The Relationship between saving and GDP in Iran based on ARDL Bounds testing approach

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Abstract
The objective of this paper is to examine the relationship between saving and economic growth in Iran for the period 1970-2010, based on the autoregressive distributed lag (ARDL) approach. The study finds a cointegrating relationship among national real GDP, national saving, labor force, oil revenues and education. Compared to the other variables, labor force and human capital (education) have the most important effect on long-run economic growth. Moreover, in short-run oil revenues and saving have the strongest effects on economic growth. Estimating error correction model revealed that the speed of adjustment to restore equilibrium is \(-0.79\) which confirms that there is a stable long-run relationship. Regarding weak impact of saving on long run 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 Saving, Economic Growth, Iran Economy

1. Introduction
The neoclassical Solow (1956) model indicates that the increase in the saving rate increases steady-state output. The new growth theories since the 1980s including Romer (1986, 1990), Lucas (1988) and Barro (1990), reconfirm the view that the accumulation of physical and human capital are the drivers of long run economic growth and that high savings rates are important determinant of the GDP growth rate as suggested by endogenous growth theories. According to theories of saving, on the other hand, saving can be affected by many factors, including economic growth. Hence, if economic growth rises, the saving increase too. According to these two point of views expressed in economic theories, investigating the relationship between saving 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 saving cause growth.

The essential idea of Lewis’s (1955) traditional theory state that an rise in saving would accelerate economic growth. Summers (1991, 1992), studying the relationship between investment to GDP ratio and growth rates since World War II; conclude that the investment determines the rate of economic growth. Solow (1956) in his study indicates that the larger investment and saving rate lead to more output per worker. Tyler (1981) investigating a sample of 55 developing countries showed that saving is the main determinant of growth rate. New growth theories insist on the importance of saving, human and physical capital in the long-run economic growth. The policies, which affect the level of growth and the investment productivity, determine the long-run economic growth. Theoretically, the gross saving affects the economic growth through either increasing the physical capital stock, or promoting the technology (Levine and Renelt, 1992 and Plossner, 1992). However, Blomstrom et al. (1996), based on econometric results of the Granger causality tests indicate that the direction of causality runs in the opposite way. That is, it is the GDP growth that leads to more saving in the economy. Therefore, they conclude something else except saving and investment should explain economic growth including economic and political environment, productivity, education, foreign investment and so on. Verma (2007) used the ARDL cointegration approach to determine the long run relationship among saving, investment and GDP for the period 1950-51 to 2003-04 and supported the Carroll-Weil hypothesis that saving does not cause growth, but growth causes saving.

In this paper we examine the short- and long-run relationships between saving and economic growth for Iran over the period 1970-2010, using Autoregressive Distributed Lag (ARDL) approach to cointegration and error correction models (ECM).
The rest of the paper is organized as follows. Section 2 describes data and methodology. Results are reported in Section 3. Section 4 concludes.

2. 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 gross domestic saving can be specified as:

$$\ln RGDP_t = \beta_0 + \beta_1 \ln SAVING_t + \beta_2 \ln L_t + \beta_3 \ln OILREV_t + \beta_4 SER_t + u_t$$  \hspace{1cm} (1)

Where RGDP is GDP at constant price, SAVING is gross domestic saving, L is labor force, OILREV is real oil revenues, SER is the secondary enrolment ratio and proxies for the quality of human capital. $\epsilon_t$ 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 2010.

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 reparametrization. The version of error correction model of ARDL approach is given by:

$$\Delta \ln RGDP_t = \alpha_0 + \sum_{i=1}^{p} \phi_i \Delta \ln RGDP_{t-i} + \sum_{i=0}^{p} \theta_i \Delta \ln SAVING_{t-i} + \sum_{i=0}^{p} \lambda_i \Delta \ln L_{t-i} + \sum_{i=1}^{p} \varphi_i \Delta \ln OILREV_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta \ln SER_{t-i} + \delta_1 \ln RGDP_{t-1} + \delta_2 \ln SAVING_{t-1} + \delta_3 \ln L_{t-1} + \delta_4 \ln OILREV_{t-1} + \delta_5 SER_{t-1} + \epsilon_t$$  \hspace{1cm} (2)

Where $\phi, \theta, \lambda, \varphi, \gamma$ refer to short run and $\delta_1, \delta_2, \delta_3, \delta_4, \delta_5$ to long run parameters. The null hypothesis of no cointegration is $H_0$: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$ against the alternative hypothesis $H_1$: $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0$. The rejection of the null based on the F-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-statistic, the null of cointegration is sustained. If the F-statistic is less than the LCB then there is no cointegration. The decision about cointegration will be inconclusive if the F-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:

$$\ln RGDP_t = \alpha_1 + \sum_{i=1}^{p+1} \phi_{1i} \ln RGDP_{t-i} + \sum_{i=0}^{p+1} \rho_{1i} \ln SAVING_{t-i} + \sum_{i=0}^{p+1} \theta_{1i} \ln L_{t-i} + \sum_{i=0}^{p+1} \lambda_{1i} \ln OILREV_{t-i} + \sum_{i=1}^{p+1} \varphi_{1i} SER_{t-i} + \epsilon_t$$ \hspace{1cm} (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:
\[ \Delta \ln RGDP_t = \alpha_2 + \sum_{i=1}^{p} \phi_{2i} \Delta \ln RGDP_{t-i} + \sum_{i=1}^{p} \rho_{2i} \Delta \ln SAVING_{t-i} + \sum_{i=0}^{p} \theta_{2i} \Delta \ln L_{t-i} + \sum_{i=0}^{p} \lambda_{2i} \Delta \ln OILREV_{t-i} + \sum_{i=0}^{p} \psi \Delta ECM_{t-i} + \varepsilon_t \]  (4)

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).

3. 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>ln RGDP</td>
<td>-1.29</td>
<td>-4.14**</td>
</tr>
<tr>
<td>Ln SAVING</td>
<td>-1.23</td>
<td>-4.14**</td>
</tr>
<tr>
<td>ln L</td>
<td>-1.91</td>
<td>-3.99***</td>
</tr>
<tr>
<td>ln OILREV</td>
<td>-1.38</td>
<td>-7.81***</td>
</tr>
<tr>
<td>SER</td>
<td>-2.18</td>
<td>-5.29***</td>
</tr>
</tbody>
</table>

Notes: ** and *** denotes significance 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, SAVING, oil revenues, labor force and education over the period of 1970-2010 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></td>
<td></td>
<td></td>
<td>I(0)</td>
</tr>
<tr>
<td>6.62</td>
<td>2</td>
<td>1%</td>
<td>4.324</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5%</td>
<td>3.116</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10%</td>
<td>2.596</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 SAVING is expected to increase GDP per capita by just 0.19 percent. Although SAVING 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>3.21</td>
<td>0.00</td>
</tr>
<tr>
<td>ln SAVING</td>
<td>0.19</td>
<td>0.01</td>
</tr>
<tr>
<td>ln L</td>
<td>0.36</td>
<td>0.00</td>
</tr>
<tr>
<td>ln OILREV</td>
<td>0.27</td>
<td>0.00</td>
</tr>
<tr>
<td>SER</td>
<td>0.34</td>
<td>0.01</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 labor force and human capital on the economic growth are small and insignificant. The coefficients for the other explanatory variables have the expected sign and are significant. 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 -0.75, implying that a deviation from the long-run equilibrium is corrected by 75% after each year.

The diagnostic tests e.g., Lagrange Multiplier (LM) for serial correlation, ARCH effects, normality of residual terms, white heteroskedasticity and Ramsay 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>∆ln SAVING</td>
<td>0.46</td>
<td>0.00</td>
</tr>
<tr>
<td>∆ln L</td>
<td>0.16</td>
<td>0.15</td>
</tr>
<tr>
<td>∆ln OILREV</td>
<td>0.17</td>
<td>0.00</td>
</tr>
<tr>
<td>∆SER</td>
<td>0.12</td>
<td>0.21</td>
</tr>
<tr>
<td>ECM</td>
<td>-0.75</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Serial Correlation LM = 0.93 (0.61)
ARCH Test = 0.72 (0.47)
Normality Test = 1.42(0.33)
Heteroscedasticity Test = 1.10 (0.44)
Ramsey RESET Test = 1.56 (0.41)

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

4. Conclusion

This paper has investigated the determinants of economic growth with an emphasis on the effects of gross domestic saving in Iran using annual data for the period 1970-2010 applying autoregressive distributed lag (ARDL) approach. According to the results, we found a cointegration relationship among real GDP, saving, labor force, oil revenues and education. Estimating error correction model revealed that the speed of adjustment to restore equilibrium is -0.75 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 labor force and education do not have significant effects on economic growth, explaining just a small part of economic growth. But the saving and oil revenues appear to play a more important role in short-run growth. Therefore, it does not seem that saving contribute to economic growth particularity in long-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 long-run economic growth than saving. 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.
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References


