The Causality between Savings and GDP in Petroleum Exporting Countries

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

This paper investigates the causal relationship between gross domestic savings (GDS) and GDP in a panel of 11 selected oil exporting countries by using panel unit root tests and panel cointegration analysis for the period 1970-2010. A three-variable model is formulated with oil exports as the third variable. The results show a strong causality from oil revenues and economic growth to savings in the oil exporting countries. Yet, savings does not have any significant effects on GDP in short- and long-run. It means that it is the oil and GDP that drives savings in mentioned countries, not vice versa. So the findings of this paper support the Keynesian point of view that it is higher economic growth that leads to higher saving growth. According to the results, decision makings should be employed to achieve sustainable growth through higher productivity and substantially enlarging the economic base diversification in the future.

JEL classifications: C12; C33; E21; F43
Keywords: Panel Unit Root, Panel Cointegration, Granger Causality, Gross Domestic Savings (GDS), Oil Exporting Countries, Export-led Growth (ELG), Growth-led Export (GEL)

1. Introduction

There is robust empirical evidence indicating that there is a positive correlation between savings and growth. There is, however, no consensus about the direction of the causality between them. This issue can be explained with several hypotheses. The first one is that increased savings may enhance economic growth through increased investment (Bebczuk 2000). This approach is confirmed by Harrod (1939), Domar (1946) and Solow (1956) growth models. Also results of empirical research by Alguacil, Cuadros and Orts (2004), and Singh (2009) favor the hypothesis that if savings increase, economic growth will rise. The second hypothesis is that economic growth stimulates increased savings. This approach is supported by the Keynes model (1936). Moreover, the results of empirical research carried out by Sinha and Sinha (1998), Saltz (1999), Agrawal (2001), Anoruo and Ahmad (2001), Narayan and Narayan (2006), Abu (2010), etc. confirm this hypothesis (Misztal, 2011).

The focus of the paper is, therefore, to examine the relationship between savings and economic growth in petroleum exporting countries for the period 1970-2010 The direction of causality between these two variables is examined by utilizing a cointegration and error correction modeling framework. The paper is organized in four sections. Section 2 provides a review of the empirical literature. Section 3 discusses the methodology and data. Section 4 shows the empirical results of the study. Section 5 concludes.

2. Review of Literature

Carroll and Weil (1994) examined the relationship between income growth and saving using both cross-country as well as household-level data. As to cross-country data, they used two samples of countries in their work. They started with the Summers and Weston (1991) Mark 5 data set, and then excluded all countries whose data received a grade of lower than “C-“. They further excluded communist countries, countries whose economies were dominated by oil production, and countries with 1985 populations of less than one million. The remaining sample consisted of 64 countries. Their second sample was the 22 members of the OECD with 1985 populations greater than one million. As household-level data, they used data from three household surveys, the Panel Study of Income Dynamics (PSID), the 1983 Survey of Consumer Finances (SCF), and the 1961-62 Consumer Expen,diture Survey (CEX). At the aggregate level, they found that growth Granger causes saving, but saving does not Granger cause growth. Using household data, they found that households with predictably higher income growth save more than households with predictably low growth.

Kónya (2004) investigated the possibility of Granger causality between the saving ratio (the proportion of gross domestic saving in GDP) and the growth rate (annual percentage change of real per capita GDP) in eighty-four countries for the period of 1961-2000. Granger causality was tested applying a new panel-data approach based on SUR systems and Wald tests. Kónya found a two-way Granger causality between saving ratio and growth rate in Austria, one-way causality from saving to growth in Ireland, Trinidad & Tobago, Mauritania, and the Central African Republic, and one-way causality from growth to saving in Finland, France, Japan, Sweden, Switzerland, Saudi Arabia, and Niger.

Mohan (2006) carried out an empirical study on the relationship between domestic savings and economic growth for various economies with different income levels. Using time series annual data, the Granger causality test was conducted. The study was interested in exploring whether the direction of causality in these economies was different based on their income class: namely low−income, low−middle income, upper−middle income, and high−income countries. According to the results, Mohan stated that the economic growth rate Granger causes growth rate of savings in 13 countries. The opposite results prevailed in two countries. In five countries, a bi-directional causation was found. In summary, based on the results, the study favored the hypothesis that the causality is from economic growth rate to growth rate of savings. Based on the empirical results, the main conclusion of the study was that income class of a country does play an important role in determining the direction of causality. In low−income countries the empirical results were mixed. In most of low−middle income countries, the causality was from economic growth rate to growth rate of savings. In all high−income countries except Singapore, the causality is from economic growth rate to growth rate of savings. However, it appeared that in upper−middle income countries, bi-directional causality is more prevalent.

Misztal (2011) analyzed analyze causal relationship between economic growth and savings in advanced economies and in emerging and developing countries based on cointegration models and Granger causality test. All statistical data used in his paper came from the International Monetary Fund database (World Economic Outlook database). According to the results, he confirmed the existence of one-way causality from gross domestic savings to gross domestic product (GDP) in the case of developed countries as well as in developing and transition countries. The main conclusion drawn from the study is that the occurrence causal links between savings and economic growth is not determined significantly by the level of economic development.

3. Data and empirical results

We apply a three variable model to examine the causal relationship between savings and GDP with oil revenues included in model as conditioning variable along with these two variables. Data used in the analysis are annual time series during the period 1970-2010 on (logarithm of) real gross domestic savings (GDS) and real GDP per capita (GDP) and real oil revenues (OIL) in constant 2000 prices in local currency units for the 11 oil exporting countries. The data were obtained from World Development Indicators (WDI) 2009, published by the World Bank and OPEC Bulletins. The choice of the starting period was constrained by the availability of data.

To test the nature of association between the variables while avoiding any spurious correlation, the empirical investigation in this paper follows the three steps: We begin by testing for non-stationarity in the three variables of GDS, GDP and OIL. Prompted by the existence of unit roots in the time series, we test for long run cointegrating relation between three variables at the second step of estimation using the panel cointegration technique developed by Pedroni (1995, 1999). Granted the long run relationship, we explore the causal link between the variables by testing for granger causality at the final step.

3.1. Panel Unit Roots Results

The panel data technique referred above has appealed to the researchers because of its weak restrictions. It captures country specific effects and allows for heterogeneity in the direction and magnitude of the parameters across the panel. In addition, it provides a great degree of flexibility in model selection. Following the methodology used in earlier works in the literature we test for trend stationarity the three variables of GDS, GDP and OIL. With a null of non-stationary, the test is a residual based test that explores the performance of four different statistics. Together, these four statistics reflect a combination of the tests used by Levin-Lin (1993) and Im, Pesaran and Shin (1997). While the first two statistics are non-parametric rho-statistics, the last two are parametric ADF t-statistics. Sets of these four statistics have been reported in Table 1.

The first three rows report the panel unit root statistics for GDS, GDP and OIL at the levels. As we can see in the table, we cannot reject the unit-root hypothesis when the variables are taken in levels and thus any causal inferences from the three series in levels are invalid. The last three rows report the panel unit root statistics for first differences of GDS, GDP and OIL. The large negative values for the statistics indicate rejection of the null of non-stationary at 1% level for all variables. It may, therefore be concluded that the three variables of GDS, GDP and OIL are unit root variables of order one, or, I (1) for short.

Table 1: Test of Unit Roots for HE, GDP and OIL

variables	Levin-Lin Rho-stat	Levin-Lin t-Rho-stat	Levin-Lin ADF stat	IPS ADF stat
GDS	0.31	-0.52	-0.99	-1.73
GDP	-1.03	-1.16	-1.22	-0.82
OIL	-0.76	-1.84	-0.27	-0.22
ΔGDS	-11.45^{***}	-6.09^{***}	-9.62^{***}	-18.89^{***}
ΔGDP	-11.24^{***}	-6.63^{***}	-8.11^{***}	-18.62^{***}
ΔOIL	-6.57^{***}	-9.28^{***}	-11.39^{***}	$-.18.43^{***}$

***significant at 1%

3.2. Panel Cointegration Results

At the second step of our estimation, we look for a long run relationship among GDS, GDP and OIL using the panel cointegration technique developed by Pedroni (1995, 1999). This technique is a significant improvement over conventional cointegration tests applied on a single country series. While pooling data to determine the common long run relationship, it allows the cointegrating vectors to vary across the members of the panel. After including real OIL as an additional variable, the cointegration relationship we estimate is specified as follows:

$$GDS_{it} = \alpha_i + \delta_t + \beta_i GDP_{it} + \gamma_i OIL_{it} + \varepsilon_{it} \quad (1)$$

Where α_i refers to country effects and δ_t refers to trend effects. ε_{it} is the estimated residual indicating deviations from the long run relationship. With a null of no cointegration, the panel cointegration test is essentially a test of unit roots in the estimated residuals of the panel. Pedroni (1999) refers to seven different statistics for this test. Of these seven statistics, the first four are known as panel cointegration statistics; the last three are group mean panel cointegration statistics. In the presence of a cointegrating relation, the residuals are expected to be stationary. These tests reject the null of no cointegration when they have large negative values except for the panel-v test which reject the null of cointegration when it has a large positive value. All of these seven statistics under different model specifications are reported in Table 2. The statistics for all different model specifications suggest rejection of the null of no cointegration for all tests except the panel and group $\rho -$tests. However, according to Perdroni (2004), ρ and PP tests tend to under-reject the null in the case of small samples. We, therefore, conclude that the three unit root variables GDS, GDP and OIL are cointegrated in the long run.

Table 2: Results of Panel Cointegration test

Statistics	
Panel v-stat	5.30***
Panel Rho-stat	-0.41
Panel PP-stat	-4.67***
Panel ADF-stat	-2.54**
Group Rho-stat	-0.49
Group PP-stat	-6.91***
Group ADF-stat	-5.69***

***significant at 1%

** significant at 5%

3.3. Panel Causality Results

Cointegration implies that causality exists between the series but it does not indicate the direction of the causal relationship. With an affirmation of a long run relationship among GDS, GDP and OIL, we test for Granger causality in the long run relationship at the third and final step of estimation. Granger causality itself is a two-step procedure. The first step relates to the estimation of the residual from the long run relationship. Incorporating the residual as a right hand side variable, the short run error correction model is estimated at the second step. Defining the error term from equation (1) to be ECT_{it}, the dynamic error correction model of our interest by focusing on savings (GDS) and GDP is specified as follows:

$$\begin{aligned}\Delta GDP_{it} &= \alpha_{yi} + \beta_{yi} ECT_{i\ t-1} + \gamma_{y1i}\Delta GDS_{i\ t-1} + \gamma_{y2i}\Delta GDS_{i\ t-2} + \\ &\delta_{y1i}\Delta GDP_{i\ t-1} + \delta_{y2i}\Delta GDP_{i\ t-1} + \lambda_{y1i}\Delta OIL_{i\ t-1} + \lambda_{y2i}\Delta OIL_{i\ t-2} + \varepsilon_{yit}\end{aligned} \quad (2)$$

$$\begin{aligned}\Delta GDS_{it} &= \alpha_{hi} + \beta_{hi} ECT_{i\ t-1} + \gamma_{h1i}\Delta GDS_{i\ t-1} + \gamma_{y2i}\Delta GDS_{i\ t-2} + \\ &\delta_{h1i}\Delta GDP_{i\ t-1} + \delta_{h2i}\Delta GDP_{i\ t-1} + \lambda_{h1i}\Delta OIL_{i\ t-1} + \lambda_{h2i}\Delta OIL_{i\ t-2} + \varepsilon_{hit}\end{aligned} \quad (3)$$

Where Δ is a difference operator; ECT is the lagged error-correction term derived from the long-run cointegrating relationship; the β_y and β_h are adjustment coefficients and the ε_{yit} and ε_{hit} are disturbance terms assumed to be uncorrelated with mean zero.

Sources of causation can be identified by testing for significance of the coefficients on the lagged variables in Eqs (2) and (3). First, by testing $H_0 : \gamma_{y1i} = \gamma_{y2i} = 0$ for all i in Eq. (2) or $H_0 : \delta_{h1i} = \delta_{h2i} = 0$ for all i in Eq. (3), we evaluate Granger weak causality. Masih and Masih (1996) and Asafu-Adjaye (2000) interpreted the weak Granger causality as ‘short run’ causality in the sense that the dependent variable responds only to short-term shocks to the stochastic environment.

Another possible source of causation is the ECT in Eqs. (2) and (3). In other words, through the ECT, an error correction model offers an alternative test of causality (or weak exogeneity of the dependent variable). The coefficients on the ECTs represent how fast deviations from the long run equilibrium are eliminated following changes in each variable. If, for example, β_{yi} is zero, then GDP does not respond to a deviation from the long run equilibrium in the previous period. Indeed $\beta_{yi} = 0$ or $\beta_{hi} = 0$ for all i is equivalent to both the Granger non-causality in the long run and the weak exogeneity (Hatanaka, 1996).

It is also desirable to check whether the two sources of causation are jointly significant, in order to test Granger causality. This can be done by testing the joint hypotheses $H_0 : \beta_{yi} = 0$ and $\gamma_{y1i} = \gamma_{y2i} = 0$ for all i in Eq. (2) or $H_0 : \beta_{hi} = 0$ and $\delta_{h1i} = \delta_{h2i} = 0$ for all i in Eq. (3). This is referred to as a strong Granger causality test. The joint test indicates which variable(s) bear the burden of short run adjustment to re-establish long run equilibrium, following a shock to the system (Asafu-Adjaye, 2000).

The results of the F test for both long run and short run causality are reported in Table 3. As is apparent from the Table, the coefficients of the ECT, GDP and OIL are significant in the GDS equation which indicates that long-run and short-run causality run from GDP and OIL to savings. So, GDP and OIL strongly Granger-causes savings. OIL does Granger cause GDP at short run at 5% level, without any significant effect on output in long run. Weak exogeneity of GDP indicate that this variable does not adjust towards long-run equilibrium.

Moreover, the interaction terms in the GDS equation are significant at 1% level. These results imply that, there is Granger causality running from GDP and Oil to savings in the long-run and short run, while savings have a neutral effect on GDP in both the short- and long-run. In other words, GDP is strongly exogenous and whenever a shock occurs in the system, savings would make short-run adjustments to restore long-run equilibrium.

Table 3:Result of Panel causality tests

	Source of causation(independent variable)						
Dependent Variable	Short-run			Long-run	Joint (short-run/long-run)		
	ΔGDP	ΔGDS	ΔOIL	ECT(-1)	ΔGDP, ECT(-1)	ΔGDS, ECT(-1)	ΔOIL, ECT(-1)
ΔGDP	-	F=0.46	F=6.31***	F=0.39	-	F=0.40	F=2.81**
ΔGDS	F=4.41**	-	F=4.89***	F=5.82***	F=5.98***	-	7=8.11***

***significant at 1%

** significant at 5%

4. Conclusion

The objective of this study is to examine Granger causality between savings and income for oil-exporting developing countries over the period 1970-2010. Oil exports are also included in the model along with these two variables. The panel integration and cointegration techniques are employed to investigate the relationship between the three variables: savings, GDP, and oil exports. The empirical results indicate that we cannot find enough evidence against the null hypothesis of unit root. However, for the first difference of the variables, we rejected the null hypothesis of unit root. It means that the variables are I(1). The results show that there is a long-run relationship between GDS and GDP. Utilizing Granger Causality within the framework of a panel cointegration model, the results suggest that there is strong causality running from GDP and oil revenue to savings with no feedback effects from savings to GDP for oil exporting countries. Moreover, savings have significant effects on GDP just in short-run. It means that it is the oil and GDP that drives the savings in mentioned countries, not vice versa. So the findings of this paper support the Keynesian point of view that it is higher economic growth that leads to higher saving growth. According to the results, it seems that oil revenues have mostly contributed to investment and economic growth during the sample period.

According to the results, policymakers should take a way to accelerate economic growth through enhancing total factor productivity so as to increase saving growth in the mentioned countries. For this purpose, the governments of the countries under investigation should increase their investments in the provision of infrastructures like power, roads, education and so on to reduce the costs of doing business. Providing the higher political stability in the countries, encouragement of inflows of foreign direct investment, and increasing the war on corruption are some other recommendations.

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

1- Abu, N., 2010. Saving-Economic Growth Nexus in Nigeria, 1970-2007: Granger Causality and Co-Integration Analyses, Review of Economic and Business Studies 3 (1).
2- Agrawal, P., 2001. The Relation between Savings and Growth: Co-integration and Causality Evidence from Asia, Applied Economics 33.
3- Alguacil, M., Cuadros, A., Orts, V., 2004. Does Saving Really Matter for Growth? Mexico (1970-2000), Journal of International Development 16 (2).
4- Anoruo, E., Ahmad, Y., 2001. Causal Relationship between Domestic Savings and Economic Growth: Evidence from Seven African Countries, African Development Bank 13 (2).
5- Asafu-Adjaye, J., 2000. The Relationship between Energy Consumption, Energy Prices and Economic Growth: Time Series Evidence from Asian Developing Countries, Energy Economics 22: 615–625.
6- Bebczuk, R. N., 2000. Productivity and Saving Channels of Economic Growth as Latent Variables: An Application of Confirmatory Factor Analysis, Estudios de Economia 27(2).
7- Domar, E. D. 1946. Capital Expansion, Rate of Growth, and Employment, Econometrica 14: 137–147.
8- Carrol, C. D., and Weil, D. N., 1994. Saving and Growth: A Reinterpretation, Carnegie-Rochester Conference Series on Public Policy 40, 133–192.
9- Granger, C. W. J., 1969. Investigating Causal Relations by Econometric Models and Cross-spectral Methods, Econometrica 37 (3): 424-438.

10- Granger, C. W. J., 1988. Some Recent Developments in a Concept of Causality, Journal of Econometrics 39: 199–211.
11- Harrod, R. F., 1939. An Essay on Dynamic Theory. Economic Journal 49: 14–33.
12- Hatanaka, M., 1996. Time-Series-Based Econometrics: Unit Roots and Co-integration. Oxford University Press, Oxford.
13- Im, K. S., Pesaran, M. H., and Shin, Y., 1997. Testing for Unit Roots in Heterogeneous Panels, University of Cambridge, Department of Applied Economics.
14- Im, K. S., Pesaran, M. H., and Shin, Y., 2003. Testing for Unit Roots in Heterogeneous Panels, Journal of Econometrics 115: 53–74.
15- Keynes, J. M., 1936. The General Theory of Employment, Interest and Money, Macmillan Cambridge University Press, Cambridge.
16- Kónya, L., 2004. Saving and Growth: Granger Causality Analysis with Bootstrapping on Panels of Countries, Working Papers 2004.02, School of Economics, La Trobe University.
17- Levin, A., Lin, C.F., 1992. Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties.Department of Economics, University of California at San Diego, Working Paper 92–23.
18- Levin, A., Lin. C. F., 1993. Unit Root Test in Panel Data: New Results. Department of Economics, University of California, San Diego, Working paper 93-56.
19- Levin, A., Lin, C. F., and Chu, C. S. J. 2002. Unit Root Test in Panel Data: Asymptotic and Finite Sample Properties. Journal of Econometrics 108: 1-24.
20- Masih, A.M.M., Masih, R., 1996. Energy consumption, real income and temporal causality: results from a multi-country study based on cointegration and error-correction modeling techniques. Energy Economics 18:165–183.
21- Misztal P., 2011. The Relationship Between Savings and Economic Growth in Countries with Different Level of Economic Development, Financial Internet Quarterly, e-Finanse 7 (2).
22- Mohan, R., 2006. Causal Relationship between Savings and Economic Growth in Countries with Different Income Levels, Economics Bulletin 5 (3): 1−12.
23- Narayan, P. K., Narayan, S. (2006). Savings Behavior in Fiji: An Empirical Assessment Using the ARDL Approach to Co-Integration, International Journal of Social Economics 33 (7).
24- Pedroni, P., 1995,Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis. Indiana University, Working Papers in Economics, No. 95-013.
25- Pedroni, P., 1997, Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis: New results, India University, Working Papers in Economics.
26- Pedroni, P., 1999. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. Oxford Bulletin of Economics and Statistics 61 (4): 5–49.
27- Pedroni, P., 2004. Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis: New Results. Econometric Theory 20 (3): 597–627.
28- Pesaran, M. H., Shin Y., 1997. An Autogressive Distributed Lag Modelling Approach to Cointegration Analysis, Working Paper Trinity College, Cambridge.

29- Saltz, I. S., 1999. An Examination of the Causal Relationship between Savings and Growth in the Third World, Journal of Economics and Finance 23.
30- Singh, T. 2009. Does Domestic Saving Cause Economic Growth? A Time-Series Evidence from India, Journal of Policy Modeling 32 (2).
31- Sinha, D., Sinha, T., 1998. Cart before the Horse? The Saving-Growth Nexus in Mexico, Economics Letters 61.
32- Solow, R. M., 1956. A Contribution to the Theory of Economic Growth. Quarterly, Journal of Economics 70: 65–94.