Exchange Rate, Interest Rate and Ricardian Equivalence Evidence from Pakistan

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The aim of this study is to investigate the validity of Ricardian Equivalence Hypothesis in Pakistan by using annual data from 1973-2010. In our previous studies we investigated the Ricardian Equivalence Hypothesis and its sources of deviation in Pakistan by using Structural Consumption function and Euler Equation approach. The present study investigated this hypothesis in terms of rate of interest and exchange rate. Results of Auto Regressive Distributed Lag cointegration investigate the long run relationship among variables. By using OLS technique this study rejected Ricardian Equivalence Hypothesis in case of Pakistan. The findings of the study demonstrate the focus towards the significance of fiscal policies in raising private consumption and controlling budget deficits.

Keywords: Ricardian Equivalence Hypothesis, Exchange Rate, Pakistan
JEL Classifications: E4, E6

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1. Introduction

The issue of large budget deficits and hefty government debt has fascinated the attention of policy makers, since last decade. Both developing and developed nations are facing the consequences of these problems. The current debate focuses that how much and how fast to cut the deficits. There are three possibilities for government to finance its spending in case of budget deficits; print new money, raise taxes, and start borrowing. Hence, budget deficit and government debt has multidimensional impacts on other macroeconomic variables. After the work of Barro (1974) the debate on Ricardian Equivalence Hypothesis (REH) takes a flame. REH[3] states that consumer deals government debt as a future tax liability. Thus they inspect that a tax-cut will not increase their consumption expenditure (aggregate demand will unaffected) but that will increase their savings, because they believe that present borrowings will increase future tax on their generations. Consumer do this because after the maturity of borrowing government has to repay borrowing amount plus rate of interest; so government impose new taxes on their generation. Thus, in order to protect new generation from these taxes consumer buys

[3] REH holds number of assumptions that must be satisfied for its validity (Giorgioni and Holden, 2001). Like taxes and bonds must be perfect substitute, taxes must be used to pay interest on the debt, consumer invest same rate as government invest and consumer have perfect information about future and taxes are lump sum.
Diamond (1965) said that this will be only possible if consumer lives forever, if consumer realizes that government will collect the tax after his death his consumption pattern definitely will changed.
Bernheim (1987), King's (1983) and Con and Jappeli (1990) results showed that consumer's behavior is changed due to liquidity constraints. Feldstein (1988) said that uncertainty in parent's future income fails REH.

bonds and does not consider them as a net wealth. Hence private savings rise by similar amount as budget deficit and national savings stay unchanged and there will be no crowd out of private investment.
Opponents of this hypothesis, the Keynesians, are of view that a consumer does not treat government bonds as a net wealth. On the response of tax cut consumers private consumption will increase (aggregate demand increases) and private saving will remain unaffected because consumer prefers present on past and does not consider the welfare of their generations in their mind. Several studies[4] investigated the issue of REH with reference to budget deficit, private consumption and saving behavior but limited studies explored the issue of REH with reference to rate of interest and exchange rate[5]. In the views of REH budget deficit and government debt has no effect on exchange rate and rate of interest.
Hence, the study on the theme of REH is needed before drawing any stabilization program. In case of Pakistan several studies draw attention towards this issue but each of them has own precincts. This study serves up as an attempt to spread out the existing knowledge of this research. Emphasizes is given to the use of less restrictive model for the analysis of REH. Rest paper is balanced as; part two presents the detail about data sources and empirical methodology, part three explains the results of the study and last part gives conclusion of the study.

[4] The studies that check the validity of REH are Khalid (1996), Rockerbie (1997), Cardia (1997), Lucke (1999), Drakos (2001,2003), Sachsida and Carneiro (2001), Giorgioni and Holden (2001), Walker (2002), Kaadu and Usukula (2004), Safa and Siddiq (2005), Cuaresma and Reitschuler (2007), Haq and Montiel (1987), Whelan (1991), Kazmi (1992, 1994), Ghatak and Ghatak (1996), Abimanyu (1998), Carlos (2001), Khan and Ashraf (2003), Ricciuti and Laurea (2003), Malengier and Pozzi (2004), Gray and Stone (2005), Gracia and Ramajo (2005), Nipple (2006), Apergis and Lyroudi (2006), Afonso (2008), Siddiki (2008), George and Vassilios (2008), Waqas et al. (2011), Waqas and Awan (2011).
[5] These studies include Polser (1982), Evans (1986), Feldstein (1986), Beck (1994), Abimanyu (2006), Lucke (1999), Yi (2006)

2. Data and Methodology

The study used annual data of Pakistan from 1973-2010. Data on government debt, government budget deficit, exchange rate and rate of interest, are gathered from IFS CD-ROM 2010. All the variables are transformed into real terms.

We have developed two models and each model is based on certain restriction which must be fulfilled in order to support REH.

$ER_t = \alpha_0 + \propto_1 GD_t + \propto_2 GBD_t + u_t$ (*Equation*1)

Where dependent variable is exchange rate (ER) while, government debt (GD) and government budget deficit (GBD) are independent variables.

$\propto_1 = 0, \quad \propto_2 = 0$

To hold REH following restrictions must be fulfilled. First restriction states that government debt has no impact on exchange rate, while second restriction depicts that government budget deficit has no impact on exchange rate.

In the argument of rate of interest we have following model in which dependent variable is rate of interest (RI) whereas, independent variables are same as we have in first model.

$RI_t = \alpha_0 + \propto_1 GD_t + \propto_2 GBD_t + u_t$ (*Equation* 2)

$\propto_1 = 0, \quad \propto_2 = 0$

Before the estimation of above discussed models it is very important to check the long run and short run dynamics among the variables, before the estimation of any time series model. In econometric literature there are lots of uni-variate[6] and multi-variate[7] techniques to check the cointegration among the variables. Before applying any cointegration technique, firstly we have to detect order of integration.

[6] Engle&Granger, (1987) and Phillips& Hansen's FMOLS procedures (1990).
[7] Johansen, (1988), Johansen & Juselius, (1990),and Johansen's (1995) and Auto-Regressive Distributed Lag (ARDL), proposed by Pesaran& Shin, (1995, 1998), Pesaran et.al., (1996), and Pesaran et.al., (2001)

Mostly time series data is non-stationary and in order to beware spurious regression results researchers used different unit root test.

2.1 Augmented Dickey Fuller (ADF) Unit Root Test

Dickey and Fuller, after Dickey Fuller (DF) unit root test, suggested a new test to check unit root, ADF. In order to remove the autocorrelation this test includes additional lagged terms of the dependent variable as a one of the independent variable. Mostly the time series data have a trend, but ADF test give following three possibilities.

$$\Delta Z_t = \phi Z_{t-1} + \sum \gamma_i \Delta Z_{t-1} + e_t \quad \ldots\ldots(1)$$

$$\Delta Z_t = \alpha_0 + \phi Z_{t-1} + \sum \gamma_i \Delta Z_{t-1} + e_t \quad \ldots\ldots(2)$$

$$\Delta Z_t = \alpha_0 + \phi Z_{t-1} + a_2 t + \sum \gamma_i \Delta Z_{t-1} + e_t \ldots\ldots(3)$$

Equation 3 states the possibility when no trend and no intercept found in the data, equations 4 states the possibility when data has intercept only 5 states the possibility when data has both intercept and trend. D eterministic elements α_0 and $a_2 t$ differentiate the above three equation form each other. While using ADF test there are two important things which a researcher has to keep in his mind. Specify the lagged first difference terms. If we select zero lagged difference this will be DF test. In ADF, in order to remove serial correlation among residuals, sufficient lags are included. Secondly, when we choose the different possibilities of ADF, discussed above, their critical values also changed. McKinnon (1991) table of critical values is used to check the acceptance or rejection of null hypothesis.

2.2 The Phillips-Perron Unit Root Test (PP)

The Dickey-Fuller test is based on the assumption that the error terms are statistically independent and have a constant variance. Phillips and Perron (1988) introduced a new test of unit root in which they used

mild assumptions as compared to Dicky and Fuller. Consider AR(1) process;

$$\Delta Z_{t-1} = \alpha_0 + \gamma Z_{t-1} + e_t \ldots\ldots(4)$$

PP test is the modification of ADF test it just make a correction of the t-statistic of Z's coefficient by using comparatively less restrictions than ADF, in order to remove serial correlation. McKinnon (1991) critical values are also used for this test. Moreover, this test also has the same three possibilities which ADF has; intercept, intercept and trend and no intercept and no trend.

2.3 Augmented Distributed Lag (ARDL) Cointegration Approach

Pesaran and Shin (1996), Pesaran and Pesaran (1997), Pesaran and Smith (1998), and Pesaran et al. (2001) introduced a new technique to test the Cointegration among variables. The main feature of this approach is that it can be applied whether the series are *I*(0) or *I*(1). This approach has an advantage on other Cointegration test due to certain reasons like;This approach is based on OLS method.

This approach integrates short run dynamics form long run equilibrium without loosing long run information (Banerjee et.al., 1993).

This is more flexible approach because deals both types of integrating orders (Pesaran and Pesaran, 1996).

In a conditional unrestricted ECM to test the significance of lagged levels of the variables F-statistic or Wald test is used (Pesaran et al., 2001).

This approach is more significant than other approaches because it is more robust for small samples (Ghatak and Siddiki, 2001).

Under this approach the model takes sufficient numbers of lags in order to capture the data generating process in general to specific modeling (Laurenceson and Chai, 2003).

This approach also evades the unit root pre-testing (Pesaran et. al., 2001). The main purpose of unit root test is to determine whether

series is $I(1)$ or $I(0)$. This approach deals with both $I(1)$ or $I(0)$ so this evade the unit root approach (Bahmani-Oskooee, 2004).

It avoids all the things which Johansen's approach has. There is no need to determine that whether data has deterministic trend or not? Optimal lag orders and order of VAR.

The augmented ARDL equation is specified by (Pesaran and Pesaran, (1997); Pesaran and Shin, (2001)) is as follow;

$$\alpha(X,p)y_t = a_0 + \sum_{i=1}^{k}\beta_i(X,q_i)l_{it} + \lambda' z_t + \varepsilon_t$$

$$\forall_t = 1,2,....,n \quad \ldots\ldots(5)$$

Whereas,

$$\alpha(X,p) = 1-\alpha_1 X - \alpha_2 X^2 - .... - \alpha_p X^p \quad \ldots(6)$$

And

$$\beta_i(X,q_i) = \beta_{i0} + \beta_{i1}X + \beta_{i2}X^2 + ... + \beta_{iq}X^q \quad \ldots(7)$$

$$\forall_i = 1,2,....., k$$

$$\beta_i(X,q_i) = 1-\beta_{i1}x - \beta_{i2}X^2 - ..... - \beta_{iqi}X^{qi} \quad \ldots(8)$$

Equation (8), states that the dependant variables are y_t, l_{it}, X and z_t, along with intercept terms, a lag operator, time trends, $S\times 1$ vector of deterministic variables and exogenous variables with fixed lags. Optimum lags are choosing by the Akaike Information Criterion (AIC) and Schwarz Bayesian Criteria (SBC). By using these criterions long run coefficients are calculated. Long run elasticity are calculated by using following formula (Wilson and Chaudhry, 2004);

$$\phi_i = \frac{\hat{\beta}_i(1,\hat{q}_i)}{\alpha(1,\hat{p})} = \frac{\hat{\beta}_{i0} + \hat{\beta}_{i1} + ... + \hat{\beta}_{i\hat{q}}}{1-\hat{\alpha}_1 - \hat{\alpha}_2 - .... - \hat{\alpha}_{\hat{p}}} \qquad \forall_i = 1,2,....,k$$

$$\hat{\theta}_i = \hat{\beta}_{i0} + \hat{\beta}_{i1} + ... + \hat{\beta}_{qi}$$

$$1-\hat{\theta}_1 - \hat{\theta}_2 - ..... - \hat{\theta}_p \qquad\qquad i = 1,2,.....k$$

where $\hat{p}$ and $\hat{q}_i$, $i = 1,2,...,k$ are the selected (estimated) values of $\hat{p}$ and $\hat{q}_i$. The relationship of long run co-integration can be shown as;

$$y_t - \hat{\theta}_0 - \hat{\theta}_1 l_{1t} - \hat{\theta}_2 l_{2t} - ... - \hat{\theta}_k l_{kt} = \varepsilon_t \qquad \forall_t = 1,2,....,n \quad ...(9)$$

In equation (27) constant term is equal to;

$$y_t - \hat{\theta}_0 - \hat{\theta}_1 l_{1t} - \hat{\theta}_2 l_{2t} - ... - \hat{\theta}_k l_{kt} = \varepsilon_t \qquad \forall_t = 1,2,....,n \quad ...(10)$$

Coefficients of long run relationship are estimated as;

$$\pi = \frac{\hat{\lambda}(\hat{p}, \hat{q}_1, \hat{q}_2, ..., \hat{q}_k)}{1 - \hat{\alpha}_1 - \hat{\alpha}_2 - .... - \hat{\alpha}_{\hat{p}}} \quad .....(11)$$

where $\hat{\lambda}(\hat{p}, \hat{q}_1, \hat{q}_2, ..., \hat{q}_k)$ gives OLS estimates of λ for selected ARDL model in equation (11) and rewriting this equation in terms of lagged levels and first difference of $y_t, l_{1t}, l_{2t}, ..., l_{kt}$ and z_t, one can get ECM related to the ARDL $(\hat{p}, \hat{q}_1, \hat{q}_2, ..., \hat{q}_k)$;

$$\Delta y_t = \Delta a_0 - \alpha(1, \hat{p}) EC_{t-1} + \sum_{i=1}^{k} \beta_{i0} \Delta l_u + \lambda' \Delta z_t - \sum_{j=1}^{\hat{p}-1} \alpha^* j \Delta y_{t-1} - \sum_{i=1}^{k} \sum_{j=1}^{\hat{q}_{t-1}} \beta_q \Delta l_{t,t-j} + \varepsilon_t \ldots (12)$$

Here ECM is described as below;

$$ECM_t = y_t - \hat{a} - \sum \hat{\beta}_t l_u - \lambda' z_t$$

For the estimation of long run association between variables, ARDL entails two steps. In first step long run association between variables are investigated and F-statistic is used for this purpose. Based on the number of regressor and whether ARDL has intercept or trend, Pesaran et al. (1996) have tabularized the critical values. These values provide a Band. If F-statistic falls outside this band than the variables are fractionally integrated and if F-statistic falls within the Band the result is inconclusive. If the F-statistic falls above this Band, than a Cointegration occur among the variables. The second stage estimates the coefficients of long run estimates. The speed of adjustment towards equilibrium is estimated through ECM.

4. Results and Discussion

Table 1 gives the results of ADF and PP, commonly used unit root tests. All the variables are stationary at first difference under both tests, except GDP and MT. Under ADF results GDP is stationary at first difference but in PP it is not stationary. The study preferred ADF test result and considered GDP stationary at first difference. MT is stationary at level under ADF result but PP result showed that MT is stationary at first difference. Study again preferred ADF and deals MT at level.

Table 1

Results of ADF and PP unit root tests

Variables	ADF				PP			
	Level	P*	Difference	P*	Level	Q*	Difference	Q*
With trend								
ER	-1.762	3	-3.229*	1	-2.170	8	-5.905***	1
GD	-2.656	1	-7.096***	3	-7.227***	7	-5.826***	3
GBD	-1.491	1	-3.838***	1	-2.022	6	-7.291***	1
RI	-2.979		-5.327***		-3.776***		-4.314***	
Without trend								
ER	-1.152	2	-3.267*	1	-1.302	3	-5.978***	1
GD	-2.123	2	-6.708***	2	-5.881***	4	-5.777**	7
GBD	-0.117	2	-3.562***	1	-0.478	3	-6.969***	3
RI	-2.967	4	-5.068***	1	-5.120***	9	-3.822***	3

Notes: ER is real exchange rate; GD is real government debt; GBD is real government budget deficit and RI is rate of interest. P* shows the maximum lag length, as determined by using AIC. Under PP test Q* shows Newey-West Bandwith, as determined by Bartlett-Kernel.

*** shows 1% significance level; ** shows 5% significance level and * represents 10% significance level.

The ARDL cointegration approach is used in order to explore the long run equilibrium relationship among variables. ARDL approach is adopted because two variables are stationary at first difference and one is stationary at level. Table 2 shows the results of bonds test for

cointegration. Results illustrated the long run relationship between the variables because the F-statistics lies above upper bonds.

Table 2

Results of bonds test for cointegration

Variables	F-Statistics	Conclusion (H0)
F (ER/GD, GBD)	4.930***	Conitegration
F (GD/ER, GBD)	1.249*	No Conitegration
F (GBD/ER, GD)	1.7962*	No Conitegration

Note: AIC and SBC were used for the lag length. * Indicates that the statistic lies below the lower bound, ** it falls within the lower and upper bounds and *** it lies outside the upper bound.

The next step is to estimate the short run dynamics among variables. ECM model is estimated from SBC-ARDL (1,0,0,0). Coefficient of error correction is insignificant and negative in sign. Coefficients of government debt and government budget deficit are positively significantly related with exchange rate.

Table 3

Results of Error Correction Model

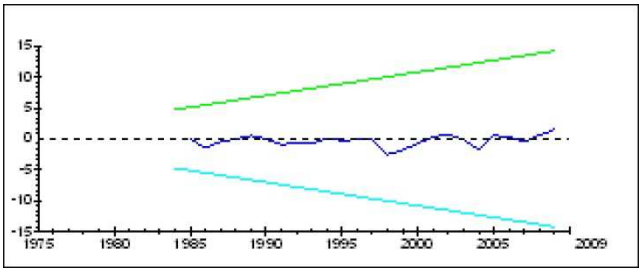
Error Correction Representation for the Selected ARDL Model			
ARDL(1,0,0,0) selected based on Schwarz Bayesian Criterion			
Variables	Coefficient	T-Ratio	
Constant	1.356	2.982	
dGD	0.1923	3.146	
dGBD	0.1435	1.986	
ECM(-1)	-0.1262	0.524	
R-Squared	0.527	R-Bar-Squared	0.502
S.E. of Regression	0.033	F-stat.	4.984[0.00]
DW-statistic	1.916		

Note: R-Squared and R-Bar-Squared measures refer to the dependent variable dER and in cases, where the error correction model is highly restricted, these measures could become negative.

Brown et al. (1975) proposed two tests Cumulative Sum and Cumulative Sum of Square, to check the structural stability. CUSUM test captured the systematic changes in regression coefficients, while CUSUMSQ detain the departure of parameters from constancy. Hence, parameter consistency is checked by using these two tests. Following graphs shows the stability of model for whole sample because the residuals are within 5% critical bonds (Fig. 1 & 2).

Figure 1

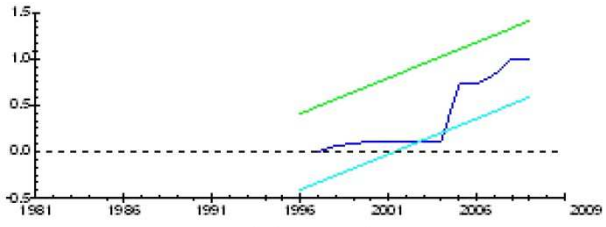
Cumulative Sum of Recursive Residual



The straight line represents critical bonds at 5% significance level

Figure 2

Cumulative Sum of Square Recursive Residual



The straight line represents critical bonds at 5% significance level

By using OLS technique we estimated equation 1, which have certain restrictions. Under these restrictions government debt and

government budget deficit has no impacts on exchange rate. Results of Wald test show that these restrictions are rejected; hence REH is rejected in case of Pakistan. These results are in line with Waqas et al. (2011)[8], Waqas & Awan (2011), Kazmi (1992, 1994).

Table 4

Results of the Model by Using OLS Technique

Variables	Coefficients	t-value	
Constant	3.574	2.115	
ΔGD	0.125	1.936	
ΔGBD	0.136	3.587	
$\alpha1=0$, $\alpha2=0$ χ^2 (2) = 10.95 [0.00]			
R-square	0.563	D.W	1.999
SER	2.383	F-statistic	4.98 [0.000]
Adjusted R-square	0.543		

The ARDL cointegration approach is also used to investigate the long run equilibrium relationship among the variables of equation 2 because two variables are stationary at first difference and one is stationary at level. Table 5 shows the results of bonds test for cointegration. Results illustrated the long run relationship between the variables because the F-statistics lies above upper bonds.

[8] By using Euler equation approach, this study investigates that liquidity constraints and infinite horizons are one of the main reasons of the failure of REH in case of Pakistan.

Table 5

Results of bonds test for cointegration

Variables	F-Statistics	Conclusion (H0)
F (RI/GD, GBD)	4.484***	Conitegration
F (GD/RI, GBD)	1.996*	No Conitegration
F (GBD/RI, GD)	1.799*	No Conitegration

Note: AIC and SBC were used for the lag length. * Indicates that the statistic lies below the lower bound, ** it falls within the lower and upper bounds and *** it lies outside the upper bound.

ECM model is estimated from SBC-ARDL (1,0,0,0). Coefficient of error correction is again insignificant and negative in sign. Coefficients of government debt and government budget deficit are positively significantly related with rate of interest.

Table 6

Results of Error Correction Model

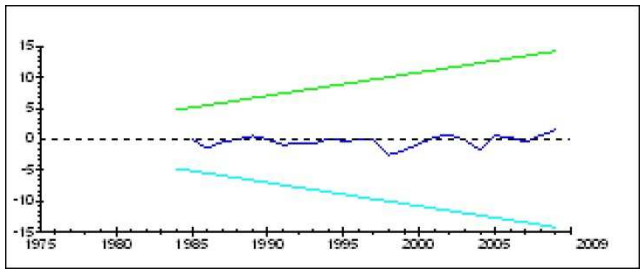
Error Correction Representation for the Selected ARDL Model ARDL(1,0,0,0) selected based on Schwarz Bayesian Criterion			
Variables	Coefficient	T-Ratio	
Constant	2.766	2.936	
dGD	0.22.9	2.121	
dGBD	0.178	1.993	
ECM(-1)	-0.225	1.230	
R-Squared	0.526	R-Bar-Squared	0.519
S.E. of Regression	0.0963	F-stat.	5.639[0.00]
DW-statistic	2.123		

Note: R-Squared and R-Bar-Squared measures refer to the dependent variable dRI and in cases, where the error correction model is highly restricted, these measures could become negative.

Following graphs shows the stability of model for whole sample because the residuals are within 5% critical bonds (Fig. 3 & 4).

Figure 3

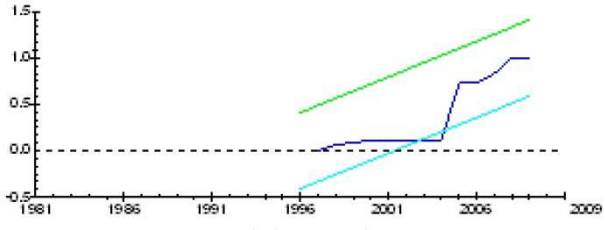
Cumulative Sum of Recursive Residual



The straight line represents critical bonds at 5% significance level

Figure 4

Cumulative Sum of Square Recursive Residual



The straight line represents critical bonds at 5% significance level

By using OLS technique we estimated equation 2, which have certain restrictions. Under these restrictions government debt and government budget deficit has no impacts on interest rate. Results of Wald test show that these restrictions are rejected; hence REH is rejected in case of Pakistan.

Table 7

Results of the Model by Using OLS Technique

Variables	Coefficients	t-value	
Constant	3.574	2.836	
Δ GD	0.653	2.899	
Δ GBD	0.945	2.538	
α1=0, α2=0 χ^2 (2) = 8.53 [0.000]			
R-square	0.596	D.W	2.001
SER	2.999	F-statistic	4.33 [0.00]
Adjusted R-square	0.563		

5. Conclusion

The aim of this study was to check the validity of REH with reference to Pakistan by using the annual data from 1973-2010. ARDL cointegration approach was used in order to check the short run and long run relationship among variables. Result depicts the long run relationship among variables. Moreover, by using Wald test the study tested some restrictions to check the validity of REH. Restrictions of both models are rejected and the study found no favour for REH with reference to Pakistan.

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