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Are Exchange Rate Exposures Nonlinear? Evidence from Pakistani Non-Financial Firms

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ABSTRACT

Purpose: This study examines the asymmetric and nonlinear effects of exchange rate changes on stock prices of Pakistani nonfinancial firms from 2000 to 2020.

Research Gap: There is a limited empirical evidence in the literature regarding the non-linear effects on FXR movements on share prices. Furthermore, limited research has examined the asymmetric effects of FXR positive and negative changes, particularly in developing economies like Pakistan. This study fills this gap by quantifying asymmetric FXREs within Capital Asset Pricing Model (CAPM) framework for individual firms.

Design/Methodology/Approach: This study includes all non-financial firms listed on the Pakistan Stock Exchange (PSX).We applied a rolling window estimation method within the CAPM framework. To address collinearity between FXR returns and equity market returns, we orthogonolized FXR returns and then orthogonalized equity market returns to the same macroeconomic factors. Finally, we estimate the sensitivity of individual firm stock returns to the orthogonalized FXR changes and the orthogonalized equity returns.

The Main Findings: The outcomes affirm that FXR appreciations positively influence stock returns. Additionally, a majority of firms exhibit positive asymmetric and nonlinear exposure.

Theoretical/Practical Implications of the Findings: Our study's results have practical implications for government authorities, investors, and firm managers. It suggests considering FXR fluctuations when making financial decisions, designing dynamic economic policies, and formulating investment strategies.

Originality/Value: Unlike prior studies mainly focusing on symmetric FXREs, this study contributes by exploring the asymmetric FXREs of both FXR appreciations and depreciations. Moreover, it sheds light on the non-linearity in FXREs relatively unexplored in the existing literature.

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1. Introduction

Financial liberalization and adoption of exchange rate flexibility have created significant uncertainties in exchange rates in both developed and emerging economies (Cuestas et al., 2018) Due to the wave of globalization, exchange rate fluctuations have become a key feature of the international economic environment. The influence of foreign exchange rate volatility on equity returns has been intensively examined in the previous literature since the breakdown of the Bretton Woods system. How exchange rate fluctuations influence economies and returns of firms has been the subject of empirical and theoretical research in financial economics. It has been investigated by a growing number of studies (Shapiro, 1975; Bartov & Bodnar, 1994; Marston, 2001; Pan & Tang, 2012; Salgado & Mora, 2019). Given the adoption of flexible foreign exchange rate system and the trend towards globalization, it is essential to analyze the impact of fluctuations in the value of the currency on stock returns. The measurement of foreign exchange rate exposure has become a central issue in international financial management, and this issue has spawned a significant amount of research.

There are several theories in economics and finance regarding the association between stock returns and FXRs. These theories explain how FXRs affect stock prices through different channels and make predictions about the sign and association between the FXR and share prices. Such theories include portfolio theory, the arbitrage pricing theory (APT) proposed by Ross (1976), pricing to market (PTM) by Krugman (1987), the efficient market hypothesis (EMH) proposed by Fama (1970), and the law of one price (LOOP) proposed by Cournot (1972). Another theory known as currency factor-mimicking portfolio by Fama and French (1992, 1993) measures the sensitivities of firms' currency in a rolling regression fashion, which allows for time variation in exchange rate exposure. The aforementioned theories propose the existence of a strong association between exchange rate changes and stock returns.

Existing studies have investigated the FXR effects on equity returns in several different ways. For example, numerous studies have explored the long-run and short-run effects of FXRs (in a cointegration sense) on stock returns of firms. This genre of studies includes Franck and Young (1972), Bahmani-Oskooee and Sorabian (1992), Ajaz et al., (2017). These studies also argue that changes in firm level characteristics can cause time-varying exposure of individual stocks to change in foreign exchange.

Another strand of literature has concentrated on exploring the FXRE (Foreign Exchange Rate Exposure) of firms by investigating the impacts of FXR changes on firms' equity returns using firm-level data (Adler & Dumas, 1980; Bartov & Bodnar, 1994; Bartram, 2008; Ihsan, Rashid, & Naz, 2018; Narayan et al., 2020; Suhaimi et al., 2021). These studies have documented significant FXREs for corporate firms.

Fama and French (1993) and several other studies have provided evidence that factors such as size and value factors have significant explanatory power in explaining stock returns. In fact, some researchers have considered the Fama-French three-factor model when quantifying FXREs. Yet, the focus of previous studies was entirely on developed countries, leaving a significant gap for emerging and developing countries like Pakistan. However, this study estimates FXREs for Pakistani firms by taking into account size and value factors along with the market factor. Doing this, we use a more robust framework, or a more appropriate CAPM, to investigate whether exchange rate exposures are long lasting.

Moreover, the study in hand addresses the gaps in the literature by quantifying foreign exchange exposures for publicly listed corporate firms on the Pakistan Stock Exchange. Exchange rate exposure is generally defined as "economic exposure to foreign exchange rate risk" (Adler and Dumas. 1984). More precisely, exchange rate exposure refers to the sensitivity of a firm's stock price to exchange rate movements. This exposure arises from various activities, including exports, imports, lending, borrowing and more. It is linked to international trade, particularly when corporate firms operate in multiple countries.

Indeed, there are very few studies, such as Koutmos and Martin (2003), Bahmani-Oskooee and Saha (2016) that have examined asymmetric effects of FXR positive and negative changes. Recognizing this gap in the existing literature, this study measures asymmetric FXREs to examine whether asymmetric changes

(positive and negative) have produced different exposures within CAPM framework for each individual firm included in the analysis.To achieve this, we initially segregate positive and negative FXR changes, following the methodology suggested by Al-Shboul & Anwar (2014) and Cuestas et al. (2018). Subsequently, this study incorporates both constructed series into the standard CAPM to observe the differential response to currency appreciations and depreciations.

There is limited empirical evidence in the literature regarding non-linear effects of FXR movements on share prices. However, an important research question revolves around whether the association between FXR and equity returns is non-linear, and whether the impacts of FXR on equity returns have long-lasting effects. In fact, only a few papers have explored both of these phenomena (Shboul & Anwar, 2014; He et al., 2021). However, the scope of these studies is restricted to developing countries, such as Pakistan.

The Empirical literature is lacking empirical evidence regarding how firms respond to different intensities of FXR changes. To address this gap, in this study, we identify small and large changes in FXRs and examine how these changes impact firms' value differently. Further, we categorize small and large positive and negative changes in FXRs to analyze how corporate firms respond to varying intensities of FXR changes.

The paper is structured as follows. Section 2 covers the literature review and theoretical background. Section 3 outlines the study's methodology. The estimated exchange rate exposures are reported in Section 4. Finally, Section 5 concludes the study.

2. Literature Review

2.1 Theoretical Discussion

The general assumption that exchange rate changes impact enterprises through stock returns finds support in the theoretical literature on exchange rate exposure. Shapiro (1975) argued that multinational companies engaged in export sales and international competition must demonstrate exchange rate exposure, correlated with the firm's export sales percentage and the intensity of foreign competition. A lot of researchers further emphasized the profitability of multinational corporations abroad affecting stock returns. Recent research by He et al. (2021) found international operations playing a negligible role in explaining exposures.

He and Ng (1998) demonstrated that the firm's degree of export ratio determines its sensitivity to exchange rate changes. Bodnar and Marston (2001) highlighted that a firm's exchange rate exposure mainly comprises net foreign revenues. Inelastic demand allows enterprises to pass price changes on to customers, as shown by Bodnar et al. (2002). Allayannis and Ihrig (2001) emphasized the importance of firm stock returns and competition in exposure, indicating that U.S. companies with low stock returns are more exposed to currency rates. The literature on exchange rate exposure shows that exposure can be complex, non-linear, and offsetting within a firm. However, it consistently underscores the significant link between exchange rates and stock returns as evidenced by Ye et al. (2014), who found that non-floating exchange rate arrangements are associated with more extensive exposure and higher magnitude.

Over the years, firms and industries have transitioned from national to global, witnessing increased international activity. Additionally, large real exchange rate changes followed the breakdown of the Bretton Woods system in 1973. These deviations in exchange rates led to significant fluctuations. These factors collectively indicate that exchange rate movements should indeed have a measurable impact on firm stock returns.

2.2 Empirical Evidence

Measurement of exchange rate exposure attracted researchers only after the break down of Bretton Woods Agreement and the Gold Standard in 1972. After this breakdown, several economists have started to explore the influence of FXRs on firm values. Different studies that have used different empirical framework with different empirical specifications to quantify FXRE. A plethora of studies in the literature of international finance have examined exchange rate exposure focusing on firms in developed countries

with flexile exchange rate system. On the contrary, studies on the exchange rate exposure of firms in emerging economies are sparse (Gokmenoglu et al., (2021)). Beginning with the works of Shapiro (1975), Dumas (1978), Adler & Dumas (1980, 1984), and Hodder (1982), there is a lengthy list of studies that explore the foreign exchange rate exposure of firms in developed countries. After these studies, Jorion (1990, 1991) examines the impact of FXR fluctuations on firm valuation of 287 US multinational corporations. He presents a two-factor model to measure foreign exchange exposure. Unlike Adler and Dumas (1984) he did not use only currency index or FXR changes but he used both variables to show their effect on return of firm. Further, he found that there are significant differences between foreign operations and FXR risk.

In spite of that, Fama and French (1992, 1993) constructs a model in which it is shown that there are many other factors like market risk premium, return of small stock minus returns minus large stocks, and returns for value relative to growth stocks that affect firm returns apart from market index. Additionally, Bodnar and Gentry (1993) did the same by using two-factor model to examine the presence of linear currency exposure in firms of US, Japan, and the US. Their results showed that only few industries out of their sample have significant foreign exchange exposure. Additionally, Molele and Petersen (2020) quantified exchange rate exposure level by applying Fama and French three factor, five factor model, and Carhart four factor model.

Williamson (2001) examins the impact of real FXR volatility on multinational corporations and also includes the influence of intra-industry competition on the link between FXR and value of the firm. They used equity returns of firms as the proxy of firm value that's why they just analyze elasticity of firm value to variations in FXR. This model is in line with the model proposed by Jorion (1990) and departed from Adler and Dumas (1984) due to inclusion of market factor, which is considered to be a significant part in generating stock returns. They found the presence of time varying currency exposure across countries for multinational corporations.

All empirical evidence on foreign exchange exposure in this literature is weak. There might be various reasons for this weak evidence of statistically significant foreign exchange exposure. De Jong, Ligterink & Macrae (2002) recommend three reasons for this weak evidence. The first reason is that these studies focused too much on least open economies. Second reason is that only few firms in their sample are exposed to FXR changes, because these studies used such techniques which are not able to measure sensitivity of FXR of individual firms. Third reason of less currency exposure is that, firms prefer to hedge the risk in order to protect themselves from foreign exchange exposure. Similarly, another study by Batram, Brown, and Minton (2010) also investigate the reason of the weak evidence of firms' currency exposure and found that due to hedging firms face less exposure.

Bodnar et al. (2002) suggest that multinational firms are less exposed to FXR changes because firms match their share of costs and revenues in foreign currency. Firms with unbalanced costs and revenues show more FXRE. Bartram (2004) found that significant linear and non-linear FXRE component can be seen for all various foreign exchange exposure and periods. They concluded that component of non-linear FXRE is of stronger statistical significance as compared to linear one. On the contrary, Priestley and Odegaard (2007) explore the FXRE after taking account the role of market portfolio and macroeconomic variables in regressions. They found presence of linear FXRE to bilateral FXRs are economically and statistically important after using orthogonalized market portfolio in estimating exposure separately for appreciation and depreciation regimes. Al-Shboul and Anwar (2014) not only check the existence of exposure during sample data but also consider the pre and post financial crises period. They concluded that foreign currency exposure affect stock returns of small number of firms significantly but when both linear and nonlinear exposures are included in a single equation then significant currency exposure is found in full and post global financial crises period.

He et al., (2021) also report significant linear and nonlinear exchange rate exposure to both bilateral and multilateral foreign exchange rates. Yacouba and Altintas (2019) empirically examine the non-linear

dynamic nexus between macroeconomic variables (money supply, industrial production, and the real effective FXR) and stock returns in Turkey. Their study concluded that influence of the variations in above mentioned macroeconomic variables on equity returns are asymmetric and the influences and asymmetry of explanatory variables on equity returns are larger. Miller and Reuer (1998) investigated the asymmetric exposure of firms' experience to depreciation and appreciation of FXR. They found that foreign direct investment helps in reducing economic exposure to movements in FXR.

Doidge, Griffin, and Williamson (2006) document that FXRE does not explain the variation in individual stock returns in large fraction. Aggarwal and Harper (2010) measure foreign exchange exposure with different horizons (monthly, quarterly, and annually). They added the variable currency change (Japanese Yen, Canadian Dollar, Mark/Euro, and Broad currency index) in Fama and French (1992, 1993) three factor model to measure FXRE for non-financial US firms. The results of the study reported that percentage of significant exposures increases with the estimation time horizon. They concluded that domestic firms are exposed to significant FXR risk because of macroeconomic effects like interest rate to FXR exchanges.

Ampomah, Mazouz, and Yin (2013) measure FXR risk by analyzing the individuals and combined impacts of time varying adjustments of risk and market return orthogonalization on the FXRE of firms. In Jorion's (1990) approach to measure exposure the coefficient of FXRE does not estimate the stock's exposure to the FXR but measures the exposure of market portfolio. To cope with this issue, they estimated the orthogonalized market return by taking market return which is uncorrelated with FXR variations as independent variable. They also argue that changes in firm level characteristics can cause time varying exposure of individual stocks to change in foreign exchange. Zhou and Wang (2013) use weekly returns of individual firms' stocks and market index and FXR at weekly intervals are used to check the impact of FXRE on equity returns. Jorion (1990), Dominguez and Tesar (2006), and Muller and Verschoor (2007) also consider weekly and monthly data as most appropriate to measure FXRE. In their study, they show that rate of return on common stock depends on market return portfolio and the rate of return on the trade weighted sterling FXR index.

Analogously, Ihsan, Rashid, and Naz (2018) followed Jorion (1990) two factor model to explore the association between foreign exchange exposure and firm value. They also include lagged value with FXR because variations in FXR take time to influence share prices. They found significant and negative coefficients in one month lagged and insignificant coefficient in two month lagged model. They also found that depreciation in FXR is not significantly related to domestic firms' stock returns but it has significant effect on stock returns in multinational firms.

Francis et al. (2017) discuss two methods namely capital market approach and cash flow approach to quantify foreign currency exposure and then they compare these two approaches. Adler & Dumas (1984), Jorion (1990), and Gentry (1993) use same equation. Following Bodnar and Marston (2014) they developed a new model in which exposure elasticity depends on foreign currency-denominated revenue, foreign currency-denominated costs as a percent of total costs, and profits as a percent of total revenues. According to them, returns of the firms with positive exposure elasticity would rise with the currency appreciation and vice versa.

Bae, Kwon, and Park (2018) uses Jorion (1990) model to measure FXRE. They showed that based on FXRE, value of firms increase when FXR increases. Salgado et al. (2019) regressed stock returns with domestic FXR variation and stock market returns as independent and control variables, respectively. They found that numerous FXR coefficients are showing negative sign. Aimer (2019) showed that sensitivities of equity returns are stronger for FXRs, which represented that FXR variations play a vital role in determining the dynamics in equity returns. Xie et al. (2020) examine the asymmetry in the nexus between FXR changes and prices of shares in order to check the whether the FXR movements respond asymmetrically to changes in prices of stock and vice versa. Their study did not provide strong proof in favor of unidirectional asymmetry causality running from FXRs to prices of shares.

Financial experts and economists are not agreed on a single theory that determines the links between the FXR and equity returns. Understanding the interconnection between equity and currency markets has been important for academic debate and empirical analysis over the several decades. The interaction between equity and currency markets is worth exploring in order to facilitate economic and financial activity.

3. Data and Methodology

The sample of the study comprises all non-financial firms of Pakistan listed on the Pakistan Stock Exchange (PSX). The study covers the period from 2000 to 2020. The daily data on stock prices are collected from the website of the PSX. We use closing price of stocks to find stock returns. We use KSE-100 index as a proxy for market portfolio. The data on KSE-100 index is also collected from the website of the PSX. The KSE-100 index is constructed by considering to 100 firms from different sectors of the economy based on market capitalization. The data on daily FXR is collected from State Bank of Pakistan. We use nominal FXR of Pak rupee with respect to US dollar. We consider the FXR with respect to dollar because most of the trading activities and business transactions are carried out in US dollar.

While quantifying FXREs, different studies have used different estimation methods to estimate the FXRE measure (Beta) for instance, Li et al. (2019), Anisak and Mohamad (2019). Similarly, some other studies have applied Generalized Least Square (GLS) method to estimate the FXREs. There are also some studies that have estimated the FXREs in ARCH and GARCH framework.

To achieve our objective we use a rolling window estimation method for estimating the proposed ICAPM in order to quantify the time variant FXREs. In principle, the size of the rolling window is considered relative to the size of the sample. However, it is well established that a relatively longer rolling window size is likely to yield smoother rolling window estimates as compared to a shorter size of rolling window. Following the existing literature, we estimate the model by using thirty-six months' window. Next, we re-estimate the model by considering one month more returns and by excluding the return of the first month from the estimation window and so on. In this way, we each time rule one observation ahead and exclude one observation from the sample to maintain the fix size of the estimation window. This procedure yields time varying estimate of FXRE (Beta).

4. Econometric Modelling/ Measuring Exchange Rate Exposure

To achieve the aims of the study we regressed firms' equity returns on FXR changes to find the elasticity which is considered as a measure of FXREs. There are two main approaches namely the single-factor and the two-factor model. Jorion (1990, 1991) examined the sensitivity of stock returns to FXR changes and market returns by using a two-factor model. He extended the standard asset-pricing model namely capital asset pricing model proposed by Sharpe (1964). Numerous studies have used the two-factor model to study FXREs like Bodnar and Gentry (1993), Bartov et al. (1996), and Griffin and Stulz (2001). The Jorion's two-factor model is expressed as follows:

$$SR_{it} = \beta_{0i} + \beta_{1i}ER_t + \beta_{2i}MR_t + \varepsilon_{it} \quad (1)$$

where SR_{it} denotes equity returns of ith firm, ER_t designates FXR returns, RM_t denotes the returns of market portfolio, ε_{it} white noise error term having zero mean and finite variance. The model presented in equation (1) states that equity returns are explained by both FXR returns as well as market portfolio returns.

The correlation between stock returns and FXR returns is generally attributed to the common macroeconomic factors such as interest rates, capital flows (FDI, FPI), money supply, and prices that simultaneously affect both equity and forex markets (Phylaktis & Ravazzolo, 2005). Thus, the collinearity between FXR returns and equity market returns will lead to biasdness in the estimated coefficient of FXR changes.

To overcome the above-mentioned issues, we have orthogonalized both FXR changes and equity market returns by following the three-step procedure suggested by Doukas, Hall, & Lang, (2003). To estimate the

sensitivity of individual firm stock returns to the orthogonalized FXR changes and the orthogonalized equity returns, the following regression model is estimated. Following previous studies including, among several others, Doukas, Hall, & Lang (2003), Aggarwal and Harper (2010), and Tang (2018), Fama-French factors (Fama & French, 1992, 1993) are also included in the specification for controlling size and value factors.

$$SR_{it} = \beta_{0i} + \theta_i \hat{\varepsilon}_t^{ER} + \varphi_i \hat{\varepsilon}_t^{MR} + \vartheta_i SMB_t + \omega_i HML_t + \mu_{it} \quad (2)$$

where SR_{it} is firm stock returns, $\hat{\varepsilon}_t^{ER}$ is the orthogonalized FXR returns, $\hat{\varepsilon}_t^{MR}$ is the orthogonalized equity market returns, SMB_t is the size factor, which is defined as the difference between the stock returns of small stocks portfolio and the stock returns of large stocks portfolio, and HML_t is the value factor that is constructed as the returns of value stock minus the returns of growth stocks. Finally, μ_{it} is the error with zero mean and constant variance. The portfolios required in the construction of both size and value factors are built as in Fama and French (1992, 1993). Specifically, the size portfolios are constructed based on market capitalization and book to market value. In this study, the model presented in equation (2) is estimated for each individual firm included in the sample for each year using weekly or daily data. The parameter θ_i is the measure of total exposure of stock i to the orthogonalized FXR changes over the sample period.

There is another strand of literature that provides strong evidence of the lagged response of stock returns to FXR changes. It is very likely that the effects of FXR changes on stock prices take some time. We also estimate the one-month and two-month lagged effects of FXR on stock returns based on the literature. We suppose that investors conduct their transactions usually both in stock exchange and foreign exchange market so, two-month is adequate period for stock prices to give information regarding FXR.

$$SR_{it} = \beta_{0i} + \beta_{1i} \hat{\varepsilon}_t^{ER} + \beta_{2i} \hat{\varepsilon}_{t-1}^{ER} + \beta_{3i} \hat{\varepsilon}_{t-2}^{ER} + \beta_{4i} \hat{\varepsilon}_t^{MR} + \vartheta_i SMB_t + \omega_i HML_t + \mu_{it} \quad (3)$$

By estimating equation (3), we can measure the response of stock returns to contemporaneous unexpected FXR changes, one and two period lagged FXR variations. Our choice of lagged periods depends on previous literature.

We also estimate the model by considering both the lag and lead value of the FXR changes along with the current FXR change to see how expected FXR changes affect stock returns.

There is another strand of literature that the response of firms' stock returns to FXR changes can be nonlinear. In addition the possibility of nonlinear exposure arises from the fact that firms may react to movements in foreign exchange rate in various ways. To capture such behavior of stock returns quadratic and cubic terms of FXR changes can be included in the specification to estimate such type of nonlinearities in FXREs.

In order to investigate the presence of a nonlinearity in exchange rate exposure a lot of approaches can be used. In this study we have used the following general specification of the model to capture the nonlinearities in exposures.

$$SR_{it} = \beta_{0i} + \beta_{1i} f(\hat{\varepsilon}_t^{ER}) + \varphi_i \hat{\varepsilon}_t^{MR} + \vartheta_i SMB_t + \omega_i HML_t + \mu_{it} \quad (4)$$

where $f(.)$ denotes a nonlinear function of the orthogonalized FXR. Specifically, we, in this study, use a quadratic and cubic form of the function to estimate the nonlinear response of firms' stock returns to FXR fluctuations. The parameter β_{1i} measures the nonlinear sensitivity of stock returns to FXR changes and it is statistically different from zero, then there would be significant evidence of the existence of nonlinearities in FXREs. In particular, we extend the baseline model by considering linear term, quadratic term, and cubic term. The two terms that are nonlinear in exchange rate are sufficient to capture various forms of nonlinearities in exchange rate exposure.

$$SR_{it} = \beta_{0i} + \beta_{1i}\hat{\varepsilon}_t^{ER} + \beta_{qi}\hat{\varepsilon}_t^{ER^2} + \beta_{ci}\hat{\varepsilon}_t^{ER^3} + \varphi_i\hat{\varepsilon}_t^{MR} + \vartheta_i SMB_t + \omega_i HML_t + \mu_{it} \quad (5)$$

Equation (5) measures the nonlinear exposures of FXR by relaxing the assumption of only linear exposures. The statistically significance of β_{qi} and β_{ci} provides evidence of the prevalence of nonlinear FXREs.

It is well established in finance literature that positive and negative news has very different impacts on investors' trading decisions. In this regard, some FXR changes are considered as good news by corporate firms and thus, they may positively respond to such changes. However, the linear model presented in equation (5) is not able to capture such differential response of firms' stock returns to FXR changes. Estimation of a linear function may balance out the effect of negative and positive FXR changes on stock returns. Therefore, we augment our earlier model of FXREs in such a way that it enables us to estimate the differential effects of depreciation and appreciation of currency in a single equation framework. Specifically, to measure the asymmetric FXREs of firms' stock returns to positive and negative FXR changes, we follow Koutmos and Martin (2003), Muller and Verschoor (2006), and Ihsan, Rashid, & Naz (2018) and expand the model given in equation (5) in the following form:

$$SR_{it} = \beta_{0i} + \theta_i^{+}\hat{\varepsilon}_t^{ER+} + \theta_i^{-}\hat{\varepsilon}_t^{ER-} + \varphi_i\hat{\varepsilon}_t^{MR} + \vartheta_i SMB_t + \omega_i HML_t + \mu_{it} \quad (6)$$

In equation (6), the FXR returns are decomposed into positive and negative returns. The positive and negative stock returns are separated as $\hat{\varepsilon}_t^{ER+} = \text{Max}(\hat{\varepsilon}_t^{ER}, 0)$ and $\hat{\varepsilon}_t^{ER-} = \text{Min}(\hat{\varepsilon}_t^{ER}, 0)$. θ_i^{+} measures the response of stock returns (exposure) to positive changes in FXRs, whereas, θ_i^{-} is a measure of the response of stock returns to negative changes in FXRs. The other variables are same as in equation (5). The model given in equation (6) captures the asymmetric response of stock returns to positive and negative changes in FXRs. Specifically, this model enables us to examine the asymmetry in firms' exposures with respect to sign (direction) of FXR innovations. However, it also very likely that size of FXR innovations (both positive and negative) may have differential influence on stock returns. Therefore, to examine asymmetric response of stock returns to the magnitude of positive and negative FXR changes, we follow Bartram (2004), Di Iorio and Faff (2001), and Karpl (2017) and estimate the following model.

$$\begin{aligned} SR_{it} = \beta_{0i} &+ \theta_i^{\text{large}+}\hat{\varepsilon}_t^{LER+} + \theta_i^{\text{small}+}\hat{\varepsilon}_t^{SER+} + \theta_i^{\text{large}-}\hat{\varepsilon}_t^{LER-} + \theta_i^{\text{small}-}\hat{\varepsilon}_t^{SER-} \\ &+ \varphi_i\hat{\varepsilon}_t^{MR} + \vartheta_i SMB_t + \omega_i HML_t + \mu_{it} \end{aligned} \quad (7)$$

where $\theta_i^{\text{large}+}, \theta_i^{\text{small}+}, \theta_i^{\text{large}-}$, and $\theta_i^{\text{small}-}$ are the parameters to be estimated to capture the response of stock returns to large positive, small positive, large negative, and small negative changes in the FXR, respectively. These changes are respectively defined as

$\hat{\varepsilon}_t^{LER+} = \text{Max}(0.5\sigma_{ER} < \hat{\varepsilon}_t^{ER}, 0)$, $\hat{\varepsilon}_t^{SER+} = \text{Max}(0 < \hat{\varepsilon}_t^{ER} \leq 0.5\sigma_{ER}, 0)$, $\hat{\varepsilon}_t^{LER-} = \text{Min}(-0.5\sigma_{ER} > \hat{\varepsilon}_t^{ER}, 0)$, and $\hat{\varepsilon}_t^{SER-} = \text{Min}(-0.5\sigma_{ER} \leq \hat{\varepsilon}_t^{ER} < 0, 0)$.

By estimating equation (7) we test the statistically significance (different from zero) of the asymmetric response of firm-level stock returns to the magnitude of changes in FXRs by applying t-tests. Further, the coefficient equality tests are applied to test the statistical difference between the estimated asymmetric exposures at different magnitudes of FXR dynamics.

5. Empirical Results

Table 1 summarizes exchange rate exposures for 4,267 non-financial firms over various timeframes. It includes mean, standard deviations, percentiles, min-max values, and the count of positive and negative exposure firms. Roughly 60% exhibit positive exposure, while about 40% show negative exposure. This pattern is expected for exporters or firms with foreign currency assets. Positive exposure implies rupee depreciation benefits Pakistani firms, while negative exposure suggests harm from rupee depreciation,

which can raise export costs and reduce foreign demand. Efficient hedging strategies could mitigate these effects.

Table 1: Exchange Rate Exposure

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	-0.036	2.535	-12.561	-1.664	0.032	1.432	6.171	135	69	66
2004	-0.667	3.288	-12.293	-2.6	-0.652	1.401	9.271	182	73	109
2005	-1.5	3.054	-11.012	-3.291	-1.43	0.309	12.556	218	64	154
2006	1.274	3.292	-8.228	-0.602	0.992	3.199	14.776	237	158	79
2007	0.759	3.728	-9.012	-1.432	0.644	2.801	15.793	226	130	96
2008	1.267	2.53	-13.788	-0.095	1.323	2.613	8.841	212	156	56
2009	0.488	2.741	-7.519	-1.005	0.166	1.793	11.909	229	123	106
2010	-0.361	2.564	-9.375	-1.895	-0.51	0.931	9.836	248	99	149
2011	-0.019	2.653	-7.72	-1.499	-0.038	1.457	10.117	253	124	129
2012	9.143	20.476	-57.832	-1.537	9.306	21.252	61.901	254	184	70
2013	-4.089	13.187	-44.138	-12.145	-2.889	4.253	34.015	267	100	167
2014	1.171	7.492	-60.799	0.35	2.394	3.972	25.859	271	215	56
2015	0.624	6.41	-67.162	-0.053	1.243	2.284	21.646	266	197	69
2016	0.803	4.086	-29.136	-0.68	0.943	2.372	19.782	270	176	94
2017	0.196	4.013	-47.34	-0.801	0.394	1.374	21.572	273	165	108
2018	0.767	1.579	-7.704	-0.119	0.643	1.869	5.056	163	116	47
2019	0.779	1.833	-8.067	-0.091	0.832	1.713	8.342	284	204	80
2020	0.949	1.48	-4.881	0.018	0.852	1.791	5.469	279	211	68
Total	0.68	7.384	-67.162	-1.08	0.608	2.325	61.901	4,267	2,564	1,703

Source: Authors' Estimations

Table 2 presents the outcomes of equation 3, estimated using a rolling window with a 1-year lag. The results reveal that both the magnitude and direction of exchange rate exposures vary across firms and time periods. The literature extensively discusses the appropriate time horizon for measuring exchange rate exposure, debating whether it is contemporaneous or involves a time lag before influencing firm stock returns.

Among the 4,253 firms analyzed, 53 percent exhibit a positive exposure to exchange rate changes, while 46 percent show a negative impact on stock returns. These findings align with previous research by Amihud (1994) and Bartove and Bodnar (1994), suggesting that contemporaneous changes in exchange rates do not have a positive impact on stock returns. Furthermore, our results indicate that there is a lag in the impact of exchange rate changes on stock returns, as it takes time for information to become public.

Notably, some years exhibit negative mean values, signaling the prevalence of firms with negative exchange rate exposure. Conversely, the majority of firms in the sample demonstrate positive mean values and exposure to exchange rate changes.

Table 2: First Lagged Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	1.375	2.676	-7.471	-0.104	1.529	2.757	11.128	132	97	35
2004	1.128	2.749	-5.204	-0.95	1.078	3.139	10.278	178	118	60
2005	1.432	4.48	-14.866	-0.894	0.852	2.891	23.051	216	134	82
2006	0.436	3.387	-9.57	-1.422	0.375	2.619	22.13	237	127	110
2007	-0.256	3.447	-9.092	-2.258	-0.731	1.524	22.603	225	95	130
2008	0.951	2.296	-7.017	-0.337	0.806	1.928	10.608	211	151	60
2009	0.246	2.65	-10.083	-1.07	0.099	1.432	10.394	229	117	112
2010	0.027	3.099	-10.568	-1.552	-0.153	1.346	18.953	247	114	133
2011	-1.133	3.475	-10.843	-2.984	-1.099	0.749	16.564	253	84	169
2012	2.719	17.378	-46.229	-7.78	1.264	11.944	59.184	254	137	117
2013	4.32	19.517	-75.383	-5.643	2.932	14.53	92.585	267	154	113
2014	1.314	6.633	-12.853	-0.896	0.471	1.748	50.804	271	158	113
2015	0.939	4.883	-25.532	-0.589	0.666	2.004	54.762	266	170	96
2016	1.521	8.311	-35.924	-0.65	1.102	2.719	84.555	269	183	86

2017	0.672	5.809	-39.337	-0.655	1.091	2.936	16.145	273	177	96
2018	-0.308	1.744	-6.642	-1.274	-0.534	0.487	6.892	162	56	106
2019	-0.026	2.174	-7.792	-1.058	-0.129	0.846	8.123	284	134	150
2020	-0.476	1.424	-4.191	-1.259	-0.54	0.171	5.341	279	87	192
Total	0.839	7.713	-75.383	-1.359	0.259	2.161	92.585	4,253	2,293	1,960

Source: Authors' Estimations

Table 3 presents the results for second-lagged exchange rate exposure. It reveals that approximately 50 percent of firms exhibit positive lagged coefficients, indicating a 50 percent increase in firms' stock returns following changes in exchange rates. Conversely, 50 percent of firms show negative lagged coefficients, signifying a decrease in firms' stock returns after exchange rate changes. These results differ from the findings of Bodnar and Wong (2003), who suggested that a longer lagged period would be appropriate for increasing stock returns if the effects of exchange rate variations are long-lasting or more permanent in nature.

Table 3: Second Lagged Exchange Rate Exposure

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	-0.559	2.099	-5.897	-1.955	-0.787	0.752	6.033	132	46	86
2004	0.463	2.832	-9.673	-1.243	0.438	2.256	8.559	178	102	76
2005	-1.134	2.851	-15.88	-2.36	-0.697	0.545	10.259	216	74	142
2006	-0.941	2.92	-13.693	-2.638	-1.108	0.921	7.477	237	88	149
2007	-0.603	2.997	-14.294	-2.513	-0.549	1.206	6.903	225	92	133
2008	-0.139	2.595	-9.188	-1.657	-0.447	1.218	11.506	211	90	121
2009	0.262	2.641	-11.507	-1.175	0.355	1.474	13.257	229	134	95
2010	0.414	2.807	-12.07	-0.785	0.352	1.726	11.908	247	147	100
2011	-0.475	2.953	-17.303	-1.864	-0.518	0.984	10.175	253	97	156
2012	-1.565	23.914	-112.788	-14.772	-1.005	13.749	69.158	254	121	133
2013	3.3	16.51	-79.819	-4.869	5.3	13.609	46.164	267	180	87
2014	0.597	6.379	-40.61	-0.437	1.198	2.308	19.908	271	185	86
2015	-0.553	4.643	-40.355	-2.052	-0.616	0.428	41.842	266	89	177
2016	-1.006	5.368	-49.414	-2.992	-1.15	0.811	41.346	269	94	175
2017	1.29	4.483	-16.352	-0.705	1.252	3.159	28.305	273	178	95
2018	0.229	1.665	-4.25	-0.553	0.236	1.055	8.358	162	91	71
2019	0.123	2.535	-10.029	-0.779	0.085	1.056	26.886	284	149	135
2020	0.677	1.286	-4.534	-0.035	0.683	1.393	5.981	279	204	75
Total	0.061	7.969	-112.788	-1.684	0.049	1.675	69.158	4,253	2,161	2,092

Source: Authors' Estimations

The empirical results, based on equation 5, aimed at capturing nonlinear exchange rate exposure, are presented in Table 4 and 5. We found that out of the total sample, 55 percent and 45 percent of firms exhibit positive and negative nonlinear exposure, respectively. The cubic-powered exposure equation also indicates that a majority of firms demonstrate positive exposure. This suggests that a single functional form may not adequately capture firms' nonlinear exposure. To study the effects of large negative and positive exchange rate fluctuations, the cubic function is considered more suitable.

Negative nonlinear exposure implies that stock returns benefit from the depreciation of the exchange rate. When the dollar appreciates, making exports more expensive, nonlinearities slow down the impact of a unit appreciation on returns. Similar outcomes are observed in both squared and cubic exposure specifications.

Analyzing the empirical results of cubic exchange rate exposure, we note that mean values are negative in only three years, with the highest SD value observed in 2012. In squared exposure, no year exhibits a negative value of P75, but in cubic exposure, the year 2005 shows a negative value. Furthermore, the majority of firms tend to display positive exposures.

Table 4: Squared Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.

2003	0.038	2.279	-9.794	-1.021	0.028	1.147	8.361	135	68	67
2004	0.947	3.753	-11.159	-0.907	0.791	2.756	14.304	182	109	73
2005	3.252	5.327	-7.904	-0.074	2.672	5.904	27.657	218	161	57
2006	-2.699	5.994	-29.368	-5.285	-2.135	0.699	17.828	237	74	163
2007	-2.244	6.386	-26.922	-5.468	-1.738	1.496	19.38	226	78	148
2008	-0.329	2.186	-7.567	-1.479	-0.334	0.792	9.544	212	86	126
2009	-0.319	3.033	-13.856	-1.953	-0.428	1.197	14.919	229	104	125
2010	0.618	2.465	-8.395	-0.722	0.561	1.83	14.958	248	145	103
2011	1.456	2.771	-15.762	0.141	1.364	2.873	9.563	253	196	57
2012	-4.356	17.829	-84.096	-13.519	-4.029	7.639	38.446	254	92	162
2013	33.225	26.123	-39.432	17.504	34.569	51.577	84.974	267	237	30
2014	1.019	8.154	-77.909	0.159	1.029	2.503	31.836	271	219	52
2015	-0.003	6.171	-20.145	-2.078	-0.214	1.316	83.466	266	122	144
2016	-0.736	5.895	-22.442	-3.151	-0.965	1.119	57.193	270	100	170
2017	0.963	4.937	-15.117	-0.819	0.351	1.985	60.305	273	156	117
2018	-0.091	0.726	-3.232	-0.437	-0.131	0.267	3.507	163	70	93
2019	0.014	1.212	-8.164	-0.402	0.018	0.389	7.222	284	145	139
2020	0.083	0.544	-1.699	-0.202	0.07	0.322	3.111	279	164	115
Total	1.93	12.157	-84.096	-1.315	0.163	2.049	84.974	4,267	2,326	1,941

Source: Authors' Estimations

Table 5: Cubic Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	0.361	1.886	-4.614	-0.743	0.261	1.424	5.663	135	76	59
2004	0.102	2.955	-13.787	-1.368	0.078	1.893	9.494	182	93	89
2005	-2.215	3.006	-21.166	-3.692	-2.07	-0.555	4.817	218	41	177
2006	0.693	3.632	-12.208	-1.033	0.586	2.277	15.258	237	139	98
2007	0.685	3.882	-16.057	-1.572	0.526	2.667	14.977	226	132	94
2008	-0.204	0.719	-6.712	-0.394	-0.133	0.12	0.991	212	75	137
2009	0.186	1.411	-5.802	-0.37	0.048	0.348	8.459	229	121	108
2010	0.189	1.273	-3.58	-0.511	0.143	0.815	5.44	248	137	111
2011	0.688	2.409	-13.355	-0.219	0.813	1.875	9.024	253	177	76
2012	14.189	25.535	-42.928	-4.072	11.281	29.823	137.099	254	172	82
2013	4.486	11.648	-36.342	-1.643	3.928	11.195	67.058	267	181	86
2014	0.38	3.875	-18.75	-0.611	-0.144	0.342	25.874	271	118	153
2015	0.038	7.795	-87.256	-0.559	0.008	0.624	88.445	266	135	131
2016	0.49	6.272	-40.139	-0.624	1.1	2.811	24.67	270	177	93
2017	-0.17	3.286	-33.336	-0.307	0.169	0.662	5.476	273	161	112
2018	0.069	0.36	-1.157	-0.113	0.063	0.23	1.496	163	95	68
2019	0.012	0.95	-11.324	-0.151	0.014	0.156	9.576	284	148	136
2020	0.039	0.19	-0.71	-0.049	0.038	0.138	0.913	279	169	110
Total	1.207	8.384	-87.256	-0.527	0.081	1.096	137.099	4,267	2,347	1,920

Source: Authors' Estimations

In Table 4 and 5, we present the outcomes of nonlinear exposure, as discussed by Al-Shboul and Anwar (2014), suggesting that an asymmetric reaction of firm value to movements in exchange rates can also lead to nonlinear exposure. Table 6 to Table 11 show the results of the influence of asymmetric exchange rate exposure on stock returns through sign bias tests. Table 4 confirms the findings that there are more firms with positive exchange rate exposure compared to negative exposure, indicating that firms stock returns asymmetrically respond to rupee appreciation.

Table 6 to Table 11 consistently show a slightly higher percentage of firms with positive exposures as compared to firms with negative exposures, except in Table 9, where negative asymmetric exposure outweighs positive asymmetric exposure. Positive mean values for dollar depreciation support import-based firms in Pakistan, resulting in lower expenses and higher stock returns during periods of dollar depreciation. Conversely, firms with negative mean values have adverse effects on importing firms.

In Table 6, years 2003, 2006, 2007, 2009, and 2018 show negative mean values, with the highest magnitude of mean and standard deviation values observed in 2013. Notably, in 2013, a large number of firms exhibited positive exposure. Although the number of firms with positive exposure was lower in 2003, it increased in following two years.

Table 6: Positive Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	-0.745	5.968	-19.122	-4.269	-1.023	1.805	15.757	135	57	78
2004	0.888	6.679	-17.24	-3.037	0.785	4.721	24.289	182	105	77
2005	0.202	4.52	-16.773	-2.188	0.399	3.228	11.384	218	117	101
2006	-1.144	5.219	-19.149	-4.216	-0.901	1.652	15.766	237	97	140
2007	-1.057	5.216	-19.774	-4.17	-0.922	2.018	21.174	226	93	133
2008	0.558	5.714	-27.764	-2.468	0.697	3.863	17.429	212	118	94
2009	-1.068	9.86	-27.22	-6.414	-1.878	3.461	60.811	229	90	139
2010	1.439	7.216	-28.262	-2.742	1.214	4.625	35.428	248	142	106
2011	2.174	5.635	-16.434	-0.854	1.772	4.416	24.996	253	179	74
2012	6.444	22.203	-83.293	-5.381	4.451	21.316	55.067	254	156	98
2013	94.294	71.971	-130.672	49.175	96.033	149.954	250.905	267	237	30
2014	6.1	12.788	-96.645	2.515	5.223	8.366	73.668	271	242	29
2015	0.395	16.421	-146.78	-1.427	0.596	2.476	185.706	266	148	118
2016	0.293	10.293	-67.472	-2.518	0.296	3.526	96.19	270	142	128
2017	0.147	7.869	-60.401	-2.938	0.105	2.601	69.551	273	141	132
2018	-0.107	2.999	-11.725	-1.661	-0.035	1.417	11.433	163	80	83
2019	0.501	4.525	-29.115	-1.077	0.539	2.632	16.988	284	176	108
2020	1.487	3.446	-10.93	-0.366	1.349	3.257	16.983	279	200	79
Total	6.938	30.416	-146.78	-2.206	0.996	4.626	250.905	4,267	2,520	1,747

Source: Authors' Estimations

Table 7 presents negative exchange rate exposures, indicating a decrease in the number of firms with positive exposure compared to the previous table. Over five years, there are negative average values, and the overall mean is also negative, suggesting that the magnitude of negative average values outweighs the positive ones. However, firms with positive exposure are still more numerous than negatively exposed firms.

Table 7: Negative Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	0.479	4.664	-15.493	-1.91	0.388	2.517	12.104	135	76	59
2004	-1.825	6.153	-26.548	-4.916	-1.297	2.092	12.378	182	72	110
2005	-5.164	10.899	-52.042	-10.552	-4.401	1.634	24.086	218	70	148
2006	6.901	9.929	-34.354	0.638	5.837	11.475	55.934	237	189	48
2007	4.789	10.901	-32.546	-1.212	4.589	10.339	58.457	226	160	66
2008	1.348	3.775	-28.82	-0.156	1.58	3.088	13.252	212	155	57
2009	1.193	4.647	-19.248	-1.012	0.742	3.082	34.236	229	144	85
2010	-1.789	5.203	-43.205	-4.132	-1.693	0.984	22.063	248	83	165
2011	-2.187	5.158	-24.288	-4.843	-2.097	0.751	18.755	253	75	178
2012	11.366	42.068	-93.521	-11.03	12.017	37.434	186.17	254	155	99
2013	-51.847	39.835	-131.378	-78.171	-52.946	-26.812	67.721	267	27	240
2014	-5.889	17.028	-120.985	-7.146	-2.397	1.422	44.969	271	92	179
2015	2.447	9.751	-72.549	-0.147	2.907	6.346	81.59	266	198	68
2016	1.565	10.304	-92.565	-1.904	1.422	5.27	44.838	270	162	108
2017	0.06	6.486	-58.963	-1.311	0.523	2.15	38.419	273	161	112
2018	1.455	2.475	-5.746	0.068	1.518	2.779	10.342	163	125	38
2019	0.892	3.36	-13.279	-0.362	1.048	2.334	33.727	284	199	85
2020	0.477	2.659	-10.273	-0.909	0.545	2.089	13.064	279	161	118
Total	-2.332	21.057	-131.378	-3.335	0.4	3.287	186.17	4,267	2,304	1,963

Source: Authors' Estimations

Table 8 presents the empirical outcomes of large positive exchange rate exposure, showing a high number of positively exposed firms. However, in the years 2005 to 2007, 2009, and 2012, there are negative average values, and standard deviation values are high from 2012 to 2016. In 2012, the standard deviation magnitude is large, and there is a large number of positively exposed firms in 2013 and 2014.

Table 8: Large Positive Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	1.269	6.493	-18.999	-2.467	0.655	4.296	25.156	135	75	60
2004	0.632	8.31	-25.537	-4.192	0.603	5.323	26.235	182	97	85
2005	-1.318	5.63	-27.873	-4.465	-1.234	1.858	14.154	218	79	139
2006	-0.902	5.96	-18.552	-4.378	-1.204	2.383	18.145	237	98	139
2007	-0.67	5.919	-19.71	-4.227	-0.948	2.585	23.598	226	101	125
2008	0.423	5.855	-24.413	-2.451	0.439	3.079	16.942	212	115	97
2009	-1.695	10.787	-28.865	-7.642	-2.891	2.922	60.352	229	82	147
2010	0.368	8.508	-31.272	-4.12	-0.236	4.333	42.798	248	121	127
2011	0.461	6.551	-27.214	-2.931	0.23	3.073	21.162	253	131	122
2012	-9.303	21.458	-88.378	-23.364	-8.132	5.785	64.841	254	91	163
2013	66.489	45.819	-110.307	38.796	72.242	100.836	170.673	267	240	27
2014	7.177	14.539	-130.059	3.098	6.809	10.127	81.025	271	244	27
2015	0.8	19.388	-151.795	-1.63	0.442	2.626	246.077	266	150	116
2016	0.17	15.737	-102.014	-2.693	0.488	3.745	175.913	270	142	128
2017	0.709	8.39	-51.186	-2.613	0.505	3.601	64.713	273	143	130
2018	0.422	4.055	-19.494	-1.542	0.659	2.703	20.062	163	96	67
2019	1.272	5.323	-35.896	-0.503	1.434	3.595	20.491	284	204	80
2020	1.245	3.535	-11.32	-0.56	1.121	3.002	16.682	279	190	89
Total	4.244	22.594	-151.795	-2.948	0.773	4.884	246.077	4,267	2,399	1,868

Source: Authors' Estimations

Table 9 presents the summary statistics of small positive exchange rate exposure, with a slight difference between the numbers of positively and negatively exposed firms. Although seven years have negative mean values, the magnitude of positive values outweighs the negative ones. In 2003 and 2013, the number of negatively exposed firms is very low, with 82 percent of firms having a positive coefficient of exposure in 2013, while in 2010, a very low percentage of firms are positively exposed.

Table 9: Small Positive Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	16.587	35.115	-122.879	-6.863	15.441	38.07	102.169	135	94	41
2004	-0.228	27.088	-65.784	-16.265	0.596	16.734	117.712	182	93	89
2005	-3.605	55.044	-92.921	-20.345	-7.39	7.39	723.316	218	76	142
2006	1.574	19.694	-87.677	-9.179	2.251	11.321	92.935	237	129	108
2007	1.412	20.318	-90.668	-10.51	1.99	11.25	111.45	226	121	105
2008	1.898	15.498	-43.143	-6.52	1.384	11.317	63.648	212	113	99
2009	-8.33	24.559	-117.903	-20.011	-7.956	4.093	104.254	229	74	155
2010	-13.058	37.086	-142.589	-31.405	-13.369	4.861	142.311	248	78	170
2011	-16.287	30.816	-116.562	-33.484	-16.96	-2.22	158.974	253	57	196
2012	-50.224	89.229	-542.385	-100.486	-51.058	-4.028	368.013	254	59	195
2013	91.158	197.136	-1734.43	33.651	110.043	172.33	659.923	267	219	48
2014	21.944	128.733	-1240.22	0.012	22.7	39.41	725.294	271	204	67
2015	2.935	32.953	-100.759	-8.644	1.548	12.745	384.131	266	144	122
2016	-1.201	43.276	-281.92	-9.642	0.229	10.74	481.561	270	138	132
2017	0.16	18.9	-161.398	-6.521	0.152	6.969	96.18	273	139	134
2018	0.781	27.874	-197.067	-8.553	3.057	12.971	110.559	163	92	71
2019	2.657	17.902	-115.179	-4.775	3.052	11.281	72.842	284	167	117
2020	-0.736	14.541	-47.383	-9.25	-1.473	5.65	72.261	279	120	159
Total	2.8	73.468	-1734.43	-14.379	-0.238	14.259	725.294	4,267	2,117	2,150

Source: Authors' Estimations

Table 10 summarizes large negative exchange rate exposure, with approximately 54 percent of firms having a positive coefficient of exposure. In 2012, there is a large positive exposure magnitude among firms, but in 2013, there are very few firms with positive exposure, and the value of P75 is negative.

Table 10: Large Negative Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	-1.03	5.486	-20.919	-3.643	-1.335	1.777	14.633	135	49	86
2004	-1.645	6.68	-23.782	-5.824	-1.239	2.33	22.049	182	75	107
2005	-4.407	11.759	-57.06	-9.377	-3.375	2.359	30.766	218	81	137
2006	6.313	10.833	-18.232	-0.35	5.711	10.909	67.449	237	174	63
2007	4.345	11.646	-34.81	-1.385	4.008	10.099	70.04	226	151	75
2008	1.257	4.138	-30.37	-0.258	1.379	3.07	11.563	212	153	59
2009	2.037	5.563	-17.264	-0.624	1.785	3.687	38.891	229	154	75
2010	-0.698	6.149	-47.319	-3.319	-0.526	2.691	24.742	248	114	134
2011	-0.819	5.357	-24	-3.264	-0.701	2.108	15.145	253	104	149
2012	31.645	43.204	-102.818	5.847	27.13	54.541	160.948	254	207	47
2013	-44.52	31.163	-114.499	-66.389	-48.146	-26.436	71.639	267	25	242
2014	-7.664	16.522	-121.646	-8.925	-4.37	-0.583	37.508	271	61	210
2015	1.939	12.499	-133.538	-0.933	3.049	6.366	67.013	266	188	78
2016	2.162	18.924	-219.071	-3.213	2.004	7.092	92.78	270	173	97
2017	0.216	6.77	-31.146	-1.529	0.385	2.378	67.172	273	153	120
2018	1.152	3.068	-11.839	-0.425	0.998	3.159	12.074	163	111	52
2019	0.664	4.08	-15.252	-0.514	0.769	2.025	46.108	284	190	94
2020	0.658	2.744	-10.282	-0.79	0.679	1.945	13.217	279	177	102
Total	-0.651	21.165	-219.071	-3.375	0.52	3.922	160.948	4,267	2,340	1,927

Source: Authors' Estimations

Finally, the results presented in Table 11 show that in 2003, the number of firms with positive and negative exposure is the same as in the previous table. The average values of small negative exposure results indicate that positive values outweigh the negative ones, resulting in an overall positive mean value. In 2012, the mean value and positive exposure are higher as compared to the outcomes in the remaining years.

Table 11: Small Negative Exchange Rate Exposures

Year	Mean	SD	Min	P25	P50	P75	Max	N	Pos.	Neg.
2003	-7.924	23.094	-91.438	-21.162	-7.166	4.311	92.184	135	49	86
2004	-0.154	17.556	-55.305	-8.993	0.877	9.505	56.256	182	94	88
2005	4.784	19.549	-59.328	-6.826	4.465	15.489	85.182	218	136	82
2006	6.969	16.991	-34.905	-3.028	6.298	15.924	81.6	237	161	76
2007	2.42	17.848	-52.401	-6.974	2.735	13.377	80.761	226	129	97
2008	2.57	18.737	-136.279	-6.194	3.118	11.201	77.498	212	128	84
2009	8.285	28.165	-79.315	-7.895	9.678	25.405	127.106	229	146	83
2010	1.807	28.793	-120.621	-10.498	2.234	16.624	89.432	248	134	114
2011	8.221	26.32	-162.526	-3.415	8.776	18.992	116.91	253	177	76
2012	124.68	174.457	-662.612	8.064	112.096	231.386	600.277	254	201	53
2013	98.765	224.751	-718.039	-51.65	81.712	242.543	1,050.87	267	173	94
2014	-13.926	61.715	-353.668	-27.598	-14.729	-0.962	487.614	271	63	208
2015	-0.031	35.242	-443.932	-6.636	3.207	11.683	143.8	266	156	110
2016	-0.367	39.372	-393.678	-12.737	-1.484	8.293	228.321	270	123	147
2017	-3.801	20.925	-118.225	-11.917	-2.92	5.136	178.635	273	110	163
2018	-4.374	19.292	-71.166	-13.322	-4.287	4.479	70.415	163	58	105
2019	-6.006	26.173	-118.18	-18.756	-6.975	5.528	153.02	284	92	192
2020	7.791	25.649	-100.062	-5.407	8.435	19.613	208.684	279	190	89
Total	14.059	84.29	-718.039	-11.522	1.942	16.616	1,050.87	4,267	2,320	1,947

Source: Authors' Estimations

6. Conclusion and Policy Recommendations

This study explores the relationship between foreign exchange rates and stock returns, which plays a crucial role in macroeconomic decisions and investments. Using the rolling window estimation in the CAPM framework to quantify the time variant FXRs, it focuses on Pakistan, a developing country with limited empirical evidence in this area. The findings reveal that approximately 60 percent of the sample firms experienced significant positive effects of exchange rate exposure from 2000 to 2020. When the Pakistani rupee appreciates against the U.S. dollar, it positively impacts stock returns, with linear effects being more pronounced. The study also highlights that investors take time to assess the impacts of exchange rate changes on stock returns, as seen in the lagged effects.

However, the variation in these effects across firms presents challenges for policymaking. The study's outcomes can guide policymakers to intervene in foreign exchange rates to mitigate negative impacts on listed firms. For firm managers and investors, understanding the dynamics between exchange rates and stock return allows for effective hedging and risk minimization. The study's innovative approach to measuring exchange rate exposure has broader applications, making it valuable for research in other countries and currencies. In a globalized world, measuring and managing exchange rate exposure should be a top priority for firms.

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