to be a non-stationary one, hence, included the new variable in their main frame of the study. In estimating the relationship, they argued that the causal relationship and the size of long-run elasticity are 'important facts' for any meaningful study of integration of different segments of the financial market. The set of variables under their study finally are the rates of call money (CMR), certificate of deposit (CDR), commercial paper (CPR), deposits (DRT), lending (LRT), 91-day Treasury bill (G91), 364-day Treasury bill (G364), and return on capital (RE) consisting of capital gains and dividend yields, price-earning ratio (PERN) of 100-scrip National Index, 3-month forward premium (FRWD3), 6-month forward premium (FRWD6) of the US dollar and the US Treasury bill rate (USTB). The authors examined the movement of monthly rates covering 60 months from April 1993 to March 1998 only. The study reported a bi-directional causality between call and foreign exchange market (forward premia), between money (91-day Treasury bill rate) and foreign exchange market (forward premia). But, at a higher level of significance, the authors found no causal link between capital market, money and credit market and no integration in capital and call money markets. In the context of only the money market rates, their bi-variate cointegration test results suggest that CPR- CMR3, CDR- CMR3 and CPR-CDR are integrated. In the multivariate analysis, considering the variable G91 as reference rate, they found the treasury-bills market (91-day) as the prime mover of the money market rates. Their attempt to find convergence of various financial markets has yielded mixed results and the integration of domestic and overseas financial markets is not robust.

Similar study has been conducted by Jena et al. (2004) to examine the impact of the policy and institutional reforms in India on narrowing down the inter market divergence. They agreed that in the post-independence but pre-reform period, the Indian financial institutions and markets were under 'control regime' causing the financial system to remain in a highly segmented and inefficient state. They have studied five markets viz. money market, credit market, capital market, government securities market and foreign exchange market for the purpose of testing the 'market integration hypothesis'. Using monthly data spanning from March 1993 to March 2002, their study finally considered seven variables -- call money rate (CMR), certificate of deposit rate (CDR), commercial paper rate (CPR), 91-day Treasury bill rate (TB-91), prime lending rate (PLR), 3-months forward premium

(FRWD), and price earnings ratio of 100 scrips BSE index (PER).They, instead of using some methodologies to ensure stationarity of the variables (Bo Sjo, 2008), used a single methodology (Phillips-Perron, 1988) and found that all the variables are I(1) save the call rate. The authors, like Bhoi and Dhal(1998) , also considered a three-month moving average of the 'weighted average of call rates' which turned out to be a non-stationary one. The study reported the presence of causality amongst the short-term interest rates but no causality between short and long term rates. Money market and foreign exchange market have shown high degree of integration between them. Furthermore, the authors found a lower degree of integration between money market, government securities market and credit market and positive relation amongst call, exchange, treasury bills and stock market. Amongst the money market instruments, they reported a long term stable and positive relation between the three-month moving average of call rates and 91-days Treasury bills but no integration between (i) certificate of deposit rate (CDR) and 91-days Treasury bills and (ii) commercial paper rate (CPR) and 91-day Treasury bills. However, on the basis of the results of both the correlation matrix and the cointegration test, they observed no long-run relationship between the capital market and other short-term markets. The authors concluded that while the reform process has helped in removing institutional bottlenecks to ensure free flow of capital across various segments of the financial markets; the event has not yet been translated into complete integration amongst the markets. Despite the best efforts of the authors, a grey conclusion towards the status of integration of Indian financial markets excited the issue to be researched further.

Murthy and Goel (2009) attempted to analyse the efficiency of the money market as they argue that the stabilization of the interest rates in the long run is possible only if the money market is integrated. The study focused on assessing the efficiency of the money market via integration, the dynamics of the sub-markets, and the transmission and absorption of shocks by the sub-markets. The variables under their study are call money rate, commercial paper rate, certificate of deposit rate and the yield of 91- day treasury bills. Monthly data from April 1993 to March 2008 is used in the study. In their unit root test based on the methodologies suggested by Dickey, and Fuller, (1981), Kwiatkowski, Phillips, Schmidt, and Shin (1992), and Phillips-Perron (1988) and using the 'majority rule' they concluded that all the variables were non-stationary. Using Johansen-Juselius (1990, 1994) methodology of cointegration they have found two cointegrating relations based on 'no intercept and trend' as the 'deterministic trend'. They have also found that: (i) all the variables maintain a long-run stable, positive and significant (except the call rate) relation

amongst themselves, (ii) the speed of adjustment of the call money market is the highest followed by commercial paper, certificate of deposit and T-bills market where the commercial paper rates and call rates are only significant (iii) the condition of call and T-bills market are similar and are rigid up to 60 percent of their variability; commercial paper, certificate of deposit markets are more flexible than call and T-bills market, (iv) uni-directional causality flows from certificate of deposit to commercial paper market and certificate of deposit to call market and the presence of bi-directional causality amongst other variables at five percent level of significance . Interestingly, the authors have found: (i) certificate of deposit rate as the reference rate, (ii) call money with a statistically insignificant cointegration with other markets but most efficient one to return to equilibrium (iii) call rates as the major determinant to forecast errors in other markets, and (iv) treasury-bills market evolved as the most prominent market in the cointegrating relation. All these findings of the study urge the need for a more robust analysis of the issue.

Sanati (2010), examined both the 'domestic' and 'international' integration of the Indian financial markets during the year 1993 to 2007. The author affirms that the increasing 'cross border gross flow of capital' and 'correlation among different asset returns of major financial markets' in India during the last couple of years provided a good platform of inter linkage across different segments of financial markets. To test the domestic integration on the basis of the monthly data, she considered (i) returns of call, 91-days treasury bills and 364-days treasury bills to represent money market, (ii) log of BSE indices and 10-year yield on Government securities to represent capital market and (iii) foreign exchange rates from spot, one, three and six- month's forward markets to represent foreign exchange market. The author started with the correlation technique dividing the sample period in to two sub-periods from the year 1993 to 2000 and 2001 to 2007 and found contradictory results about the status of integration amongst the markets represented by the select variables, especially, in the context of (i) exchange rates and all the other variables and (ii) stock market and yield on 91 days treasury bills. The results are not surprising as the author conducted the study on the basis of almost low frequency data covering a period under the 'Information Technology knowledge boom'. She then attempted to assess the integration of the markets on the basis of the methodology provided by Johansen and Juselius (1990, 1994) in a bi-variate and multi-variate framework. The author claimed the existence of co-movement among the domestic money, capital and foreign exchange markets including a strong co-movement between the short-term money and foreign exchange market. In terms of the short-term inter-bank rate, a

cross-country analysis of the markets showed convergence of two different clusters of countries, where Canada, Germany, India and the UK were the common members. After considering a stochastic time series analysis she found that the Law of One Price holds good for Indian call money market rates along with a very weak cross-border co-integration.

As the integration of domestic financial markets, especially the segments of money market, is not a well examined issue in the literature of financial integration, more observations and prescriptions can be obtained from the thesis of some scholars who, in a different context, have studied the relationship of the variables representing domestic financial markets along with several other macroeconomic, financial and money market variables. Rowe et al, (1986), studied the term structure of the interest rates and the 'expectation theory'. They found positive and statistically significant relation amongst T-Bills yields, Certificate of deposits rates, Commercial paper rates and Call rates (represented by the London Inter Bank Offered Rates (LIBOR)). Bhattacharya and Mukherjee (2003) investigated the nature of the causal relationship between stock prices and macroeconomic aggregates in the context of India. Using monthly data for the period 1990-91 to 2000-01, they found that demand for money affects interest rates. Jain and Bhanumurthy *(*2005) examined the issue of integration of financial markets in India in the post-1991 period by using monthly data of call money rates, 91 day Treasury bill rates, Indian rupee/US dollar exchange rates, and the London Inter Bank Offered Rates (LIBOR). The study observed that there is a strong integration of the domestic call money rates with the LIBOR and a long-term co-movement, although not robust, between domestic foreign exchange market and LIBOR. They have suggested to explore more policy measures necessary to increase integration of financial markets which in turn help to reduce the arbitrage advantage in some specific segment of the financial markets.

In sum, most of the earlier studies on domestic integration of the Indian financial markets used the monthly data to assess the status of the segments of the markets including the very liquid market. Scholars posit that, instead of a long and stable view, the estimations based on the monthly data provide a short-run insight (Dimitrova, 2005). Moreover, the use of a variety of methodologies, incomplete empirical searching and fractured findings suggest that enough scopes are left for further research to unveil the intricate relationship amongst the segments of the Indian money market. Wider policy implications, especially in the overall monitoring and management of the liquidity in the economy, demand the issue be settled on the basis of robust and objective investigation.

III. Data and Time period:

The structure, level and trends of returns of the financial instruments, especially the money market instruments, in India have their own peculiar nature and varied behaviour. For the purpose of the study we have selected only the prominent segments of money market like Certificate of Deposits, Commercial Papers, Treasury Bills and Call money markets. The reasons for selecting the markets are on the basis of the relevant literature in this field and by applying our own economic intuition (Chen et al., 1986, Rowe et al., 1986, Jain and Bhanumurthy, 2005). Fortnightly data are collected from the official sources of the Reserve bank of India for the period ranging from January, 2008 to July, 2016. The data at log-level are used in all the areas of this study.

IV. Empirical methodology and findings

IV (i): Some basic time series properties of the variables:

To assess the level and direction of relationship of the select segments of money market under our study, we, at first, estimated some basic time series properties of the variables. The order of integration of the variables is primarily estimated through Augmented Dickey-Fuller Test (ADF) (Dickey and Fuller 1981, Said and Dickey 1984). In addition to the ADF test, we have used the test suggested by Kwiatkowski, Phillips, Schmidt and Shin (1992). The KPSS test is a unit root test in which the null hypothesis is just opposite to that in ADF test. Under the null, the series in question is I (0) against the alternative I (1). The KPSS statistic has a well defined asymptotic distribution which is free of nuisance parameters and tabled by simulation. The Phillips-Perron (1988) test is also used in this study to avoid the restricted assumptions of ADF-Test that errors are statistically independent and have constant variance. The test is non-parametric with respect to nuisance parameters and therefore suitable for a very wide class of weakly dependent and possibly heterogeneously distributed data (Wong et al, 2005). Under all the tests, we found, the variables at log-level are integrated to the order one with ‘constant’ and ‘constant and trend’ at five percent level of significance (see Table-I, II and III).

Table-I: ADF Test for Unit Root

Variables	With Constant			With Constant and Trend		
	Lag Order (SIC)	t-statistic	p-value	Lag Order (SIC)	t-statistic	p-value
LNCR	1	-2.005284	0.2845	1	-2.172249	0.5020
ΔLNCR	0	-22.63278*	0.0000	0	-22.57631*	0.0000
LNTBL	1	-1.561514	0.5004	1	-1.757065	0.7219
ΔLNTBL	0	-11.20639*	0.0000	0	-11.17851*	0.0000
LNCP	6	-2.086925	0.2503	6	-2.250682	0.4585
ΔLNCP	5	-4.893474*	0.0001	5	-4.881640*	0.0005
LNCD	0	-1.929031	0.3185	0	-2.001442	0.5967
ΔLNCD	0	-18.24989*	0.0000	0	-18.20286*	0.0000

Note: 1) Δ Represents first difference of the respective variables. 2) SIC = Schwarz information criterion. 3) *Indicates rejection of null hypothesis at five percent level of significance.

Table-II: KPSS Test of Unit Root

Variables	With Constant			With Constant and Trend		
	Bandwidth	Test Statistic	Critical Value (at 5% level)	Bandwidth	Test Statistic	Critical Value (at 5% level)
LNCR	4	1.172255*	0.46300	4	0.323645*	0.14600
ΔLNCR	4	0.059717	0.46300	4	0.054506	0.14600
LNTBL	4	1.397036*	0.46300	4	0.347755*	0.14600
ΔLNTBL	4	0.119107	0.46300	4	0.117363	0.14600
LNCP	4	0.765993*	0.46300	4	0.271936*	0.14600
ΔLNCP	4	0.081468	0.46300	4	0.081308	0.14600
LNCD	4	1.040329*	0.46300	4	0.327193*	0.14600
ΔLNCD	4	0.108445	0.46300	4	0.102424	0.14600

Note: 1) Δ Represents first difference of the respective variables. 2) Type of bandwidth is Barlett kernel. 3) *Indicates rejection of null hypothesis at five percent level of significance.

Table-III: Ng-Perron Test for Unit Root

Observed Test Statistics

Variables	With Constant					With Constant and Trend				
	Lag@	MZa	MZt	MSB	MPT	Lag@	MZa	MZt	MSB	MPT
LNCR	2	-6.37013	-1.78391	0.28004	3.84875	1	-8.91674	-2.08936	0.23432	10.3073
ΔLNCR	2	-9.84153*	-2.19292*	0.22282*	2.59122*	2	-20.1863*	-3.17086*	0.15708*	4.55232*
LNTBL	1	-4.94221	-1.56730	0.31713	4.96923	1	-5.29607	-1.60449	0.30296	17.1289
ΔLNTBL	0	-91.6272*	-6.76663*	0.07385*	0.27124*	0	-95.2408*	-6.90031*	0.07245*	0.95852*
LNCP	4	-4.35086	-1.46274	0.33620	5.65306	4	-4.44751	-1.47872	0.33248	20.3877
ΔLNCP	4	-91.3975*	-6.75943*	0.07396*	0.26937*	4	-419.298*	-14.4792*	0.03453*	0.21746*
LNCD	1	-4.49839	-1.49817	0.33305	5.44956	2	-5.26984	-1.59711	0.30307	17.2004
ΔLNCD	1	-20.2753*	-3.16666*	0.15618*	1.27081*	2	-25.6681*	-3.56765*	0.13899*	3.63992*

Critical Values^

Level	With Constant				With Constant and Trend			
	MZa	MZt	MSB	MPT	MZa	MZt	MSB	MPT
1%	-13.8000	-2.58000	0.17400	1.78000	-23.8000	-3.42000	0.14300	4.03000
5%	-8.10000	-1.98000	0.23300	3.17000	-17.3000	-2.91000	0.16800	5.48000
10%	-5.70000	-1.62000	0.27500	4.45000	-14.2000	-2.62000	0.18500	6.67000

Note: 1) Δ Represents first difference of the respective variable; 2) @ Indicates Spectral GLS-detrended AR based on SIC; 3) ^ critical values are provided by Ng-Perron (2001, Table 1); 4) *Rejects the Null at less than five cent level of significance.

In our next step, the optimum lag order used in this study is derived by 'information criteria' like: Akaike Information Criterion (AIC) (Akaike1974), Schwarz Information Criterion (BIC) (Schwarz 1978) and Hannan-Quinn Information Criterion (HQC) (Hannan, and Quinn 1979). It is noteworthy here that none of these criteria are necessarily statistically superior to others (Gujarati, 2003). While Diebold (2001) recommends BIC, many other scholars favour AIC (Stock 1994, Caporale et al 2004). Hence, cautionary approach guides us to explore all the criteria stated above and follow Diebold (2001) in case of any disputes. We observed that the optimum lag order is 'seven', 'one' and 'one' according to AIC, BIC and HQC, respectively. We used 'one' as the optimum lag order throughout our study (Table-IV).

Table-IV: Test for Optimum Lag Order

(Variables: LNCR, LNTBL, LNCP, LNCD)

Lags	AIC	BIC	HQC
1	-9.713564	-9.444050*	-9.604431*
2	-9.803636	-9.264608	-9.585369
3	-9.773825	-8.965283	-9.446423
4	-9.800798	-8.722742	-9.364263
5	-9.855998	-8.508428	-9.310329
6	-9.837045	-8.219961	-9.182242
7	-9.894536*	-8.007937	-9.130599
8	-9.876777	-7.720664	-9.003706
9	-9.776436	-7.350809	-8.794231
10	-9.748716	-7.053575	-8.657377
11	-9.678428	-6.713773	-8.477956
12	-9.677416	-6.443247	-8.367810

Note: 1) *Indicate the best (that is, minimized) values of the respective information criteria, AIC = Akaike information criterion, BIC = Schwartz Bayesian information criterion and HQC = Hannan-Quinn information criterion; 2) VAR Lag Order: AIC = 7, BIC = 1,HQC = 1.

IV (ii): The Relationship

In the process of estimating the relationship, the number of significant cointegrating vectors is estimated by using maximum likelihood based $\lambda_{\max}$ and λ_{trace} statistics introduced by Johansen (1991,1995) and Johansen and Juselius(1990). Econometrically, a linear combination of two variables integrated individually to the order of one may be stationary if the error term from the linear regression equation of the said time series is stationary. Engle and Granger (1987) have shown that under some regulatory conditions one can write a cointegrated process y_t as a Vector Error Correction Model:

$$\Delta y_t = \mu_0 + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \ldots\ldots\ldots\ldots + \Gamma_{p-1} \Delta t_{t-(p-1)} + \Pi y_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots Eq.(1)$$

where Δ is a first difference notation, μ_0 includes (non-seasonal) deterministic components, y_t is a $px1$ vector (p=4 for this study), Γ and Π are coefficient-matrices representing short-term and long-term impacts, respectively and ε_t is residual vector assumed to be independent and identically distributed as multi-normal distribution with mean zero and variance Ω. The central idea of the Johansen procedure is simply to decompose Π in to two matrices α and β, both of which are p x r matrices ($r<p$) such that $\Pi = \alpha \beta'$, hence, the rows of β may be defined as the r distinct cointegrating vectors. Then a valid cointegrating vector will be given by the corresponding eigenvalue (Johansen 1995). Here, α and β are p x r matrices and denote the loading and the cointegrating space or vectors with order r, respectively.

Johansen (1991, 1995) and Johansen, and Juselius (1990) proposes a 'Trace test' for determining the cointegrating rank 'r' such that:

$$\lambda_{trace} = -T \sum_{i=r+1}^{k} \ln(1-\lambda_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq. (2)}$$

and also proposes another likelihood ratio test to assess whether there is a maximum number of cointegrating vectors against r+1 such that:

$$\lambda_{\max}(r, r+1) = -T \ln(1-\lambda_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq. (3)}$$

with critical values given by Johansen(1995). The authors have noted that the first cointegrating vector corresponding to the highest eigen value is most correlated with the stationary part of the model, and hence is followed by this study to report the coefficient of

the cointegrating vector. Moreover, we have estimated three models, namely, M1, M2 and M3 to ascertain the deterministic component present in the cointegrating space of the variables under our study. The models are: 1) where there is no data trend at level, and intercept with no trend is present in the cointegrating space of the variables(M-1), 2) where there is a linear trend at level, and intercept with no trend is present in the cointegrating space of the variables (M-2), and 3) where there is a linear trend at level, and intercept with trend is present in the cointegrating space of the variables (M-3). The search procedure of the deterministic term runs from the most restricted form of the models to the least one. In our four-variable system, 'intercept with no trend' as deterministic component (see Table-V) and three cointegrating ranks are obtained in the cointegrating relationships (see Table VI).

Table V: Deterministic Component in the Cointegrating Relationship.

Null(Alt)	Model-1			Model-2			Model-3		
	Eigenvalue	Trace Statistic	5% Critical Value	Eigenvalue	Trace Statistic	5% Critical Value	Eigenvalue	Trace Statistic	5% Critical Value
r = 0	0.271988	148.7428*	54.07904	0.271988	148.7109*	47.85613	0.301555	164.1512*	63.87610
r ≤ 1 (r > 1)	0.217957	83.98539*	35.19275	0.217855	83.95353*	29.79707	0.241713	90.93598*	42.91525
r ≤ 2 (r > 2)	0.140370	33.83298*	20.26184	0.140369	33.82764*	15.49471	0.140818	34.49063*	25.87211
r ≤ 3 (r > 3)	0.014489	2.977408	9.164546	0.014464	2.972148	3.841466	0.017149	3.528645	12.51798

Note: 1) Model-1 represents 'No deterministic trend with restricted constant', Model-2 represents 'Linear deterministic trend with restricted constant and Model-3 represents 'Linear deterministic trend (restricted)' 2) *denotes rejection of the null hypothesis at 5% level.

Table VI: Cointegrating Ranks of the Sample Variables.

Hypothesized	Trace test			L-Max Test		
No. of CE(s)	Eigenvalue	Statistic	Prob.	Eigenvalue	Statistic	Prob.
None *	0.27198	148.742	0.0000	0.271988	64.75740	0.0000
At most 1 *	0.217957	83.98539	0.0000	0.217957	50.15241	0.0000
At most 2 *	0.140370	33.83298	0.0004	0.140370	30.85557	0.0001

At most 3	0.014489	2.977408	0.5849	0.014489	2.977408	0.5849

Note: *denotes rejection of the null hypothesis at less than 5% level of significance,

After normalizing the call rates to one, the long-term relationship between call rates and other market variables corresponding to the highest eigenvalue at the optimum lag order with one cointegrating rank is:

LNCR= – 0.161708+0.952884LNTBL-0.254037LNCP+0.361938LNCD……..Eq. (4)

SE (0.07688) (0.13762) (0.11846) (0.19403)

t-statistic [2.10338] [6.92402] [2.14444] [1.86537]

The short term adjustment coefficient of the call, treasury-bills, commercial paper and certificate of deposit market are -0.645439, -0.012906, -0.253336 and -0.011371 with SE equals to (0.07755), (0.03833), (0.07559) and (0.04989) respectively and are well within the range of (-)1 to zero. The Portmanteau Test statistics attest the presence of no auto-correlation in the residuals of the above estimated long-term relation (Eq. 4) (Table-VII). As proposed by Johansen (1991), the likelihood ratio test is carried on to assess the 'presence' of the variables in the cointegrating space (Table-VIII). The results obtained indicate that, (i) the treasury-bills and commercial paper segments are only significantly related with the call money market and (ii) the call and treasury-bills markets significantly belong to the co-integrating space and are the major long-term determinants of the Indian liquid market. Hence, the traits in one select sample market are expected to be estimated and explained well by the activities of the other sample markets save the certificate of deposits market. The observed negative relation between call and commercial paper market is well documented in the literature (Pathak, 2011). The findings of this study are consistent with the economic theories and the empirical works carried on by several scholars (Mankiw and Summers, 1984, Brower, 1995, Bhoi and Dhal,1998, Bhanumurthy and Goel, 2009).

Table-VII. Residual Portmanteau Tests for Autocorrelations.

Lags	Q-stat	p-value	Adj Q-stat	p-value	df
1	9.653434	NA	9.700988	NA	NA
2	30.15407	0.3073	30.40460	0.2963	27

3	54.47798	0.1126	55.09155	0.1022	43

Table-VIII.Test of Cointegration Restrictions.

Restrictions on Variables	Null Hypothesis	LR Statistic	Prob.
LNCR	N:$\beta=H_{1LNCR\varphi}$	Q(1)= 11.70747	0.000622
LNTBL	N:$\beta=H_{1LNTBL\varphi}$	Q(1)= 8.932681	0.002801
LNCP	N:$\beta=H_{1LNCP\varphi}$	Q(1)= 1.679701	0.194964*
LNCD	N:$\beta=H_{1LNCD\varphi}$	Q(1)= 1.269442	0.259871*

Note: (*) indicates the rejection of null hypothesis at the 5% level of significance, 'N' tests the exclusion of variables from the cointegrating vector.

IV(iii): Causality

We have estimated the predictive causality of the different segments of the Indian money market within the framework of VECM suggested by Granger (1988). The test involves estimating the pair of regression equations of the form:

$$\Delta Y_t == \alpha_0 + au_{t-1} + \sum_{t=1}^{n} \alpha_{1i} \Delta Y_{t-i} + \sum_{t-1}^{m} \alpha_{2i} \Delta X_{t-i} + \varepsilon_{1t} \quad \text{.....} \quad \text{Eq. (5)}$$

and,

$$\Delta X_t = \beta_0 + bu_{t-1} + \sum_{t=1}^{n} \beta_{1i} \Delta X_{t-i} + \sum_{t=1}^{m} \beta_{2i} \Delta Y_{t-i} + \varepsilon_{2t} \quad \text{.....} \quad \text{.Eq. (6)}$$

where, u_{t-1} equals to the residuals of the regression equations involving Y and X as the dependent and independent variables, ε_{1t} and ε_{2t} are uncorrelated error terms and au_{t-1} and bu_{t-1} are the error correction terms obtained from the cointegrating vectors.

According to Engle and Granger (1987) and Granger (1988), failing to reject Ho: $\alpha_{11} = \alpha_{22} = \ldots\ldots = \alpha_{2m}$ =0 and a=0 implies that X_t 'does not Granger cause' Y_t. Similarly, failing to reject Ho: $\beta_{21} = \beta_{22} = \ldots\ldots = \beta_{2n}$ =0 and b=0 implies that Y_t 'does not Granger cause' X_t. We have assessed the individual influences of all the four variables on each other and found bi-directional causality amongst the markets save only the call market

‘does not Granger cause’ treasury-bills market. This result is obvious in Indian market as the issuance of treasury bills is still under the total control of Indian central bank and is expectedly insensitive, at least in the short-run, to call market. The overall Granger causality results suggest the presence of short-run relation amongst the markets and attest the integration of the segments observed in Eq. (1) (Table-IX).

Table-IX: Causal-relationship of the Select Segments of Money Market.

Null Hypothesis (H_0)	F-Statistic	p-value
LNTBL does not Granger Cause LNCR	139.382	8.E-25
LNCR does not Granger Cause LNTBL	0.71079	0.4002
LNCP does not Granger Cause LNCR	13.0653	0.0004
LNCR does not Granger Cause LNCP	35.5231	1.E-08
LNCD does not Granger Cause LNCR	32.3407	4.E-08
LNCR does not Granger Cause LNCD	29.5222	2.E-07
LNCP does not Granger Cause LNTBL	14.1565	0.0002
LNTBL does not Granger Cause LNCP	66.8636	3.E-14
LNCD does not Granger Cause LNTBL	10.3243	0.0015
LNTBL does not Granger Cause LNCD	95.9667	9.E-19
LNCD does not Granger Cause LNCP	32.0473	5.E-08
LNCP does not Granger Cause LNCD	4.21715	0.0413

V:(iv) Impulse Response Analysis

According to Greene (2006), if we assume that the equation system of a time series y_t is stable, then the equilibrium can be found by obtaining the final form of the system which, by using lag operator and stability condition, is :

$$y_t = \hat{y} + y_t + \Gamma v_{t-1} + \Gamma^2 v_{t-2} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{Eq. (7)}$$

where v_t is the error term. Hence, y_t would reach its equilibrium position $\hat{y}$, if v_t , v_{t-1} ,v_{t-2} equals to zero i.e., v =0 . Now, if a shock is injected to the system by changing one of the v’s in the equation (Eq.7) for one period and then returning it to zero thereafter then one would

find that y_{mt} will move away from, then return to its equilibrium. The impulse response of the system is the path whereby the variable m (i.e., y_{mt}) returns to the equilibrium position.

Response to the innovation is likely to be sensitive to the ordering of the variables under the study. Following the suggestion of Lutkepohl and Reimers (1992) the variables are arranged as follows: LNCR, LNTBL, LNCP and LNCD.

The Impulse Response Analysis is carried on for a horizon of ten fortnights. We have estimated the responses of call rates to 'one standard deviation shock' of other rates under our study and vice versa with all significant cointegrating ranks to check the robustness of the observations obtained from Granger causality test. The test results attest the observations of the Granger causality test. The call market is more sensitive to its own shock; the next best substantial response of the market is to the shocks of the treasury-bills market up to the period of two months and then for the next periods the response is flat. The treasury-bills market is more sensitive to its own shock; the next best substantial response of the market is to the shocks of the call and commercial paper markets up to the period of three and half months and then found flat. Similar results are also found in case of commercial paper and certificate of deposits markets where the next best markets are call and treasury bills, and treasury bills and commercial paper, respectively. Grossly, the result points to the fact that, beyond a period of almost four and half months, all the sample markets are very thinly sensitive to discount the information conveyed by the other markets (Table-X).

Table-X. Impulse Response Analysis.

Response of LNCR to One Standard Deviation Shock in the Variables

Period	LNCR	LNTBL	LNCP	LNCD
1	0.103760	0.000000	0.000000	0.000000
2	0.015653	0.047018	0.022430	-0.016478
3	0.023345	0.046072	-0.023117	0.016822
4	0.010468	0.061307	-0.013223	0.000795
5	0.012903	0.060093	-0.027618	0.011868
6	0.011230	0.063980	-0.026554	0.007637
7	0.012211	0.063667	-0.031507	0.011026
8	0.012188	0.064604	-0.032334	0.010480
9	0.012625	0.064496	-0.034329	0.011740

10	0.012776	0.064659	-0.035129	0.011985

Response of LNTBL to One Standard Deviation Shock in the Variables

Period	LNCR	LNTBL	LNCP	LNCD
1	0.000000	0.050347	0.000000	0.000000
2	0.003898	0.060119	-0.004004	-0.002936
3	0.006763	0.061656	-0.012822	0.000505
4	0.008462	0.062706	-0.018636	0.002202
5	0.009740	0.062878	-0.023698	0.004633
6	0.010589	0.062925	-0.027183	0.006386
7	0.011232	0.062729	-0.029862	0.008018
8	0.011680	0.062490	-0.031733	0.009268
9	0.012008	0.062209	-0.033091	0.010298
10	0.012238	0.061945	-0.034029	0.011085

Response of LNCP to One Standard Deviation Shock in the Variables

Period	LNCR	LNTBL	LNCP	LNCD
1	0.000000	0.000000	0.093365	0.000000
2	0.005245	0.016199	0.054078	0.003876
3	-0.000688	0.036048	0.039045	-0.005186
4	0.002377	0.044537	0.018095	-0.001677
5	0.003455	0.051914	0.006993	-0.003122
6	0.005652	0.055232	-0.004318	-0.000391
7	0.007068	0.057702	-0.011717	0.000942
8	0.008416	0.058780	-0.018005	0.003178
9	0.009373	0.059409	-0.022430	0.004861
10	0.010147	0.059566	-0.025873	0.006537

Response of LNCD to One Standard Deviation Shock in the Variables

Period	LNCR	LNTBL	LNCP	LNCD
1	0.000000	0.000000	0.000000	0.060261
2	0.005529	0.026535	0.014699	0.018247
3	0.005130	0.034256	0.000112	0.020359
4	0.006257	0.043579	-0.003881	0.011711
5	0.007321	0.048380	-0.011078	0.010626
6	0.008212	0.052255	-0.015674	0.008788
7	0.009069	0.054532	-0.020102	0.008710
8	0.009735	0.056118	-0.023381	0.008723
9	0.010302	0.057047	-0.026099	0.009168
10	0.010740	0.057621	-0.028151	0.009635

IV: (v) Forecast Error Variance Decomposition Analysis:

The 'Forecast Error Variance Decomposition Analysis' provides some more information on the strength of a causal relationship between economic variables. It is widely used to measure the relative importance of other variables in influencing a particular variable. In our study, the analysis is carried on for a future period of 10 fortnights for 'one standard deviation' innovation in variables. We have used all the significant cointegrating ranks and followed the order of the variables similar to our estimation of the Impulse Response Analysis. The results are shown in Table-XI. All the markets, at short horizon, are sensitive to their own innovations. However, as the horizon increases the markets are more explained by others save the treasury-bills market which explains itself up to 85 percent (app) till the 10 fortnights. But, interestingly, the power of the treasury-bills market is found to be highest in explaining the other segments. The forecast error variance decomposition analysis grossly reinforces the results of response analysis and Granger causality test results observed in this study.

Table-XI: Variance Decomposition Analysis.

Variance Decomposition of LNCR

Period	SE	LNCR	LNTBL	LNCP	LNCD
1	0.103760	100.0000	0.000000	0.000000	0.000000
2	0.117647	83.31479	13.24176	1.799189	1.644254
3	0.132241	70.21099	24.18427	2.947216	2.657523
4	0.147292	58.04135	36.72270	3.091365	2.144586
5	0.162783	48.67890	44.69319	4.426568	2.201343
6	0.177807	41.63869	50.99505	5.366594	1.999660
7	0.192403	36.28053	55.26237	6.474078	1.983021
8	0.206345	32.15800	58.50364	7.398067	1.940288
9	0.219703	28.91198	60.87826	8.258934	1.950821
10	0.232459	26.31336	62.72158	8.999685	1.965379

Variance Decomposition of LNTBL

Period	SE	LNCR	LNTBL	LNCP	LNCD
1	0.050347	3.003324	96.99668	0.000000	0.000000
2	0.078806	3.905750	95.59171	0.386231	0.116312
3	0.101642	4.283067	93.97748	1.667460	0.071988
4	0.121710	4.446172	92.32106	3.155139	0.077632
5	0.139891	4.512159	90.65325	4.683900	0.150694
6	0.156621	4.533699	89.13510	6.071640	0.259557
7	0.172152	4.536469	87.77143	7.295478	0.396620
8	0.186655	4.531782	86.57968	8.344537	0.544004
9	0.200268	4.525010	85.54346	9.237370	0.694158
10	0.213101	4.518371	84.64854	9.993229	0.839858

Variance Decomposition of LNCP

Period	SE	LNCR	LNTBL	LNCP	LNCD
1	0.093365	6.911315	0.235284	92.85340	0.000000
2	0.110907	9.104544	1.736894	89.05620	0.102358
3	0.122121	9.055078	8.668857	82.04052	0.235547
4	0.131304	9.076811	18.09396	72.61181	0.217418
5	0.141448	8.787997	28.25449	62.72934	0.228171
6	0.152311	8.428841	37.19422	54.17961	0.197333
7	0.163795	8.029896	44.50012	47.29658	0.173403
8	0.175533	7.651944	50.13275	42.03685	0.178455
9	0.187272	7.311660	54.41496	38.06012	0.213256
10	0.198831	7.016329	57.64619	35.05771	0.279776

Variance Decomposition of LNCD

Period	SE	LNCR	LNTBL	LNCP	LNCD
1	0.060261	1.524910	2.134779	12.53060	83.80971
2	0.073407	5.925056	16.07828	16.33772	61.65894
3	0.085569	6.890321	30.23407	12.75423	50.12138
4	0.098227	7.329099	43.76298	9.680602	39.22732
5	0.111642	7.269852	53.72653	7.877480	31.12614
6	0.125452	7.044531	60.74136	7.152401	25.06171
7	0.139294	6.769574	65.40579	7.168670	20.65597
8	0.152899	6.504215	68.51308	7.566526	17.41618
9	0.166114	6.268267	70.57154	8.149384	15.01081
10	0.178851	6.065871	71.95376	8.788196	13.19218

V. Conclusion:

Economic decisions and executions by the economies are heavily influenced by the expectation about the future. The much discussed financial reform process initiated by the Government of India in the year 1991 attempted to integrate the financial markets including the money market. The growth of the markets and our economy in the last more than two decades ignites the need to test empirically the issue of integration of the markets, especially the segments of the money market.

This study found that there exists a statistically significant long-term equilibrium relationship amongst the select segments of the Indian money market save the certificate of deposits market, call and treasury bills market are in the core of the cointegrating relationship but the efficiency of the call market to return to the equilibrium position clearly outperformed all the other sample markets. Expectedly, there is bidirectional causality amongst the segments with the only exception that call rates do not 'Granger cause' the treasury-bills. The reason, primarily, may be attributed to (i) the Indian central bank, till date, can control the supply side of the treasury-bills market, (ii) the poor state of its secondary market, and (iii) the difference in 'holding period' and 'players' compared to the other select segments under the study. Furthermore, the treasury-bills market and call money market are found to be the most prominent segments of the Indian money market, although, compared to the treasury-bills market, the call money segment is more flexible, efficient and less compartmentalized. There are distinct signals that the informational gaps amongst the segments are gradually withering away but more attention of the policy makers is warranted on the treasury-bills market to make it less compartmentalized.

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