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ORIGINAL CONTRIBUTION

An Analysis of the Dynamic Linkages of Pakistani Stock Market with the World's Leading Stock Markets

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Abstract— Using the theoretical framework of International Portfolio Diversification (IPD), the study explores the long-run relationship between the Pakistan Stock Exchange (PSX) and the world's six leading stock exchanges of Canada, China, France, Japan, United Kingdom, and the United States. These markets are represented by the indices such as KSE-100 index (Pakistan), TSX (Canada), SSE Composite (China), CAC-40 Index (France), Nikkie-225 (Japan), FTSE-100 index (UK) and DJIA (US). An extended sample period of 27 years, has been studied ranging from 1991 to 2018, using daily, weekly, and monthly frequencies. This paper investigates the existence of co-integration among the markets by employing Johansen and Juselius bi-variate and multivariate co-integration techniques. The Augmented Dicky Fuller (ADF) and Phillip and Perron (P-P) test indicate that all the series are non-stationary at level, whereas they are stationary at the first difference form. In addition, the results of the bi-variate co-integration test show that Pakistani market is weakly linked with the rest of the six markets. In addition, the findings of the multivariate co-integration test confirm two co-integrating equations—France and the UK stock exchanges are integrated on the daily data, while China and Canada stock exchanges are integrated on monthly data. An essential implication deduced from this result is that these markets are loosely connected with each other over the period investigated. Hence, international investors seeking to reduce risk can diversify their portfolio risk by including these markets in their pool of investment.

Index Terms— PSX, Stock Indices, Co-integration, IPD

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Introduction

This study examines the co-integration analysis of the PSX with world six major Stock Exchanges, which are also the leading trading partners of Pakistan, namely New York Stock Exchange (USA), Tokyo Stock Exchange (Japan), Shanghai Stock Exchange (China), Euronext Stock Exchange (France/Continental Europe), London Stock Exchange (UK), and Toronto Stock Exchange (Canada). The stock market is responsive to various macroeconomic factors, such as interest rate, inflation, money supply, exchange rate variability, oil price shocks, etc. The impact of macroeconomic variables on stock prices has also been highlighted by various researchers in previous studies (Khan et al., 2015; Wongbangpo & Sharma, 2002). Due to different liberalization policies, technological advancement in the financial system,

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international trade, and regional blocks, global markets are becoming more integrated. Resultantly, stock markets in the developing countries are also influenced by movement in leading worldwide stock exchanges (Bessler & Yang, 2003; Wong, Penn, Terrell, & Chiang, 2004). Moreover, the past literature on the study shows that the developed markets are linked with fellow developed and emerging markets. The study of Bessler and Yang (2003) confirmed that the New York stock exchange was the only stock market that continuously influenced the price movement of other stock exchanges in the long run. In another study, Wong et al. (2004) revealed that the Hong Kong stock exchange was integrated with the US and the UK. Similarly, the work of Ghosh, Saidi, and Johnson (1999) showed that Korea, India, Hong Kong, and Malaysian markets were linked with US stocks. Finally, many other studies, such as Arshanapalli and Doukas (1993); Chen, Firth and Rui, (2002); Hee Ng (2002); Guidi and Ugur (2014); Syriopoulos, (2007); Voronkova (2004); Wong et al. (2004) and examine that stock markets are linked with each other.

The focus on co-integration analysis among the stock market has been increasing in the field of finance, primarily, due to its implications for international investors and the market regulators. Co-integration analysis helps in superior portfolio diversification. The current work is related to the Modern Portfolio Theory (MPT), developed by Markowitz in 1952. The risk components of MPT can be measured through variances and co-variances equation. Portfolio risk decreases with efficient diversification of portfolio among various assets. Portfolio risk can be mitigated by sufficient allocation of funds for weakly associated stocks in the portfolio; stocks with negative correlations can even better diversify the risk (Alvi, Chughtai & Ul Haq, 2015).

MPT was developed for domestic diversification of the portfolio by adding unrelated stocks in the portfolio. Later on, the theory was extended to encapsulate international investments, where researchers empirically provided evidence that by investing globally, investors can achieve further risk reduction (Levy & Sarnat, 1970). The international equity markets are usually less correlated with each other than domestic ones (Eun & Shim, 1989). However, the findings of previous studies showed that with strongly integrated global equity markets, the investors could not benefit from international diversification (Hasan, Saleem & Abdullah, 2008). Consequently, investors shall invest in weakly correlated markets. This paper uses the theoretical framework of IPD.

The rationale for using these six major stock exchanges for the analysis is that they constitute the largest market capitalization in the world. In addition, they are leading trading partners of Pakistan, which show their influence upon PSX. The Dow Jones Index represents the US stock exchange Which has total market capitalization of 6,560 billion dollars; Japan stock exchange, represented by Nikkei 225 index, has total market capitalization 5,679 billion dollars; China's total market capitalization is 4,026 billion dollars; Euronext stock exchange is represented by France CAC 40 index with a total market capitalization of 3,927 billion dollars; UK's total market capitalization is 3,767 billion dollars, and the Canadian stock exchange market capitalization is 2,095 billion dollars. According to Wong et al. (2004), Japan has a political influence on many Asian countries. Therefore, it is expected that Japan's equity market would also have a major influence on Pakistan's market. China is represented by Shanghai Stock Exchange (SSE) composite because the Chinese equity market is one of the main stock markets due to large market capitalization. The CAC-40 index denotes France's stock exchange, the UK equity market is denoted by FTSE-100 index, and Canadian equity market is represented by the TSX index. Alvi et al. (2015) mentioned that these countries have portfolio investment in Pakistan.

The study's contribution is novel in many ways. First, many studies used the co-integration among stock exchanges in developed, emerging, and Asian nations (Sharma & Bodla, 2011; Sharma & Wongbangpo, 2002; Voronkova, 2004; Wong et al., 2004); however, the linkage of PSX with international equity markets are investigated only by a small number of researchers that also for a short span of time through low-frequency data such as weekly and monthly. For instance, Hasan et al. (2008) used weekly data; Alvi et al. (2015) and Jebran (2014) used monthly data. The main contribution of this research is to analyze the long-run relationship of Pakistan equity market with selected equity markets using daily, weekly and monthly data. Second, past research showed a lot of work on co-integration analysis in developed and Asian countries. But the literature on the co-integration analysis of PSX is scarce. Therefore, in this investigation, co-integration analysis of Pakistan's stock exchange vis-a-vis major stock exchanges has been explored. Third, we have taken a bigger sample period covering 27 years from 1991 to 2018, whereas other studies in Pakistani context took a maximum of ten years sample period, such as Alvi et al. (2015); Hasan et al. (2008), and Jebran (2014) . Many studies analyzed the pattern of interconnectedness among stock exchanges in the context of Covid-19. The domino effect of the pandemic on stock exchanges caused ripples across many markets (Naeem et al., 2021; Naeem et al., 2021,& Yousaf et al., 2021). In the year 2022, a data of 27 years from 1991-2018 has implications to analyze the co-integration among stock exchanges and helps construct an international portfolio based, especially on longer period. We restrict the data until 2018 to avoid the influence of the economic meltdown due to Covid-19.

The next section is about literature review. Section 3 provides the theoretical framework of IPD. The Section 4 presents methodology followed by data analysis in Section 5. The Section 6 concludes the paper.

Literature Review

The literature review explores the past studies on the linkages of markets in both developed and emerging countries. For example, Wong et al. (2004) investigated the linkage among developed stock exchanges of US, Japan, and UK with five emerging stock exchanges of

Malaysia, Taiwan, Hong Kong, and Korea using co-integration analysis. Using weekly data from 1981-2002, they found that only Hong Kong stock exchange was linked with US and UK stock exchanges. A similar investigation led by Arshanapalli and Doukas (1993) applied a co-integration and error correction model to measure co-movement among stock exchange indices of the US, UK, Japan, Germany, and France before and after the economic crash of 1987. The study analyzed a period of 10 years daily from 1980-1990 with total 2709 observations. The finding indicated that the US stock exchange was linked with German, the UK, and French stock exchanges during the post-crash period. While Japanese Stock Market showed no linkage with the US, the UK, Germany, and France market before and after the crash. Ghosh et al. (1999) investigated nine months of daily data in ten countries, including eight emerging countries of Hong Kong, Malaysia, Thailand, Singapore, Philippine, Korea, India, and Taiwan, with two developed countries, the US and Japan. They found evidence that the equity market of Korea, India, Hong Kong, and Malaysia shared a long-term association with the US equity market. Conversely, equity markets of Philippine, Indonesia, and Singapore were integrated with Japan while equity markets of Thailand and Taiwan showed no relationship with the US and Japan stock exchange (Tabasam, Jamil, Khan, & Khan, 2022). Bessler and Yang (2003) used a correlation model and applied an acyclic graph on nine markets. The result proves that the US stock exchange was the only market which had continued a solid influence on the price movement of other main stock markets in the long run. Voronkova (2004) analyzed the stock exchanges of seven countries, three Central European countries including Hungary, Czech Republic, Poland, with four developed countries, France, Germany, the UK, and the US, using the daily closing price of stock indices covering a period of 1993 to 2002. The analysis showed Central European Market is significantly linked with the major stock exchanges.

The association among Latin America stock exchanges includes countries such as Argentina, Brazil, Chile, Columbia, Venezuela, and Mexico had been studied by Chen et al. (2002) for 1995-2000. The co-integration results reported that index prices had a long-term relationship up to 1999. Vector auto-regression revealed that fluctuation in Mexico market prices explained the movement in all equity markets except Columbia. Syriopoulos (2007) using data from 1997-2003, investigated the Central European Markets of Hungary, Poland, and Slovakia for integration with developed equity markets of the US and Germany. The author used co-integration and Granger causality test to explore the linkage between these stock markets. The finding showed that the Central European markets were linked with these major markets. This result matched with the findings of Bessler and Yang (2003) and Voronkova (2004).

A study on the relationship of the emerging equity market with developed equity markets had been analyzed by Guidi and Ugur (2014) through a static and dynamic co-integration test. Weekly data were used in the analysis for a period of 13 years, from 2000 to 2013. The static co-integration result showed that the Chinese market was associated with the UK and Germany but not the US. While dynamic co-integration showed varying integration of the Chinese market with the developed markets in different time periods (Yanik, Osman, & Ozturk, 2020). In addition, the finding revealed that the benefit of diversification did not exist from September 2007 to June 2013 which may be attributed to Global Financial Crises and sovereign debt crises. In Asian financial crisis also called "Asian Contagion" just one market, i.e., Thailand influenced several other Asian countries such as Indonesia, Philippines, Malaysia, and South Korea. This happened because these markets were integrated. The Asian Countries' equity markets were investigated by Hee Ng (2002) in the pre-crash period from 1987-1997. The correlation result showed that all Asian markets were correlated. Sharma and Wongbangpo (2002) used monthly data over the period of 1986-1996 to explore the relationship among five Asian countries, i.e., Malaysia, Philippine, Thailand, Indonesia, and Singapore. The findings showed long term association between Thailand, Singapore, Malaysia, and Indonesia. However, Philippine stock exchange was not linked with these stock exchanges.

The co-integration analysis of the equity market of Pakistan with international equity market had been conducted by a limited number of studies, such as Hasan et al. (2008). They studied the linkage of Pakistan stock markets with developed countries like Canada, Australia, the US, the UK, Germany, France, Japan, and Italy. They used weekly data from 2000-2006 through multivariate co-integration and variance decomposition tests. The study reported that PSX is not linked with the UK, Germany, the US, Australia, and Italy. Conversely, fund managers of these countries can get benefit from diversification to put money in the stock market of Pakistan. While Pakistan stock market was linked with the stock exchanges of France and Japan. For the same countries using Alvi et al. (2015); Johansen and Juselius (1990) test, investigated nine variables from 2007-2013 on a monthly basis. The analysis showed no significant integration of Pakistan's stock exchange with the developed countries. However, these countries' investment managers can get an advantage through diversification by investing in Pakistan. Jebran (2014), using co-integration, documented no association of Pakistan stock markets with Asian countries stock markets, while the Granger causality test showed that Sri Lanka stock market has causality with India, Malaysia, and Indonesia stock markets. The author used monthly data from 2003-2013 on Pakistan and its association with five countries, China, Malaysia, India, Sri Lanka, and Indonesia.

Some research uses regression and correlation models to ascertain the relationship among various stock markets, assuming that the data would be stationary at a level that is not the case in our data set. One can argue for the use of sophisticated techniques such as GARCH family models to find interconnectedness among markets (Akhtar & Khan, 2016; Saddique and Khan, 2015); however, this study does not show signs of co-movement using co-integration techniques. We assume that the use of more sophisticated techniques would bring the same results. Resultantly, the literature review indicates a gap in to use co-integration model to measure long-term relationships among seven countries, using indices data of daily, weekly, and monthly frequencies. In addition, we use the theoretical lens of IPD, which

is discussed in the next section. The data from 2019 onward are considered abnormal years. Hence, we exclude these years from the analysis.

Theoretical framework

Harry Markowitz proposed portfolio theory in 1952 in the Journal of Finance. It assumes that investor is risk-averse and builds a portfolio that offers maximum return with minimum risk, also known as an efficient portfolio which can be possible only through diversification. Overall, the return and risk components of modern portfolio theory can be measured through statistical formulas, variances and co-variances. According to Ross, Westerfield, and Jaffe (2002), there are two kinds of risks, i.e., systemic, and non-systemic risks. Systemic (undiversifiable risk affects the whole market like interest rate, inflation, political situation, etc. The other kind of risk is controllable (company-specific risk), which affects a single firm, i.e., reduction in earnings, sales, dividend, etc.; this kind of risk can be diversified through an efficient portfolio. MPT states that pick those stocks for portfolio selection which show no or negative correlation with other stocks (Markowitz, 1952). Here, the focus is on the diversification of non-systemic risk only.

MPT is primarily developed for domestic portfolio diversification by adding unrelated stocks in the portfolio to mitigate the non-systematic risk only. Later, the MPT is extended across borders to systematically reduce the risk (Grubel, 1968; Jorion, 1985; Solnik, 1974; Lessard, 1973; Levy & Sarnat, 1970). The idea was that the international equity markets are usually less correlated with each other than domestic markets, which helps reduce the country-specific risk as well (Eun & Shim, 1989). This research is based on the theoretical framework of IPD (Khan, 2013). When different portfolios or equity markets show weak co-integration with other markets or portfolios, investors can avail benefit of diversification by investing in those markets.

Hence, the study aims to examine the long-term relationship between the US, Japan, China, France, UK, and Canadian stock exchanges with the PSX to help investors diversify portfolios.

Methodology

Daily, weekly, and monthly data from seven stock exchanges are collected to measure the long-run relationship of six major stock exchanges with PSX (Khan & Khan, 2016; Bano & Khan, 2020). Each country stock exchange is represented through index, such as KSE-100 index is a proxy for the equity market of Pakistan (Kiran & Khan, 2016; Khan et al., 2017; Kiran et al., 2020), DJIA Index is a proxy for equity market of the US, Nikkie-225 Index is proxy for equity market of Japan, SSE Composite index is proxy for equity market of China, CAC 40 index is proxy for equity market of France, FTSE 100 index is proxy for equity market of UK, and TSX index is proxy for equity market of Canada. The gigantic size of these countries' stock exchanges and their trading partnership with Pakistan provide rationale for opting them for the current study. (Khan et al., 2021; Khan et al., 2011; Khan et al., 2013). The closing prices of these indices are extracted in their local currency for the period covering 27 years, from 1991-2018. The data used in the analysis consists of closing indices prices on three frequencies: daily, weekly, and monthly. Three frequency data is more suitable as it addressed the issue of thin trading of daily data (Patra & Poshakwale, 2006; Khan & khan, 2016; Khan et al., 2016; Shan & Khan, 2019; Shah et al., 2020; Shah et al., 2021).

A quantitative co-integration technique is applied to find the long-term relationship of the PSX with six major stock exchanges. For that purpose, Johansen (1988) and Johansen and Juselius (1990) techniques are considered the best for measuring long-run relationships (Alvi et al., 2015; Bessler & Yang, 2003; Ghosh et al., 1999; Khan, 2013; Voronkova, 2004). This co-integration technique was primarily presented by Granger (1981) and later developed by Engle and Granger (1987). This was the simplest test and only accounted for integrated series and did not perform co-integration analysis. The drawback of Engle and Granger test is that any error that occurred in one step would make all the estimations erroneous. Finally, the improved version is the tests of Johansen (1988) and Johansen and Juselius (1990) which are based on the maximum likelihood method. This co-integration test uses two-way bivariate co-integration and multivariate co-integration tests. Bivariate co-integration means finding pairwise relationships between variables, while multivariate co-integration means measuring combine relationship among variables. The test further consists of two values to trace statistic and maximum Eigen value. Prior to applying the co-integration test. The data must be stationary at first or second difference. If means and variance constantly grow over time, then data is non-stationary, while, if means and variance do not grow over time, then data is stationary. Therefore, stationarity of time series is tested through a unit root test. For this purpose, ADF is applied before the co-integration test. There is also P-P Test for checking stationarity of data (Khan & Khan, 2016; Shan & Khan, 2019; Shah et al., 2020; Shah et al., 2021). According to Patra and Poshakwale (2006), the ADF test is considered a reliable and superior test over other tests to check for unit root in time series. However, for robustness, we use both ADF and P-P tests for analysis. After finding unit root, the second step is finding lag length criteria. The lag length value is selected based on Schwartz value which considers the significant value for testing co-integration. Regression is preferred instead of co-integration because the former requires data to be stationary at level (Sardar et al., 2018), and the mean and variance of series must be constant. While time series variables often deviate from their mean and variance due to various shocks and cycle variations. So, regression analysis may lead to a spurious relationship. Therefore, co-integration test is employed for analysis. In addition,

co-integration test is used for measuring long-term relationships among several variables even if data are not stationary at level but only on 1st or 2nd difference (Johansen, 1988 & Johansen & Juselius, 1990). One can argue in favor of using sophisticated GARCH models for studying the interconnectedness of stock exchanges. We, however, do not use those models as our findings do not show connectedness among exchanges using co-integration. It is very rare to have differing results using sophisticated models.

Results and Discussion

Descriptive statistic

The descriptive statistics consist of mean, median, maximum, minimum, and standard deviation. The number of observations for a single country of daily frequency is 6,239 (Panel A), for weekly it is 1,407 (Panel B) and for monthly it is 325 observations (Panel C).

Table I
Descriptive statistic

Variable	Mean	Median	Maximum	Minimum	Std. Dev
Panel A: Daily Data					
Pakistan	0.201571	0.012535	0.084751	0.001227	0.221583
USA	0.173804	0.16936	0.426618	0.045901	0.076407
Japan	0.238600	0.248471	0.399917	0.113078	0.065320
China	0.031455	0.027793	0.097644	0.003600	0.016696
France	0.060599	0.061381	0.109901	0.025821	0.019484
UK	0.083091	0.087730	0.120974	0.036560	0.020782
Canada	0.153015	0.150849	0.255207	0.051216	0.059958
Panel B: Weekly Data					
Pakistan	0.837041	0.466228	3.741071	0.055242	0.961378
USA	0.788341	0.750390	1.900746	0.205145	0.373718
Japan	1.080465	1.123074	1.740333	0.509815	0.301213
China	0.140286	0.125703	0.419563	0.016417	0.073281
France	0.273187	0.277926	0.484268	0.117164	0.088287
UK	0.374078	0.393148	0.552864	0.164363	0.096780
Canada	0.691307	0.679637	1.17705	0.227981	0.276205
Panel C: Monthly Data					
Pakistan	3.663511	2.110837	15.56664	0.258984	4.175889
USA	3.436452	3.237532	8.141018	0.975024	1.624889
Japan	4.674606	4.872797	7.421551	2.328745	1.301807
China	0.609918	0.560247	18.32235	0.090076	.0316458
France	1.189838	1.210394	2.038591	0.518430	0.381970
UK	1.626694	1.714554	2.384246	0.711569	0.415818
Canada	3.013742	2.966031	5.056615	1.010092	1.197527

Table I shows descriptive statistics of seven stock exchanges. The 27-year data from 1991-2018 on three frequencies are displayed through Panel A, B, and C for daily, weekly, and monthly returns respectively. Descriptive statistics provide a overall picture of the data for analysis (Israel & Khan, 2016; Ullah & Khan, 2018; Khan et al., 2021). The results of descriptive statistics from the Table confirm that all stock exchanges and PSX show a positive return for a given time period. Japan stock exchange shows the best average return of 0.23, 1.08, and 4.67 with the lowest standard deviation for daily, weekly and monthly data. PSX shows the second-best average return of 0.20, 0.83, and 3.66 with high standard deviation for daily, weekly, and monthly returns. Therefore, the Table indicates that PSX is the riskiest stock exchange among these stock exchanges with high standard deviation while Chinese stock market appears to be the least risky market base on low standard deviation with less average return. Further, the Table confirms that PSX is a highly volatile market compared to other markets based on the maximum value. This is a key feature of Pakistan's stock exchange during the last decades (Akhtar & Khan, 2016). Hence, based on the following information, Japan stock exchange is finest for investors to gain the advantage of maximum returns while PSX is suitable for aggressive speculators in order to gain the advantage of fast risky returns in a short time period.

Unit root tests results

It is mandatory for time series data to be stationary at 1st difference before applying the co-integration test i.e., I (1). Therefore, stationarity of time series is explored through unit root tests i.e., ADF and P-P. Dickey and Fuller developed the test of ADF in 1979 and 1981. ADF test states that all the error terms are independently distributed and having constant variance. The ADF test is considered a reliable and

superior test over other tests (P-P tests etc.), however, to be more reliable, the current study used both ADF and P-P tests for checking unit root in time series with auto-regressive structure (Patra and Poshakwale, 2006). Table II shows the ADF, and P-P tests results for daily (Panel A), weekly (Panel B), and monthly (Panel C) data, respectively.

Table II
Unit root tests results

Panel A: Test results for the daily data				
Pakistan	1.47	-22.06*	0.49	-70.49*
US	0.57	-62.24*	0.61	-86.09*
Japan	-2.34	-83.24*	-2.24	-83.36*
China	-2.04	-32.56*	-1.86	-78.57*
France	-1.94	-81.67*	-1.76	-82.29*
UK	-1.99	-50.38*	-1.79	-82.72*
Canada	-0.97	-80.20*	-0.89	-80.40*
Panel B: Test results for the weekly data				
Pakistan	0.39	-35.55*	0.39	-35.55*
US	-0.02	-41.83*	0.07	-42.06*
Japan	-2.41	-38.55*	-2.40	-38.54*
China	-2.15	-34.43*	-2.29	-34.67*
France	-1.99	-39.83*	-1.94	-39.86*
UK	-2.08	-40.16*	-1.93	-40.59*
Canada	-1.30	-40.50*	-1.35	-40.39*
Panel C: Test results for the monthly data				
Pakistan	0.48	-17.22*	0.33	-17.36*
US	0.18	-17.16*	0.17	-17.15*
Japan	-2.17	-16.85*	-2.35	-16.86*
China	-2.57	-10.51*	-2.59	-17.57*
France	-1.87	-16.54*	-2.59	-16.71*
UK	-1.94	-18.46*	-1.95	-18.46*
Canada	-1.39	-14.74*	-1.37	-14.79*

Test critical values: -2.57 at 1% level and -1.94 at 5% level

The Table shows the unit root test results using the ADF and the P-P tests. Panel A summarizes the results for the daily data, while Panels B and C show the results for the weekly and monthly, respectively. The critical values are based on MacKinnon (1996). An * indicates significance.

The Table shows unit root test results of ADF and P-P tests at level and first difference. It is evident from the results that all series have a unit root in their level form, whereas they are stationary at first differenced form. For applying Johansen co-integration technique, the data series must be integrated at order one i.e., I (1). This condition is met in all the three frequencies of data. Therefore, all the data are stationary at the first difference and having no unit root. For all three frequencies, the critical values are greater at 5% at first difference. This means that data of the stock markets of given countries across all the frequencies are stationary at the first difference. All variables are non-stationary at level but show stationarity at first difference of given data. Furthermore, the result of the test confirms the requirement of a co-integration test on all data frequencies of daily, weekly, and monthly. All variables lag lengths are selected based on Schwarz Info Criteria, SIC (Schwarz, 1978). This further asserts the application of Johansen (1988) and Johansen and Juselius (1990) bivariate and multivariate co-integration tests.

Co-integration analysis

After testing stationarity in data through the unit root tests, the next step is to apply a co-integration test to measure the long-run relationship. The technique of Johansen (1988) and Johansen & Juselius (1990) are used. Both procedures of co-integration multivariate and bivariate have been employed on data, while lag length criteria are selected based on VAR statistics. The lag value based on Schwarz value considers the significance value used for testing co-integration between selected equity markets. Further, bivariate and multivariate co-integration tests have been used on three data frequencies. The Table III shows the results of bivariate co-integration and Table IV is about the findings of multivariate co-integration analysis.

Table III
Bivariate co-integration test

Indices	Hypothesis	Critical value	Eigenvalue	Trace statistics	Remarks
Panel A: Daily					
KSE 100-DJIA	r = 0	15.49471	0.001465	10.77765	No Co-integration
	r ≤ 1	3.841466	0.000183	1.195867	
KSE 100- NIKKIE 225	r = 0	15.49471	0.001734	9.876714	No Co-integration
	r ≤ 1	3.841466	1.22-05	0.068918	
KSE 100 –SSE-COMPOSITE	r = 0	15.49471	0.000917	7.625785	No Co-integration
	r ≤ 1	3.841466	0.000225	1.661032	
KSE 100 – CAC 40	r = 0	15.49471	0.000907	6.24707	No Co-integration
	r ≤ 1	3.841466	0.000126	0.76276	
KSE 100 – FTSE 100	r = 0	15.49471	0.001061	8.15681	No Co-integration
	r ≤ 1	3.841466	0.00225	3.841466	
KSE 100 – TSX	r = 0	15.49471	0.00634	5.753371	No Co-integration
	r ≤ 1	3.841466	0.000282	1.769173	
Panel B: Weekly					
KSE 100-DJIA	r = 0	15.49471	0.005126	7.606558	No Co-integration
	r ≤ 1	3.841466	0.000264	0.371259	
KSE 100- NIKKIE 225	r = 0	15.49471	0.006688	9.47245	No Co-integration
	r ≤ 1	3.841466	1.7305	0.024397	
KSE 100 –SSE-COMPOSITE	r = 0	15.49471	0.006913	9.97625	No Co-integration
	r ≤ 1	3.841466	0.000382	0.521306	
KSE 100 – CAC 40	r = 0	15.49471	0.002982	4.6495	No Co-integration
	r ≤ 1	3.841466	0.000316	0.444556	
KSE 100 – FTSE 100	r = 0	15.49471	0.005063	7.259863	No Co-integration
	r ≤ 1	3.841466	7.6805	0.108235	
KSE 100 – TSX	r = 0	15.49471	0.00418	5.924447	No Co-integration
	r ≤ 1	3.841466	1.9405	0.027249	
Panel C: Monthly					
KSE 100-DJIA	r = 0	15.49471	0.026252	8.562346	No Co-integration
	r ≤ 1	3.841466	0.000155	0.049477	
KSE 100- NIKKIE 225	r = 0	15.49471	0.021959	7.647102	No Co-integration
	r ≤ 1	3.841466	0.00168	0.538063	
KSE 100 – SSE-COMPOSITE	r = 0	15.49471	0.034296	11.17387	No Co-integration
	r ≤ 1	3.841466	2.0205	0.006478	
KSE 100 – CAC 40	r = 0	15.49471	0.01577	5.107298	No Co-integration
	r ≤ 1	3.841466	6.4405	0.020601	
KSE 100 – FTSE 100	r = 0	15.49471	0.020732	6.705155	No Co-integration
	r ≤ 1	3.841466	4.0906	0.00131	
KSE 100 – TSX	r = 0	15.49471	0.019268	6.30324	No Co-integration
	r ≤ 1	3.841466	0.000242	0.077461	

The result data bivariate co-integration tests for daily, weekly and monthly are documented in Panel A, B, and C of the Table III, respectively. The result from the Table of the Pairwise co-integration test shows that the PSX is not co-integrated with any selected market because probability value is insignificant at 5% in each pairwise relationship between stock markets. Hence, the fund managers of these countries can avail the opportunity of diversification of putting money in PSX. Also, Pakistani investors can invest in these counties' stock exchanges to get diversification benefits. The result of the study is aligned with the theory of IPD. These results are the same with the result of Hasan et al., (2008) and Alvi et al., (2015). However, the results are in contrast to the work of Chaudary et al., (2018).

Table IV
Multivariate co-integration test

Indices	Hypothesis	Critical value	Eigenvalue	Trace statistics	Probabilities
Panel A: Daily					
KSE 100	r = 0*	125.6154	0.0095	151.127	0.0006
DJIA	r ≤ 1*	95.75366	0.0072	96.99182	0.0416
NIKKIE 225	r ≤ 2	69.81889	0.0047	56.96808	0.3400
SSE-COMPOSITE	r ≤ 3	47.85613	0.0030	31.12859	0.6596
CAC – 40	r ≤ 4	29.79707	0.0019	14.68920	0.7998
FTSE – 100	r ≤ 5	15.49471	0.0007	4.100397	0.8953
TSX	r ≤ 6	3.841466	1.3107	0.000705	0.9799
Panel B: Weekly					
KSE 100	r = 0	125.6154	0.020590	97.00573	0.6936
DJIA	r ≤ 1	95.75366	0.018754	67.83698	0.7903
NIKKIE 225	r ≤ 2	69.81889	0.014590	41.81087	0.9152
SSE-COMPOSITE	r ≤ 3	47.85613	0.006146	21.77754	0.9772
CAC – 40	r ≤ 4	29.79707	0.005601	13.37429	0.8738
FTSE – 100	r ≤ 5	15.49471	0.004024	5.719131	0.7284
TSX	r ≤ 6	3.841466	0.000164	0.223031	0.6367
Panel C: Monthly					
KSE 100	r = 0	125.6154	0.109230	111.2568	0.2671
DJIA	r ≤ 1	95.75366	0.076153	74.01898	0.5799
NIKKIE 225	r ≤ 2	69.81889	0.062225	50.93616	0.5967
SSE-COMPOSITE	r ≤ 3	47.85613	0.052310	30.37771	0.6995
CAC – 40	r ≤ 4	29.79707	0.024142	13.18472	0.8830
FTSE – 100	r ≤ 5	15.49471	0.016003	5.364457	0.7689
TSX	r ≤ 6	3.841466	0.000631	0.202115	0.6530

Note: Max-Eigen value and trace statistic test indicate 2 co-integrating eqn (s) at 0.05 level in the daily series only

Table IV presents the result of a multivariate co-integration test on daily (Panel A), weekly (Panel B), and monthly (Panel C) data. The result of Panel A for daily returns shows two co-integrating vectors based on trace statistic at 0.05 significance level—the trace statistic value is more than the critical value, which confirms two co-integrating equations. The maximum eigenvalue also shows the same result. These hypotheses are accepted at a 5% significance level. These are the stock exchanges of the United Kingdom and France. A possible reason for this relationship between the UK and France may be having common regulatory structures due to their membership in European Union. The UK is the major trading partner of European countries and France, with major investments in Europe.

Panel B displays weekly data results for a multivariate co-integration test. The results confirm no co-integration vector based on both trace statistic and maximum eigenvalue. Trace statistic is less than the needed critical value for rejection, and probability value is more than 0.05, which confirms no integration among all variables. Therefore, the fund managers of all these countries can utilize the benefit of diversification to invest in any stock exchange for a longer period. The same result is obtained by Hasan et al., (2008); Alvi et al., (2015). While this result contradicts the study of Chaudary et al. (2018), they found that Pakistan's Stock Exchange were linked with the equity markets of the US, Japan, and Australia. The result of monthly data is shown in Panel C of Table IV. This data of multivariate co-integration test also confirms one co-integration equation. Both trace statistic and maximum eigenvalue tests show one co-integrating vector. Trace statistic value is more than the critical value, and the probability value is less than 0.05 value for one variable. Only two countries exchanges are integrated with each other, i.e., China and Canada. Therefore, the results recommend that Chinese investors refrain from investing in Canada, and the same is true for Canadian investors not to invest in Chinese Stock Exchanges for a long time. However, the investors of other countries can reap the benefit of diversification by investing in foreign stock exchanges.

Conclusion

The study explores the long-run relationship of the PSX with the world's six major stock exchanges of, the United States, Japan, China, United Kingdom, France, and Canada, using three frequency data for 27 years from 1991-2018. A number of conclusions emerge from the summary of descriptive statistics. The descriptive statistics show that all stock exchanges and the PSX share a positive return for a given time period. Japan stock exchange has the highest average return based on all frequency data with the lowest standard deviation while PSX has the second-best average return but with high standard deviation. Therefore, it is evident that PSX is the riskiest stock exchange among these stock exchanges with the highest standard deviation while China stock market appears to be the least risky market with least average returns. This is not surprising in the case of Pakistan as literature review indicated similar results during the last decades such as

Akhtar & Khan, 2016. Based on the following information, Japan stock exchange is the most suitable for investors to gain the advantage of maximum returns while PSX is suitable for aggressive speculators in order to gain the advantage of fast returns in a short time period.

The ADF and P-P tests confirm that all indices' prices are stationary at the first difference and non-stationary at level. This further allows testing the long-run relationship between PSX with selected stock exchanges. The result from bivariate co-integration test confirms that PSX shows no significant linkage with selected stock exchanges in three frequencies of data. While the result from the multivariate co-integration Trace statistic and maximum Eigenvalue test finds two significant co-integration equation at 0.05 level. Two co-integrating equation shows that only France stock exchange is co-integrated with the UK stock exchange based on daily data while the Chinese Stock Exchange is co-integrated with Canada Stock Exchange based on monthly data. Except for these two co-integration, no integration is found among these stock exchanges. Thus, for implication, the study recommends that individual and institutional investors can better diversify their international portfolio through investment in the PSX and the six equity markets of the US, Japan, China, the UK, France, and Canada.

Limitations and Future Research Directions

The study encounters several limitations. Firstly, the lack of co-integration between variables may be because the time period needs to be shorter, during which myriad changes occurred in the markets in different countries. In order to overcome this limitation, it is recommended that the time period should be divided into three or four periods for distinct investigation (Wong et al., 2004). Secondly, according to Wongbangpo and Sharma (2002), some stock markets integration affects stock prices for a short term, called common cycle, while these relationships may only be found in the short run . Therefore, it is recommended that future researchers can use the latest methodology imported from the engineering department to finance known as wavelet methodology used by Alvi et al. (2015). This methodology can be used for short term data as well as for the long term.

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