Impact of Savings on Economic Growth: Approach by ARDL and Toda-Yamamoto – Case of Saudi Arabia-

أثر الادخار على النمو الاقتصادي باستخدام نموذج ARDL وتحليل Toda-Yamamoto –حالة المملكة العربية السعودية–

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Received: 12/12/2019 ; Accepted for reviewing: 18/02/2020 ; Accepted for publishing: 31/12/2020

Abstract The main purpose is to investigate the long-run equilibrium relationship between savings and economic growth for Saudi Arabia from 1971 to 2018 by using the ARDL co-integration approach of Pesaran & Shin (2001) as well as Toda-Yamamoto test (1995) of no causality. The findings of ARDL bound test show that there is co-integration between variables and a significant positive impact of savings on economic growth in short and long run. Additionally, the Toda-Yamamoto test found out bi-directional causal relationship.

Key Words: Economic Growth; Savings; Autoregressive Distributed Lag Model; Toda-Yamamoto Test.

JEL classification code: C50; C51

***ملخص*:** تهدف هذه الدراسة إلى البحث في وجود علاقة توازنية طويلة الأجل بين النمو الاقتصادي والادخار للاقتصاد السعودي خلال الفترة الممتدة من 1971 إلى 2018. وقد تم لذلك تطبيق منهجية الانحدار الذاتي ذي الابطاء الموزع المطور من طرف Pesaran & Shin (2001) إلى جانب استخدام اختبار Toda-Yamamoto (1995) لتحليل اتجاه السببية. وقد دلت نتائج نموذج ARDL إلى وجود علاقة تكامل مشترك بين المتغيرتيين إضافة إلى وجود أثر معنوي وموجب للادخار على النمو الاقتصادي على الأجل الطويل والقصير. كما أن تحليل اتجاه السببية لاختبار Toda-Yammato قد دل على وجود علاقة ثنائية الاتجاه.

الكلمات المفتاحية : : نمو اقتصادي؛ ادخار؛ ARDL؛ اختبار Toda-Yammato .

تصنيف JEL : C50، C51

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1. Introduction :

Savings has long been considered as an engine for economic growth. A study has been conducted in China (Chow, 1993) stated countries that had made sustained accumulation of fixed capital have been able to achieve higher and sustained economic growth and development than other countries. A serious constraint to sustainable economic growth can cause from the low rate of savings.The crucial role of the domestic savings in economic growth process has continued to attract the interest of economists since the formulation of Harrod-Domar model. Therefore the developing countries, especially savings largely depends on oil incomes, are in a fundamental question about the use of savings in economic development.

Based on the above, the following problem has been formulated:

Does savings cause growth or vice versa? And does existe a long-run equilibrium relationship between savings and economic growth for Saudi Arabia over the period 1971-2018?

Research Hypotheses

In the light of the problem, the following hypothesis was put forward:

There is a significant long-run equilibrium relationship between savings and economic growth in Saudi Arabia over the period 1971-2018.

Research Objectives

Through this research paper, we seek to achieve a set of goals summarized below:

- To add it to field of Arab applied studies;
- To analyze the causality trend between savings and economic growth;
- To investigate the significant relationship between savings and growth in Saudi Arabia;

- To suggest a set of implications and policies to accelerate the economic growth in the country.

Research Structure

The study covers both theorical and applied sides, thus will justify the use of two approaches the ARDL bound testing and Toda-yamamoto test. It was developed in three sections, the first focused in the theorical literature models undertaken the relation between savings and economic growth. The second section mainly directed to a brief presentation on the approaches used. The last covered the empirical study for Saudi Arabia from 1971 to 2018.

Previous studies

There were many important studies for many countries, but most of them are connected to Latin American, Sub-Saharan and East Asian countries.

Saltz (1999) used different approaches both vector error correction (VEC) model and vector auto regressive (VAR) model. He found that for most countries in his sample causality run from economic growth rate to growth rate of saving. Saltz argued that higher per capita income leads to both higher consumption and higher saving rates (Saltz, 1999, p 91).

Anorou.E & Ahmad.Y (2001) investigated the relationship between savings and economic growth in 7 African countries, Congo, Cote d'Ivoire, Ghana, Kenya, Nigeria, South Africa and Zambia using vector error correction model. The result indicated that there is a long run relationship between economic growth and saving. Also they found that savings Granger causes growth in Congo and there is bi-directional causality in South Africa (Anorou.E & Ahmad.Y, 2001, p 238).

Baharumshah & al. (2003) used VEC model to investigate the behavior of the saving rate in five Asian countries. Based on data from 1960 until 1997, only in one country the saving rate Granger causes the economic growth rate (Baharumshah & al, 2003, p 1).

Tinaromm (2005) studied the relationship between savings and economic growth in North Africa using Vector Error Correction Model

for 1946-1992. He concluded that private saving has both direct and indirect effects on economic growth. In his view, the direct effect of savings is through private investment. He also showed that economic growth has a positive effect on the private savings rate (Tinaromm, 2005, p 171).

Mohan (2006) investigated the causality relationship between savings and economic growth in 13 countries with different income levels during 1960- 2001. The countries were divided into four different income levels: low income, less than the average, more than the average and high income. He used a Granger causality test and showed that the causality relation and direction differs among countries depending on income levels. In general, the Keynesian theory of savings as a function of growth was confirmed in countries with low and less than average incomes while the Solow hypothesis that savings is a determinant of economic growth was confirmed in countries with high and more than average incomes (Mohan, 2006, p 1).

Hemmi & al. (2007) studied the relationship between precautionary savings and economic growth. They used an Autoregressive Conditional Heteroskedastic (ARCH) model with annual data from 1955 to 1990. They concluded that increased savings can have favorable impact on sustainable growth. They also found that stronger shocks on precautionary savings result in the higher levels of savings as a whole (Hemmi & al, 2007, p 60).

Olajide. S. O (2009) employed the Toda and Yamamoto methodology to analyse the direction of causal relationship between savings and economic growth in Nigeria between 1970 and 2006. The findings revealed the unidirectional causality between savings and economic growth, but the result from the study was different from what others had been proved in this area (Olajide. S. O, 2009, p 87).

Singh (2010) studied the causal relationship between domestic savings and economic growth in India. He analyzed the short and long run relation between these variables using an Autoregressive Distributed Lag model for the period 1950 to 2002. The results indicate

that there is a two-way relationship between savings and economic growth. His results also showed that an increase in savings and capital accumulation lead to higher income and economic growth (Singh, 2010, p 231).

Bakare (2011) used OLS Multiple Regression analytical method in the economy of Nigeria to examine the relationship between capital formation and economic growth. The test proved that the growth rate of national income will positively related to savings and capital formation, so the study emphasised the need for the government to encourage the savings to promote sustainable growth in the economy (Bakare, 2011, p).

Robson. M (2014) studied the casual relationship between investment and economic growth based on Zimbabwe, but the findings revealed that there is no causality from any direction between two variables. However the study does not deny any other relationship between the investment, savings and economic Growth (Robson.M, 2014, p136).

Jagadeesh (2015) used the ARDL technique to model GDP and second it used the DOLS model. The empirical study found that the data were stationary and co-integrated and showed that there is a significant relationship between savings and economic growth in Botswana. The results supported the Harrod-Domar model which proved that saving rate positively or directly related to the GDP. Policies have been identified to boost capital formation and savings to promote sustainable growth (Jagadeesh, 2015, p10).

Philippe.A & al (2016) focused that the growth results from innovations that allow local sectors to catch up with frontier technology. They used a cross country regression and concluded that lagged savings is positively associated with productivity growth in poor countries but not in rich countries (Philippe.A & al, 2016, p 381).

Finally, Kumar & al (2017) attempted to analyze the long-run association between savings and economic growth; and investigated the causality issue in Indian context. The study suggested that savings

boost the real activity, while economic growth couses savings in short-run. They concluded that the productivity-based measures would be useful to generate higher savings and reinforce the acceleration of income and growth (Kumar & al, 2017, p 380).

2. Theorical Literature Review:

Early economic growth theories go back to the studies of Harrod and Domar in 1939 and 1946 where economic growth was assumed to be determined mostly by the equilibrium path for an economy. Their model focused on the limited role of government in the economy and the role of savings as the main determinant of investment. They assumed that interest rates moved to an equilibrium level over time and then remained unchanged (najarzadech, R & al, 2014, p 111).

2.1. The Saving Rate in the Neoclassical Model:

The effect that the saving rate can have on economic growth and on output depends whether the capital stock is below or above the Golden Rule level. When the capital stock is currently below the Golden Rule level (i.e., MPK – $\delta > 0$), an increase in capital leads to a higher level of consumption until the Golden Rule level is reached. This can be achieved by increasing the saving rate. An increase in the saving rate leads to an immediate decrease in consumption, because a larger fraction of output is saved and invested. However, this fall in consumption is only temporary. Higher investment increases the capital stock and the accumulation of capital leads to an increase in output and eventually a new steady state is reached. As consumption is a fraction of output, consumption will rise as well in the long run. When the capital stock is above the Golden Rule level (i.e., MPK – $\delta < 0$) a decrease in capital will lead to an increase in consumption. The saving rate must fall in order to lower investment, which declines the capital stock until the Golden Rule steady state is reached.

2.2. Including Human Capital: Mankiw, Romer & Weil

Mankiw, Romer and Weil (1992) examined whether the original neoclassical growth model of Solow was consistent with real world evidence. They look in particular at the predictions about the influence of the saving rate and population growth on economic growth. They show that the higher the saving rate, the richer the country and the higher the rate of population growth the relatively poorer the country (Mankiw et al, 1992).

However, the magnitudes they have found are too large to be realistic, although the direction of the effects was the same as predicted by Solow. Mankiw et al. (1992) argued that these unrealistically high estimates can be explained by the exclusion of human capital in the Solow-Swan model, for two reasons. Firstly, when accumulation of human capital is taken into account, accumulation of physical capital and population growth have a larger impact on income. Secondly, they have found that accumulation of human capital is correlated with saving rates and population growth. So omitting human-capital accumulation leads to biased estimates of the coefficients on saving and population growth (Opscheer, S.J.A, 2015, p14).

3. Approaches Overview:

3.1. ARDL Approach:

The ARDL technique is adopted to estimate our model. This single cointegration approach has been developed by Pesaran and others in 2001. This method has a lot of advantages which can be stated as follows (Narayan, 2005, p 1981):

- It gives unbiased estimates of the long-run coefficients even if there is an endogeneity problem among the regressors.
- It can estimate the long and short-run parameters simultaneously.
- It can test for the existence of a long-run relationship between the variables in levels irrespective of whether they are I (0), I (1), or a combination of both.

- In small samples, it gives estimates with properties more superior to that of Gregory and Hansen cointegration procedures.

The ARDL test presupposes the estimation of the following unrestricted error correction model. We can formulate the equation (1) as follows:

$$\Delta Y_t = \beta_0 + \sum \beta_i \Delta Y_{t-i} + \sum \gamma_j \Delta X_{t-j} + \theta_1 Y_{t-1} + \theta_2 X_{t-1} + e_t \ldots\ldots\ldots\ldots \textbf{(1)}$$

Where Δ denotes the first difference operator, and e_t is error term

The ARDL (p, q) approach consists of a procedure with the following stages:

- We choose the maximum values for lags p and q of the unrestricted error correction model using the minimum values on Akaike Information Criterion (AIC), Schwarz (SBC), Hannan-Quinn (HQC) criteria.
- A prerequisite on ARDL model on equation (1) is that errors are serially independent (should not be auto correlated). Pesaran & al. (2001) mention that this assumption is important for choosing the maximum number lags.
- When errors on equation (1) are independent, we continue on testing the dynamic stability of ARDL model using the unit circle.
- Meanwhile, we apply the bounds test on equation (1). This test uses the F distribution and the null hypothesis of no co-integration is the following:

H_0: $\theta_1=\theta_2=0$ (No co-integration).

Against the alternative hypothesis of co-integration

H_1: $\theta_1 \neq \theta_2 \neq 0$ (co-integration).

If bounds testing lead us to co-integration we can estimate the long run relationship of series on equation (2) as well as the restricted error correction model from equation (3).

$$Y_t = \alpha_0 + \alpha_1 X_t + u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(2)}$$

$$\Delta Y_t = \beta_0 + \sum \beta_i \Delta Y_{t-i} + \sum \gamma_j \Delta X_{t-j} + \delta Z_{t-1} + \eta_t \ldots\ldots\ldots\ldots\ldots\ldots \textbf{(3)}$$

Where p and q are order lags on $\boldsymbol{Y_t}$ and $\boldsymbol{X_t}$ variables respectively, $\boldsymbol{Z}_t$; COINEQ(-1), is the error term created by co-integrating regression (equation 3).

2.3. Toda-Yamamoto Test:

Toda and Yamamoto (1995) in order to investigate Granger causality (1961), they developed a method based on the estimation of augmented VAR model ($k+d_{max}$) where k is the optimal time lag on the first VAR model and d_{max} is the maximum integrated order on system's variables (VAR model). The Toda and Yamamoto approach follows the steps below (Dritsaki, 2017, p 123):

- We find the integration order for each series. If the integration order is different we get the maximum (d_{max}).
- We create a VAR model on series levels regardless of integration order that we found.
- We define the order of VAR model (k) from lag length taken from LR, final prediction error (FPE), AIC, SC, HQ criteria.
- We test if VAR ($k+d_{max}$) (adjusted VAR model) is correctly specified.
- If series have the same integration order then we continue on cointegration test using Johansen methodology. Otherwise, we employ Pesaran et al. (2001) approach.
- No matter what the result will be on cointegration, we continue with causality test.
- We get VAR ($k+d_{max}$) model using suitable lags for every equation of the system.
- We apply Granger causality test for non-causality using pairwise equations and modified Wald test (MWald) for the significance of parameters on examined equations on number time lags ($k+d_{max}$).
- The modified Wald test (MWald) follows Chi-square (χ^2) distribution asymptotically and the degrees of freedom are equal to the number of time lags ($k+d_{max}$).

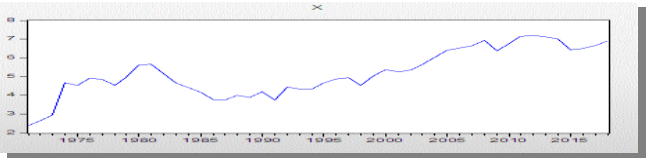
- Rejection of null hypothesis entails the rejection of Granger causality.
- Finally, we check if there is cointegration on VAR model.
- If two or more series are cointegrated, then there is one causal relationship (unidirectional or bilateral) but not vice versa.

4. Study Methodology :

4.1. Variable Introduction and Data Sources

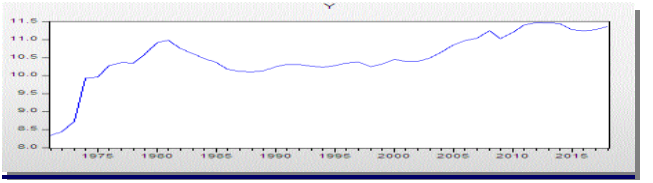
In order to investigate the relationship between savings and economic growth in Arabia Saudi, the study uses annual data series from 1971 till 2018 of gross domestic savings (S) and gross domestic production (GDP). The data was obtained from the World Development, after they are converted into natural logarithms to facilitate the estimation procedure. According to figures (1) and (2) demonstrate the evolution of these variables; they change in the same directory, i.e, increasing or decreasing together all over the period studied.

Fig.1 : Evolution of Savings (1971-2018)



Source: *Outputs, Eviews.10.*

Fig.2 : Evolution of GDP (1971-2018)



Source: *Outputs, Eviews.10.*

4.2. Model Specifications

Testing the long run relationships between the examined variables for Saudi Arabia using ARDL approach developed by Pesaran

& al (2001). The model in this study used the original version of ARDL model; it usually represents the following form.

$$\Delta LnGDP_t = \beta_0 + \sum \beta_i \Delta LnGDP_{t-I} + \sum \gamma_j \Delta LnS_{t-j} + \theta_1 LnGDP_{t-1} + \theta_2 LnS_{t-1} + e_t \ldots\ldots\ldots\ldots\ldots (4)$$

Once cointegration has been proven to exist, the short-run and long-run dynamics can be examined following the estimation of the ARDL model in Equation (4). The long run model is formulated as follows:

$$\Delta LnGDP_t = \beta_0 + \beta_1 lnGDP_{t-1} + \beta_2 lnS_{t-1} + \mu_t \ldots\ldots\ldots\ldots (5)$$

The ARDL specification for the short-run dynamics is obtained from formu-lating an error correction model in the following form:

$$\Delta LnGDP_t = \beta_0 + \sum \beta_i \Delta lnGDP_{t-i} + \sum \gamma_j \Delta S_{t-j} + \delta COINEQ(-1)_{t-1} + \eta_t \ldots\ldots\ldots (6)$$

5. Study Results :

5.1. Stationary test of variables

Global domestic production (GDP) and Savings must be tested before running the co-integration and causality test. The ADF was applied to data series and the results are reported in table (1). It shows that the variables are non-stationary in levels, but they become stationary after taking the first difference (look at the probabilities between brackets which are lower than 1% or 5% or 10%). The unit root tests make sure that there is no I(2) variable. Therefore, an ARDL procedure of co-integration test can be applied for this study.

Table 1 : *ADF Test for Global Domestic Production and Savings*

GDP	*Intercept*	*Intercept & trend*	*None*
At level	−3.5732 (0.010)	−3.8799(0.210)	0.2737 (0.945)
1st Difference	-5.1585(0.0001)	-5.3197(0.0004)	-4.881(0.0000)
Savings	*Intercept*	*Intercept & trend*	*None*
At level	−1.8835 (0.3370)	−2.2872 (0.4323)	1.1440 (0.932)
1st Difference	-6.4497(0.0000)	-6.4216(0.0000)	-6.2112(0.0000)

Source: *Outputs, Eviews.10.*

5.2. Determination of the optimum lag

The order of optimal lag length is chosen from the minimum value of AIC, SBC and HQC criteria. On table (2) the results of these criteria are presented and the maximum time lag is 1which will be taken in the modeling the ARDL bounds testing approach.

Table 2 : *VAR lag order selection criteria*

LAG	LOGL	LR	FPE	AIC	SC	HQ
0	-47.899	NA	6.0331	2.2681	2.3492	2.2982
1	44.658	172.49*	0.0005*	-1.7572*	-1.5139*	-1.6669*
2	45.781	1.9900	0.0006	-1.6264	-1.2209	-1.4760
3	49.949	7.0097	0.0006	-1.6340	-1.0663	-1.4235
4	51.979	3.2295	0.0007	-1.5445	-0.8146	-1.2738

Source: *Outputs, Eviews.10.*

5.3. Causality test of Toda-Yamamoto

The existing literature suggests that the income level of a country can influence the causal relation between savings and economic growth, especially Saudi Arabia is considered as upper – middle income countries. To find the direction of causality between the variables, we have used the causality test of Toda-Yamamoto (1995); the outcomes of analysis are summarized in table (3). The causal relationship is bi-directional between savings and GDP, so the rejection of null hypothesis (see the probability of $\chi 2$ is lower than 5% are 0.0011 and 0.0061 respectively).

Table 3: *Causality Test of Toda-Yamamoto*

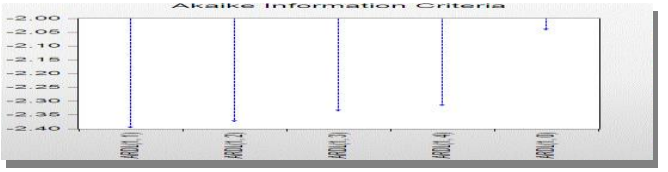
Dependent Variable Y=lnGDP			Dependent Variable X=lnS		
Exluded	Chi-sq	Prob.	Exluded	Chi-sq	Prob.
X	13.56069	0.0011	Y	10.21270	0.0061
all	13.59069	0.0011	all	10.21270	0.0061

Source: *Outputs, Eviews.10.*

5.4. Estimation of ARDL model and Bound Testing of co-integration

Before applying an ARDL bounds testing approach of co-integration to examine the existence of long run equilibrium relationship among variables, we should running the ARDL model (1, 1) lag order. The last was chosen as the most suitable model from top 5 models (see figure (3)), it requires the lowest AIC value.

Fig. 3: *Akaike Information Criteria (top 5 models)*



Source: *Outputs, Eviews.10.*

The estimation is provided in table (4) in which appear all most of variables significant and have positive influences on GDP.

Table 4 : *Estimation of ARDL Model (1, 1)*

Dependent Variable ΔY=ΔlnGDP				
Variable	***coefficient***	***Std-Error***	***t-statistic***	***Prob.***
C	1.659409	0.430820	3.851748	0.0004
Y(-1)	-0.201554	0.053131	-3.793524	0.0005
X(-1)	0.093272	0.028295	3.296390	0.0020
Δ (X)	0.406056	0.038331	10.59350	0.0000

Source: *Outputs, Eviews.10.*

Table (5) presents the co-integration test results. The results indicate that the null hypothesis of no co-integration is rejected since calculated F-statistic of 5.521 exceeds the upper bound critical value at levels of significances 2.5%, 5% and 10%. The asymptotic critical values for the bounds test were obtained from under restricted intercept and no trend and not from since the study's sample size is small.

Table 5: *ARDL Bound Test for co-integration*

Critical Values					
2.5%		5%		10%	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
4.18	4.79	3.62	4.16	3.02	**3.51**
		F-statistic = 5.521423 k=1			

Source: *Outputs, Eviews.10.*

5.5. Estimation of long-run and ECM regression (short-run)

After checking from all necessaries whether the variables co-integrated or not, we can accurately estimate the long-run and short-run models shown in tables (6) and (7). The findings result in table (7) pointed that the explanatory variable savings got a positive and a significant impact on GDP. A 1% increase in savings accelerates GDP by 4.6%; hence it is act as a major booster of output growth in Saudi Arabia.

For the table (6), it presents the estimated Error Correction Model (ECM) for GDP. The estimated model results reveal that the coefficient of the error correction term (ECT); COINEQ(-1), is -0.201554 and is highly statistically significant. This means that approximately 20.15% of the disequilibria in GDP owing to a shock to the system in the previous year can be corrected back to the long run equilibrium in the current period.

Table 6 : *Estimation of ECM Regression (Short-Run)*

Variable	coefficient	Std-Error	t-statistic	Prob.
Δ(X)	0.406056	0.036494	0.036494	0.0000
COINEQ(-1)*	-0.201554	0.048410	0.048410	0.0001

Source: *Outputs, Eviews.10.*

Table 7: *Estimation of Long -Run*

Variable	*coefficient*	*Std-Error*	*t-statistic*	*Prob.*
X	0.462763	0.058778	7.872998	0.0000
C	8.233087	0.318772	25.82749	0.0000

Source: *Outputs, Eviews.10.*

5.6. Robustness check

The diagnostic tests presented in the table (8) summarize that there is no evidence of diagnostic problem with the model. Measuring the explanatory power of the model by their adjusted R squared proxy 81.80 % of the variation in the GDP can be explained. The Breusch - Pagan-Godfrey heteroskedasticity test confirm that the errors are white noise and no serial correlation with p-value 95.20%.

Table 8: *LMT and ARCH Test*

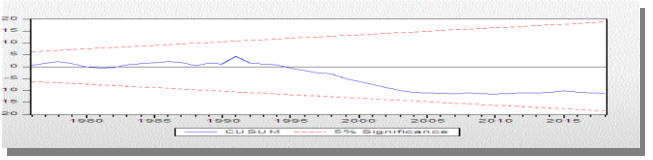
LMT Test		**ARCH Test**	
F-statistic	**Prob. (1,42)**	**F-statistic**	**Prob. (1,44)**
0.00367	**0.9520**	**0.193535**	**0.6621**

Source: *Outputs, Eviews.10.*

Furthermore, The Ramsey RESET test indicates that the model is well specified and that there are no omitted variables in the model. The stability of the long-run and short-run model coefficients is checked through the cumulative sum (CUSUM).

The results of the CUSUM presented in figure (4) demonstrate that the CUSUM of recursive residuals are within the critical bounds, meaning that all coefficients are stable over the sample period.

Fig.4: *Recursive Test*



Source: *Outputs, Eviews.10.*

6. Conclusion :

The main conclusion that can be drawn from this study is that gross domestic saving have a positive significant effect on economic growth in both short and long term. It conducts to raise the GDP proximately 4.6% in long term. The findings of ARDL bound test give a clear answer to our principal question the existing of equilibrium relationship which meaning that there is co-integration between variables.

It is clear from the results that policy makers in Saudi Arabia need to stimulate savings in order to increase economic growth. Since saving includes both private and public savings, and public savings largely depend on oil revenues, conditions should be improved to encourage the private sector to increase savings. The demands for public sector spending are very large under the conditions surrounding the market oil and strengthening the dollar that makes the public savings in critical situation by breakdown. Therefore, policies must be taken and appreciated. The first implication should take appropriate strategy to divert savings in to productive investment, while the second is that government should underline some measurement to encourage export.

Although this is an interesting result it might be insightful to further specify the domestic saving rate. It is likely that some components contribute to this positive effect, while others do not. For that, it can be considered as the next research intention that will give more insights on this issue.

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