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OPENNESS, INFLATION AND GROWTH RELATIONSHIPS IN PAKISTAN
An Application of ARDL Bounds Testing Approach

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Abstract. Employing ARDL approach to cointegration, the present study validates the Romer (1993) hypothesis, *i.e.* the existence of the inverse connection between inflation and openness in Pakistan for the period of 1970-71 to 2008-09. A more robust inverse linkage between inflation and openness is noted in the short-run as compared to the long-run. Bi-directional causality running between inflation and openness is also found. The positive linkage between real GDP and inflation is observed that seems to be in line with the truth of Phillips curve and Okun's law. The study recommends that the economic managers of Pakistan's economy should adopt such policies that promote openness so that inflation can be controlled and economic growth can be accelerated.

Keywords: Inflation, Openness, Economic growth, ARDL, Causality

JEL classification: O11, F41

I. INTRODUCTION

The world has now become a global village. Knowledge, information and products are being exchanged very quickly and rapidly among nations. The

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word 'globalization' is not new, yet both the scope and the rate of change of the globalization process seem to have changed in the positive direction over time (Taylor, 2006). Both the foreign direct investment (FDI) and global trade flows have witnessed significant increase since early 1980s (IMF, 2006) and almost all the open economies are affected by the current globalization process. However, the impact of globalization seems to be varying from economy to economy, depending upon the nature, structure and degree of openness of the economy. Starting right from laymen, politicians, sociologists, economists, and international relation experts to academia all are widely and rigorously discussing and debating the impact of globalization and liberalization on human well being in the 21^{st} Century. Economic globalization is a process of increasing the connectivity and interdependence of markets and business by removing restrictions and barriers on exchange of knowledge, products and commodities across the borders and regions. Economic globalization promotes cultural, financial and trade reliance among nations. Globalization is generally expected to reduce poverty and enhance economic development through faster growth in most integrated economies. Burger and Krueger (2003) has shown that trade openness causes an increase in aggregate incomes and thereby economic growth (EG). According to IMF (2006), economic globalization depends on over time human innovation and technological progress. It is concerned with increasing integration of economies around the world, particularly through trade and finance flows. It is also concerned with the movement of labour and technology across international borders. In addition, globalization has broader cultural, political and environmental dimensions. Economic globalization and trade openness have become the major cause of the flows of the international capital and more productive utilization of the under employed resources. The link between trade openness and the inflation (*Inf*) is still an empirical question or even a puzzle in the economic literature. For a better macroeconomic management, *Inf* must remain in control. *Inf* affects (is affected by) EG and trade openness. Therefore macroeconomic managers must take into account the interrelationship among trade openness, EG and *Inf* Understanding the relationship among trade openness, EG and *Inf* is being studied in economic literature for development of the economy of a nation. Theoretical literature illustrates that openness helps in the efficient allocation and utilization of resources through comparative advantage that, in turn, leads to increased EG (IMF, 2006).

Trade openness is a tool of anti-monopoly as well as a medium for the long-windedness of the new technology, ideas and managerial skills among nations. It also harmonizes or even unifies the monetary and fiscal policies.

GATT was introduced and signed by twenty-three countries in 1947. The motive behind the GATT was to promote free trade among nations. Countries were agreed on lowering the trade barriers. They gained from trade and world output enhanced due to free trade and reduction in trade barriers. The South Asian Association for Regional Cooperation (SAARC), an economic and political organization, was founded by governments of Pakistan, Bangladesh, India, Bhutan, Sri Lanka, Maldives, and Nepal on December 8, 1985. Its motive was to speed up social development and EG in the member states. The North American Free Trade Agreement (NAFTA) was signed in 1994 by the governments of the United States, Canada, and Mexico to create a trilateral trade in North America. The agreement diminished the trade obstruction and import-export duties between United States, Canada and Mexico. It significantly eliminated the Mexican tariff by 65 percent on roughly half of all US industrial manufactured products. NAFTA has two components, the North American Agreement on Environmental Cooperation (NAAEC) and the North American Agreement on Labor Cooperation (NAALC). The Agreement on South Asian Free Trade Area (SAFTA) was signed at Islamabad (Pakistan) during the 12th SAARC Summit on 6th January 2004. SAFTA was established on 1st January 2006. The objective of this agreement was to encourage and promote economic cooperation and mutual trade among contracting nations by removing barriers to trade, facilitating movement of goods across borders and promoting fair competition in the free trade area. To liberalize international trade and stimulate EG, the World Trade Organization (WTO) was established in 1995 under the Marrakech Agreement, replacing GATT. The WTO deals with regulation of trade and provides a framework for economic negotiating and designing trade agreements. Pakistan has been a WTO member since 1st January 1995. One hundred and thirty-nine countries are now members of WTO. The WTO commitment to harmonization the tariff structure across countries lowers the import cost of a significant portion of traded commodities. This motivated the researchers to check the impact of trade openness on inflation and other macro economic variables in countries like Pakistan.

Economies specialize in the products on the basis of comparative advantage and factor prices equalize among trading nations because of identical technology and production throughout the world. Trade is adversely affected by many factors such as demand and supply shocks, *Inf*, over population, and technological shocks etc. But among all these factors, high *Inf* affects the economy as well as the society significantly and adversely. Improper price regulation and imperfect information about aggregate price level causes inflationary situation in the economy. A high rate of inflation causes many economic problems like poverty, unequal distribution of wealth, market imperfections, deficit in balance of payments and unemployment as well as non-economic problems like social evils such as smuggling and hoarding *etc.* Inflation also disturbs the very important role of smoothness of price mechanism. Moreover, high inflation rate has more volatility over time. The volatility of inflation rate is a hindrance for future economic planning and project evaluation and productive use of resources. High and unpredictable inflation slows down the process of EG and hurts the economy. Friedman (1977) found inverse effect of a highly volatile *Inf* rate on economic efficiency because of two reasons. Firstly, increased volatility in *Inf* causes long-term contracts more expensive on account of that the future value of dollar payments is more uncertain. Secondly, increased volatility in *Inf* lowers the ability of markets to pass on the information to market participants about relative price movements. Greater *Inf* reduces economic efficiency which increases the rate of unemployment in the short term and reduces EG. Samimi and Shahryar (2009) also supported these results. It is believed that reasonable and stable *Inf* rate boosts up the EG and hence development process of a country. Moderate *Inf* increases returns to savers, enhances investment, and therefore, speeds up the EG of the country. Maintaining non-inflationary stable EG is inevitable not only to uphold macroeconomic stability but also to save the poor from unfavorable effects of inflation (Ashra, 2002).

Openness to trade (OT) or trade integration affects *Inf* through "direct import price effects" and "indirect competition enhancement effects". The flow of low cost imports diminishes the *Inf* in the high cost economies. The higher the share of imports, the more the domestic prices will be driven down. An increase in cheaper imports promotes price competition in importing countries that in turn narrowing markups and raising productivity and hence dampens the inflation. An increase in the productivity for manufacturers through exposure to global competition in their export markets is another example of the "indirect competition enhancement effect". The overall price level may turn down because of direct and indirect price effects of cheaper imports of finished goods and intermediate inputs. There are some direct and indirect, quantitative and qualitative methods of controlling inflation. Opening the economy is one of them. Increasing openness is likely to have negative effect on *Inf* and output (Jin, 2006). Increased openness can also lead to lower *Inf* indirectly. As the competition increases there will be faster domestic productivity growth and firms can pay high wages without shifting their cost in the form of high prices. Grossman and Helpman (1991) identified four channels such as transfer of technical knowledge, competition among firms to innovate, greater reward for successful innovation and specialization in dynamic sectors, through which increased openness leads to faster productivity growth. There are also many other ways such as central bank's *Inf* objectives, imperfect competition and debt crises through which openness lower the price level. But most of them may be over time effects. They have transitory effects on the *Inf* rate but it may last for a long time (Wynne and Kersting, 2007). In a more integrated world, competition between currencies forces central bank to adopt best practices and keeps *Inf* low (Tytell and Wei, 2004). Rogoff (2003) is of the opinion that closing up the gap between natural rates of output and desired level of output, the globalization would down size the *Inf* bias that were not restrained by rule. Causality runs from openness to *Inf* (Romer, 1993). Rogoff (2003) indicated some factors such as increased competition in labor and product markets and better monetary policy that resulted from increased globalization. These factors contributed in lowering inflation.

Monetary, fiscal and structural variables can also influence inflation. However, when the economies become more open such fiscal, monetary and structural tools lose their control over *Inf*. Fluctuations in the exchange rate, foreign investment inflows and balance of payments also influence the price level. According to Friedman (1963), "Inflation is always and everywhere a monetary phenomenon." So when monetary authority loses their hold on *Inf* then trade openness acts as a brake to the gains, obtained by the Inflationary surprise. As a result there exists inverse relationship between openness and *Inf* in the more open economies (Sachsida, Carneiro and Loureiro, 2003). Terra (1997, 1998) argued that negative linkage between openness and *Inf* existed in the economies which were heavily indebted. Gruben and Macleod (2004) supported the inverse linkage between *Inf* and *Inf* and examined that this linkage is stronger in countries which experienced floating exchange rate. They also did not support Terra's (1998) hypothesis and found that inverse linkage between *Inf* and openness was more significant among less indebted economies.

Two alternative theoretical views exist concerning the effect of openness (openness in a trade flow sense) on *Inf*. Openness slows down the rate of *Inf* according to spillover hypothesis while according to the cost push hypothesis; openness causes a faster rate of *Inf*. Opening the economy not only improves the trade but it also helps to control the inflation. Romer (1993) hypothesized that inflation would be lower in the economies that are more open in trade. The inverse linkage between *Inf* and openness was validated by Lane (1997), Sachsida, Carneiro and Loureiro (2003), Farvaque and Shah (2009) and many others.

Since 1970s, Pakistan's growth record underscores that high and persistent *Inf* is harmful to growth. Periods of high *Inf* have coincided with low growth spells, while high growth episodes tend to be associated with a low *Inf* environment (Khan and Schimmelpfennig, 2006). In Pakistan, a number of policy options were used such as 47% devaluation of Pakistani rupee in 1973, liberalization of import policy, delinking of Pak rupee from US dollar in 1982, the State Bank of Pakistan's Export Refinance in 1973 to facilitate exporters to promote exports and hence trade. Pakistan adopted trade liberalization polices since late 1980s to bridge up socio-economic gaps and to enhance the EG. Pakistan signed 1st Structural Adjustment Program (SAP) with IMF to address her balance of payments problem and liberalize both exports and imports in 1988. A case study on Pakistan by the Social Policy Development Center (SPDC, 2006) showed that due to the trade liberalization and stable macroeconomic strategies, Pakistan's trade has grown very fast. Pakistan's exports increased by 14% per annum on average from 1980-81 to 2008-09. The exports of primary, semi manufactured and manufactured goods, capital and consumer goods increased, on average, by 16%, 15%, 20%, 9.2% and 19% per annum, respectively. Although Pakistan's overall trade to GDP ratio has improved from 10.9% in 1970-71 to 26% in 2008-09 but trade performance of Pakistan is still lacking below many other developing countries even below the countries of South Asia. High episodes of *Inf* badly affected less open and less developed Pakistan's economy. Tackling *Inf* has always remained one of the economic challenges for Pakistan's economic managers.

Several empirical studies (such as Lane, 1997; Batra, 2001; Sachsida, Carneiro and Loureiro, 2003; Terra, 1997, 1998; Bowdler and Malik, 2005; Hanif and Batool, 2006; Al Nasser *et al.*, 2009; Lin, 2010) have tested Romer's (1993) main finding and found support for conventional view about the negative linkage between inflation and openness in different way and by including different measures of openness. Some other empirical studies (such as Alfaro, 2005; Kim and Beladi, 2005; Zakaria, 2010) refute Romer's argument. One potential elucidation for this mix and contrasting findings is the difficulty in measuring trade liberalization or trade openness. Many studies utilize trade volumes (export plus import), or the share of trade in GDP, and import or export as a ratio of GDP as measure of trade openness. Others have applied trade barriers, like average tariff rates or composite index measures, like Dollar's (1992) price distortion and variability index or Sachs and Warner's (1995) openness index or innovative index of trade restrictiveness (TRI) that measures the degree of protection in the economy. However, none of these proxy measures is free from major weaknesses. As Kee *et al.* (2009) pointed out that the volume of trade may also incarcerate macroeconomic shocks, tastes differences and other factors that are not linked to trade policy. The composite measures may reflect poor economic management, or primarily affected by geographic parameters. The trade-weighted average tariffs are lacking in theoretical foundation and may also introduce significant biases in estimation (Manole and Martin, 2006). The present work is designed to examine the nature of the relationship between different measures of openness [such as ratio of exports to GDP, ratio of imports to GDP, ratio of trade (exports plus imports) to GDP and ratio of exports to availability of commodities {(exports/ (GDP + imports)}] and inflation using time series data for Pakistan. Does increasing trade openness affect inflation in Pakistan? How much trade openness affects EG of Pakistan? What type of linkage exists between inflation and EG in Pakistan? How does EG affect the linkage between inflation and openness in Pakistan? The present research work is designed to answer all the above questions. This study is also planned to relate openness to change in inflation in Pakistan because both inflation and openness influence the EG.

OBJECTIVES

This study is planned to pursue the following objectives:

- To empirically determine the short-run and long-run relationship between inflation (*Inf*), growth and openness in Pakistan using time series macroeconomic data.
- To see the impact of openness on *Inf* in Pakistan.
- To test the validity of Romer's (1993) main finding in case of Pakistan, *i.e.* the existence of negative relationship between openness and *Inf* or not.

The basis of this study is the hypothesis that whether there exists an inverse linkage between *Inf* and openness in Pakistan. This study has its significance in giving benefit to the researchers to explore the new channels through which general price level can be eased by more integration with the rest of the world. This research work also differs from others in economic literature because it utilizes a more robust cointegration technique known as ARDL approach to cointegration. The findings of this empirical work shall be helpful for Government of Pakistan to control inflation.

ORGANIZATION OF THE STUDY

The rest of the work is planned as: Review of literature is given in section II. Section III includes the data sources and model specification. The empirical findings and their analysis is given in Section IV. Conclusions, recommendations for policy implications are presented in Section V.

II. REVIEW OF LITERATURE

Openness-inflation linkage has gained a great attention in literature. Romer (1993) postulated the hypothesis that average *Inf* rate was lower in relatively smaller, more open economies by utilizing cross country data for 114 countries. He used the average annual change of log of GDP or GNP deflator to measure *Inf* for most of the countries. He used the change in the log of CPI as a measure of *Inf* for the countries for which series of GDP deflator was not available. He used average share of imports in GDP as a measure of openness. This study considered three types of control variables: (*i*) real income per capita: a general measure of development, (*ii*) a set of dummy variables for OECD membership and for various regions, (*iii*) dummy variables for the use of CPI rather than GDP deflator as an alternative measure of *Inf*. The results of this study were significant for a wide range of countries except for a small group of developed economies where *Inf* is lower and unrelated to openness. Romer (1993) argued that more open economies have low *Inf*. The inverse linkage between openness and *Inf* was stronger in politically less stable countries and countries that had less autonomous central bank. Lane (1997), Campillo and Miron (1997) and Gruben and Mcleod (2004) also supported the Romer's (1993) findings. They demonstrated that *Inf* was negatively related to *Inf* even for industrially advanced and developed economies. Lane (1997) reported that the negative linkage between *Inf* and openness was due to price rigidity and imperfect competition in the non-traded sector. Lane (1997) for small open economy found that after controlling for country size and autonomy of central bank, openness and *Inf* are inversely related and statistically significant in the OECD economies. Campillo and Miron (1997) also investigated the inverse linkage between openness and *Inf*. Gruben and Mcleod (2004) found an inverse relationship between *Inf* and trade openness. They found this relationship to be stronger in the countries with floating exchange rate. They also rejected the Terra's (1998) hypothesis and favored that the negative relationship between openness and *Inf* was more significant among less indebted economies.

Bowdler and Nunziata (2006) found that increased openness reduced the probability of *Inf* start. Using data for the period 1980-2006, Farvaque and

Shah (2009) postulated that *Inf* dynamics linked to globalization process varies in Asian developing countries compared to developed OECD countries. They studied thirty-seven countries in which there are twenty-one industrialized countries and sixteen developing countries of Asia. They found negative relationship between *Inf* and trade openness for both the developing and developed countries; however the impact of openness was observed stronger in the developing countries. Al Nasser *et al.* (2009) examined the relationship between *Inf* and trade openness for152 countries for the period 1950-1992. They found that the Terra's (1998) criticism about the negative relationship between *Inf* and trade openness in the heavily indebted countries did not hold in the 1990s. However, their results supported the Romer's (1993) main result of the negative relationship between *Inf* and openness to trade.

Alfaro (2005) investigated panel data set for the period of 1973-1998 for 130 countries and found that the openness did not play a significant role in curbing *Inf* in the short-run (SR). *Inf* and openness are positively related. Kim and Beladi (2005) estimated the trade openness and price level relationship for sixty-two countries and found the direct relationship between *Inf* and openness in trade for some advanced economies such as Ireland, Belgium and the US. Kim and Beladi (2005) also supported the Romer's (1993) main finding about the negative relationship between *Inf* and trade openness for most of the developing economies.

Badinger (2009) postulated that globalization has played a key role in reducing the worldwide *Inf* rate. This will be possible by directing the policy makers to design polices which are helpful in reducing *Inf.* In his study, he also examined the 'Taylor Rule' for 83 countries over the period 1985-2004 by using variables such as short-term interest rate, real GDP growth and actual Inf, trade openness and financial openness. He utilized GDP as a measure for economic activity because of unavailability of data on potential output for most of the countries. He showed that output gap has negative relationship to the trade openness and financial openness. But this result is not found valid for the OECD economies.

Bowdler and Malik (2005) suggested two mechanisms through which *Inf* volatility can be declined. Trade openness reduces *Inf* volatility through minimizing more diversification in the pattern of consumption and through creating incentives for the policy makers to adopt stable macroeconomic policies. This paper also found evidence for the negative relationship between openness in trade and *Inf* volatility by applying dynamic panel model. This inverse relationship is strongest among the developing economies and emerging market economies than OECD countries. They also "provide evidence that openness may promote inflation stability through dampening monetary and terms of trade shocks." Cooke (2004) developed a general equilibrium model which is based on the assumptions of the small open economies and analyzed the *Inf* bias. He showed that openness caused decrease in *Inf* because it changes the slope of Phillips curve. Phillips curve is steeper in more open economies. Wynne and Kersting (2007) provided evidence on the robust negative relationship between *Inf* and trade openness, across countries in the long-run (LR) as Romer (1993) stated. Furthermore, they stated that it was not only the *Inf* which reduced the *Inf* rate but openness to capital flows and openness to labor also reduced the *Inf* rate. Jin (2006) examined the effect of increasing openness on *Inf* and growth for the South Korea and found that increasing openness negatively and significantly affected *Inf* and output.

Many empirical studies utilize cross-country data but the empirical literature based on country level time series data on the relationship between openness in trade and *Inf* in Pakistan is relatively scant. Some empirical studies in the recent years are summarized as: Hanif and Batool (2006) tested the Romer's (1993) main finding that small open economies experienced low *Inf*, for the country of Pakistan for the period 1973-2005. They found that besides conventional determinants of *Inf* like growth of real GDP, wheat support price, overnight interest rate, monetary growth, the openness variable measured by growth in 'overall trade to GDP ratio' had a significant and negative impact on the price level in the economy of Pakistan. The time series analysis conducted by Zakaria (2010) showed a positive linkage between openness in trade and *Inf* in Pakistan.

All the above reviewed studies give mixed result in supporting the Romer's (1993) main finding about negative relationship between *Inf* and openness and give rise to empirical puzzle. So, the main objective of the study is to test the existence of Romer's (1993) main finding in case of Pakistan's economy.

III. DATA SOURCES AND MODEL SPECIFICATION

In the trade and growth theories, a direct relationship has been observed between inflation and EG. Inflation not only adversely affects the economy but high inflation is a hindrance for the future economic planning and hence EG. New growth theories proposed that output is a channel through which openness might check the inflation. So, the countries integrated more to the world economies have better economic performance and lower inflation.

DATA SOURCES

This empirical work employs annual time series data on real gross domestic product (Y), inflation (Inf) and openness to trade (OT_i) for the span of 1970-71 to 2008-09 to examine the relationships between openness, growth and *Inf*. Data were collected from *Pakistan Economic Survey* (various issues), Pakistan Bureau of Statistics (PBS) publications and various issues of *Annual Reports*, State Bank of Pakistan (SBP).

MODEL SPECIFICATION

Inflation enhances the world EG. Trade openness eliminates the trade barriers and leads to a more integration among economies. If the economies are liberalized and markets are deregulated then the international competition will enhance the productivity growth and increase the labor supply. Openness of an economy affects the *Inf* by the better capacity utilization, increased efficiency and better allocation of resources.

To determine the relationships among inflation (Inf_t), real GDP (Y_t), and openness to trade (OT_{it}), various specifications have been tested and most appropriate one is presented below:

$$\ln Inf_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln OT_{it} + u_1 \quad (1)$$

$$\ln OT_{it} = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln Inf_t + u_2 \quad (2)$$

Where:

ln = Natural logarithm.

Y_t = Real GDP – a proxy used to measures the EG of an economy; Current GDP at market prices which is divided by GDP deflator. This proxy has been used by Ashra (2002) and Hanif and Batool (2006).

Inf_t = GDP deflator: one of the most important indicators of inflation. This measure has been used by Sachsida *et al.* (2003), Alfaro (2005), Kim and Beladi (2005), Rajagopal (2007), Al Nasser *et al.* (2009) and Lin (2010).

OT_{it} = Different measures of openness to trade. Due to non-availability of perfect single measure of openness, the present study utilizes the ratio of exports to availability of goods and services, the ratio of exports to GDP, the ratio of imports to GDP and the ratio of trade to GDP as best alternative proxies of openness.

OT_{1t} = The ratio of exports to availability of commodities [(exports/ (GDP + imports)]. This proxy has been used by Combes, Jean-Louis, Patrick and Sandra (2003).

OT_{2t} = The ratio of exports (X) to GDP. This proxy has been used by Alfaro (2005).

OT_{3t} = The ratio of imports (M) to GDP. This proxy has been used by Romer (1993); Terra (1998); Alfaro (2005); Temple (2002); Bowdler and Nunziata (2006); Jin (2006) and Hsin-Yi Lin (2010).

OT_{4t} = The ratio of trade to GDP. This proxy has been used by Hanif and Batool (2006); Jin (2006); Shahbaz, Aamir and Butt (2007); Bowdler and Malik (2005); Farvaque and Shah (2009) and Zakaria (2010).

The openness of an economy can be defined through numerous ways, for example, low average tariff barriers, cut off import quotas, government procurement policies, no barrier to foreign investment and export subsidies *etc.* In economic literature, a number of variables such as trade to GDP ratio, import to GDP ratio, export to GDP ratio, growth rates of imports, growth rates of exports and growth rates of trade are also used as a proxy measures of Inf_t. This study uses the *traditional measures*: (*i*) ratio of exports to GDP, (*ii*) the ratio of imports to GDP (*iii*) the ratio of trade to GDP and a more comprehensive *non-traditional measure*, *i.e.* the ratio of exports to availability of goods and services as a measure of Inf_t.

In economic literature, a number of cointegration techniques such as Engle-Granger (1987), Johansen (1988), Johansen-Juselius (1990), Saikkonen and Lutkepohl (2000) and Pesaran and Pesaran (2001) ARDL approach are used. To examine SR and LR linkage between Inf_t and OT_{it}, a more recent cointegration technique known as Bounds testing approach to cointegration in the ARDL framework has been applied in this study. A brief introduction of ARDL model is given below.

AUTOREGRESSIVE DISTRIBUTIVE LAG (ARDL) APPROACH TO COINTEGRATION

Cointegration techniques such as Johansen (1988), Johansen-Juselius (1990) and Pesaran and Pesaran (2001) ARDL approach are utilized in the economic literature to empirically determine the relationship among the variables. The ARDL model has some advantages over other cointegration approaches.

Firstly, this technique is comparatively more robust in small or finite samples consisting of 30 to 80 observations (Pattichis, 1999; Mah, 2000).

Secondly, it can be utilized irrespective of whether regressors are of I(0) or I(1) or mutually integrated, There is still perquisite that none of the explanatory variables is of I(2) or higher order, *i.e.* the ARDL procedure will, however, be inefficient in the existence of I(2) or higher order series.

Thirdly, the ARDL Model applies general-to-specific modeling framework by taking sufficient number of lags to capture the data generating process. It estimates $(p + 1)^k$ number of regressions in order to obtain an optimal lag length for each variable, where p is the maximum lag to be used, and k is the number of variables in the equation. The model is selected on the basis of different criteria like SBC, AIC, RBC and HQC.

Furthermore, traditional cointegration methods may also experience the problems of endogeneity, whereas the ARDL method can distinguish between dependent and explanatory variables and eradicate the problems that may arise due to the presence of autocorrelation and endogeneity. ARDL cointegration estimates SR and LR relationship simultaneously and provide unbiased and efficient estimates. The appropriateness of utilizing ARDL model is that the ARDL model is based on a single equation framework. The ARDL model takes sufficient numbers of lags and direct the data generating process in a general to specific modeling framework (Harvey, 1981). Unlike further multivariate cointegration techniques such as Johansen and Juselius (1988), ARDL model permits the cointegration relationship to be estimated by OLS once the lag order of the model is identified. Error Correction Model (ECM) can also be drawn from by ARDL approach (Sezgin and Yildirim, 2003). This ECM allows drawing outcome for LR estimates while other traditional cointegration techniques do not provide such types of inferences. "ECM joins together SR adjustments with LR equilibrium without losing LR information" (Pesaran and Shin, 1999).

The above advantages of the ARDL technique over other standard cointegration techniques justify the application of ARDL approach in the present study to analyze the relationship among Inf_t, Y_t and OT_{it}.

The second step in the analysis is to "test the null hypothesis of no cointegration against the alternative hypothesis that there exists cointegration between all variables by using F-statistic. This test is sensitive to the number of lags employed on each first differenced variable (Bahmani-Oskooee, 1999)". In the next step, SR and LR linkage is examined by using the error correction model (ECM).

The SR and LR relationships among Inf_t, Y_t, and OT_{it} have been investigated in the 2nd stage of this study. The ECM description given in equations (3) and (4) of the ARDL model is used to determine SR and LR relationships among the variables.

$$\begin{aligned}\Delta \ln (Inf_t) \; = \; & a_{0Inf} + \sum_{i=1}^{p} b_{i\ Inf}\, \Delta \ln (Inf)_{t-i} + \sum_{i=1}^{p} c_{i\ Inf}\, \Delta \ln (Y)_{t-i} \\ & + \sum_{i=1}^{p} d_{i\ Inf}\, \Delta \ln (OT_i)_{t-i} + \lambda_1 \ln Inf_{t-1} + \lambda_2 \ln Y_{t-1} \\ & + \lambda_3 \ln (OT_i)_{t-1} + \varepsilon_{Inf} \qquad (3)\end{aligned}$$

$$\begin{aligned}\Delta \ln (OT_{ti}) \; = \; & a_{0OTi} + \sum_{i=1}^{p} b_{i\ OTi}\, \Delta \ln (OT_i)_{t-i} + \sum_{i=1}^{p} c_{i\ OTi}\, \Delta \ln (Y)_{t-i} \\ & + \sum_{i=1}^{p} d_{i\ OTi}\, \Delta \ln (Inf)_{t-1} + \theta_1 \ln (OT_i)_{t-1} + \theta_2 \ln Y_{t-1} \\ & + \theta_3 \ln (Inf)_{t-1} + \varepsilon_{OTi} \qquad (4)\end{aligned}$$

The coefficients (*a*, *b*, *c, and d*) of the part one of the equations (3) and (4) stand for SR dynamics and θs determine the long-run relationship. In the ARDL model, as a first step, the LR relationship among variables is carried out by calculating partial 'F' test on the first differenced part of Unrestricted Error Correction Model (UECM) of equations (3) and (4). In this step the regression equation for *OTi* is specified as:

$$\begin{aligned}\Delta \ln (OT_{ti}) \; = \; & a_{0OTi} + \sum_{i=1}^{p} b_{i\ OTi}\, \Delta \ln (OT_i)_{t-i} + \sum_{i=1}^{p} c_{i\ OTi}\, \Delta \ln (Y)_{t-i} \\ & + \sum_{i=1}^{p} d_{i\ OTi}\, \Delta \ln (Inf)_{t-i} \qquad (5)\end{aligned}$$

To create error correction mechanism, the first lag of the level of each variable is included to equation (5) and a variable addition test by using Microfit 4.0 is performed through F-test on the joint significance of all the added lagged level variables.

$$\begin{aligned}\Delta \ln (OT_{ti}) \; = \; & a_{0OTi} + \sum_{i=1}^{p} b_{i\ OTi}\, \Delta \ln (OT_i)_{t-i} + \sum_{i=1}^{p} c_{i\ OTi}\, \Delta \ln (Y)_{t-i} \\ & + \sum_{i=1}^{p} d_{i\ OTi}\, \Delta \ln (Inf)_{t-i} + \theta_1 \ln (OT_i)_{t-1} \\ & + \theta_2 \ln Y_{t-1} + \theta_3 \ln (Inf)_{t-1} + \varepsilon_{OTi} \qquad (6)\end{aligned}$$

The null hypothesis for no cointegration for the variable OT_i against alternative research is given as:

H$_0$: $\theta_1 = \theta_2 = \theta_3 = 0$

H$_1$: $\theta_1 \neq \theta_2 \neq \theta_3 \neq 0$

This is denoted as F_{OTi} $(OT_{it} \mid Y_t, Inf_t)$

The null hypothesis of no cointegration for the variable Inf_t against research hypothesis is given as

H$_0$: $\lambda_1 = \lambda_2 = \lambda_3 = 0$

H$_1$: $\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq 0$

This is denoted as F_{Inft} $(Inf_t \mid Y_t, OT_{it})$

These hypothesis are tested by *partial F-test*

Pearson *et al.* (2001) have tabulated two sets of appropriate critical values. One set assumes that all variables are of order I (1) while the other set assumes that all are I(0). This provides a band covering all possible classifications of the variables into I(0) or I(1) or even fractionally integrated.

If the estimated *F-statistic* is higher than the upper bounds critical value, the null hypothesis of no cointegration is rejected. This establishes LR relationship among the real GDP (Y), Inf_t and OT_i. If the calculated *F-statistic* is less than the lower bounds critical value, then the null hypothesis of no cointegration cannot be rejected, establishing no cointegartion. If the *Fvalue* falls in between lower and upper bounds critical values, the test statistic will be inconclusive. The *Fvalue* depends upon the number of explanatory variables, sample size, and constant and/or a trend of ARDL.

IV. EMPIRICAL RESULTS AND THEIR ANALYSIS

In this section, empirical results are presented along with their analysis by using ARDL approach. Before applying ARDL, the order of integration is examined by using different unit root tests.

UNIT ROOT TESTS (UR Test)

To apply ARDL technique to cointegration it is very necessary to make sure that not a single time series variable under study here is of I(2) or higher order because the calculated *F-statistic* doesn't remain valid in the presence of I(2) or higher order lags (Sezgin and Yildirm, 2003; Ouattara, 2004). So, before applying the ARDL model, testing the UR of the time series is very essential. For this purpose, order of integration of the variables under considered is tested by "Dickey-Fuller Generalized Least Square Test Statistics (DF-GLS)", "Augmented Dickey-Fuller UR Test (ADF 1979; 1981)", "Phillips-Perron (PP) (1988)", and "Ng-Perron (2001)" UR tests'. 'Ng-Perron (2001)' UR test is considered more robust for the small samples than the other standard UR tests. 'Ng-Perron (2001)' UR test does not over-reject the null hypothesis of UR (Ng-Perron 2001; Omisakin, 2008). The results of the 'DF-GLS', 'ADF', 'PP' and 'Ng-Perron' UR tests of under consideration variables are documented in Tables 1, 2 and 3.

TABLE 1

UR Analysis by ADF and PP

Variables	ADF		PP	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
$\ln Y_t$	0.2176 (0.9702)	–1.7769 (0.6961)	0.2435 (0.9719)	–1.8978 (0.6360)
$\Delta \ln Y_t$	–6.6079 (0.0000)		–6.5859 (0.0000)	
$\ln Inf_t$	–1.1407 (0.6891)	–2.4554 (0.3466)	–0.5802 (0.8633)	–2.0369 (0.563)
$\Delta \ln Inf_t$	–3.7375 (0.0074)		–4.07385 (0.0030)	
$\ln OT_{1t}$	–3.9479 (0.0042)		–3.83063 (0.0057)	
$\ln OT_{2t}$	–4.1140 (0.0027)		–3.9637 (0.0040)	
$\ln OT_{3t}$	–4.9316 (0.0003)		–4.8980 (0.0003)	
$\ln OT_{4t}$	–4.3264 (0.0015)		–4.4674 (0.0010)	

Values in parentheses are p-value

The results of ADF and PP expose that $\ln Inf_t$ and $\ln Y_t$ are stationary at I(1) with constant. Each of $\ln OT_{1t}$, $\ln OT_{2t}$, $\ln OT_{3t}$, and $\ln OT_{4t}$ is stationary at its level, *i.e.* I(0) with constant. The results are presented in Table 1.

TABLE 2

UR Analysis by DF-GLS

Variables	DF-GLS	
	Intercept	Intercept & Trend
ln Y_t	–0.3589	–1.8299
Δ ln Y_t	–6.1158*	
ln Inf_t	1.1762	–2.8719
Δ ln Inf_t	–1.7970***	3.1299**
ln OT_{1t}	–1.4301	–2.6478
Δ ln OT_{1t}	–0.9198	–4.2155*
ln OT_{2t}	–1.3936	–2.7198
Δ ln OT_{2t}	–1.0001	–4.1291*
ln OT_{3t}	–3.5841*	
ln OT_{4t}	–1.3055	–3.5218**
Δ ln OT_{4t}	–7.1661*	

*, **, *** indicate that DF-GLS is significant at 1%, 5% and 10% level of significance, respectively.

The results of the DF-GLS UR test presented in Table 2 show that ln Y_t is stationary at its first difference, *i.e.* I(1) with constant. Each of ln Inf_t, ln OT_{1t} and OT_{2t}, is stationary at its first difference, *i.e.* I(1) with constant and trend, while ln OT_{4t} is stationary at first difference, *i.e.* I(1) with constant. ln OT_{3t} is stationary at level, *i.e.* I(0) with constant.

The results of Ng-Perron UR tests reported in Table 3 reveal that ln *Y* and ln OT_{3t} are stationary at their levels, *i.e.* I (0) with constant, while the ln Inf_t is stationary at its level, *i.e.* I (0) with constant and trend. Each of ln OT_{1t}, ln OT_{2t}, ln OT_{3t} and ln OT_{4t} each is stationary at its first difference, *i.e.* of I(1) with constant and trend.

TABLE 3

UR Analysis by Ng-Perron

Variables	MZa	MZt	MSB	MPT
ln Y_t (with constant)	–69.1807	–5.7922	0.0837	0.5486
ln Inf_t (with constant)	–0.6339	–0.2659	0.4196	13.9249
ln Inf_t (with constant and trend)	–21.5219	–3.2767	0.1522	4.2562
ln OT_{1t} (with constant)	–2.1697	–0.9978	0.4599	10.9243
ln OT_{1t} (with constant and trend)	–8.2991	–1.7791	0.2144	11.7270
Δ ln OT_{1t} (with constant)	–0.1255	–0.0667	0.5313	20.1624
Δ ln OT_{1t} (with constant and trend)	–15.1928	–2.7452	0.1807	6.0622
ln OT_{2t} (with constant)	–0.9683	–0.9371	0.476	11.841
ln OT_{2t} (with constant and trend)	–8.3064	–1.7756	0.2138	11.731
Δ ln OT_{2t} (with constant)	0.0829	0.0398	0.4798	18.3561
Δ ln OT_{2t} (with constant and trend)	–15.1528	–2.7256	0.1799	6.1717
ln OT_{3t} (with constant)	–14.0134	–2.6008	0.1856	1.9238
ln OT_{4t} (with constant)	–2.8940	–1.1051	0.3819	8.2092
ln OT_{4t} (with constant and trend)	–11.9988	–2.3812	0.1984	7.9532
Δ ln OT_{4t} (with constant)	–29.8044	–3.7638	0.1263	1.1181
99% level of confidence (with constant)	*–13.8000*	*–2.5800*	*0.1740*	*1.7800*
95% level of confidence (with constant)	*–8.1000*	*–1.9800*	*0.2330*	*3.1700*
90% level of confidence (with constant)	*–5.7000*	*–1.6200*	*0.2750*	*4.4500*
99% level of confidence (with constant and trend)	*–23.8*	*–3.42*	*0.143*	*4.03*
95% level of confidence (with constant and trend)	*–17.3*	*–2.90*	*0.168*	*5.48*
90% level of confidence (with constant and trend)	*–14.20*	*–2.62*	*0.185*	*6.67*

Table 4 is the tabulated description of order of integration using 'DF-GLS', 'ADF', 'PP' and 'Ng-Perron' UR tests of under considered variables.

TABLE 4

Order of Integration

Variables	ADF	PP	DF-GLS	Ng-Perron
ln Y	I(1)	I(1)	I(1)	I(0)
ln Inf_t	I(1)	I(1)	I(1)	I(0)
ln OT_{it}	I(0)	I(0)	I(1)	I(1)
ln OT_{2t}	I(0)	I(0)	I(1)	I(1)
ln OT_{3t}	I(0)	I(0)	I(0)	I(0)
ln OT_{4t}	I(0)	I(0)	I(1)	I(1)

From Table 4, it can easily be deduced that not a single variable is of I(2) or higher order. Since the present study is based on 39 observations and none of the variables is integrated of I(2) or higher order, the most appropriate technique to analyze SR and LR relationships among the variables of interest is the ARDL cointegration technique, developed by Pearson *et al.* (1996, 2001).

COINTEGRATION

In order to check the cointegration status among Inflation (Inf_t), real GDP (Y_t), and openness to trade (OT_{it}), the familiar F-test has been applied. The calculated *F-statistic* for Inf_t and OT_{it} of models 1 and 2 are presented in Table 5.

There is at least one *Fvalue* that is greater than the upper critical values. This means that cointegration is established among the Inf_t, Y_t and OT_{it} when both of the Inf_t and OT_{it} are the dependent variables in models 1 and 2. However, these results are preliminary and there is a need for more evidence of cointegration among the variables of interest.

TABLE 5

ARDL Approach: Results of F-Test for Cointegration

	Lag Length				Results
	1	2	3	4	
ΔInf_t [F_{Inf} (Inf_t | OT_{1t})]	3.25	6.66	8.57	18.57	Cointegration
ΔInf_t [F_{Inf} (Inf_t | Y, OT_{1t})]	3.63	3.20	4.06	10.35	Cointegration
$\Delta Inf_{t\cdot}$ [F_{Inf} (Inf_t | OT_{2t})]	1.34	6.21	5.97	13.21	Cointegration
$\Delta Inf_{t\cdot}$ [F_{Inf} (Inf_t | Y, OT_{2t})]	1.14	2.93	1.58	6.39	Cointegration
ΔInf_t [F_{Inf} (Inf_t | OT_{3t})]	2.81	5.48	7.48	16.95	Cointegration
ΔInf_t [F_{Inf} (Inf_t | Y, OT_{3t})]	3.13	2.62	3.97	9.28	Cointegration
ΔInf_t [F_{Inf} (Inf_t | OT_{4t})]	1.98	8.23	8.34	16.85	Cointegration
ΔInf_t [F_{Inf} (Inf_t | Y, OT_{4t})]	1.63	3.74	2.34	8.15	Cointegration
Δ OT_{1t} [F_{OT1t} (OT_{1t} | Inf_t)]	3.75	0.00	0.20	3.26	Cointegration
Δ OT_{1t} [F_{OT1t} (OT_{1t} |Y, Inf_t)]	4.88	2.20	1.16	2.64	Cointegration
Δ OT_{2t} [F_{OT2t} (OT_{2t}| Inf_t)]	12.89	8.93	13.05	10.71	Cointegration
Δ OT_{2t} [F_{OT2t} (OT_{2t} | Y, Inf_t]	9.69	13.18	6.61	7.40	Cointegration
Δ OT_{3t} [F_{OT3} (OT_{3t} | Inf_t)]	4.66	0.03	0.02	2.82	Cointegration
Δ OT_{3t} [F_{OT3t} (OT_{3t} |Y, Inf_t)]	6.02	1.51	1.76	2.20	Cointegration
Δ OT_{4t} [F_{OT4t} (OT_{4t}| Inf_t)]	6.98	8.13	9.75	9.33	Cointegration
Δ OT_{4t} [F_{OT4t} (OT_{4t} | Y, Inf_t)]	6.78	16.00	4.34	6.60	Cointegration

Lower and upper critical values for 1%, 5% and 10% significance level are 3.65-4.66, 2.79-3.67 and 2.37-3.20, respectively.

In the next step of the analysis, the LR coefficients and the Unrestricted Error Correction Model (UECM) for the variables *Inf* was estimated. The dynamic ARDL estimates based on Schwarz Bayesian Criterion (SBC) for the variable *Inf* are given in Table 6.

TABLE 6

Dynamic ARDL Model 1 Based on SBC (Full Model)
(Dependent Variable = ln *Inf*)

	Model 1a ARDL (3,0,0)	Model 1b ARDL (3,0,0)	Model 1c ARDL (1,4,3)	Model 1d ARDL (1,0,0)
Regressors	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
ln *Inf* (–1)	1.05 (0.000)	1.04 (0.000)	0.70 (0.000)	0.90 (0.000)
ln *Inf*(–2)	0.15 (0.571)	0.16 (0.532)		
ln *Inf*(–3)	0.33 (0.032)	–0.33 (0.031)		
Y				0.00006 (0.000)
ln *Y*	0.25 (0.002)	0.26 (0.001)	–0.04 (0.836)	
ln *Y*(–1)			–0.67 (0.018)	
ln *Y*(–2)			0.23 (0.375)	
ln *Y*(–3)			0.35 (0.206)	
ln *Y*(–4)			0.57 (0.023)	
ln OT_{1t}	–0.07 (0.092)			
ln OT_{2t}		–0.08 (0.070)		
ln OT_{3t}			0.12 (0. 042)	
ln OT_{3t}(–1)			0.20 (0.018)	
ln OT_{3t}(–2)			–0.12 (0.109)	
ln OT_{3t}(–3)			0.15 (0.010)	
OT_{4t}				–0.003 (0.040)
Constant	–3.05 (0.002)	–3.13 (0.001)	–6.21 (0.000)	0.36 (0.000)
	Diagnostic test Statistics: R^2 = 0.99, F-statistic = 4986.9 (0.000), SBC = 65.12, Serial Correlation (LM) = 0.65 (0.421) Heteroscedasticity (LM) = 0.02 (0.883), Ramsey's RESET test = 1.85 (0.174), Normality (LM) = 1.60 (0.449)	**Diagnostic test Statistics**: R^2 = 0.99, F-statistic = 5068.0 (0.000), SBC = 65.39, Serial Correlation (LM) = 1.27 (0.260) Heteroscedasticity (LM) = 0.03 (0.876), Ramsey's RESET test = 1.98 (0.160), Normality (LM) = 1.40 (0.495)	**Diagnostic test Statistics:** R^2 = 0.99, F-statistic = 3365.6 (0.000), SBC = 65.22, Serial Correlation (LM) = 0.38 (0.539) Heteroscedasticity (LM) = 0.69 (0.407), Ramsey's RESET test = 1.68(0.196), Normality (LM) = 1.21 (0.547)	**Diagnostic test Statistics**: R^2 = 0.99, F-statistic = 8005.9 (0.000), SBC = 66.84, Serial Correlation (LM) = 2.42 (0.120) Heteroscedasticity (LM) = 0.67 (0.412), Ramsey's RESET test = 2.14 (0.143), Normality (LM) = 0.84 (0.656)

FIGURE 1a (a)

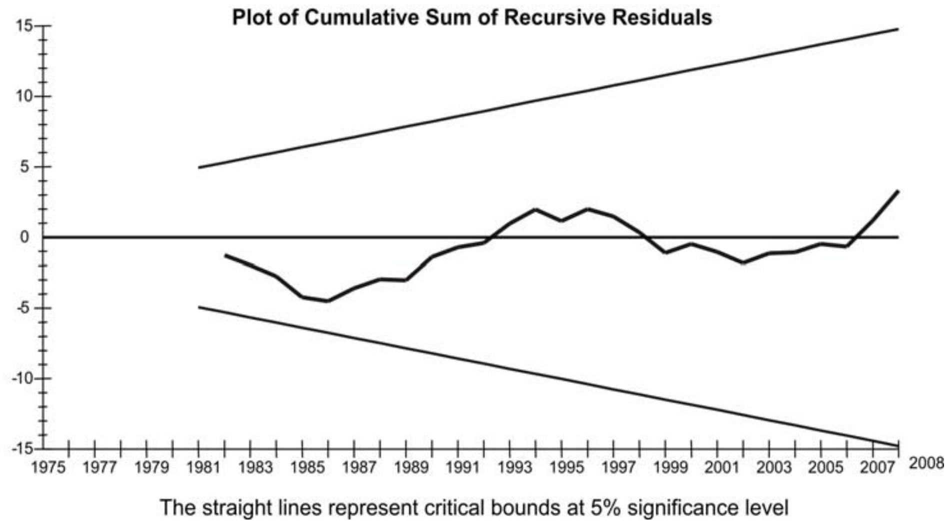
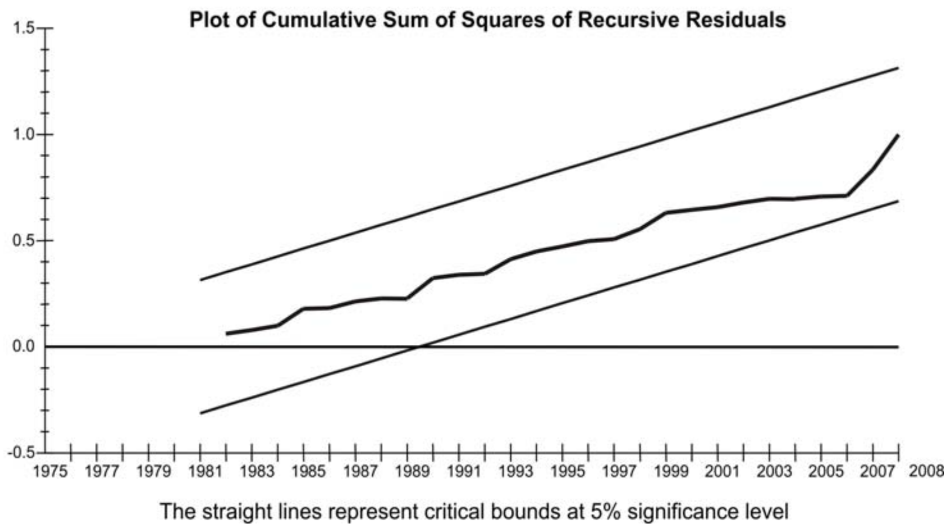


FIGURE 1a (b)



The results in Table 6 of the dynamic models 1a, 1b, 1c, and 1d for *Inf*. demonstrate that the coefficients of *Inf(–1), Y* and OT_{1t}, OT_{2t}, OT_{3t} and OT_{4t} seem to be significant and helpful in explaining the inflation in Pakistan. All the models presented above also qualify the standard diagnostic tests. The plots of "Cumulative Sum of Recursive Residuals (CUSUM)" and "Cumulative Sum of Squares Recursive Residuals (CUSUMSQ)" tests in

Figures 1a (a) and 1a (b), Figures 1b (a) and 1b (b), Figures 1c (a) and 1c (b), and Figures 1d (a) and 1d (b) for determining the stability of the model illustrate that the model 1a, 1b, 1c, and 1d are stable. These plots follow a central path representing a high level of parameter stability.

FIGURE 1b (a)

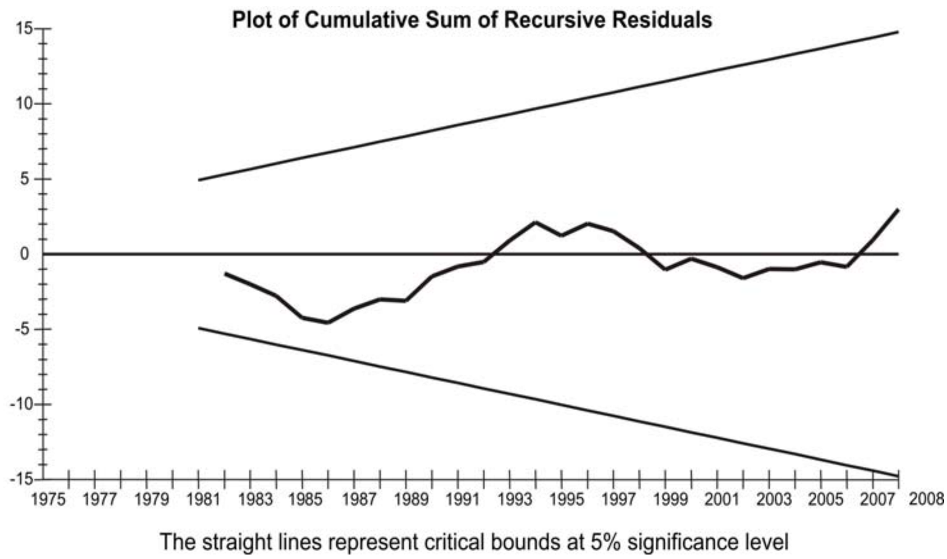


FIGURE 1b (b)

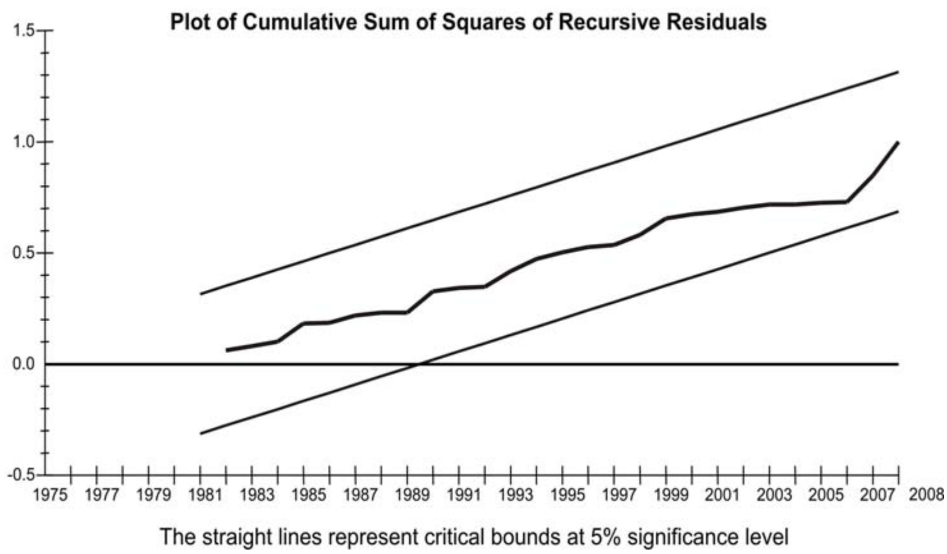


FIGURE 1c (a)

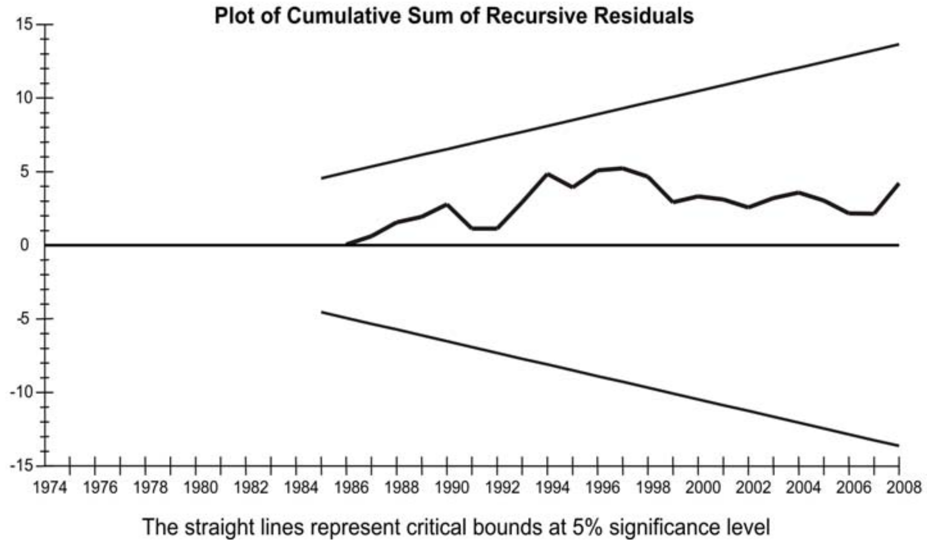
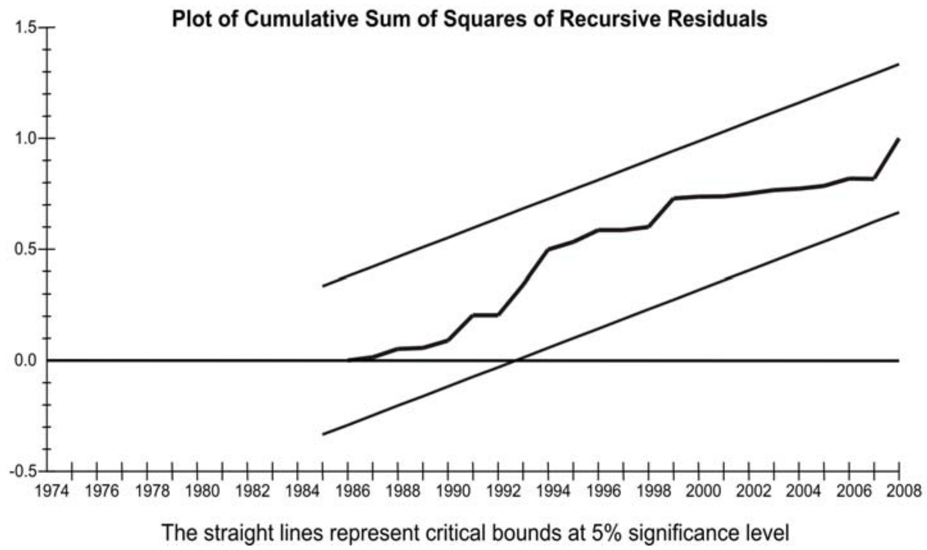


FIGURE 1c (b)



After ascertaining the stability of the model 1, the results of long-run coefficients are drawn and given in Table 7. The LR elasticity coefficient of real GDP in ARDL models (1a, 1b and 1c) in Table 7 is positive and highly statistically significant. This implies that an increase in real GDP leads to inflation in LR. The estimated LR elasticity coefficient of inflation is negative and significant at 15%, 12%, and 6% level of significance in model 1a, 1b and 1d, respectively. The LR relationship between import to GDP ratio (one of the measures of openness) and inflation has been observed as positive.

FIGURE 1d (a)

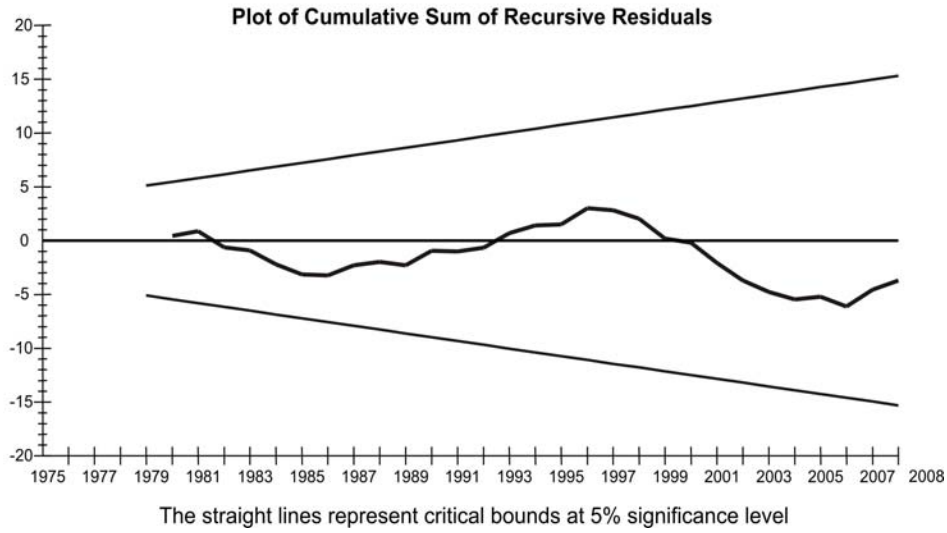


FIGURE 1d (b)

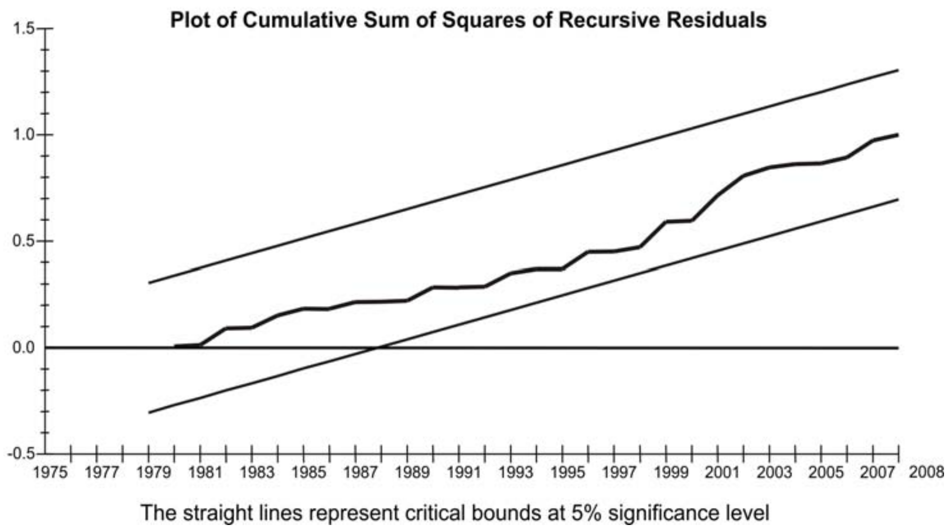


TABLE 7

Estimated LR Coefficients of Model 1 Based on
ARDL Model and SBC
(Dependent Variable = ln *Inf*)

Regressors	Model 1a ARDL (3,0,0)	Model 1b ARDL (3,0,0)	Model 1c ARDL (1,4,3)	Model 1d ARDL (1,0,0)
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Y				0.006 (0.000)
ln Y	1.90 (0.000)	1.94 (0.000)	1.41 (0.000)	
ln OT_{1t}	–0.49 (0.142)			
ln OT_{2t}		–0.56 (0.117)		
ln OT_{3t}			1.14 (0.000)	
OT_{4t}				–0.03 (0.055)
Constant	–22.98 (0.000)	–23.28 (0.000)	–19.38 (0.000)	3.62 (0.000)

Error Correction Mechanism (ECM) for model 1 is reported in Table 8. Coefficient of ECM(–1) indicates the speed of adjustment back to LR equilibrium after a SR shock. Coefficient of ECM(–1) from the Table 8 for models 1a, 1b, 1c, and 1d are 13%, 13%, 32% and 10%, respectively. The absolute value of all the coefficients of ECM(–1) except model 1c indicates that OT is not quickly adjusted to changes in component of the LR equilibrium. All the lagged error correction terms (ECM (–1)) are highly significant with correct negative sign, indicating the establishment of cointegration and LR causality (LR causality runs from OT_i to *Inf*) among *Inf*, real GDP and openness when *Inf* is the dependent variable. The only SR causality running from OT_{3t} to *Inf* is observed. The values of $\overline{R}^2$ in all above models, *i.e.* 0.38, 0.39, 0.61 and 0.35 imply that all the error correction models fit the data reasonably well. Furthermore, the highly significant *F-statistic* for all the ECMs also confirm over all goodness of fit of model 1.

Table 8 shows that the real GDP affects *Inf* positively and significantly in SR in all models except model 1c. The positive linkage between real GDP and *Inf* both in SR and LR seems to be in line with Phillips curve and Okun's law. The linkage between one, two and three periods lagged value of real GDP and *Inf* has been found negative and statistically significant in model

1c. The *Inf* measures (OT_{it}) affect *Inf* negatively and significantly at less than 10% significant levels in all models in the SR. This implies that there exists negative and significant relationship between *Inf* and all measures of trade openness in the SR in all of the above models.

TABLE 8

ECM Representation for Selected ARDL Model 1 Based on SBC (Dependent Variable = Δ ln *Inf*)

	Model 1a ARDL (3,0,0)	Model 1b ARDL (3,0,0)	Model 1c ARDL (1,4,3)	Model 1d ARDL (1,0,0)
Regressors	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Δln *Inf* (–1)	0.18 (0.236)	0.17 (0.271)		
Δ ln *Inf*(–2)	0.33 (0.032)	0.33 (0.031)		
Δ ln *Y*	0.25 (0.002)	0.26(0.001)	–0.04 (0.836)	
Δ *Y*				0.0006 (0.000)
Δ ln *Y*(–1)			–1.16 (0.000)	
Δ ln *Y*(–2)			–0.93 (0.001)	
Δ ln *Y*(–3)			–0.57 (0.022)	
Δ ln OT_{1t}	–0.06 (0.092)			
Δ ln OT_{2t}		–0.08 (0.070)		
Δ ln OT_{3t}			0.12 (0. 041)	
Δ ln OT_{3t}(–1)			–0.04 (0.513)	
Δ ln OT_{3t}(–2)			–0.16(0.009)	
Δ OT_{4t}				–0.003(0.040)
Constant	–3.05 (0.002)	–3.12 (0.001)	–6.21 (0.000)	0.36 (0.000)
ECM(–1)	–0.13 (0.006)	–0.13 (0.006)	–0.32 (0.000)	–0.10 (0.000)
	ECM = ln (*Inf*) – 1.90 ln (*RGDP*) + 0.48 ln (OT_{1t}) + 22.98 **Diagnostic test Statistics:** $\overline{R}^2$ = 0.38, *F*-value = 5.02 (0.002) DW-statistic = 1.77	ECM = ln (*Inf*) – 1.94 ln (*RGDP*) + 0.56 ln (OT_{2t}) + 23.28 **Diagnostic test Statistics:** $\overline{R}^2$ = 0.39, *F*-value = 5.02 (0.002) DW-statistic = 1.72	ECM = ln (*Inf*) – 1.41 ln (*RGDP*) – 1.14 ln (OT_{3t}) + 19.38 **Diagnostic test Statistics:** $\overline{R}^2$ = 0.61, *F*-value = 7.86 (0.000) DW-statistic = 2.11	ECM = ln (*Inf*) – 0.63 ln (*RGDP*) + 0.03 (OT_{4t}) – 3.62 **Diagnostic test Statistics:** $\overline{R}^2$ = 0.35, F-value = 7.05 (0.001) DW-statistic = 1.51

To examine model 2 regarding the effect of *Inf*, and real GDP on OT_{it}, it was estimated by using ARDL Model. The outcomes of dynamic ARDL model 2 for the variable OT_i are given in Table 9.

TABLE 9

Dynamic ARDL Model 2 (Full Model)
(Dependent Variable = ln Openness to Trade (OT_i)

	Model 2a ARDL (1,0,1) Based on SBC (Dependent Variable = ln OT_{1t})	Model 2b ARDL (1,3,4) Based on RBC (Dependent Variable = ln OT_{2t})	Model 2c ARDL (1,3,3) Based on SBC (Dependent Variable = ln OT_{3t})	Model 2d ARDL (1,0,0) Based on SBC (Dependent Variable = ln OT_{4t})
Regressors	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
ln OT_{1t} (–1)	0.81 (0.000)			
ln OT_{2t} (–1)		0.55 (007)		
ln OT_{3t} (–1)			0.42 (0.009)	
ln OT_{4t}(–1)				0.40 (0.018)
Y			0.001 (0.492)	
Y(–1)			0.007 (0.020)	
Y(–2)			–0.004 (0.228)	
Y(–3)			–0.006 (0.022)	
ln *Y*	0.56 (0.114)	–0.70 (0.356)		–0.063 (0.812)
ln *Y*(–1)		0.27 (777)		
ln *Y*(–2)		–19 (0.837)		
ln *Y*(–3)		1.42 (0.075)		
ln *Inf*	–1.54 (0.002)	–1.08 (0.071)		–0.604 (0.010)
ln *Inf* (–1)	1.45 (0.003)	–0.14 (0.883)		
ln *Inf*(–2)		0.33 (0.690)		

	Model 2a ARDL (1,0,1) Based on SBC (Dependent Variable = ln OT_{1t})	Model 2b ARDL (1,3,4) Based on RBC (Dependent Variable = ln OT_{2t})	Model 2c ARDL (1,3,3) Based on SBC (Dependent Variable = ln OT_{3t})	Model 2d ARDL (1,0,0) Based on SBC (Dependent Variable = ln OT_{4t})
ln *Inf*(–3)		–0.06 (0.942)		
ln *Inf*(–4)		0.52 (0.326)		
Inf			–7.56 (0.869)	
Inf (–1)			–0.01 (0.275)	
Inf(–2)			0.03 (0.008)	
Inf(–3)			–0.02 (0.072)	
Time trend	–0.019 (0.573)			0.059 (0.020)
Constant	–6.99 (0.164)	–8.82 (0.031)	1.53 (0.001)	3.965 (0.293)
	Diagnostic test Statistics: R^2 = 0.87,F-statistic = 437.83 (0.000), SBC = 25.60, Auto Correlation (LM) = 0.41 (0.406) Heteroscedasticity (LM) = 1.62(0.202), Ramsey's RESET test = 0.36 (0.548), Normality (LM) = 0.68 (0.713)	**Diagnostic test Statistics:** R^2 = 0.91,F-statistic = 23.40 (0.000), SBC = 22.17, Serial Correlation (LM) = 0.05 (0.826) Heteroscedasticity (LM) = 2.85 (0.092), Ramsey's RESET test = 0.31(0.577), Normality (LM) = 0.87 (0.647)	**Diagnostic test Statistics:** R^2 = 0.87,F-statistic = 17.79 (0.000), SBC = 32.32, Auto Correlation (LM) = 1.79 (0.181) Heteroscedasticity (LM) = 0.02 (0.888), Ramsey's RESET test = 1.66 (0.197), Normality (LM) = 1.98 (0.372)	**Diagnostic test Statistics:** R^2 = 0.75, F-statistic = 27.89 (0.000), SBC = 34.33, Auto Correlation (LM) = 1.08 (0.298) Heteroscedasticity (LM) = 1.05 (0.304), Ramsey's RESET test = 0.32 (0.570), Normality (LM) = 0.58 (0.747)

The results in Table 9 of the dynamic ARDL models 2a, 2b, 2c and 2d for OT_i illustrate that coefficients of lagged OT_i, lagged value of real GDP and *Inf* and lagged values of *Inf* seem to be helpful in explaining OT_i. All the models presented in Table 9 also qualify the standard diagnostic tests. To test the stability of SR and LR, the graph CUSUM and graph of CUSUMSQ are used. Brown, Durban and Evans (1975) proposed these graphs of CUSUM and CUSUMSQ and were firstly used by Pesaran and Pesaran (1997).

FIGURE 2a (a)

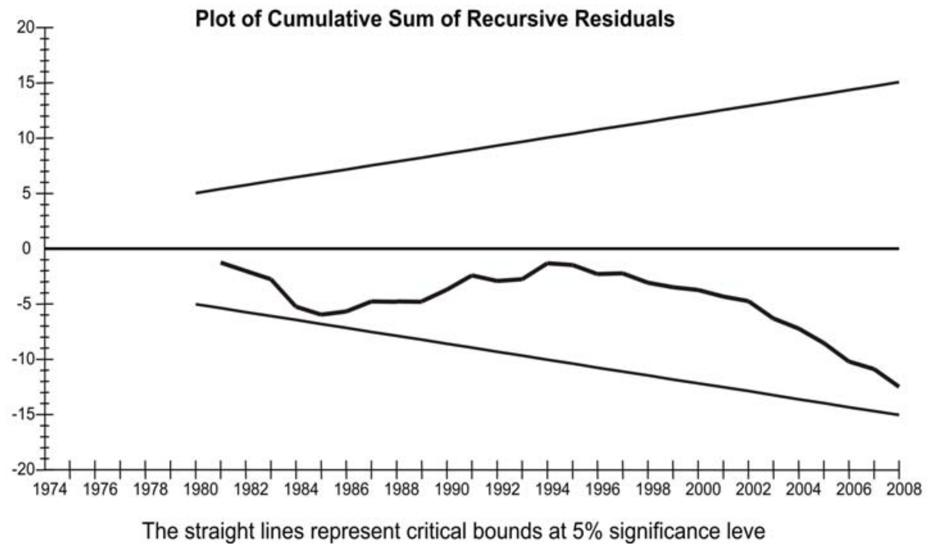
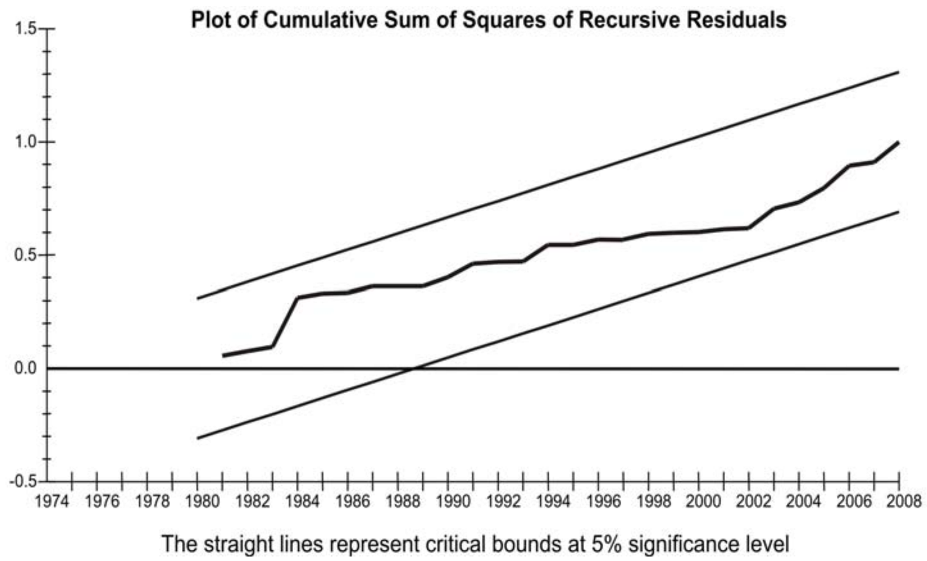


FIGURE 2a (b)



The results of CUSUM and CUSUMSQ are presented in Figures 2a (a) and 2a (b), 2b (a) and 2b (b), 2c (a) and 2c (b), and 2d (a) and 2d (b). Since plots of CUSUM and CUSUMSQ positioned within 5% level of significance, the estimated coefficients are stable. Figures 2a(a) and 2a(b), Figures 2b(a) and 2b(b), Figures 2c(a) and 2c(b), and Figures 2d(a) and 2d(b) presented the stability of the model and LR relationship among the variables because plots of CUSUM and CUSUMSQ stay within 5% level of significance. Now, in the next step, the results of LR coefficients of the ARDL model 2 are presented in Table 10.

FIGURE 2b (a)

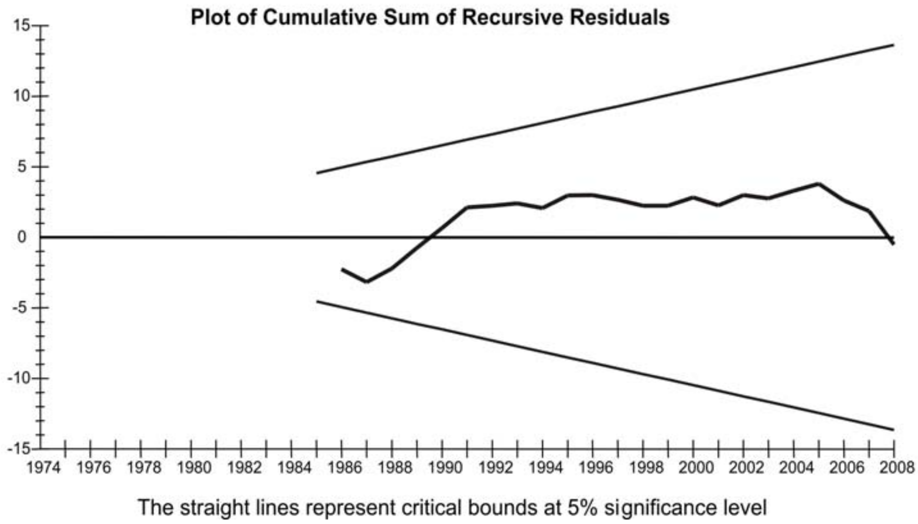


FIGURE 2b (b)

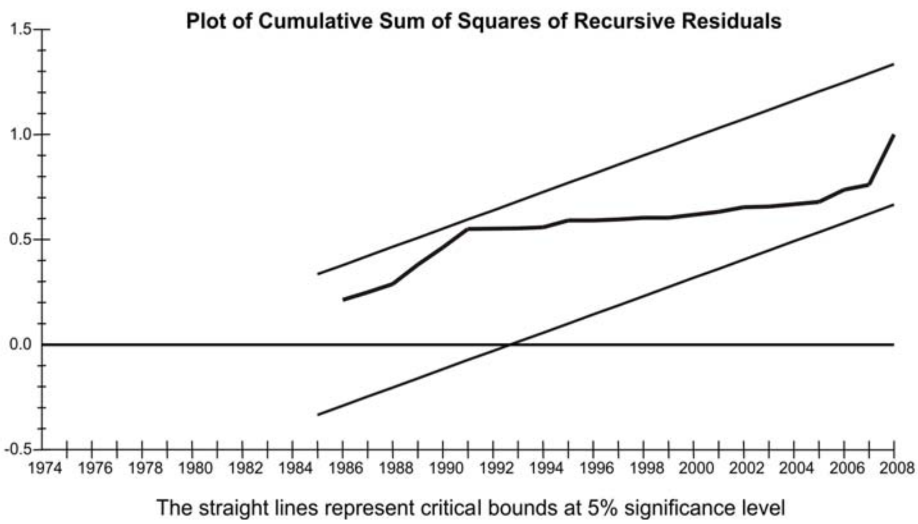


FIGURE 2c (a)

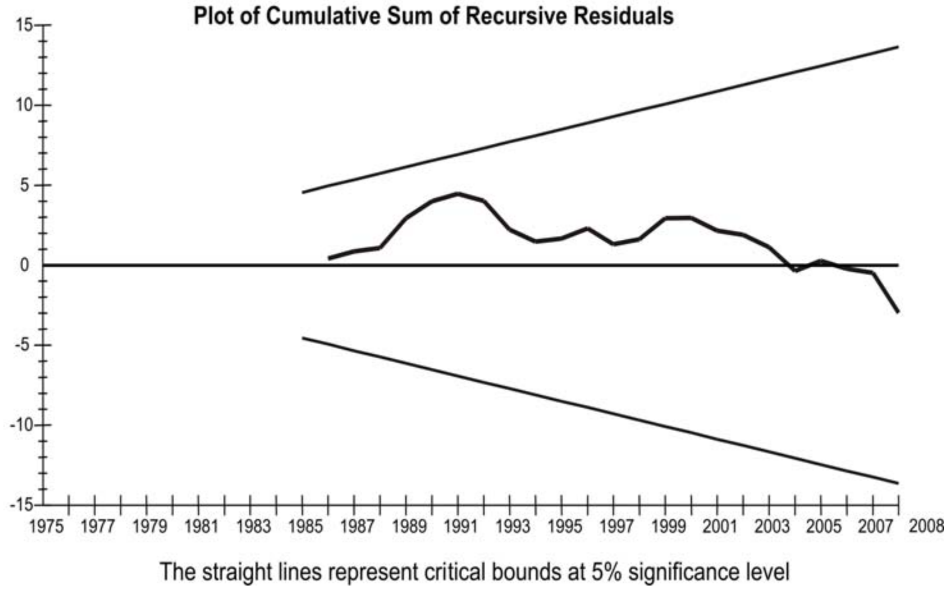


FIGURE 2c (b)

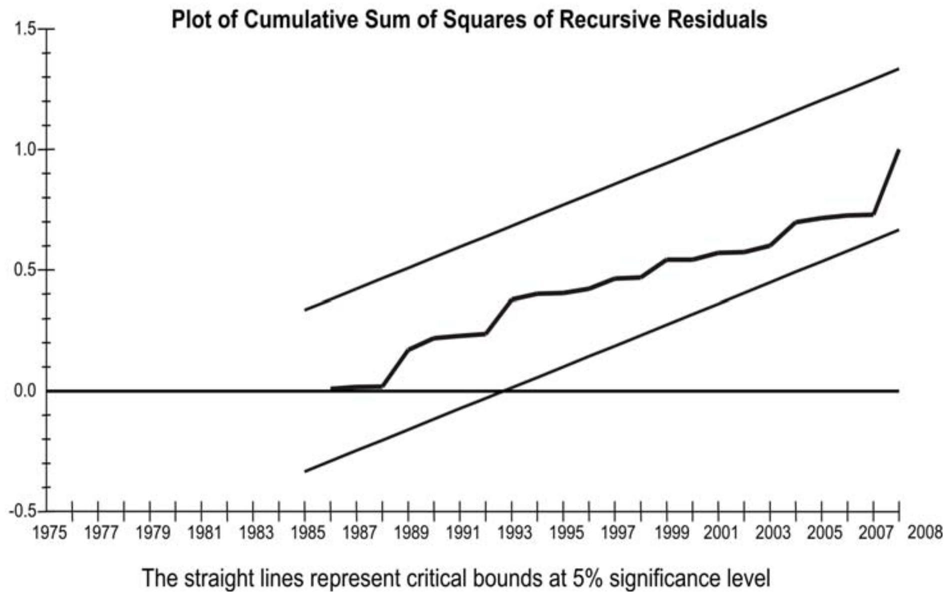


FIGURE 2d (a)

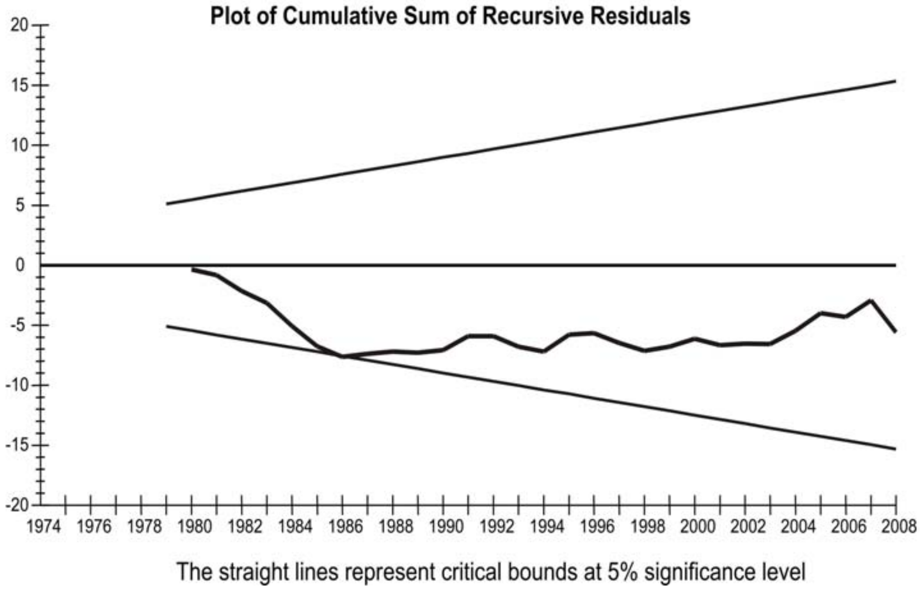


FIGURE 2d (b)

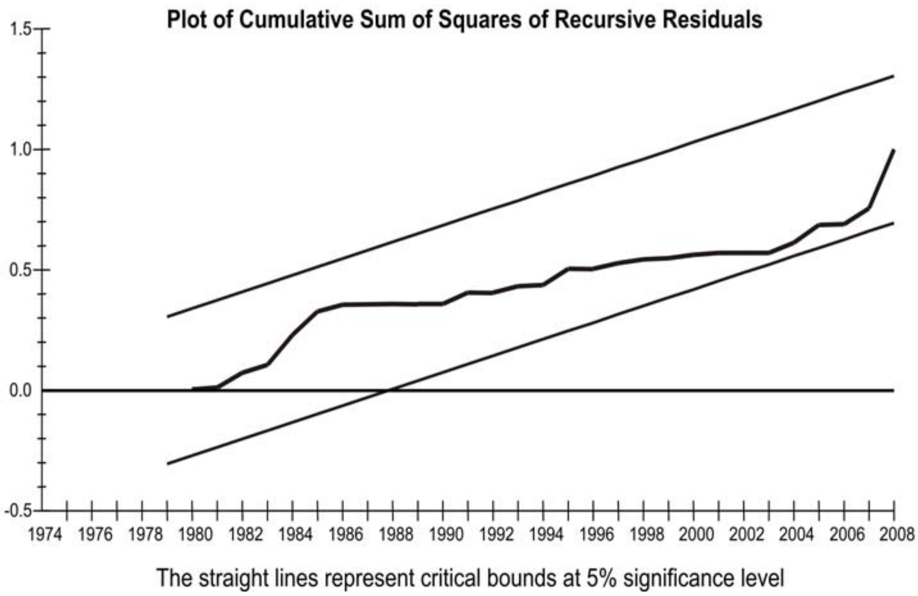


TABLE 10

Estimated LR Coefficients of Model 2 Using the ARDL Model (Dependent Variable = ln OT_i)

	Model 2a ARDL (1,0,1) Based on SBC (Dependent Variable = ln OT_{1t})	Model 2b ARDL (1,3,4) Based on RBC (Dependent Variable = ln OT_{2t})	Model 2c ARDL (1,3,3) Based on SBC Dependent Variable = ln OT_{3t})	Model 2d ARDL (1,0,0) Based on AIC (Dependent Variable = ln OT_{4t})
Regressors	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
ln *Y*	2.89 (0.302)	1.81(0.035)		–0.11 (0.814)
Y			–0.002 (0.078)	
ln *Inf*	–0.44 (0.772)	–0.98 (0.079)		–1.01 (0.035)
Inf			0.003 (0.224)	
Time trend	–0.098 (0.626)			0.09 (0.044)
Constant	–36.19 (0.346)	–19.72 (0.053)	2.64 (0.000)	6.59 (0.306)

The results in Table 10 show that the LR coefficients of real GDP in model 1b and 1d are positive and significant. Though the LR estimated coefficients of *Inf* are found negative in models 2a, 2b, and 2d but significant at 8% and 4%level of significance only in model 2b and 2d.

The next step of the analysis involves the "estimation of a Dynamic Error Correction Representation (DECR) for the variables involved and tests whether or not the lagged levels of the variables are statistically significant by estimating Unrestricted Error Correction Mechanism (UECM)". The UECM representation for selected ARDL model 2 for the dependent variable ln OT_{it} is presented in Table 11.

If the ECM(–1)) is significant with negative sign, then this is a proficient way to set up LR causality and cointegration. The coefficient of ECM(–1), is known as *adjustment parameter*. The coefficient of ECM(–1) points out the swiftness of variables towards equilibrium. It should be negative and statistically significant. If the coefficient of ECM(–1) is highly statistically significant then it establishes LR causal effect and confirms the existence of

TABLE 11

ECM Representation for Selected ARDL Model 2
(Dependent Variable = Δ ln OT_i)

Regressors	Model 2a ARDL (1,0,1) Based on SBC (Dependent Variable = ln OT_{1t})	Model 2b ARDL (1,3,4) Based on RBC (Dependent Variable = ln T_{2t})	Model 2c ARDL (1,3,3) Based on SBC (Dependent Variable = ln OT_{3t})	Model 2d ARDL (1,0,0) Based on AIC (Dependent Variable = ln OT_{4t}
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Δ*Y*			0.14 (0.492)	
Δ *Y*(–1)			0.009 (0.000)	
Δ *Y*(–2)			0.006 (0.022)	
Δ *Y*(–3)				
Δ ln *Y*	0.55 (0.114)	–0.70 (0.355)		–0.06(0.812)
Δ ln *Y*(–1)		–1.23 (0.138)		
Δ ln *Y*(–2)		–1.42 (0.074)		
Δ *Inf*			–7.56 (0.869)	
Δ *Inf*(–1)			–0.01 (0.045)	
Δ *Inf* (–2)			0.02 (0.071)	
Δ ln *Inf*	–1.54 (0.001)	–1.08 (0.070)		–0.60 (0.010)
Δ ln *Inf* (–1)		–0.79 (0.143)		
Δ ln *Inf* (–2)		–0.45 (0.427)		
Δ ln *Inf* (–3)		–0.52 (0.325)		
Δ Time trend	–0.02 (0.572)			0.06 (0.020)
Constant	–6.99 (0.164)	–8.82 (0.030)	1.53 (0.001)	3.96 (0.293)
ECM(–1)	–0.19 (0.161)	–0.45 (0.026)	–0.58 (0.001)	–0.60 (0.001)
	ECM = ln (OT_{1t}) – 2.89 ln (*RGDP*) + 0.44 ln (*Inf*) + 36.19 + 0.0981(T) Diagnostic test Statistics: $\overline{R}^2$ = 0.30, F-value = 4.95 (0.003), DW-statistic = 2.17	ECM = ln (OT_{2t}) – 1.81 ln (*RGDP*) + 0.98 ln (*Inf*) + 19.72 Diagnostic test Statistics: $\overline{R}^2$ = 0.57, F-value = 4.03 (0.003), DW-statistic = 1.95	ECM = ln (OT_{3t}) + 0.0018 ln (*RGDP*) –0.003 ln (*Inf*) – 2.64 Diagnostic test Statistics: $\overline{R}^2$ = 0.64, F-value = 9.78 (0.000), DW-statistic = 1.62	ECM = ln (OT_{4t}) + 0.11 ln (*RGDP*) + 1.00 ln (*Inf*) – 6.59 – 0.0974 (T) Diagnostic test Statistics: $\overline{R}^2$ = 0.34, F-value = 5.45(0.002), DW-statistic = 1.66

cointegration. Furthermore, the negative sign of the coefficient of ECM(–1) validates the stability of the model. The coefficients of ECM(–1) in all models except model 2a in Table 11 are negative and highly significant. This implies that LR causality (running from *Inf* to OT_i) and cointegration is established among *Inf*, real GDP and openness when openness is the dependent variable. The only SR causality running from OT_{3t} to *Inf* is found. This means that there exists SR bidirectional causality running between OT_{3t} and *Inf* in trivariate analysis.

The SR elasticity coefficient of *Inf* in models 2a, 2b, 2c, and 2d are negative and significant. It confirms the existence of inverse linkage between *Inf* and openness in the SR. It can easily be concluded from Tables 8, 9, 10 and 11 that the inverse linkage between *Inf* and openness is found to be more robust in the SR than in the LR. So, Romer (1993) main finding about the negative relationship between openness and *Inf* seems to be more valid in the SR in case of Pakistan.

V. CONCLUSION AND RECOMMENDATIONS

This study was designed to provide empirical evidence on the Romer's (1993) main finding about the inverse linkage between *Inf* and openness in Pakistan. Using the ARDL model, this paper provides evidence of a stable negative and significant relationship between *Inf* and openness both in SR and LR. The inverse relationship seems to be more robust and significant in the SR. The LR bidirectional causality running between *Inf* and all measures of openness is observed in trivariate analysis. The SR bidirectional causality running between openness and *Inf* in trivariate analysis is found only when openness is measured by import to GDP ratio. This work also finds positive linkage between real GDP and *Inf* both in SR and LR that seems to be in line with the truth of Phillips curve and Okun's law. On the basis of its findings, the present study recommends that some solid steps may immediately be taken to reduce inflation. Government of Pakistan and State Bank of Pakistan should initiate some measures to more integrate the domestic economy with the world economy so that *Inf* may reduce and economy may boost up. Openness must be included in empirical studies while studying sources and determinants of *Inf,* especially in Pakistan as it was not included in recent studies conducted by Noor (2007) and Khan and Gill (2010).

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