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Exchange rate volatility and foreign direct investment (FDI) behavior in Pakistan: A time series analysis with auto regressive distributed lag (ARDL) application

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This empirical study is an effort to find the impact of exchange rate volatility on foreign direct investment for the Pakistan economy. A secondary time series data set is utilized over the period 1980 to 2010. The most robust and modern technique of auto regressive distributed lag (ARDL) has been applied to find the short run as well as the long run estimates of the study. Furthermore, after establishing the long run relationship multivariate vector error correction method (VECM) causality test has been applied to find the direction of causality between the aforementioned said variables. This analysis included real gross domestic product (GDP), capital account balance, trade openness, real exchange rate and volatility of exchange rate as independent variables along with the introduction of a dummy variable for the structural adjustment programme implemented during the late 1980s as explanatory variable, while foreign direct investment as dependent variable. Major findings of this study included that exchange rate volatility has negative impact on FDI inflow in short run while this impact is positive in the long run. It has found that adjustment and liberalization programme has favourable outcomes in the short run for Pakistan.

Key words: Volatility of exchange rate, foreign direct investment, auto regressive distributed lag (ARDL) methodology.

INTRODUCTION

Structural adjustment programmes funded and introduced by international funding agencies has been implemented by a number of developing countries. This resulted into the high inflow of foreign direct investment

(FDI) into these economies. According to Kosteletou and Liargovas (2000), the outflow of capital in the world rose to 30% which was more than three times the rate of world exports (Kosteletou and Liargovas, 2000).

Abbreviations: FDI, Foreign direct investment; ARDL, auto regressive distributed lag; VECM, vector error correction method; GDP, gross domestic product; OLS, ordinary least squares; ECM, error correction mechanism; 2SLS, two stage least square; GARCH, generalized auto regressive conditional heteroscedasticity; ARCH, auto regressive conditional heteroscedasticity; LDCs, least developed countries; VAR, vector auto regressive; CUSUM, cumulative sum; CUSMSQ, cumulative sum of square; IFS, international financial statistics; IMF, International Monetary Fund; WDI, World Bank Indicators; SBP, State Bank of Pakistan; VEXCR, exchange rate volatility; TOPEN, openness of ; ADF, augmented Dicky Fuller; GDP, gross domestic product; OECD, Organization for Economic Cooperation and Development.

The developing countries of the world face a number of problems. The one of the major problems is scarce financial resources, with the passage of time investment needs to increase along with other things, these needs in the LDCs are fulfilled by the capital inflow from the developed nations either in the form of aid or foreign direct investment (Ellahi and Ahmad, 2011). FDI is the key determinant of capital inflow that brings technological spill over in the least developed countries (LDCs) by introducing better production methods. So it is required to maintain smooth inflow of inward investment into these countries, and control any factors that cause disruption of this FDI stability (Agnes and Thierry, 2005).

Volatility of exchange rate is a sort of risk challenged to international traders and investors engaged in FDI. So we may conclude that volatility of exchange rate is a factor

that curtails the trade volume and reduces the investment. This volatility when appears in developed nations causes instability all over the world (Chege, 2009). It is a wide recognized fact that exchange rate volatility in LDCs is the key factor to bring economic instability all over the world (Chege, 2009).

Exchange rate uncertainty affects FDI through the channel that depreciation of the currency of host country against the home currency raises the relative wealth of foreigners thereby increasing the attractiveness of the host country for FDI as firms are able to acquire assets in the host country relatively cheaply. Thus a depreciation of the host currency should increase FDI into the host country, and conversely an appreciation of the host currency should decrease FDI (Froot and Stein, 1991).

Objectives and organization of the study

This study is an empirical analysis conducted to find the link between exchange rate volatility and inflow of foreign direct investment by applying modern and robust technique of Auto Regressive Distributed Lag (ARDL) modeling approach.

LITERATURE REVIEW

Tokunbo and Lloyd analyzed the volatility of exchange rate and foreign direct investment link for Nigeria using secondary time series data set ranging over the time 1970 to 2004. The study applied two econometric techniques of ordinary least squares (OLS) and error correction mechanism (ECM). The major outcomes of the study include a positive and robust link between foreign direct investment and exchange rate, a negative impact of structural adjustment programme on real inward FDI, the major cause attributed to this negative impact is identified as deregulation accompanied by exchange rate volatility. The main outcome suggested that foreign investors must not be worried about the exchange rate volatility. The study recommended that it is required for central Bank of Nigeria to attain stable exchange rate in real terms so that production in home country is enhanced and bring positive increase in real FDI along with internal and external balance maintenance (Osinubi and Lloyd, 2009).

Ogunleye (2009) analyzed the relationship between volatility of exchange rate and foreign direct investment for the sub Saharan Africa region taking the Nigeria and South Africa. The study stated that, share of FDI is low across the globe because of risk of exchange rate volatility. Using a time series data set this study applied two stage least square (2SLS) techniques of estimation the variable of exchange rate volatility was found by using the generalized auto regressive conditional heteroscedasticity (GARCH) model. The major findings highlighted

that exchange rate volatility has harmful impacts on flow of FDI. The sources of exchange rate volatility were identified as inflation and nominal foreign reserves shocks in both the countries of this region. Recommendations include that in order to reduce the harmful impacts of exchange rate volatility it is required to introduce the exchange rate and FDI policy coordination (Ogunleye, 2009).

Coleman and Tettey (2008) studied the exchange rate volatility and foreign direct investment link for the sub Saharan African region taking into consideration a small and developing economy of Ghana. This empirical analysis employed auto regressive conditional heteroscedasticity (ARCH) and GARCH models to find the exchange rate volatility over the time period ranging over 1970 to 2002. Advanced and robust econometric methodologies of ECM and cointegration were applied to find the outcomes of empirical analysis. Major outcomes and results of the study included that process of liberalization adopted by Ghana has not been effective to attract the FDI inflow in the country. In addition, it also found a negative impact of volatility of exchange rate on inward flow of FDI (Kyereboah-Coleman and Tettey, 2008).

Russ (2007) conducted an analysis to show that volatility of exchange rate and interest rate affects the behavior pattern of multinational firms. This study also provided an empirical explanation of the problems of endogeneity that occurs when regression is run between foreign direct investment and uncertainty of these variables. It found that volatility of fundamental variables causes adverse impacts on entry of firms for the foreign direct investment. Chowdhry and Wheeler (2008) in an empirical analysis studied the relationship between volatility of exchange rate for the four developed countries of Canada, Japan, United State and United Kingdom. Using a number of variables this study applied vector auto regressive (VAR) approach and found that shocks to exchange rate volatility have positive and significant impact on flow of FDI (Chowdhry and Wheeler, 2008).

Kiyota and Urata (2004) analyzed the link between exchange rate, volatility of exchange rate and foreign direct investment for Japan industrial sector. It specifically analyzed the impact of volatility of exchange rate on trends of FDI. Findings suggested that currency depreciation of the host country attract the FDI, while on the other hand uncertainty and volatility of exchange rate affects negatively to the FDI. Recommendations included that, to attract FDI, countries must maintain a stable flexible exchange rate and its over valuation. Jeanneret (2006) empirically analyzed the impact of exchange rate volatility on FDI. The study utilized panel data set of 28 Organization for Economic Cooperation and Development (OECD) countries ranging over 1982 to 2002 and applied OLS fixed effects and GLS random effects estimation. Findings suggested that there is statistical insignificant relation which appeared to be

decreasing over the 1990 to 2002 and became positive since mid-1990s. Bo (2009) analyzed the link between foreign direct investment and exchange rate volatility along with political risk. A data set of two decades was utilized to conduct empirical relationship on a panel of countries. Using time series techniques study found that decisions of firms for FDI are affected by volatility of exchange rate. Variation of exchange rate and political stability causes a dampening impact on FDI inflow (Bo, 2009). Similarly Dhakal et al. (2010) studied the link between volatility and FDI for East Asian Countries with a focus on Indonesia, Malaysia, China, Philippines, South Korea, Thailand and China. The study found the time series properties of data and applied panel data techniques of estimation. The results suggested that exchange rate volatility has favorable impact on foreign direct investment for these countries (Dhakal et al., 2010).

Chege (2010) analyzed the link between exchange rate volatility and FDI for 26 emerging market economies. Applying panel analysis the study found that there is a negative link between exchange rate volatilities and inward foreign direct investment for these emerging economies (Chege, 2009). Hall et al. (2004) investigated that link between uncertainty of exchange rate and foreign direct investment for Europe. The study estimated foreign investment of UK and Europe and constructed a panel of seven manufacturing industries. The study found that volatility of exchange rate affects negatively the inward flow of foreign direct investment (Barrell et al., 2004).

THEORETICAL BACKGROUND

FDI is determined by a number of factors, the first and foremost factor is market size in the host country. The hypothesis which relates market size with FDI asserts that foreign direct investment is possible in those countries where market is large enough to accommodate and benefit through economies of scale. Developed countries possess the largest share of FDI as compared to developing due to their extensive markets. Theoretically studies have been conducted to find the linkage between market size and inflow of FDI. These studies used GDP as an indicator of market size and found that it has positive and significant impact on FDI inflow (Daniels and Quigley, 1980). Another factor responsible for determining the flow of FDI is current account balance; alternatively, it measures the strength of country's currency. It is widely accepted that, a deteriorating current account balance is indicative of depreciation of that country's currency. The deficit of current account balance causes to fluctuations and variations in exchange rate and consequently brings inflation in economy. Hence we are right in arguing that reduction in FDI inflows is caused by deficit in current account balance Froot and Stein (1991).

The effect of exchange rate on FDI are complicated

and ambiguous Exchange rate depreciation causes FDI to decrease, it may increase exports and provide gains. Foreign investors may lose as well because they incur costs to prevent transaction and translation losses when currencies depreciate. Tuman and Emmert (1999) find mixed investor reactions to exchange rate depreciation. Therefore, the impact of exchange rate depreciation on FDI inflows seems to be ambiguous.

On the other hand exchange rate risk, created by exchange rate volatility and variation also affects the flow of FDI; various studies have pointed to scenarios where the impact may be negative as well as positive. The relationship between international trade and FDI is also not entirely clear. On the one hand, protectionist policies in the host country encourage FDI. Conversely, firms' ability to successfully export may justify their making more permanent investment in that country. Nevertheless, many countries have imposed import substitution policies to successfully attract FDI, a fact that helps to explain why most FDI historically has been market seeking rather than resource seeking. Under this scenario, one would expect a country's high import restrictions and low levels of trade to correlate with high FDI. In order to capture this phenomenon, our model is defined as below and mentioned below are the determinant of FDI inflows, and it is expected that these variable will be associated with FDI inflows.

$$FDI = F(EXCR, VEXCR, OPEN, Y_t, Dummy, CAB) \quad (1)$$

Where FDI is foreign direct investment, EXCR is real exchange rate, VEXCR is volatility of exchange rate, TOPEN is trade openness, Y_t is real GDP, and Dummy is structural adjustment programme dummy, CAB is capital account balance and ε is error term. The expected sign of EXCR. In this study we are interested in finding the sign of VEXCR. If the coefficient of VEXCR is positive and statistically significant then we say that exchange rate uncertainty positively affects FDI inflows in the host country. If the coefficient is negative and statistically significant, FDI negatively affects FDI inflows. An insignificant coefficient would imply that there is no effect.

METHODOLOGY

This study is aimed to find the impact of exchange rate volatility on inflow of foreign direct investment with a specific focus on economy of Pakistan. This study applied the most robust technique of ARDL modeling technique to find the short run and long run estimates of the model. This methodology have got a few advantages over the other parallel approaches including (i) this methodology is good for finding the cointegration for small sample (Ghatak and Siddiki 2001), (ii) It avoids the pre testing requirements of other methods which require that all variables be of the same order of integration. However the variables integrated of different order can be used for further estimation. The estimation procedure consists of two steps. First step involves the application of F-test for finding the existence of long run relationship and second step includes finding the short run and long run estimates of the model. In this study we also

Table 1. Unit root test results.

Variable	ADF at level	ADF at first difference	Decision
FDI	1.1245	-3.6422	I(1)
TOPEN	0.2568	-2.9527	I(1)
EXCR	-1.4850	-3.6356	I(1)
VEXC	-0.0177	-2.6356	I(1)
CAB	-1.6137	-3.6453	I(1)
GDP	-1.9403	-5.6526	I(1)

The *shows significance at 5% level of significance, null hypothesis states that series is non-stationary or contains a unit root.

Table 2. Bounds cointegration test.

F-statistics	Probability
9 (4.01)	0.0001

Note: Null hypothesis has no cointegration; figures in parenthesis are showing the critical values that are taken from Pesaran (2002).

applied cumulative sum (CUSUM) and cumulative sum of square (CUSMSQ) tests to check the stability of parameters. The error correction form of ARDL model to be estimated can be written in the following form: Present analysis used annual time series data set ranging over the period 1980 to 2010. Major data sources include various issues of International Financial Statistics (IFS) issued by International Monetary Fund (IMF), Official website of State Bank of Pakistan (SBP), various issues of Pakistan Economic Survey issued by Ministry of Finance Pakistan and World Bank Indicators (WDI).

The present study is an attempt to find the link between volatility of exchange rate and FDI. The variables to be estimated and which are included in the model are:

Foreign direct investment (RFDI): This variable is calculated by taking FDI at current prices as a share of GDP it includes the real foreign investment inward which is considered as a key determinant for the developing countries to achieve economic development and growth through technological advancements.

Exchange rate (EXCR): It is defined as the value of one country's currency in terms of another (foreign) currency. This variable is included in the model to express the strength of a currency to attract the inward FDI. This variable can be calculated by nominal exchange rate times the foreign price divided by the domestic prices.

Exchange rate volatility (VEXCR): This variable is measured as standard deviation of exchange rate and defined as mean adjusted relative change in exchange rate squared taken from Gujrati, Osinubi (2009) and Dhakal (2010).

Openness of trade (TOPEN): Trade openness is calculated by taking ratio of sum of exports and imports with GDP.

Real gross domestic product (GDP): It is the real GDP. It measures the size of the home economy and it is included in order to control for the supply of FDI, as in Blonigen (1997). The assumption is that growth in the host country is likely to generate a greater supply of FDI.

Dummy: This variable is for structural adjustment programme. This

adjustment started in Pakistan during the mid-1980s.

Capital account balance: This is the net influx of money from overseas investors. It is calculated as net purchases of domestic financial assets by foreigners minus net purchases of foreign financial assets by domestic citizen.

RESULTS AND DISCUSSION

Output estimation

The application of ARDL method yielded the following results. Table 1 shows the augmented Dicky Fuller (ADF) unit root test results. The ADF test is applied for all the variables, and the unit root results suggest that all the variables are non-stationary at their level, but become stationary after taking the first difference. Here, application of the ARDL methodology is justified.

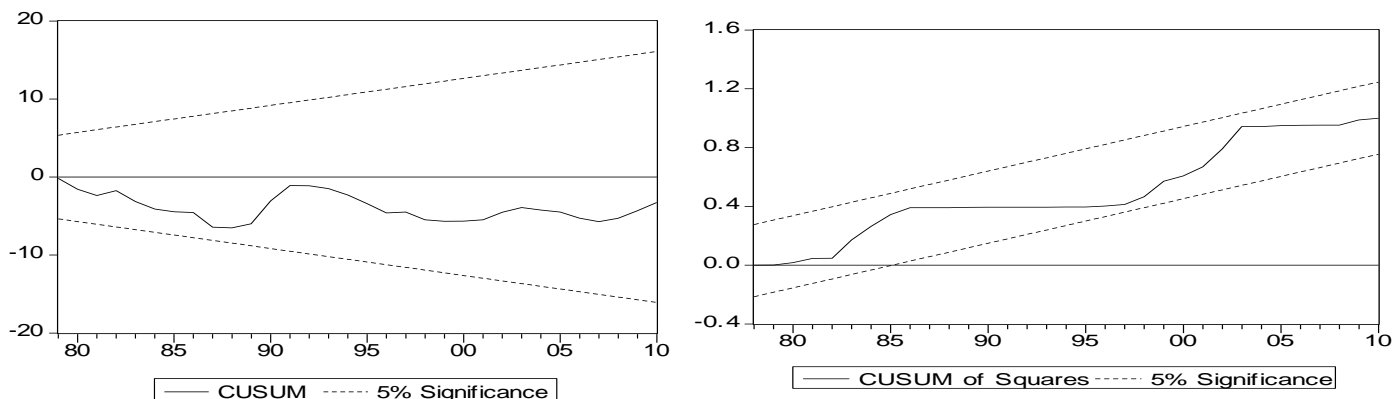
Table 2 shows the bounds cointegration tests that is, F test application to find the cointegration and long run relationship between the exchange rate volatility and foreign direct investment. Here, the value in parenthesis is the critical value and using the criteria of decision of probability, we reject the hypothesis of no cointegration and conclude that there exists a long run relationship between the variables include in our model. As there exists long run relationship so we move to find the short run as well as the long run estimates of our model along with error correction term in the next step.

Table 3 presents outcomes of short run as well as long run estimates. In short run, real exchange rate possesses negative sign but its impact is significant, it suggests that a 1% increase in real exchange rate causes 0.15% decrease in FDI. Volatility of exchange rate is the most important variable in which we are interested. The sign of its coefficient is positive and it has a significant positive

Table 3. Short run and long run coefficients.

Variable	Coefficients	Short run diagnostic statistics	
C	75.09		
D(EXCR)	- 0.15**		
D(VEXCR)	-0.25***		
D(CAB)	0.235*		
D(GDP)	- 0.585**	R ² _{adj}	0.69
D(TOPEN)	-0.336	DW stat	2.02
Dummy	0.58**	F- Stat	24.15
FDI(-1)	-0.207**	S.E of Regression	0.021
EXCR(-1)	-0.15***		
VEXCR(-1)	0.017***		
CAB(-1)	0.568		
TOPEN(-1)	-0.568		
GDP(-1)	0.006*		

*Significance at 1% level; **significance at 5%level; ***significance at 10% level.

**Figure 1.** Graphs of CUSUM and CUSMSQ.

impact on FDI in the short run. Capital account balance has positive and robust impact on inflow of FDI in Pakistan and the result is significant at 1% level of significance, a 1% increase in volatility of exchange rate causes 0.25% increase in capital inflow in the form of FDI. In short run GDP and trade openness variables have negative impact but impact is significant for GDP while insignificant for openness of trade.

Here, the coefficient of FDI (-1) is ECM, it is negative and significant. We can interpret it as 20% deviation in long run equilibrium is corrected in the long run. By normalizing the next coefficient with the coefficient of FDI (-1) we get long run equation which is given in (2). This equation suggested that long run exchange rate has positive and significant effect on FDI, volatility of exchange rate has negative but robust impact on real FDI inflow in long run, and insignificant but negative impact of trade openness and capital account balance have been found in the long run, while the impact of real GDP is negative but significant at 1% level of significance.

$$FDI = -74.883 + 0.057 EXCR^{***} - 0.207 VEXCR^{***} - 2.743 CAB - 2.74 TOPEN - 0.027 GDP^* (2)$$

Some short run diagnostic statistics have been given on the right hand side of the estimation output. R square showing the overall goodness of fit of the model indicates 69% variation in real FDI explained by other explanatory variables in the model. DW test statistic is 2.02 indicative of no auto correlation in the model estimated. F=stat is relatively large showing that model is overall fit and indicating a good fit. Furthermore, the cumulative sum and CUSMSQ graphs are given in Figure 1 for testing the stability of parameters estimated.

Conclusion

This empirical analysis has been conducted to find the link between volatility of exchange rate and inflow of foreign direct investment for Pakistan over the time

period 1980 to 2010. Using a number of support variables along with the volatility of exchange rate this study applied ARDL methodology to find the short run as well as the long run estimates. The outcomes in general are summarized as the overall estimation results are consistent with theoretical predictions. We find that exchange rate volatility has negative impact in short run, while it has a favorable effect on foreign direct investment in Pakistan. Furthermore, the study found that structural adjustment programme has caused positive and favourable impact on inflow in short run.

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