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Saving and Growth Nexus in Pakistan: Innovation Accounting Technique

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Abstract

The paper investigates the relationship between economic growth and domestic savings. We used ARDL Bounds Testing and Johansen Cointegration approaches for long-run association, and Innovation Accounting Technique along with Toda and Yamamoto (1995) for causal relationship using annual time series data for the period 1971 to 2007. Ng-Perron De-trended Test is used to determine the order of integration among data series. Results reveal that there exists a long-run relationship between economic growth and domestic savings. Causal results through innovation accounting technique assert that there is one-way causality, running from economic growth to domestic savings while very weak from opposite side. Results by Toda and Yamamoto's technique also confirm that economic growth leads domestic savings in Pakistan.

I. Introduction and Background of the Issue

According to Lewis's (1955) conventional development theory 'savings stimulate the economic growth through investment activities' while saving behavior also encourages the economic growth (Kaldor 1956; Samuelson & Modigliani 1966). In 1990s, contrary to conventional theory a new aspect emerged, i.e., 'savings contribute to accelerate investment which enhance Gross Domestic Product (GDP) in short span of time' (Bacha 1990; DeGregorio 1992; Jappelli & Pagano 1994). A number of studies showed that economic growth encourages the savings (see for instance, Sinha & Sinha 1996; Sinha & Sinha 1998; Salz 1999; Anoruo & Ahmad 2001; Ramesh 2006; Sinha & Sinha 2007). Edwards (1995) argued that economic growth is one of

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the most important determinants of not only private savings but also of public savings.[2]

In economic literature, researchers have used different econometric techniques and probed the issue. For example, several economists (e.g., Bacha 1990; Otani & Villanueva 1990; DeGregorio 1992); and Jappelli & Pagano 1994) have employed Ordinary Least Squares (OLS) method using cross-sectional data and concluded that higher savings leads to higher economic growth. Recently, Krieckhaus (2002) argued that increased national savings leads to higher investment and hence contribute to higher economic growth. The concept of Granger-causation in this area was introduced by Caroll & Weil (1994). They concluded that economic growth causes high savings. Using five-year averages of the economic growth rate and savings for OECD countries, Attanasio, et al. (2000) argued that using annual data rather than the five-year average increases exactness and significance of empirical estimation as well as direction of causal relation.

Sinha and Sinha (1996) found that economic growth leads to higher savings and it is particularly true in the case of a developing economy such as Pakistan. Sinha and Sinha (1998) investigated the causal relationship between economic growth and savings for Mexico and found that it runs from economic growth to savings.[3] In 2007, they also investigated the same relationship for Philippines and concluded that economic growth leads to higher domestic savings. On the other hand causality was found from gross domestic savings to economic growth for Sri-Lanka (Sinha and Sinha 1999). Saltz (1999) investigated the causal relationship between the same variables by employing Vector Error Correction (VEC) and VAR (Vector Auto Regressive) model. The study concluded that higher growth rate of real GDP contribute to higher growth of savings. Anoruo and Ahmad (2001) employed VEC to find out direction of causality between savings and economic growth in seven African countries. They found a bi-directional causality for Cote d'Ivoire and South Africa. Only for Congo, the growth rate of domestic savings leads economic growth.

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[2] *Caroll, et al. (2000) demonstrated that 'if utility depends partly on how consumption compares to a habit stock determined by past consumption, an otherwise-standard growth model can imply that increase in growth can cause increased saving'.*

[3] *Triantis (1997) questioned the validity of the life cycle model.*

Mavrotas and Kelly (2001) investigated direction of causal relationship among gross domestic product, gross domestic savings, and private savings through employing Toda and Yamamoto (1995) technique for India and Sri Lanka. They concluded that for India no causality between GDP growth and private savings exists while for Sri-Lanka bi-directional causality prevails. Agrawal (2001) examined the causality between GDP and saving for a number of Asian countries and concluded that for most countries causality flows from GDP to saving. Countries like Singapore, South Korea, Malaysia, Thailand, and the Philippines were investigated by Baharumshah, et. al. (2003). The study employed VEC on time series data from 1960-1997 and found that there is no causality between gross domestic savings and economic growth except for Singapore. Ramesh (2006) determined the direction of same type of causality for high income countries, lower middle countries, upper middle countries and lower income courtiers and supported the hypothesis that economic growth leads to higher gross domestic savings. The relationship between savings and growth is differing for economies due to their economic structure and possibly due to different research techniques. To entangle the relationship of Pakistan, it is attempted by new techniques and fresh data.

The present study is an innovational addition in the literature due to its difference from existing literature. It is different from the previous ones in the following aspects; long-run association and its robustness is examined through ARDL Bounds Testing and Johansen Cointegration techniques, for direction of causality Innovation Accounting Technique and Toda and Yamamoto (1995) is employed and to check the order of integration of variables, Ng-Perron (2001) is applied. The organization of the study is as follows; following introduction, Section II outlines methodology of the study. Section III describes results and discussion while section IV provides conclusions of the paper.

II. Methodology

Vector Auto Regression (VAR) approach is commonly used to investigate the dynamics of the relationship between two macroeconomic variables, as well as for the other variables such as gross domestic savings and economic growth. VAR is usually applied to avoid shortfalls of endogeniety and integrating order of variables**.** The present endeavor is different as it would employ Innovation Accounting Technique (Impulse Response Function and Variance Decomposition) to investigate causal relationship. It is based on the property that forecast error variance decomposition allows inferences to be

concluded with reference to the proportion of movements in particular time periods due to its own shocks and shocks arising from other variables in the VAR. By using VAR, impact of a shock can be checked in a particular variable traced through the system of equations that determine the impact on other variable and also variables that include future values of shocked variables.

This approach breaks down the variance of the forecast error for each variable following a shock to particular variable that makes possible to identify which variable affects strongly and vis-à-vis impact. For example, a shock in economic growth leads subsequently to a change in gross domestic savings in the estimated VAR approach, but shock in gross domestic savings has only minor or small effect on economic growth, from this exercise, we can infer and conclude that economic growth leads gross domestic savings or causality runs from economic growth to gross domestic savings.

On the other hand, impulse response function investigates the time path of the effects of shocks of independent variables. This approach also determines, how each actor responds over time to the first shocks in other variables. So these two methods are named as Innovation Accounting that allows an intuitive insight into the dynamic relationship between gross domestic savings and economic growth. They are applied on the annual time series data for the years 1971-2007 for Pakistan.

According to variance decomposition, it breaks down the forecast error for gross domestic savings and economic growth, if gross domestic savings explain more of the variance**,** then, in accordance with the above discussion, a VAR system is established for the present study that makes following model:

$$V_t = \sum_{i=1}^{k} \delta_i V_{t-1} + \eta_t \qquad (1)$$

Where, $V_t = (LEG, LGDS)$, and $\eta_t = \langle \eta_{LEG}, \eta_{LGDS} \rangle$, $\delta_1 - \delta_k$ are two by two matrices of coefficients and η is a vector of error terms. LEG = log of economic growth peroxide by income per capita and LGDS = log of gross domestic savings as share of GDP.

III. Results and Discussion

Ng-Perron (2001) test is employed to investigate the order of integration for the said actors. The results of unit root test at level and at 1st

difference with constant and trend are shown in table-1. The values of *MZa, MZt, MSB & MPT* are greater than critical values indicating non-stationary at level. Results at the 1st difference show that both variables are stationary. It concludes that economic growth and gross domestic savings are having *I(1)* order of integration.

Table-1: Variable's Order of Integration

Ng-Perron at Level				
Variables	MZa	MZt	MSB	MPT
LEG	-9.1833	-2.0172	0.2196	10.3964
LGDS	-10.624	-2.2484	0.2116	8.84327
Ng-Perron at 1st Difference				
LEG	-16.9357	-2.9052	0.1715	5.4087
LGDS	-31.4951	-3.8847	0.1233	3.3594

*Ng-Perron (2001, Table 1)

After obtaining the order of integration of running actors, table-2 and 3 show evidences of the existence of long-run relationship between gross domestic

Table-2: ARDL Estimation with Parsimonious Model Results

ARDL with Constant & Trend			
Dependent Variable	**F-Statistics**	**Wald- Statistics**	**Chi-square**
LEG	*11. 284*	8.889 (0.0013)	17.778 (0.0001)
LGDS	5.798	3.349 (0.0522)	6.698 (0.0351)
Critical Bounds	**Instability Level**	***Lower Bound***	***Upper Bound***
	1% 5% 10%	8.74 6.56 5.59	9.63 7.30 6.26

Pesaran, et, al (2001)

Table-3: Johansen First Information Maximum Likelihood Test for Co-integration

Hypotheses	**Trace-Test**	**5% critical value**	**Prob-value****	**Hypotheses**	**Max-Eigen Statistic**	**5% critical value**	**Prob-value**
R = 0	35.4882	18.3977	0.0001	*R = 0*	33.5729	17.1476	0.0001
R ≤1	1.91531	3.8415	0.1664	*R= 1*	1.91531	3.8415	0.1664

**MacKinnon, et al. (1999) p-values.

savings and economic growth in Pakistan.[4] ARDL bounds testing approach is intimating the one co-integrating vector between variables like Johansen First Information Maximum Likelihood Test for Co-integration.Table-4 shows that how the forecast error variance of the variables can be broken down into components that can be attributed to each of our variables in VAR. It shows the exact explanations about their relationship through innovation shocks while forecast error variance decomposition of unrestricted VAR (3) models are estimated over a 10-year forecast time horizon.

From the test it may be concluded that each time series describes the prevalence of its own values. Economic growth explains more than 97 percent of its forecast error variances that is explained through its own innovative shocks, whereas, gross domestic savings show innovative impact through its own shocks by nearly 58 percent. It shows that economic growth is predominantly explained by its past values or innovative shocks and mildly through gross domestic savings. It may also be concluded that current economic growth influences future growth trends. Gross domestic savings lead economic growth not more than 3 percent through its innovative shocks while economic growth leads gross domestic savings by more than 42 percent through their innovative shocks on each. The phenomenon explained that there is one-way causality running from economic growth to gross domestic savings. It is supported by Sinha and Sinha's (1996) arguments for Pakistan based on simple Granger causality approach.

Table-4: Variance Decomposition Percentages of 35-Year Error Variance

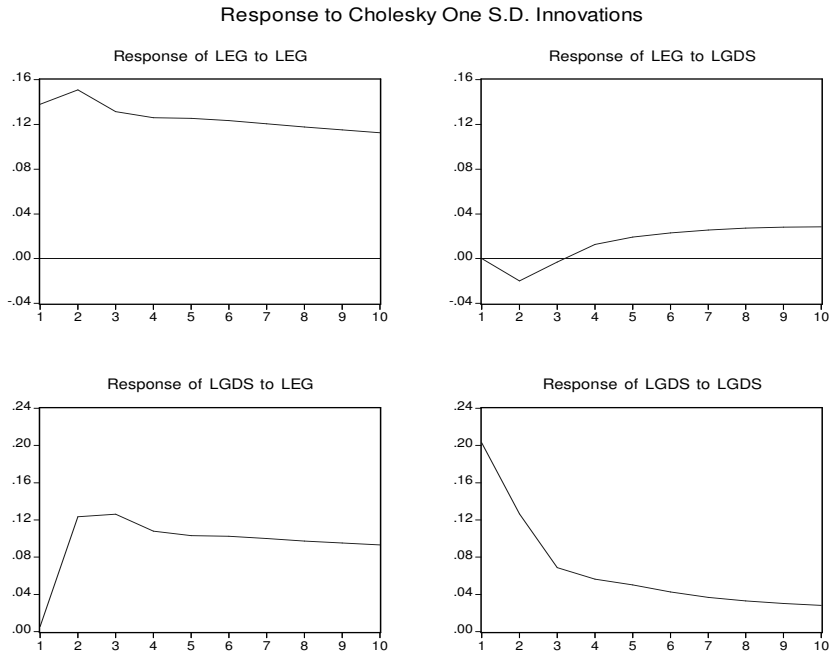
	Typical Shocks in	
Percentage of Forecast Error Variation in	LEG	LGDS
LEG	97.30	2.70
LGDS	42.11	57.89
Toda and Yamamoto for Granger Causality		
Variables	LGNPC	LGDS
LEG	-	0.058
LGDS	8.065*	-

[4] *Methodological Framework of both ARDL and Johansen Co-integration approaches is given in Appendix-A.*

To test the robustness of the causality between economic growth and domestic savings Toda and Yamamoto (1995) technique has also been employed.[5] The results of table-4 show that only economic growth leads the gross domestic savings but gross domestic savings has no causal relation with economic growth. The results are matching with the results by Innovative Accounting Techniques.

Finally, Impulse response function is utilized to investigate the time paths of log of economic growth (LEG) in response to one-unit shock to log of gross domestic savings (LGDS) and vice versa. A graphical representation of impulse response function provides a spontaneous insight into dynamic relationships as it shows that how economic growth responds over time to a shock in gross domestic savings and vice versa.

Figure-1: Impulse Response Functions



[5] *One of the shortcomings of the Granger causality test procedure is that the variables used in the test must be stationary. While the main advantage of Toda and Yamamoto (1995) is that it allows for the variables in the VAR to be non-stationary or even co-integrated. It, therefore, allows us to test for causality between the levels of economic growth with domestic savings even though, if both actors are known to be non-stationary.*

IV. Conclusions

The main focus of this study was to investigate the long-run relationship between economic growth and savings in Pakistan. For the purpose ARDL, Bounds and Co-integration techniques were applied. The results explain that in the case of Pakistan, there prevailed not only long-run relationship between economic growth and gross domestic savings but also the robustness of relationship in long span of time. To find out the direction of causality, Innovation Accounting Approach and Granger-causality by Toda and Yamamoto (1995) were applied. Both results suggest that economic growth leads to the gross domestic savings that means the direction of causality is from economic growth to domestic savings but there is no response from opposite side. It explains that Pakistan's society is a consumption society and has fewer tendencies to save at micro and macro level for national investment.

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Appendix-A

A1. ARDL Bounds Testing Procedure

The ARDL approach to cointegration is selected as it performs better in small sample sizes than other cointegration techniques. Besides, it is applicable irrespective of whether the underlying regressors are purely *I*(0), purely *I*(1) or mutually co-integrated.[6] The statistic underlying this procedure is similar to Wald or F-statistic in a generalized Dickey-Fuller type regression, which is used to test the significance of lagged levels of the variables under consideration in a conditional unrestricted equilibrium error correction model (ECM) (Pesaran, et. al. 2001). The ARDL approach involves estimating the following Unrestricted Error Correction Model (UECM):

$$\Delta Y_t = a_\circ + \sum_{i=1}^{p} \alpha_1 \, \Delta Y_{t-i} + \sum_{i=1}^{p} \alpha_2 \, \Delta X_{t-i} + \beta_1 \, Y_{t-1} + \beta_2 \, X_{t-i} + \varepsilon_{1t} \qquad (2)$$

Where Δ is the difference operator, p represents the lag structure, Y_t and X_t are the underlying variables, and ε_{1t} and ε_{2t} are serially independent random errors with mean zero and finite covariance matrix. The null hypothesis is H_0: $\beta_1 = \beta_2 = 0$, i.e. there exists no long-run equilibrium relationship, and the alternative hypothesis is $H_1: \beta_1 \neq \beta_2 \neq 0$ (Pesaran, et. al. 2001). These hypotheses are tested using the *F*-test. However this test has non-standard distributions depend on the sample size, the inclusion of intercept and trend variable in the equation, and the number of regressors. The estimated ARDL test statistics are compared to two asymptotic critical values reported in Pesaran, et. al. (2001:300-304) rather than to conventional critical values. If the test statistic is above than upper critical value, the null hypothesis of long-run relationship can be rejected regardless of the orders of integration of the underlying variables. The opposite is the case if the test statistic falls below a

[6] *The second advantage of using the bounds testing approach to Co-integration is that it performs better than Engle and Granger (1987), Johansen (1988) and Philips and Hansen (1990) Co-integration test in small samples (see, e.g., Haug 2002). The third advantage of this approach is that, the model takes sufficient number of lags to capture the data generating process in a general-to-specific modeling framework (Laurenceson and Chai 2003). However, Pesaran and Shin (1999) contented that 'appropriate modification of the orders of the ARDL model is sufficient to simultaneously correct for residual serial correlation and the problem of endogenous variables.'*

lower critical value. If the sample test statistic falls between these two bounds, the result is inconclusive.

A2. Johansen Co-integration

In order to test the robustness of the results, we also applied the traditional Johansen Co-integration procedure. The Johansen (1991, 1995) Co-integration involves investigation of the *p*-dimensional vector Autoregressive procedure of k^{th} order:

$$\Delta X_t = \alpha + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \eta_t \qquad (3)$$

where Δ is the first difference lag operator, X_t is a $(p \times 1)$ random vector of time series actors with order of integration equal to *I(1)*, α is a $(p \times 1)$ vector of constant, Γ_i are $(p \times p)$ matrices of parameters η_t is a sequence of zero-mean *p*-dimensional white noise vectors, Π is a $(p \times p)$ matrix of parameters, the rank of which contains information about long-run link between the underlying variables. Vector error-correction model (VECM) expressed in equation reduces to an orthodox vector autoregressive (VAR) model in first differences if the rank *(r)* of Π is zero, while if Π has full rank *p=r*, all elements in X_t are stationary. Further more, $0 < r < p$ suggests the prevalence of *r* co-integrating vectors, such that there exists $(p \times r)$ matrices, δ and β each of the rank *r* such that $\Pi = \delta\beta'$, where the columns of the matrix, δ is adjustment factors and rows of the matrix β is the cointegrating vectors with property that $\beta' X_t$ is stationary even though X_t may comprise of individually *I(1)* process. Test of the hypothesis that the number of Cointegration vectors is at most r(r=1….p) are conducted utilizing the likelihood ration (trace) test for reduced rank in the context of restrictions forced by Cointegration on the unrestricted VAR involving series X_t.