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An Empirical Examination of Dynamic Linkages of Banking Sectors of Select Countries

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Abstract
Banking supports an economy, and when it's integrated across economies, financial crises can spread. This study investigates banking sector integration in India, the US, the UK, China, and Japan. I use weekly data from January 4, 2021 to April 25, 2023 to do this. I then develop portfolios of carefully selected banking equities from each country with identical weights. I use the Autoregressive Distributed Lag (ARDL) Model with bound testing methods from Pesaran and Shin (1999) and Pesaran, Shin, and Smith (2001) to assess the long-term connection. My data shows no cointegration in banking sector stock portfolios. There is no common factor affecting portfolio pricing, and there is no long-term correlation between banking sectors in the selected countries. However, pairwise autoregressive distributed lag (ARDL) bounds tests show cointegration between UK-India. I use Granger causality analysis to identify short-term effects. My findings show that bank portfolio returns of one country do not affect those of other countries, except for the United States and United Kingdom, which have a significant causal effect on India and China at a 10% significance level.

Keywords: Unit root, integration, cointegration, ardl bounds testing, banking sector, granger causality.

Introduction

The issue of integration among financial markets has received considerable attention in theoretical and empirical studies. Due to increased globalization and fewer restriction on capital flows, the global financial markets are expected to become more integrated. Market integration implies identical expected returns for assets exposed to same risk factors regardless of the country (Bekaert & Harvey, 1995). Knowledge about the degree of integration among markets is important for several reasons. For example, Bekaert and Harvey (1995) state that the relevant measures of risks for integrated and segmented markets is covariance and variance respectively. Similarly, the potential benefits of diversification can be realized only if the markets are not completely integrated.

There is ample literature examining the integration among equity markets of countries. Campbell and Hamao (1989) find evidence of comovement in excess stock returns in US and Japan. Longin and Solnik (1995) find that correlation among markets have increased over time. Bessler and Yang (2002) provide evidence of linkages among nine major markets including US, Japan and UK. Using cointegration analysis Chen and Firth (2002) report that the markets in Latin America are integrated. Using Johansen cointegration procedure, Narayan and Smyth (2005) find that stock market of New Zealand, Australia and G7 countries are not integrated. However, they report evidence of cointegration between New Zealand and United States based on Gregory and Hansen test. Bekaert, Hodrick and zhang (2009) analyse 23 countries and 26 industries and conclude that there are benefits of international diversification. Analyzing five south east Asian markets, Shabri *et al*. (2009) find cointegration among the markets during pre and post 1997 crisis period. Menon, Subha and Sagaran (2009) use Engle-Granger methodology and find that Indian markets are cointegrated with many Asian markets and USA. Aslanidis, Dungey and Savva (2009) report evidence of enough financial integration

among Eastern European and Euro zone countries. Using correlation analysis Mukhopadhyay (2009) presents evidence of integration among world financial markets at the level of country as well as sector. Mukhopadhyay finds evidence of US banking sector having influence on Indian banking sector. Wong, Agarwal and Du (2014) investigate the long-run and short-run dynamic relationships between the equity markets of India, United States, United Kingdom and Japan. They find that Indian markets are cointegrated with US and Japan and that there is unidirectional granger causality from US and Japan to India. Using daily data Sehgal, Pandey and Deisting (2018) report that there is no integration among the equity markets of South Asian countries.

Just like integration among equity markets has important implications, similarly international linkages of key industrial sectors like banking across economies is important. Banking sector is backbone of any economy and integration of banking sector across the boundaries of an economy can lead to contagion especially during crises. Understanding the interrelationships between the banking sector of different economies can help policy makers design appropriate policies to stabilize the economy. Though several studies are available which have examined the linkages between the diversified equity indices of countries, only a few studies have investigated sectoral linkages among economies.

The current study has investigated the integration of banking sector equities from five countries: India, United States, United Kingdom, China, and Japan. I examine both long-term and short-term connections. To analyse the long-term relationship, i utilise the Autoregressive Distributed Lag (ARDL) Model with bound testing methods developed by Pesaran and Shin (1999) and Pesaran, Shin, and Smith (2001). My findings indicate that there is no cointegration among the portfolios of banking sector stocks. There is no single common factor influencing the prices of the portfolios being considered, and there is no long-term connection between the banking sectors of the chosen countries. Nevertheless, the pairwise autoregressive distributed lag (ARDL) bound tests demonstrate the presence of cointegration between the United Kingdom and India. Furthermore, i employ Granger causality to reveal short-term fluctuations and determine that the bank portfolio returns of one country do not have a causal relationship with the bank portfolio returns of other countries, except for the fact that the returns of the United States and the United Kingdom have a causal effect on the returns of India and China, respectively, with a significance level of 10 percent. The rest of the paper is organised as follows. Section II discuses data and methodology; section III presents empirical analysis; and section IV concludes.

Data and Methodology

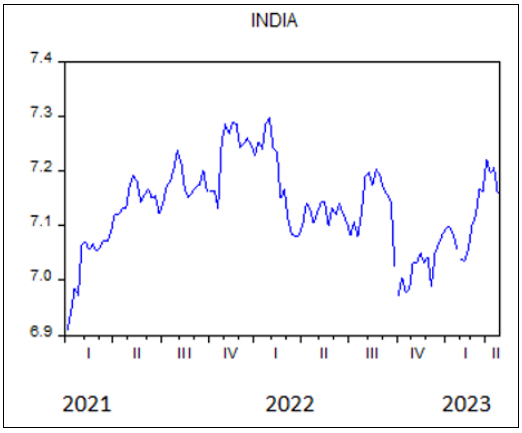
The data for this study comprises of weekly stock prices of banking sector stocks of India, United States, United Kingdom, China and Japan from January 04, 2021 to April 25, 2023. First, I construct equally weighted portfolios of selected banking stocks from each country. Then the entire series of examination is carried out on the levels /returns of these portfolios. Table I presents the summary statistics of portfolio returns from each country. The weekly returns are computed as - $R_{i,t} = \Delta P_{i,t} = 100 \times [\ln P_{i,t} - \ln P_{i,t-1}]$, where $R_{i,t}$ is return on the portfolio of ith country at time t, $P_{i,t}$ and $P_{i,t-1}$ are values of the portfolio of ith country at time t and t−1 respectively. From Table I it can be seen that weekly percentage returns for US, UK and China are close to zero but positive. Mean return for India is the largest among all countries i.e. 0.0020 per cent, while for Japan mean return is negative i.e. -0.0016 per cent. The standard deviations of portfolio returns range from the lowest 0.0203 per cent for UK to the highest 0.0328 per cent for India.

Table 1: Summary Statistics of Weekly Portfolio Returns of Banking Stocks

	INDIA	US	UK	CHINA	JAPAN
Observations	117	117	117	117	117
Mean	0.0021	0.0008	0.0005	0.0001	-0.0016
Median	0.0038	0.0032	0.0013	0.0013	0.0003
Maximum	0.1223	0.0754	0.0499	0.0574	0.0755
Minimum	-0.1182	-0.0973	-0.0716	-0.1145	-0.0864
Std. Dev.	0.0328	0.0273	0.0203	0.0267	0.0301
Skewness	0.0164	-0.7563	-0.4539	-0.6693	-0.2738
Kurtosis	5.1982	4.7027	3.7396	5.1403	3.1912
Jarque-Bera	23.5618	25.2867	6.6851	31.0658	1.6400
Probability	0.0000	0.0000	0.0353	0.0000	0.4404

Source: The author.

All the return series except India are negatively skewed and are leptokurtic as can be seen from kurtosis. The Jarque-Bera test reveals that except Japan all series are non-normal and have fat tails.



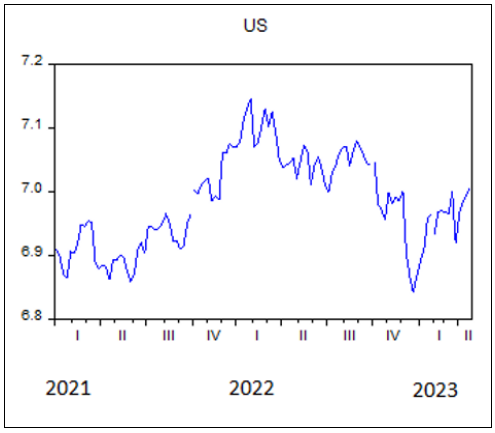


Fig 1: Time Plot of Values of Equally Weighted Bank Portfolios

Figure 1 displays the time plot of the log levels of the value of the portfolios of each country. From figure 1, it seems that most of the time series have a unit root, i.e. I(1). To test it formally, Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are used. The results of ADF, PP and KPSS are given in Table II. The null hypothesis under ADF and PP is that the series has a unit root, while KPSS has null hypothesis of stationarity. ADF and PP tests suggest that all but India have a unit root. However, for US and China, KPSS test suggests that these series are I(0). Thus, it can be inferred on the basis of these tests that India is I(0), UK and Japan are I(1). However, owing to conflicting results of ADF/PP and KPSS, we cannot conclude with certainty that US and China are I(1). Looking at the ADF/PP/KPSS tests results on first difference, it is evident that the returns (first difference) of all the series are stationary and none of the series is I(2).

Table 2: Results of Unit Root tests

	Log Levels			First Difference		
Country	ADF	PP	KPSS	ADF	PP	KPSS
India	-3.1609**	-3.2276**	0.2438	-10.5161**	-10.5227**	0.1818
US	-2.1207	-2.1153	0.4129	-11.0950**	-11.2471**	0.0911
UK	-1.9444	-1.9399	0.4638**	-11.0721**	-11.0981**	0.1125
China	-1.8388	-1.8388	0.3965	-13.0145**	-13.1825**	0.1743
Japan	-1.5222	-1.5887	0.479162**	-10.3895**	-10.5362**	0.1291

Source: The author.
Note: ** indicates significance at 5% level.

As noted by Pesaran *et al*. (2001, if we have mix of I(0) and I(1) variables, then Autoregressive Distributive Lag (ARDL) Bounds testing is the appropriate methodology for testing long-run relationship. Under this approach, the following unrestricted error correction model (UECM) is estimated.

$$\Delta Y_t = \psi_0 + \sum_{s=1}^{p} \gamma_s \Delta Y_{t-s} + \sum_{i=0}^{p_1} \beta_{1,i} \Delta X_{1,t-i} + \sum_{j=0}^{p_2} \beta_{2,j} \Delta X_{2,t-j} + \ldots + \sum_{k=0}^{p_m} \beta_{m,k} \Delta X_{m,t-k} + \theta_0 Y_{t-1} + \theta_1 X_{1,t-1} + \cdots + \theta_m X_{m,t-1} + \epsilon_t \ldots (1)$$

The bounds testing approach involves testing for the joint significance of θs. If the null hypothesis that all θs are jointly zero is not rejected, then there is no long run relationship. Because the underlying F-statistic is non-standard, the usual Wald-test cannot be used. To deal with this, Pesaran *et al*. (2001) have tabulated bounds of the critical values. If the observed F-stat is more than I(1) bound, then the null is rejected, and long-run relationship is supported. If the observed F-statistic falls below I(0) bound, then no long-run relationship is possible. Finally, if F-statistic falls between I(0) and I(1) bounds, then no inference can be drawn.

For examining the short-run relationship, I have used granger causality based on the following VAR:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{p} \beta_i \Delta X_{t-i} + \epsilon_t \ldots (2)$$

In equation (2) above, if all βs are jointly zero, then it indicates that past values of ΔX have no role in predicting the futures values of ΔY. In other words, zero or insignificant βs implies that ΔX does not granger cause ΔY.

III. Empirical Evidence.

In the previous section, i find that i have a mix of I(0) and I(1) variables, hence the appropriate technique is ARDL bounds testing suggested by Pesaran and Shin (1999) and Pesaran *et al*. (2001). To test the long run relationship, i have formulated the following unrestricted ECM.

$$\Delta INDIA_t = \psi_0 + \sum_{i=1}^{p} \alpha_i^{INDIA} \Delta INDIA_{t-i} + \sum_{i=0}^{p_1} \beta_i^{US} \Delta US_{t-i} + \sum_{i=0}^{p_2} \beta_i^{UK} \Delta UK_{t-i} + \sum_{i=0}^{p_3} \beta_i^{CHINA} \Delta CHINA_{t-i} + \sum_{i=0}^{p_4} \beta_i^{JAPAN} \Delta JAPAN_{t-i} + \theta_0 INDIA_{t-1} + \theta_1 US_{t-1} + \theta_2 UK_{t-1} + \theta_3 CHINA_{t-1} + \theta_4 JAPAN_{t-1} + \epsilon_t \dots (3)$$

The above model is estimated, and it is tested whether all θs are zero. The F-statistic along with the lower and upper bounds is presented in Table III. From the table, it can be seen that when ΔINDIA is dependent, then the F-statistic is 3.34 which is between lower and upper bounds at 10 per cent and 5 per cent levels of significance. Hence the inference about long-run relationship is inconclusive. Only at 1 per cent level of significance the computed F-statistic is less than the lower bound suggesting that there is no long-run relationship between the series under consideration. The unrestricted ECM in equation (3) is estimated for each country as dependent variable and the results are displayed in Table III.

It can be seen from Table III that F-statistic for US, China and Japan are 0.98, 1.28 and 0.67 respectively. All these are below the lower bound at 5 per cent level of significance which confirms that there is absence of long-run relationship.

Table 3: Results of Bounds test

Dependent	F-statistic	Sig. Level	Lower Bound I(0)	Upper Bound I(1)
INDIA	3.34	10%	2.45	3.52
US	0.98	5%	2.86	4.01
UK	2.94	2.50%	3.25	4.49
CHINA	1.28	1%	3.74	5.06
JAPAN	0.67			

Source: The author.

Note: As 5 series are considered, so k = 4 in all cases above.

For UK, the F-statistic is 2.94 which is between lower and upper bounds at 5 per cent level suggesting inconclusive inference Combining the results from the bounds tests, it can safely be inferred that there is no long-run link between the banking sector of the chosen nations.

For additional evidence about long-run relationship, the bounds test is also performed for each pair of countries and the results are presented in Table IV. Table IV also presents the result of bounds t-test to substantiate the result of bounds F-test as suggested by Pesaran *et al*. (2001). When India is taken as dependent, the bounds test results given in Table IV reveal that there is inconclusion about cointegration between India and any other country at 5 per cent level of significance as both F-statistic and t-statistic are between lower and upper bounds. When US is dependent, then both F and t tests suggest that there is no long-run relationship between US-UK, US-China and US-Japan. The F-statistic for US-India is more than upper bound, but t-statistic is below lower bound which is contradictory. It can be verified from Table IV that there is no cointegration between any pair of countries except UK-India at 5 per cent level of significance.

Table 4: Results of Bounds Tests for Pair of Countries

	India-US	India-UK	India-China	India-Japan
F-statistic	5.14	5.49	5.32	4.73^{L}
t-statistic	-2.5^{L}	-3.04	-3.13	-2.94
	US-India	US-UK	US-China	US-Japan
F-statistic	6.02^{U}	1.57^{L}	2.55^{L}	1.58^{L}
t-statistic	-2.76^{L}	-1.27^{L}	-2.17^{L}	-1.65^{L}
	UK-India	UK-US	UK-China	UK-Japan
F-statistic	6.36^{U}	2.63^{L}	5.03	1.78^{L}
t-statistic	-3.27^{U}	-1.73^{L}	-3.17	-1.14^{L}
	China-India	China-US	China-UK	China-Japan
F-statistic	2.55^{L}	1.53^{L}	2.41^{L}	1.72^{L}
t-statistic	-2.16^{L}	-1.2^{L}	-2.17^{L}	-1.85^{L}
	Japan-India	Japan-US	Japan-UK	Japan-China
F-statistic	2.66^{L}	0.59^{L}	1.18^{L}	2.68^{L}
t-statistic	-2.07^{L}	-1.08^{L}	-1.33^{L}	-2.26^{L}

Note: ^{U} and ^{L} implies that the respective statistic is beyond the 5% upper and lower bound respectively, otherwise the statistic is between the bounds. The 5% lower and upper bounds for F-statistic are 4.94 and 5.73 respectively and for t-statistic are -2.86 and -3.22 respectively. In the pair of countries, the first country is treated dependent in UECM.

Source: The author.

For examining the short-run relationship between the banking sector of the selected countries, the granger causality based on bivariate-VAR as described in equation (2) in methodology section is employed. The results are presented in Table V. For estimating VAR, returns rather than prices are considered. From Table V, it is visible that there is no granger causality between any pair of countries at 5 per cent level of significance. Only at 10 per cent level of significance, there is causality from US to India and from UK to China. These results imply that there is no short run relationship between the banking sector of the selected countries.

Table 5: Results of Granger Causality

Null Hypothesis	X^2-stat	df	P-value
US does not granger cause INDIA	2.1143	1	0.0987
INDIA does not granger cause US	0.0013	1	0.9069
UK does not granger cause INDIA	0.0098	1	0.5461
INDIA does not granger cause UK	2.2161	1	0.3348
CHINA does not granger cause INDIA	0.0171	1	0.7855
INDIA does not granger cause CHINA	3.1409	1	0.1317
JAPAN does not granger cause INDIA	0.0056	1	0.7944
INDIA does not granger cause JAPAN	0.0052	1	0.8955
UK does not granger cause US	0.6492	1	0.3569
US does not granger cause UK	0.2035	1	0.6271
CHINA does not granger cause US	0.1018	1	0.7304
US does not granger cause CHINA	1.5599	1	0.1430
JAPAN does not granger cause US	0.0671	1	0.8207
US does not granger cause JAPAN	0.2568	1	0.5063
CHINA does not granger cause UK	3.3655	2	0.2356
UK does not granger cause CHINA	5.4821	2	0.0585
JAPAN does not granger cause UK	1.5952	1	0.1996
UK does not granger cause JAPAN	1.6226	1	0.1681
JAPAN does not granger cause CHINA	0.2732	1	0.5252
CHINA does not granger cause JAPAN	0.7382	1	0.3012

Source: The author.

Conclusion

The present study is an attempt to examine the relationship between banking sector of India, US, UK, China and japan. Analysis of weekly data from January 2021 to April 2023 reveals that the banking sector of the selected countries has a high degree of independence. The ARDL bound test indicates that there is no long-run relationship among the banking sectors of the countries. This indicates that there are no common risk factors influencing the banking sectors of all the countries in similar fashion. In other words, the movements in banking sector stocks of each country is largely governed by country specific factors. This absence of long-run relationship is good for investors seeking international diversification. The results of granger causality suggest that past returns of banking sector in one country have no predictive power for explaining the future returns in other countries. The results of the present study should be interpreted with great caution as the sample size which is slightly above two years is too small to conclude about level of integration among markets. In addition, integration among markets may be time varying and may also be influenced by style of portfolios.

The results of this study have significant repercussions for policymakers, portfolio managers, and investors. Gaining insight into the interconnectedness of financial markets, particularly the banking sector, can assist policy makers in achieving economic stability. Understanding the interconnectedness of markets can assist portfolio managers and investors in making informed investment decisions and implementing various strategies.

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