International Journal on Emerging Technologies 11(4): 46-55(2020)

ISSN No. (Print): 0975-8364
ISSN No. (Online): 2249-3255

An ARDL Approach to the Dynamic Linkage between Equity Markets and Long-Term Bond Yield: Pre and Post Period of the Global Financial Crisis

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(Received 12 May 2020, Revised 17 May 2020, Accepted 20 June 2020)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: This study examines the impact of the global financial crisis of the year 2008 on the presence of long-run relationships (if any) between the yield on a ten-year government bond and national stock exchange benchmark index nifty by using the monthly observations from December 1995 to July 2019. The key challenge for the study was the availability of suitable literature concerning the pre- and post-impact of the financial crisis of 2008 on the dynamic relationship between the equity index and government bonds with concern to India. For the study, we constructed two sample periods by using a breakpoint of September 2008 for pre-crisis and post-crisis samples. Firstly, we tested the presence of unit-root in both time series by using the Augmented Dickey-Fuller test. ADF test confirmed both time-series are of integrated order of one, i.e., I (1). ARDL model is used to study the short-run dynamics for both variables' pre-crisis and post-crisis period, and we find ten-year government bond yield significantly impact nifty with lag 0, lag 1, lag 3. The ARDL bound test results revealed the presence of no cointegration, i.e., the long-run relationship between the ten-year government bond yield and nifty for both pre-crisis and post-crisis period. The study contributed to new insights about interplay between equity market index and government bonds, which is useful for optimizing the portfolio and for the policymakers to fine-tune their monetary policies to minimize the mutual impact on equity markets and yields on government bonds.

Keywords: ARDL, Bonds, Cointegration, Equities, Financial Markets, Global Financial Crisis

Abbreviations: NSE, National Stock Exchange; ARDL, Auto-Regression Distributive Lag; ADF, Augmented Dickey-Fuller; GFC, Global Financial Crisis; GSEC, Government Security

I. INTRODUCTION

Belke *et al.,* (2017) commented about the global financial crisis of 2008 by exploring the effects of non-standard monetary policies on international relationships between yields of US-European Interest-rates and mentioned that the global financial crisis of 2008 impacted the economies and financial assets all around the globe and generated large shocks which resulted into a deep recession in the financial markets [1]. The risk management and interlinkage between various financial assets went over a toss because of the weakness in financial markets. However, it brought a systematic and structural change in surveillance and operational capabilities to the biggest financial players in the markets. It led to the effective identification of company-wise risk and analysis, constant diligence of independent and arduous assessment run-throughs across the firm, liquidity management, managing of funding the liquidity, and optimization of cost of capital. The sub-prime crisis of 2008 showed the vulnerabilities of financial institutions that were dependent on uninterrupted funding. The change in investors' sentiments regarding equity and bond markets were visible during the crisis, which led to the slowing in the issuance of bonds, rise in the yield of bonds as investors turned cautious, increase in the spread between different maturities of bonds, decreased volumes in secondary markets. Krishnamurthy (2010) argued that the financial crisis, which started in 2007, was especially a crisis in the debt markets by stating and comparing the fall in Dow Jones Industrial Average and mortgage-backed securities [2]. Mustafa *et al.,* (2015) said that the global financial crisis which originated in the U.S. impacted and led to the collapse of many large financial institutions in other countries and the volatility levels in U.S. stock markets surged to almost 200% on a daily basis [3]. Output growth of the world economy dropped by six percentage points from its pre-crisis crest to its trough in 2009. The widespread perception was that emerging economies did well and sustained better than the developed countries during the crisis, as their financial systems were not interlinked at a higher level with the global network. Still, studies by (Blanchard *et al.,* 2010; Lane and Milesi-Ferretti, 2011) shown, keeping in mind the crumple in growth rates, that global financial crisis battered the emerging economies and developed countries in the same way [4, 5]. Growth of real output in emerging economies dropped by about four percentage between Q3: 2008 to Q3: 2008 as it was the most intense period of crisis.

Moreover, emerging nations were capable of using an outsized set of policy tools such as fiscal and monetary ones, which differed across the countries, such as Eastern Europe and Central Asia performed the worst. In contrast, because of the lower degree of trade with the outer world and a low level of financial openness, low-income countries experienced a lesser degree of drops in their output growth. In the context of the Indian economy, the pre-crisis period witnessed a sustained rise in growth and moved to a range of above nine percentage, rested on the strong domestic consumption, investment, and a surge in exports. The combined fiscal deficit of central and state government as a percentage of GDP was in a comfortable position at 4.12 rate, Current account deficit as a percentage of GDP was 1.30 which led to the consolidation of fiscal position and improvement in debt to GDP ratio, but soon after the crisis, stiff liquidity conditions, the slowdown in tax collections, shot up in short-term rates by 100-125 basis points, there was enormous pressure on liquidity. Post the crisis-2008, Indian policymakers took swift actions to support growth. The central bank sliced policy interest rates from 7 percent to a low of 3.5 percent, the yield on ten-year government bonds dropped from 9 percent to 5 percent by the year-end of 2008, and fiscal deficit, which was in manageable position pre-crisis breached 6 percent in the year 2008.John Maynard Keynes commented that long term interest rates determined by the actions taken by the central bank through short-term interest rates and measures in monetary policy. The capital markets which are dominated by secondary markets went under a radical transformation after the global financial crisis, the equity markets which went to a new peak just before the crisis declined to their lowest level three years back. They were in a bull run till January of the year 2008, but from the second quarter of the year 2008, the bears hugged the markets owing to the financial crisis. Therefore, it becomes vital to study the dynamic linkage between the long-term bond yield on government securities and equity markets before and after the crisis of 2008. In this paper, we tried to answer the below-mentioned research questions.

Q1: Were there any changes in the short and long-run relationship between the yield on long term government bonds and equity markets' benchmark index pre- and post-crisis of 2008?

Q2: Was the nature and direction of causality changed between the yield on long term government bonds and equity market's benchmark index, pre- and post-crisis of 2008?

II. REVIEW OF LITERATURE

The equity markets and yield on long term government bonds can provide a clue about the future direction of the growth output of a country. The linkage between asset markets and real economic output was modeled by Irving Fisher. He specifically said that if a recession is expected next year, then an investor will have an incentive to purchase a bond that pays off in the bad times, which will shore up the price of the bond and pushed yields lower. Similarly, the price of a stock reflects the expected cash flows, which indirectly depend on the economic situation. Harvey(1989)by using the quarterly data from 1953 to 1989 and divided into three samples of 140 observations, 94 observations and 54 observations each, and the variables included five-year yield spread, ten-year yield spread, S&P 500 stock returns and economic growth numbers. He concluded in his paper that thirty percent variations in economic growth could be attributed to yield curves and five percent to the stock market variables. The association between prices of stocks and nominal interest rates suggests the ability of an investor to modify the overall structure of the portfolio between bonds and stocks [6]. Hashemzadeh and Taylor (1988) in their study, addressed the relationship between stock prices and interest rates by using weekly data from the period of January 1980 to July 1986. Their regression results found a strong empirical link between stock market prices and market interest rates, although the direction of causality suggested that the relationship was not sensitive to varying lags or leads [7]. Malkiel (1982) commented in his editorial about the risk premium commanded by investors directly related to the prevailing interest rates in the economy gauged by the yields on bonds [8]. Modigilani and Cohn (1979) studied about two mistakes; investors make by considering inflation (indirectly interest rates prevailing in the economy) in their valuation of U.S. equities by failing to correct reported accounting profits and capitalizing the equity earnings at the same rate that follows the nominal rate [9]. Nielsen and Risager (2001) in their study analyzed the returns on bonds and stocks in the context of Denmark from 1922 to 1999, and they came out with an interesting conclusion that over a longer period, equities outperformed bonds. The yield on bonds affects the sentiments of investors and indirectly impacts the return on equities, credit rating agencies rate government bonds. This rating does influence equity returns as government bonds carry a sovereign guarantee [10]. Ferreira and Gama (2007) examined the spillover effects of revisions of ratings by using the S&P history of sovereign ratings that are included in the T.F. DataStream Global Equity Indices Database. The data period was between July 1989 to December 2003 for twenty-nine countries, which met the criteria set by them. They concluded that changes in the credit outlook and sovereign debt ratings had an asymmetric and significant effect on returns of stock markets in the concerned period. Moreover, a downgrade acted as a spillover effect around the world, whereas upgrades had no significant impact [11]. Hsing (2011) studied the quarterly data from Q3: 1997 to Q1: 2001 in the context of Croatia to investigate the linkage between the Croatian stock market index and macroeconomic variables in which euro area government bond yield was one of them. He used regression statistics tools, EGARCH model, and concluded that the Croatian stock market index impacted by euro area government bond yield [12]. Jape and Ambhore (2019) used monthly data from 2014 to 2018 to examine the relationship between bond yield and seven macroeconomic variables in the context of India using regression analysis; they

concluded that both Sensex and Nifty have a moderately negative correlation with the yield on bonds [13]. Panda (2008) deliberated whether stock markets impacted by interest rates, and used monthly data for Sensex and Nifty from April 1996-June 2006 and month-end yields on ten-year government bonds and treasury bills of 15-91 days maturity to take a long term and short term interest rates into consideration. The Johansen-cointegration methodology results revealed that a long-run relationship existed between stock prices and interest rates and short-run causality from ten-year bond yields to stock prices. He concluded that long term interest rates negatively impacted stock prices, whereas short term interest rates positively impacted stock prices [14]. Durreand Giot (2007) examined the relationship between stock index, earnings and bond yields on long term government bonds for a collection of countries (Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Switzerland, The Netherlands, United Kingdom, and the United States) for a period of thirty years by using the quarterly dataset from January 1973 to December 2003, and concluded in their working paper by using cointegration framework developed by Engle and Granger (1987)that a long-run relationship existed between long term government bonds and stock index for a couple of countries and short term empirical results revealed that a rise/fall in bond yields impacted returns on stock markets [15, 16]. Ratanapakorn and Sharma (2007) investigated the relationship between the S&P500 and six macroeconomic variables from 1975 to 1999 and revealed that long-term interest rates negatively impacted the prices of stock. All these studies revealed long term and short-term relationships between stock market index and long-term government bond yields, can the same relationship tested by using forecasts generated from bond yields to beat stock markets [17]. Wong *et al.,* (2001) used standardized yield differential, which is a monthly indicator introduced by (Wong, 1993; Wong, 1994) which consisted of E/P Ratio and the bond yields and applied to ten-year treasury yields of the United States, Germany, and Singapore from January 1975 to December 1994 and concluded that using SYD model. Investors can predict and save themselves from most of the crashes in stock markets, the trading signals and performance of SYD indicator was significantly better than other trading strategies [18-20]. Haubrich (2006) expressed his views in an economic commentary published by Federal Reserve Bank of Cleveland that investors have always been fascinated with forecasting the future, and when it comes to economic forecasting, it matches the inquisitiveness by presenting a gamble to turn a profit. The yield curve as a forecasting tool made to the news because it might forecast a recession; as of now, economists do not presently have a well-accepted theory of why the yield curve forecasts future economic growth [21]. Wang and Yang (2012) investigated why an inverted yield curve could assist as a leading indicator of an upcoming recession. They employed an IS-LM model with long term interest rates and demonstrated that an inverted yield curve might act as a leading indicator for an impending recession [22]. Zakamulin and Hunnes (2020) used historical data of almost 150 years to study the relationship between stock's earnings and bond yields by using a vector error correction model where they allowed for multiple structural breaks. Their results suggested the presence of an equilibrium relationship throughout 1871-1932 and 1958-2017 [23].

The main motivation for this research paper was to study the changes (if any) in the short- and long-term relationship between ten-year government bond yield and national stock exchange benchmark index nifty pre- and post-crisis of the year 2008. We applied ARDL long run bound test for the monthly observations of ten-year bond yield and Nifty from Dec 1995 to July 2019.

III. MATERIALS AND METHODS

For our investigation, we used monthly observations from Dec-1995 to July 2019. The entire study period is divided into the pre-crisis period and the post-crisis period.

Bifurcation of the study period in the pre-crisis and post-crisis period.

Pre-Crisis Period	Dec 1995-September 2008	154 observations
Post-Crisis Period	October 2008-July 2019	130 observations

Ten-year government yield is used as a proxy for long term interest rates and Nifty as a benchmark index for the Indian economy. Although data is available a way back from 1995, Nifty started its journey as an index from November 1995. The information for ten-year bond yield has been collected from the web portal of tradingeconomic.com, and for nifty, we referred to the National stock exchange web portal. For the Unit root test and ARDL test, the data is transformed into natural logs.

A. Econometric Tools

Preliminary Test. Descriptive Statistics such as mean, median, mode, skewness, kurtosis, and Jarque-Bera test will be used to understand the nature of data.

Mean: Mean is a measure of central tendency and represented by a single number which is calculated by using the formula

$$\mu = \frac{\sum x}{N}$$

Median: The value that lies in the middle of the data when the data set is ordered. If the data set has an odd number of entries, then the median is the middle data entry. If the data has an even number of entries, then the median is obtained by adding the two numbers in the middle and dividing result by two

When N is odd $\frac{(N+1)^{th}}{2}$

When N is even $\frac{\frac{N^{th}}{2}+\left(\frac{N}{2}+1\right)}{2}$

Standard Deviation: Standard deviation is a measure of dispersion, lower value of standard deviation states that observations are closer to the mean whereas a higher standard deviation value indicates observations are at a distance from the mean. The formula for standard deviation is stated below:

$$s = \sqrt{\frac{\sum_{i=1}^{N}(y_i - \bar{y})^2}{N-1}}$$

Skewness: It is a measure of the asymmetry of the distribution of the series around its mean

$$S = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i - \bar{y}}{\hat{\sigma}}\right)^3$$

Where $\hat{\sigma}$ is an estimator for the standard deviation that is based on the biased estimator for the variance. The skewness of asymmetric distribution, such as the normal distribution, is zero. Positive skewness means that the distribution has a long right tail and negative skewness implies that the distribution has a long-left tail

Kurtosis: It measures the peaked-ness of flatness of the distribution of the series which is computed as

$$S = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i - \bar{y}}{\hat{\sigma}}\right)^4$$

Where $\hat{\sigma}$ is based on the biased estimator for the variance. The value of kurtosis for the normal distribution is 3; if the value exceeds 3, the distribution is leptokurtic, i.e., peaked relative to the normal whereas if the value is less than 3, then distribution is platykurtic, i.e., distribution is flat relative to the normal.

Jarque-Bera: It is used to test whether the given series is normally distributed. It measures the difference between the skewness and kurtosis of the series from the normal distribution. It is computed as

$$= \frac{N}{6}\left(S^2 + \frac{(K-3)^2}{4}\right)$$

Where S is Skewness and K is Kurtosis

Unit Root Test. Empirical analysis based on time series assumes that time-series are stationary. A stochastic process is said to be fixed if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed, For the test of stationarity, we used Augmented-Dickey Fuller test whose equation is as follow:

$$\Delta Y_t = \beta_1 + \beta_2 + \delta Y_{t-1} + \sum_{i=1}^{m}\alpha_i \Delta Y_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where ε_t is a pure white noise error term and where $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}), \Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$ etc. In the ADF test, we still test whether δ =0 and the ADF test follows the same asymptotic distribution as the D.F. statistics so that the same critical values can be used.

B. ARDL approach

Pesaran *et al.,* (2001 developed the Auto-Regressive Distributed Lag (ARDL) procedure for testing cointegration developed. It allows estimation of the cointegration relationship to be estimated by ordinary least square once the optimal lag order is identified [24]. There is no pre-requisite for testing of unit-root in the bound test procedure, which means ARDL procedure can be used with mixed order of integration series, i.e., I (0) and I (1) or both. The basic equation form for an ARDL model is as

$$y_t = \beta_0 + \beta_1 y_{t-1} + \ldots\ldots + \beta_k y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \ldots\ldots\ldots + \alpha_q x_{t-q} + \varepsilon_t$$

where ε_t is a random disturbance term

The error correction method integrates the short-run dynamics with long-run equilibrium without losing long run information. The ARDL model to examine the long run and short-run relationship is as follows:

$$\Delta LNIFTY_t = \delta_0 + \delta_1 T + \delta_2 LGSEC_{t-1} + \sum_{i=1}^{q}\alpha_i \Delta LNIFTY_{t-1} + \sum_{i=1}^{q}\beta_i \Delta LGSEC_{t-1} \ldots (2)$$

Where T is time trend, and L means the variables have been transformed in natural logs. The first of the equation (2) with δ_2 refer to the long-run coefficients and the second part with α, β refers to the short-run coefficients.

The null and alternative hypothesis of no cointegration is

H_0: δ_2=0 $\qquad$ H_1: $\delta_2 \neq 0$

C. ARDL bound testing approach

To test for the existence of the long-run relationship between variables, a Wald test (F-statistics)for the joint significance of the coefficients of the lagged levels of variables is conducted, and then calculated F-statistics is compared to the tabulated values at lower bound and upper bound. If the F-test value is greater than the lower bound and upper bound at a 5% significance level (we are using a 5% significance level for this study), then the null hypothesis can be rejected. If the F-value falls between lower and upper bound, no inference can be drawn.

IV. RESULTS AND DISCUSSION

A. Descriptive Results

The pre-crisis period consists of 154 observations, and the post-crisis period comprised of 130 observations. Figure 1. shows that the pre-crisis period observations are not normally distributed around the mean as inferred from Jarque-Bera *p*-value. In contrast, post-crisis the observations in figure 2 are normally distributed. Kurtosis value tells the height and sharpness of the central peak, relative to that of a standard bell curve. The pre-crisis period kurtosis value is greater than three, which means the leptokurtic nature of the curve, i.e., nifty has more values in the distribution tails. In contrast, the post-crisis, the kurtosis value of 2.10 indicated the platykurtic nature of distribution which means, fewer extreme outliers than the normal distribution. In both the samples, observations are positively skewed, which is also confirmed by a mean value greater than the median value. Figure 3 and Figure 4 shows the descriptive statistics with a histogram for both pre-crisis and post-crisis period for the g-sec variable.

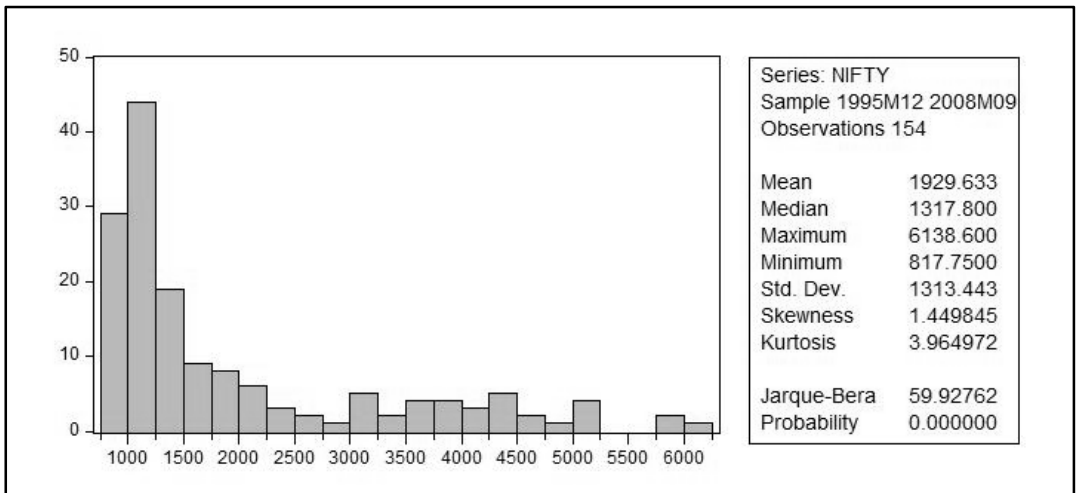

Fig. 1. Pre-Crisis NIFTY descriptive.

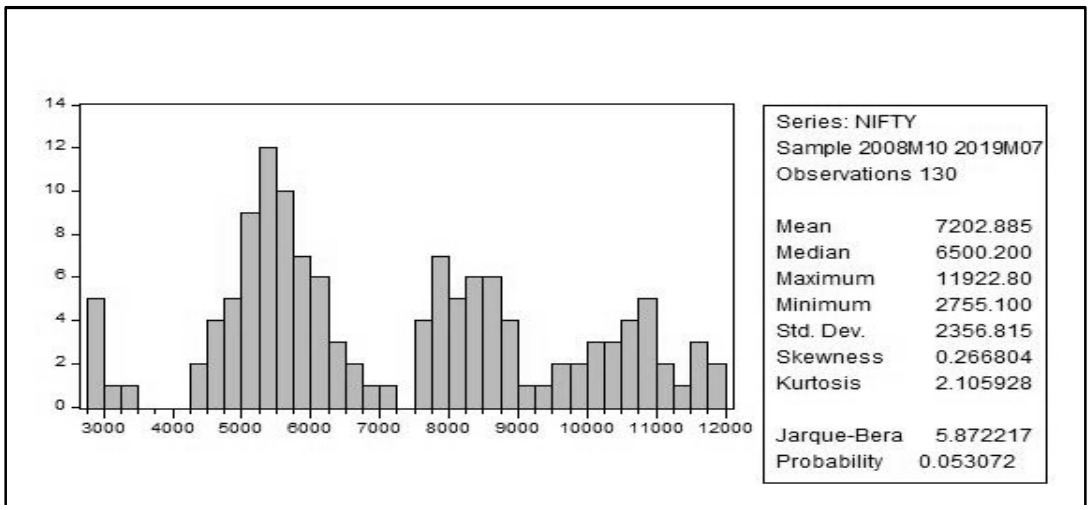

Fig. 2. Post-Crisis NIFTY descriptive.

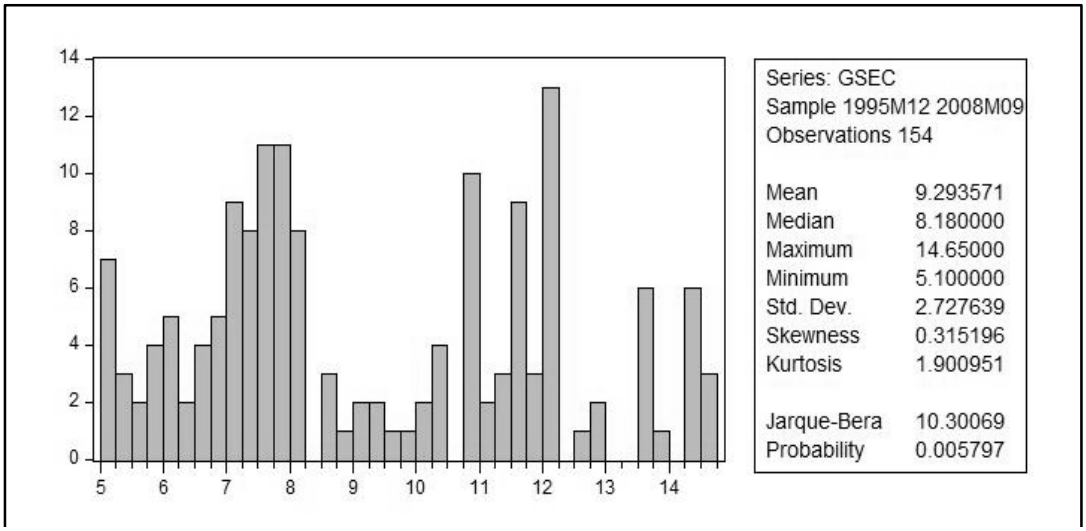

Fig. 3. Pre-Crisis GSEC Descriptive.

The observations of g-sec time-series during pre-crisis are not normally distributed as the *p*-value of Jarque-Bera statistics confirm. In contrast, post-crisis, the distribution is normal, the g-sec variable following the same distribution pattern as nifty. The width of the distribution in the pre-crisis period is quite larger as compared to the post-crisis period, which can be inferred from the high standard deviation value of 2.72 in the pre-crisis period as compare to 0.70 post-crisis. The nature of the curve turned to leptokurtic in the post-crisis period suggesting heavy tails in the distribution. In contrast, pre-crisis period distribution has fewer and less extreme outliers than the normal distribution.

B. ADF Unit Root Test

H_0: There is a presence of Unit root

H_1: There is no existence of Unit root

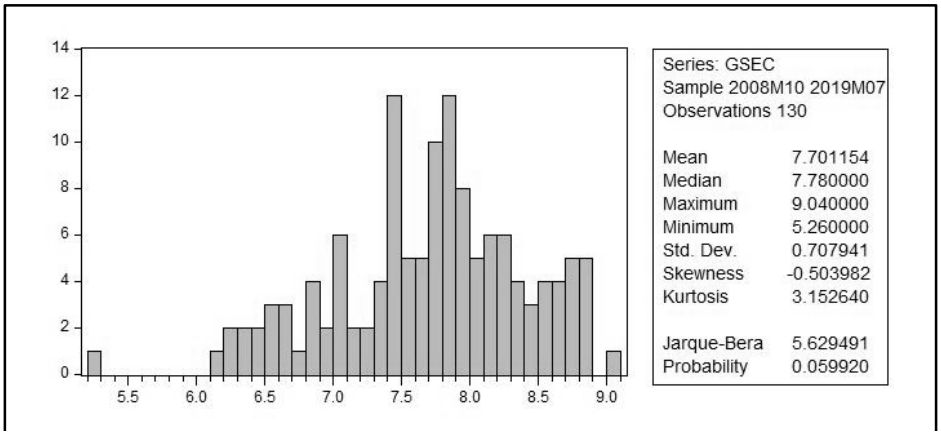

Fig. 4. Post-Crisis GSEC Descriptive.

Table 1: NIFTY ADF Unit root test results.

Level				1st difference			
Intercept		Trend & Intercept		Intercept		Trend & Intercept	
t-Statistic	p-value	t-Statistic	p-value	t-Statistic	p-value	t-Statistic	p-value
-0.614345	0.8639	-2.52651	0.3151	-16.5635	0.0000	-16.53266	0.0000

Notes: *p< 0.05.

Table 2: GSEC ADF Unit root test results.

Level				1st difference			
Intercept		Trend & Intercept		Intercept		Trend & Intercept	
t-Statistic	p-value	t-Statistic	p-value	t-Statistic	p-value	t-Statistic	p-value
-2.63663	0.0868	-2.479678	0.3381	-9.653509	0.0000	-9.715349	0.0000

Notes: *p< 0.05.

Akmal (2007), although it's not necessary to conduct a unit root test in case of an ARDL approach, it's better to identify the order of integration to check the presence of second-order integration if there is any[25]. For this study, we followed the Augmented Dickey-Fuller test, which tests the null hypothesis of the presence of unit root in a time series. We conducted the test both for intercept, trend, and intercept. Table 1 presents the output of the ADF unit root test results for nifty& Table 2 for g-sec conducted by EViews. Both the time series are not stationary at level but become stationary at the first difference, i.e., nifty, and g-sec are of integrated of order 1, I (1).

C. *ARDL Test Results*

After checking for the order of integration, we can proceed with the test of cointegration through ARDL bound test approach. The main exercise in the use of the A.R. model is the identification of autoregressive lag length. In this regard, several lag length selection criteria have been used in econometrics to decide the Autoregressive (A.R.) lag length of time series. In brief, an Auto-Regressive method of lag length p represents a time series in which its present value is determined on its first p lagged values and is generally denoted by A.R. (p). To mention here, that the lag length p in A.R. process is always unspecified and therefore has to be assessed via various lag length selection criteria; Akaike's information criterion (AIC), Akaike(1973) [26], Schwarz information criterion (SIC)Schwarz(1978) [27], Hannan-Quinn criterion (HQC) Hannan *et al.,* (1978) [28] and Bayesian information criterion (BIC) Akaike (1979) [29].

The choice of a lag-length determines the efficacy of the model as the lag selection is a sensitive choice. Lütkepohl (2005), in his book "*New Introduction to multiple time series analysis,"* mentioned that an increase in mean square forecast errors of the VAR could be observed if one selects a higher-order lag

length than the actual lag length. The commonly used approach for selection of lag order is to examine among different information criteria and select the model that minimizes these information criteria [30]. Maghyereh (2002), in his study that cointegration tests are quite sensitive to the choice of the lag length, therefore, to determine the optimal lag length, we must run the VAR model [31]. Hsiao (1981) said if lag lengths are too few, it can lead to miss-specification of the model, whereas a considerable lag length led to the loss of degrees of freedom [32]. For the selection of optimal lag length for the ARDL model, we used Vector Auto Regression (VAR) on the log of nifty (lnifty) and log of g-sec(lgsec) using statistical information criteria. The VAR model is fitted for various lengths, and a certain statistic is calculated. Sarkar and Kanjilal (1995) in their study, mentioned that the lag-length with the smallest statistics in a model is to be selected, [33]. Given the monthly frequency of the data, we used 12 lags for the initial VAR model, has also done in the study by Hamilton and Herrera (2004) analysing the role of monetary policy on oil shocks and aggregate macroeconomic behavior [34] in investigating the role of monetary policy on oil shocks and aggregate macroeconomic behavior. After running the initial VAR model, we proceed to lag-length criteria. For the pre-crisis period, the lags for the ARDL model is lag one as S.C. information criterion. For the post-crisis period, the lag length for the ARDL model is three as the S.C. information criterion. After obtaining the lags for ARDL model, we will run the ARDL estimation equation EViews ARDL estimation process allows the researchers to select automatic lag selection where the auto-generated process test regressors and dependent variables on different combinations of lag orders and the fixed lag allow to fix the lags, both for regressors and dependent. We used Automatic selection; however, we fix the lags both for regressors and dependent variables up to a maximum of lags, which we selected through the VAR model. The results for the ARDL short-run model are presented in Table 3 and Table 4 for the pre-crisis period and post-crisis period, respectively. Table 3 shows the output of the ARDL short-run model for the pre-crisis period, where the dependent variable is lnifty, and the regressor is lgsec.

Table 3: ARDL Short-Run Model Pre-Crisis.

Variable	Coefficient	Std. Error	t-Statistic	*p-value*
lnifty (-1)	0.996518	0.011784	84.56274	0.0000
lgsec	-0.576297	0.185182	-3.112051	0.0022
lgsec (-1)	0.547278	0.185371	2.952333	0.0037
C	0.09678	0.114771	0.843242	0.4004
R-squared	0.983503	Mean dependent var		7.390508
Adjusted R-squared	0.983171	S.D. dependent var		0.562567
S.E. of regression	0.07298	Akaike info criterion		-2.371479
Sum squared resid	0.793576	Schwarz criterion		-2.292251
Log-likelihood	185.4181	Hannan-Quinn criteria		-2.339295
F-statistic	2961.04	Durbin-Watson stat		2.041894
Prob(F-statistic)	0.0000			

Notes: *p< 0.05

Table 4: ARDL Short-Run Model Post-Crisis.

Variable	Coefficient	Std. Error	t-Statistic	*p-value*
lnifty (-1)	0.977756	0.014491	67.47414	0.0000
lgsec	-0.0558	0.118159	-0.472246	0.6376
lgsec (-1)	0.018834	0.151055	0.12468	0.901
lgsec (-2)	0.296271	0.150718	1.965729	0.0516
lgsec (-3)	-0.387702	0.118889	-3.26103	0.0014
C	0.466872	0.181657	2.570078	0.0114
R-squared	0.974331	Mean dependent var		8.825563
Adjusted R-squared	0.973296	S.D. dependent var		0.346626
S.E. of regression	0.056643	Akaike info criterion		-2.859025
Sum squared resid	0.397852	Schwarz criterion		-2.726677
Log-likelihood	191.8366	Hannan-Quinn criteria		-2.805248
F-statistic	941.3428	Durbin-Watson stat		1.823326
Prob(F-statistic)	0.0000			

Notes: *p< 0.05

The coefficient value for one lagged value of lnifty and of lgsec are significant at a 5% level and impacting the dependent variable lnifty positively, whereas the coefficient value of lgsec is significant at a 5% level but impacting the lnifty negatively which is in line with the study by Kalu *et al.,* (2020) where they found that the estimated coefficients of the US10YBY were negative and statistically significant [35]. Any change in the yield of ten-year government bond impacts price behavior of nifty negatively when considered at a zero lag, but as nifty started to discount the new information, the one month lag of gsec has a positive impact on nifty; however, the magnitude of the effect is approximately similar in both the situations whereas post-crisis, the dynamics changed with the coefficient of zero lag of lgsec, one lagged value of lgsec and two lagged value of lgsec becomes insignificant at a 5% significance level. In both, the sample period, one lag value of lnifty is significantly positive at a 5% significance level. If we observe the ARDL short-run model post-crisis period, nifty is impacted negatively with a lag of three months as the coefficient of lgsec is significant at a 5% significance level. The finding is in line with the study done by Estrella and Mishkin (1996)[36].The difference in the level of informational efficiency may be due to the presence of the different categories of investors present in the market, such as government bonds that are dominated by institutional investors. In contrast, stock markets perceived to a combination of institutional and retail investors. The Durbin Watson (D.W.) test is used to discover the occurrence of autocorrelation in the selected model. The acceptable value of the D.W. statistics test lies in the range of 1.75 to 2.25. The results indicate that the values of D.W. statistics for pre-crisis and post-crisis ARDL models are 2.04 and 1.82, respectively, which are within the range of acceptance. Thus, the hypothesis of autocorrelation has been satisfied. After obtaining the ARDL short-run model, we will run the ARDL long bound test approach to determine the presence of a long-run relationship between nifty and gsec. The results are presented in Table 5 and Table 6 for both pre-crisis and post-crisis periods, respectively.

D. Autoregressive Distributed Lag Model Pre-Crisis Null and Alternative hypothesis

H_0: There is no long-run relationship between the dependent variables and regressor variables pre-crisis period

H_1: There is a long-run relationship between the dependent variables and the regressor variables pre-crisis period

Autoregressive Distributed Lag Model Post-Crisis null and alternative hypothesis

H_0: There is no long-run relationship between the dependent variables and regressor variables post-crisis period

H_1: There is a long-run relationship between the dependent variables and the regressor variables post-crisis period.

Table 5: Pre-Crisis F-Bound Test Results.

F-Bounds Test				
Test Statistic	Value	Significance Level	I(0)	I(1)
F-statistic	1.179151	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.50%	4.18	4.79
		1%	4.94	5.58

Table 6: Post Crisis F Bound Test Results.

F-Bounds Test				
Test Statistic	Value	Significance Level	I(0)	I(1)
F-statistic	3.272222	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.50%	4.18	4.79
		1%	4.94	5.58

The F-statistics value for the pre-crisis period and post-crisis period is lower than the lower bound and upper bound at a 5% significance level; therefore, we accept the null hypothesis of no long-run relationship between the dependent variables and regressor variables. It means, the time-series of nifty and ten-year government bond yield do not converge to their mean in the long run and even after the structural changes in financial markets after the post-crisis period, there is no long-run relationship between ten-year government bond(used as an alternative for the measurement of sovereign credit) which are in contrast with the study done in case of Turkey by AVCI(2020), the author found a long-run relationship between CDS premiums(alternative to sovereign credit risk) and stock markets [37]. The findings of short-run results supporting the general hypothesis that a rise in the yield of government bonds makes corporate borrowings costlier, hitting the profit margins of companies, as well the performance of long-term gilt funds will be impacted negatively as their net asset value declines with rising yields. In the short term, during the period of turbulence in capital markets, the risk premium demanded by equity investors to a foothold on their stocks may rise relative to the premium commanded by bonds. As there is no long-run relationship between equity market index and government bond yield indicated by ARDL bound test approach, reasons could be shifting of liquidity preference, quick adjustment of equity markets about the rise and fall in yields on government bonds. Therefore, further processes such as Error-Correction Process and determination of cointegrating equation cannot be done.

IV. CONCLUSION

Global Financial Crisis of the year 2008 brought focus on the domestic macro-economic variables as several economies tended to safeguard their financial markets.

Emerging countries such as India focused on the recovery of economic growth by providing the fiscal stimulus as well as relaxation in monetary policies, which affected the yields on government bonds. Bond yields are a leading indicator for an upcoming recession, and investors pay attention to the movement in yields to optimize their equity portfolios. This paper investigated the presence and change in the long-run relationship (if any) between the yield on ten-year government bonds and stock market benchmark index's nifty by using ARDL bound test approach on monthly observations from December 1995 to July 2019 and dividing the study period into two samples by a breakpoint of September 2008 when the global financial crisis of 2008 was into full swing and creating mayhem all over the globe. We used descriptive statistics to understand the impact of the global financial crisis of 2008 on the nature of time-series data. We found evidence of observations returning to their normal distribution post-crisis for both nifty and ten-year government bonds. ADF test results indicated that both time-series are stationary at first difference. The ARDL short-run model stated the presence of a relationship between Nifty and Government Security's long-term yield on a short-term period on non-lag and lag period of lgsec. The ARDL bound test approach results indicated the presence of no long-run relationship between nifty and ten-year government bond yield for the pre-crisis and post-crisis period. The implications of this study to a wide variety of investors are that investors should not be using long term government yields in optimizing their equity portfolios as it can be misleading as variables that explain equity prices change over time.

V. FUTURE SCOPE

The current study considered yield on long-term bonds, which reflects the overall economic scenario of a country, but scope exists for the identification of short-run and long-run relationships between the prices of equity index and yields on different maturities of bonds including the corporate bonds as well. Moreover, the amount of liquidity infused by central banks, the shifting of risk premium can be explored as well in determining the impact on interplay between equity market indices and government bonds.

ACKNOWLEDGMENTS

I want to acknowledge Mr. Neeraj Pizar, Assistant Director, Scientific Writing Cell, Shoolini University, for the proofread.

Conflict of Interest: It is confirmed that none of the three authors has any conflict of interest associated with the publication of this paper.

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How to cite this article: Yadav, A, Kumar, D., Dhanta, R., (2020). An ARDL Approach to the Dynamic Linkage Between Equity Markets and Long-Term Bond Yield: Pre and Post Period of the Global Financial Crisis. *International Journal on Emerging Technologies*, *11*(4): 46–55.