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EXCHANGE RATE VOLATILITY AND AGGREGATE EXPORTS DEMAND THROUGH ARDL FRAMEWORK: AN EXPERIENCE FROM PAKISTAN ECONOMY

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Abstract: *This study estimates the exports demand for Pakistan by employing Autoregressive Distributed Lag model and using quarterly data for the period 1982Q1-2008Q2. The paper seeks to examine the long run as well as short run impact of real effective exchange rate volatility along with foreign real income, relative price of exports and real effective exchange rate on demand for exports. The empirical results reveal that demand for real exports are co-integrated with real foreign income, relative price of aggregate exports, real effective exchange rate and volatility of real effective exchange rate. Real foreign income is found to have a significant positive effect on exports demand, suggests that Pakistan's aggregate exports demand depend significantly on its trading partner's income. The relative price of exports carries significant negative coefficient suggesting that increase in relative price of exports may decrease the level of exports demand in the long run. The volatility of real effective exchange rate, has adversely affect the Pakistan's aggregate exports in the long run. The result further demonstrates that real effective exchange rate volatility and relative price of exports ranger causes aggregate exports in the short run.*

JEL Classifications: *F10, F31, and C32.*

Keywords: *Exchange rate volatility, aggregate exports and real foreign income*

1. INTRODUCTION

Globalization could only be beneficial for a country when its growth process is being supplemented with the development of external sector through international trade. For this purpose domestic and external environment – economic development and enhanced trading activities – play an important role in shaping the country's trade. The effectiveness of any country's international trade policy depends on the magnitude of income and price elasticities of its exports and imports as well as the impact of its exchange rate and volatility of exchange rate on export and import demand. Therefore, the empirical work on this issue has great importance for policy makers for the formulating trade policies.

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This study is an endeavor to estimate the exports demand for Pakistan by employing Autoregressive Distributed Lag model (ARDL) and using quarterly data for the period 1982Q1-2008Q2. The paper seeks to examine the long run as well as short run impact of real effective exchange rate volatility along with foreign real income, relative price of exports and real effective exchange rate on the demand for exports in case of Pakistan by computing various export elasticities with respect to income, price, exchange rate and volatility of exchange rate. Exchange rate volatility is a measure that intends to capture the uncertainty faced by exporters due to unpredictable fluctuations in the exchange rates. This is an unobservable variable and thus its measure is a matter of serious disagreement and also the literature is not unanimous as to which measure is most appropriate. Recent literature, however, seems to be increasingly adopting the use of Bollerslev's (1986) generalized autoregressive conditional heteroscedasticity (GARCH) models, and the moving average standard deviations, and to a very less extent simple standard deviations. The present study employed the measure derived from the GARCH model. Augmented Dickey Fuller (ADF) and Phillips-Perron unit root tests are performed to examine the stationarity of the individual series. ARDL approach is employed to detect the long as well as short run impact of exchange rate volatility, foreign economic activity, real effective exchange rate and relative price of exports on demand for exports.

The present empirical study is an addition in the developing countries literature generally and Pakistani literature particularly and different from previous research in various dimensions. First, it uses long sample period covering 106 quarterly observations as compare to previous studies for Pakistan, such as Kumar and Dhawan (1991) covers 12 years quarterly period 1974-1985 (about 48 observation), Mustafa and Nishat (2004) covers 13 years quarterly period (about 52 observations) and Kemal (2005) covers 23 annual observations.

Second, it employed ARDL approach to detect long as well as short-run relationship among variables under study. There is no previous study for Pakistan which employed this approach in the said area of research. Third, it uses real effective exchange rate to construct the measures of exchange rate volatility instead of nominal and real exchange rate[1]. The existing literature provides sets of studies using nominal (Stockman, 1995; Taglioni, 2002) as well as real (Pozo, 1992; Doyel, 2001) exchange rate and both nominal and real effective exchange rate (Bahmani-Oskooee and Gelan, 2006). Finally, it uses GARCH process for estimating volatility of real effective exchange rate. The rest of the paper is structured as follows: Section 2 reviews the previous literature; Section 3 specifies the model of exports demand; Section 4 describes data sources and variable definitions; Section 5 presents empirical framework and Section 6 discusses the findings for empirical analyses. Finally, section 7 summarizes and offers some concluding remarks and policy implications.

2. REVIEW OF PREVIOUS STUDIES

The present study discusses the empirical literature with reference to less developed and developing countries, because present study is related to Pakistan, which is itself a developing country. For example Doganlar (2002) examined export demand function for five Asian countries (Turkey, South Korea, Malaysia, Indonesia and Pakistan); Doroodian (2002) estimated export demand function for three developing countries (India, South Korea, and Malaysia), Arize, Malindretos and Kasibhatla (2003) investigated export demand for 10 developing countries

(Burkina Faso, Colombia, Costa Rica, Jordan, Kenya, Korea, Myanmar, Pakistan, Venezuela and South Africa), Arize, Osang and Daniel (2000) investigated empirically export demand for thirteen less developed countries and Bahamani-Oskooee and Payesteh (1993) estimated export demand function for six less developed countries (Greece, Korea, Pakistan, Philippines, Singapore and South Africa). All of the above studies found adverse effect of exchange rate volatility on the volume of exports. They further found that income of trading partner countries has positive impact and relative price has negative impact on exports for most of the countries under investigation. Baak (2004) investigated the impact of exchange rate volatility on exports among 14 Asia Pacific countries; detected a significant negative impact of exchange rate volatility on the volume of exports. In addition, for sub-sample periods indicated that the negative impact had been weakened since 1989, when APEC had launched, and surged again from 1997, when the Asian financial crisis broke out. It also, showed that the GDP of the importing country and the depreciated currency of the exporting country have positive impacts on exports.

Now the study turns the review on country specific studies for example Todani & Munyama (2005) estimated export demand function for South Africa, over quarterly period 1984 to 2004 and found that incomes of South Africa's trading partners have positive effect on South Africa's exports, relative price have negative and insignificant effect on export, while exchange rate volatility effect on exports are positive but statistically insignificant. Hassan and Tufte (1998) examined long and short run determinants of Bangladeshi export growth. The study modeled Bangladeshi export growth is depending on world trade volume, Bangladeshi and world export prices and exchange rate volatility. This study demonstrated that in the long run Bangladeshi export growth is driven by the volume of world trade and is negatively and in-elastically related to the volatility of Bangladeshi exchange rates. Weliwita, Ekanayake and Tsujii (1999) have found positive long run relationship between Sri Lanka's export and income of her importing countries. Weliwita, *et al.*, (1999) found positive effect of real exchange rate and adverse effect of exchange rate volatility on Sri Lanka's export. Takaendesa, Tsheole and Aziakpono, (2005) estimated export demand function for South Africa; found foreign income has a significant negative effect on exports. The real exchange rate carried positive sign, while exchange rate volatility has a strong adverse impact on South Africa's exports to the United States. Dash (2005) have found negative impact of foreign income on India's exports to United States and also demonstrated positive effect of relative price, negative effect of real exchange rate and exchange rate volatility on India's exports.

Previous studies for Pakistan such that Kumar and Dhawan (1991) estimated the relationship between exchange rate volatility and Pakistan's exports to developed world covering quarterly data from 1974 to 1985. This study revealed that exchange rate volatility has adversely affect export demand for Pakistan. The study also found the expected results about the effect of foreign income, price and exchange rate on export demand for Pakistan. The study also analyzed the third country effect and suggested that Japan and West Germany provide an alternate market for Pakistan's export instead of United States and United Kingdom. Mustafa and Nishat (2004) examined the impact of exchange rate volatility on exports growth between Pakistan and various regional and economic blocks such as SAARC, ASEAN, European and Asia-Pacific regions. Moreover this study found mixed results for different countries with effects of exchange rate volatility, income of trading partners and real devaluation on exports as realized. Kemal (2005) examined the association of exchange rate instability with Pakistan's exports and imports covering the annual data from 1982 to 2004. Kemal (2005) employed simultaneous equations model using 3SLS (Three Stage Least Square) technique and found that exchange rate instability do not affect exports significantly where as devaluation of local currency have negative and significant effect on Pakistani exports.

3. MODEL SPECIFICATION

Following Goldstein and Khan (1978), the main determinants of the demand for a country's exports are external relative prices of exports; and foreign income levels. Another important variable is the real exchange rate which measures the competitiveness (Ian and Stephen, 1996). Forbes (2001) has found that income effects and competitive effects are among the most important determinants explaining trading fluctuations between countries. In addition, sharp moment in the foreign exchange markets in the last decade (Bird and Rajan, 2001) call for the inclusion of exchange rate volatility as another explanatory variable in the export demand function. Incorporating all of the determinant factors, study can derive the following export demand function:

$$LX_t = \alpha_o + \alpha_1 LRFI_t + \alpha_2 LRPI_t + \alpha_3 LREER_t + \alpha_4 LVREER_t + u_t \tag{1}$$

where X_t is real exports at time t, RFI_t is a measure of real foreign income index of 12 major trading partners (calculated by author), RPI_t is relative price index of aggregate exports (relative price is define as the ratio of unit price index of exports to world price index, which is calculated by the author from the geometric mean of selected trading partners' export weighted consumer price indices), $REER_t$ represents the real effective exchange rate at time t, $VREER_t$ is the measure of real effective exchange rate volatility at time t. The present study used standard deviation of GARCH variance to measure the real effective exchange rate volatility. All the variables presented in natural log transformation. u_t the stochastic error term with standard white noise properties. If foreign economic activity increases, the demand for exports will rise, so α_1 is expected to be positive. On the other hand, as relative price rises, the demand for exports will fall, so α_2 is expected to be negative.

Real effective exchange rates take account of price level differences between trading partners. Movements in real effective exchange rates provide an indication of the evolution of a country's aggregate external price competitiveness, therefore, it used as a measure of competitiveness. This variable is expected to have a negative impact on exports, i.e. if the real effective exchange rate index is decreasing the country experiences depreciation and the commodities in the home country become relatively cheaper for foreigners. The foreign traders in the foreign market will choose our commodities, since they are relatively cheaper; hence, our exports will boost. The common belief shows that depreciation would stimulate exports in the long run in most of the economies (Backman, 2006). Where as, the short-run results are mixed and inconclusive to support the hypothesis that depreciation increases competitiveness of a country in international market; thus promoting exports and output growth (Poon, Choong and Habibullah, 2005).

In the relevant empirical literature exchange-rate volatility is being considered as a source of risk and uncertainty about the profit to be made. Consequently the net profit if international trade could be received to the trading partners particularly in the absence of any hedge because in most of the developing countries like Pakistan, forward market neither exist nor accessible for all traders. As a result it is very much difficult to ascertain a prior the due effect of exchange rate volatility on international trade, in a country like Pakistan.

4. DATA SOURCES AND VARIABLE DEFINITIONS

The data is quarterly and spans the time period 1982:Q1 to 2008:Q2. The time series data for nominal exports, consumer price indices for chosen countries, real effective exchange rate and unit value index of aggregate exports are compiled from International Financial Statistics - IFS 2009 CD- ROM (IMF, 2009). The gross domestic products for selected countries are collected from various sources (see appendix). All real values are measured in base year 2000. All the variables are measured as natural logarithms, so that their differences approximate growth rates. The variables are constructed as follows:

Real exports: Nominal exports are measured in US \$. Real exports (X_t) are constructed as nominal exports (NX_t) deflated by the unit value index of exports ($UVIX_t$) as follows:

$$X_t = \frac{NX_t}{UVIX_t} * 100 \tag{2}$$

Real Foreign Income Index: Real foreign income index (RFI) is the geometric export-weighted average of the real gross domestic products (See Arize, Osang and Daniel, 2004) of 12 major trading partner countries (USA, UK, Japan, Saudi Arabia, UAE, Hong Kong, Canada, Korea, France, Netherlands, Germany and Italy) weighted based on year 2000, where weights are Pakistan's exports share of chosen trading partners (wi).

$$RFI = G.M\{wi * RGDPi\} \tag{3}$$

Relative price index of export: Relative price index of export (RPI) is the ratio of unit value index of Pakistani exports (UVIX) to world price index (WPI) for base period 2000, where world price index is estimated from geometric export-weighted average of 12 major trading partner's consumer price indices based on year 2000.

$$RPI = \frac{UVIX}{WPI} * 100 \tag{4}$$

Where
$$WPI = G.M\{wi * CPIi\} \tag{5}$$

Real Effective Exchange Rate: The weighted average of a country's currency relative to an index or basket of other major currencies adjusted for the effects of inflation. The weights are determined by comparing the relative trade balances, in terms of one country's currency, with each other country within the index.

Exchange Rate Volatility: Exchange rate volatility is a measure that intends to capture the risk faced by exporters due to unpredictable fluctuations in the exchange rates. The study used a measure derived from Bollerslev (1986) generalized autoregressive conditional heteroscedasticity (GARCH) models.

- ***ARCH and GARCH Models:*** The measure of exchange rate volatility is the conditional variance of the first difference of the natural log of exchange rate. The GARCH is the generalization of ARCH model proposed by Engel (1982). The exchange rate is generated by the following autoregressive process:

$$\Delta REER_t = \Phi_0 + \sum_{i=1}^{p} \partial_i \Delta REER_{t-1} + \mu_t;\ \mu \sim N\left(0, \sigma^2\right) \tag{6}$$

where Φ_0 is a constant, ∂_i are coefficients, Δ is the first difference operator and μ_t, is the error term normally distributed with mean zero and variance σ^2. Engel (1982) allowed for the variance to vary over time and the idea behind the ARCH model is to characterize how this variance changes over time. The ARCH model assumes that the variance can be captured by the following autoregressive process:

$$\sigma_t^2 = \lambda_0 + \sum_{i=1}^{p} \phi_i \mu_{t-i}^2 \tag{7}$$

where σ^2_t is the conditional variance of the exchange rate, μ^2_{t-i} represents the squared residuals derived from equation (6) and ϕ_i are parameters to be estimated. To ensure that the predicted variance is always positive, the restriction that $\phi_{i'} s \geq 0$ is necessary. It is important to note here that in equation (6) the current levels of volatility is influenced by the previous levels of volatility and thus high or low periods of volatility will tend to persist. The GARCH (*p, q*) process is just an extension of the ARCH in which σ^2_t becomes a function not only of μ^2_{t-i} but also of the lagged values of itself. The conditional variance in this case is estimated by:

$$\sigma_t^2 = \lambda_0 + \sum_{i=1}^{p} \phi_i \mu_{t-i}^2 + \sum_{i=1}^{q} \delta_i \sigma_{t-i}^2 \tag{8}$$

In the GARCH (*p*, *q*) model, (*p*, *q*) in parentheses is a standard notation in which the first letter refers to the number of autoregressive lags, or ARCH terms that should appear in the equation, while the second letter refers to how many moving average lags are specified, which is often called the number of GARCH terms. Sometimes models with more than one lag are needed to find good variance forecasts (Engle, 1982).

5. EMPIRICAL FRAMEWORK

5.1. Test of Unit Root

The test of unit root is the usual practice today. The said test is used to determine the order of integration of a time series. Engle and Granger (1987), define a non-stationary time series to be integrated of order d if it achieves stationarity after being differentiated d. times. This notion is usually denoted by $X_t \sim I\,(d)$. Hence all the series are tested for the probable order of difference stationarity by using the augmented Dickey-Fuller (ADF) and Phillips & Perron tests. ADF test is a standard unit root test, it analyze order of integration of the data series. These statistics are calculated with intercept. These tests have a null hypothesis of non-stationarity against an alternative of stationarity. ADF test to check the stationarity of the series is based on the equation of the form:

$$\Delta Y_t = \beta_1 + \beta_2 t + \beta\ Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \tag{9}$$

where ε_t is a pure white noise error term and $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$ etc.

ADF test determines whether the estimates of δ are equal to Zero. Fuller (1976) provided the cumulative distribution of the ADF statistics, if the calculated t-ratio of the coefficient d is less than the critical value from Fuller table, then Y_t is said to be stationary. (Note that 't' ratio of coefficient d is always with a negative sign). Phillips and Perron have developed a more comprehensive theory of unit root non-stationarity. The tests are similar to ADF tests, but they incorporate an automatic correction to the Dickey-Fuller procedure to allow for autocorrelated residuals. The tests usually give the same conclusions as the ADF tests, and the calculation of the test statistics is complex.

5.2. Autoregressive Distributed Lag (ARDL) Bound Testing Approach

In the present study, the long- and short-run dynamic relationships between Pakistan's aggregate exports and real effective exchange rate volatility are estimated by using the relatively newly proposed ARDL bound testing approach was popularized by Pesaran and Pesaran, (1997). The ARDL has numerous advantages[2] (Charemza and Deadman, 1992; Banerjee, Dolado and Mestre, 1998 and Pesaran, 2001). First, unlike the most widely used method for testing cointegration, the ARDL approach can be applied regardless of the stationary properties of the variables in the samples and allows for inferences on long-run procedures. In other words, this procedure can be applied independently of whether the series are I(0) or I(1) or fractionally integrated (Pesaran and Pesaran, 1997; and Bahmani-Oskooee and Ng, 2002), thus avoiding problems resulting from non-stationary time series data (Laurenceson and Chai, 2003). Second, the ARDL model takes sufficient numbers of lags to capture the data generating process in a general-to-specific modeling framework (Laurenceson and Chai, 2003). Finally, ARDL model helps to derive dynamic error correction model (ECM) through a simple linear transformation without losing information about long run elasticities (Banerjee, Dolado, Galbralth and Hendry, 1993). To illustrate the ARDL modeling approach, the error correction version of the ARDL model is presented as follows:

$$\begin{aligned}\Delta LX_t &= \alpha_0 + \alpha_1 LX_{t-1} + \alpha_2 LRFI_{t-1} + \alpha_{21} LRPI_{t-1} + \alpha_4 LREER_{t-1} + \alpha_5 LVRE\,ER_{t-1} + \sum_{i=1}^{p} \beta_i \Delta LX_{t-i} \\ &+ \sum_{i=0}^{q} \delta_i\, \Delta LRFI_{t-i} + \sum_{i=0}^{s} \gamma_i \Delta LRPI_{t-i} + \sum_{i=0}^{w} \varphi_i \Delta LREER_{t-i} + \sum_{i=0}^{d} \rho_i \Delta LVREER_{t-i} + \mu_i\end{aligned} \tag{10}$$

The first part of equation (10) with α_1 to α_5 represents the long run elasticities[3] of the model whereas the second part with β, δ, γ, φ and ρ represents the short run dynamics of the model. The null hypothesis of no long run relationship among the variables is symbolically defined as Ho: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$ (all α's are simultaneously equal to zero), is tested against the alternative of Ha: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq 0$ (not all α's are simultaneously equal to zero), by the means of familiar F-test. However, the asymptotic distribution of this F-statistic is non-standard irrespective of whether the variables are $I(0)$ or $I(1)$.

5.3. ARDL Model Testing Procedure

The ARDL model testing procedure starts with conducting the bound test for the null hypothesis of no co-integration. The calculated F-statistic is compared with the critical value tabulated by Pesaran and Pesaran (1997) or Pesaran *et al*. (2001). If the test statistic exceeds the upper critical value, the null hypothesis of no long-run relationship can be rejected regardless of whether the underlying orders of integration of the variables are zero or one. Similarly, if the test statistic falls below a lower critical value, the null hypothesis is not rejected. However, if the sample test statistic falls between these two bounds, the result is inconclusive. When the order of integration of the variables is known and all the variables are $I(1)$, the decision is made based on the upper bound. Similarly, if all the variables are $I(0)$, then the decision is made based on the lower bound.

The ARDL method estimates $(p+1)k$ number of regressions in order to obtain optimal lag length for each variable, where p is the maximum number of lag to be used and k is the number of variables in the equation. The model can be selected using the model selection criteria like Schwartz-Bayesian Criteria (SBC) and Akaike's Information Criteria (AIC). SBC is known as the parsimonious model: selecting the smallest possible lag length, whereas AIC is known for selecting the maximum relevant lag length. In the second step, the long run relationship is estimated using the selected ARDL model. When there is a long run relationship between variables, there exists an error correction representation. Therefore, in the third step, the error correction model is estimated. The error correction model result indicates the speed of adjustment back to the long run equilibrium after a short run shock.

To ascertain the goodness of fit of the ARDL model, the diagnostic test and the stability test are conducted. The diagnostic test examines the serial correlation, functional form, normality and heteroscedasticity associated with the model. The structural stability test is conducted by employing the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ).

6. EMPIRICAL ANALYSIS

6.1. Test of Unit Root Hypothesis

However the ARDL framework does not require pre-testing variables to be done, the unit root tests could convince us whether or not the ARDL model should be used. The results obtained are reported in Table 1. Based on these tests statistic, it is found that there is a mixture of I(1) and I(0) of underlying regressors and therefore, the ARDL testing could be proceeded.

6.2. Long run Analysis of Export Demand Function

Before estimating the short- and long-run relationship between variables under consideration, the study has to decide the lag-length on the first differenced variables. Bahmani-Oskooee and Bohl (2000) have shown that the results of this first step are usually sensitive to lag-length. To verify this, study incorporate lag length equal to 1 to 10 (taken more lags because there are 106 quarterly observations) on the first-differenced variables. The computed F-statistic for each lag-length is reported in Table 2 along with the critical values at the bottom of the table. As reported, the test statistics at lag 1 to 8 are all significant at 99%; at lag 9 and 10 are significant at 95% and 90%

Table 1
Unit Root Test

Variables	*ADFTEST with intercept*		*Phillips-Perron with intercept*	
	Level	*First Difference*	*Level*	*First Difference*
LX	-1.8515	-5.0876	-1.5973	-14.8463*
LRFI	-2.0969	-4.4860*	-5.4643*	-24.2161*
LRPI	0.4162	-3.5964*	0.4671	-10.4791*
LREER	-2.6191	-9.4183*	-2.7224***	-9.4090*
LVREER	-3.4577**	-11.5696*	-3.4293**	-13.7934*

Note: Critical values are: -3.4963, 2.8903, 2.5821 (significant at 1%, 5%, and 10% respectively when 1st difference is constant). *, ** and *** represent significant at 1%, 5% and 10% respectively.

Table 2
F-Statistics for Testing the Existence of a Long-run Export Demand Equation

No. of Lags	*F-Statistics (Unrestricted intercept and no trend)*
1	12.4191*
2	10.8638*
3	11.4814*
4	9.7317*
5	9.9946*
6	7.0479*
7	5.5340*
8	5.5835*
9	4.8806**
10	4.0576**

Note: The relevant critical value bonds are taken from Pesraran, Shin & Smith (2001) [Case III with an unrestricted intercept and no trend and number of regressors = 4 from]. They are 3.74 – 5.06 at the 99%; 2.86 – 4.01 at the 95%; and 2.45 – 3.52 at the 90% significance levels respectively. * and ** denotes that F-statistics falls above the 99% and 95% upper bond, respectively.

respectively. The results seem to provide evidence of the existence of a long-run relationship among aggregate real exports, real foreign income, relative price, real effective exchange rate and volatility of real effective exchange rate in Pakistan. In other words, these variables have a tendency to move together in the long run. This results should be considered preliminary and indicate that in estimating Equation (1) the study must retain the lagged level of variables.

In the second stage, the study retains the lagged level of variables and estimates error correction version of ARDL framework. The long-run ARDL model selected on the bases of AIC (Akaike Information Criterion), are reported in table 3. Based on ARDL (1, 1, 0, 0, 0), the long run elasticities of exports demand with respect to real foreign income is 0.67, which demonstrated that if the income of trading partners increases by 1 per cent, the aggregate exports demand for Pakistan will raise by 0.67 per cent. Further results indicate that in the long run relative price index of export is negative and statistically significant. The coefficient implies that one per cent increase in relative price of exports may decrease the exports demand by 0.23 per cent. The long run coefficient of real effective exchange rate is positive but statistically insignificant, and implies that depreciation in real effective exchange rate may not helpful to boost up demand for real exports demand. The results further point out the significance of volatility of real effective exchange rate. The volatility coefficient suggests 1 per cent increase in volatility of real effective exchange rate will generate a drop in aggregate export demand by 0.32 per cent. The results of Kumar and Dhawan (1991) for Pakistan, Arize et al., (2000) and Doroodian (1999) for developing countries also support this result that volatility of exchange rate adversely affects the exports demand in Pakistan.

Table 3
Long run Model of Exports Demand Function

Regressors	*Coefficient*	*Standard Error*	*T-Ratio [Prob.]*
Constant	16.8821*	3.8619	4.3714[0.000]
LRFI	0.6758**	0.3404	1.9852[0.050]
LRPI	-0.2302**	0.1207	-1.9062[0.060]
LREER	0.3504	0.4391	0.7978[0.427]
LVREER	-0.3233*	0.1143	-2.8284[0.006]

*, ** and *** represent significant at 1% 5% and 10% respectively.

The calculated F-statistic from Wald test of ARDL model, reported in Table 4(a) is higher than the upper bound critical values at one per cent level of significance. This implies that the null hypothesis of no co-integration can be rejected and therefore there is evidence to support the long run relationship among the variables. The study also tests the model using Henry's "General to specific Approach" to get the parsimonious specification (See Hendry 1979 and Krolzig and Hendry, 1999). In doing so, the study sets initially optimal lag length based on SBC and eliminates the variables which are not significant, except for the level variables and the intercept. The F-statistic of Wald test on the level variables of the new model, as displayed in Table 4(b), shows stronger results as compare to the previous model. This confirms the existence of long run relationship among the variables used.

Table 4(a)
F-statistic of Cointegration Relationship

Set of Variables	*No. of Lags*	*F-Statistic*
LX LRFI LRPI LREER LVREER	1	6.8386*
	*Bound Critical values**	
Level of significance	*Unrestricted intercept and no trend*	
	I(0)	I(1)
1%	3.74	5.06
5%	2.86	4.01
10%	2.45	3.52

* denotes that F-statistics falls above the 99% upper bond.

Table 4(b)
F-Statistic of Cointegration Relationship
(in Parsimonious Specification)

Set of Variables	*No. of Lags*	*F-Statistic*
LX LRFI LRPI LREER LVREER	1	7.7715*

Bound Critical values* same as in table 4(a)

6.3. Short Run Dynamics of Export Demand Function

The short run dynamics i.e. error correction model for real export demand are presented in Table 5. The highly significant error correction term further confirms the existence of a stable long run relationship (See Banerjee *et al.*, 1993). The coefficient of error correction term represents the speed of adjustment of this variable back to its long- run value following a shock. The model implies a reasonably quick adjustment back towards equilibrium following a disturbance. The highly significant error correction terms suggest that following a shock, about 59% of the adjustment back to the long run equilibrium is completed after one quarter. The dynamic short run causality among the relevant variables is also shown in Table 5. The causality effect can be obtained by restricting the coefficient of the variables with its lags equal to zero (using Wald test). If the null hypothesis of no causality is rejected, then we conclude that relevant variables cause to exports demand. The results of the said test demonstrate that relative price and real effective exchange rate volatility are statistically significant and cause to exports demand while real foreign income and real effective exchange rate, do not cause exports demand in the short run.

Table 5
Error Correction Model for Export Demand Function

Dependent Variable: DLX
ARDL (1, 1, 0, 0, 0) based on AIC

Independent Variables	*Coefficients*	*Std. Error*	*t-statistics*	*p-value*
Constant	9.9842*	4.4158	4.1329	0.000
ΔLRFI	0.0115	0.2610	0.0439	0.965
ΔLRPI	-0.1361**	0.0691	-1.9679	0.052
ΔLREER	0.2072	0.2713	0.7637	0.447
ΔLVREER	-0.1912*	0.0743	-2.5726	0.012
ECM(-1)§	-0.5914*	0.0975	-6.0639	0.000
Diagnostic tests:				
A. Serial Correlation		CHSQ= 50.0942 (0.000)	F-statistic=21.4406 (0.000)	
B. Functional Form		CHSQ= 3.3537 (0.067)	F-statistic= 3.2004(0.077)	
C. Normality		CHSQ= 3.3586 (0.187)	N. A.	
D. Heteroscedasticity		CHSQ= 2.7555 (0.097)	F-statistic= 2.7759(0.099)	
R^2 = 0.4999		AdjustedR^2 = 0.4693	Durbin-Watson= 2.1429	

A: Lagrange multiplier test of residual serial correlation
B: Ramsey's RESET test using the square of the fitted values
C: Based on a test of skewness and kurtosis of residuals
D: Based on the regression of squared residuals on squared fitted values
*, ** and *** represent significant at 1% 5% and 10% respectively.

§ ECM = LRX -.67587*LRFI + .23018*LRPI -.35038*LREER + .32332*LVREER -16.8821*C1

Further, the diagnostic tests reject some obvious econometric problems. The test for normality confirms residual normality and ARCH test rejects heteroscadasticity in the disturbance term at 5 per cent level of significance. The Ramsey's RESET test indicates no specification error for the estimated model at 5 per cent level of significance. However, the LM test result indicates that there exists serial correlation in the residuals. The ARDL model has been shown to be robust against residual autocorrelation. Therefore, the presence of autocorrelation does not affect the estimates (Laurenceson and Chai, 2003).

Since the stability of the export demand function is essential for making an effective trade policy, checking whether the coefficients of the ECM model are stable over the sample period, the study carried out the CUSUM and CUSUM SQUARE tests of structural stability. As shown in figures 1 and 2, CUSUM and CUSUM SQUARE plots indicate parameters stability in the ECM model over the sample period. To confirm the stability of the parameters the present study conducts the Recursive Coefficient Test. As the coefficients do not display significant variation as more data are added to the estimating equation, it is a strong indication of stability.

Figure 1: Plot of Cumulative Sum for ECM

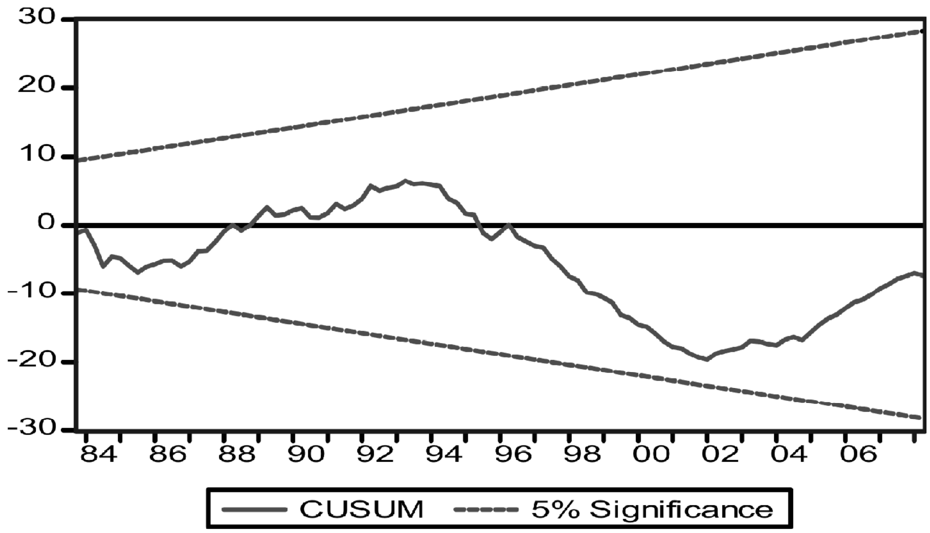


Figure 2: Plot of Cumulative Sum of Square for ECM

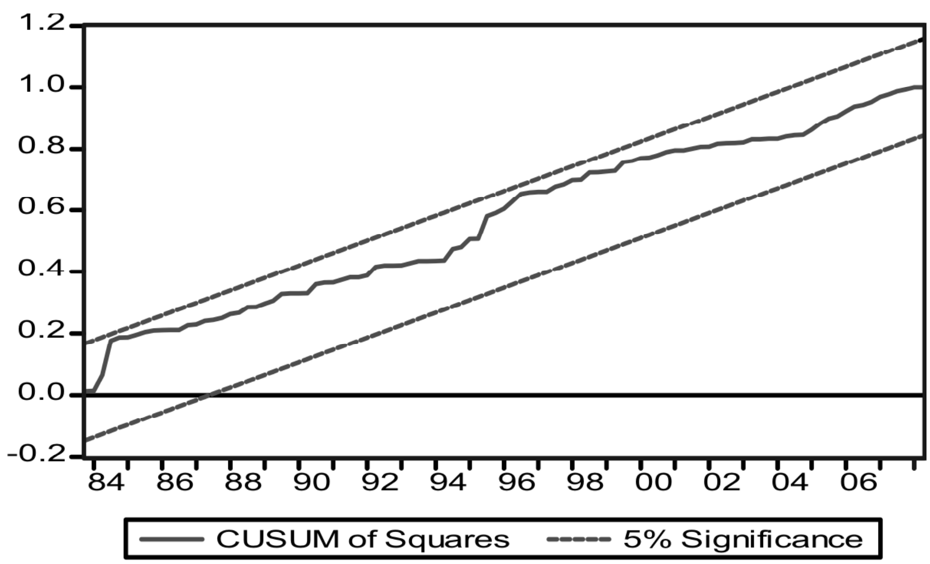
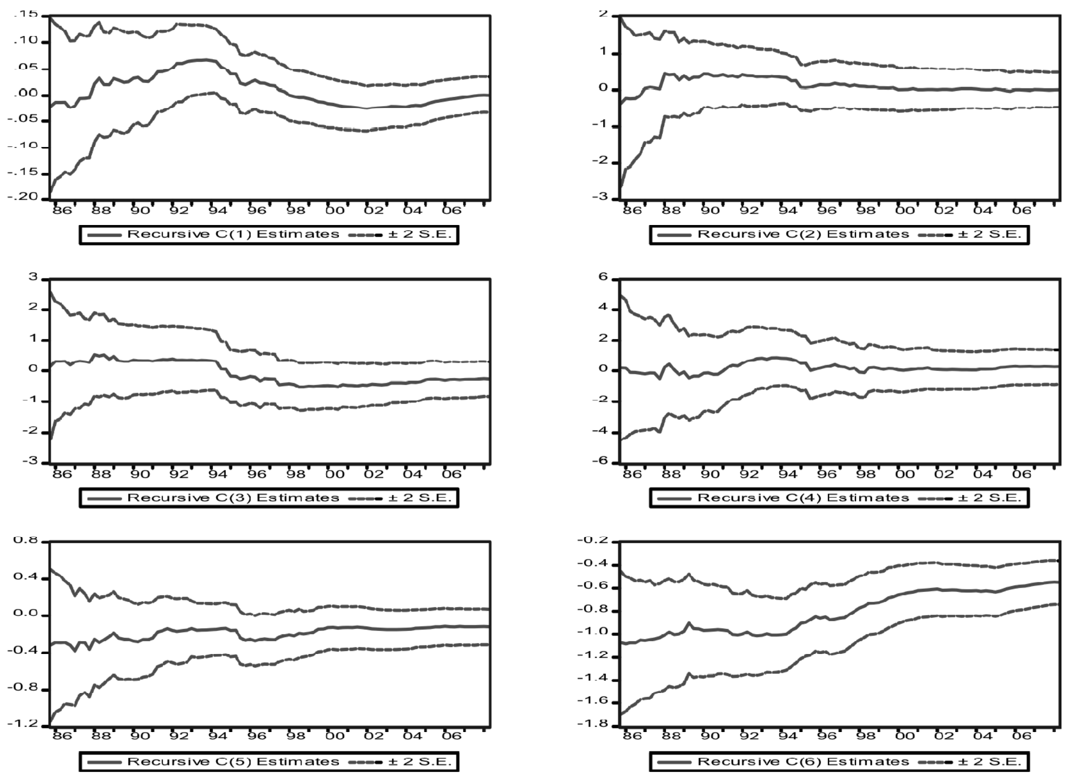


Figure 3: Recursive Coefficient Test for Stability for ECM



DATA APPENDIX

To construct the real foreign income index, study compiled the gross domestic product of 12 major trading partners of Pakistan. The quarterly GDP data for each selected country is taken from various sources. The most of the GDP series collected from IFS, these are available in local currency. To convert these series in US$, the study used their relevant exchange rates. Annual GDP of Saudi Arabia and United Arab Emirates are taken from *www.sesrtcic.org/stat_indicators.php* and converted in quarterly GDP from the weights described by Suliman M. Al-Turki (1995). Quarterly Series of GDP of USA in constant US$ based of year 2005, is taken from Federal Reserve Bank of Dallas, and changed its base year to 2000. All the series of real GDP are constructed as nominal GDP deflated by their relevant CPI. All quarterly GDP, data series are in constant US$ of base year 2000.

7. CONCLUDING REMARKS

This paper examined the aggregate export demand function to estimate the impact of real effective exchange rate volatility along with real foreign income, relative price of exports and real effective exchange rate on Pakistan's aggregate exports to rest of the world using quarterly data covering the period 1982Q1-2008Q2. The test for integration revealed that variables under consideration are of mixed order of integration (i.e., I(0) and I(1)), recommended that an ARDL technique be appropriate. The empirical results based on the ARDL co-integration analysis show that demand for real exports are co-integrated with real foreign income, relative price of aggregate exports, real effective exchange rate and volatility of real effective exchange rate. Real foreign income is found to have a significant positive effect on exports demand, which suggests that Pakistan's aggregate exports demand depend significantly on its trading partner's income. The relative price of exports carries significant negative coefficient suggest that increase in relative price of exports may decrease the level of exports demand in the long run in case of Pakistan. The volatility of real effective exchange rate, has adversely affect the Pakistan's aggregate exports, while real effective exchange rate does not effect significantly in the long run.

As far as the short run dynamics analysis concern the study demonstrates that about 59 per cent of variation in exports demand is corrected within a quarter. The dynamic short run causality did not detected from real income of trading partners and real devaluation to demand for exports in Pakistan. The short run causality hypothesis that real effective exchange rate volatility and relative price of exports cause export demand can not be rejected implies that volatility and relative price of exports Granger causes aggregate exports in the short run. Pakistan needs to improve its external competitiveness for the enhancement of demand for its aggregate exports. The presence of forward exchange markets in currencies that enables the exporters to hedge against the risks in international trade will certainly help them cope with adverse effects of exchange rate volatility on exports. As discussed earlier that Pakistan's economy experienced a huge trade deficit, policy makers should consider both the existence and the degree of exchange rate volatility and notice the likely impact of the exchange rate volatility for each trading partner in implementation of trade policies for the growth of exports demand and ultimately for the improvement in trade balance. Further research needs on disaggregated trade data to recommend clear policy implications.

Notes

1. The use of *real effective exchange rate* (REER) index requires assigning relative weights to observations from different countries. The fact that a country's trade shares vary internationally in terms of volumes and values necessitates such a conversion in order to gauge global competitiveness. Moreover, in the case of export weights, an exporting country competes not only with domestic producers in the importing country but also with other countries which export similar products. This distinction becomes particularly important when there are variable movements in exchange rates across countries.
2. The Engle-Granger two- step cointegration approach has some limitations. Firstly it ignores short-run dynamics while estimating the cointegrating vector. When short-run dynamics are complex in nature, it biases the estimate of the long-run relationship in finite samples. To counter this, a test based on the coefficient of the lagged dependent variable has been proposed (Banerjee et al. 1998). However, the parameter estimates are only asymptotically efficient on the assumption of weak exogeneity of the regressors. The procedure only assumes that one cointegrating vector exists leading to inefficiency in estimation but actually exists more than one vectors. The Johansen procedure deals with this problem but it presumes that the order of integration of all variables is the same and known with certainty. However, the power of unit root test is low hence it can never be known with certainty. The autoregressive distributed lag (ARDL) approach to cointegration proposed by Pesaran et al. (2001) overcomes some of these problems. (i) it captures both short-run and long-run dynamics. (ii) it permits the estimation of cointegration relationships when variables are I(0), I(1) or a mixture of the two. (iii) it offers explicit tests for the existence of a unique cointegration vector rather than assuming one. (iv) it takes into account the possibility of reverse causality (i.e. the absence of weak exogeneity of the regressors) thereby ensuring that the parameter estimates are efficient and consequently valid.
3. The long run elasticities measure the total impact of an explanatory variable on the dependent variable during the total time period under consideration, whereas short run elasticities measure the immediate impact of explanatory variable on dependent variable for optimal lag length.

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