

Openness-Inflation Puzzle: Evidence from Pakistan

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In the literature, there is evidence of an inverse relation between trade openness and inflation which has been widely questioned. More recently, economic openness has been related to aggregate demand and supply to shed light on inverse openness-inflation in the developed countries. This paper contributes to the literature by examining the long run connection between trade openness and inflation in a developing country, Pakistan, using the Autoregressive Distributed Lag. The empirical finding suggests that the negative openness-inflation relationship holds for Pakistan.

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I. INTRODUCTION

The link between openness and inflation is one of the puzzles of international economics (Temple 2002). Theory suggests that there is an inverse relationship between openness and inflation. For instance, in the Mundell-Fleming version of the Barro and Gordon (1983) model, loss monetary policy leads to an increase in output and deterioration in the terms of trade. More precisely, with increased openness, the incentives for the monetary authorities change as the degree of openness raises the Phillips curve and the effect of monetary policy on output changes. Hence, the trade-off comes to be less promising and optimal monetary policy becomes less expansionary. This provides an inverse relationship between openness and inflation.

Some empirical studies have indicated an inverse relationship between openness and inflation. Studies conducted by Triffin and Grubel (1962), (1973), Romer (1993), Terra (1998), and Hanif and Irem (2006) over various developing and developed countries have revealed negative relationship between trade openness and inflation. Gruben and McLeod (2004) revealed the negative

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relationship between trade openness and inflation using dynamic panel estimates for both high income OECD and developing countries. They also found that trade openness was linked with less inflation through the 1990s and had a robust disinflation outcome in economies with more unstable floating exchange rates. On the other hand, studies such as Temple (2002) showed that openness and inflation do not have a regular relationship as suggested by the earlier studies. The authors assert that each country has different correlation between openness and inflation, and it is not possible to reach any universal conclusion. Hence, the nexus between openness and inflation remains a puzzle and warrants further scrutiny.

In a recent empirical study, Granato, Lo and Wong (2007) provide evidence for 15 developed countries to explain the recent empirical failure in finding the existence of the negative openness-inflation relationship. The authors attempt to explain why the openness-inflation relation can be ambiguous by linking economic openness to the slopes of aggregate supply (AS) and aggregate demand (AD) curves, primarily in the case of developed countries. Surprisingly, this puzzle has received relatively scant attention in the case of developing countries. The present study makes a contribution to the existing literature primarily on the methodological front as it uses the ARDL bounds testing procedures to shed light on the inflation-openness puzzle in the case of Pakistan both in the long-run and short-run perspectives. The rest of the paper is structured as follows: section II presents modeling, data and the methodological framework, section III provides the empirical findings, and Section IV summarises the conclusions.

II. MODELING, DATA AND METHODOLOGY

In light with the theoretical assumptions, we used the following given model in linear form:

$$CPI = \beta_0 + \beta_1 EX + \beta_2 LEXP + \beta_3 LGDPC + \beta_4 LMS + \beta_5 LIMP + \beta_6 ATR + v_i \quad (1)$$

where CPI = Consumer price index, EX = Exchange rate against US Dollar, LEXP= Natural log of export as a share to GDP, LGDPC = Natural log of real GDP per capita income, LMS = Natural log of money supply, LIMP = Natural log of Import as a share to GDP, ATR = Average tariff rate proxy for trade openness. Data for all selected variables, time series annual data that cover the period of 1975 to 2011, have been obtained from World Development Indicators (WDI-2012), International Financial Statistics (IFS-2012) and Economic Survey of Pakistan (various issues).

ARDL Bounds Testing Procedure

For econometric analysis we employ ARDL bounds testing approach of cointegration to analyse the long run bond among related variables. This approach is introduced by Pesaran, Shin and Smith (2001). The ARDL bounds testing method for cointegration is easier than other classical methods. For example, the ARDL bounds testing is applicable to analyse the cointegration if variables are integrated with mixed order of integration like I(0) or I(1)¹. F-statistics or Wald statistics developed by Pesaran *et al.* (2001) becomes useful for cointegration. This approach to cointegration produces better and reliable results for small time series data set. Finally, a simple linear transformation or re-parameterisation of variables is carried out to derive the short run dynamic of Error Correction Mechanism (ECM). This approach is having ability to combine long and short run relationship without dropping information regarding long run results. The unrestricted error correction model (UECM) of the ARDL version is modeled as follows:

$$\Delta y_t = \lambda_1 + \lambda_2 y_{t-1} + \lambda_3 z_{t-1} + \lambda_4 x_{t-1} + \sum_{i=1}^p \gamma_i \Delta y_{t-i} + \sum_{j=0}^q \alpha_j \Delta x_{t-j} + \sum_{s=0}^r w_s \Delta z_{t-s} + \varepsilon_t \quad (2)$$

where λ_1 is measured as constant and ε_t is residual term supposed to be white noise. The ARDL bounds testing approach to cointegration calculates number of regressions following $(p+1)^k$ formula which helps in choosing appropriate lag order. The optimal lag order allows the model to address serial correlation problem and provides appropriate F-statistics to take decision about the existence of cointegration between the series. Where “p (k)” is the total number of lags (variables) to be used in equation 2. To test the existence of cointegration, Pesaran *et al.* (2001) generated two critical bounds i.e. upper critical bound (UCB) and lower critical bound (LCB). F-test was developed by Pesaran *et al.* (2001) to analyse the joint significance of the parameters in equation-2.

The possible null hypothesis $H_0 : \lambda_2 = \lambda_3 = \lambda_4 = 0$ shows no cointegration between the series; cointegration exists if alternative hypothesis $H_1 : \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$ is found to be significant. The null hypothesis for cointegration among the variables is accepted, the calculated F-calculated or Wald statistics value more than upper critical bound (UCB) helps to accept the

¹In this study Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) tests were applied to estimate unit root. ADF test is parametric while Philip-Perron is non-parametric test.

alternative hypothesis, which means that long run relationship exists among the variables.² On the contrary, if null hypothesis is accepted it indicates no cointegration; in this case, F-statistic does not exceed the lower critical bound (LCB). The results will be inconclusive or no decision about cointegration if F-statistic lies between LCB and UCB. When the first differenced variables jointly equal to zero, i.e. $\Delta x = \Delta y = \Delta z = 0$.

Thus,

$$y_t = \partial_0 + \partial_1 t + \partial_2 x_t + \partial_3 z_t + v_t \quad (3)$$

where $\partial_0 = -\lambda_0 / \lambda_2$; $\partial_1 = -\lambda_1 / \lambda_2$; $\partial_2 = -\lambda_3 / \lambda_2$; $\partial_3 = -\lambda_4 / \lambda_2$ and v_t are the random errors. These long run coefficients are estimated by the ARDL model in equation-2 by OLS. Once long run relationship between the series is found, then the next step is to estimate the short run behaviour of the variables regressed on the dependent variable by using error correction model (ECM). The estimable equation of error correction model is modelled as follows:

$$\Delta y_t = \sum_{i=1}^p \lambda_i \Delta y_{t-i} + \sum_{j=0}^m \beta_j \Delta x_{t-j} + \sum_{k=0}^n \beta_k \Delta z_{t-k} + \eta ECT_{t-1} + \varepsilon_t \quad (4)$$

Where ECT is error correction term indicating speed of adjustment from short run disequilibrium towards long run. The stability and diagnostic tests are carried out to test the goodness of fit of autoregressive distributive lag model (ARDL). In diagnostic test, we explore serial correlation between error terms, specification problem, normality of residual term and white heteroscedasticity that are of concerns for the short run model. The cumulative sum of recursive residuals (CUSUM) is applied to test the constancy of ARDL parameters. This is another way to find out prediction error, which indicates the reliability of the ARDL model. The model presents the best fit if difference between real and estimated value is minimal.

III. EMPIRICAL RESULTS

Before determining whether the time series are integrated or not, ADF and PP unit root tests are conducted. The results are reported in Tables I and II which suggest that the exports and imports as share of GDP and real GDP per capita are I(0), while CPI and money supply exchange rate and average tariff rate are I(1). Next we turned to ARDL bounds testing for cointegration. In the first step, we

² If all the series are integrated at I(1) then decision regarding cointegration depends upon the upper critical bound (UCB) and vice versa.

made a selection of lag order on the basis of SBC, which suggests a lag order of 1. The total number of possible regressions estimated following the ARDL method in equation 2 is $(1 + 1)7 = 128$. The results of the approach for cointegration long-run relationship tell that the calculated F-statistic is 32.96, which is higher than the upper level bound value of 4.52. This points out that the null hypothesis of no co-integration among the variables cannot be accepted and, indicates that there is definitely a co-integration association among the variables.

TABLE I
UNIT-ROOT ESTIMATION

Variables	Level ADF test Statistics	Level P-P test Statistics
Consumer price index	-0.021	-1.030
Exchange rate	-1.581	-1.231
Exports as share of GDP	-4.934 ^a	-3.246 ^b
Imports as share of GDP	-4.912 ^a	-6.534 ^a
Money supply	-0.111	-0.077
Real GDP per capita	6.851 ^a	4.369 ^a
Average Tariff rate	-0.226	-0.427

Note: a and b indicate significant at 1 per cent and 5 per cent level of significance respectively.

TABLE II
UNIT-ROOT ESTIMATION

Variables	1 st Difference ADF test statistics	1 st Difference P-P test statistics
Consumer price index	-3.153 ^b	-3.312 ^b
Exchange rate	-9.176 ^a	-8.521 ^a
Exports as share of GDP	-6.897 ^a	-6.879 ^a
Imports as share of GDP	-5.634 ^a	-5.622 ^a
Money supply	-4.397 ^b	-6.199 ^a
Real GDP per capita	-5.372 ^a	-5.346 ^a
Average Tariff rate	-4.212 ^b	-5.226 ^a

Note: a and b indicate significant at 1 per cent and 5 per cent level of significance respectively.

TABLE III
F-STATISTICS FOR COINTEGRATION

Testing for existence of a level relationship among the variables in the ARDL model				
F-Statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
32.96*	4.1833	5.6299	3.4495	4.6655

Note: * indicates optimal lag order one selected by Schwarz information criterion.

TABLE IV
ESTIMATED LONG RUN COEFFICIENTS USING THE ARDL APPROACH

Variable	Coefficient	Std. Error	T-Statistic	Inst-values
Constant	2.5974	0.7683	3.3805	0.0021
LEXPO	-0.3603	0.0636	-6.3165	0.0000
LEXCH	0.1211	0.0489	2.4771	0.0195
LIMPO	0.1720	0.0579	2.9696	0.0061
LRGDP	-0.7587	0.0855	-8.8721	0.0000
LMS	0.6563	0.0342	19.190	0.0000
LATR	0.1117	0.0130	8.5913	0.0000

Adjusted-R² = 0.9971, F-Statistics = 1372.56 (0.00)

Durbin-Watson stat = 1.971

Note: Inst-values indicate the probability-values.

OLS regression results, shown in Table IV, indicate that high growth rate of exports causes to reduce the inflationary pressures. While imports increase inflation, the net effect of exports to reduce it is greater. Also, a 1 per cent rise in per capita GDP reduces inflation by 0.75 per cent. Exchange rate and money supply increase inflation indicating that depreciation in exchange rate and rise in money supply enhance inflation. This phenomena cause to reduce the real value of per capita income of the individual. Tariff rate has also positive impact on inflation, means that increase in tariff rate causes to high prices in the economy.

Overall, it can be concluded that growing trend in consumer prices in Pakistan is due to the economy's internal problems and not due to trade openness. Table V reports the short-run coefficient estimates found from the ecmt-1 version of ARDL model of equation 4. In short-run dynamics, inflation is influenced positively by its lagged value by 0.5864 per cent at 1 per cent level of

significance. Exchange rate has a positive but non-significant impact on inflation. The same is the case with money supply in the short-run. Tariff rate seems to reduce inflation in the short-run but it is not significant. On the other hand, imports seem to enhance inflation at 1 per cent level of significance, but exports and real GDP per capita seem to reduce inflation at 10 and 1 per cent levels of significance respectively. The coefficient of the lagged error correction term, which shows the short run dynamics i.e. how fast variables converge to the long-run equilibrium following a shock, has an inverse sign and is statistically significant at 5 per cent level, ensuring that long-run equilibrium can be attained. The speed of adjustment of coefficient is -0.432 for short-run towards long-term.

TABLE V
ERROR CORRECTION REPRESENTATION FOR ARDL (1, 0, 0, 0, 1, 0, 0)

Variable	Coefficient	T-Statistic	Inst-values
Constant	0.0723	3.1131	0.0040
Δ LCPI _{t-1}	0.5864	4.6309	0.0001
Δ LEXCH	0.0751	0.1243	0.6047
Δ LEXPO	-0.0998	-1.6427	0.1146
Δ LRGDP	-0.4189	-4.6829	0.0001
Δ LIMPO	0.1358	3.5497	0.0018
Δ LIMPO _{t-1}	-0.0513	-1.5811	0.1281
Δ LMS	0.0822	0.6760	0.5060
Δ LATR	-0.0039	-0.3216	0.7507
ecm _{t-1}	-0.4322	-2.1600	0.0419
R-squared= 0.8230		Adjusted R-squared = 0.7506	
Akaike info criterion = -3.9374		Schwarz criterion = -3.4794	
Durbin-Watson stat = 2.096		F-statistic = 11.368	

Sensitivity Analysis:

Serial Correlation LM Test = 0.8523 (0.4413)

ARCH Test = 0.2429 (0.7861)

Heteroscedasticity Test=2.0340(0.0927)

Ramsey RESET Test = 0.0369(0.8494)

Jarque-Bera Test = 0.2591(0.8784)

Sensitivity analysis is also done to test for the serial correlation, functional form, normality and heteroskedasticity connected with the model. The model passes said tests against serial- correlation, conditional autoregressive serial correlation, and functional form misspecification successfully. The regression for

the underlying ARDL equation-2 also fits quite well as indicated by the R^2 of 85%. Lastly, the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) stability tests are employed. Both models indicate stability of long-run coefficients over the sample period as the CUSUM and CUSUMSQ lines do not exceed 5% critical bounds, as shown in Figures 1 and 2.

FIGURE 1: Plot of Cumulative Sum of Recursive Residuals

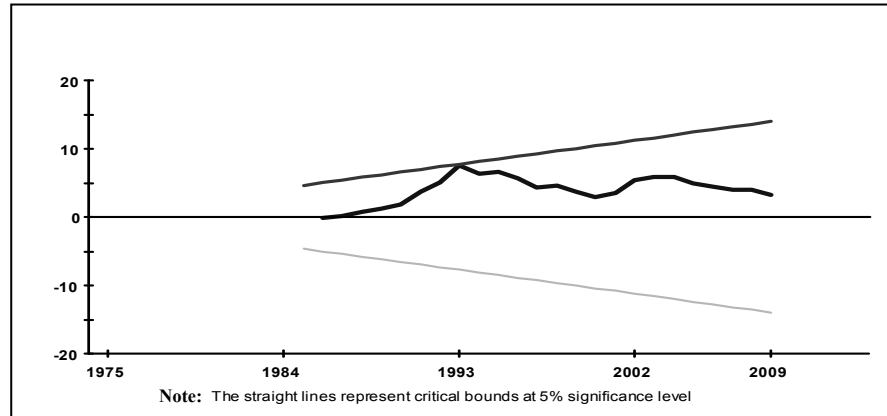
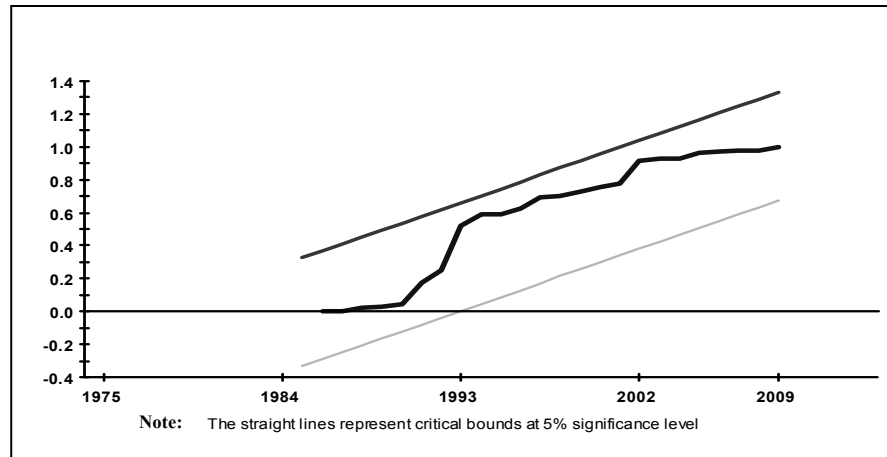


FIGURE 2: Plot of Cumulative Sum of Squares of Recursive Residuals



IV. CONCLUSIONS

This paper has shed light on the openness-inflation puzzle in the case of Pakistan. The results are in line with that of Granato *et al.* (2007) who reported evidence of a negative openness-inflation relationship. Empirical results obtained for Pakistan show that export growth causes to reduce the inflationary pressures both in the long-run and short-run. On the other hand, imports growth surges the inflation, but net impact of exports is greater than that of imports in the long run, while, in the short-run, the opposite is the case. It is concluded that trade openness works as buffer against higher prices in the case of small developing economy like Pakistan.

Also, real GDP per capita drives down consumer prices abruptly while money supply is a major cause to enhance the prices in long-run significantly. The same applies to exchange rate, demonstrating that large depreciation in money value increases demand for money printing, which pushes up the price level in the economy. Furthermore, average tariff rate also positively links with inflation; tariff rate causes to higher prices.

This finding makes a contribution to the debate on the role of the monetary authorities within the openness-inflation context. According to Romer (1993), Central Banks in economies open to trade tend to exercise more restraint as opposed to their closed economy counterparts due to currency fluctuations caused by monetary shocks. On the other hand, Fischer (1993) argues that as the economies open up, the fiscal and monetary authority tend to lose control over the rising trend of inflation through fiscal and monetary policies. The main policy implication that emerges from the analysis is the necessity to enhance economic growth through export-oriented policy, which is able to exploit the positive effect of imports on inflation through the abovementioned two main channels. There is also need to reduce tariff rate on trade openness coupled with stabilise monetary and exchange rate policies to curb inflation in the economy.

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