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Early phase success and long run failure of economic sanctions

With an application to Iran

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Table of Contents

ABSTRACT

We develop a model of the dynamics of economic sanctions in conjunction with the response of the sanction target. We apply this model to the case of the EU and US boycott of Iranian oil. Our VAR model finds significant impacts of sanctions both on key economic variables and on the political system. These effects, however, are limited in time and occur in the first two to four years of the sanction episode only because adjustment of economic structures mitigates the economic and political impact of the sanctions.

Keywords

Vector autoregressive model, sanctions, Iran.

Early phase success and long run failure of economic sanctions.[1]
With an application to Iran

1 Introduction

The first two years of a sanction episode are crucial for the success of economic sanctions. According to the Hufbauer et al. (2008) dataset 55% of the successes (that is changes of behaviour and/or political regime type) occur during the first two years of a sanction episode. The probability of success decreases substantially after this initial phase of a sanction episode (Table 1).[2] The mirror image of this empirical regularity, namely the longevity of sanction episodes, has drawn the attention of many authors. Patterns of success, failure, duration and termination of long-lived sanctions have been related to the target's and sender's institutional characteristics and the changes therein (Bolks and Soyawel, 2000, McGillivray and Stam, 2005), commitment strategies (Dorussen and Mo 2001) and Bayesian learning (van Bergeijk and van Marrewijk 1995).

TABLE 1
Frequency distribution of duration of post-1945 sanctions

Duration	Failures (%) (A)	Successes (%) (B)	Ratio (B/A)
< 1 year	17	41	2.4
1-2 years	6	14	2.3
2-3 years	15	9	0.6
> 4 years	62	37	0.6
	100	100	

Note: Totals may not add up to 100% due to rounding
Source: Calculations based on Hufbauer et al. (2008)

Our paper is a natural component to this literature as we offer an explanation of why success predominantly occurs in the early phase of a sanction episode. We analyse the economic dynamics of an economy that is hit by economic sanctions since this enables us to zoom in on the early short run and later long run phases of a sanction episode in order to uncover the economic drivers of

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[1] Sajjad Faraji Dizaji is at Tarbiat Modares University, Tehran, Iran. This working paper was written while he was a visiting scholar at ISS

[2] A problem with Table 1 might be its partial bivariate nature and also that the table reports on on-going sanctions that eventually might succeed. Detailed multivariate logic analyses however, do not find differences with respect of the impact of duration on sanction success in ended and on-going sanctions, respectively; see van Bergeijk (2009), Table 6.4, p.131

the empirical regularity that successes by and large occur in the early phase of the sanctions. We design a Vector Autoregression (VAR) model for Iran that includes economic and political variables. Our methodology has its roots in economics (Sims 1980), but has long been recognized as a useful approach in political science as well (Freeman, Williams and Lin, 1989), in particular when it is important to distinguish the short-run and long-run impact of interventions (see for example Enders and Sandler, 1993). Our model simultaneously investigates the impacts of sanctions both on selected key economic variables (exchange rate, consumer price index, investment, government consumption, imports and GDP per capita) and the political system (in particular shifts in democratic versus autocratic elements). These effects are limited in time and occur in the early phase of the sanction episode only. So our VAR estimates show that adjustment of economic structures mitigates the effects, the effectiveness and success of the sanctions.

Our paper studies the topical case of sanctions against Iran, but has a much wider application. The choice of country application is motivated, firstly, by the availability of recent VAR models for the Iranian economy that deal with the main sectorial target of US and EU sanctions, namely oil exports (Dizaji 2012, Farzanegan, 2011, Farzanegan and Markwardt, 2009) and, secondly, by our observation that the current debate is mainly qualitative and based on interpretation of selected events (see for examples Maloney 2009 and Esfandiary and Fitzpatrick 2011). The analysis of this particular case could thus benefit from an empirical analysis. This paper contributes to the debate on sanctions against Iran by clarifying a number of economic issues in this discussion and by pointing out the linkages between economics and politics and *vice versa*.

The remainder of this paper is organized as follows. Section 2 develops a theory that relates sanction effectiveness (sanction damage) and sanction success (compliance with the sanction sender's objective) to economic adjustment over time. We use the neoclassical trade model to clarify that sanction damage is largest in the early phase of the sanction episode while in the long run the economic benefits of compliance reduce. Both these points have been overlooked so far as theories have by and large relied on comparative statics.[3] Section 3 sets out the research design that is aimed at estimating a set of 20 relatively small Vector Autoregression (VAR) models covering the early 1960s to mid-2000s. The models always include a sanction shock variable related to real oil revenues or rents per capita and a political outcome variable. Section 4 presents the empirical results for these 20 models using impulse -response functions to show the development of the variables over time. Building on this set, we then derive a more comprehensive VAR model on which we report in Section 5. We also provide a variance decomposition as a check. Section 6 concludes.

[3] Van Bergeijk and Van Marrewijk (1995) come close, but do only address our former and not our latter point.

2 The short-run and long-run impact of sanctions

We propose a simplified sanction episode in a neoclassical setting, but focus on dynamics rather than the usual comparative statics analysis that has been the main analytical economic framework since it was introduced by Kemp (1964, pp. 208–17). For ease of exposition we analyse the case of a sanction that cuts off all trade. The comparative static analysis sees the long run loss of the gains from free trade as the main determining factor for a change of behaviour of the target economy's leadership. The target will not comply if free trade utility is less than non-compliance utility (consisting of autarky utility and utility derived from non compliance). In the neoclassical model a sanction will produce more hardship on the target economy, the more intensive the target's pre-sanction international trade and investment relationships with the sender and the more inflexible the target's consumption preferences and production structures.

FIGURE 1
Production, consumption and specialization at different stages of international trade

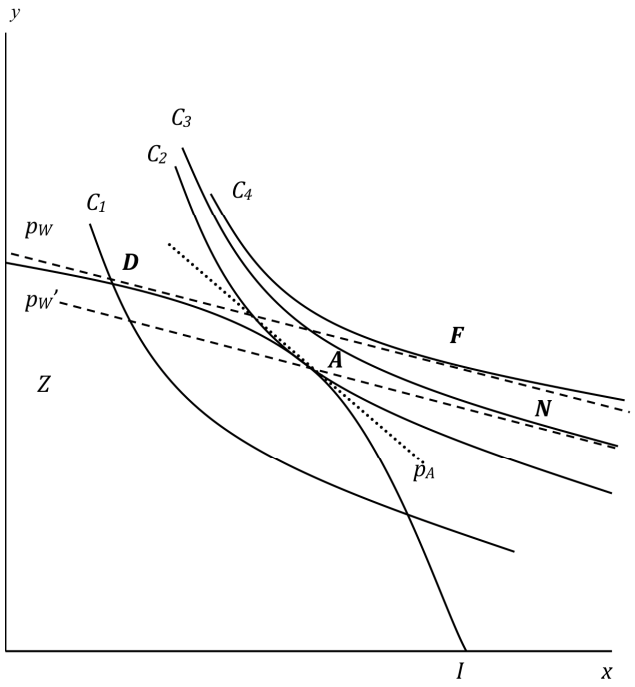

Figure 1 illustrates this model depicting production, consumption and trade. The production possibilities curve *I* shows the maximum attainable combinations of goods *x* and *y* that can be produced by the economy given the

available endowments and technology.[4] The curve is concave and its shape reflects decreasing return. Consumer preferences are depicted by a selection of four convex indifference curves C_1, C_2, C_3 and C_4 that each represent combinations of x and y that yield a constant level of utility. The further the transformation curve and the indifference curve lie from the origin, the higher is the level of production *c.q.* the utility that these curves represent. Finally the figure contains two price ratios: the ratio p_A that results in autarky (that is if the economy does not intend to trade), and the price ratio p_W that is the world price. Point A, the 'autarky point reflects long run production and consumption in the hypothetical case that no other country exists with which the target economy can trade as in the case of a complete sanction. The long run post sanction market outcome is determined by the endowments, the production function and consumer preferences. Markets are in equilibrium balancing demand by consumers and supply by producers for the two goods: in point A the rate of transformation (the tangent to the transformation curve) equals the marginal rate of substitution (the tangent of the indifference curve) and in A obviously x and y are exchanged against the price ratio p_A. Point F, the free trade point, is the pre sanction consumption point (at a superior utility level of C_4); the concomitant production point is D and export of y and import of x can be easily read as the difference between D and F on the horizontal and vertical axes, respectively. The utility level of free trade C_4 exceeds the utility level of autarky C_2.Let U_{NC} be the utility that the target derives from the activity that the sender seeks to discourage. The comparative static analysis states that the target will comply if $U_F > U_A + U_{NC}$. By implications sanctions in the comparative static framework will work either directly or never.

Moving beyond comparative statics, Figure 1 sheds light on the early phase of a sanction episode. A non-sanctioned fully specialized economy will produce at D and this is thus the production point directly after the imposition of sanctions because the factors of production have been used in specific combinations and reallocation of the factors of production will take time. By necessity consumption therefore drops to D, that is the production mix that is actually being produced at the start of the sanction period. Since this production combination is the result of decisions that assumed that international trade would be possible, the resulting consumption combination logically cannot be optimal if trade is impossible. The extent of specialization is thus and this situation will yield a lower utility level than in autarky. Since the rate of transformation in point D (and the price ratio $p_{"}$) is not equal to the marginal rate of substitution, consumers are willing to exchange y for x and the price of x in this economy increases. The production pattern will adjust, the economy de-specializes and more x will be produced until prices settle at p_A in A. Clearly the time path of utility (Figure 2) is directly related to the consumption possibilities in the economy and shows an abrupt drop from point F to point D at time T when the sanction is imposed and then the more gradual movement towards point A.

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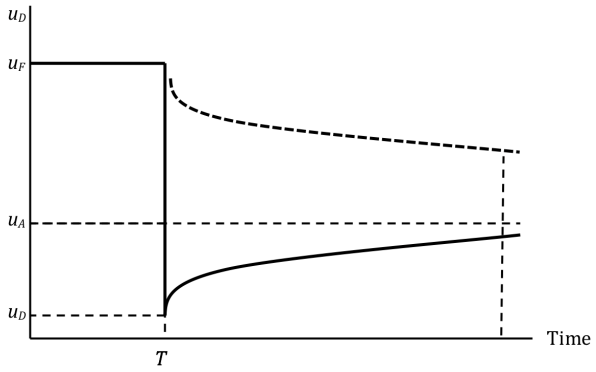
[4] Points within I such as Z can of course be produced but these points are inefficient as the economy can be reorganized so as to get a higher level of y for the observed level of x.

FIGURE 2
Time path of utility as the economy moves from free trade to autarky due to sanctions



Specialization and de-specialization, however, do not only have an impact on the dynamics of the no trade utility level and will also influence free trade utility levels. A de-specializing economy will have to re-specialize and bear the costs of adjustment towards free trade. We can now reformulate the condition for sanction success: the target will not comply if the net present value of the stream of future free trade utility is less than the net present value of the stream of non-compliance utility (consisting of autarky utility and utility derived from non compliance). Both streams are influenced by adjustment and the future costs of an on-going sanction. Consider the moment when adjustment is almost complete as at time *a* in Figure 2. The target will consider the net present value of the future stream in case of non compliance, equal to $(U_A+U_{NC})/(1+i)$ where i is the discount rate as in the comparative static analysis and compare this to the net present value of compliance but now taking the costs of adjustment and thus less than $U_F/(1+i)$. Our analysis of the dynamics of adjustment thus gives us two important results: Firstly, the strongest impact in terms of utility forgone occurs in the initial phase of the sanction episode and, secondly, the long gain of compliance decreases during a sanction episode and is lower in the long run than acknowledged by the comparative static analysis. On both accounts we expect that sanctions have a higher probability of success in the early phase and a lower in the long run. The next sections investigate the validity of this description.

3 Research design

The key issue in this paper is the interplay of macroeconomic and political variables and how these factors determine the result of sanctions. Over the past four years on average 83% of Iranian exports, 34% of Iranian government revenues and 24% of Iranian GDP were related to the main target of the sanctions: the Iranian oil industry (Central Bank of the Islamic Republic of Iran, 2012, the data refer to Persian calendar). For practical reasons we will model the sanctions as a shock to real per capita oil income. From the macroeconomic perspective we are interested in the impact of this shock on

consumer prices, the real exchange rate, real imports, real government consumption, real gross investment and real Gross Domestic Product per capita. From the political perspective we want to know if and how changes in these macroeconomic variables change the Iranian institutional context with regard to the dimension autocracy-democracy.[5] The inclusion of the political system is straightforward and deploys the standard international political science data source Polity IV that describes the combinations of autocratic and democratic characteristics of the institutions of government. Subtracting the autocracy score from the democracy score yields a summary measure Polity. The variable Polity thus detects shifts in the autocracy-democracy dimension. For example a shift towards more democracy can be caused by a lower score for the sub characteristic autocracy, a higher score for the sub characteristic democracy or by any combination where the increase (decrease) of democracy is larger (smaller) than the increase (decrease) of autocracy. The stated goal of the sanctions is to stop nuclear proliferation, but commentators have also linked the sanctions to democratization:

> The new US consensus on Iran favors economic sanctions, preferably "crippling" measures that target Iran's purported Achilles' heel, primarily as a means to derailing an Iranian nuclear weapons capability, but also with hope of facilitating a democratic breakthrough (Maloney, 2010, p. 132; see also Farzanegan 2011, p. 19)

We investigate the response of the macroeconomic and political variables to the sanction shocks deploying a set of unrestricted vector autoregressive models (VAR). The VAR treats all variables as jointly endogenous and does not impose *a priori* restrictions on structural relationships. This is helpful for our research because we do not need to specify *a priori* the structural interrelationships between politics and economics (and *vice versa*) in a sanction case.[6] All that we need is a specification of the chain of influence between the variables and here we can rely both on theory and information collected in other descriptive and analytical studies. Obviously, many economic variables are relevant and ideally one would include all those variables in the VAR and test extensively for robustness of the sequence of the variables.[7] Unfortunately the data for the polity variable are available only at an annual basis and therefore we have only 48 observations (annual data from 1961 to 2008, inclusive).[8] So we have to be parsimonious. This means that our method runs the risk of suffering from omitted variables bias. In order to avoid this

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5 In our VAR the political system, which in itself is a determinant of sanction success (see Kaempfer and Lowenberg (1988) van Bergeijk (1999), is thus endogenously determined.

6 See for general discussions of these points: Pindyck and Rubinfeld (1991) and Enders, (1996).

7 The Cholesky procedure implicitly assumes recursivity in the VAR model as it is estimated. Although theoretical considerations may help in determining the order of the variables in the VAR model and ex-post sensitivity analysis may further help provide insights regarding appropriate ordering, it remains largely at the discretion of the modeller (Eltony and Al-Alwadi, 2001).

8 For oil and gas rents we have 46 observations only.

problem as far as possible we will follow an alternative approach pioneered by Christiano et al (1996) and Jansen (2003) in section 4 and then move on to a more comprehensive model in section 5. They analyze a set of separate VARs that always include the starting variable and the result variable (in our case: the sanction shock and polity), but different sets of transmission variables. We always use an oil revenues related variable as the most exogenous amongst the VAR variables, because oil prices and consequently oil revenues are determined by world market conditions and we expect that significant shocks in oil revenues affect contemporaneously the other key macroeconomic variables in the system. Like Christiano et al (1996) and Jansen (2003) we always include one key macroeconomic variable (imports *c.q.* government consumption) that we combine with other variables (government consumption *c.q.* imports or gross fixed capital formation or Gross domestic product per capita or real exchange rate or consumer price index). We always include polity because we want to investigate if and how changes in the key macroeconomic variables due to the shocks to oil revenues (oil and gas rents) caused by economic sanctions will change political behavior. Diagram 1 illustrates the conceptualization of the VAR models; all in all we estimate 20 separate VAR models based on two different (oil revenue versus oil and gas rents[9]) per capita measures for the sanction shock, two different key economic indicators and five economic variables that are entered separately in the VAR model. We report the results in section 4. Then we move on in section 5 and build a more comprehensive VAR by considering the results of the 20 small VAR models.

DIAGRAM 1
Conceptualizations of the VAR models

Beginning of the process	***Economic impact***	***End of the process***
OIL REVENUE SHOCK	MACRO ECONOMIC VARIABLES	POLITICAL VARIABLE
Real oil revenues per capita *or* Real oil and gas rents per capita	1. Imports 2. Government consumption *or* gross fixed capital formation *or* Gross domestic product per capita *or* real exchange rate *or* consumer price index	Polity
Real oil revenues per capita *or* Real oil and gas rents per capita	1. Government consumption 2. Imports *or* gross fixed capital formation *or* Gross domestic product per capita *or* real exchange rate *or* consumer price index	Polity

[9] Rent is the difference between the output value of non-renewable resources (oil and gas in this case study) and intermediary consumption (or intermediary costs).

3.1 Choice and sequence of variables

The starting point is the boycott of oil that is modeled as a negative shock in oil revenue per capita *c.q* rent per capita. This way of operationalizing is in line with recent VAR models on the Iranian economy in the context of economic sanctions (Dizaji 2012, Farzanegan 2011). We expect that significant shocks in per capita oil revenues and rents affect contemporaneously the other key macroeconomic variables in the system and the polity variable.

Next we proceed to motivate the choice of the key economic variable that we want to include in the VARs. We will present two variants: imports and government expenditures. Providing two variants will enable us to demonstrate robustness of some of the key findings.

Government expenditures

The common practice in recent VAR modelling of the Iranian economy (Dizaji 2012, Farzanegan, 2011, Farzanegan and Markwardt, 2009) is to use public consumption expenditures (including current consumption, rents and depreciation) as a key variable. Current expenditures (payments of governmental employees, subsidies and so on.) try to preserve the current capacities of government administration. Since 1970 a large and growing wage bill of the public sector reflects the dominant role of the government in the economy, especially since the Islamic Revolution in 1979. Subsidies also play an important role in the size and inflexibility of current expenditures in Iran. The government, as a main recipient of oil rents, redistributes part of the oil revenues through different kinds of subsidies. The inflexible structure of government expenditure suggests substantial exogeneity with respect to other 'downstream' variables. Recent analysis (Farzanegan, 2011) however indicates that the impact of oil revenues on different categories of government expenditure is limited (actually the only significant impact is on military expenditures). For this reason we also consider an alternative variant, *in casu* imports.

Imports

The reason to include imports is straightforward. Imports are rationed and changes in the other explanatory variables cannot increase imports beyond that level. The rationing is an immediate consequence of the boycott that reduces the availability of foreign currency and this will by necessity lead to a reduction of imports in a hard currency constrained economy.[10]

[10] The target economy has some temporary leeway in running down international reserves and in theory could borrow on the international capital market. In the case of Iran this is not realistic also in view of the restrictions on international payments that form part of the US and EU sanctions.

Further downstream: gross fixed capital formation, GDP per capita, exchange rate and CPI

Both imports and government expenditures have an impact on the quality and quantity of new capital goods. In the longer run this will reduce the production capacity of the economy. All factors (reduced government expenditures, reduced gross capital formation, reduced production and reduced imports) inject scarcity in the economy and this will influence relative prices. Two important candidates to take these effects into account are the Consumer Price Index (Spindler 1995) and the real exchange rate (Sobel 1998).

Polity

All in all sanctions reduce government expenditure and investment and deprive the economy from (some of) the gains from international trade and this disutility influences the target's behaviour. The economic variables ultimately have an impact on the political system leading to shifts in the underlying autocracy and democracy scores of Polity.

3.2 Econometric issues

We use the vector autoregression (VAR) model to understand the interrelationships among our variables. The VAR model provides a multivariate framework that relates changes in a particular variable to changes in its own lags and to changes in other variables and the lags of those variables. The mathematical representation of a VAR is:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + B x_t + \varepsilon_t \qquad (1)$$

where y_t is a vector of k endogenous variables, x_t is a vector of d exogenous variables, $A_1,\ldots,A_p$ and B are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated both with their own lagged values and with all of the right-hand side variables. We define the vector of exogenous variables as X_t =[constant, D_1, D_2], where D_1 and D_2 are dummy variables for capturing the effects of the Islamic Revolution of 1979 and Iran-Iraq war (1980-1988), respectively. Since only lagged values of the endogenous variables appear on the right-hand side of the equations, simultaneity is not an issue and OLS yields consistent estimates. We opt for an unrestricted VAR models in levels. Firstly, structural VAR models are "very often misspecified" (Tijerina-Guajardo and Pagán, 2003).

TABLE 2
Phillips-Perron unit root test

	Level	1st difference
Real oil revenue per capita	-2.25	-5.9***
Real oil and gas rent per capita	-1.43	-5.39***
Real public consumption	-2.51	-4.28***
Real investment	-1.45	-4.41***
Real GDP per capita	-1.90	-3.76***
Real exchange rate	-2.13	-6.71***
Real imports	-1.72	-4.84***
Polity	-2.09	-7.27***

***: Null hypothesis rejection at 1%

Secondly, as reported in Table 2 the Phillips-Perron unit root test indicates that all variables are integrated of order 1, so I(1).[11] If all the variables in the system are non-stationary, it is better to use a VAR in levels (Fuller 1976). Since we have a variety of VAR models we determine the lag length for each VAR separately. For the model of this study the lag length of 2 is the modal score of the LR, FPE, AIC and HQ criteria. We estimate our model using annual data for the period 1965 to 2008 (oil revenues) or 1961 to 2006 (oil and gas rents). All variables except for polity are in logarithmic form. Appendix I discusses the data and the sources.

The main tools in the VAR model estimation are the impulse response functions and variance decompositions. Impulse response functions enable us to study the dynamic response of the macroeconomic variables to sanction shocks. With the impulse response functions we can observe both the magnitude and statistical significance of such responses to one standard deviation increase in the oil market related variable (Stock and Watson, 2001). We refer to the discussion above regarding the choice of our variables.

4 Empirical results

Table 3 summarizes the results for the 20 estimated VARs (Appendix 2 provides the impulse response functions of all VARs and variables). This study empirically investigates the impact of sanctions on the Iranian economy. The impulse response functions trace out the response of current and future values of the variables in the system to a one standard deviation decrease in the current value of oil revenue(rent) errors.

Table 3a reports on VARs that use real oil revenues per capita as a shock variable and 3b on VARs that use real oil and gas rent per capita as a shock variable. The upper part of Tables 3a and 3b reports VAR variants that always

[11] We also applied the ADF test with similar results although government consumption expenditures were stationary in their level.

include imports and the bottom part of the tables reports on VARs that always include government expenditures. Each line in the tables represents a different specification of the VAR and reports on the sign and significance of the short term (up to 5 years after the initial shock) and the long-run (10 years after initial shock) impact according to the impulse response functions.[12] For example, the first line in Table 3.a states that imports are reduced due to the sanction shock and this effect is significant in the short term but is not significant anymore in the long-run. In this VAR the intermediate variable is government expenditure which shows a similar pattern. The polity variable is positive in the short run representing a move towards a more democratic framework and negative in the long run. The change in polity does not meet our requirements for significance.

TABLE 3a
VARs with real oil revenues per capita as sanction shock variable

Intermediate	*INTERMEDIATE*		*IMPORTS*		*POLITY*	
	Short run	*Long run*	*Short run*	*Long run*	*Short run*	*Long run*
Government consumption	**Negative**	Negative	**Negative**	Negative	Positive	Negative
Gross capital formation	**Negative**	Negative	**Negative**	Negative	Nil	Negative
GDP per capita	**Negative**	Negative	**Negative**	Negative	Positive	Negative
Exchange rate	Negative	Nil	**Negative**	Negative	Negative	Nil
CPI	Positive	Negative	**Negative**	nil	**Positive**	Negative
	INTERMEDIATE		*GOV. CONS.*		*POLITY*	
	Short run	*Long run*	*Short run*	*Long run*	*Short run*	*Long run*
Imports	**Negative**	Negative	**Negative**	Negative	Positive	Negative
Gross capital formation	**Negative**	Nil	**Negative**	Negative	Positive	Negative
GDP per capita	**Negative**	Positive	**Negative**	Nil	Nil	Negative
Exchange rate	**Negative**	Positive	**Negative**	**Negative**	Positive	Negative
CPI	Positive	Negative	**Negative**	Negative	Positive*	Negative

Notes: Significant deviations in **bold** * Border case almost significant

[12] We determine significance using standard procedures calculating confidence bands around the impulse response function (Sims and Zha 1999) and report significance if the null hypothesis of "no effects of impulse variable shocks" on the specific variable can be rejected (Berument et al., 2010). Short term significance can also occur in a limited number of years in the first five years; long run effects always refer to the 10th year.

TABLE 3b
VARs with real oil and gas rents per capita as sanction shock variable

Intermediate	*INTERMEDIATE*		*IMPORTS*		*POLITY*	
	Short run	*Long run*	*Short run*	*Long run*	*Short run*	*Long run*
Government consumption	**Negative**	Negative	**Negative**	Negative	positive*	Negative
Gross capital formation	**Negative**	Nil	**Negative**	Negative	**Positive**	Negative
GDP per capita	**Negative**	Negative*	**Negative**	**Negative**	Positive	Negative
Exchange rate	Nil	Nil	**Negative**	Negative	Positive	Nil
CPI	Nil	**Negative**	**Negative**	Negative	Positive	Negative
Intermediate	*INTERMEDIATE*		*GOV. CONS.*		*POLITY*	
	Short run	*Long run*	*Short run*	*Long run*	*Short run*	*Long run*
Imports	**Negative**	Negative	**Negative**	Negative	positive*	Negative
Gross capital formation	**Negative**	Nil	**Negative**	Negative	**Positive**	Negative
GDP per capita	**Negative**	Positive	**Negative**	Nil	Positive*	Negative
Exchange rate	Negative	Positive	Negative	Negative	**Positive**	Negative
CPI	Positive	**Negative**	**Negative**	Negative	Positive	Negative

Notes: Significant deviations in **bold** * Border case almost significant

The information uncovered in the 20 VAR models allows for the following robust conclusions:

- We find strong and consistent evidence for an initially significant negative economic impact of sanctions that wanes at the end of the simulation period for government consumption, imports, gross capital formation and GDP per capita.
- The evidence for the impact on prices and exchange rate is weak as significance is the exception.
- The impact on polity is consistent (although not always significant) showing in most of the cases a change from positive to negative, and in the other cases a change in the same direction (from positive to zero or from nil to negative). This implies that the political impact of sanctions although is occasionally positive in the short term deteriorates in the long run.

5 Extended VAR and variance decomposition

The previous section by considering only a limited number of the variables may run the risk of omitted variables bias. In order to address this problem we follow an intermediate strategy by specifying a VAR model that includes those variables that are supported by the findings reported in section 4.

5.1 VAR

We do not include CPI and exchange rate in view of their weak performance in all variants and use oil and gas rents per capita in compare with oil revenues per capita as the sanction shock variable and have the following Cholesky ordering in our VAR system: real oil and gas rents per capita, real public consumption, real imports, real gross capital formation, real per capita GDP, polity. This ordering, indicates that oil rents have an influence on public consumption expenditures and then later on all other variables in the model. Oil revenues basically depend on world market conditions so its behavior is the least determined by other variables that we include in the model. Section 3 clarified that (a) government expenditures are strongly influenced by oil shocks and (b) transmit the effects of sanctions to other macroeconomic variables significantly. Hence their second position in the Cholesky ordering.[13] The negative development in oil and gas rents due to the economic sanctions decrease the financial sources first for financing imports and second for investment projects. The changes in these economic variables influence per capita GDP and ultimately the changes in the economic variables affect polity.[14] For our comprehensive VAR model the lag length of 3 is selected on the basis of the LR, FPE, AIC and HQ criteria.[15]

Figure 3 reports the impulse response functions that trace out the response of current and future values of the variables in the system to a one standard deviation decrease in the current value of real oil and gas rents per capita. In addition to the response of each variable to a one standard deviation shock in the impulse variable the figure shows confidence bands. Figure 3 shows that a negative shock in real per capita oil and gas rents is accompanied

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13 An additional reason is that the inflexible structure of government expenditure implies that it is relatively exogenous (i.e. in comparison with variables further down the Cholesky ordering).

14 As robustness test for our VAR model we also calculated the generalized impulse responses (GIR) of our variables in the VAR system to a one standard deviation shock in real oil and gas rents per capita. This method has been introduced by Pesaran and Shin (1998) in order to avoid the difficulties of identifying orthogonal shocks in VAR models. The GIR functions construct an orthogonal set of innovations that does not depend on the VAR ordering. Our findings showed that the responses in GIR are similar to those which we obtained using Cholesky one standard innovation.

15 Three lag order selection criteria supported a lag length of 3, one criteria (SC) select lag number of 1 and another one (AIC) supported lag length of 4 as the optimum lag. Thus, the lag length of 3 is used for estimation of the VAR model; IRFs and VDCs in this section. The lag specification tests are available upon request.

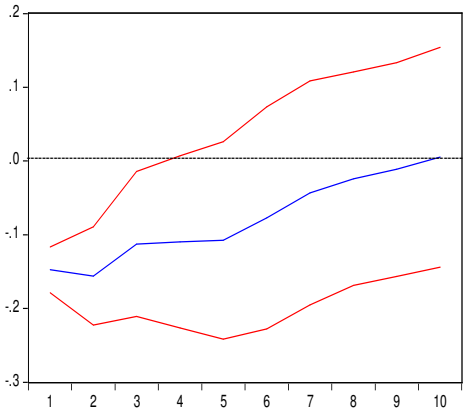
by, on the one hand, negative and statistically significant responses in oil and gas rents per capita, real public consumption expenditures, real imports, real gross capital formation and real GDP per capita and, on the other hand, a positive response in polity. Real public consumption expenditures (Figure 3b) decrease rapidly and for 7 years before recovering (after 7 years the impact is also no longer significantly different from zero). Imports (Figure 3c) decrease for 4 years, but the impact is only significant in the 2nd and 3rd years. Real investment (Figure 3d) decreases for 5 years and then also looses its significance. Per capita GDP (Figure 3e) decreases for 5 years and this decline is no longer significant after the 6th year. Figure 3f shows that the sanction shock has a significantly positive effect in the 1st year only and this turns into an increasingly more negative effect in the 7th year, however, without becoming significant before the end of the simulation period.

5.2 Variance decomposition analysis

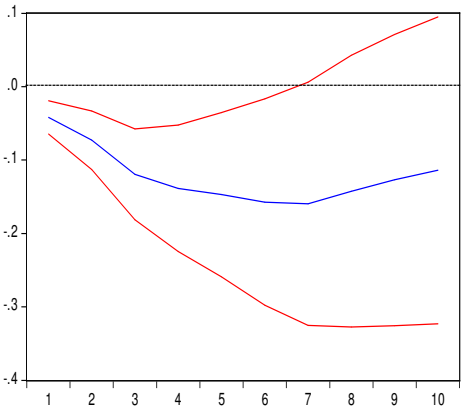
We also examine the forecasting error variance decomposition to determine the proportion of the movements in the time series that are due to shocks in their own series as opposed to shocks in other variables. Table 4 shows that almost for all of the variables the biggest portion of variations is typically explained by the variables' own trend in the first year. Hence at the start of the simulations the historical trend of each variable explains a large part of its own variations. The only exception is for GDP per capita, as about 36 per cent of its variations in the first year are explained by oil and gas rents reflecting high dependency of GDP per capita on oil and gas rents in Iran (compare also that at this increases to 46% at the end of the simulation period).

FIGURE 3
VARs with real oil and gas rents per capita as sanction shock variable (Lag: 3)

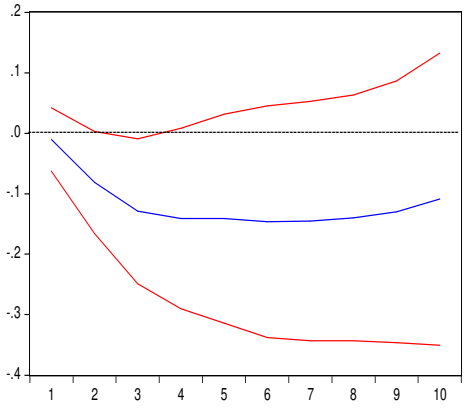
3a Response of real oil rent per capita consumption



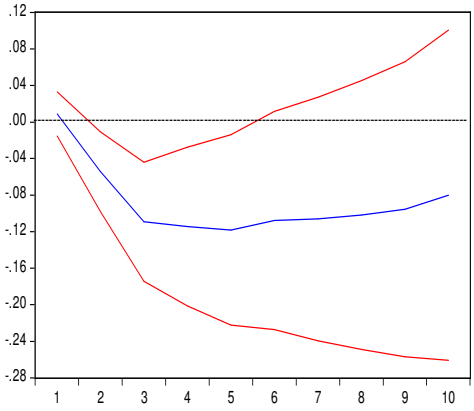
3b Response of public



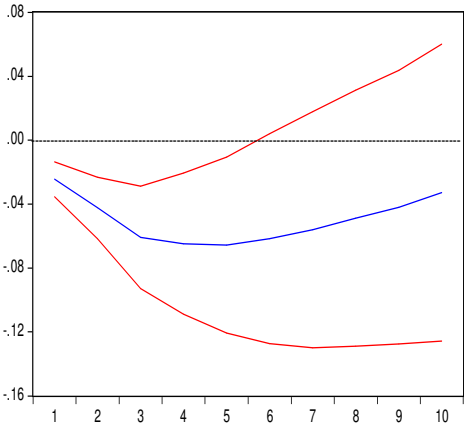
3c Response of imports



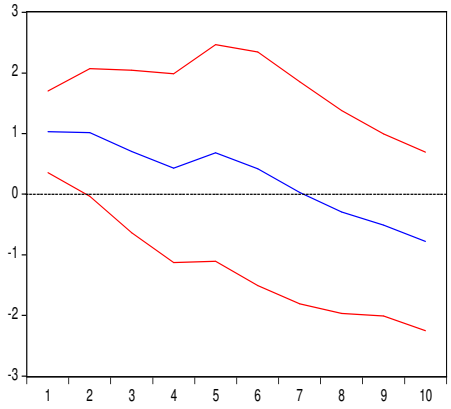
3d Response of gross capital formation



3e Response of GDP per capita



3f Response of polity



The variance decomposition analysis finds that for most of the variables except polity the biggest portion of variations in the long run (after 10 years) is explained by the variations in oil and gas rents. This implies the important role of oil and gas rents in explaining the variations in Iranian macroeconomic variables. In combination these findings suggest that sanctions that bite into the oil and gas rents can affect the Iranian key macroeconomic variables directly, but the impact on its polity is indirect. In the long run at the end of the simulation period the biggest portion of variations in polity are explained by the shocks to imports illustrating the importance of foreign trade as a determinant of changes in the political behavior.

TABLE 4
Variance decomposition

	loilrentpc	lpubcons	limp	linv	GDP pc.	polity
Variance Decomposition of loilrentpc						
1 Year	100.00	0.00	0.00	0.00	0.00	0.00
4 Years	71.93	10.15	4.07	3.36	1.22	9.24
8 Years	55.09	8.90	15.99	4.00	9.34	6.65
10 Years	46.38	9.65	18.94	3.73	15.56	5.72
Variance Decomposition of lpubcons						
1 Year	25.91	74.08	0.00	0.00	0.00	0.00
4 Years	63.33	22.58	4.85	2.73	3.39	3.08
8 Years	67.10	10.16	8.30	4.71	8.22	1.48
10 Years	57.34	7.58	15.06	4.67	14.02	1.30
Variance Decomposition of limp						
1 Year	0.34	38.11	61.53	0.00	0.00	0.00
4 Years	26.17	26.18	37.54	5.17	2.39	2.53
8 Years	40.17	14.72	31.13	3.42	8.79	1.74
10 Years	36.46	11.73	34.07	3.52	12.67	1.53
Variance Decomposition of linv						
1 Year	1.20	15.95	16.38	66.45	0.00	0.00
4 Years	43.44	27.59	11.52	11.40	3.74	2.28
8 Years	48.49	12.46	22.84	6.06	7.48	2.65
10 Years	41.80	9.68	27.39	5.72	13.07	2.31
Variance Decomposition of lgdppc						
1 Year	36.06	10.38	0.46	18.12	34.95	0.00
4 Years	62.99	18.10	4.22	4.71	6.68	3.26
8 Years	58.82	8.60	16.42	4.59	8.57	2.96
10 Years	45.42	7.60	24.34	4.12	15.69	2.79
Variance Decomposition of polity						
1 Year	18.86	0.29	14.87	0.89	1.73	63.34
4 Years	16.06	8.40	34.52	0.84	3.22	36.94
8 Years	15.81	9.14	35.47	0.89	8.25	30.40
10 Years	15.64	11.80	37.49	1.46	6.87	26.70

6 Concluding remarks

The impact of an oil boycott on the Iranian is considerable: oil and gas rents are important drivers of the Iranian key macroeconomic variables and ultimately of its political system. A reduction of these rents creates economic costs that act as incentives for the government in changing its political behavior from an autocratic form to an institutional setting that is more democratic. This effect, however, is only significant in the first year after the sanction shock shock and turns negative after 7 years. These findings reflect that even high short term sanction costs will wane off due to adjustment.

The policy implication of this result is clear: increasing global pressure on the energy industry of Iran, which is the core element of very recent sanctions, may cause initial effective damage on the Iranian key macroeconomic variables possibly softening the negotiation position of Iran. In the long run the sanctions however are likely to have the opposite effect.

These findings are relevant for the policy debate on economic sanctions against Iran that all to often assume that "protracted duration" is a key prerequisite for success (Maloney 2009, p. 132) or that sanctions will not persuade "Iran to return to the negotiation table" (Esfandiary and Fitzpatrick 2011, p. 147).

Our significant results, in contrast with these reported impacts of an oil boycott, indicate that both key economic variables and the political system are not immune for economic coercion by other states. The agreement between our results and other literatures are that the impact is limited in time and occurs only in the first phase of the sanction episode. After the initial phase adjustment of economic structures mitigates the economic and political impact of the sanctions. Sanctions may work in the short term; their impact in the long run is limited at best.

Appendix I Data sources and description

Considering the ability of the data we use annually data for the period 1965 to 2008 while the oil revenues per capita is the shock variable and also annually data for the period 1961 to 2006 while oil and gas rents per capita is the shock variable. The variables considered in this paper are as follow:

- Real public consumption expenditure (pubcons)

This variable is extracted from the Central Bank of Iran (CBI) online database and it is on the base of constant prices of 1997.

- Real imports (imp)

This variable is extracted from the Central Bank of Iran (CBI) online database and it is on the base of constant prices of 1997.

- Domestic prices (cpi)

This variable is Iranian consumer price index and has been extracted from IMF via Data stream.

- Real GDP per capita (gdppc)

This variable is Gross domestic product of Iran on the base of constant prices of 1997 extracted from the Central Bank of Iran online database and it is divided by population. (The data for population has been extracted from IMF via Data stream).

- Real gross fixed capital formation (inv)

Formally it is gross domestic fixed investment on the base of constant prices of 1997 and it is extracted from CBI online data base.

- Real exchange rate (exr)

This is official rate of US dollar in Iranian domestic prices extracted from CBI online data base, and it is divided by CPI to become in real term.

- Real oil revenues per capita (oilrpc)

This is the Iranian government incomes from the oil exports extracted from the CBI online data base and it is divided by CPI and population to become in real and per capita terms respectively.

- Real oil and gas rents per capita (oilrentpc)

This variable is oil, gas, refined product value added on the base of constant prices of 1997 extracted from CBI online data base and it is divided by total population.

- Polity (polity)

This variable is the modified version of the POLITY variable indicated as Polity2 in our data source. The modifications were added in order to facilitate the use of the POLITY regime measure in time-series analyses; see Marhall (2011)

Data sources were accessed May 20, 2012. CBI data base is available at http://www.cbi.ir/simplelist/5796.aspx and http://tsd.cbi.ir/

Appendix II Impulse response functions for 20 different VAR specifications

FIGURE A1
Ordering: loilrpc, imp, pubcons, polity (Lag length: 1)

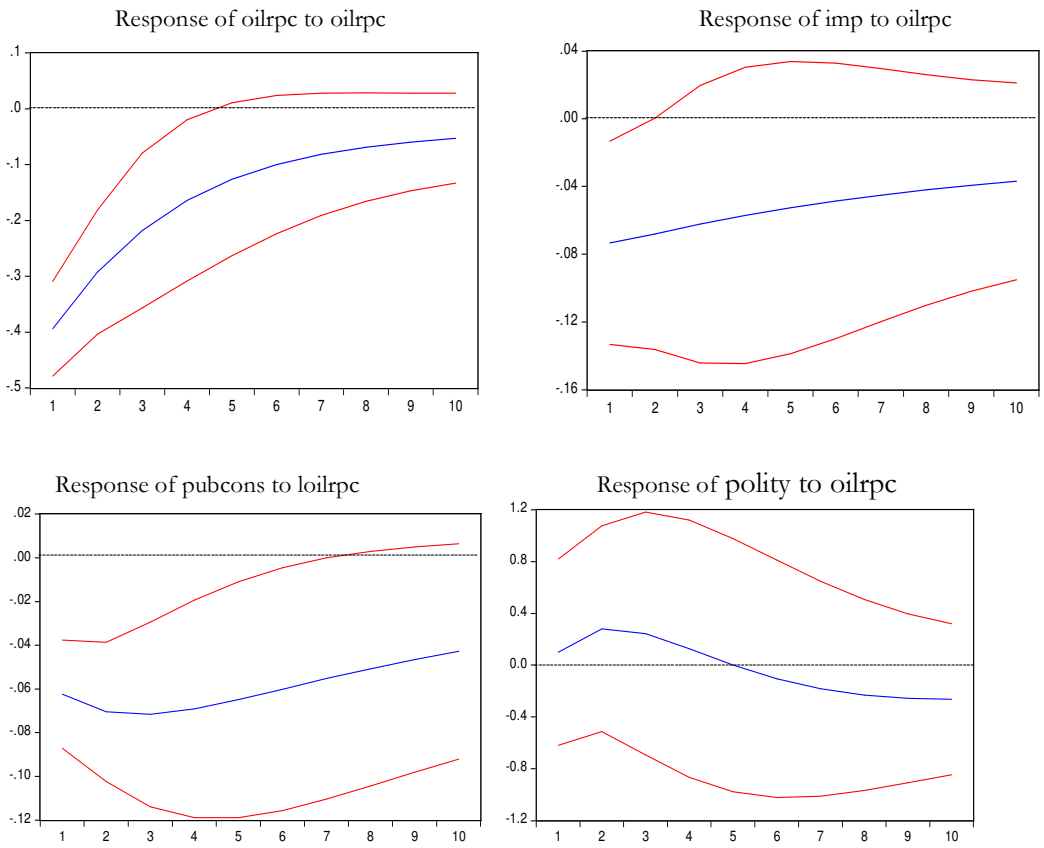


FIGURE A2
Ordering: oilrpc, imp, inv, polity (Lag length: 1)

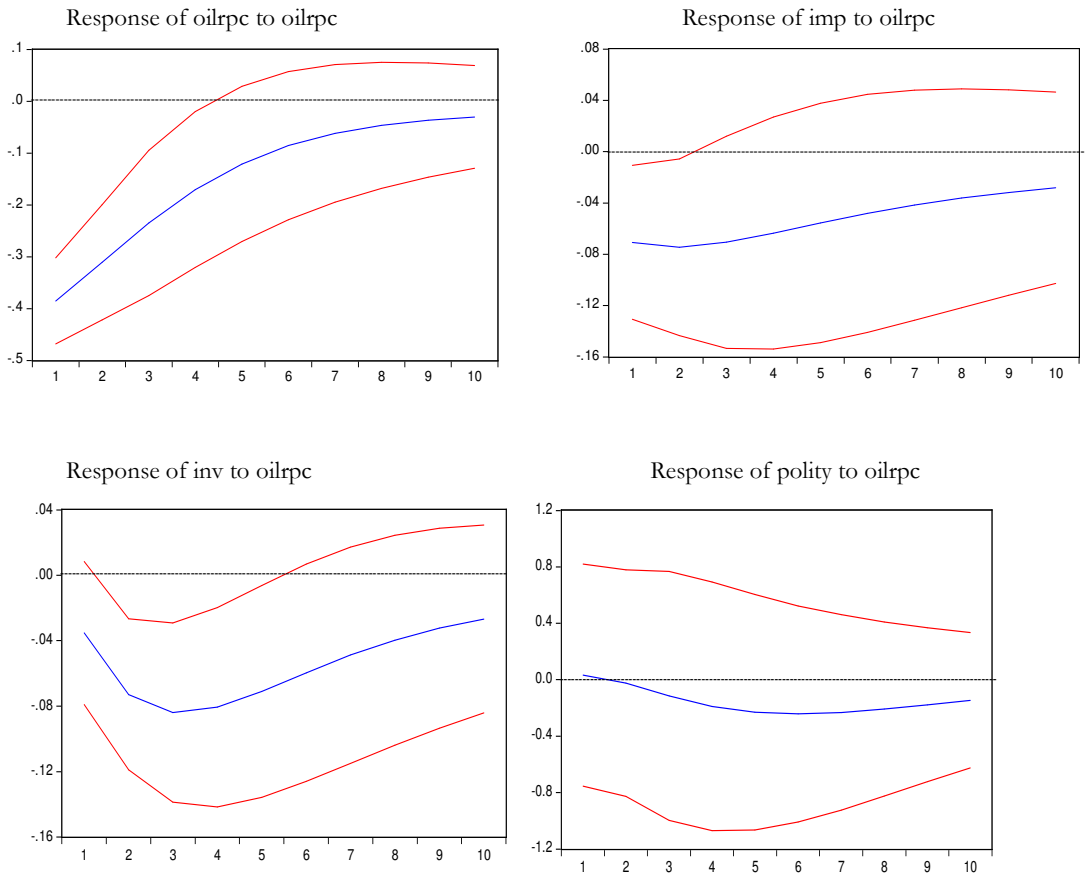
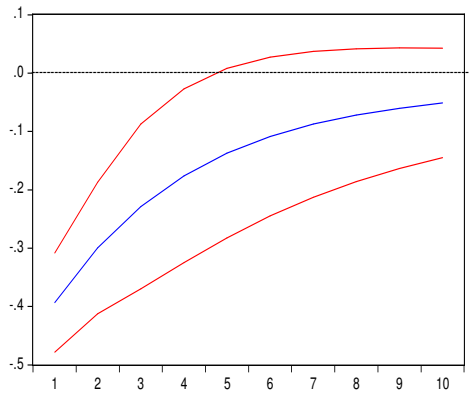
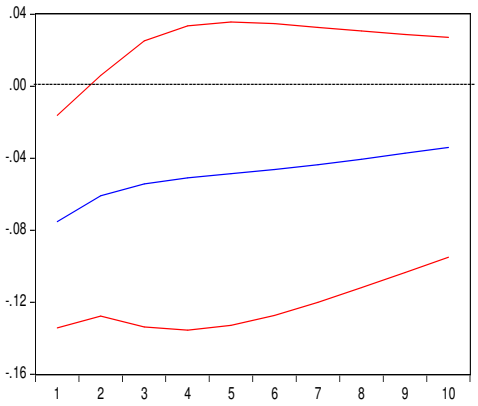


FIGURE A3
Ordering: oilrpc, imp, gdppc, polity (Lag length: 1)

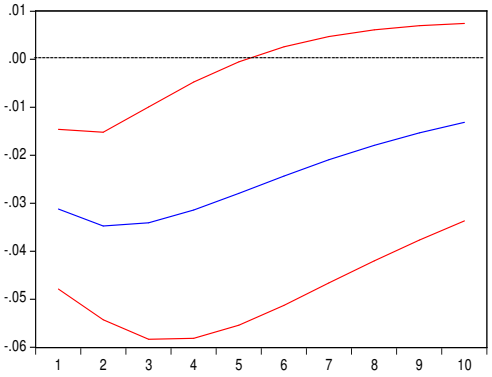
Response of oilrpc to oilrpc



Response of imp to oilrpc



Response of gdppc to oilrpc



Response of polity to oilrpc

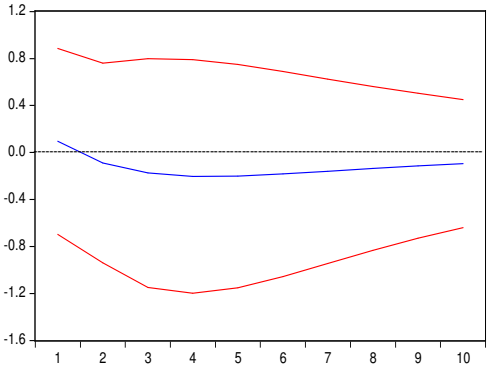
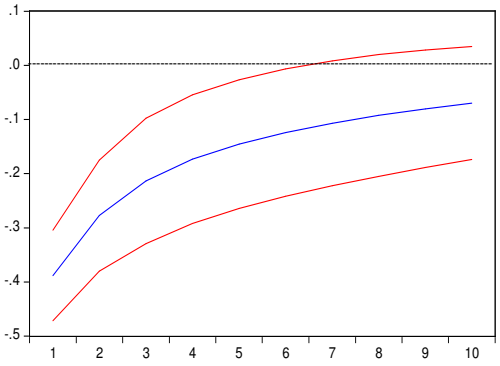
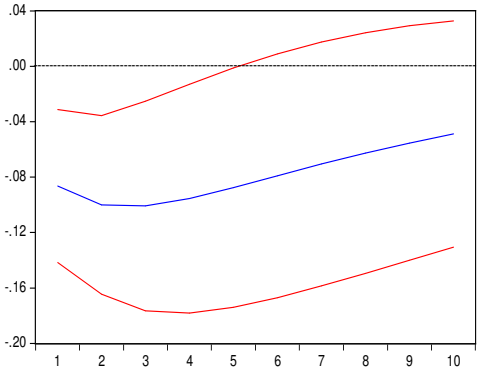


FIGURE A4
Ordering: oilrpc, imp, exr, polity (Lag length: 1)

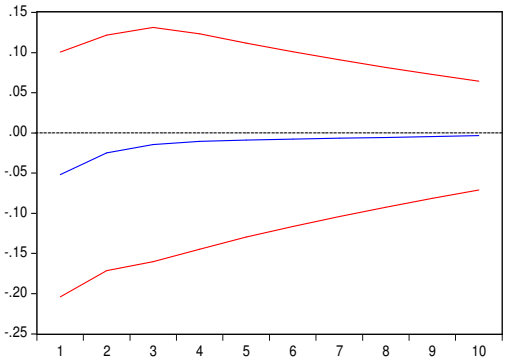
Response of oilrpc to oilrpc



Response of imp to oilrpc



Response of exr to oilrpc



Response of polity to oilrpc

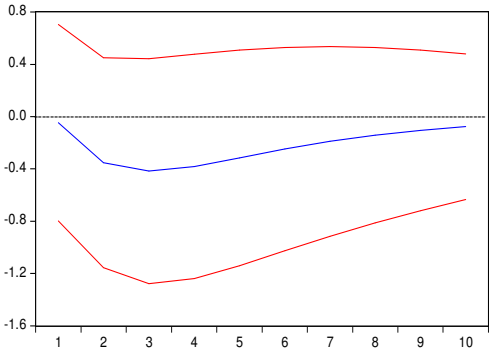


FIGURE A5
Ordering: oilrpc, imp, cpi, polity (Lag length: 2)

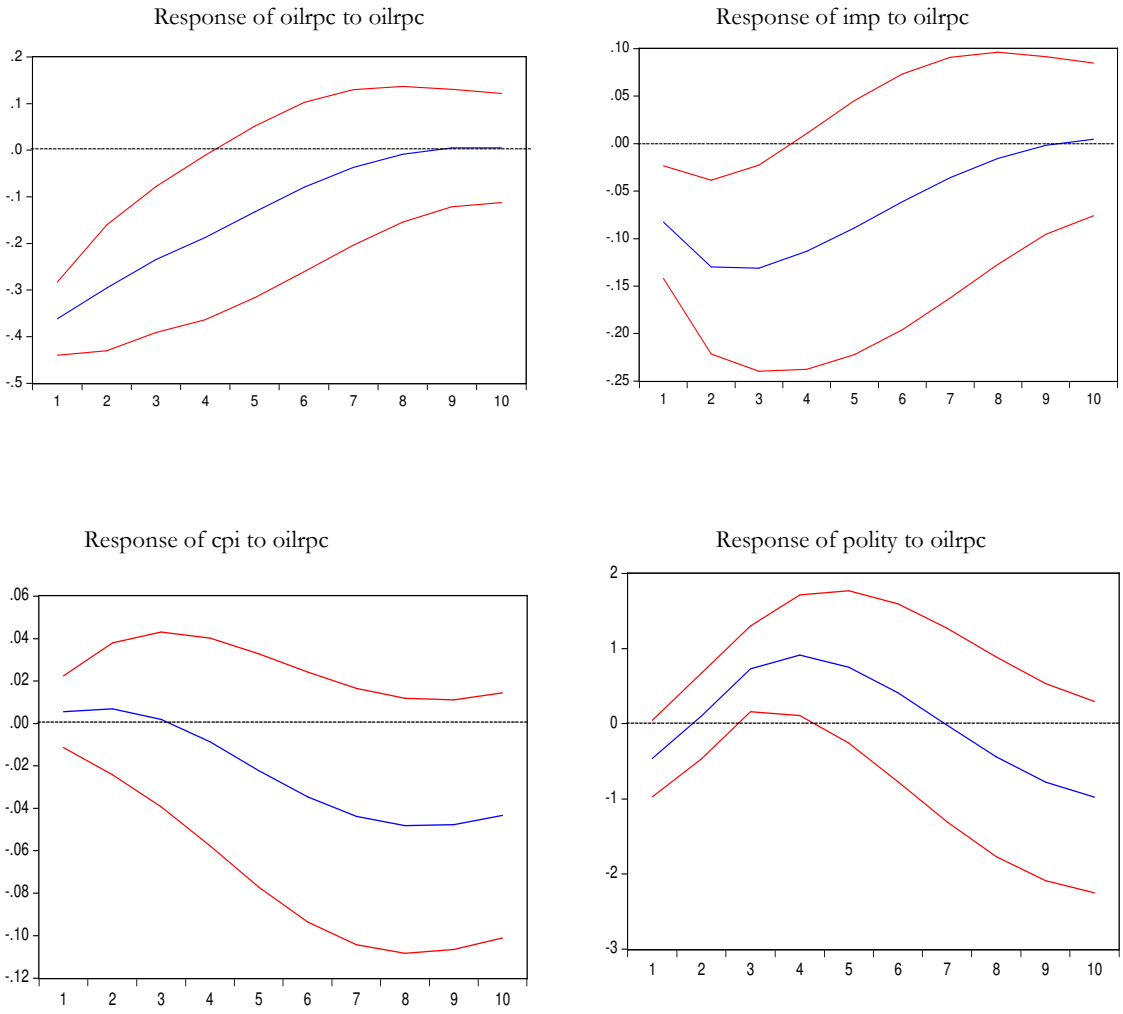
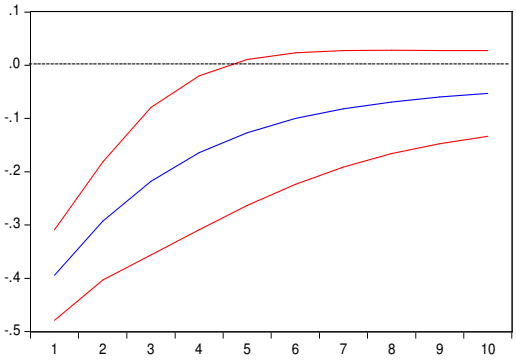
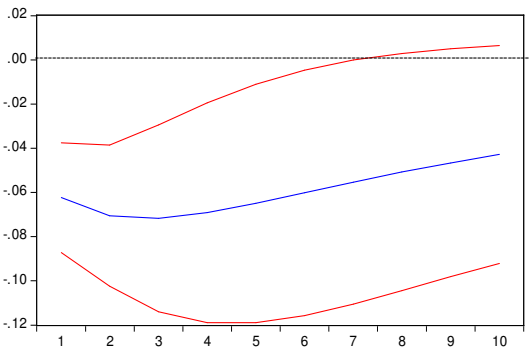


FIGURE A6
Ordering: oilrpc, pubcons, imp, polity (Lag length: 1)

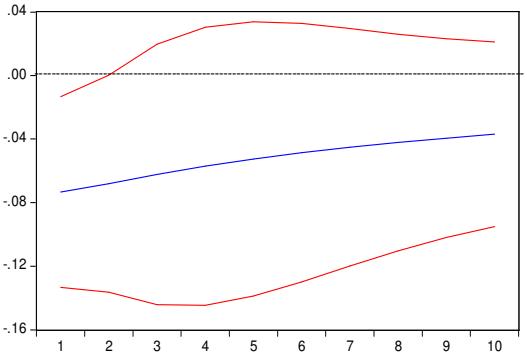
Response of oilrpc to oilrpc



Response of pubcons to oilrpc



Response of imp to oilrpc



Response of polity to iolrpc

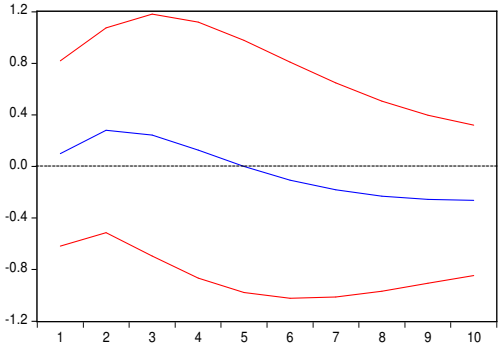
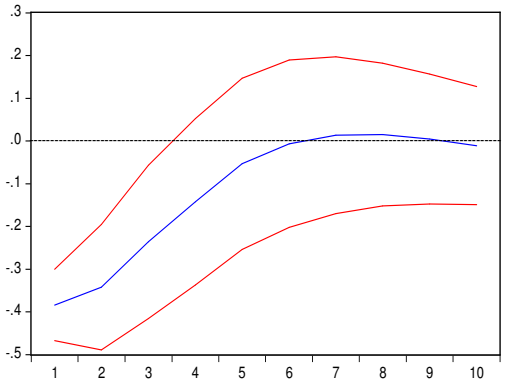
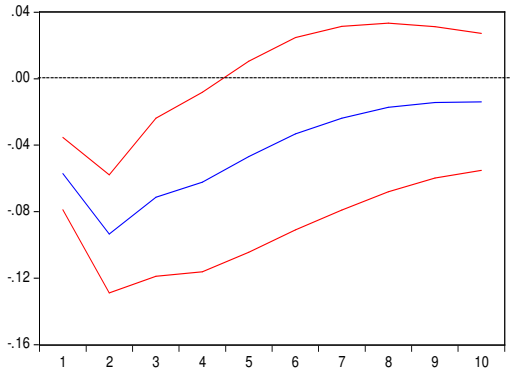


FIGURE A7
Ordering: oilrpc, pubcons, inv, polity (Lag length: 2)

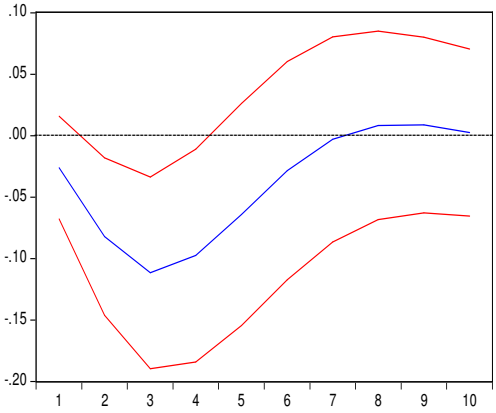
Response of oilrpc to oilrpc



Response of pubcons to oilrpc



Response of inv to oilrpc



Response of polity to oilrpc

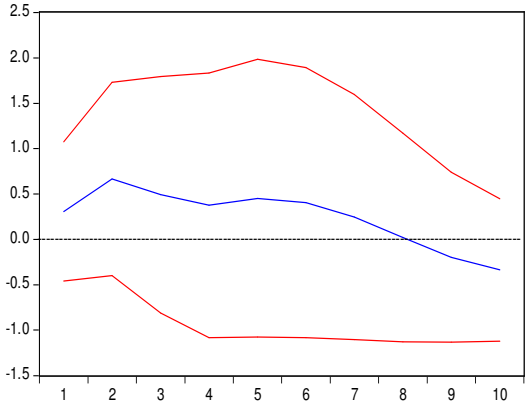
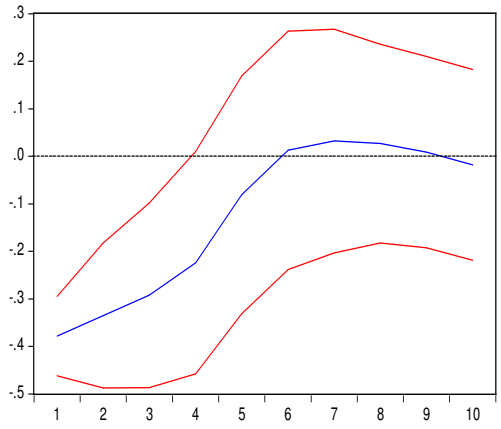
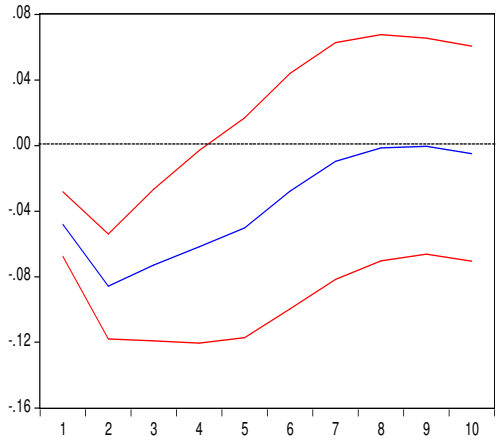


FIGURE A8
Ordering: oilrpc, pubcons, gdppc, polity (Lag length: 3)

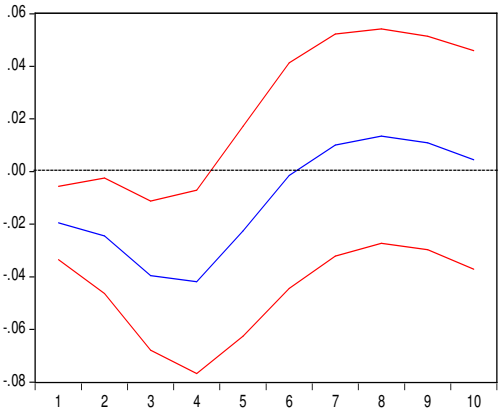
Response of oilrpc to oilrpc



Response of pubcons to oilrpc



Response of gdppc to oilrpc



Response of polity to oilrpc

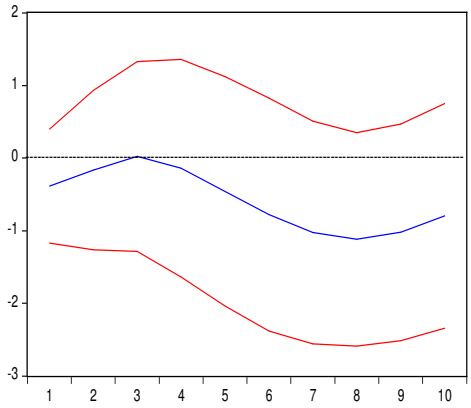
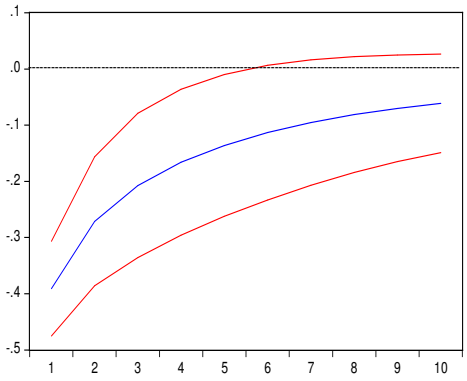
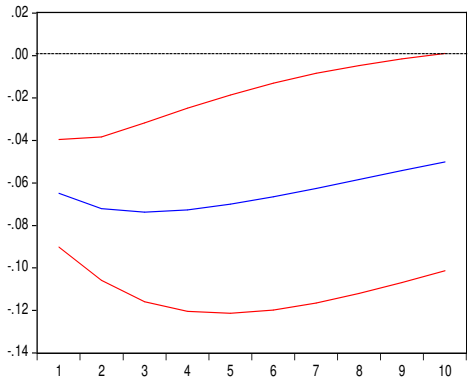


FIGURE A9
Ordering: oilrpc, pubcons, exr, polity (Lag length: 1)

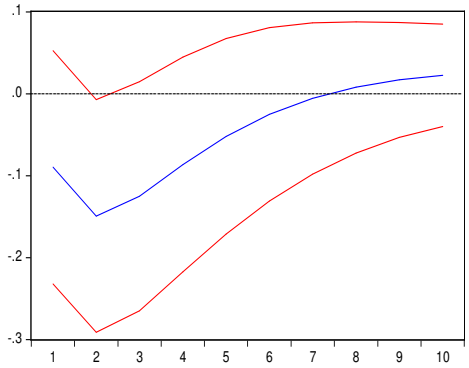
Response of oilrpc to oilrpc



Response of pubcons to oilrpc



Response of exr to oilrpc



Response of polity to oilrpc

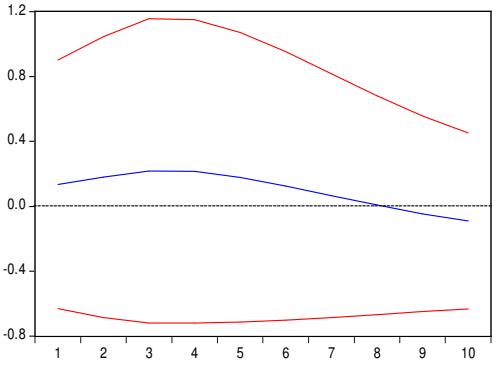
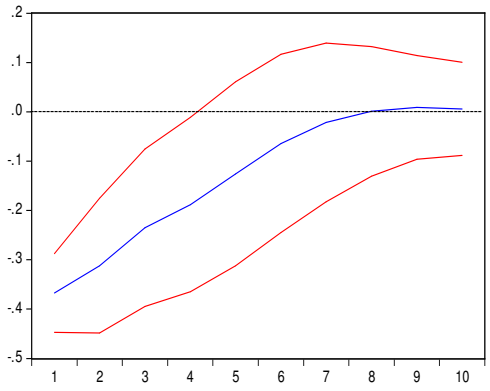
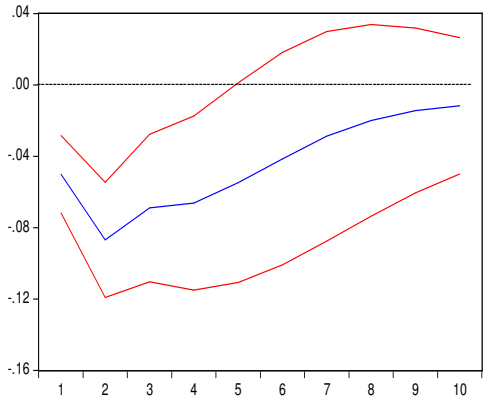


FIGURE A10
Ordering: oilrpc, pubcons, cpi, polity (Lag length: 2)

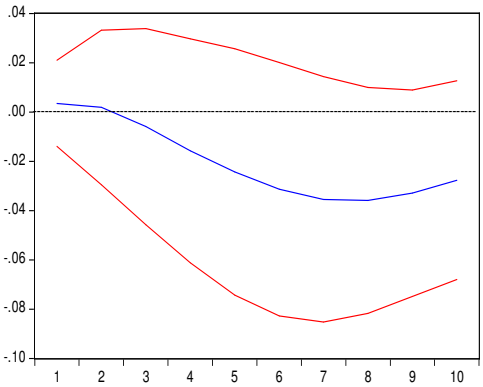
Response of oilrpc to oilrpc



Response of pubcons to oilrpc



Response of cpi to oilrpc



Response of cpi to oilrpc

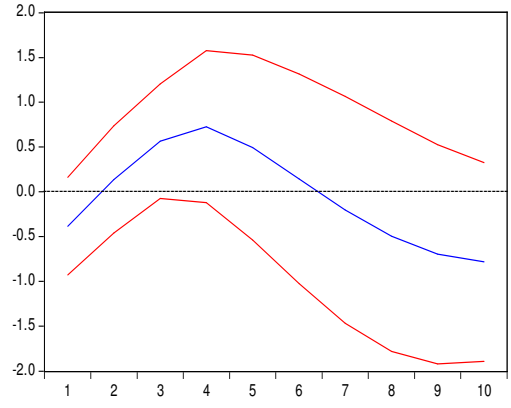
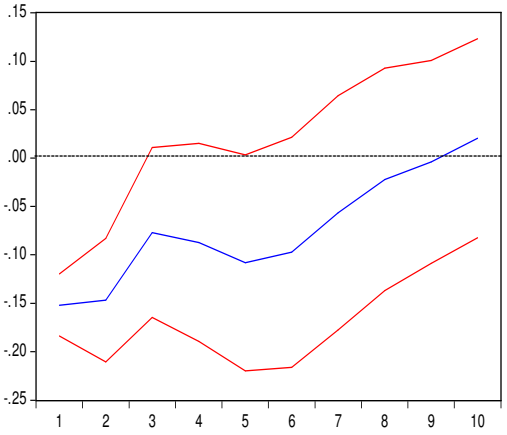
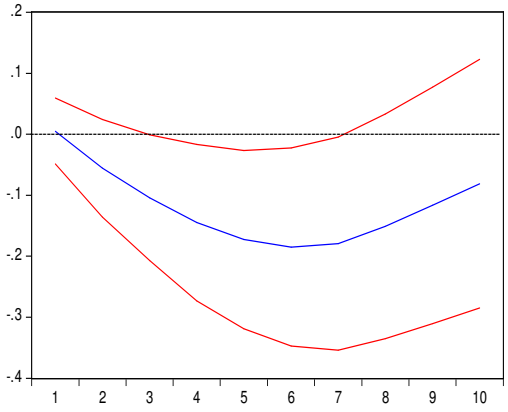


FIGURE A11
Ordering: oilrentpc, imp, pubcons, polity (Lag length: 3)

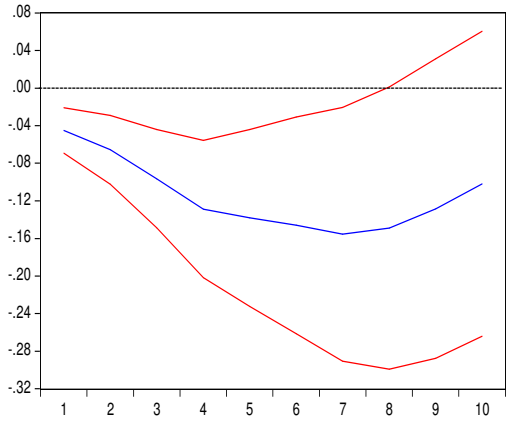
Response of oilrentpc to oilrentpc



Response of imp to oilrentpc



Response of pubcons to oilrentpc



Response of polioty to oilrentpc

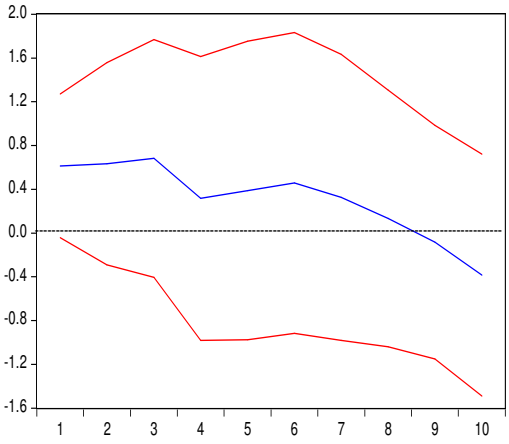
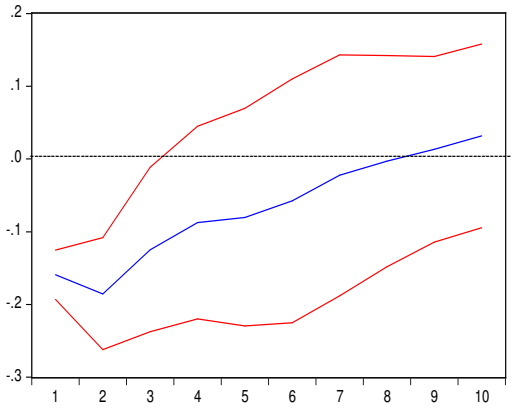
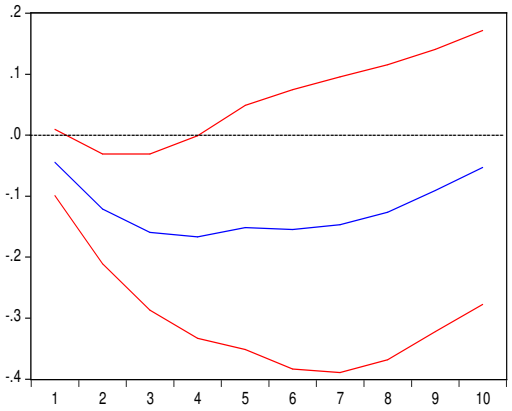


FIGURE A12
Ordering: oilrentpc, imp, inv, polity (Lag length: 4)

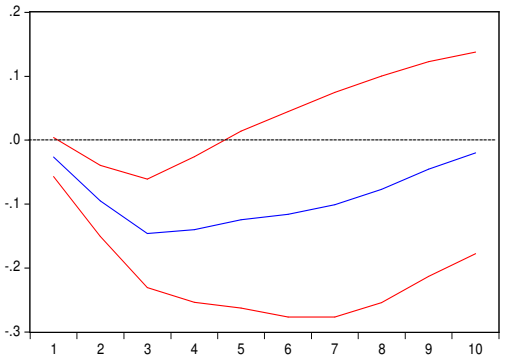
Response of oilrentpc to oilrentpc



Response ofimp to oilrentpc



Response of inv to oilrentpc



Response of polity to oilrentpc

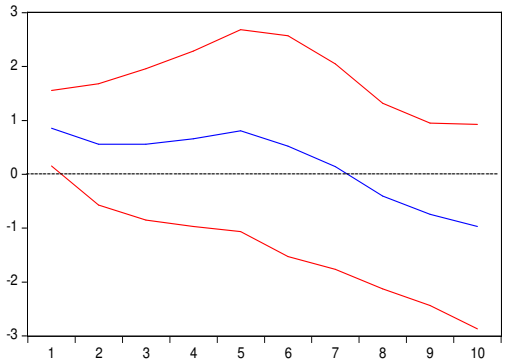
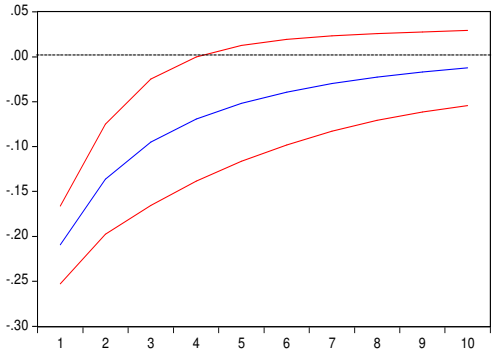
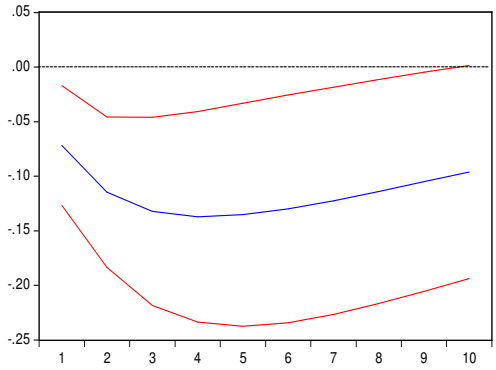


FIGURE A13
Ordering: oilrentpc, imp, gdppc, polity (Lag length: 1)

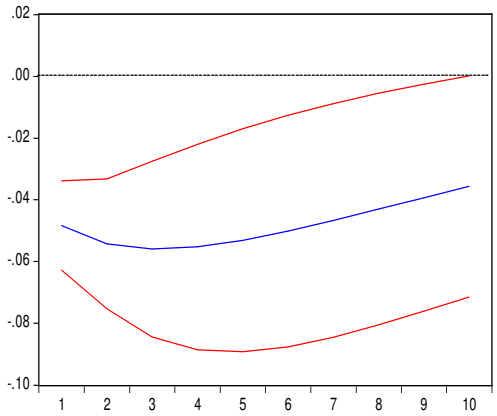
Response of oilrentpc to oilrentpc



Response of imp to oilrentpc



Response of gdppc to oilrentpc



Response of polity to oilrentpc

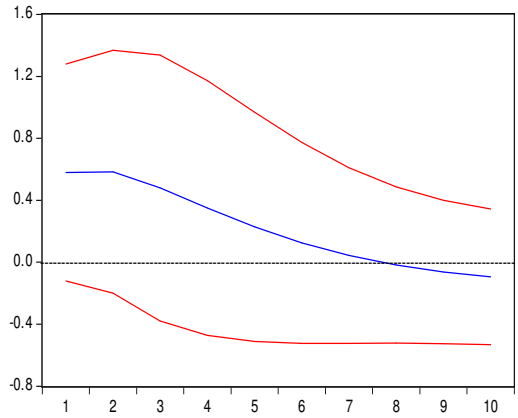
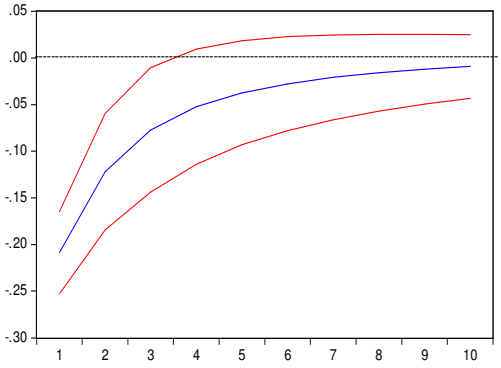
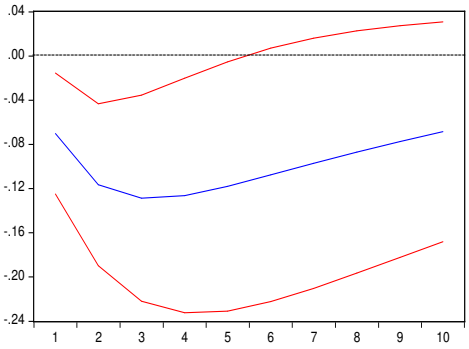


FIGURE A14
Ordering: oilrentpc, imp, exr, polity (Lag length: 1)

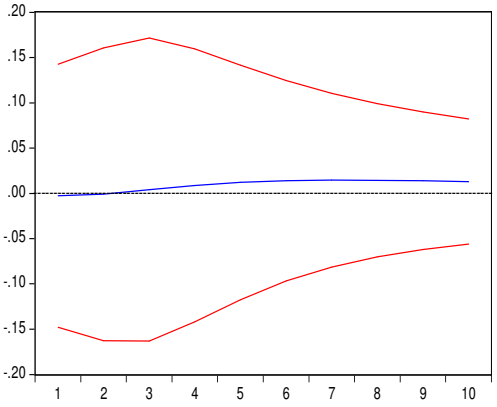
Response of oilrentpc to oilrentpc



Response of imp to oilrentpc



Response of exr to oilrentpc



Response of polity to oilrentpc

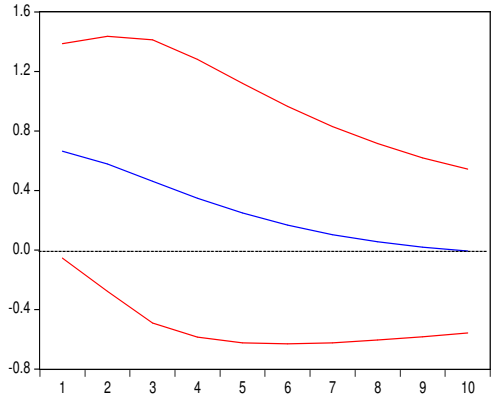
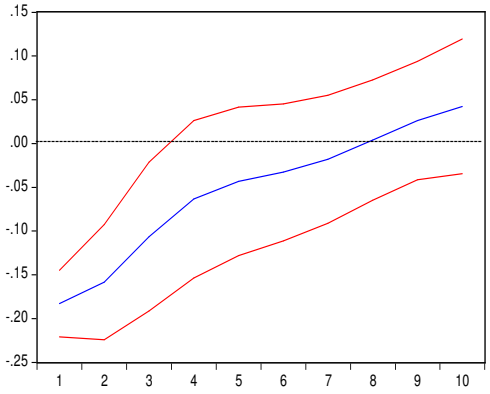
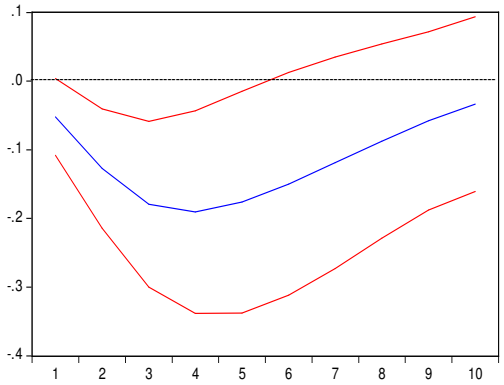


FIGURE A15
Ordering: oilrentpc, imp, cpi, polity (Lag length: 2)

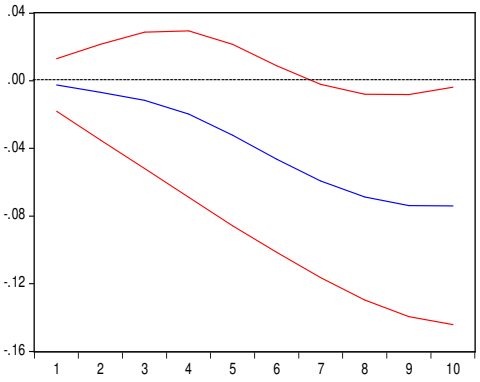
Response of oilrentpc to oilrentpc



Response of imp to oilrentpc



Response of cpi to oilrentpc



Response of polity to oilrentpc

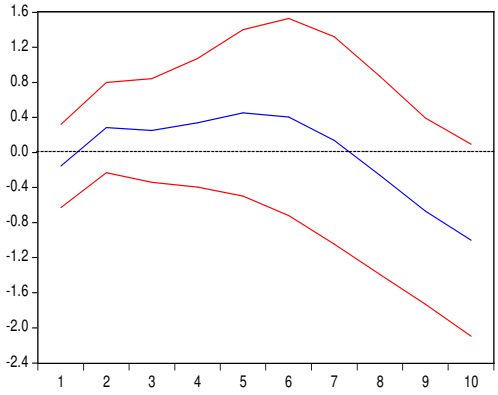


FIGURE A16
Ordering: oilrentpc, pubcons, imp, polity (Lag length: 3)

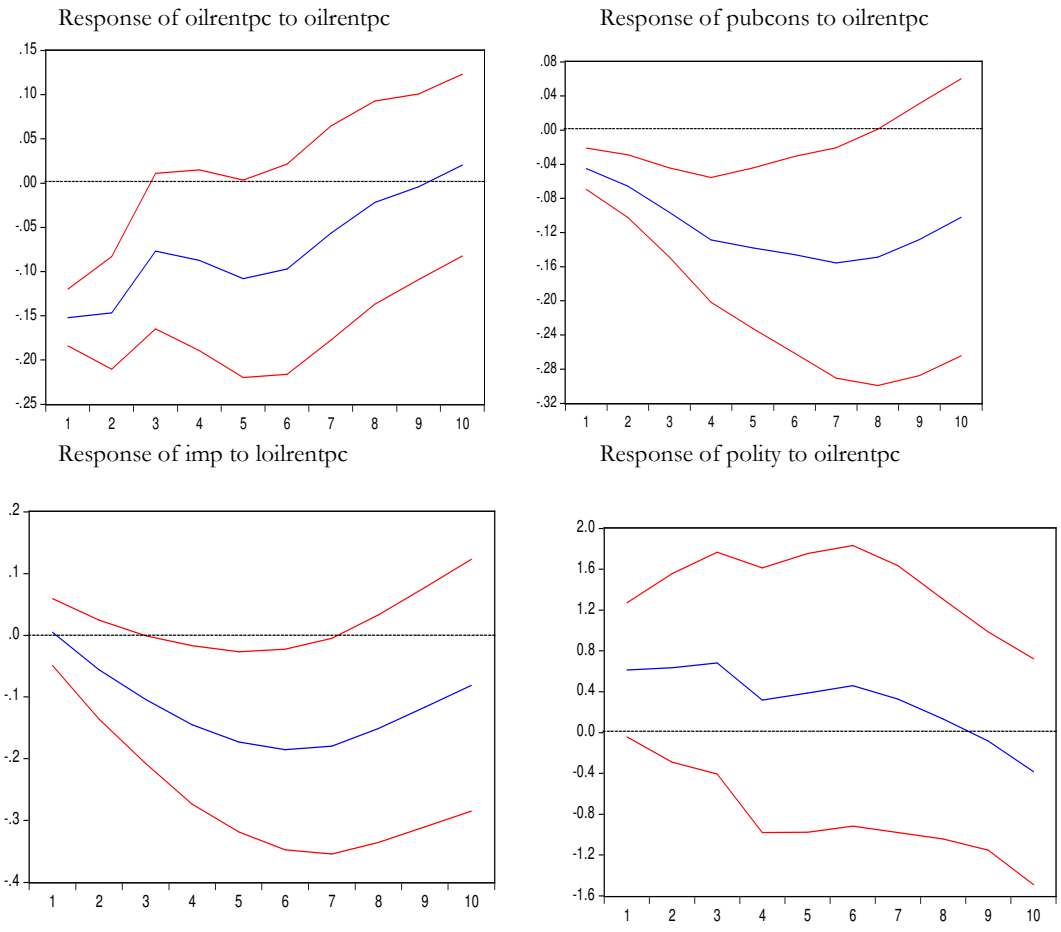
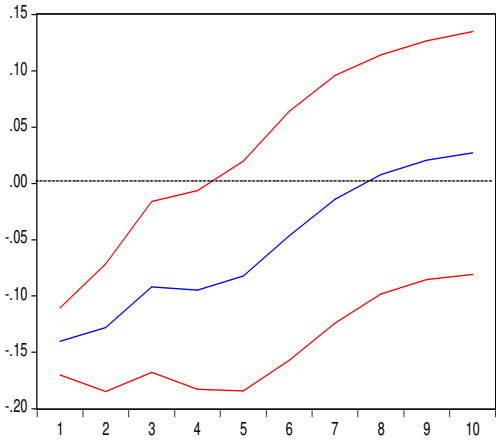
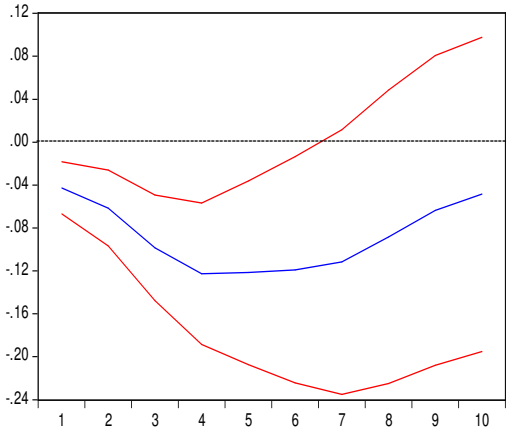


FIGURE A17
Ordering: oilrentpc, pubcons, inv, polity (Lag length: 3)

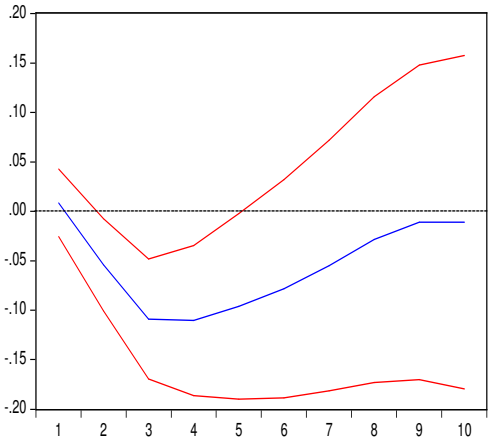
Response of oilrentpc to oilrentpc



Response of pubcons to oilrentpc



Response of inv to oilrentpc



Response of polity to oilrentpc

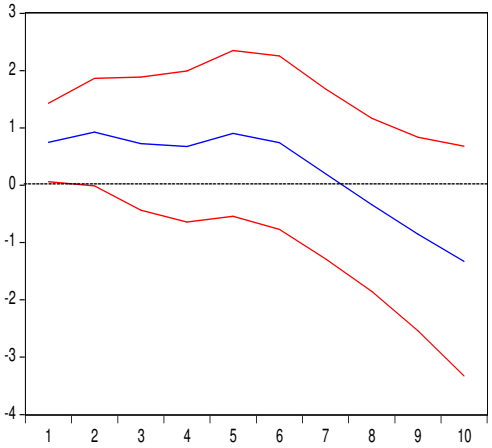
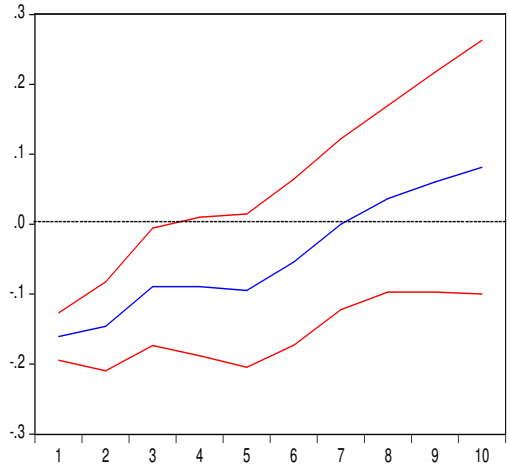
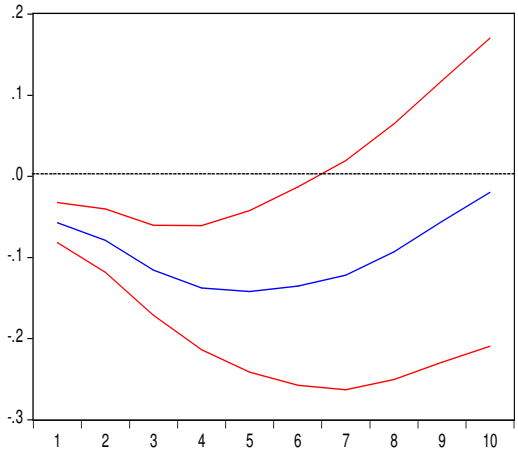


FIGURE A18
Ordering: oilrentpc, pubcons, gdppc, polity (Lag length: 3)

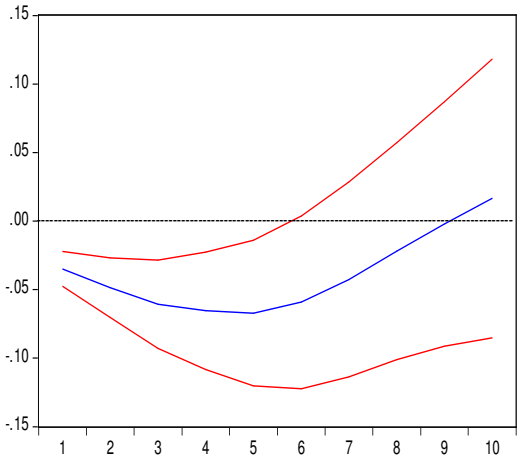
Response of oilrentpc to oilrentpc



Response of pubcons to oilrentpc



Response of gdppc to oilrentpc



Response of polity to oilrentpc

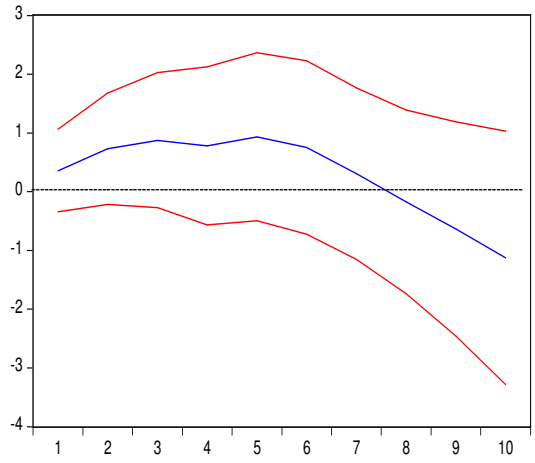
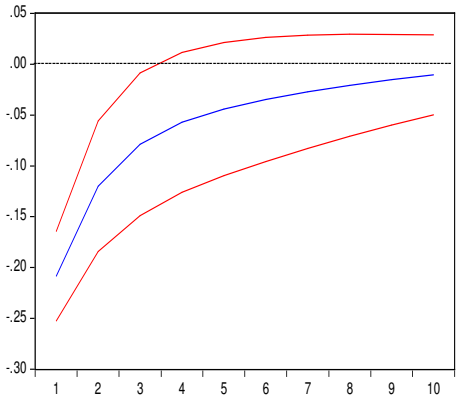
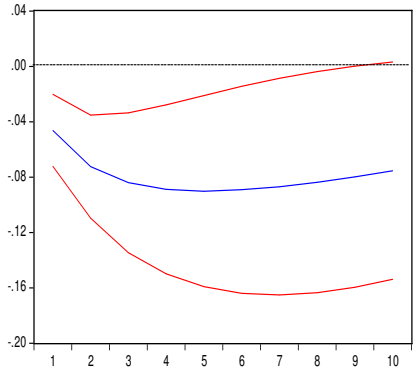


FIGURE A19
Ordering: oilrentpc, pubcons, exr, polity (Lag length: 1)

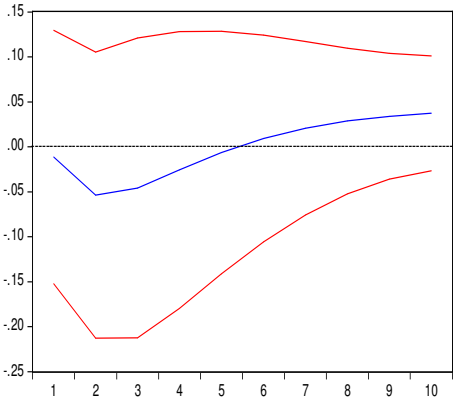
Response of oilrentpc to oilrentpc



Response of pubcons to oilrentpc



Response of exr to oilrentpc



Response of polity to oilrentpc

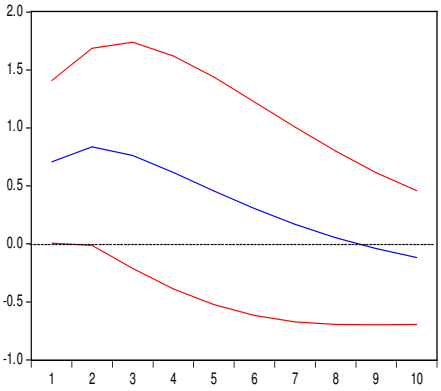
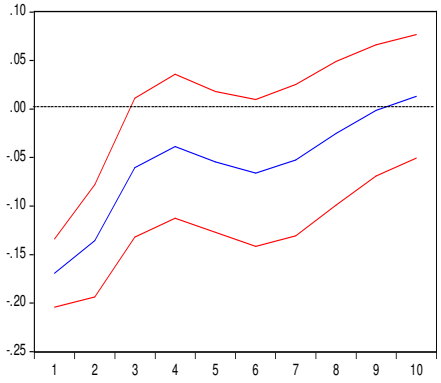
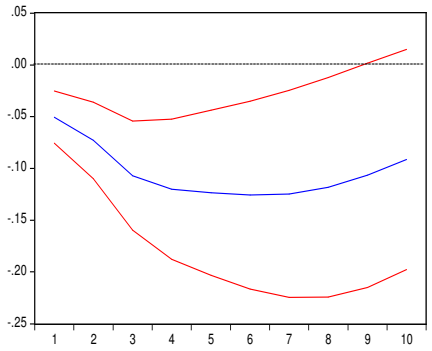


FIGURE A20
Ordering: oilrentpc, pubcons, cpi, polity (Lag length: 2)

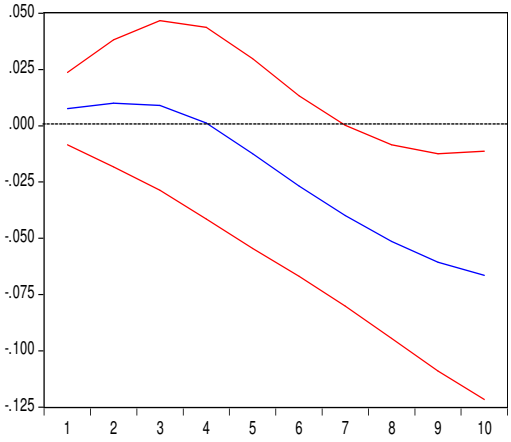
Response of oilrentpc to oilrentpc



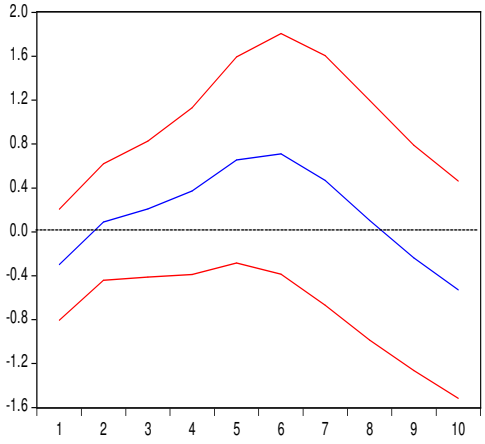
Response of pubcons to oilrentpc



Response of cpi to oilrentpc



Response of polity to oilrentpc



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