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The Relationship Between Inflation and Economic Growth: A Further Evidence

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Abstract: This paper focuses on exploring the relationship between inflation and economic growth in Saudi Arabia. The real growth of non-oil measure is used as a dependent variable, whereas wholesale price is implemented as a proxy for inflation. This study covers the period of 1985-2015. The short and long-run relationships are estimated using co-integration techniques. The results support the existence of positive effects of inflation over economic growth. The threshold level of inflation for non-oil GDP is around a 10 percent. In addition, the long-run causality is running from inflation to real growth of non-oil GDP. The impulse responses test points out that future responsiveness of growth due to impulse of inflation is negative and significant after a year and a half. Whereas, the inflation responsiveness due to a shock in growth is effective positively after three years and a half in the future.

Keywords: Non-oil GDP, Saudi Arabia, Co-integration Analysis, Causality, Inflation

1. Introduction

The objectives of macroeconomic policies in any country, as well as Saudi Arabia are, to maintain levels of economic growth coupled with low rates of inflation. Applying fiscal policy with the goal of productivity growth, and monetary policy with the stability of price endeavor, should be implemented and executed well. There has been a tremendous debate on the existence and the nature of the correlation between inflation and growth. Some economists view low inflation is positively related to economic growth. “Furthermore, uncertainty, could happen due to inflation leading to low profitability of investment projects which negatively harm growth [8]”. In the classical theory, growth depends on capital and labor, factors in the standard classical production function. In order to achieve economic growth, either capital or labor has to rise. So, Growth is determined by saving accumulation, through the negative relationship between interest rate and saving accumulation and hence, investment. Since money is neutral, no long-run effect on output rather than on prices. In the Keynesian view full employment is neglected, so, expansionary fiscal policy leads to an increase in output and prices. Thus, economic growth and inflation have a stable long-run positive relationship. The rigidity of wages and prices cause longer time to the economy to reach equilibrium. Despite this view, moderate inflation stimulates economic growth. [18]. Other economists argue that, given rational expectations and inflationary spiral, gradual increase in price levels can be transformed into high price levels and macroeconomic uncertainty stems, and will be harmful for economic growth. [9]. Monetarists, on the other hand, argue that there is a positive short-run relationship between inflation and economic growth, because of the decline in unemployment. However, this is true if the policy raising aggregate demand is not anticipated. However, new classical approach stresses that unexpected increase in prices or wages will surprise suppliers of labor and goods, and will have a real impact on the economy in the short-run until agents adjust their expectations. Hence, expected increase in money supply will not affect the economy. [24]. Nevertheless, new Keynesians, stress that the rise in inflation will have a negative impact on economic growth. Low and stable inflation causes economic growth and fair distribution of income. Furthermore, no consensus about the nature of inflation and economic growth. [9], Hasanov [9], summarized four categories of predictions in the literature regarding the effects of inflation on growth. First, Sidrauski [22], predicts that there is no effect of inflation on growth.

Hence, money is super neutral. Secondly, Tobin [24], assumes that money is a substitute for capital causing inflation to has a positive effect on long-run output and growth.

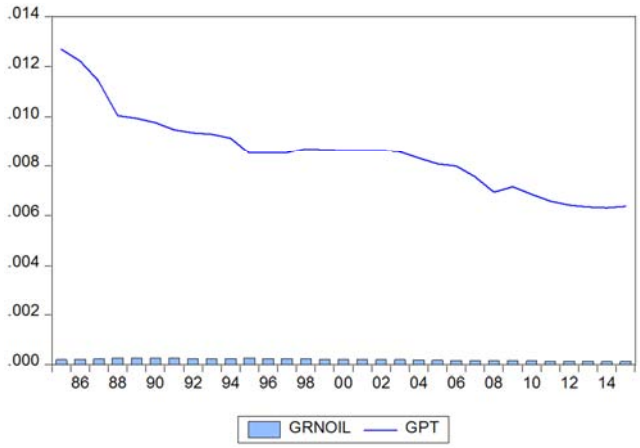

Figure 1. *Growth rate of inflation and growth rate of real non-oil GDP.*

Thirdly, Stockman [23], puts forward cash-in-advance model in which money is complementary to capital, causing a negative effect on long-run growth. Fourth, new models in which inflation has a negative effect on long-run growth, but only if inflation exceeds certain threshold level.

The purpose of this paper, is to examine theoretically and empirically the existence of coherent meaningful relationship between inflation and economic growth in the Saudi economy, using co-integration methodology. The analysis covers the period of 1985-2015. Test for the threshold level of inflation is implemented. Figure 1 shows true plot of growth rate of inflation and the growth in non-oil GDP. This paper is organized as follows. Section 1 is the introduction. Section 2 reviews the empirical studies on inflation and economic growth. Section 3 deals with the theoretical model and methodology, and discusses the empirical results and their meaningful interpretations. Section 4 provides the conclusion and the policy implications. The, appendix is in section 5.

2. The Review of Empirical Literature

The relationship between inflation and economic growth is one of the most controversial issues in the field of economics. Economists and experts from different schools of thoughts, whether they are policy makers, or central banking officials everywhere, not yet reached a conclusive evidence concerning the impact of inflation on growth. The main issue is, whether inflation necessary for economic growth or it is detrimental to growth, and what threshold is to keep necessary growth. It is widely believed that moderate and stable inflation rates promote the development process of a country and hence, economic growth. Moderate inflation supplements return to savers, enhances investment and therefore, accelerates economic growth. [10]. The suitable level of economic growth and thus the acceptable level of inflation is somewhere in the middle. Mild inflation might benefit the economy, whereas no inflation is harmful to the economic sectors. Empirical studies are inconclusive yet regarding the impact of inflation on economic growth.

Cooley and Hansen [4], postulate that there exists positive correlation between marginal product of capital and the quantity of labor. If inflation rises then labor declines and, hence decline in return on capital. They concluded that inflation rise causes permanent decline in the output.

Khan and Sendhadji [14], examined the relationship between high and low inflation with economic growth. They suggested threshold inflation level for both industrial and developing countries. Their work involved using panel data for 140 countries for the period of 1960-1998. Their findings confirm the threshold beyond which inflation exerts negative effect on economic growth. The threshold estimates are 1-3 percent and 7-11 percent for industrialized and developing countries respectively.

Barro [2], used data for 100 countries in order to assess the effect of inflation on economic growth. Other things being equal, a 10 percent rise in inflation per year leads to a reduction of growth rate by 0.2-0.3 percent per year, and reduces the ratio of investment GDP by 0.4-0.6 percent per year. Although the adverse effect looks small, but long-run effects on standards of living are substantial.

Sarel [20], used a joint panel of annual data for 87 countries. Different variables are used among them: GDP, consumer price indices, and government expenditure. His study covered the time of 1970-1990, and concluded that, there exists structural break which is significant. This break occurs when inflation rate is 8 percent.

Gokal and Hanif [8], reviewed different theories considering the relationship between inflation and economic growth. Their test revealed that the relationship between inflation and economic growth is weak.

Sargsyan [21], estimated the threshold for the Armenian economy for the period of 2000-2008. He concluded that inflation between 3-4 percent threshold level might benefit the Armenian economy.

Munir and Kasim [19], discussed the relationship between inflation and economic growth in Malysian economy for the period of 1970-2005. They found that the relationship is non-linear. Moreover, the threshold suggests 3.89 percent value of inflation. Above this threshold inflation is significantly retards growth rate of GDP. Below the threshold, inflation is statistically significant with positive relationship between inflation and economic growth.

Gillman and Harris [7], presented a monetary model of endogenous growth and specified an econometric model consistent with it. Their findings suggest negative inflation-growth effect. Lower level of inflation had a stronger effect on growth. A large panel of OECD and APEC member countries are included over the period of 1961-1997.

Birma [3], presented theoretical aspects related to the relationship between inflation and economic growth for Romanian economy for the period 2000-2011. The methodology being used is VAR model. The results showed

that a sudden increase in the change of output gap does not determine an increase in CPI. So, the hypothesis of the existence of speed limit effect in Romania is rejected. The study also showed positive response of the growth rate of output gap to a positive shock in inflation, with maximum effect after 3 quarters.

Eggoh, and Khan [5], used panel data for both developed and developing economies employing PSTR and dynamic GMM techniques. First, they analyze non-linearity of the relationship between inflation and economic growth, and identify sever thresholds for global sample and for various income specific sub samples. Second, identifies some country-based macroeconomic features that influence non-linearity. Their results validate non-linearity of inflation-growth which sensitive to the level of financial development, capital accumulation, and trade openness.

Joudaki, et al [13], have attempted to explain how the relationship between inflation and economic growth has been concentrated. Their hypothesis is two-way causal relationship between inflation and economic growth in Iran during the years 1978-2011. Co-integration test is employed. The result is that, the relationship between inflation and economic growth is one sided. There is a negative significant correlation between inflation and economic growth.

Hossain [10], explores the present relationship between inflation and economic growth for Bangladesh, using annual data on real GDP and GDP deflator for the period of 1961-2013. Co-integration methodology, error correction models and Granger causality tests are implemented. The findings revealed the existence of a negative statistically significant relationship between inflation and economic growth in the long-run. This indicates that, there exists a statistically significant long run relationship causality running from GDP deflator to GNP. Also, findings revealed a statistically significant long run positive causality running from GDP to GDP deflator.

Madurapperuma [17], empirically explores the relationship between inflation and economic growth for Sri-lanka for the period of 1988-2015. The estimated long-run coefficient is -0.49 and is statistically significant. He concluded that, in the long-run real GDP will adjust to equilibrium by 25 percent yearly. So, inflation has a real negative effect on GDP. The results founded support the literature in which inflation affects economic growth.

3. The Model, Estimation and Discussions

3.1. The Threshold Model

Following the methodology applied by Hasanov [9], who followed the estimation techniques of numerous scholars, Khan and Sendhadji [14], Mubarik [18], Hossain [10], and others.

The threshold level of inflation is based on the following equation:

$$\Delta y_t = \lambda_0 + \lambda_1 * \Delta x_t + \lambda_2 * D_t (\Delta x_t - k) + \lambda_{3i} * Z_{it} + U_t \quad (1)$$

Where:

Δy_t The growth rate of real non-oil GDP.

Δx_t Inflation rate.

D_t Dummy variable.

k The threshold level of inflation.

Z_{it} Set of control variables such as: growth rate of investment, money supply, population…etc.

U_t An error term.

λ_0, λ_1, λ_2, λ_{3i} Coefficients to be tested.

The dummy variable is defined as follows:

$$Dt = \begin{cases} 1: \Delta xt > k \\ 0: \Delta yt \leq k \end{cases} \quad (2)$$

The parameter k reflects the threshold inflation level. The relationship between economic growth and inflation is given as:

i) Low inflation λ_1.

ii) High inflation $(\lambda_1 + \lambda_2)$.

High inflation indicates that inflation estimates is significant, then both $(\lambda_1 + \lambda_2)$ would be added and considered the threshold.

Once we regress for different values of k, which is chosen arbitrary, that maximizes (R^2), and minimizes (RSS) from regressions.

3.2. The Unit Root Test

Due to the stationarity of economic variables, it is of interest to perform the unit root tests and the error-correcting methodology. To achieve this task, Augmented Dickey-Fuller (1987), (ADF), and Phillips and Perron (PP) (1990) tests are executed. Results for these tests are close to each other, and reported in table 1. Both tests showed that variables are stationary at the difference in the ADF and PP tests. Some of the variables are not stationary at level I (0), whereas stationary at difference I (1). However, in order to carry out short and long-run analyses, it is necessary to have all relevant variables stationary in the same order, I (1). To test the stability of the long-run relationship, estimate of VEC model in this case is needed.

Table 1. *Augmented Dickey-Fuller and Phillips-Perron tests.*

	Augmented-Dickey Fuller (ADF)		**Phillips Prron(PP)**	
	LEVEL	**1st DIFFERENCE**	**LEVEL**	**1stDIFFERENCE**
series	Intercept T&I None	Intercept T&I None	Inter. T&I None	Intercept T&I None
GPt	3.259** 3.55* 4.33*	3.740* 4.05* 3.106**	2.98** 3.4** 3.8*	3.7402* 4.04* 3.02*
GRNOIL	0.9211 5.51* 1.27	3.5164** 3.73* 3.18**	0.387 11.9* 0.98	3.4949** 3.5** 3.10*

(*), (**), and (***) are statistically significant at 1%, 5% and 10% level respectively. T&I: trend and intercept.

Using Engle and Granger (1987), a single equation method is built on the assumption that all variables in the model have to be integrated of the same order. Thus, in our model, all variables implemented are integrated of order one, I (1). To examine the long-run relationship between $GRNOIL_t$ and GP_t, the following equation is specified:

$$GRNOIL_t = \beta_0 + \beta_1 GP_t + e_t \quad (3)$$

Where:

GP_t: is the wholsale price (proxy for inflation).

$GRNOIL_t$: is the non-oil GDP, represents growth variable. The rationale behind using non-oil GDP is warranted. Oil production and its revenues dominate the GDP. The price of oil is determined abroad and there exists a need to see the effects of domestic policies on the non-oil traded and service sectors. These sectors constitute about 13 percent of total GDP and reflect diversification of productivity base efforts.

e_t: is random error term.

Utilizing OLS the above equation (3), the endogenous growth model, is estimated and the residual saved and tested for stationarity. Moreover, if residual e_t is stationary, then $GRNOIL_t$ and GP_t are co-integrated and have long-run relationships. Applying ECM, all short run variable is significant at 5 percent level, table 2. The residual (e_{t-1}) has been tested for stationarity, and the results came up significant at 5 percent level, with a positive sign indicating no long-run relationship between growth rate of non-oil GDP ($GRNOIL_t$) and the growth rate of GP_t (Proxy for wholesale price).

Table 2. *Estimates of the growth real non-oil GDP coefficients in the short run.*

Dependent Variable: $GRNOIL_t$	
Constant	-0.00002
	(-1.8076)
GPt	0.02543
	(16.975)*
e_{t-1}	0.78366
	(11.7041)*
R^2	0.94199
F statistics	219.2560
D-W statistics	1.8362

Notes: t-statistics are in parentheses. (*) denotes significance at 1% level.

3.3. Co-integration Methodology

Once unit root tests have been confirmed, the next step is to examine the long-run equilibrium relationship among the variables. The existence of long-run equilibrium (stationary) relationship is called a co-integration, and is an important to rule out spurious regression. Johansen co-integration test is sensitive to the choice of lag length. To find out the lag length, VAR model is fitted to the time series. From table 3, both trace and maximum eigen statistic tests confirm the existence of 1 co-integrated equation at the 5 percent level. The null hypothesis for both tests is that, there is no co-integration between $GRNOIL_t$ (growth rate of real non-oil GDP) and GP_t (growth rate of Wholesale price). So, the null hypothesis of None is rejected. On the other hand, the null hypothesis of trace test is accepted, indicating that there is at most one co-integration. Similarly, the null hypothesis of maximum eigen test is accepted, indicating that at most one co-integrated equation. Moreover, the two variables GRNOIL and GP_t are co-integrated and have long-run relationship and is plausible to run vector error correcting model VECM.

Table 3. *Trace and max-eigen statistic tests, indicate 1 co-integrating equation at the 0.05 level.*

Hypothesized No of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None*	0.50516	20.5255	15.4947	0.0080
At most 1	0.00424	0.12334	3.8414	0.7254
Hypothesized No of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None*	0.50516	20.4022	14.2646	0.0047
At most 1	0.00424	0.12334	3.8415	0.7254

*denotes rejection of the hypothesis at the 0.05 level. **Mackinnon-Haug-Michelis (1999) p-values.

Before indulging into VECM analysis, it is worthwhile to mention that VAR lag order selection criteria is applied. According to lag structure, FPT, AIC, SC, and HQ criterion, a one lag period is suggested. Vector error correction estimates reported in table 4. The coefficient of the co-integrated model, or the error correction term, explains the speed of adjustment towards equilibrium. Since this coefficient is negative and significant at 1 percent level, there exists long-run stable relation between inflation and growth of non-oil GDP. This results also suggest that causality is running from inflation to the non-oil GDP.

Table 4. *Estimates of the VEC.*

Dependent Variable: GRNOIL			
Series	**Coefficient**	**t-statistics**	**Prob.**
ECT	-0.1352	(-3.9657)*	0.0005
D(GRNOIL(-1))	0.3581	(1.34484)	0.1908
D(GPt(-1))	0.0051	(0.69156)	0.4956
C	-1.00005	(-0.52100)	0.6070
R^2 0.60			
F 11..6532			

Notes: t-statistics are in parentheses. The asterisk denotes significance at 0.05% level.

Table 5, reports the VAR estimates. In accordance, last period inflation influences the growth of non-oil GDP positively. The coefficient is significant at 5 percent level. However, this effect tends to be small. In contrast, it is notable that last period growth non-oil GDP tends to influence inflation in a positive manner. The coefficient is significant at 5 percent level. There exist long-run causality running from inflation GP_t to the growth of non-oil GDP. However, from the results alluded to, there might exist long run causality to running from the growth rate of non-oil GDP to inflation GP_t too.

Finally, it is of interest to check the degree of acceptance of the model. R^2 is about 0.60, and the F statistics is significant at 5 percent level. There is no serial correlation, The p-value is greater than 5 percent indicating the rejection of the null hypothesis of the presence of serial correlation. In addition, no heteroscedasticity exists. Residuals are not normally distributed which is a bad sign. However, since no serial correlation the, model is generally accepted.

Table 5. *Results of VAR estimates.*

Dependent variables	GRNOIL(-1)	GPt(-1)	
$GRNOIL_t$	0.8542	0.003130	R^2 0.968
	(17.7406)*	(2.8339)**	F 848.24
GPt	4.4164	0.8739	R^2 0.967
	(2.9603)**	(25.7629)*	F 846.23

Note: (*) and (**) are statistically significant at 1% and 5% respectively.

3.4. The Threshold Estimate

Assuming k=1 to k=13, equation 1 is tested by least squares method. According to the results obtained, table 6, a 10 percent threshold level of inflation in the Saudi economy is close to the estimates of numerous scholars for the oil based economies, that is 11-13 percent. Moreover, in his study on Azerbaijan, Hasanov [9], found that 13 percent threshold level of inflation satisfies the maximum R^2 and minimum RSS. The coefficients are meaningful and significant at 5 percent level. Furthermore, due to the closeness of the estimation results of the threshold equation by OLS and TSLS, [9], i abstained from applying the TSLS in searching for the threshold level of inflation in the Saudi economy. It is clear from table 6, that inflation lower than 10 percent is expected to harm the economy and lower the non-oil GDP. However, inflation exceeds 10 percent would benefit the non-oil GDP by about 0.20 percent, that is ($\lambda_1 + \lambda_2$ = 0.026 + 0.176 = 0.202). Policy makers should weight the cost and benefits of keeping the threshold level of inflation at it's level in order to stabilize the economy. Our results confirm the existence of the Dutch disease phenomenon. In the Dutch disease literature, the relative price hike will benefit the service sector. Thus, the service sector constitutes about 47 percent of the non-oil GDP in Saudi Arabia in the year 2015.

Table 6. *The dependent variable: Real growth of non-oil GDP.*

Variable	Coefficient	t-test	Prob.	
C	-0.000009	-0.95078	0.3502	
Inf	0.0352	1.7841	0.0856	R^2 0.65
X1(-1)	-0.8585	-0.4766	0.6376	
C	-0.000008	-2.9871	0.0061	
Inf	0.0382	3.5586	0.0015	R^2 0.79
X2(-2)	-0.2287	-0.5157	0.6104	
C	-0.000129	-5.5530	0.0000	
Inf	0.03941	5.8323	0.0000	R^2 0.88
X3(-3)	-0.01093	-0.0633	0.9500	
C	-0.000133	-5.5375	0.0000	
Inf	0.03688	5.8562	0.0000	R^2 0.88
X4(-4)	0.06064	0.50331	0.6193	
C	-0.000140	-5.6851	0.0000	
Inf	0.03435	6.0211	0.0000	R^2 0.88
X5(-5)	0.10892	1.2505	0.2237	
C	-0.000148	-5.9094	0.0000	
Inf	0.0330	6.2484	0.0000	R^2 0.89
X6(-6)	0.11249	1.8651	0.0756	
C	-0.000152	-5.7696	0.0000	
Inf	0.03234	6.2089	0.0000	R^2 0.89
X7(-7)	0.11898	2.1103	0.0470	
C	-0.000165	-65612	0.0000	
Inf	0.02988	6.61649	0.0000	R^2 0.90
X8(-8)	0.14643	3.3616	0.0031	
C	-0.000182	-9.3355	0.0000	
Inf	0.022747	8.51498	0.0000	R^2 0.94
X9(-9)	0.17162	6.26431	0.0000	
C	-0.000192	-18.3241	0.0000	
Inf	0.02583	15.5184	0.0000	R^2 0.98
X10(-10)	0.17615	14.1522	0.0000	
C	-0.000167	-13.1517	0.0000	
Inf	0.02564	12.2640	0.0000	R^2 0.97
X11(-11)	0.13367	9.30601	0.0000	
C	-0.000141	-9.97811	0.0000	
Inf	0.02563	10.20482	0.0000	R^2 0.96
X12(-12)	0.09645	6.0938	0.0000	
C	-0.000118	-8.4970	0.0000	
Inf	0.02543	9.1572	0.0000	R^2 0.96
X13(-13)	0.06980	4.36091	0.0000	

Note: Inf. is growth rate of wholesale price (GP_t). X1=0.01*GP_t; X2=0.02*GP_t and so on.

4. Conclusion and Policy Implications

This paper has sought to investigate the relationship between inflation and non-oil GDP, in a major oil producing country, Saudi Arabia, for the period of 1985-2015 using real factors, rather than nominal variables. The data were in millions of Saudi Riyals (National currency), and in nominal values before adjusting them to real variables. To better understand this controversial relationship, the wholesale price has been used in addition to the growth rate of real non-oil GDP. In search for better results, Global price and World price indices has been implemented. However, no attainable improvements achieved in the tests. The results support the existence of the Dutch disease. The relative price rise benefits the non-traded goods sector (service sector) at the expense of tradable sectors. Hence, the positive direction of price affects largely the service sector. The threshold level of inflation for non-oil GDP is about 10 percent. Inflation exceeds 10 percent will have statistically positive effect on the growth of non-oil gross domestic products, i.e. 0.20 percent. However, inflation below the threshold level of 10 percent will decrease economic growth of non-oil GDP. Maintaining prices at this threshold level without clear cut measures of supporting the traded sectors, means that policy makers are not enthusiastic toward diversifying the production base as fast as possible to maintain sustainable growth.

Appendix

From Figure A1, it is clear that responsiveness of growth due to impulse of inflation is negative and significant after a year and a half in the future. Whereas, the inflation responsiveness due to shocks in growth is effective positively after three and a half years in the future. However, the shocks of $GRNOIL_t$ to $GRNOIL_t$ and GP_t to GP_t are positive and declining till about seven years in the future.

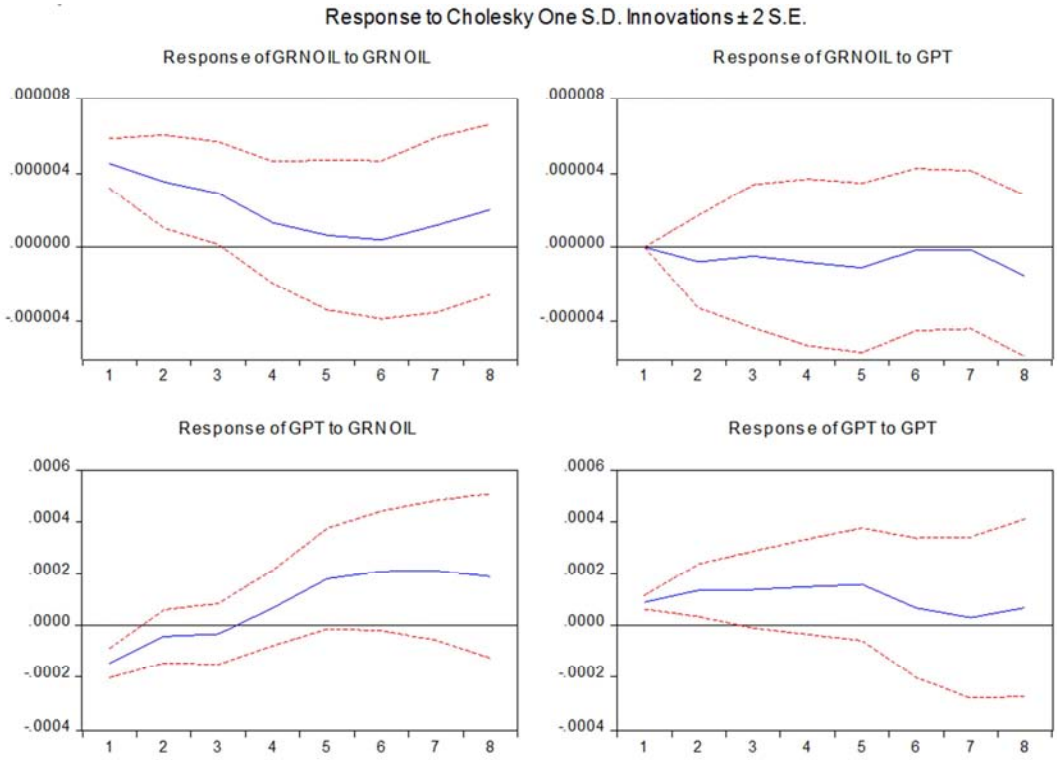

Figure A1. *Impulse Response Function.*

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