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Abstract

Iranian government budget on military over the last decade has been higher than the average of the world. The current increasing international sanctions aim to reduce the military capabilities and capacities of the Iranian government. In this study, we analyze the response of the Iranian economy to shocks in its military budget from 1959-2007, using Impulse Response Functions (IRF) and Variance Decomposition Analysis (VDA) techniques. The Granger causality results show that there is unidirectional causality from military spending to the economic growth. The response of income growth to increasing shocks in the military budget is positive and statistically significant.

JEL classification: C22, H56, H50
Keywords: Military spending, Economic growth, VAR model, Impulse Response, Sanctions, Iran

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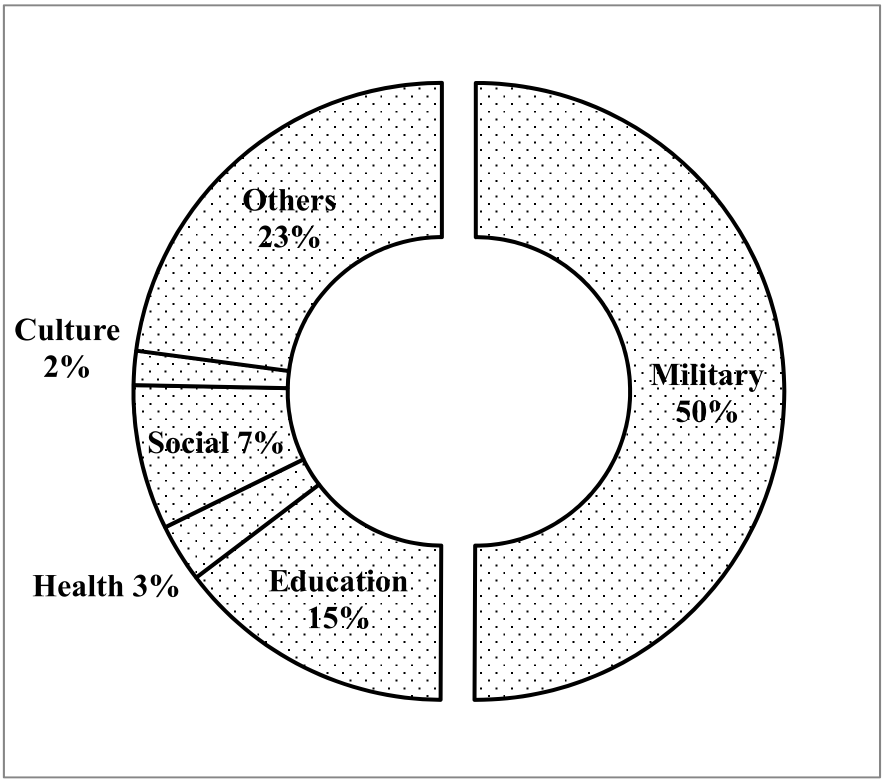
1. Introduction

In the past decade, the Iranian government has allocated a significant amount of budget to the military and security fields. According to the World Bank (2011), in 2000s, on average, Iran's military expenditures as a share of total expenditures amount to 16% which was higher than the average of this budget in Middle East and North Africa (13%), OECD countries (10%), Latin America (7%) and European Union (5%). Iran has also the highest number of military personnel in the Persian Gulf region. It is more than double the combined number of military personnel in the Gulf Cooperation Council (GCC). More specifically, the number of Iran military personnel is more than the 3 times of the Saudi Arabia and more than 10 times of the UAE, 35 times of the Kuwait and 37 times of Bahrain. In 2007, Iran was the 15th top country in the world in a term of absolute value of military spending in PPP (purchasing power party and constant prices) (Askari et al., 2009, pp. 25 and 72).

It is interesting to consider the trend of allocation budget into different groups of spending within the Iranian government after war with Iraq. Since the country began reconstruction of economy, one may expect that the government pay more attention to human capital and social issues. However, the official statistics show a different picture. The Iranian National Accounts show a significant increase in the share of military spending in total government spending (in constant prices) since the end of the war with Iraq. While this share was 16% in 1993, it has reached to 52% in 2006 (CBI, 2011). The share of education spending at the same period shows a reduction from 27% to 15%. The same pattern can be observed for the case of spending on health and social affairs. Indeed, the country has gone to more militarization and strengthening of military linkages to the national economy. Figure 1 shows the relative size of military budget in the Iranian government for the last available year in the National Accounts (2007). While the half of government spending allocated to the military fields, the health section received only 3% of the budget. The military industry of Iran has been a source of income and employment as well. The share of armed force personnel in total labor force of Iran in 2008 was about 2%, while the same figure of the average country in the world and low & middle income group was 0.87% and 0.83%, respectively. The effects of military spending on the supply side of the economy can be contradicting. On one side, the scare economic resources which are spent in the military fields could be invested in the other more productive fields, reducing the inefficiencies and waste. On the other side, if there are technological spill overs from military sector to other parts of the economy, then a boosting military industry can foster economic growth and increase of human capital (Malizard, 2010 and Ram, 1993). On demand side, increasing government spending on military affairs may increase new employment and disposable income of households as is discussed in the Keynesian theory.

Figure 1. Budget allocation to different spending categories in Iran (2007)



Source: CBI (2011) and author's calculations

The current United States and the European Union pressures on energy industry of Iran aim to affect the Iranian military ambitions and its financial sources. Approximately 90% of Iran foreign exchange reserves depend on oil exports and about 60% of the Iranian budget ties with oil revenues. In other words, major portion of government spending finances through oil rents. Farzanegan (2011) shows that military and domestic security expenditures of Iranian government are the only category which respond statistically significantly to asymmetric shocks in oil prices or revenues[1]. The response of other spending groups such as education, health and social expenditures to oil revenue shocks is not statistically significant. It means that increasing pressure on Iran energy sector may indeed affect the military programs of the Iranian government. Our goal in current study is to investigate the dynamic relationship between military spending and economic growth in Iran. If energy sanctions affect the military expenditures in a significant way, what kind of implications it will have for the growth? Do economic development responses to shocks in military budget are statistically significant? Is there a causal relationship between these two variables? In the case of lack of significant feedback from the Iranian GDP, the targeted sanctions can only affect the military budget without causing economic slowdown. However, in the case of significant interconnections between growth and military spending, any significant negative impact on the military budget may cause economic crisis and stress. To examine this timely issue, we use the Vector Auto Regressive (VAR) model and its powerful tools namely Impulse Response Functions (IRF) and Variance Decomposition Analysis (VDA), using annual observations on GDP per capita and military spending burden from 1959 to 2007. Our main results show that response of economic growth to increasing shocks in the military expenditures is positive and statistically significant. By contrast, the military spending response to economic growth shocks is weak and statistically insignificant. This finding has important policy message for current debates on energy sanctions on Iran. Oil rents are the main source of financing the military budget of Iran. Thus such negative shocks on the oil revenues which affect significantly military spending of Iran (see Farzanegan, 2011) can also lead to economic stagnation and additional problems in local economy of Iran.

[1] For the effects of oil price shocks on other aspects of the Iranian economy such as inflation, real effective exchange rate, and imports see Farzanegan and Markwardt (2009).

The remaining of the paper is organized as follows. Section 2 provides some background information on the role of military forces in the post-revolution Iranian economy. Section 3 presents a brief review of literature on the growth-military spending nexus. Section 4 presents the data and empirical method. Section 5 explains the results. Section 6 concludes the paper.

2- Background

In this section, we present some background information on the economic activities of the military forces in the post-revolution Iranian economy. This helps to understand the forward and backward linkages of the military section with the national economy. The main military organization which has strong role in the Iranian economy is the Islamic Revolutionary Guard Corps (IRGC, Sepah). The Sepah was founded at the order of Ayatollah Khomeini at the start of the revolution to protect the Islamic revolution from external and in particular internal enemies. Article 150 of the Constitution assigns the IRGC the "role of guarding the Revolution and its achievements". But the IRGC is performing a double role. When it is not guarding the revolution, it is a business. After the end of Iran's war with Iraq in 1988, the IRGC began its presence in the Iranian economy. It has since become one of the most powerful national players, controlling perhaps one third of the Iranian economy.[2] A subsidiary, Khatam Company (www.khatam.com), has become the largest contractor with the Iranian government, managing 1500 national projects in the last four years.

The IRGC is comprised of five branches: Army, Air Force, Navy, the Basij militia, and Qods Force special operations. The legal basis of this military establishment in the economy is article 147 of the Iranian constitution: "*In time of peace, the government must utilize the personnel and technical equipment of the Army in relief operations, and for educational and productive ends, and the Construction Jihad, while fully observing the criteria of Islamic justice and ensuring that such utilization does not harm the combat-readiness of the Army.*"

[2] http://www.bbc.co.uk/news/world-middle-east-10743580 (Access: 20.12.2011)

The size and far-reaching impact of the IRGC can be seen in its engineering arm Khatam-ol-Anbia. Khatam, under sanctions from the UN and the US, is the main contractor with the government and has five divisions with their own specialized fields and affiliated firms. Its divisions are Ghaem, Nooh, Karbala and Kosar.

The IRGC and its affiliated firms try to expand their market share, especially in the oil and gas industry, now that foreign firms are effectively barred from entering because of sanctions. But the IRGC's increasing monopolistic role in the oil sector under the Ahmadinejad government has marginalized the private sector in the most important part of the economy. In 2011, a senior Oil Ministry official, Mahdi Fakoor, said the IRGC's key financial venture, Khatam-ol-Anbia, would develop two gas fields in the south of the country without tender.[3] According to BBC news, the Iranian Oil Ministry under Ahmadinejad's reign awarded projects valued at $21 billion in the South Pars gas field to domestic firms, with the IRGC taking more than half.[4] In addition, the IRGC is involved in several significant oil and gas transmission pipelines inside of the country. For example, at the beginning of the Ahmadinejad presidency, the IRGC was awarded a gas pipeline project worth $1.3 billion. In 2009, the estimated amount of the IRGC projects in road, dam, oil and gas fields was $15 billion.[5]

Under the Ahmadinejad government, the IRGC has had rather easy access to the (former) Oil Stabilization Fund. When in 2009 the IRGC faced financing difficulties for the gas phases 15 and 16 of South Pars, it was able to take $1 billion from the Oil Stabilization Fund. [6] This is an example of financial nepotism thanks to its military influence. But the military connections do not always deliver. Apparently short of funds, Khatam unexpectedly withdrew from two

[3] http://au.finance.yahoo.com/news/Iran-awards-gas-projects-to-apf-473685212.html?x=0 (Access: 20.12.2011)
[4] http://www.bbc.co.uk/persian/iran/2011/02/110226_ka_sepah_khatam_oil.shtml (In Farsi, Access: 20.12.2011)
[5] http://www.bbc.co.uk/persian/business/2010/06/100605_l01_elec_anniv_khatam.shtml (In Farsi, Access: 20.12.2011)
[6] http://zamaaneh.com/news/2009/12/post_11607.html (In Farsi, Access: 20.12.2011)

key gas treatment projects in South Pars in July 2010.[7] The IRGC has also established its own banks such as Ansar Bank[8] and Mehr Finance and Credit Institution.[9] The IRGC is rapidly expanding its influence on different aspects of the formal and informal Iranian economy.[10]

3. Review of literature: military spending and economic growth

There are two different branches in the literature on the effects of military spending on economic growth. Some argues for positive nexus between military spending and growth, the others refer to negative link.

There are some studies which argue in support of the positive growth effects of military spending. In his seminal works, Benoit (1973, 1978) show that spending on military industry increases education and medical care, job opportunities, scientific and technological innovations. Indeed the supporters of positive growth effects of military expenditures are in favor of the Keynesian theory. There are several case studies which find this positive nexus between military spending and growth. Atesoglu (2002) use a cointegration analysis and shows that there is a positive and quantitatively important effect of military spending on growth in the United States. In an analysis for a sample of countries in the European Union, Kollias et al. (2007) find a positive impact of military spending on economic growth in the short run. In an analysis for the South Asian countries, Wijeweera and Webb (2011) find that a 1% increase in the military spending increases real GDP by 0.04%, concluding that substantial spending on military industry has negligible economic impacts. Kollias et al. (2004a) examine the case study of Cyprus. Their causality test shows a bi-directional causality between military spending and growth from 1964-1999. Kollias et al. (2004b) examine the relationship between military expenditure and growth among the EU 15 members

[7] http://www.washingtonpost.com/wp-dyn/content/article/2010/07/22/AR2010072203933.html (Access: 20.12.2011)
[8] http://www.ansarbank.com/ (Access: 20.12.2011)
[9] http://www.mebank.ir/ (Access: 20.12.2011)
[10] Farzanegan (2009) provides some information regarding the role of IRGC in the smuggling, estimating the size of illegal trade in Iran. Alfoneh (2010) also presents some detailed information regarding the economic activities of the IRGC in Iran.

using co-integration and causality tests for the period 1961–2000. In most cases they find a positive causality from economic growth to military spending and not vice versa. They conclude that most countries in the EU decide how much to spend on their military spending by considering their economic status. Dunne et al. (2001) show that there is some weak evidence on positive effect of changing military burden on growth for Greece. In a causality analysis for 62 developing countries, Dakurah et al. (2000) show that in 23 countries there is a unidirectional causality from military spending to economic growth or *vice versa* and a bidirectional causality in 7 countries. Studying the Arab-Israel conflict, Abu-qarn (2010) does not find any persistent adverse impact of military expenditures on economic growth. Dicle and Dicle (2010) examine Granger causality between military spending and growth in 65 countries, for the 1975–2004 periods. They find a bidirectional positive causal relationship between these variables in 54 of the 65 countries. Feridun et al. (2011) investigate the military spending-growth for the case of North Cyprus from 1977 to 2007. Their results show a strong, positive unidirectional causality running from military expenditures to economic growth. Yildirim et al. (2005) examine the effect of military spending on economic growth in a panel of Middle Eastern countries and Turkey. They employ a dynamic panel data estimation method and find positive growth effects of military spending from 1989-1999.

The second group of studies point out the negative growth effects of military spending through different channels such as lower saving rates and investment, reduction of other productive spending (health and education), higher budget deficit, higher debt, increase of corruption, higher tax rates and lower productivity of private sector and lower capital formation and resource extraction (see, for example, Deger 1986; Chan 1988; Lebovic and Ishaq, 1987; Mintz and Huang, 1990; Scheetz, 1991; Asseery, 1996; Dunne and Vougas, 1999; Gupta et al., 2001; and Dunne et al., 2002).

Chowdhury (1991) examines the Granger causality between military spending and economic growth for the 55 developing countries. He concludes that the relationship between these two variables cannot be generalized across countries and may vary from one country to another. Dunne et al. (2005) provide a critical review of the literature on military spending-economic growth nexus. Although there are some studies which investigate a sample of MENA countries (see Askari et al., 2009 and Yildirim et al., 2005 for a survey of related works), however, there has been less attention to the case study of Iran. We fill this gap in the literature by analyzing the military spending-economic growth nexus in Iran.

4. Data and methodology

4.1. Data

To examine the dynamic effects of military spending shocks on the Iranian economic growth and *vice versa*, we made use of two variables: military expenditures and GDP per capita. Both variables are in constant prices (billion rials) of 1997 and in logarithmic form. The percentage change of variables defined as first difference of logarithmic transformation is used in subsequent analysis. We use the share of military spending in total government spending as a proxy for defense burden in national budget. For robustness we also use per capital military spending. The military spending of the Iranian government covers the payrolls to military personal (current spending) as well as equipment and exercise spending (non-current spending)[11]. The sample comprises of annual observations from 1959-2007[12]. The source of variables is the Annual National Accounts of Iran published by the Central Bank of Iran (CBI, 2011). Furthermore, we take the effects of the Iran-Iraq war (1980-1988) into account by using a dummy as exogenous variable.

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[11] Separation of current and capital (or development) spending in military industry could provide more interesting insights in such an analysis. However, the Iranian National Accounts do not provide detailed data for the military part of spending.

[12] Higher frequency data (e.g. quarterly or monthly) may produce more precise results than annual data on some special occasions. National Accounts of Iran (produced by the Central Bank of Iran) only present annual figures on government expenditures based on different kinds of function. The quarterly data is only available for aggregated general government expenditures from 1988 onwards.

4.2. Methodology

The most appropriate approach to investigate the dynamic interconnections between economic growth and military spending is the unrestricted vector autoregressive (VAR) model and applied tools such as Impulse Response Functions (IRF) and Variance Decomposition Analysis (VDA). Stock and Watson (2001) suggest that "*since VARs involve current and lagged values of multiple time series, they capture comovements that cannot be detected in univariate or bivariate models*". In a VAR model developed by Sims (1980), changes in a specific variable such as economic growth are explained by its own lags and the past information of other variable in the system. One of the main advantages of this methodology is that it assumes that both growth and military spending are endogenous variables. This assumption is plausible in our context as well. Increasing the share of military spending affects growth through different channels: it may increase growth through positive externalities, technological spillover and expansion of aggregate demand. It may also decrease growth by channelizing the scare economic and human resources from productive activities to rent seeking and corruption which is shown to be correlated with higher levels of military spending (Gupta et al., 2001).[13] Additionally, income growth can also affect the allocation of government budget and the share of military spending. Higher income growth increases the domestic stability and more resources are available for investing in quality of institutions. This positive development may lead to lower demand for investing in weapon and other military capacities. Therefore, we can see the feedback effects from economic growth to the size of military budget. The VAR model is an appropriate approach to accommodate the endogeneity problem in our context. We do three different investigations. First, we examine the Granger causality between economic growth and military spending. We are interested to know that whether the predictions of income growth based on knowledge of past values of

[13] A recent annual of the SIPRI mentions: "Resource revenues are often managed non-transparently and without proper accountability, which may lead to large off-budget military spending and corrupt arms purchases" (SIPRI, 2010).

military spending and income growth is better than the predictions of growth based only on the past values of growth and vice versa for the predictions of military spending. Second through the IRF techniques we would like to measure the size, duration and statistical significance of responses of economic growth (military spending) to shocks in military spending (economic growth). Third, we also use the VDA tool. VDA is slightly different from IRF. VDAs examine the relative importance of military spending shocks in the volatility of economic growth in the system. A shock to the military spending budget will of course directly affect the variable itself, but it will also transfer to other variables in the VAR system such as income growth. VDA measures the share of the movements in a respected variable (e.g. military expenditures) that are due to their own shocks and at the same time shocks to other variable (e.g. income growth).

IRF and VDA analyses are based on the estimation of the following unrestricted VAR model with the order of p:

$$y_t = \Sigma_{i=1}^{p} A_i . y_{t-i} + B.X_t + e_t \tag{1}$$

where y_t is a vector of endogenous variables, X_t is a vector of exogenous variables which their values are determined outside of the VAR system (e.g. there are not equations in the VAR system with an exogenous dependent variable), A_i and B are coefficient matrices and p is the optimum lag number. In our unrestricted VAR model, the vector of endogenous variables (both variables are in real growth rates) is as follows:

$$y_t = [\textit{Military spending, GDP per capita}] \tag{2}$$

We try two different Cholesky orderings of variables. In one ordering, military spending has an immediate impact on income but affect itself with lags. As impulse response may be sensitive to the order of variable, for robustness test we also use Generalized Impulse Response introduced by Pesaran and Shin (1998).

The vector of exogenous variables is as follows:

$$X_t = \left[constant,\ w1 \right] \quad (3)$$

where w1 controls special situation under the Iran-Iraq war (1980-1988).

5. Results

Our empirical analysis includes three steps: Frist we do a Granger causality investigation between income per capita growth and military spending (as a share of total spending as well as per capita) growth following an estimation of VAR model. Second, we implement an impulse response function analysis to examine the dynamic responses of income growth to shocks in military budget and vice versa. Third, we carry out a variance decomposition analysis to understand the relative importance of military spending (income growth) for the explanation of volatility in income growth (military spending).

In order to examine the Granger causality between military spending and income growth, we need to use the stationary variables (Malizard, 2010). Therefore, as a first step we carry out the unit root tests: ADF test (Dicky and Fuller, 1979) and PP test (Phillips and Perron, 1988). The unit root tests results are presented in Table 1. The ADF and PP tests results show that our variables are stationary and a VAR model can be used to examine the causality. To estimate a VAR model we need to find an optimum lag length.

Table 1. Unit-root tests

Variables	ADF		PP	
	Without trend	With trend	Without trend	With trend
	Level	Level	Level	Level
GDP per capita growth	-3.60***	-3.56***	-3.60***	-3.56***
Military spending (% of total spending) growth rates	-5.89***	-5.84***	-5.85***	-5.79***
Military spending per capita growth rates	-5.29***	-3.87***	-5.28***	-5.27***

Note: *** means a rejection of null hypothesis of unit-root in 1 percent significance level.

There are some statistical criteria which help us to find the optimal lag length. These information criteria are LR (sequential modified likelihood ratio), FPE (final prediction error), and AIC (Akaike information criterion). Table 2 shows the optimum lag for [real GDP per capita growth rate, real military spending share growth rate]. The optimum lag length is 3.

Table 2. Number of the optimum lags in the VAR model

Lag	LR	FPE	AIC
1	9.91	0.000206	-2.812
2	3.24	0.000227	-2.716
3	**10.50***	**0.000205***	**-2.826***
4	4.77	0.000215	-2.784

5.1. Granger causality test

Using the optimum number of lag length (3), we proceed to investigate the Granger causality test. Military spending budget growth may be said to cause real GDP per capita growth if and only if the expectation of real GDP per capita growth given the history of military spending budget growth is different from the unconditional expectation of real GDP per capita growth:

$E\,(INCOME \mid INCOME_{t\text{-}k}, MIL_{t\text{-}k}) \neq E\,(INCOME \mid INCOME_{t\text{-}k})$.

For 3 optimum numbers of lags, we model:

$$INCOME_t = \beta_0 + \beta_1 INCOME_{t-1} + \ldots + \beta_3 INCOME_{t-3} + e_t \qquad (4)$$

Now, we investigate whether adding similar information about military spending budget growth rate (*MIL*) will improve our ability to predict real GDP per capita growth (*INCOME*):

$$INCOME_t = \beta_0 + \beta_1 INCOME_{t-1} + \ldots + \beta_3 INCOME_{t-3} + \lambda_1 MIL_{t-1} + \ldots + \lambda_3 MIL_{t-3} + e_t \,.(5)$$

If the λ's are jointly significant then we have established cause. The similar test can be used to examine the causality of income growth for the military spending.

Table 3 presents the Granger causality tests. We notice some interesting results: the previous information on the values of military budget growth rate can be useful for prediction of future development in the Iranian economic growth. This causal effect is unidirectional. In other words, there is no granger causality from economic growth to military spending growth rates. The Granger causality results have some policy implications. Since previous studies show that the negative oil revenues shocks (for example due to energy sanctions) can affect significantly military and security expenditures of the Iranian government (see Farzanegan, 2011), then the effects of such sanctions will also transfer to the economic growth of Iran. In other words, those sanctions which only affect the general output of the Iranian economy such as banking or political sanctions may not significantly mitigate the expansion of military budget of Iran. The reason is that the past values of income growth are not detrimental for future changes in the military budgets of Iran. The results do not change if we use the per capita military spending growth rates instead of share of total spending. We have also examined the results of the Granger causality test using the share of military spending in GDP instead of total government spending and per capita. Military spending as a share of GDP (in constant prices) show the military burden for the whole economy. We estimated a VAR model using this third indicator of military burden, finding an optimum lag length of 4 on the basis of FPE and AIC criteria. Then we controlled for the diagnostics statistics such as stability of VAR model, residual normality and residual autocorrelation which turn out to be satisfactory. Finally, we proceed for the Granger causality test. As we can see from Table 3, the results do not change using this proxy of military burden. There is strong evidence that the military spending (% of GDP) growth rates Granger causes economic growth but not vice versa.

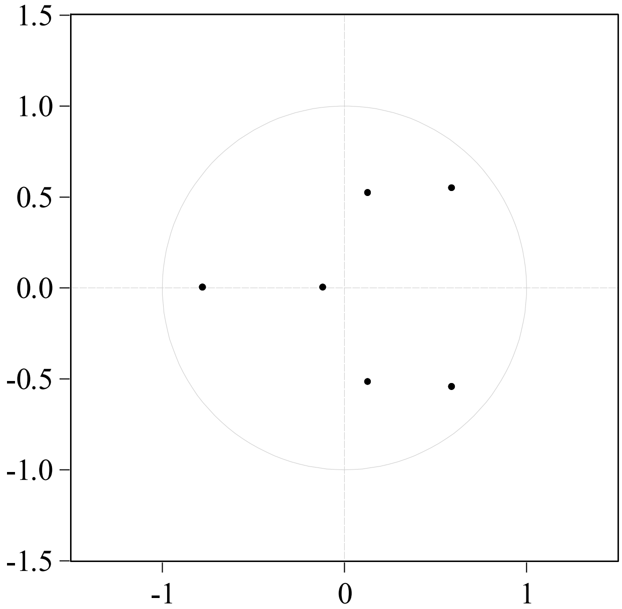
Table 3. Granger causality tests

	Null Hypothesis	F - Statistic	probability
a	Real military spending (% of total spending) growth rate *does not Granger Cause* real GDP per capita growth	3.31	**0.03**
	Real GDP per capita growth *does not Granger Cause* real Military spending (% of total spending) growth rate	0.97	0.41
b	Real military spending per capita growth rate *does not Granger Cause* real GDP per capita growth	4.22	**0.00**
	Real GDP per capita growth *does not Granger Cause* real Military spending per capita growth rate	1.90	0.13
c	Real military spending (% of GDP) growth rate *does not Granger Cause* real GDP per capita growth	4.22	**0.00**
	Real GDP per capita growth *does not Granger Cause* Real military spending (% of GDP) growth rate	1.64	0.18

Note: sample period is from 1959-2007. A total observation is 45 (after adjustments). Lag length is 3 (based on Table 2). For the equations including per capita military spending and share of military spending in GDP, the optimum lag on the basis of FPE and AIC is 4.

In the second step, we estimate a VAR model using real GDP per capita growth rates and military spending (% of total spending) growth rates as endogenous variables and Iran-Iraq war dummy as exogenous variable. The main goal is to apply the impulse response function tools and variance decomposition analysis on the basis of estimated VAR model. Prior to estimate and interpret the impulse responses, we need to investigate the stability of estimated VAR model. As for stability test of our model, the AR table/graph reports the inverse roots of the characteristic AR polynomial (see Lütkepohl, 1991). The estimated VAR is stable (stationary) if all roots have modulus less than one and lie inside the unit circle. If the VAR is not stable, certain results (such as impulse response standard errors) are not valid (QMS, 2010). Figure 2 shows that no roots of characteristic polynomial lie outside of the circle and our estimated VAR model satisfies the stability conditions.

Figure 2. Stability of VAR model



We have also examined whether the residuals of our estimated VAR model are multivariate normal. It compares the 3rd and 4th moments (skewness and kurtosis) to those from a normal distribution. To do this test, we need to specify a factorization of the residuals. We use inverse square root of residual correlation matrix (Doornik and Hansen, 2008) which is invariant to the ordering and to the scale of the variables in the VAR. The results show that the residuals of estimated VAR are multivariate normal (Joint *p-value:* 0.28). Finally, VAR residual serial correlation LM test shows that up to 12 lags we cannot reject the null hypothesis of no serial correlation. Considering these diagnostic results we can safely continue our analysis for the impulse response function and variance decomposition. [14]

5.2. Impulse Response Functions (IRF)

The impulse response functions trace out the response of current and future values of the Iranian military spending (economic growth) to a one standard deviation increase in the current value of economic growth (military spending). Runkle (1987) emphasizes the construction and report of confidence bands around the impulse responses in the VAR models. Following Sims and Zha (1999), we use 68% confidence intervals (one standard

[14] We checked also these diagnostic indicators for the models with the per capita of military spending instead of share in total spending. We notice satisfactory performance in all criteria.

deviation) for the IRFs. We use 1000 Monte Carlo simulations to build these confidence bands. The middle line in IRFs displays the response of military spending (economic growth) to a one standard deviation shock in economic growth (military spending). The dotted lines represent confidence bands. When the horizontal line in the IRFs falls between confidence bands, the impulse responses are not statistically significant (Berument et al., 2010). In other words, the null hypothesis of "no effects of military spending (economic growth) shocks" on the economic growth (military spending) cannot be rejected. The horizontal line in IRFs shows the time period after the initial shock. The vertical line in IRFs shows the magnitude of response to shocks.

Figures 3 and 4 display the impulse responses of the Iranian economic growth (military spending as a share of total spending growth) to a one standard deviation shock in military spending (economic growth) for a period of 1959-2007 with a uniform lag order of 3. The military spending (economic growth) shock was identified on the basis of a standard Cholesky factorization, ordering military spending first followed by real GDP per capita growth.

From Figure 3 we notice that the response of economic growth to a one standard deviation increase in the share of military spending growth is positive and increases over the first 3 years after initial shock. It reaches its maximum in the 3rd year, falling afterwards. This response of real GDP per capita growth is also statistically significant. Figure 3 shows that military spending can foster and drive economic growth in Iran for the short and middle run.

Therefore, a negative shock in the military budget through energy sanction can lead to economic stagnation, at least in the short and middle run. These results also support the Keynesian theory in which the government increases aggregated demand through military and security related spending.

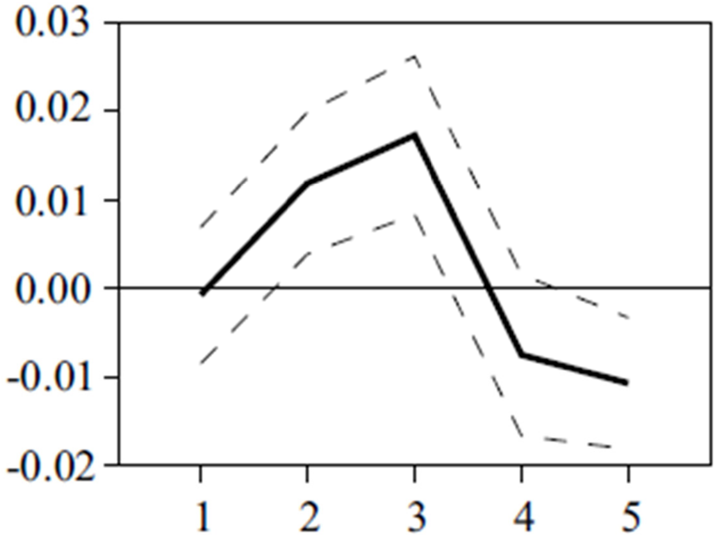
Figure 4 shows the response of military budget to a shock in economic growth. There is no immediate effect. The response of military budget to an increasing shock in economic growth is also increasing for the first three years after shock but is not statistically significant for the first 2 years following initial shock. This response is only statistically significant in the 3rd year after shock. When comparing Figures 3 and 4, we notice that the shocks to military budget are more detrimental in a term of statistical significance for current and future GDP per capita growth rate.

In order to complete the results obtained from the Granger causality and IRFs, we proceed with the variance decomposition analysis (VDA).

5.3. Variance decomposition analysis

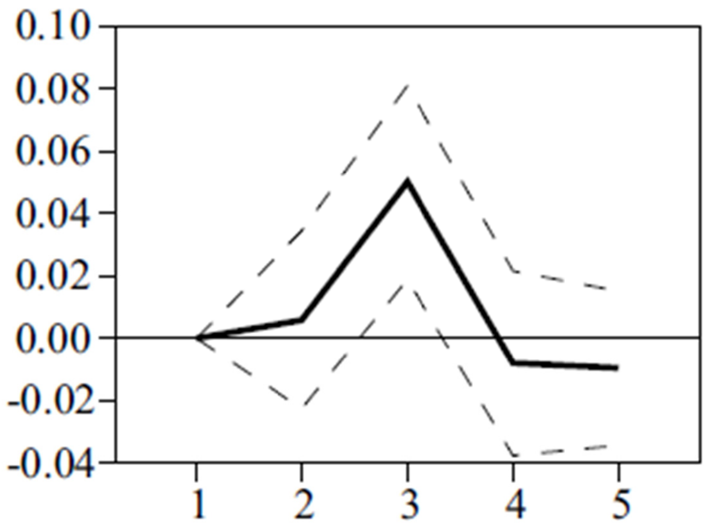
What is the relative importance of military spending growth rate shocks in changes economic growth rates and vice versa? To reply this question, we apply the variance decomposition analysis. It provides the proportion of movement in a specific variable in connection with its own shock against the shocks to other variable. The higher the share of explanation of error variance, the more important that variable is for the other variable in the system. For calculating VDA, we follow the Cholesky ordering which was presented in section 5.2 for IRFs analysis. Table 4 presents the variance decomposition analysis results for 20 years after the initial shock. We can see that military spending growth rate has a stronger role to explain the volatility of the Iranian economic growth in the short and middle run. By contrast, the variance of forecast error of military spending is mainly due to its own innovations and the role of economic growth to explain the volatility of military budget is marginal. This is in line with our Granger causality and IRFs findings. In the long run about 20% of the variance forecast error of the Iranian economic growth can be explained by the innovations in the military budget growth rate.

Figure 3. Response of GDP p.c. growth to a shock in military spending share growth



Note: The graphs display impulse responses of real GDP per capita growth to one-standard-deviation shocks in *the military spending (% of total spending) growth.* The dotted lines represent ±1 standard deviation. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

Figure 4. Response of military spending share growth to a shock in GDP p.c. growth



Note: The graphs display impulse responses of *the military spending (% of total spending) growth* to one-standard-deviation shocks in real GDP per capita growth. The dotted lines represent ±1 standard deviation. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

5.4. Using per capita military spending

As an alternative specification, we use the per capita of government military spending growth rate instead of its growth rate of relative share in budget in our impulse response analysis. How innovations in real per capita spending on military growth rates affect the real per capita GDP growth rates? The Granger causality testing using this per capita specification of military spending is presented in Table 3. Military spending per capita growth Granger causes economic growth but not vice versa. Using an optimum number of 4 lags, we estimated a VAR model for this new specification. All diagnostic criteria such as stability test, residual normality and auto correlation tests show a satisfactory performance.

Table 4. Variance decomposition analysis

Years ahead	Variance decomposition of real GDP per capita growth		Variance decomposition of military spending (% of total spending) growth	
	% due to military spending (% of total spending) growth	% due to real GDP per capita growth	% due to military spending (% of total spending) growth	% due to real GDP per capita growth
1	0.02	99.97	100	0.00
2	4.89	95.10	99.91	0.08
3	13.09	86.90	94.18	5.81
4	14.47	85.52	94.30	5.69
5	17.13	82.86	94.11	5.88
10	20.15	79.84	92.35	7.64
15	20.28	79.71	92.23	7.76
20	20.30	79.69	92.22	7.77

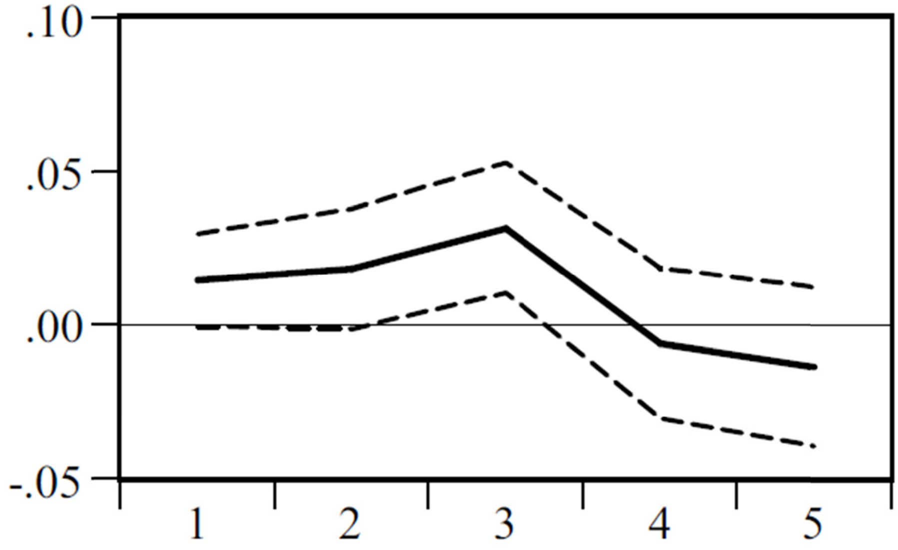
Upon estimation of VAR, we proceed to examine the IRFs and VDA. For robustness analysis, we use generalized impulses as decomposition method instead of Cholesky method. Ordering of variables in the VAR system is important in order to calculate the IRFs and VDA analyses. Different ordering can produce different IRF results.

In order to avoid the difficulties of identifying orthogonal shocks in VAR models, Pesaran and Shin (1998) introduced Generalized Impulse Responses (GIR). The GIR is not sensitive to the ordering of variables in the VAR model. Another robustness check is estimating 2 standard deviation error bands (95% confidence intervals) instead of 1 standard deviation error bands suggested by Sims and Zha (1999).

As we can see from Figures 5 the Iranian GDP per capita growth shows the statistically significant (at 95% confidence intervals) response to an increasing shock to the military spending per capita growth during the 2^{nd} and 3^{rd} years after initial shock. Although the response of military spending per capita growth to a shock in economic growth is positive, as is shown in Figure 6, but this response is not statistically significant at 95% confidence intervals. This robustness test again shows the sensitivity of the overall economic performance of Iran to unexpected shocks in the military budget. We also re-estimate variance decomposition from VAR model using per capita specification of military spending growth. Table 5 shows the results.

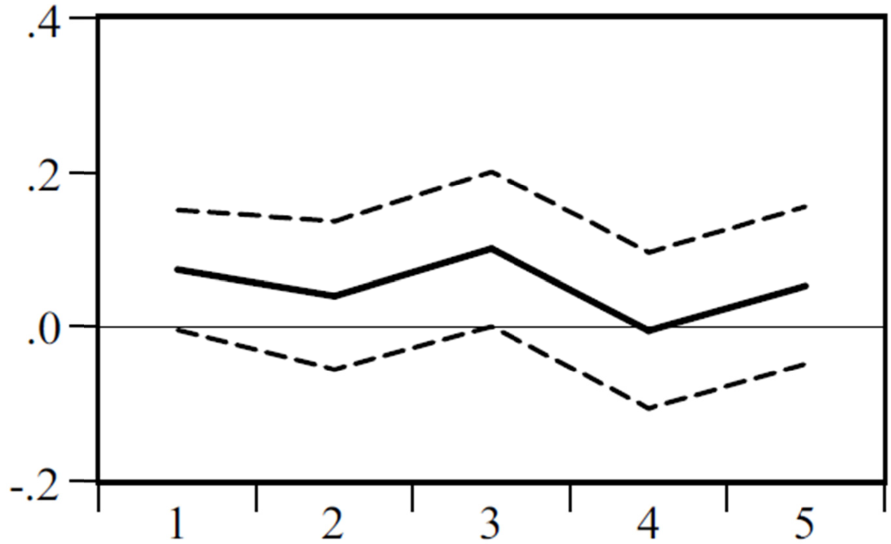
We notice that innovations in per capita military spending growth has more explanatory power for the variance of forecast error of per capita income growth than military spending as share of total spending. More than 8% of volatility of growth in this first year after shock can be explained by shocks in per capita military spending while income growth has no direct impact on volatility of military spending per capita. The attributed percentage of income growth in the first year after shock is 0. After 5 years from initial shock, military spending per capita growth rates can explain up to 40% of volatility of per capita income growth. After 10 years of this shock, about 44% of the variance of per capita income growth can be attributed to innovations in military spending per capita growth. Shocks in the per capita income growth can explain only 15% of variance of military spending per capita growth in the long run.

Figure 5. Response of *GDP p.c. growth* to a shock in *military spending p.c. growth* - Generalized Impulses



Note: The graphs display impulse responses of *real GDP per capita growth* to one-standard-deviation shocks in *the military spending per capita growth.* The dotted lines represent ±2 standard deviation. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

Figure 6. Response of *military spending p.c. growth* to a shock in *GDP p.c. growth* - Generalized Impulses



Note: The graphs display impulse responses of *the military spending per capita growth* to one-standard-deviation shocks in real GDP per capita growth. The dotted lines represent ±2 standard deviation. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

Table 5. Variance decomposition analysis- using per capita military spending

Years ahead	Variance decomposition of real GDP per capita growth		Variance decomposition of military spending per capita growth	
	% due to military spending per capita growth	% due to real GDP per capita growth	% due to military spending per capita growth	% due to real GDP per capita growth
1	8.18	91.81	100	0.00
2	17.11	82.88	99.47	0.52
3	36.16	63.83	88.29	11.70
4	36.58	63.43	88.44	11.55
5	39.16	60.83	85.39	14.60
10	43.97	56.02	84.18	15.81
15	43.95	53.04	84.15	15.84
20	43.99	56.00	84.13	15.86

6. Conclusion and policy implications

This study examines the dynamic interactions between the economic growth and military spending of the Iranian governemnt. Current studies such as Farzanegan (2011) show that negative oil revenue shocks due to increasing sanction on the Iranian energy industry and crude oil sales have a significant effect on the Iranian military and security expenditures. We investigate whether such shocks on the Iranian military budget is also relevant for the Iranian economic growth. We employ the Vector Auto Regressive models (VAR), Garnger causality, impulse response functions and variance decompsoition tools to trace the effects of shocks on the macroeconomy performance of Iran. The period of analysis is the past 49 years from 1959 to 2007. Our results show that past information on the military spending (as a share of total spending or in per capita) growth rates are useful to explain the future developments of economic growth in Iran. There is a statistically significant unidirectional causality from military spending to economic growth. Our additional analyses through IRFs and VDA also highlight the importance of military budget shocks in explaining volatility in the Iranian economic growth in future. There are strong forward and backward linkages between the Iranian military industry and overal output of the economy. Strong presense of the military forces such as the the Islamic Revolutionary Guard Corps (IRGC)’#affiliated firms in the Iranian economy may explain some parts of this significant effect. The IRFs results show that response of economic growth to a one standard deviation increasing shock in the military spending is positive and statistically significant for the short and middle run.

The policy implications of these results are straightforward. Those sanctions aiming to restrict the Iranian government’s oil export capacities and consequently military budget may affect the overal performance of the Iranian economy significantly. However, if the sanctions do not target the financial sources of military budget (i.e., oil rents) and deal with political targets or economic transactions which increases transaction costs of trade and shocks to the economic output may not have a significant effect on the military budget.

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