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Dynamic Connectedness among Forex Markets of Pakistan and Its Major Trading Partners

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Abstract

Globalization and financial liberalization have made market participants and policymakers ponder over the importance of financial interconnectedness and shock spillovers. This discussion is in line with the International Portfolio Theory & Diversification. In this context, this study investigates the intensity and direction of return and volatility spillovers of foreign exchange (FX) markets of Pakistan and its major trading partners. Using an innovative research technique by Diebold and Yilmaz (2009, 2012), we separately compute measures of return and volatility spillovers. Furthermore, we also calculate total spillover, directional spillover, and net spillover indices using a daily data set over the period 1995 to 2019. To capture secular and cyclical movements in the trading partners' FX markets, we rely upon a rolling window analysis. Our results, based on the spillovers indices, support the presence of dynamic connectedness among currency pairs of the major trading partners. We also note that among the sample economies, the USA, the EU, Singapore, and Malaysia are the main sources and originators of shocks spillover while Pakistan, India, Japan, Kuwait, Singapore, and UAE are net shock receivers. The rolling window analysis indicates that returns and volatility spillovers intensify during the phases of financial or economic anxiety. These results have some important implications for individuals working on risk management, portfolio diversification, and trading strategies.

Keywords: *Connectedness; Return & Volatility Spillover; Forex market*

JEL Classification: *C32; F31; G01; G15.*

1. Introduction

Globalization and financial liberalization has led the attention of stakeholders towards the concept of financial connectedness (FC). Numerous empirical studies of the last two decades show an increase in the overall level of connectivity of the

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international financial markets for different countries (Kearney & Lucey, 2004; Yu et al., 2010; Chevallier et al., 2018). Advances in information technology are also contributing to the flow of information in global financial markets. Similarly, global trade liberalization opens the channel for investors to choose and manage their portfolios around the globe. Globalization of the financial market has also won the confidence of investors permitting them to use their funds across borders in search of economically lucrative opportunities. All this has reduced the isolation of domestic markets and increased their responsiveness to global news and shocks. Consequently, interdependence among different financial markets has become stronger in both developed and emerging economies. Financial markets include stocks, bonds, forex markets etc.

Recently, currencies have also been added as an asset class in investors' portfolios, making their co-movements important for investors. It has also been observed that trade level and degree of fluctuation of currency pairs have a direct connection. If a currency pair indicates high volatility, both importers and exporters face high risk. Furthermore, with the globalization of markets, currency risk is embedded in the investors' portfolio even if a representative individual does not take a direct position in the currency market. For instance, if an investor buys shares from the US stock market, any fluctuation in the US dollar concerning the investor's domestic currency will change the return profile. Therefore, it is even more important for an investor to understand the currency markets' connectedness than just the connectivity of the stock markets (Rajhans & Jain, 2015).

Against this backdrop, financial markets integration among regions has been studied by different scholars in the finance literature (King & Wadhwani, 1990; Chevallier et al., 2018; Law et al., 2018). Several studies of the previous literature investigate the spillover effects and related turbulence for developed economies.4 However, there is scant empirical evidence for emerging FX markets. Coming to our sample economy Pakistan, here the FX market is evolving rapidly and it is the target of both local and international investors5. Due to its strategic and political position, Pakistan's trade with other countries has changed its course many times in recent times. Since, Pakistan imports raw materials of many consumption goods from other countries, therefore, its exchange rate with other countries is very important for the investors and traders both. Over the last few decades, the FX market of Pakistan has

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4 See, for example, (Hu et al., 1997 ; Chou et al., 1999 ; Harris & Pisedtasalasai, 2006 ; Diebold & Yilmaz, 2009 ; Xiao & Dhesi, 2010 ; Li (2016) Antonakakis et al., 2018 ; Jain & Sehgal, 2019)

5 For our sample dataset from 1995 to 2019, it is evident that the PKR has depreciated and Stock market index has improved. KSE 100 index in 1996 was 1339.9 (https://file.pide.org.pk/pdf/Seminar/Seminar_Pre10-08-2006.pdf) and in 2019 its value was 40,735.08 (https://dps.psx.com.pk/progress-report). The exchange rates was PKR 33.57/US dollar in 1996 which increased to PKR 150.2016/US dollar in 2023.

witnessed overwhelming growth and high volatility. This market is often considered to be influenced by domestic, regional, and international dynamism. Due to its strategic position, Pakistan occupies an important position in the South Asian region, but there is no single study that investigates the dynamics of return and volatility spillovers of Pakistan's FX market with its major trading partners. The literature suggests that due to bilateral trade and information flows the forex markets may show correlation among different currencies. The previous result report that these spillovers flow from strong economies to weak economies.

Concerning the major trade partners included in this study, the total trade volume of Pakistan with these countries is approximately 80%. This comprises China (CHI) with 16.9%, European Union (EU) with 13%, United Arab Emirates (UAE) with 10.9%, and Saudi Arabia (SA) with 9%. Other significant countries include the United States of America (USA) with 6.7%, Kuwait (KUW) with 4.4%, India (IND) with 3.2%, Malaysia (MAL), Iran (IRN), Japan (JAP) with 2.9% and, finally, Singapore (SING) and Afghanistan (AFG) with 2.8% each.6 Pakistan has bilateral/ multilateral agreements with various countries and global organizations and is also a member of the World Trade Organization (WTO), China /Pakistan Free Trade Agreement, and South Asia Free Trade Area (SAFTA) Agreement. Concerning the recent trends in trade balance of Pakistan, fiscal year 2013-14 observed a trade deficit of $7.74 billion (export, $10.37 billion and import $ 18.11 billion) while during 2021, the trade deficits increased to $32 billion in net imports. This shows a widening trade deficit over time since the same negative trade balance value was a mere $664 million (in net imports) during the year 1995. As per the recent data by the Pakistan Bureau of Statistics (PBS), the average value of Pakistan Rupee (PKR) depreciated by against the US dollar depreciated from (1$ = Rs. 118) in August 2018 to (1$ =Rs. 177) in December 20217, a depreciation of 30.5% in just 40 months. The idea of bilateral trade and informational flows (Evans & Hnatkovska, 2014) can be gauged through financial connectedness among forex markets. This among others motivate us to study the following questions related to our sample economy: Is there any spillover of returns and volatility in the FX markets of Pakistan and its main trade partners? Is connectedness among Pakistan and its main trade partner's FX markets intense during crises periods? What are the major sources and recipients of shocks in the FX markets of Pakistan and its main trade partners? Is there any shift in relations to net shock originators and shock receivers (directional connectedness over-time) in Pakistan and its main trade partners' FX markets?

By answering all these questions, this study extends the existing empirical lit-

6 Please visit: https://tdap.gov.pk/trade-statistics/

7 PKR 302/US dollar

erature in the following dimensions: first, this study makes a seminal attempt to analyze the dynamic connectedness of the FX markets among Pakistan – an emerging market of the South Asian region – and its main trade partners. Second, this study uses the methodology of (Diebold & Yilmaz, 2009; 2012) which is based on the generalized variance decomposition (GVD) of the vector autoregression (VAR) model to establish the daily returns and volatility spillover indices in the market. The earlier literature testing the dynamic connectedness uses different methods including cross-market correlation coefficients (Forbes & Rigobon, 2002; Lee & Kim, 1993; King & Wadhwani, 1990) multivariate ARCH and GARCH models (Bartram et al., 2007; Hamao et al., 1990) and cointegration techniques by Longin and Solnik (1995). However, all these methods have certain limitations. For instance, since the spillover in the financial markets should be analyzed as a system, the multi-variable ARCH and GARCH models need many parameters to estimate, so the value of the related method in terms of its estimation power is compromised. Likewise, the cointegration method is a long-term method which fails to capture the dynamic fluid property of FX markets. By contrast, our selected methodology allows us calculating the origin and destination of the shocks' effects for each variable of the model. Moreover, using the rolling window analysis, the spillover estimates reveal whether a specific country is a net recipient or transmitter of the foreign shocks.8 The last contribution of this study is to analyze the intensity and direction of spillover effects across various crisis events such as the Asian financial crisis (AFC), the global financial crisis (GFC), and the European debt crises (EDC).

The remainder of this study is planned as follows. Section 2 presents a brief review of the selected studies on this topic. Section 3 presents our methodology. Section 4 contains the data description. The empirical results are presented and discussed in section 5. Finally, section 6 concludes the study.

2. Review of Literature

One of the key issues faced by individual investors and financial institutions is the distribution of wealth – free funds – among existing assets available in the market. If investors try to diversify their portfolios on a global scale, the complexity of this issue will increase. The Modern Portfolio Theory (MPT) of Markowitz (1952) is an important milestone in the field of finance, which changed the dynamics of portfolio diversification/creation. He introduced the idea of an association between securities and argued that while creating a portfolio, it is necessary to select securities having a negative correlation. This assists in reducing the unsystematic risk for investors. After the introduction of MPT, investors began to diversify their portfolios, initially at the

8 See Abbas et al., (2019, p.2) for a detail discussion on the unique features of this modelling technology.

domestic level but later at the international level. Levy & Sarnat (1970) posits international diversification of investment portfolios. This theory underpins the current study. In past, some authors including (Grubel & Fadner, 1971; and Levy & Sarnat, 1970) claim that investing in other countries' capital markets offers good opportunities for diversification. In the similar lines, Ahmad, Khan, Shah & Khan (2022) underpins international portfolio theory and diversification in different asset classes for selection of securities across emerging and developed economies. They support and emphasize the notion that an maintaining an international portfolio provides the investor with an exposure of emerging and developed markets and presents option of diversification. This has led investors to diversify their portfolios across borders. This has led investors to diversify their portfolios across borders.

The literature on connectedness between FX markets is plentiful. The relevant literature presents various aspects of connectedness, such as, evolution of interdependence between developed and emerging markets across different continents and reasons for evolution of interdependence and subsequent consequences. The finance and econometrics literature presents numerous methods to examine the phenomenon of cross market connectedness, which have evolved greatly over the period resulting in improved ways of quantifying interaction and connectedness between FX markets.

Shock spillover is a catchphrase in the aftermath of the global financial crisis (GFC) 2008. Therefore, it is important to understand the consequences of spillover effects. In the financial literature, terms such as spillover, co-movement, co-integration, and contagion are often used synonymously. Researchers in the field have defined the spillover in different ways. For instance, Dornbusch et al., (2000) come up with three definitions of spillover according to their ranks. The first definition of contagion provides a broader perspective with cross countries transmission of spillover effect. This spillover effect can occur in both good and bad periods. The second definition is restrictive and here the contagion effects are co-movements of shocks, elucidated by herding behavior of investors. The third definition is of an even more restrictive nature as it explains that contagion during a crisis period is greater when correlations across countries increase as compared to tranquil period correlations, the latter represents the spillover effect transmission following a crisis period. Besides, Forbes and Rigobon (2002) posit that a contagion effect is an increase in the spillover of volatility between two financial markets during the post-crisis period. Financial markets co-movement depicts similarity of the trend in the financial markets. Co-movement in different financial markets is based on characteristics and economic integration of financial markets (Pretorius, 2002). The terms co-integration and co-movement are used synonymously as both depict the existence of a long-run trend among financial markets, whereas a correlation change in financial markets is defined as connectedness.

In the recent literature of financial markets, return and volatility have received much attention because of their impact on portfolio management and portfolio diversification strategies (Fengler & Gisler, 2015; Aboura & Chevallier, 2014; Garcia & Tsafack, 2011), and hedging and option strategies (James et al., 2012; Jayasinghe & Tsui, 2008). With regards to volatility spillovers of the FX market, Kanas (2001) argued that significant and positive volatility spillovers increase the nonsystematic risk, resulting in a reduction of return from IPD. The argument even supports the evidence that systematic return and volatility play a leading role in world currencies' return and volatility spillovers (Greenwood-Nimmo et al., (2016).

Based on the following distinct arguments, studying connectedness in the FX market is different from other types of financial markets. Firstly, FX markets remain global markets on the base of transcontinental operations with a bulk of information flow. Secondly, FX markets for key currencies exhibit a very high degree of connectedness (Kitamura, 2010). Thirdly, FX markets' daily turnover is higher than other financial markets' trading volume (BIS, 2016). Fourthly, currency pairs' exchange rates are more affected than bonds and stocks by monetary policy actions and interventions (Dick et al., 2015). Likewise, monetary policy decisions are also influenced by both volatility and spillover of exchange rates. Fifthly, in the emerging markets, central bank interventions significantly influence their exchange rate volatility (Menkhoff, 2013; Fratzscher et al., 2019). Finally, FX markets' return and volatility connectedness increased moderately following the financial crisis of 2007 and are more stable than the ones of bonds and stock markets (Diebold & Yilmaz, 2015).

The seminal work on the FX market volatility spillover comes from Engle et al., (1990) where the authors show the existence of intra-day spillover in different FX markets (meteor shower hypothesis) instead of country-specific (heatwave hypothesis). The subsequent literature reports conflicting evidence on the subject. For instance, Baillie, and Bollerslev (1991) using exchange rates data of different currencies did not find evidence of systematic spillover of volatility. However, Hong (2001) reports a directional spillover from the former Deutsche mark to the Japanese Yen. Melvin and Melvin (2003) use a non-parametric approach to analyze different currency pairs (America, Europe, Europe-America overlap, Asia, and Asia-Europe overlap) and indicate spillover evidence for intra- and inter-region – the former being stronger than the latter. Cai et al., (2008) use dollar-yen and euro-dollar pairs to report similar evidence of spillover across their selected regions. They find that at both the levels, intra- and inter-region informational relationships are statistically significant but in intra-region, volatility spillovers dominate in terms of economic significance. Kitamura (2010) uses M-GARCH model to analyze a volatility spillover from Euro to Japanese Yen and Swiss Franc. The author finds evidence for an intra-day interdependence and volatility spillover for these currency pairs.

Current evidence associated with return and volatility spillovers is connected to a network approach, investigating connectedness among markets. However, in the FX market, their application is still infrequent. One important contribution is the DY index application by Diebold and Yilmaz (2015) which analyzes exchange rates of nine major currencies with the US dollar as a base over the period 1999 to 2013. The authors indicate that connectedness in FX markets increased moderately after the crisis of 2007-08, however, it exhibits numerous periods of high and low intensity which is not linked with the business cycle. Interestingly, directional spillovers differ among currency pairs. As in the international FX markets, both the euro and the US dollar are the leading vehicle currencies so their exchange rates indicate the highest volatility connectedness, compared to the other currency pairs. Greenwood-Nimmo et al., (2016) document and generalize the framework of connectedness for risk-return spillovers of G-10 currencies during 1999 to 2014. They find that the intensity of spillover is countercyclical and connectedness among currencies increases during crisis periods. Bubák et al., (2011) argue that intra-regional volatility spillovers are statistically significant among emerging FX markets of the European Union, and also increased during market uncertainty such as the 2007 financial crisis. In addition, McMillan and Speight (2010) note the existence of volatility spillovers among some major currencies including the British Pound, the US Dollar, and Japanese Yen with the Euro serving as a base currency. The study recommends that the US dollar has dominating effects on the other currencies. Antonakakis (2012) documents major currencies volatility spillovers before and after the introduction of the Euro and show that the Euro (and the Deutsche mark before Euro) are the dominant transmitters of volatility, while the British Pound is the dominant receiver of volatility. Recently, Khan, Rehman, Shahzad, Khan and Razak (2023), underpinned theoretical framework of International Portfolio Diversification (IPD) and examined the spillover relationship between global uncertainty indices (GUIs) and leading sector indices of twenty-eight emerging economies. They employed quantile spillover-based connectedness and minimum connectedness portfolio approach to investigate the relationship. The study reported high connectedness among all indices at high and low quantiles. The study implies that since communication service is least connected with other indices, which increased in COVID-19 period. They suggest that communication services sector and consumer discretionary sector should be included in the watch list of investors.

Finally, coming to our sample economy, Qayyum and Kamal (2006) analyze return and volatility spillovers between stock and FX markets of Pakistan. Likewise, Jebran and Iqbal (2016), investigate the volatility spillover dynamics between the FX and stock markets of Asian countries (i.e., Pakistan, China, India, Hong Kong, Japan, and Sri- Lanka), by using E-GARCH model. Both these studies support the existence of a bidirectional spillover for Pakistan while the overall volatility persistence of the FX market is higher than that of the stock market. Similarly, Ahmad, Khan, Shah and Khan (2022) used IPD framework to examine the long run relationship among the indices: PSX (Pakistan), TSX (Canada), SSE Composite (China), CAC-40 Index (France), Nikkie-225 (Japan), FTSE-100 index (UK) and DJIA (USA). They used daily, weekly and monthly frequencies spanning from 1991-2018. They imply that international investors can reduce risk by adding these markets into their portfolios. However, the dynamic connectedness among Pakistan and its major trading partners was yet to be explored. This provides room for this study and keeping in mind the importance of this topic, a relatively advanced technique is being used to investigate the said relationship.

3. Data & Methodology

3.1. Data description

The study uses daily exchange rates of major business partners of Pakistan from 1995-to 2019. The pair of these currencies are named as (USD/PAK), (USD/CHI), (USD/EU), (USD/IND), (USD/JAP), (USD/KUW), (USD/MAL), (USD/SA), (USD/SING), (UDS/UAE), (DXY). IRN and AFG are excluded from the sample because of the unavailability of data. The selected series are extracted from data Stream of "Yahoo Finance", "Thomson Reuters" database (i.e., DataStream), and investing.com (www.investing.com) to check for dynamics, intensity, and direction of return and volatility spillover of Pakistan with its major trading partners FX markets. The opening, closing, high and low prices of exchange rates are collected. In all these currencies, exchange rates quoted against the U.S. dollar follow the same unit of currency.

3.2. Econometric technique

The paper computes the returns as $R_{i,t} = log\ (P_{i,t} / P_{i,t\ -1})$ where Pi,t denotes the closing price of the FX market index of a relevant country *i* at time *t*. To examine the volatility of the returns, we follow previous studies (Parkinson, 1980; Diebold & Yilmaz, 2012) and use range-based estimates. By estimating the volatility using high and low prices at day t for market i, we get the variance as: σ_{it}^{2}= 0.361 [ln $(P_i t^{\max})$ – ln $(P_i t^{\min})$] 2. Here $(P_i t^{\max})$ denotes the maximum (high) price at day t in market *i* and $(P_i t^{\min})$ is the minimum low price at day t in market i. With σ_{it}^{2} as variance estimator, the annualized percent volatility is retrieved as:

$$\sigma_{it} = 100\sqrt{365\ .\sigma_{it}^{2}}$$

To examine the connectedness among the FX markets of Pakistan's major trading partners, this study utilizes a recently developed model of Diebold-Yilmaz (2012), known as the spillover index approach. This approach is the generalized version of Diebold and Yilmaz (2009)'s model and relies upon Koop et al., (1996) and Pesaran and Shin (1998) *forecast error variance decomposition* (FEVD) of the Vector autoregression (VAR) framework. This recent approach aims to assess the shocks contributions 'to' and 'from' of each variable in the model in terms of the FEV of each variable. In addition, to examine the magnitude and direction of the spillover, this methodology adopts an estimation of a rolling window that helps identifying whether a specific variable is a 'net receiver' or a 'net transmitter' of the spillovers at different points in time. The start of the spillover index measures specifications using the following equation which has the p-th order for stationary in case of N- variable VAR:

$$x_t = \sum_{(i=1)}^{p} \phi_i x_{(t-1)} + \varepsilon_t \qquad (1)$$

Where stands for a vector of N endogenous variables, represents N×N matrix of estimated parameters, t =1.... T denotes time index, i = 1.... p denotes variable index. Moreover, ε ~ (0, Σ) represents a vector of error terms that is identically and independently distributed over time.

In equation (1), the representation of the moving average of the VAR system can be written as:

$$x_t = \sum_{i=1}^{\infty} A_i \varepsilon_{(t-i)} \qquad (2)$$

In equation (2), A_i represents N×N coefficient matrices derived as:

$A_i = \sum_{(t=1)}^{p} A_{(i-t)} \phi$t, with A_0 is a N×N identity matrix and A_i= 0 where i < 0. The coefficients of moving average translate VAR model dynamics. The main advantage of this approach is that it is invariant to the order of variables in the model.9 After the Diebold- Yilmaz (2012) approach, which is independent of the model variables, the generalized forecast error variance decomposition (GFEVD) at H-step ahead is expressed as:

$$\theta_{ij}^{g}(H) = \frac{\sigma_{ij}^{-} \sum_{h=0}^{H-1} ((e_i^{'} A_h \sum ej)2}{\sum_{h=0}^{H-1} (e_i^{'} A_h \sum A_h^{'} ei)} \qquad (3)$$

In equation (3), Σ represents the variance matrix of the error vector (ε), σ_{ij} is the error term standard deviation for the equation j^{th}, and represents selection vector with value one for the i^{th} element, zero otherwise. This produces N×N matrix θ (H) = [θ_{ij}

9 Diebold and Yilmaz (2009) propose spillover measures using Cholesky factorization of the variance matrix in order to orthogonalize the errors. However, the results of this method depend heavily on the specific ordering of the variables under the VAR system. Furthermore, the spillover direction does not find with the Cholesky decomposition.

(H)] $_{i, j=1,N,}$ where each entry provides a contribution of j variable to the i variable's FEV. In the θ (H) matrix, the main diagonal elements denote the contribution of own shock, whereas off-diagonal elements denote contributions "from other" and "to other" variables in the FEVD. The sum of own and cross variables variance contributions is not equal to one under GVD (i.e.$\Sigma_{(j=1)}^{N} \theta_{ij}^{g}(H) \neq 1$) as statistically independent shocks to each variable, hence each entry in θ (H) matrix becomes normalized by dividing it with the sum of a row as:

$$\theta_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j}^{N} = 1\theta_{ij}^{g}(H)} \quad (4)$$

where $\sum_{j=1}^{N} \theta_{ij}^{g}(H) = 1 and \sum_{i,j=1}^{N} \theta_{ij}^{g}(H) = N$, by construction. As Fengler and Gisler (2015) mention that equation (4) is the approximation fraction representation of H-step ahead FEV of i variable coming from the j variable. The total spillover index is:

$$S^{g}(H) = \frac{\sum_{i,j=1,i\neq j)}^{N} \theta_{ij}^{g}(H)}{\sum_{i,j=1)}^{N} \theta_{ij}^{g}(H)} = \frac{\sum_{ij=1,i\neq j)}^{N} \theta_{ij}^{g}(H)}{N} \quad (5)$$

The index in equation (5) measures the average contributions of spillover to the FEV. This spillover index methodology of Diebold-Yilmaz (2012) is invariant to the order of variables as well as to the direction of spillover. The transmission of directional spillover from the variable i to the variable j is defined as:

$$S_{i\to j}^{g}(H) = \frac{\sum_{i,j=1,i\neq j}^{N} \theta_{ji}^{g}(H)}{\sum_{i,j=1)}^{N} \theta_{ji}^{g}(H)} = \frac{\sum_{i,j=1,i\neq j}^{N} \theta_{ji}^{g}(H)}{N} \quad (6)$$

Likewise, directional spillover received from variable j to variable i are as follows:

$$S_{j\to i}^{g}(H) = \frac{\sum_{i,j=1,i\neq j}^{N} \theta_{ji}^{g}(H)}{\sum_{i,j=1)}^{N} \theta_{ji}^{g}(H)} = \frac{\sum_{i,j=1,i\neq j}^{N} \theta_{ji}^{g}(H)}{N} \quad (7)$$

Here, the directional spillover gives a breakdown of the index into a spillover effect 'to' and 'from' the variables i to j where i ≠ j. Hence, the directional spillovers detect the specific factors of the total spillover index. In addition, the net-directional spillovers from the variables i to j, where a net result of the equations (6) and (7) i ≠ j can be obtained as:

$$S_{(i)}^{g}(H) = S_{(i\to j)}^{g}(H) - S_{(j\to i)}^{g}(H) \quad (8)$$

In the above equation, when the value of the net spillover index is positive, it specifies that i variable is the spillover effect transmitter and the spillover direction is from variable i to all the j variables and vice versa. The directional spillover is further decomposed into pairwise directional spillovers to analyze bivariate spillover. The directional spillover of net pairwise between variables is measured by the shocks transmitted difference in either direction of i(j) variables and is written as follows:

$$(H) = \frac{S_{(ij)}^{g}(H) - S_{(ji)}^{g}(H)}{N} \quad (9)$$

The net pairwise spillover index value offers information about the variable of the transmitter or receiver of shocks. If the values are positive, it means i variable is the net transmitter of shocks effect and vice versa. To summarize, the spillover index approach measures the connectedness intensity across the variables and also decomposes the source and recipient spillover effects.

4. Results & Analysis

4.1 Descriptive statistics

The study provides descriptive statistics of the returns and volatilities in Tables 1 and 2. The mean values of PAK daily returns are high in this group whereas CHI and SING have negative values. For the deviation from the mean, JAP has a high value (highly volatile) whereas UAE has the lowest value (less volatile). In addition, the daily return series of all countries are positively skewed, while PAK is highly positively skewed. In weekly return series PAK, CHI, MAL, SING, and UAE are highly positively skewed, other series are only positively skewed. According to ADF and PP tests, all return and volatility series are stationary at level. For the volatility series, JAP has a high value of the mean, whereas UAE has the lowest value in these series. All volatility series are positively skewed and leptokurtic. Besides, the Augmented dickey-fuller (ADF) and Phillips Perron (PP) tests values are significant at 1% level, rejecting the null hypothesis of unit root for both returns and volatility series.

Table 1: Daily Exchange Rate Return

	Mean	Std. D	Skewness	Kurtosis	JB	ADF	PP	Obs.
PAK	0.024	0.178	4.323	87.235	2042864.4	-87.08	-86.84	6380
CHI	-0.004	0.013	0.661	55.603	822344.03	-44.02	-78.13	6380
EU	0.002	0.294	0.027	2.82	2118.200	-71.35	-71.27	6380
IND	0.013	0.163	0.471	11.583	35900.057	-78.35	-78.61	6380
JAP	0.002	0.324	0.052	7.524	15050.918	-70.35	-70.48	6380
KUW	0.000	0.051	0.242	52.491	732511.78	-50.80	-127.44	6380
MAL	0.008	0.228	1.605	63.071	1060215.9	-12.48	-65.16	6380
SA	0.000	0.002	0.117	375.771	37536662.1	-23.67	-308.31	6380
SING	-0.001	0.101	0.185	8.220	17996.337	-71.36	-71.24	6380
UAE	0.000	0.001	0.056	598.067	95084452.2	-29.12	-747.77	6380
USA	0.001	0.226	0.075	3.420	3115.255	-79.40	-79.39	6380

Note: descriptive statistics for exchange rates are presented here. The table show mainly average (mean), std. dev, ADF and PP tests for return, kurtosis, skewedness and JB tests for normality

Table 2: Daily Exchange Rate Volatility

	Mean	Std. D	Skewness	Kurtosis	JB	ADF	PP	Obs.
PAK	7.664	10330	53.981	3023.96	2431683815.8	-79.27	-79.28	6380
CHI	1.073	28.876	70.739	5416.16	7796144132.4	-11.59	-83.44	6380
EU	11.829	364.26	20.489	585.457	91477271.484	-6.07	-98.01	6380
IND	6.804	26.206	2.115	8.270	22913.304	-4.76	-77.58	6380
JAP	11.482	47.851	3.499	28.281	225420.835	-7.17	-92.34	6380
KUW	4.914	26.466	3.585	29.445	243917.467	-4.86	-71.74	6380
MAL	4.883	65.117	5.498	46.167	598177.333	-3.77	-48.35	6380
SA	0.590	1.589	6.600	63.395	1113627.634	-7.59	-53.74	6380
SING	6.269	17.625	3.903	31.126	273494.313	-4.66	-77.26	6380
UAE	0.306	0.142	8.163	153.33	6314833.161	-6.18	-90.29	6380
USA	8.229	19.324	2.081	10.002	31171.229	-5.26	-114.82	6380

Note: descriptive statistics for exchange rates are presented here. The table show mainly average (mean), std. dev, ADF and PP tests for volatility, kurtosis, skewedness and JB tests for normality

In the next step, we plot the markets' return and volatility series in Figures 1 and 2. As can be viewed from the volatility graphs, all the return series of different countries are volatile with varying degrees. Moreover, both the returns and volatilities observe an increase during the crisis period with some series except PAK and CHI demonstrating huge jumps.

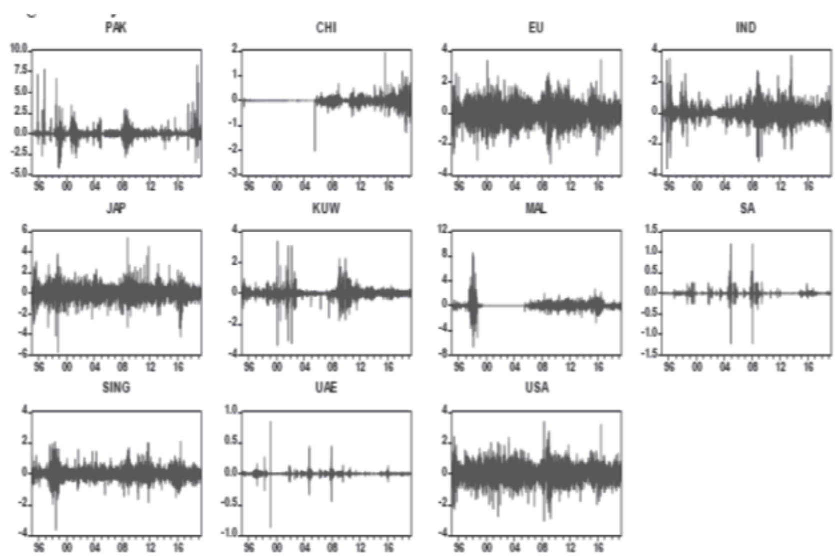

Figure 1: Exchange Rate Returns

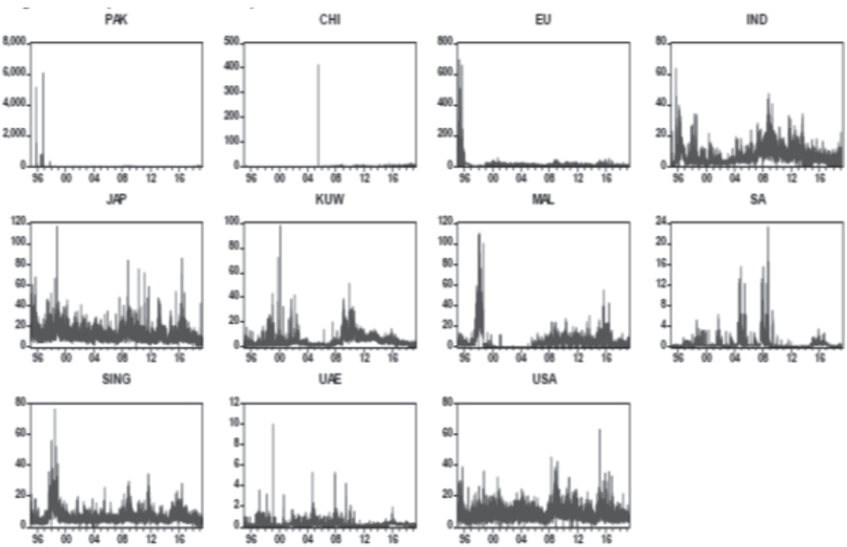

Figure 2: Exchange Rate Volatility

4.2. Inferential statistics

To test the overall connectedness of Pakistan's trading partners' FX markets, this study analyzes the intensity of returns and volatility spillovers of the FX markets. All the results are estimated using 4 lags in the generalized VAR, and the spillover index calculation is based on a 10- day ahead forecast error in the GVD. The results are described in tables 3 and 4. The contents of these tables read as: the ijth entry signifies the estimated contributions to the FEV of market i coming from innovations to market j. Therefore, the off-diagonal row sums (contribution from others) and column sums (contribution to others) are the 'from' and 'to' directional spillovers, and the differences of 'from' minus 'to' are the net returns and volatility spillovers. The total connectedness indices (TCI) are reported at the right lower corner of the relevant spillover tables. The TCI is measured as the sum of total off-diagonal rows sums or column sums relative to all the sum of column sums including diagonals, expressed in percentage. As can be viewed in Tables 3 and 4, the TCI is 40% and 36% over the full sample. These results complement the outcomes by Diebold and Yilmaz (2009) where the authors report the same magnitude of return and volatility spillovers for their sample economies. However, these results are in contrast with Yarovaya et al., (2016) for their sample of developed and emerging economies. This outcome implies that for our selected 11 countries, less than half of the total FEV are shocks from other countries as opposed to countries' self-shocks.

The results proceed to directional spillovers values in rows, known as, 'contribution to others' and the last column 'contribution from others'. Directional spillover

Table 3: Daily Exchange Rate Return Dynamic Connectedness

	PAK	CHI	EU	IND	JAP	KUW	MAL	SA	SING	UAE	USA	FROM
PAK	78.522	3.097	1.695	2.109	1.835	1.85	2.293	2.676	2.008	2.107	1.808	21.478
CHI	2.025	68.227	4.761	3.035	2.530	1.842	3.391	1.807	5.373	2.304	4.705	31.773
EU	0.969	2.223	40.749	3.021	5.083	3.276	2.819	1.245	10.037	0.898	29.68	59.251
IND	1.957	2.917	4.751	64.241	2.500	1.811	5.867	1.530	8.295	1.243	4.888	35.759
JAP	1.403	1.99	7.285	2.067	57.653	3.303	2.536	1.570	9.403	1.389	11.4	42.347
KUW	1.365	2.19	8.156	2.068	4.788	62.524	2.538	2.238	4.679	1.902	7.552	37.476
MAL	1.816	4.715	5.76	5.794	3.360	2.192	53.865	1.850	13.304	1.515	5.831	46.135
SA	1.866	2.105	2.121	2.139	2.204	1.744	1.778	76.623	1.695	5.399	2.327	23.377
SING	0.967	3.318	11.53	5.45	8.490	2.683	8.612	1.264	44.374	1.011	12.301	55.626
UAE	2.045	2.25	2.473	1.882	2.335	1.942	2.099	4.899	2.147	75.577	2.351	24.423
USA	0.907	2.112	28.758	3.039	8.003	3.651	2.725	1.234	10.225	0.948	38.398	61.602
TO	15.319	26.917	77.289	30.604	41.129	24.295	34.657	20.312	67.165	18.716	82.843	439.245
Including own	93.841	95.144	118.038	94.844	98.782	86.82	88.523	96.936	111.539	94.293	121.241	TCI
Net spill-overs	-6.159	-4.856	18.038	-5.156	-1.218	-13.18	11.477	-3.064	11.539	-5.707	21.241	39.931

Note: spillover indices are estimated by using 4 lag, 10 day forecast horizon and 250 rolling windows.

Table 4: Daily Exchange Rate Volatility Dynamic Connectedness

	PAK	CHI	EU	IND	JAP	KUW	MAL	SA	SING	UAE	USA	FROM
PAK	74.449	3.669	2.922	2.093	2.482	1.854	2.492	2.855	2.268	2.383	2.533	25.551
CHI	1.903	76.815	2.505	2.082	2.043	2.506	2.809	1.828	2.427	2.666	2.414	23.185
EU	1.428	1.694	47.362	2.287	6.397	3.101	1.736	1.675	7.61	1.527	25.184	52.638
IND	2.387	2.455	3.97	69.818	3.637	2.159	3.469	2.314	5.04	1.811	2.941	30.182
JAP	1.616	2.37	8.758	3.032	56.027	3.126	2.258	1.651	8.126	1.811	11.227	43.973
KUW	1.877	2.247	4.81	2.094	4.194	67.98	2.606	3.762	3.413	2.759	4.257	32.02
MAL	2.163	3.715	3.867	3.907	3.195	2.476	64.674	2.398	7.948	2.049	3.608	35.326
SA	1.721	1.828	2.455	2.71	2.576	3.708	2.279	71.843	2.721	5.774	2.385	28.157
SING	1.463	3.607	9.812	3.226	7.81	3.001	5.244	2.06	53.198	1.701	8.879	46.802
UAE	1.651	2.154	2.589	2.182	2.455	2.949	2.23	7.838	2.324	71.454	2.174	28.546
USA	1.242	1.655	26.061	1.777	9.403	2.68	1.668	1.591	7.335	1.555	45.033	54.967
TO	17.452	25.395	67.749	25.39	44.192	27.559	26.79	27.972	49.212	24.036	65.601	401.347
Including own	91.902	102.21	115.111	95.208	100.218	95.539	91.464	99.816	102.409	95.489	110.633	TCI
Net spill-overs	-8.098	2.21	15.111	-4.792	0.218	-4.461	-8.536	-0.184	2.409	-4.511	10.633	36.486

Note: spillover indices are estimated by using 4 lag, 10 day forecast horizon and 250 day rolling window Note: spillover indices are estimated by using 4 lag, 10 day forecast horizon and 250 rolling windows.

values indicate that Pakistan's contribution to others in the daily return is 15% of which 2% are shared by CHI and UAE each. In addition, Pakistan's self-contribution is 79%, and received return spillover from others is 21% of which all countries contribute around 2%. Similarly, the USA's contribution to other countries of the group is 83% as EU, SING, and JAP are 30%, 12%, and 11%, respectively. In addition, USA's self-contribution is 38% and received 62% as EU around 29%, SING and JAP around 10% and 8%, respectively. These values recommend that the intensity of daily return spillovers to others (source) are much higher for the USA, followed by EU, SING, and MAL, while PAK has the lowest values. On the other side, the spillover contribution from others (receiver) indicates approximately the same pattern as 'contribution to', which means the USA is at the top and Pakistan is at low order. These results are in line with the economic justification of spillover from strong economies to weak economies. In addition, diagonal values against off-diagonal values have decreased as proceeded to daily return and volatility spillovers. Table 4 report the results of daily volatility spillover. Here, the row 'to' EU with a value of 68% is at the top followed by the USA, SING, and JAP, while Pakistan is at the low order with a value of 17%. On the other hand, directional volatility spillover 'from' has slightly changed values as the USA has a high value at 55% and CHI has a low value at 23%, while the magnitude of PAK's received volatility shocks from other countries is 26%. Consistent with the earlier literature (Rapach et al., 2013; Qarni & Gulzar, 2018), the empirical outcomes show that the US market is the most influential FX market in this group. This highlights the role of the US as a dominant market of the sample economies. Despite the CHI's growing presence in the global economy along with its huge financial market size, our results suggest that tight capital control still insulates the CHI market from the outside world. This isolation result of CHI financial market is also reported by Manopimoke et al., (2018). For our economy of interest, these outcomes specify Pakistan's significance to other economies and vice versa. Indeed, the smaller markets like Pakistan are segmented from other markets and hence exert a limited contribution in systematic risk, as evidenced by the earlier literature (Akdogan, 1996). Likewise, in these markets, most of the local events are responsible for the spillovers of return and volatility (Aggarwal et al., 1999).

Concerning the net returns spillovers, Diebold and Yilmaz (2012) posit that positive values indicate net shock transmitters while negative values indicate net shock receivers. It is also worth noting that the shock transmitters are less vulnerable to external shocks and vice versa. In the present case, as can be viewed from Table 3, positive (net shock originator) values are noted for the USA, EU, SING, and MAL with their respective values as 21%, 18%, 12%, and 11%. The other countries including Pakistan have negative values, confirming their net shock receiver status. This suggests that the USA, EU, SING, and MAL give more than they receive in the trading partners' FX markets while others (KUW, PAK, UAE, IND, CHI, SA, and JAP) in ascending order give less than they receive. These conclusions support the significance of the countries having positive values.

Our results of net volatility spillover, reported in Table 4, show that five countries (EU, USA, SING, CHI, and JAP) out of eleven exhibits positive (net shock originator) values, and the remaining six economies including Pakistan contain negative (net shock receiver) values. The first group of countries is less vulnerable to external shocks whereas the second one is more sensitive to external shocks. In the latter group, most of the local events are responsible for the spillovers of return and volatility (Aggarwal et al., 1999). This is true for Pakistan as well as for the other frontier and developing markets of the selected sample economies including KUW, SA, and UAE (Yu & Hassan, 2008). Our results are consistent with Wang and Moore (2008) and Serwa and Bohl (2005) who give evidence that these smaller economies are minor prone, though not entirely invulnerable to the effects of the crisis.

Although the above findings indicate the behavior of 'average' return and volatility spillover in the trading partners' FX markets, it is still insufficient since the significant secular and cyclical activities in spillovers are not captured here Diebold and Yilmaz (2012). In light of this issue, the study also estimates return and volatility spillover using a rolling window of 250, 100, and 50[10] to address the episodes of events or crises that may have occurred during the sample period. To this end, Figure 3 presents an overall trend of total returns and volatility spillovers. The study finds the divergent behavior of pieces of evidence in the return and volatility spillovers. Total daily returns and volatility spillovers show a gentle trend while the total daily volatility displays a clear burst. It is also observed that total daily return and volatility follow approximately the same trend of spillovers over the full sample period.

However, the total daily returns and volatility connectedness range are low and range between 25% to 50%. The starting point of total daily return and volatility spillover plots are 40% and 33%, respectively. The daily return and volatility connectedness index is close to 37% and 35% between 1997 to 1999 (crisis period, 1997-98) and then falls to 26% and 24 %, again upward bursts in 2001 (9/11 terrorist attack). In 2002, these values are close to 40%, while in 2004-5 (Dollar Crisis) the connectedness of these indices is close to 45% and 43%. Again in 2006, it jumps to 50 % and then downward near to 37% in the mid of 2007 and again at the end of 2007 (GFC) index connectedness rose up to 46% and 42%. The connectedness is around 45% from 2008 to 2011 (after the Lehman Brother default period). In 2011-12 (EDC) the return and volatility connectedness reach 51% and 35%, showing also a huge difference

10 Those who are concerned with the frequency base of connectedness in variables, they may consider diverse forecast horizon for variance decomposition. (Barunik & K□ehlík 2018).

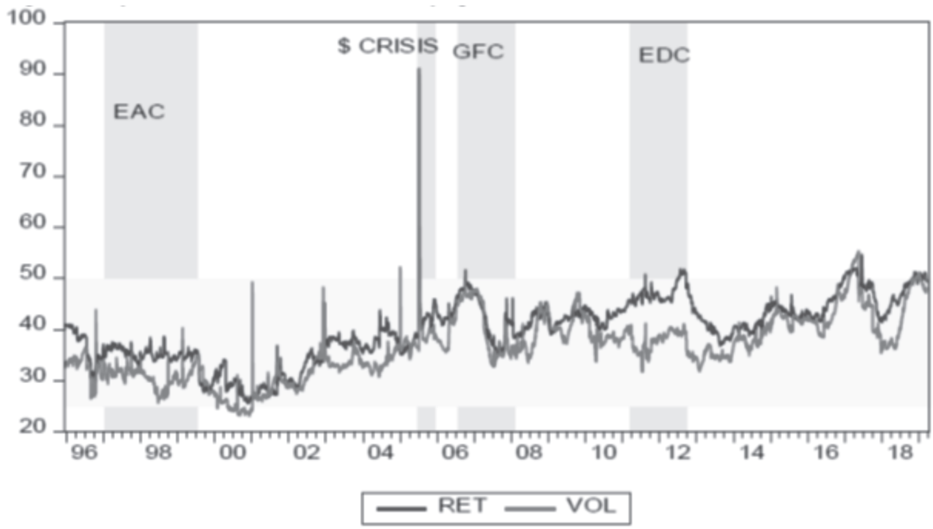

Figure 3: Exchange Rate Total Return and Volatility Spillovers

These results provide evidence that a majority of the sample markets, except CHI and SING, were affected by the recent crisis. The results regarding the EU are

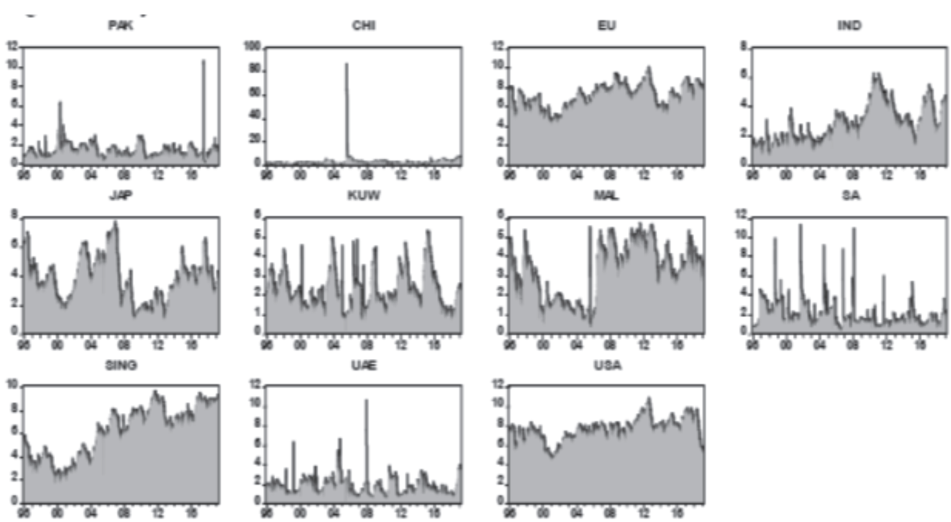

Figure 4: Exchange Rate Return To

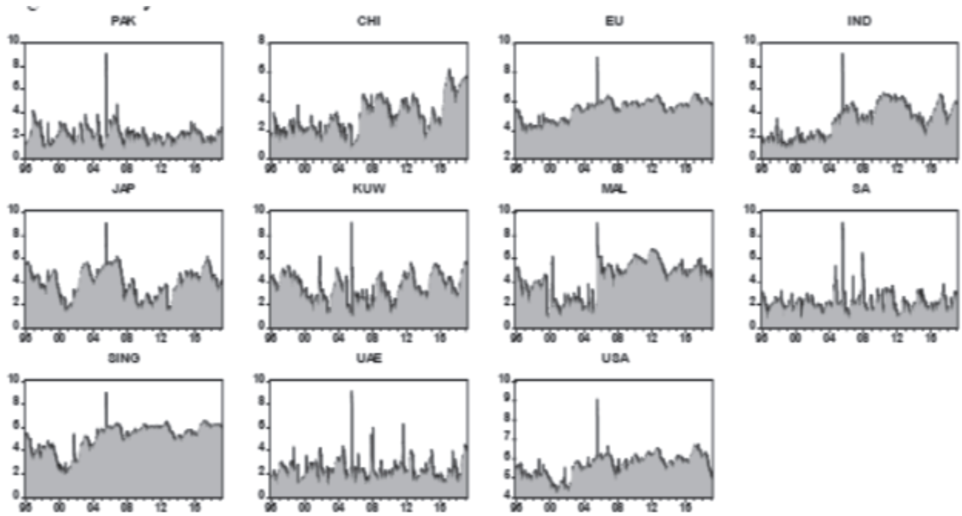

Figure 5: Exchange Rate Return From

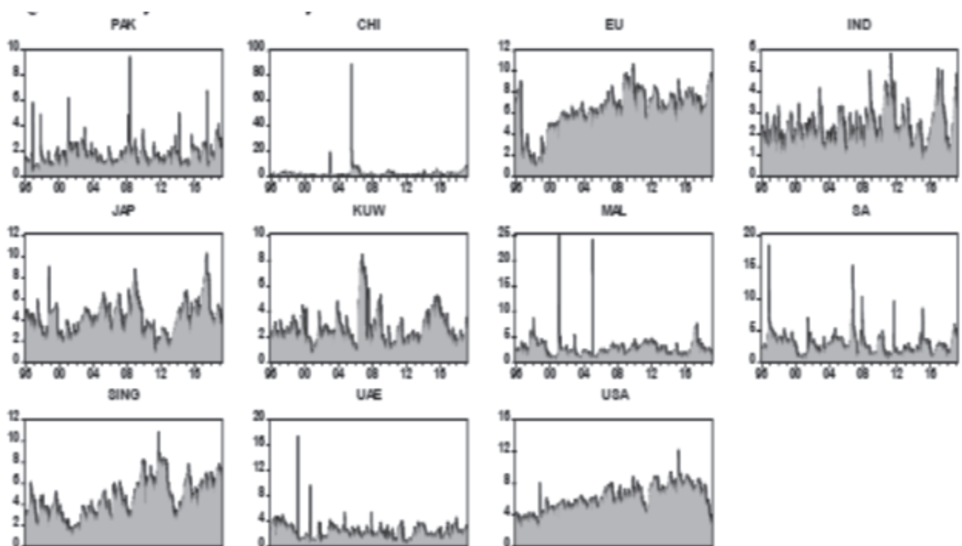

Figure 6: Exchange Rate Volatility To

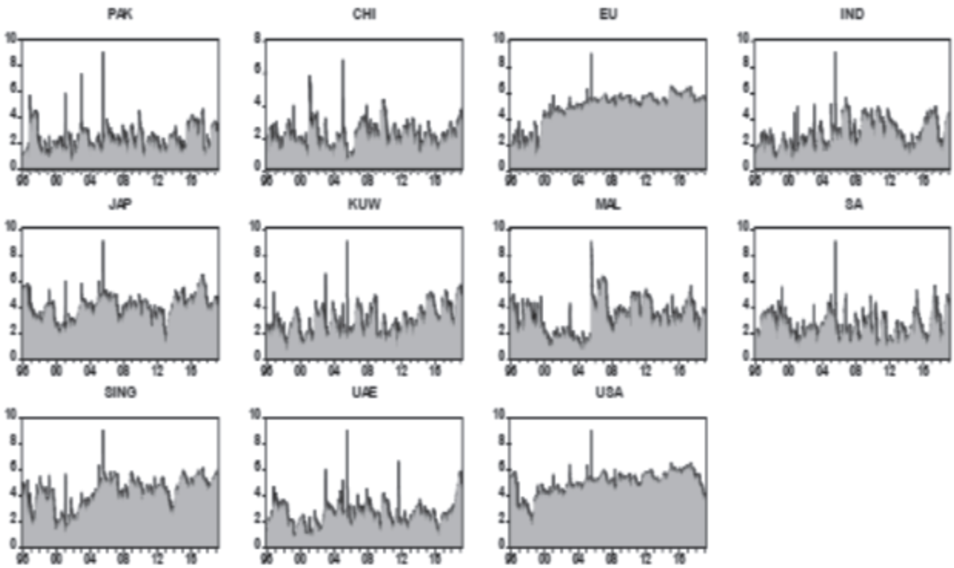

Figure 7: Exchange Rate Volatility From

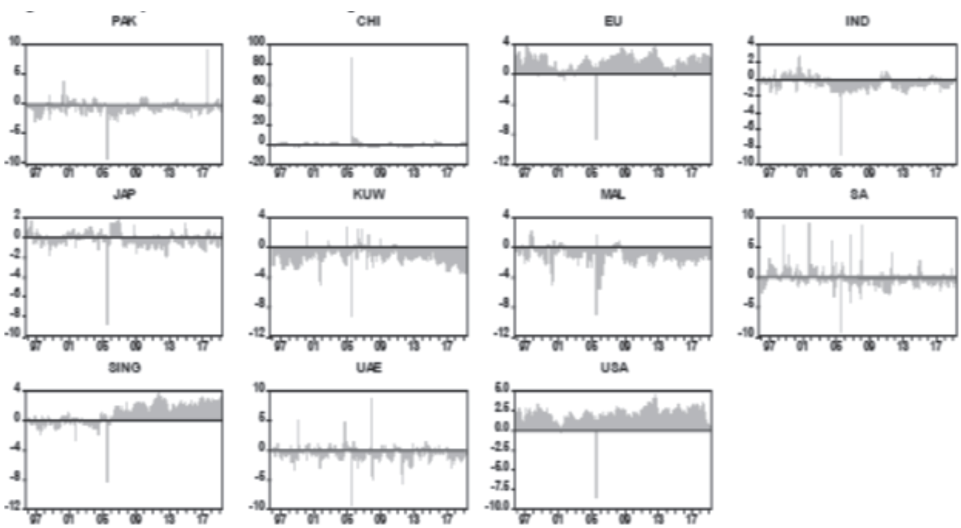

Figure 8: Exchange Rate Return Net Spillover

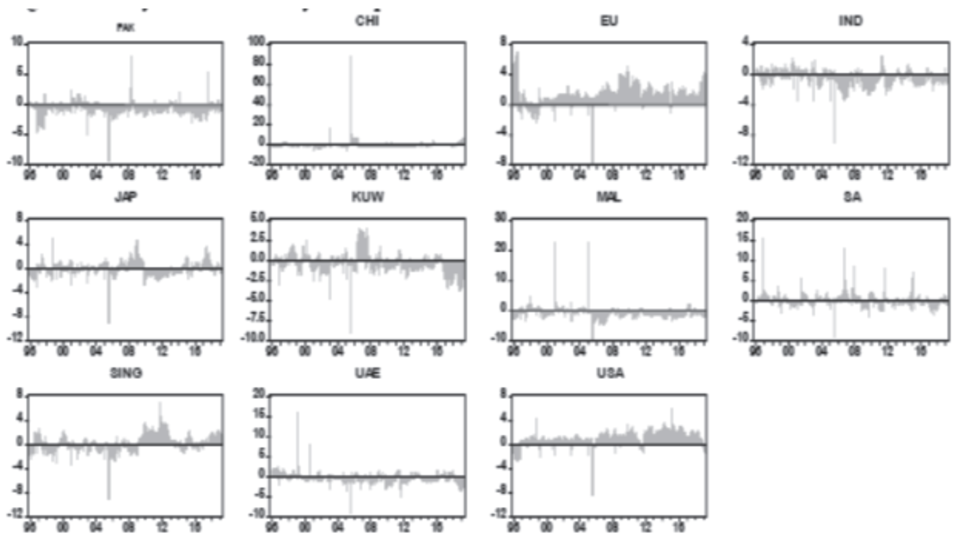

Figure 9: Exchange Rate Volatility Net Spillover

between them, and again in 2014 both indices are close to each other. The last and highest jump of total connectedness of the full sample period is about 55% in 2017.

In the next step, we document the daily directional return and volatility spillovers (Figures 4 to 7). Both directional return and volatility 'to' and 'from' spillovers indicate a similar pattern as daily spillovers. Significant changes during the crisis periods and the subsequent downward trend is also recorded during the sample period. Consistent with the total spillovers plots, the directional return and volatility spillover plots also reveal bursts over the rolling window.

Lastly, we examine the net directional spillover to perceive the net spillover transmitter or receiver, and the overall contribution in the total spillovers. Figures 8 and 9 plot the net return and volatility spillovers for the respective currency pairs. Figures depict that the net spillovers for PAK, KUW, MAL, and UAE are predominantly negative suggesting that these currency pairs are net receivers of return spillovers whereas, the USA and EU are the net spillover transmitters over the rolling window. On the other hand, CHI, IND, JAP, SA, and SING show mixed behavior. The exceptions come in the form of SING and JAP where the former remains a net transmitter of return spillover and the latter becomes a net receiver of return spillover after the crisis period 2007-08. In addition, the USA appears to be the highest contributor to the trading partners group followed by the EU, SING, and MAL. This reinforces our earlier results of the spillover indicating the status of these economies as net contributors of spillovers.

consistent with the recent study of Dajcman (2013), who documents evidence that these crises had long-term effects on EU economies. These findings also suggested evidence of greater connectedness among the developed markets, during the normal as well as the crises periods. From the spillover tables and plots, the developed markets also indicate a higher magnitude of spillovers among themselves as compared to the emerging markets. These outcomes also indicate that Pakistan's contribution to return was higher than its contribution to volatility. This may suggest that trade partners of Pakistan, especially the developed countries' FX markets, affect the volatility in Pakistan whereas national level events largely describe returns in Pakistan. While the estimates of return and volatility in spillover tables recommend minor influence 'from' and 'to' Pakistan markets during the analysis period, the spillover plots for the entire sample report some influence during the GFC-2008 and EDC-2011-12 periods. [11]

5. Conclusion & Implications

This study examines the dynamic connectedness in the major trading partners of Pakistan FX markets using eleven currency pairs in line with IPD. In total, these economies account for around 80% of Pakistan's trade. For our empirical investigation, we rely upon the most recent approach of the DY (2009, 2012) method that enables us to compute the relevant daily spillovers indices including gross spillover index, directional (to and from) spillover index and net spillover index. Besides, we also complement these average fixed spillover indices using a rolling window analysis. Our empirical outcomes can be categorized into four parts. Firstly, the study finds cross-market spillover evidence among the eleven currency pairs. Secondly, the intensity of return spillovers to others (source) is much higher for the USA, followed by the EU, SING, and MAL, while PAK has the lowest value, and all other countries have more or less comparative values. On the other side, the spillover contribution from others (receiver) indicates approximately the same pattern as 'contribution to', which means the USA is at the top, and Pakistan is at low order. Third, the USA, EU, SING, and MAL give more than they receive in the trading partners' FX markets while others (KUW, PAK, UAE, IND, CHI, SA, and JAP) in ascending order give less than they receive. The former group is the net shock originator and less vulnerable to external shocks whereas the latter group is the net shock receiver and is more vulnerable to external shocks. Fourthly, the study finds mixed evidence in the return and volatility

11 It is worth mentioning that this study also assesses the sensitivity of spillover results by employing an alternative H-step ahead of the FEVD and M-day rolling window. We also test the robustness of our results by using both weekly and monthly data. All these robustness tests are conducted in the spirit of different empirical studies of the recent literature (Diebold & Yilmaz, 2014; Kang et. al, 2017; Baruník & Krehlík, 2018; Benlagha & Mseddi, 2019). On the whole, the results of the robustness tests do not contradict our main findings. These results are available from the authors upon request.

spillovers. Total return spillovers show a moderate trend while volatility displays clear bursts. It is concluded that returns and volatility spillovers intensify during phases of financial or economic anxiety. These outcomes remain very robust with respect to changes in VAR lags, forecast horizon, and length of the rolling window.

The results presented by this study have practical implications for asset allocation strategies/international portfolio diversification (IPD). The spillovers between PAK, CHI, IND, KUW, SA, and UAE markets are weaker than between USA, EU, JAP, MAL, and SING markets. Consequently, the benefits of IPD are best achievable by investing in PAK, CHI, IND, KUW, SA, and UAE markets. During crisis periods the burst in spillovers is verified hence it is critical for the investors because diversification benefits are limited during the turmoil period. These findings are helpful for financial regulators and policymakers because macroeconomic stability is affected during crisis periods with the effect of contagion. The connectedness of economic cycles with the international return and volatility spillovers intensity provides an opportunity to use this spillover intensity as an indicator of recession/recovery. This research can be extended to incorporate different country groups comprising different FX markets and other asset classes.

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