The Relationship between Savings and GDP in Iran: An ARDL Approach for the case of Iran

Mohsen Mehrara

Faculty of Economics, University of Tehran, Tehran, Iran

Maysam Musai

Faculty of Social Sciences, University of Tehran

Sima Nasibparast

MSc in Economics, University of Tehran

Abstract
The objective of this paper is to examine the relationship between savings and economic growth in Iran for the period 1970-2008, based on the autoregressive distributed lag (ARDL) approach. The study finds a cointegrating relationship among real GDP, savings, labor force, oil revenues and education. Compared to the other variables, labor force and human capital (education) have the most important effect on economic growth particularly in long-run. Moreover, in short-run just oil revenues and labor have significant effects on economic growth. Estimating error correction model revealed that the speed of adjustment to restore equilibrium is -0.68 which confirms that there is a stable long-run relationship. Regarding weak impact of saving on economic growth, it seems that government and policy makers should employ policies that would accelerate economic growth through higher productivity and privileged human capital.

JEL classification: C12, C22, C52, E21, F43
Keywords: ARDL, Gross Domestic Savings (GDS), Economic Growth, Iran Economy

1. Introduction

In the theories of economic growth, it is often argued that increased level of savings can enhance economic growth through increased level of investment. According to theories of consumption, On the other hand, Savings can be affected by many factors, including economic growth. Hence, if economic growth rises, the level of savings can be increased. According to these two point of views expressed in economic theories, investigating the relationship between savings and economic growth is an important as well as controversial issue for economists and policy makers. Some researchers have analyzed it as cause and effect relationship. Another group of economists believe in capital fundamentalists’ point of view that savings cause growth.
There is a third group of economics who have confirmed Keynesian theory that savings depend upon the level of output.

As a result, because of the importance of savings in economic growth and also the effective role of economic growth in increasing savings, it is necessary to investigate the relationship between the level of savings and economic growth in Iran, and its results can be useful in designing policies.

In this paper we examine the short- and long-run relationships between savings and economic growth for Iran over the period 1970-2008, using Autoregressive Distributed Lag (ARDL) approach to cointegration and error correction models (ECM).

The rest of the paper is organized as follows. Section 2 reviews the literature. Section 3 describes data and methodology. Results are reported in Section 4. Section 5 concludes.

2. Review of Literature

Andersson (1999) investigated the causality between saving and growth in Sweden (1950-1996), UK (1952-1996), and USA (1950-1997). Saving and GDP were estimated in bivariate vector autoregressive or vector error-correction models, and tests of Granger non-causality were performed within the estimated systems. According to the results, the author suggested that the causal chains linking saving and output was different across countries. In the UK, there was a bi-directional causality between GDP and gross saving. In the Swedish case, the temporal dependence is more unidirectional from saving dynamics to output growth. For the US there was no statistically significant long-run relationship between the variables. The results also indicated that the variables could be connected in Granger-causal chains through different channels, in ‘long run’ and 'short run' chains, which might differ both regarding direction and sign.

In his paper, Romm (2003) applied Johansen VECM estimation technique to investigate the directions of relationship between savings and growth in South Africa over the period 1946-1992. The results of this study indicated not only a direct and an indirect effect of private saving rate on growth but also a positive effect of growth on the private saving rate. Romm implied that the indirect effect of private saving rate on growth is through the private investment rate. He suggested the existence of a virtuous cycle as growth enhances saving, which in turn further enhances growth.

Nwachukwu and Egwaikhide (2007) examined the determinants of private saving in Nigeria or the period 1970-2005. They compared the estimation results of the Error-Correction Model with those of three conventional models: Partial-Adjustment, Growth Rate and Static Models. The conclusion was that the ECM performed much better than the other models. The estimation results for the error-correction model pointed to the level of per capita income, terms of trade changes, public saving rate, external debt service ratio, and the inflation rate as having statistically positive influences on domestic saving. The real interest rate and growth rate of income had a negative impact on the saving rate. They also found a clear role for fiscal policy in increasing total saving in the economy, with the private sector considering public saving as a complement for its own saving.

Sajid and Sarfraz (2008) applied cointegration and vector error correction techniques to investigate causal relationship between savings and output in Pakistan using quarterly data for the period of 1973:1 to 2003:4. They discovered a bidirectional long-run relationship between savings and output level, a unidirectional long-run causality from public savings to output (GNP
and GDP), and a unidirectional from private savings to gross national product (GNP). They also found that the speed of adjustment in case of savings is stronger than that of level of output. Their results also indicated that there is a mutual short-run relationship between GDP and domestic savings, and a unidirectional short-run causality from GNP to national and domestic savings, and a unidirectional relationship from GDP to public savings.

In their study, Agrawal and Sahoo (2009) investigated the long-run determinants of total and private savings and the direction of causality between savings and growth in Bangladesh over 1975-2004. The evidence indicated that total savings rate is determined by GDP growth rate, dependency ratio, interest rates and bank density. It is also revealed that private savings rate is affected by the public savings rate. In addition, using the Granger Causality tests, the results suggested a bi-directional causality between savings and growth. Agrawal and Sahoo also applied the Forecast Error Variance Decomposition (FEVD) analysis using the VAR framework. The causality results obtained using the Granger causality tests and the estimated savings functions are confirmed using FEVD analysis.

Abu (2010) employed Granger causality and cointegration techniques to analyze the association relationship between saving and economic growth in Nigeria during the period 1970-2007. According to the results, he concluded that the variables (economic growth and saving) are cointegrated, and that a long-run equilibrium exists between them. He also suggested that causality runs from economic growth to saving. So the Solow’s hypothesis that saving precedes economic growth is rejected, and the Keynesian theory that it is economic growth that leads to higher saving is accepted in Abu's study.

Shahbaz and Ali Khan (2010) investigated the relationship between economic growth and domestic savings in Pakistan for the period of 1971-2007. In doing so, Cointegration techniques and ARDL Bounds Testing were employed to examine for long run association, while Innovative Accounting Techniques and Toda and Yamamoto (1995) were applied for causal relationship. Ng-Perron de-trended test was used for order of integration of running actors. The results revealed that there was a long run relationship between economic growth and domestic savings and their association was robust at least in long span of time. Causal results through Innovative Accounting technique asserted that there was one-way causality running from economic growth to domestic savings. But the causality from the opposite side was weak. The results attained by Toda and Yamamoto’s technique also confirmed that economic growth causes domestic savings in Pakistan.

Budhedeo (2012) attempted to empirically examine the growth-saving relationship in India for determining the causal linkages between the two using annual data for over sixty years of the planned economic era. In his study, Budhedeo examined the causal relationship between growth rate of saving and economic growth rate using the unit root test and Wald’s F statistic for Granger causality testing. The empirical results revealed that there is absence of any causal relationship between saving growth rates and economic growth rates in either direction for India and hence the two variables are independent of each other.

3. Data and Methodology

To allow for causality and dynamics and given that not all of our time-series may be stationary to the same order (some are I(0) while others are I(1)), the cointegration technique suggested by Pesaran et al. (2001), the autoregressive distributed lag model (ARDL) procedure will be used. The approach can be implemented regardless of whether the variables are
integrated of order (1) or (0) and can be applied to small finite samples. Based on empirical literature, theories of economic growth, and diagnostic tests, the long run relationship between economic growth and savings can be specified as:

\[ \ln RGDP_t = \beta_0 + \beta_1 \ln GDS_t + \beta_2 \ln L_t + \beta_3 \ln OILREV_t + \beta_4 \ln SER_t + u_t \]  

(1)

Where RGDP is GDP at constant price, GDS is gross domestic savings, L is labor force, OILREV is real oil revenues, SER is the secondary enrolment ratio and proxies for the quality of human capital. \( \varepsilon_t \) is an stationary error term. All variables except SER are expressed in natural logarithm (\( \ln \) stands for logarithm). The main sources of variables are from the Central Bank of Iran (CBI) and Statistical Center of Iran (SCI). The time period of the study is over the years 1970 to 2008.

To examine long run relation among the series we implement ARDL bounds testing approach to cointegration developed by Pesaran et al., (2001). The bounds testing approach has several advantages: it applies irrespective of the order of integration for independent variables, I(0) or I(1); is better suited to small samples; and a dynamic error correction model (ECM) can be derived from the ARDL model through a simple linear reparameterization. The version of error correction model of ARDL approach is given by:

\[
\Delta \ln RGDP_t = \alpha_0 + \sum_{i=1}^{p} \phi_i \Delta \ln RGDP_{t-i} + \sum_{i=0}^{p} \theta_i \Delta \ln GDS_{t-i} + \sum_{i=0}^{p} \lambda_i \Delta \ln L_{t-i} \\
+ \sum_{i=0}^{p} \varphi_i \Delta \ln OILREV_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta \ln SER_{t-i} + \delta_1 \ln RGDP_{t-1} + \delta_2 \ln GDS_{t-1} \\
+ \delta_3 \ln L_{t-1} + \delta_4 \ln OILREV_{t-1} + \delta_5 \ln SER_{t-1} + \varepsilon_t \]  

(2)

Where \( \phi, \theta, \lambda, \varphi \text{ and } \gamma \) refer to short run and \( \delta_1 \text{ to } \delta_5 \text{ to long run parameters. The null hypothesis of no cointegration is } H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0 \text{ against the alternative hypothesis } H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0. \text{ The rejection of the null based on the } F-\text{statistic suggests cointegrating relationship. The critical bounds have been tabulated by Pesaran et al. (2001). The upper critical bound (UCB) is based on the assumption that all series are I(1). The lower bounds (LCB) applies if the series are I(0). If UCB is lower than the calculated } F-\text{statistic, the null of cointegration is sustained. If the } F-\text{statistic is less than the LCB then there is no cointegration. The decision about cointegration will be inconclusive if the } F-\text{statistic lies between UCB and LCB. In such situation, we will have to rely on the lagged error correction term to investigate long run relationship.}

The orders of the lags in the specification (2 are selected by the Schwarz Bayesian criterion (SBC). For annual data, Pesaran and Shin (1999) recommended choosing a maximum of 2 lags. From this, the lag length that minimizes SBC is selected.

If a long run relationship exists, the ARDL representation of equation (1) is formulated as follows:

\[
\ln RGDP_t = \alpha_1 + \sum_{i=1}^{p+1} \phi_{ii} \ln RGDP_{t-i} + \sum_{i=0}^{p+1} \rho_i \ln GDS_{t-i} + \sum_{i=0}^{p+1} \theta_i \ln L_{t-i} + \sum_{i=0}^{p+1} \lambda_i \ln OILREV_{t-i} \\
+ \sum_{i=1}^{p+1} \varphi_i \ln SER_{t-i} + \varepsilon_t \]  

(3)
The ARDL method estimate \((p+1)^k\) number of regressions in order to obtain the optimal lags for each variable, where \(p+1\) is the maximum number of lags to be used and \(k\) is the number of variables in the equation (Shrestha and Chowdhury, 2005). The model is selected based on the Schwartz-Bayesian Criterion (SBC) that use the smallest possible lag length and is therefore described as the parsimonious model.

The ARDL specification of short run dynamics is investigated using ECM version of ARDL model of the following form:

\[
\Delta \ln RGDP_t = \alpha_2 + \sum_{i=1}^{p} \phi_{2i} \Delta \ln RGDP_{t-i} + \sum_{i=1}^{p} \rho_{2i} \Delta \ln GDS_{t-i} + \sum_{i=0}^{p} \theta_{2i} \Delta \ln L_{t-i} + \sum_{i=0}^{p} \lambda_{2i} \Delta \ln OILREV_{t-i} + \sum_{i=0}^{p} \varphi_{2i} \Delta SER_{t-i} + \psi ECM_{t-1} + \epsilon_t
\]  

The lagged residual term (ECM) in equation 4 shows the disequilibrium in long run relationship (\(ut\) in equation 1). The goodness of fit for ARDL model is checked through stability tests such as cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ).

4. Empirical Results

Pesaran et al. (2001) critical values are based on the assumption that the variables are integrated of order I(0) or I(1). Unit root tests insure that none of the series is integrated of I(2) or higher. Both the augmented Dickey–Fuller (ADF) (1979) and Phillips–Perron (PP) (1988) unit-root tests have been employed for that purpose and the results are summarized in Tables 1. Test for stationarity shows that all variables are integrated of order 1 and thus stationary in difference.

Table 1: Unit Root Test

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF test statistic (with trend and intercept)</th>
<th>PP test statistic (with trend and intercept)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>First Difference</td>
</tr>
<tr>
<td>In RGDP</td>
<td>-1.26</td>
<td>-4.19**</td>
</tr>
<tr>
<td>In GDS</td>
<td>-1.22</td>
<td>-3.71**</td>
</tr>
<tr>
<td>In L</td>
<td>-1.82</td>
<td>-3.92**</td>
</tr>
<tr>
<td>In OILREV</td>
<td>-1.32</td>
<td>-7.91***</td>
</tr>
<tr>
<td>SER</td>
<td>-2.13</td>
<td>-5.71***</td>
</tr>
</tbody>
</table>

Notes: ** and *** denotesignificance at 5% 1% levels respectively. The optimal lag structure is determined by SBC.
To investigate the presence of long-run relationships among the variables, testing of the bound under Pesaran, et al. (2001) procedure is used. The results of the bound test are given in Table 2. The critical values used in this paper are extracted from Narayan (2004). The calculated F-statistics is 6.19 while upper critical bound at significance level 1% is 5.642. This implies that there is long run relationship among GDP, GDS, oil revenues, labor force and education over the period of 1970-2008 in Iran.

Table 2: Bounds Test Results

<table>
<thead>
<tr>
<th>F-statistics</th>
<th>Lag</th>
<th>Significance Level</th>
<th>Bound Critical values</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.19</td>
<td>2</td>
<td>1%</td>
<td>I(0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.324</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.642</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.116</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.094</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.596</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.474</td>
</tr>
</tbody>
</table>

The next stage of the procedure would be to estimate the coefficients of the long-run relations and the associated error correction model (ECM) using the ARDL approach. The optimal lags on variables were selected by the Schwartz Bayesian Criterion (SBC) and turned out to be the ARDL (1, 0, 1, 1, 1). The long-run estimated coefficients are shown in the Table 3. As can be seen, all the coefficients are significant. One percent rise in GDS is expected to increase GDP per capita by just 0.22 percent. Although GDS appears with the expected positive sign and significant, but the coefficient is small in size. The labor force and the quality of human capital have been the main ingredients for economic growth. The variable of oil revenues has also the expected positive sign.

Table 3. Estimated long run coefficients based on ARDL approach

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>4.20</td>
<td>0.00</td>
</tr>
<tr>
<td>ln GDS</td>
<td>0.22</td>
<td>0.00</td>
</tr>
<tr>
<td>ln L</td>
<td>0.61</td>
<td>0.00</td>
</tr>
<tr>
<td>ln OILREV</td>
<td>0.26</td>
<td>0.00</td>
</tr>
<tr>
<td>SER</td>
<td>0.39</td>
<td>0.02</td>
</tr>
</tbody>
</table>

The results of error correction model, reported in Table 4. The short-run coefficients are less than the long-run ones. The results suggest that the short-run impact of savings and human capital on the economic growth are small and insignificant. The coefficients for the other explanatory variables have the expected sign and are significance. Moreover, the coefficient of the ECM is negative and strongly significant at 1% level. This corroborates the existence of a
stable long-run relationship and points to a long-run cointegration relationship among variables. The ECM represents the speed of adjustment to restore equilibrium in the dynamic model following a disturbance. The coefficient of the ECM is around -0.68, implying that a deviation from the long-run equilibrium is corrected by 68% after each year.

The diagnostic tests e.g., Lagrange Multiplier (LM) for serial correlation, ARCH effects, normality of residual terms, white heteroskedasticity and Ramsey RESET for functional form reported in Table 5 suggest that the short-run model passes all diagnostic tests. We find no evidence of serial correlation, autoregressive conditional heteroskedasticity and white heteroskedasticity. The residual terms are normally distributed and the functional form of the model appears well specified.

Table 4. Error correction representation for the selected ARDL model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δln GDS</td>
<td>0.03</td>
<td>0.22</td>
</tr>
<tr>
<td>Δln L</td>
<td>0.28</td>
<td>0.00</td>
</tr>
<tr>
<td>Δln OILREV</td>
<td>0.11</td>
<td>0.00</td>
</tr>
<tr>
<td>ΔSER</td>
<td>0.15</td>
<td>0.26</td>
</tr>
<tr>
<td>ECM</td>
<td>-0.68</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Serial Correlation LM = 0.72 (0.69)  
ARCH Test = 0.21 (0.89)  
Normality Test = 1.31(0.51)  
Heteroscedasticity Test = 0.91 (0.60)  
Ramsey RESET Test = 1.46 (0.42)

Notes: The probability values for the diagnostic tests are given in parenthesis

The plots of the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ) stability tests as shown respectively in figures 1 and 2 indicate that all the coefficients of estimated model are stable over the study period as they fall within the critical bounds.
5. Conclusion

This paper has investigated the determinants of economic growth with an emphasis on the effects of savings in Iran using annual data for the period 1970-2008 applying autoregressive distributed lag (ARDL) approach. According to the results, we found a cointegration relationship among real GDP, savings, labor force, oil revenues and education. Estimating error correction model revealed that the speed of adjustment to restore equilibrium is -0.68 which confirms that there is a stable long-run relationship. Compared to the other variables, labor force and human capital have the most important effect on economic growth in long-run. In short-run, however, the variables of saving growth and education do not have significant effects on economic growth, explaining just a small part of economic growth. But the labor force and oil revenues appear to play a more important role in short-run growth. Therefore, it does not seem that savings would contribute to economic growth particularity in short-run.

With regard to the important impact of labor force and human capital on economic growth, training skilled labor and professionals in various sectors of the economy and increasing labor productivity can be an essential step in order to stimulate higher long-run growth. In this regard, it is necessary to develop some appropriate policies.

The results show that oil revenue has a more important role in economic growth than savings. To achieve sustainable growth in the future, given the high dependence of Iran economy on oil revenues, it must take policy measures that substantially enlarge and diversify their economic base.

Acknowledgements

The authors would like to acknowledge the financial support of university of Tehran for this research under the grant number 4401012/1/18.
References