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# Ricardian equivalence hypothesis: Evidence from Pakistan

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**This paper provides empirical evidence on the soundness and relevance of the Ricardian equivalence hypothesis (REH) for Pakistan over the period 1960–2009. Time series properties have been examined in order to take care of the criticism made against the previous studies on REH notably model-specification, simultaneity bias and stationarity of data. Real income, real consumption, real government expenditure and real government revenue, though nonstationary, are not cointegrated. There is unidirectional causality from real income to real consumption, real government expenditure and real government revenue and from real government expenditure to real government revenue. We used impulse response functions to ascertain the impact of shocks of one variable upon others. The impact of real government expenditure and real government revenue on consumption is most notable and substantial that provides some support in favour of the REH. This happens in the short-run. Stabilization policies are adopted that aim at averting those shocks that harm the economy substantially in the short-run.**

**Key words:** Ricardian Equivalence; Granger-causality; Impulse Response Functions. **JEL Classification:** H3

## INTRODUCTION

The Ricardian equivalence hypothesis (REH)<sup>i</sup> is an economic theory that suggests it does not matter whether a government finances its spending with debt or a tax increase, the effect on total level of demand in an economy being the same. Governments can raise money either through taxes or by issuing bonds. Since bonds are loans, they must eventually be repaid presumably by raising taxes in the future. The choice is therefore, “tax now or tax later”. David Ricardo was the first to propose this possibility, though he was unconvinced of it (McCulloch 1888). Antonio De Viti De Marco elaborated on Ricardian equivalence starting in the 1890s (Feldstein 1985). Barro (1974, 1976) took the question up independently in the 1970s, in an attempt to give the proposition a firm theoretical foundation. The proposition remains controversial (Elmendorf and Mankiw 1998).

According to REH tax cuts do not affect desired consumption and hence desired saving given no change in current or planned government purchases because people know that they will pay higher taxes in future as the government has to pay its debt in the form of higher taxes that implies lower future disposable income. However, the Ricardian equivalence proposition may not

apply if consumers fail to take into consideration the expected future tax increases in their planning. In such situation a tax cut will increase consumption and reduce saving (Abel and Bernanki 2001). The REH simply states that consumers are indifferent or equivalent regarding the way government finances expenditure by taxation or issuing bonds. Barro (1974) has shown that the Ricardian equivalence proposition may still apply even if the current generation receives the tax cut and future generations bear the burden of repaying the government debt. REH implies that deficit-financed government spending may have neutral impact in the long-run (Barro 1989). Ricardian equivalence requires assumptions that have been seriously challenged. Feldstein (1976) argued that Barro ignored economic and population growth. He demonstrated that the creation of public debt depresses savings in a growing economy. O'Driscoll (1977) opined that Ricardo, in expanding his treatment of this subject for Encyclopedia Britannica article, changed so many features of it as to result in a Ricardian Nonequivalence Theorem. Ricardian equivalence has been the subject of extensive empirical inquiry (Briotti 2005). Blanchard (1985) and Bernheim (1987) have argued against the Ricardian equivalence proposition. Abel and Bernanki

(2001) have concluded that tax cuts that lead to increased government borrowing affect consumption and national saving, though the effect may be small because there are theoretical reasons to expect Ricardian equivalence not to hold exactly. Since the influential paper by Barro (1974) there have been a large number of theoretical and empirical studies of the REH.<sup>ii</sup>

Therefore, empirical tests of the REH became a necessity to arrive at some conclusion. Earlier studies have used single equation estimation based on ordinary least squares including at most a few lagged values of the consumption and income variables. It appears that non-availability of data determined the choice of estimation technique. Because of availability of long period and advanced econometrics notably time series econometrics techniques, it is agreeable that REH is examined from long-term perspective using more recent techniques of time series econometrics. The problem with the single-equation estimation methods is that these deal with the unidirectional influence of the regressors upon the regressand. The use of simultaneous equation models also did not overcome the standard econometrics problems. The problems of short-run as well as long-run relationship (cointegration) and causality in the variables is addressed by the time series econometrics methods. We will get highly misleading results if we apply conventional econometric methods to nonstationary data. This problem has been pointed out in the literature on Ricardian equivalence by Modigliani and Sterling (1990) and Khalid (1996) among others. Therefore, the purpose of the paper is to present an empirical analysis of the REH to see its soundness and relevance for Pakistan for the period 1960–2009. We explore the time series properties in order to overcome the problems of spurious regression, simultaneity bias, and the use of nonstationary data.

Barro (1974, 1976, 1989) did not accept the assertion that the decision to finance government expenditure by issuing bonds instead of raising taxes should lead to increased private consumption because economic agents are expected to regard those bonds as net worth and therefore might be tempted to increase consumption. Barro argued that if certain (rigorous) assumptions are satisfied, the way governments finances its expenditure either way should not really affect consumers' decisions. This implies that there should be equivalence (Ricardian equivalence) between the two different methods of financing. According to Barro, the decision of the government to finance its expenditure by issuing bonds to reduce taxation should induce the consumers to save the tax cut and invest it in the bonds in order to provide for future increase in taxation. Therefore they would increase their savings and not consumption. If consumers regard the bonds as net worth and decide to increase consumption rather than savings, then the increased supply of bonds would force interest rates to rise in order

to induce a higher demand for them. This increase in interest rates would lead to a substitution of private investment (crowding out) by government expenditure. This characterizes the Keynesian approach and is usually included in ISLM models. Knowing which of these two approaches is compelling is noticeably important since these have the implications for stabilization policies. The REH is based on restrictive assumptions: constant tax payers' population, perfect capital markets, forward-looking rational economic agents; future income flows and future tax burdens are certain; and tax is collected as a lump-sum etc. The theoretical studies have examined how the assumptions are realistic? Tobin (1980), Seater (1993), and others have shown doubts about the plausibility of the REH assumptions. Seater (1993) noted that Ricardian equivalence is only an approximation and its real relevance for the behaviour of an economy is an empirical question. The evidence supporting or otherwise has not been found to be conclusive (for example Barro 1989, Bernheim 1987, Seater 1993, and Khalid 1996). Empirical evidence on REH is mixed. Some studies have provided support for it (Evans 1988, Seater 1993, Kormendi and Meguire 1990, Bayoumi and Masson 1998). Other studies provided evidence against it (Bernheim 1987, Modigliani and Sterling 1990, Feldstein and Elmendorf 1990, Dalamagas 1992). Graham and Himarios (1996) and Khalid (1996) found mixed evidence for a sample of developing countries.

Giorgioni and Holden (2001) argued that these empirical tests suffer from certain weaknesses because in these tests it has been implicitly assumed that fiscal policy is an exogenous instrument in the hands of governments implying that government expenditure is independent of the level of real income. However, this assumption needs to be tested against the alternative hypothesis of Wagner's law that government expenditure rises in line with (or more than) income.<sup>iii</sup> Another unsettled issue is the relationship between government expenditure and gross domestic product. By extension, government consumption and investment on goods and services that are complementary will increase private consumption. Therefore, it is important to incorporate these inter-relationships among the different variables in the model.

## METHODOLOGY

Since we will deal with time series data, it is necessary that time series properties of the variables under study are explored in order to overcome the problem of spurious regression as highlighted in literature. The examination of stationarity/nonstationarity is important before doing any empirical work which is closely linked to the tests for unit roots. A series is stationary if its mean, variance and covariance are time-invariant otherwise

**Table 1:** ADF Results

Variable	Level With Trend	P	Result	First Difference	P	Result
lny	-2.09 (0.5381)	2	NS	-7.07 (0.000)	1	S
lnrc	-1.58 (0.785)	2	NS	-8.08 (0.000)	1	S
lnrg	-2.32 (0.4116)	0	NS	-6.92 (0.000)	0	S
lnrgr	-2.98 (0.1358)	0	NS	-6.05 (0.000)	1	S

Note: Test critical values for 1%, 5% and 10% are -4.17, -3.51 -3.18 for with trend and the figures in parentheses are MacKinnon (1996) one-sided p-values and p is the automatic lag length based on SIC (Schwarz Information criterion). S = stationary and NS = nonstationary, ln = natural log, y = real gross domestic product, rc = real private consumption, rg = real government expenditure, rgr = real government revenues

nonstationary. Cointegration may provide useful information about the relationship between the nonstationary variables. The general requirement for applying the cointegration technique is to have variables of the same order of integration at hand. Therefore, acceptance of cointegration between two series implies that there exists a long-run relationship between them. To test the data series for unit roots, Augmented Dickey-Fuller (ADF) test is used which is based on the following regression:

$$\Delta Y_t = \psi + \gamma Y_{t-1} + \beta_t + \sum \beta_j \Delta Y_{t-j} + \varepsilon_t \quad (1)$$

Where  $\varepsilon_t$  is assumed to be Gaussian white noise, test statistics based on (1) is called the  $\tau$  (tau) statistic. In the above regression equation the parameter of interest is  $\gamma$ . If the computed  $|\tau| < DF$  or MacKinnon(1996) critical  $\tau$  values then we do not reject the hypothesis that  $H_0: \gamma = 0$  and the given time series has unit root that is it is nonstationary or is integrated of order one or I (I) in Engle and Granger (1987) terminology. Now if  $H_0: \gamma = 0$  is rejected, then first difference stationary is confirmed which means that the original time series is integrated of order one.

Two-step procedure of Engle and Granger (1987) is a simple and popularly used test of cointegration. However, this test is appropriate for bivariate models. We use the maximum likelihood procedure of Johansen (1991, 1995). If the series are not cointegrated, standard Granger causality can be used. This test is highly sensitive to the choice of lag length that can be decided using diverse criteria and for lag selection, Akaike information criterion (AIC), Schwarz information criterion (SIC) and final prediction error (FPE) are generally used. The reported F-statistics are the Wald statistics for the joint hypothesis.

Following Giorgioni and Holden (2001), our model consists of four variables — real gross domestic product, real private consumption, real government expenditure and real government revenues — which have been commonly used in most empirical tests of the

REH. Bernheim (1987) observed that many models attempting at estimating REH were miss-specified because these models used aggregate revenues rather than marginal rates of taxation. Besides Bernheim (1987) contended that budget deficits were relevant for the REH, and he did not approve the use of vector autoregressions (VARs) for empirical examination of REH. VARs of differenced variables may be used but that have resulted in poor forecasting (Holden 1995). We use real values of the variables obtained by deflating the nominal variables by consumer price index. Non availability of data prevented the inclusion of the wealth effect. Similarly, budget deficit has not been included due to presence of both government expenditure and government revenues. We use an unrestricted vector autoregression (VAR) relating the four variables of interest. Holden (1995) and Robertson and Wickens (1994) noted that if all the variables are stationary, a VAR could be estimated. However, any shocks to stationary variables can only have a temporary effect. If the variables are not stationary and not cointegrated, the variables could be transformed to be stationary by taking first differences and the VAR could then be estimated with first differenced (now stationary) variables. However, a shock on a first-differenced variable will have a temporary effect on the change of the variable and a permanent effect on its level (Giorgioni and Holden 2001).

Therefore, the methodology consists of three steps. In the first step, we examine the variables for unit roots using ADF. In the second step, we use an unrestricted VAR comprising the underlying variables and determine the optimal lag length using three information criteria (AIC, FPE, SC). The third step involves the use of Johansen cointegration test in order to see the presence of cointegration. If the variables are cointegrated, then an ECM (error correction model) exists based on Engle and Granger Representation theorem (1987) otherwise we use Granger Causality test.

The data on the aforementioned four variables have been taken from Government of Pakistan, Economic

**Table 2:** VAR Lag Order Selection Criteria: variables Iny Inrc Inrg Inrgr

Sample: 1960 - 2009			
Lag	FPE	AIC	SC
0	2.40e-07	-3.891943	-3.732931
1	1.16e-10*	-11.53122*	-10.73616*
2	1.89e-10	-11.05600	-9.624886
3	1.57e-10	-11.28631	-9.219148
4	2.58e-10	-10.87227	-8.169060

\* indicates lag order selected by the criterion

**Table3:** Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.187095	22.54742	47.85613	0.9678
At most 1	0.142467	12.60463	29.79707	0.9088
At most 2	0.097174	5.227230	15.49471	0.7842
At most 3	0.006653	0.320435	3.841466	0.5713

Trace test indicates no cointegration at the 0.05 level; \*\*MacKinnon-Haug-Michelis (1999) p-values ; CE(s) = number of cointegrating equations. Test Results Series: Iny Inrc Inrg Inrgr; Lags interval (in first differences): 1 to 1; Unrestricted Cointegration Rank Test (Trace)

**Table 4:** Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.187095	9.942788	27.58434	0.9857
At most 1	0.142467	7.377402	21.13162	0.9376
At most 2	0.097174	4.906795	14.26460	0.7536
At most 3	0.006653	0.320435	3.841466	0.5713

Max-eigenvalue test indicates no cointegration at the 0.05 level; \*\*MacKinnon-Haug-Michelis (1999) p-values

survey (various issues). We have used annual data because quarterly data were not available. The period of the study is 1960-2009.

## EMPIRICAL RESULTS

We performed ADF test to check whether data series are stationary or not. Table1 provides the ADF test results for level as well first difference. The results show that the variables are nonstationary or integrated of order 1 in level as well as first difference. The null hypothesis that the series has a unit root in level form is accepted as the

absolute values of the  $\tau$ - statistic are less than critical values. Similarly the null hypothesis that the series is first difference nonstationary is rejected because the absolute value of the  $\tau$ -statistic exceeds the critical values for all the underlying variables coupled with significant MacKinnon (1996) one-sided p-values. Thus all the variables are nonstationary and have a unit roots. Before applying the Johansen test, we determined the lag order of our four variables VAR. Lag 1 was preferred by AIC, FPE and SC (Table 2). Since the three information criteria have indicated lag 1 for the VAR, we use the same lag for empirical examination. Johansen cointegration results (Table 3 and Table 4) show absence of cointegration

**Table 5:** Granger Causality Test

<b>Null Hypothesis:</b>	<b>Obs</b>	<b>F-Statistic</b>	<b>Probability</b>
rc does not Granger Cause y	50	2.09533	0.15453
y does not Granger Cause rc		5.27881	0.02619
rg does not Granger Cause y	50	0.01338	0.90841
y does not Granger Cause rg		4.93752	0.03124
rgr does not Granger Cause y	50	0.31515	0.57726
y does not Granger Cause rgr		3.27920	0.07670
rg does not Granger Cause rc	50	0.44089	0.51001
rc does not Granger Cause rg		5.39578	0.02466
rgr does not Granger Cause rc	50	0.01805	0.89370
rc does not Granger Cause rgr		2.32260	0.13435
rgr does not Granger Cause rg	50	4.11408	0.04834
rg does not Granger Cause rgr		2.07065	0.15693

between the four variables. We performed standard Granger causality test. This test is sensitive to lag length. We used the three information criteria to determine the lag length and lag 1 was found optimal. The Granger causality test results (Table 5) show that the null hypothesis that real income (y) does not Granger-cause real consumption, real government expenditure and real government revenue, and government expenditure does not Granger-cause government revenue is rejected by the F-statistic at 5% level. These results imply that there is unidirectional causality from real income to real consumption, real government expenditure and real government revenue and from real government expenditure to real government revenue. Masih and Masih (1995) pointed out two limitations of the Granger-causality tests. First, these tests do not indicate the positive or negative direction of response. Second is the fact that they can be interpreted as within-sample tests but might provide little evidence on the dynamic properties of the system. To solve these problems impulse response functions are used. An impulse response function traces out the response of the dependent variable in the VAR system to shocks in the error terms. We use the first differences of the variables because the variables are neither stationary nor cointegrated.

The results of impulse response functions indicate the impact of shock of one variable upon others (Table 6 and Table 7). We considered 10-periods that seem sufficient examining the effects of shocks. Because of income shock (1), income falls in the second period; becomes negative in the third period and dies out in the remaining periods. The same pattern is observed for other three variables. For consumption shock (2), we see almost similar pattern. It becomes negative in the second period and dies out in the subsequent periods. Considering real government expenditure shock (3), real government revenue falls considerably in the third period but

improves in period 5 and consequently dies out in the remaining periods. Real government revenue follows similar trend. The impact of both government expenditure and government revenue on consumption even in the first period is negative. Figure 1 shows the above-mentioned responses to respective shocks. Shock to income due to consumption shock is noteworthy. It demonstrates a precipitate fall vis-à-vis expenditure and revenue shocks. Consumption falls appreciably due to expenditure and revenue shocks. This happens in the short-run. In the long-run they all almost converge. This implies that the shocks have not perennial effect. Economy possesses adequate resilience to absorb those shocks. However, in the short-run the shocks affect the economy to a greater extent. Therefore, macroeconomic stabilization policies are adopted that aim at averting those shocks that harm the economy substantially in the short-run that baulk the smooth functioning of the economy.

## Conclusions

This paper provides empirical evidence on the soundness and relevance of the Ricardian equivalence hypothesis for Pakistan over the period 1960-2009. Time series properties have been examined in order to take care of the criticism made against the previous studies on REH notably model-specification, simultaneity bias and stationarity of data. Real income, real consumption, real government expenditure and real government revenue, though nonstationary, are not cointegrated implying that the long-run relationship does not exist among the variables under consideration. Causality runs from real income to real consumption, real government expenditure and real government revenue. Government expenditure Granger-causes government revenue. This means that there is unidirectional causality from real income to real

**Table 6:** Impulse Response Functions: Cholesky Ordering: dln (income), dln (rc), dln (rg) dln (rgr)

<b>(1) Response to one standard Deviation shock of dlny</b>				
<b>Period</b>	<b>dlny</b>	<b>dlnrc</b>	<b>dlnrg</b>	<b>dlnrgr</b>
1	0.049710	0.000000	0.000000	0.000000
2	0.008299	-0.015606	0.007443	-0.008384
3	-0.025195	-0.010737	-0.011198	-0.010720
4	-0.005894	0.007709	-0.004856	-0.006194
5	0.007258	-0.002901	0.002927	0.009475
6	-0.000631	0.003272	0.004028	0.003574
7	-0.001045	0.007973	-0.004155	-0.002431
8	0.002071	0.002481	-0.002488	-0.004871
9	-0.003480	-0.003642	0.000965	0.000968
10	-0.002197	-0.001054	0.002001	0.001894
<b>(2) Response to one standard Deviation shock of dln_(rc)</b>				
1	0.049903	0.029437	0.000000	0.000000
2	0.014874	-0.017973	0.011585	-0.006017
3	-0.033471	-0.008791	-0.016049	-0.017759
4	-0.010258	0.006834	-0.002803	-0.003115
5	0.013944	-0.003693	0.003233	0.010698
6	0.003875	0.000728	0.007504	0.006690
7	-0.003509	0.007702	-0.006563	-0.005644
8	0.001448	0.003707	-0.003552	-0.006314
9	-0.004535	-0.004833	0.001345	0.000995
10	-0.002841	-0.001561	0.003072	0.003786

**Table 7:** Impulse Response Functions: Cholesky Ordering: dln (income), dln (rc), dln (rg) dln (rgr)

<b>(3) Response to one standard Deviation shock of dln(rg)</b>				
<b>Period</b>	<b>dlny</b>	<b>dlnrc</b>	<b>dlnrg</b>	<b>dlnrgr</b>
1	0.034227	-0.051918	0.096972	0.000000
2	-0.011346	-0.012303	-0.009599	-0.004043
3	0.034160	-0.031874	0.009239	-6.75E-05
4	-0.004554	0.010199	-0.015329	-0.006682
5	-0.019055	0.014095	0.028146	0.015527
6	-0.011122	0.015009	-0.011782	-0.006526
7	0.005741	0.003704	0.005578	0.004272
8	-0.003688	-0.002436	-0.001875	0.002141
9	0.005539	0.002903	0.009608	0.007305
10	0.004507	-0.002072	-0.001665	-0.002929
<b>(4) Response to one standard Deviation shock of dln_(rgr)</b>				
1	0.041287	-0.011602	0.028887	0.066832
2	-0.000840	-0.027265	0.014669	-0.008039
3	-0.020021	0.003330	-0.023599	-0.011205
4	-0.002614	-0.005364	0.004391	-0.009284
5	0.002038	-0.015576	0.007447	0.019737
6	-0.001185	0.001761	0.011740	0.004879
7	0.008243	0.004807	-0.010464	-0.001469
8	0.001972	0.002473	0.000981	-0.007496
9	-0.011271	-0.003753	-2.88E-05	0.002667
10	-0.002446	0.002013	0.004003	0.001274

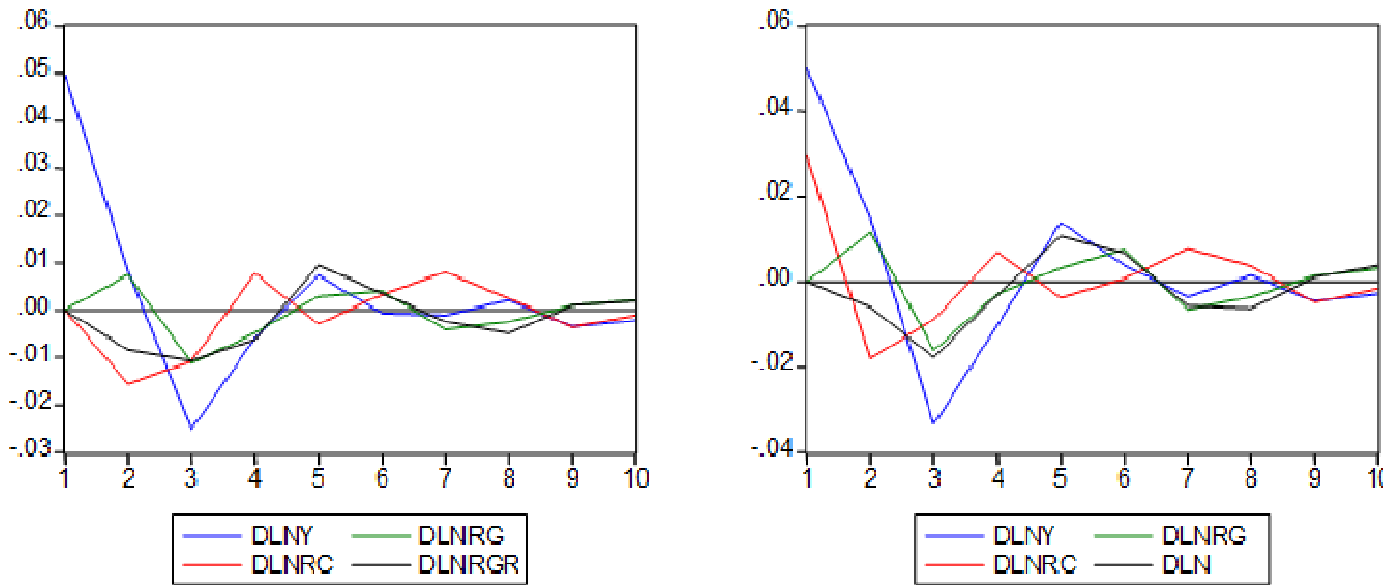


Figure 1. Response of DLNY to Cholesky one S.D innovations

consumption, real government expenditure and real government revenue and from real government expenditure to real government revenue.

Due to the problems associated with Granger causality, we used impulse response functions to ascertain the impact of shocks of one variable upon others. Similar patterns of shocks have been observed. However, the impact of real government expenditure and real government revenue on consumption is most notable and substantial. This happens in the short-run and these shocks have not perennial effect. Economy possesses adequate resilience to absorb those shocks. Therefore, stabilization policies are adopted that aim at averting those shocks that harm the economy substantially in the short-run that baulk the smooth functioning of the economy.

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#### ENDNOTES

- i It is also known as the Barro-Ricardo equivalence theorem (Buchanan 1976)
- ii For a survey see Briotti (2005), Seater (1993), Leiderman and Blejer (1988), Bernheim (1987)
- iii see Afzal and Qaisar (2010) for detail in the context of Pakistan economy