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Exchange Rate Shocks and Sectoral Returns Dynamics in Pre-Covid Era: An Examination through GARCH Based Dynamic Models

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ABSTRACT

Purpose: The main goal of this article is to examine, using daily data from June 2000 to June 2018, the relationship between the exchange rate and sectoral returns in Pakistan.

Design and Methodology: Using the ARMA GARCH model, mean and volatility Spillover are evaluated. DCC-GARCH models are also utilized to investigate the dynamic disposition of constant correlation.

Findings: The study's findings suggest that exchange rate volatility has a significant Spillover effect on industries such as those that assemble cars, cement, chemicals, commercial banks, oil and gas, and power generation and distribution, although there is little evidence to support this claim. Strong evidence is discovered against industries using the DCC-GARCH model, which is also utilized to assess the time-varying conditional correlation.

Implications: The results' implications are crucial for the advantages of portfolio diversification as well as risk management in erratic foreign exchange and stock markets. The insights of this study can be used by investors to develop investing strategies for risk control and portfolio diversification.

Keywords: Mean & Volatility Transmission, Exchange Rate, Sectoral Returns, Time-varying Conditional Correlation & DCC-GARCH models.

1. Introduction

A sharp increase in equity investments is observed in international market during last few decades that has significant impact on the demand and supply of the foreign currency and influences the inter-dependence between exchange rate returns and stock returns (Jebran & Iqbal, 2016). This increasing inter-dependency increases the volatility transmission between these two markets (i.e., stock returns and foreign exchange market) and attracts the focus and concern of portfolio managers as well as investors (Kanas, 2000). This mean and volatility transmission is not only observed at market level but also visible at sectoral level. The transmission and intensity of shocks across

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financial markets is considered very important because it helps different policy makers to devise policies and strategies that have direct link with macroeconomic fundaments.

Policy implementers and economists have always been worried about exchange rate fluctuations due its prime importance (Wesseh & Niu, 2012). Numerous researchers have assessed previously the dynamic connection between exchange rate movements and industrial returns see for example, (Ajayi & Mougouė, 1996; Ajayi, Friedman, & Mehdian, 1998; Nieh & Lee, 2001; Phylaktis & Ravazzolo, 2005; Mishra, Swain, & Malhotra, 2007; Stavarek, 2005). The flow-oriented model as well as the stock-oriented model are the two potential theoretical frameworks that the literature uses to explain this linkage. According to a flow-oriented model developed by Dornbusch and Fischer (1980), a firm's competitiveness is boosted by the depreciation of its home currency, which subsequently results in an increase in exports and future predicted cash flows that have an impact on the industry. Second, the portfolio balance approach and stock-oriented approaches of exchange rate regimes explain how exchange rates and prices are related (Branson, 1983; Frankel, 1992). These models contend that the supply and demand for financial assets like stocks and bonds serve as the main determinants of the exchange rate. The profitability of domestic industries is reflected by exchange rate shocks. The ups and downs in the exchange rate can determine the price change and it may be the result of (a) altered terms of competition with foreign firms for domestic exporters or import competitors, (b) altered input costs for sectors reliant on exorbitant input, and (c) altered estimations of advantages specified in foreign currency benchmarks. Owing to these unfavourable arrangements of effects, certain industries are more directly impacted by exchange rate changes than others, and the impact of exchange rate changes on a given industry should primarily depend on its relationship to the rest of the global economy.

In earlier studies, most of the empirical work examine the mean and volatility transmission between the two financial markets (foreign exchange market and stock markets) for different countries. In developed countries, this information spillover is also extensively seen in previous studies (Beer & Hebein, 2008; Francis, Hasan, & Hunter, 2006; Grobys, 2015; Yang & Doong, 2004; Antonakakis, 2012). Moreover, some previous empirical studies also document the evidence of co-integration between these two markets of developing countries (Choi, Fang, & Fu, 2009; Kang & Yoon, 2013; Mishra, Swain, & Malhotra, 2007; Morales, 2008; O'Donnell & Morales, 2009). A small set literature also focus on information spillover in emerging countries as well (Adjasi, Harvey, & Agyapong, 2008; Li & Majerowska, 2008; Oberholzer & Von Boetticher, 2015; Okpara & Odionye, 2012; Walid, Chaker, Masood, & Fry, 2011).

Although there exists an extensive body of literature that examines the interactions between exchange rates and stock returns, but only a limited work is done on information spillover to different industries. Literature about exchange rate-to-market is available but the evidence on exchange rate-to-Industries is subtle. Moreover, Pakistan is an important emerging market and limited insight regarding such phenomena is available. So, this study focuses on analyzing the impact of exchange rate fluctuations on the return and volatility of various industries.

Additionally, all GARCH models focus to explain the heteroskedasticity and asymmetry in volatilities but didn't discuss these features in correlation. The criticism on CCC-GARCH models is that they didn't incorporate the effect of time-varying correlation. To overcome these limitations, DCC-GARCH model is used as an extension of CCC-GARCH model which restrict the correlation to vary. Moreover, ADCC GARCH models is also used to address the asymmetries between different industries. DCC-GARCH model relaxes the assumption of constant correlation, and it further measures the asymmetries through Asymmetric Dynamic conditional correlation-GARCH model. So, this study also investigates the time varying aspect of conditional correlation. The study also gets its support from market efficiency theory. As market efficiency theory states that when new information inflow is seen in market it is eventually depicted in stock prices (Amadou, 2021). The spillover is thus examined in the underlying study to evaluate the sectoral returns in Covid 19 era.

The mean and volatility Spillover mechanism will also shed light on the creation of precise models for risk premiums and stock valuation. The empirical evidence on spillovers will also help to refine our approximation of conditional volatility, which has practical uses in finance including portfolio optimization and optimum hedging. However, the current study has investigated how the exchange rate's impact on industrial returns in the pre-Covid era spread. The paper further explains the theoretical bonding between the variables using prior literature and theory to support the hypothesis of the study. Moreover, the paper discusses the methodological strategy opted with the results found. The results are also discussed in the next section with the relevant literature. Lastly, the paper explains the scope and implications of the study with conclusion drawn from the current investigation.

2. Literature Review

The exchange rate and stock prices have a lead-lag relationship, according to conventional theories. Exchange rates have an impact on both domestic and international companies' stock prices. The cash flows of a nation are instantly impacted by changes in exchange rates. Yet, the portfolio balance approach and stock-oriented theories of exchange rate determination explain a complex chain between exchange rates and stock prices (Branson, 1983; Frankel, 1992). Indeed, changes in stock prices may influence exchange rate fluctuations by adjusting for changes in the supply and demand of domestic and foreign assets in globally diversified portfolios.

Ross (1989) argues that volatility in stock returns is based on the rate of information flow. Since the time required for the process of information and the rate of information flow is different for each sector or market, so one should be clear that the different pattern of the volatility can be observed over the time. Globalization is serving as a catalyst in the integration of the financial markets and this connectedness of the markets has attracted the interest of market participants to understand the transmission mechanism of the volatility across different markets, regions, and

countries. The changes in the volatility of one market transmit to the other markets and influence the expectations of the different people across asst classes, industries, and markets. Bodart and Reding (2001) study the linkage between exchange rates and expected sectoral returns and find a positive but week mean and volatility spillover from exchange rates to sectoral returns. This study, further, explains that the exchange rate regime, the intensity, and the direction of the transmission of information has a significant influence on the spillover of exchange rates.

In India, Mishra et al., (2007) document the relationship between two financial markets i.e., currency and equity markets. Using GARCH based models (i.e., ARCH, GARCH, EGARCH), the study reveals that there is bi-directional flow of shocks from one financial market (currency market) to another financial market (equity returns). Mun (2007) documents that, how the variations in exchange rates influence the correlation in stock markets and volatility. The study finds that local stock market volatility is more affected by the variations in the high FX rate, but this effect is negligible in the U.S. stock markets. In Japan, Jayasinghe and Tsui (2008) identify the relationship between exchange rate and stock market. This study reveals the presence of volatility spillover in stock prices of six industries of Japan. It further adds that all these six sectors (i.e., Auto Parts, Construction & Build Material, Electronics Equipment, Household Goods, IT and gas exploration, respectively) show increased volatility in equities as compared to volatility of exchange rate.

Fedorova and Saleem (2009) examine the volatility spillover between currency market and stock markets in Eastern Europe by using GARCH-BEKK model and provide evidence about the presence of spillover effect between currency and stock market. However, this spillover is only from currency to stock markets. In China, Zhao (2010) examines the relationship between currency market and stock market by using VAR and MV-GARCH models to find the evidence of spillover effects between these two financial markets. The tests didn't detect any mean spillover effects, but bi-directional volatility spillovers are found. Walid, Chaker, Masood and Fry (2011) examine the volatility of exchange rate in four developing countries; Hong Kong, Malaysia, Singapore, and Mexico and finds that volatility of the stock indices depends on the mean and variance of the exchange rates.

Wang, Wu, and Lai (2013) determine the dependence structure between stock markets and exchange rate market over the period of 1990 to 2010 for the industrial indices of six major countries (Canada, France, Germany, Italy, Japan and the United Kingdom) by using dependence-switching copula model. They conclude their studies in terms of dependence and tail dependence structure and reveal that the market statuses of most of the countries are asymmetric in negative correlation regime, while the market statuses are symmetric in positive correlation regime. Kumar (2013) takes the sample of ISBA nations; India, Brazil & South Africa and explores the spillover effects between exchange rate and stock prices. Using VAR and MV-GARCH methodology with time varying variance-covariance BEKK model models, he investigates the mean and volatility spillover between exchange rate and stock prices of these three countries and find the evidence on the bi-directional spillover volatility between stock market and currency market of these countries.

Andreu, Swinkels, and Tjong-A-Tjoe (2013) use the sample of 12 countries (Australia, Belgium, Canada, France, Italy, Hong Kong, Japan, Netherlands, Singapore, Spain, Sweden, Switzerland, U.K. and U.S) and find the spillover effects between foreign exchange rate and stock market. While the effect is not observed for Columbia stock market. Using GJR GARCH model, Kang and Yoon (2013) document the uni-directional flow from exchange rate market to stock market of Korea in terms of volatility. Valls & Chuliá, (2014) use MVA GARCH models to examine the dynamics of Asian economies in term of mean and volatility spillover and report the evidence of bi-directional spillover volatility between both markets rather than incorporating the level of the development of country.

Andrikopoulos, Samitas and Kougepsakis (2014) investigate the relationship between exchange rate and stock markets of European union and find a bi-directional volatility spillover between these two markets. Inci and Lee (2014) take the sample of five European countries (France, Germany, Italy, Switzerland, United Kingdom) to determine the connection between stock prices and exchange rate. They summarized that; exchange rate has a significant impact of stock prices of the sample countries. Xiong and Han (2015) use GC-MSV model and reveal that there exists a bidirectional spillover between China's currency and equity market.

Using a time-varying structural VAR model, Tian and Hamori (2016) analyze the response of foreign exchange, equity, bond, and commodities markets by financial shock transmission in the United States. Their findings report the time varying nature of volatility. Considering the data of six Asian countries (China, Hong Kong, India, Japan, Pakistan, and Sri Lanka), Jebran and Iqbal (2016) employ E-GARCH model in their study and investigate spillover between equity markets and currency market. The results reveal that for Pakistan, China, Hong Kong and Sri Lanka, there exists a bi-directional spillover volatility between the foreign exchange market and stock market. Most recent work in India is done by Jain and Biswal (2016) in which they take the global prices of gold, crude oil, exchange rate, and the stock market of India and use DCC GARCH model to determine the relationship between exchange rate and Indian stock markets. The study report that there exists a correlation between these two variables. The study also reveals that the fall in the domestic stock market is due to the depreciation of the Indian rupee. In BRICS zone (Brazil, Russia, India, China, and South Africa), Sui and Sun (2016) use VAR framework and explore the dynamic relationship between stock markets and exchange rate. The findings depict a significant relationship in between exchange rate and stock returns. Additionally, they also suggest that the performance of a firm or a sector can also be affected by exchange rate volatility. Thus, a stable exchange rate can lead to stabilize the stock market, particularly in the period of financial crisis.

From all empirical evidence discussed in above literature, a lot of work has been done on financial integration and relationship between foreign exchange rate and equity markets. Most of the previous studies generally discuss the co-movements between the series using Co-integration, Vector Auto-regression framework, and Granger Causality, and too is for the developed countries see for example, (Ahmad, Ashraf, & Ahmed, 2005; Bhattacharya & Samanta, 2003; Eun & Shim,

1989; Al Asad Bin Hoque, 2007). However, the previous literature does not offer enough evidence on the impact of return and volatility spillover between exchange rate and industrial return, especially for developing countries i.e., Pakistan. Therefore, studying the mean and volatility spillover mechanism between exchange rate and industrial returns in an emerging economy will add some valuable insight to existing literature in current times.

3. Methodology

This study uses the daily closing prices of Exchange rates and industrial indices (Automobiles Assemblers, Cement, Chemicals, Commercial Banks, Engineering, Fertilizers, Oil & Gas, Pharmaceuticals, Power Generation & Distribution, Refineries, Sugar, Technology & Telecommunication, Textiles and Tobacco) to examine the mean and volatility spillovers from currency market-to-industries. Sample period is 18 years starting from June-2000 to June-2018. Data has been gathered from two reliable sources. First is the website of central bank of Pakistan and the other is Pakistan stock exchange. The reason for the selection of these industries is size of industry, liquidity, and their relative exposure to the foreign exchange market. These sectors represent more than 85% of market capitalization. These factors help to capture the true dynamics of the pricing movement. The returns of exchange rate series are determined by using return formula:

$$r_t = \ln\left(\frac{ER_t}{ER_{t-1}}\right) \quad (1)$$

Where ER_t is Exchange rate of day "t" in terms of rupees/dollar and ER_{t-1} is Exchange rate of day "t-1" in terms of rupees/dollar. The current study constructs an equally weighted index that is used to extract the average industrial returns as detailed in Table 1.

Table 1: Industrial Indices

1	Automobiles Assemblers	58.33%
2	Cement	68.18%
3	Chemicals	51.72%
4	Commercial Banks	45.83%
5	Engineering	50.00%
6	Fertilizers	71.43%
7	Oil & Gas	58.33%
8	Pharmaceuticals	55.56%
9	Power Generation & Distribution	52.63%
10	Refineries	100.00%
11	Sugar & Allied Industries	50.00%

12	Technology & Telecommunication	50.00%
13	Textiles	30.97%
14	Tobacco	66.67%

Source: *Authors' own calculation*

3.1. Econometric Models

To determine the mean and volatility transmission from exchange rate to various industries, ARMA GARCH Model is used as follows:

$$r_{p,t} = \psi_o + \psi_1 . r_{p,t-1} + \psi_2 . v_{p,t} + \psi_3 . \varepsilon_{p,t-1} + \mu_{p,t}, \mu_{p,t} \sim (0, v_{p,t}) \quad (2)$$

$$v_{p,t} = \xi_o + \xi_1 . \iota_{p,t-1}^2 + \xi_2 . v_{p,t-1} \quad (3)$$

Where $r_{p,t}$ is the daily returns series of exchange rate at time t and $\mu_{p,t}$ is the error term of equation.

$$r_{q,t} = \psi_{q,o} + \psi_{q,1} . r_{q,t-1} + \psi_{q,2} . v_{q,t} + \psi_{q,3} . \mu_{q,t-1} + \chi_q . \varepsilon_{p,t} + \chi_q . smf + \mu_{q,t}, \mu_{q,t} \sim (0, v_{p,t}) \quad (4)$$

$$v_{q,t} = \xi_o + \xi_1 . \iota_{q,t-1}^2 + \xi_2 . v_{q,t-1} + \varsigma_q . \varepsilon_{p,t}^2 + \varsigma_q . Smf \quad (5)$$

In the second stage, the standardized error term is obtained and with its square and mean a volatility transmission is examined across the markets and then adjusting them into the equation of mean and volatility equations of various industries along with structural break that is included to account for the presence of stock market freeze.

Where $\varepsilon_{p,t}$ is obtaining the mean return spillover effects from these sources and it is the standard error term. Conditional volatility equation ($\varepsilon_{p,t}^2 = \frac{\varepsilon_{p,t}^2}{v_{p,t}}$) includes the exogenous variable $\varepsilon_{p,t}^2$ which is also defined as the square of the standardized error term which examined the volatility in spillover. Smf is introduced as interactive dummy construct that is measuring the impact of structural break of 2008 in KSE stock Exchange. The subscript q refers to a specific industry of Pakistan as detailed in Table 1.

ARMA GARCH model incorporate the condition of constant correlation in the data. But with the passage of time, it's not necessary that correlation remains constant. Correlation can exhibit the dynamic nature as well. So, if the correlation between the series is dynamic, in short, the time varying, then above model loses its practicality and becomes less important. In such cases, DCC GARCH Models can be used. In addition, in case of asymmetric behaviour of data, ADCC model is applied which was proposed by Cappiello, Engle and Sheppard (2006).

DCC is described as …

$$Q_t = \bar{R} + \zeta_1 (\varepsilon_{t-i} \acute{\varepsilon}_{t-i} - \bar{R}) + \zeta_2 (Q_{t-1} - \bar{R}) \quad (6)$$

ADCC is described as …

$$Q_t = \bar{R} + \zeta_1(\varepsilon_{t-i}\acute{\varepsilon}_{t-i} - \bar{R}) + \zeta_2(Q_{t-1} - \bar{R}) + \zeta_3(\eta_t\eta_t' - \bar{N}) \quad (7)$$

4. Data Analysis

The analysis for current examines the return and volatility transmission from exchange rates-to-industries Pakistan by using ARMA (1,1) GARCH-In-Mean model presented by Liu and Pan (1997) and time-varying conditional correlations is examined between exchange rate and different industries by using Dynamic Conditional Correlation (DCC) and Asymmetric-DCC (ADCC) Multivariate Generalized Autoregressive Conditional Heteroskedasticity (MV-GARCH) models proposed by Engle (2002) and Cappiello, et al (2006), respectively.

Table 4 represents that there exists a spillover among industries based on their exchange rate by estimating the volatility and mean of spillover. A significant but negative effect of spillover mean φ have been captured on Cement-CEM, Chemicals-CHEM, Commercial Banks-CB & Refineries-REF that means, the returns of all these industries are influenced by the fluctuations in exchange rate. The negative sign indicates that the shocks in foreign exchange rate decrease the mean returns of Cement-CEM, Chemicals-CHEM, Commercial Banks-CB & Refineries. This indicates that unexpected depreciation in the currency has negative impact of stock returns of above stated sector. One possible reason of this reduction in these industries is relatively higher exposer to foreign portfolio investment. The similar evidence about the spillover effect is also provided in a study by (Bodart & Reding, 2001) that reports a significant and negative mean and volatility transmission from exchange rate to industrial indices. Secondly, the depreciation of currency does increase the exports but local consumption decreases. However, appreciation of currency gives them boost in local market. Moreover, the significant negative variation in financial sector is directly associated with higher exposure of the sector to currency fluctuations.

In contrast, only Automobile Assemblers-AA reflects significant positive impact which may be result of oligopolistic market structure that helps them to transfer the impact of depreciation of currency to end user, which in turns increases the returns of this sector. On the other side, the insignificant variations in Oil & Gas-O&G, Power Generation & Distribution-P&D and Technology & Telecommunication-T&T shows that there exists no return spillover in these industries. It is because, these industries are relatively more regulated. Meanwhile, when the effect of stock market freeze (dummy variable) is captured by using interaction dummy (i.e., φ*Smf), most of the results are now insignificant which provides a strong theoretical reasoning that when stock market freezes, any variation comes from exchange rate is not priced by market due to halt in trading. On the other hand, Automobile Assemblers-AA & Chemicals-CHEM still exhibit a significant negative impact. It means the firms which are not the part of index, are still showing some trading pattern in case of stock market freeze. There is only one industry Technology & Telecommunication-T&T which shows a significant positive impact during the period of structural break that implies, the

Source: Authors' own calculation. Values in parenthesis are the p-values. Smf=Stock Market Freeze Dummy Variable. χ denotes the parameters of mean Spillover and ς denotes the parameters of volatility Spillover. The interactional terms (χ *Smf and ς *Smf) show the effect of stock market freeze with mean and volatility Spillover depreciation of currency is increasing the mean returns of Technology & Telecommunication-T&T during stock market freeze.

Similarly, the results of volatility spillover λ show a significant negative impact on Automobile Assemblers-AA, Cement-CEM, Chemicals-CHEM, Commercial Banks-CB, Oil & Gas-O&G and Refineries-REF. This negative trend in volatility reveals that, the volatility of exchange rate decreasing the volatility of these industries.

Table 2

	ER	AA	CEM	CHEM	CB	O&G	P&D	REF	T&T
ψ_o	4.94E-05 (0.1779)	0.0002 (0.2717)	0.0003 (0.3362)	-2.05E-05 (0.9397)	0.0003 (0.1264)	0.0002 (0.2291)	-0.0003 (0.1838)	-0.0206 (0.0000)	-8.41E-05 (0.6348)
ψ_1	0.0617 (0.5028)	0.6647 (0.0000)	0.2188 (0.0716)	1.2049 (0.0001)	0.3843 (0.0005)	0.2586 (0.1217)	-1.0957 (0.3468)	0.0086 (0.9426)	-0.0659 (0.6882)
ψ_2	4.9011 (0.2752)	-0.1828 (0.9144)	0.6636 (0.7383)	-0.3093 (0.8569)	-0.1676 (0.9243)	2.4322 (0.1805)	13.1909 (0.0682)	-0.0026 (0.0000)	0.6667 (0.5692)
ψ_3	-0.2798 (0.0017)	-0.4642 (0.0000)	-0.1010 (0.4049)	-1.1566 (0.0002)	-0.2605 (0.0194)	-0.1679 (0.3183)	1.0992 (0.3459)	0.1070 (0.3857)	0.1566 (0.3449)
χ	-	0.0008 (0.0000)	-0.0004 (0.0005)	-0.0044 (0.0001)	-0.0001 (0.0011)	-8.09E-05 (0.3477)	-6.03E-05 (0.3684)	-0.0041 (0.0000)	-0.0001 (0.1216)
χ*Smf	-	-0.0005 (0.0000)	0.0009 (0.8485)	-0.0088 (0.0000)	0.0009 (0.5962)	0.0006 (0.8147)	-0.0007 (0.5694)	0.0054 (0.4317)	0.0159 (0.0000)
ξ_o	7.10E-07 (0.0000)	0.0001 (0.0000)	0.0001 (0.0000)	0.0001 (0.0000)	0.0001 (0.0000)	0.0001 (0.0002)	6.13E-05 (0.0000)	8.21E-05 (0.0000)	0.0002 (0.0000)
ξ_1	0.6944 (0.0000)	0.6000 (0.0000)	0.6000 (0.0000)	0.6000 (0.0000)	0.6000 (0.0000)	0.6000 (0.0000)	0.6000 (0.0000)	0.6000 (0.0000)	0.6000 (0.0000)
ξ_2	0.2483 (0.0000)	0.1500 (0.0000)	0.1500 (0.0000)	0.1500 (0.0000)	0.1500 (0.0002)	0.1500 (0.0001)	0.1500 (0.0000)	0.1499 (0.0000)	0.1500 (0.0001)
ς	-	-1.93E-13 (0.0000)	-1.51E-12 (0.0000)	-1.90E-1 (0.0000)	-9.00E-13 (0.0524)	-1.22E-12 (0.0549)	-3.49E-1 (0.2437)	9.68E-11 (0.0000)	-2.26E-12 (0.3518)
ς*Smf	-	-7.79E-10 (0.0000)	-7.15E-10 (0.0000)	-7.07E-1 (0.0000)	-6.22E-10 (0.0000)	-5.76E-10 (0.0000)	-2.58E-1 (0.0000)	-2.15E-10 (0.7614)	-2.80E-10 (0.5919)

Source: Authors' own calculation. Values in parenthesis are the p-values. Smf=Stock Market Freeze Dummy Variable. χ denotes the parameters of mean Spillover and ς denotes the parameters of volatility Spillover. The interactional terms (χ *Smf and ς *Smf) show the effect of stock market freeze with mean and volatility Spillover

The possible reason may be that uncertainty in exchange rate is either reducing activity in stock market which is resulting to decrease the volatility or stock market being a forward-looking market that may already have anticipated and priced it. The negative relationship between these industries and exchange rate can also be attributed to a country's heavy reliance on imports which in turn increases the costs and reduces the returns (Jayasinghe & Tsui, 2008). Another reason may be the oligopolistic structure of these sectors that make them more stable. In Power Generation & Distribution-P&D and Technology & Telecommunication-T&T Sector, the volatility is not influenced by exchange rate's variations as they are more regulated sector. In power sector, most of the cash flows are contractually guaranteed under project finance framework so little change is expected in cash flows. These contractual guarantees are implemented through offtake contracts. Refineries-REF shows a significant but positive impact of volatility spillover and represents itself as a volatile sector due to high volatility and an excessive use of Crude Oil imports as an input.

The interesting thing is that, when the crisis dummy variable is applied with the volatility spillover i.e., λ*Smf, all results become significant and negative except Refineries and Technology & Telecommunication-T&T. It also reveals that when stock market freezes, although the volatility spillover exists but it is quite less. The reason is that the trading in the freezing period has been reduced so the volatility of all these industries has also been decreased. The results of Technology & Telecommunication-T&T are also consistent with the study of Jayasinghe and Tsui (2008) in which they explored that this sector is positively related with exchange rate during the volatility shocks transmission. However, only Refineries-REF did not show any relationship with exchange rate volatility. It means the volatility of this industry is not influenced by exchange rate changes. The increasing & decreasing effect of volatility spillover is also documented by Mishra et al., (2007) in which they find the same trend with respect of the transmission of volatility between exchange rate and stock market indices in India.

Table 5 represents the results of ARMA(p,q) Model across remaining six industries. The six mentioned industries are homoscedastic as explained by return data in ARMA model making GARCH model inappropriate. The mean spillover is significant and negative in two industries: Engineering-ENG and Sugar-SUG. It means, the mean returns of Engineering-ENG and Sugar-SUG industries are influenced by exchange rate returns. The negative sign shows that the mean returns of these industries are decreasing with depreciation of the domestic currency. The reason is same that when currency depreciates, it leads to decrease the cashflows that ultimately reduce the returns. The remaining industries like; Fertilizers-FERT, Pharmaceuticals-PHAR, and Tobacco-TOB exhibit no spillover from exchange rate. The reason is the small size and inelastic demand of these

industries that reduces the immediate impact of fluctuation in currency. However, insignificant impact on Textile industry is unexpected as textile sector is largest exporting industry of the country. However, this sector is comprised of family-owned business which is relatively illiquid (Shah, Mehboob, & Raza, 2012).

Table 3: Mean Spillovers from Exchange Rates to Other Industries – ARMA Model

$\boldsymbol{\rho_o}$	4.94E-05 (0.1779)	0.0002 (0.4437)	0.0001 (0.3494)	0.0011 (0.0661)	-0.0003 (0.3418)	0.0009 (0.1115)	0.0122 (0.0000)
$\boldsymbol{\rho_1}$	0.0617 (0.5028)	-0.1108 (0.6752)	0.1265 (0.5957)	-1.2360 (0.0262)	1.8207 (0.0000)	-2.1540 (0.2159)	-12.6078 (0.0000)
$\boldsymbol{\rho_2}$	4.9011 (0.2752)	-	-	-	-	-	-
$\boldsymbol{\rho_3}$	-0.2798 (0.0017)	0.0580 (0.8264)	-0.0678 (0.7765)	1.2116 (0.0294)	-1.7888 (0.0000)	2.1427 (0.2175)	12.6254 (0.0000)
$\boldsymbol{\varphi}$	-	-0.0006 (0.0389)	-0.0001 (0.4835)	-3.75E-05 (0.9451)	-0.0006 (0.0473)	-0.0005 (0.0840)	-0.0011 (0.1298)
$\boldsymbol{\varphi}$*Smf	-	0.0009 (0.7791)	0.0001 (0.9192)	0.0002 (0.9676)	0.0004 (0.8999)	0.0006 (0.8486)	0.0020 (0.8205)

Source: *Authors' own calculation*

*ER=Exchange Rates, ENG=Engineering, FERT=Fertilizers, PHAR=Pharmaceuticals, SUG=Sugar, TEX=Textiles & TOB=Tobacco. Smf=Stock Market Freeze Dummy Variable. Values in parenthesis are p-values. φ denotes the parameters of mean Spillover. While the interactional term (φ*Smf) shows the effect of stock market freeze with mean Spillover.*

Again, the dummy variable is used to see the mean spillover during market freeze. The results are insignificant which provide clear evidence that spillover vanishes during stock market freeze. As the trading in the market is nonexistent or limited there is no mean spillover from exchange rate to the sample industries.

Table 4: Estimates B/W Exchange Rate & Industries and DCC GARCH Models

		ζ_1	ζ_2
Automobile Assemblers	GJR/TARCH	-0.0017 (0.0000)	-0.7900 (0.0056)
Cement	GJR/TARCH	0.0038	0.9532

		(0.4805)	(0.0000)
Chemicals	GARCH	-0.0017	0.7805
		(0.0000)	(0.0000)
Commercial Banks	EGARCH	0.0052	-0.2860
		(0.4667)	(0.4705)
Engineering	GARCH	0.0237	0.5135
		(0.1666)	(0.0987)
Fertilizers	GARCH	4.00E-04	8.31E-01
		(0.9359)	(0.2233)
Oil & Gas	GJR/TARCH	-0.0017	0.7870
		(0.0000)	(0.1356)
Pharmaceuticals	GARCH	-0.0003	0.9703
		(0.1789)	(0.0000)
Power Generation & Distribution	GJR/TARCH	0.0089	0.8769
		(0.2340)	(0.0000)
Refineries	GJR/TARCH	0.0062	0.5604
		(0.4665)	(0.4405)
Sugar	GJR/TARCH	0.0017	0.9336
		(0.7757)	(0.0000)
Technology & Telecommunication	EGARCH	0.0081	-0.1939
		(0.0000)	(0.0000)
Textiles	GJR/TARCH	0.0077	0.8674
		(0.6990)	(0.0000)
Tobacco	EGARCH	-1.20E-03	7.96E-01
		(0.0000)	(0.1089)

Source: *Authors' own calculation. Values in parenthesis are the p-values.*

Two aspects with their associated p values have been depicted in the table above, out of which, one is referring to lagged dynamic conditional correlation (ζ_2) and the other is referring to past residual shocks (ζ_1). All industries successfully fulfill the required stability condition. In such a case time varying conditional correlation can be evaluated by using DCC model. The parameters of (ζ_1) are significant for Automobile Assemblers, Chemicals, Oil & Gas, Technology & Telecommunication and Tobacco. These results thus explain that, conditional correlation is being affected by past residual shocks. On the other side, the Parameter (ζ_2) are significant for Automobile Assemblers, Cement, Chemicals, Pharmaceuticals, Power Generation & Distribution, Sugar, and Textiles which indicates that, there exists lagged dynamic conditional correlation in these industries.

Table 5: Estimates B/W Exchange Rate & Industries and ADCC GARCH Models

Automobile Assemblers	ζ_1	ζ_2	ζ_3

	GJR/TARCH	-0.0017	0.7891	-0.0040
		(0.0000)	(0.0246)	(0.8493)
Cement	GARCH	0.0018	-0.2287	0.0984
		(0.0000)	(0.0000)	(0.0000)
Chemicals	GJR/TARCH	-0.0017	0.7773	-0.0039
		(0.0000)	(0.0000)	(0.8683)
Commercial Banks	GJR/TARCH	-0.0016	0.7924	0.0056
		(0.0000)	(0.0000)	(0.2025)
Engineering	GARCH	0.0274	0.5103	-0.0132
		(0.1691)	(0.0740)	(0.7023)
Fertilizers	GARCH	7.00E-04	6.64E-01	3.37E-02
		(0.0000)	(0.0000)	(0.0000)
Oil & Gas	EGARCH	-0.0015	0.5584	0.0183
		(0.0000)	(0.0000)	(0.0000)
Pharmaceuticals	GARCH	-0.0047	0.8120	0.0172
		(0.1668)	(0.0015)	(0.3713)
Power Generation & Distribution	GJR/TARCH	0.0040	0.6964	0.0523
		(0.5574)	(0.0000)	(0.0015)
Refineries	GJR/TARCH	0.008	-0.0246	0.1156
		(0.4257)	(0.9247)	(0.0083)
Sugar	GJR/TARCH	-0.0097	0.7951	0.0203
		(0.0000)	(0.1508)	(0.6225)
Technology & Telecommunication	GJR/TARCH	0.0096	-0.1641	0.0459
		(0.5748)	(0.5937)	(0.1654)
Textiles	GJR/TARCH	0.0087	0.8301	0.0432
		(0.7072)	(0.0000)	(0.2756)
Tobacco	GJR/TARCH	-1.10E-03	8.10E-01	3.75E-02
		(0.0000)	(0.0000)	(0.4771)

Source: *Authors' own calculation. p-values are reported in parenthesis.*

The results for ADCC model have been depicted in table 7. It is representing the estimation that exist between industries and exchange rate. The table mentioned above has its prime focus on representation of output of asymmetric effects i.e. (ζ_3). Power Generation & Distribution and Refineries has been declared positive significant for the parameter (ζ_3). Same is the case for Fertilizers and Oil & Gas. These results indicate the presence of a strong positive influence of

negative news in these industries. In other words, the correlation has been increased with the arrival of negative news in these sectors.

5. Discussion and Conclusion

This study explores the two issues. First covers two aspects of spillover of exchange rate to numerous industries i.e., mean and the volatility, in which unexpected depreciation of currency increases the costs and decreases the revenues for Cement, Chemicals, Commercial Banks, and Refineries that ultimately leads to decrease in the returns. Moreover, selling by foreign investors in the wake of depreciation may also have negative impact on returns. For Automobile Assemblers, an oligopolistic structure of market helps to transfer their cost to end users. So, a frequent increase is seen in the prices of Automobile Assemblers in Pakistan which may result to increases the revenues and decreases the costs that further leads to increase the returns.

Moreover, in case of structural break, Automobile Assemblers & Chemicals show that returns in these industries decrease during market freeze. During the market freeze period, Automobile Assemblers, Cement, Chemicals, Commercial Banks, Oil & Gas and Power Generation & Distribution exhibit low volatilities in the market due to reduction in trading. Secondly, the time-varying conditional correlation among exchange rate and returns of Pakistan is observed in most of the industries that provide the evidence of dynamic correlation with the asymmetric effect.

5.1 Implications of the Study

These insights can be used by investors to develop investing strategies for risk control and portfolio diversification. The mean and volatility spillover mechanism also sheds light on the creation of precise models for risk premiums and stock valuation. The empirical evidence on spillovers also helps us to refine our approximation of conditional volatility, which has practical uses in finance including portfolio optimization and optimum hedging. However, the current study has investigated how the exchange rate's impact on industrial returns in the pre-Covid era spread.

5.2 Limitations and Recommendations

Researchers in the future can examine the spillover effect by using Covid 19 as a structural break in the existing approach. Also, this study is restricted to studying the exchange rate, a single macroeconomic concept. Other economic variables with industrial returns can be tested in the future across many locations and nations.

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