Granger causality between Health and Economic Growth in oil exporting countries

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ABSTRACT

This paper examine the causal relationship between the health expenditure and the GDP in a panel of 11 selected oil exporting countries by using panel unit root tests and panel cointegration analysis. A three variable model is formulated with oil revenues as the third variable. The results show a strong causality from oil revenues and economic growth to health expenditure in the oil exporting countries. Yet, health spending does not have any significant effects on GDP in short- and long-run. The findings imply high vulnerability of oil dependent countries to oil revenues volatility. To insulate the economy from oil revenue volatility requires institutional mechanisms de-linking health expenditures decisions from current revenue.

JEL classifications: *Q43; Q48*
Keywords: *Money Supply, Real GDP, Inflation, Granger Causality, Panel Cointegration*

1. INTRODUCTION

Growth and health are correlated in both directions. Health is a normal good, so more income leads to more spending on health. During recent five decade, there has been considerable worry about the increasing ratio of GDP devoted to health expenditure. So, much research has focused on the determinants of health expenditure. The factor that has been identified as the most dominant is real GDP (see e.g. Tang, 2009; Tosetti and Moscone, 2007 and Hartwig, 2008). On the other hand, health condition could have important effects on growth. A study by Fogel (1994), from the University of Chicago, indicated that thirty percent of British economic growth over the last two hundred years could be attributed to improvements of nutrition. Nutrition gives them fuel to work, and also affects labor force participation. Improved health raises the quantity and the efficiency of labor. Improved health not only decrease lost time due to illness, but also increases the quality of work from a given quantity of labor. Barro (1997) has found that 10% increase in life expectancy lead to a four-tenth percent increase in economic growth. For every 10% increase in life expectancy you can expect almost half a percent in economic growth. Psychiatric disorders in the United States have been estimated to cost 148 billion dollars (Rice, et al., 1990). Mental illness decreases employment by 14 percent in women and about 12.5 percent in men. Improved health also has an effect on the choice of occupation. Better allocation of labor can thus result from improved health.

So, the causal relationship between Health spending and GDP may run in either or both directions. Moreover, there may be some intermediate factor, which causes both better health and higher income. An example would be higher education levels in an economy which increase demand for health that independently increase income. In this study, we examine the causality issue between health expenditure and income in a panel of 11 selected oil exporting countries by means of applying a dynamic panel framework allowing us to capture both inter-country and inter-temporal variation. In order to do this a three variable model is formulated comprising health expenditure, GDP and oil revenues. Firstly, existence of a long-run relationship among these three variables is tested by using Pedroni (1995, 1999) panel cointegration approach. Panel Granger causality test is applied on the corresponding vector error correction model to examine short-run causal relationship between the variables. The paper is organized in four sections. A brief study of previous empirical studies is presented in section 2. Section 3 discusses the methodology, data and results. Section 4 concludes.

2. REVIEW OF LITERATURE

Theoretical literature suggests that there could be a two way relationship between health and income. The effect of economic growth on health is well known. By definition, health expenditure is a function of income or resources available both in private and public sectors. Higher income implies that there is more money to spend on health. A large body of research within health economics Indicate that variation in per capita health care expenditure could be mostly explained by variations in per capita GDP (Gerdtham and Jonsson, 2000). On the other hand, a reverse causation from health expenditure to income has also a theoretical basis. Health is a capital and hence investment on health is a important source for economic growth. the report of the WHO's Commission on Macroeconomics and Health (2001), states that "extending the coverage of crucial health services….to the world's poor could save millions of lives each year, reduce poverty, spur economic development and promote global security" (World Health Organization, 2001). Theoretically, health is a determinant of human capital, and labor productivity. So, regarding health expenditure as an investment in human capital and accordingly the engine of growth, an increase in health expenditure is expected to lead to higher income. In addition, rises in health expenditure possibly increase labor supply and productivity, which eventually must lead to a higher income (e.g., Muysken, Yetkiner, and Ziesemer, 2003). Finally, there may be some intermediate variable, which causes both better health and higher income. for example, more education increase health and income for households.

The relationship between health and economic growth has been empirically investigated intensely, although, the evidence is mixed. Moreover, most of empirical studies have focused on developed countries by using a panel data analysis For example; Devlin and Hansen (2001) examined Granger causality between health expenditure and GDP and showed some (mixed) evidence that indeed there might be bi-directional (Granger) causality between health spending and income. Haider ali shah bukhari, and and Sabihuddin butt(2007) support for the existence of a long run relationship between GDP and health expenditure and the exogeneity of GDP in Pakistan. Hartwig(2010) revisits the question whether health capital formation stimulates GDP growth in rich countries applying the panel Granger-causality framework. His results do not lend support to the view that health capital formation fosters long-term economic growth in the OECD area. For more studies on the income and health see Roberts (1999), Freeman (2003), Gerdtham and Lothgren(2000), Sen(2005) and Wang and Rettenmaier, 2007).

3. DATA AND EMPIRICAL RESULTS

We apply a three variable model to examine the causal relationship between health spending 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 1971-2007 on (logarithm of) real health expenditure (HE) 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 including Iran, Kuwait, Saudi Arabia, United Arab Emirates, Bahrain, Oman, Algeria, Nigeria, Mexico, Venezuela and Ecuador. 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 HE, 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 HE, 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 HE, GDP and OIL at the levels. As it can be inferred from this 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 HE, 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 HE, GDP and OIL are unit root variables of order one, or, I (1) for short.

3.2. Panel Cointegration Results

At the second step of our estimation, we look for a long run relationship among HE, 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:

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

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 HE, GDP and OIL are cointegrated in the long run.

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 HE, 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 health expenditure (HE) and GDP is specified as follows:

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

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

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 Health equation which indicates that long-run and short run causality run from GDP and OIL to health expenditure. So, GDP and OIL strongly Granger-causes Health spending. 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 Health equation are significant at 1% level. These results imply that, there is Granger causality running from GDP and Oil to health expenditure in the long-run and short run, while health 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, health expenditure would make short-run adjustments to restore long-run equilibrium.

4. CONCLUSION

The purpose of this study was to test for Granger causality between health expenditure and income for 11 oil-exporting developing countries over the period 1971-2007. Real oil revenues are also included in the model along with these two variables. The panel integration and cointegration techniques are applied to investigate the relationship between the three economic series: health spending, output and oil revenues. Utilizing Granger Causality within the framework of a panel cointegration model, our findings suggest that there is strong causality running from GDP and oil revenues to health expenditure with no feedback effects from health to GDP for oil exporting countries. Moreover, oil revenues have significant effects on GDP just in short run. So it is the oil and GDP that drives the health spending, not vice versa. Indeed, the rich-resource countries suffering from a weak and undiversified economic base without stabilizing mechanisms in order to cushion shocks would be so vulnerable to boom–bust cycles, There is therefore a strong case for institutional mechanism to insulate the health sector from oil revenue volatility.

ACKNOWLEDGEMENTS

This paper was funded by grant from the University of Tehran submitted to the author. We would like to thank Hossein Hosseini for editing of this paper.

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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
HE	0.42	-0.23	-1.10	-1.69
GDP	-1.04	-1.19	-1.21	-0.71
OIL	-0.78	-1.89	-0.29	-0.20
Δ*HE*	-12.89***	-6.65***	-10.22***	-21.72***
Δ*GDP*	-11.48***	-6.29***	-8.10***	-18.99***
ΔOIL	-6.35***	-9.29***	-11.10***	-.18.87***

***significant at 1%

Table 2: Results of Panel Cointegration test

Statistics	
Panel v-stat	4.21***
Panel Rho-stat	-0.65
Panel PP-stat	-2.11**
Panel ADF-stat	-2.99***
Group Rho-stat	-0.21
Group PP-stat	-4.54***
Group ADF-stat	-6.87***

***significant at 1%

** significant at 5%

Table 3:Result of Panel causality tests

	Source of causation(independent variable)						
dependent variable	Short-run			Long-run	Joint (short-run/long-run)		
	ΔGDP	ΔHE	ΔOIL	ECT(-1)	ΔGDP, ECT(-1)	ΔHE, ECT(-1)	ΔOIL, ECT(-1)
ΔGDP	-	F=0.88	F=4.22***	F=0.43	-	F=0.47	F=3.12***
ΔHE	F=1.91**	-	F=3.78***	F=4.65***	F=3.04***	-	F=7.23***

***significant at 1%

** significant at 5%