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Military Spending and Economic Growth: The Case of Iran

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Military Spending and Economic Growth: The Case of Iran

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Over the last decade, the Iranian government budget on military 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. 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). The Granger causality results show that there is unidirectional causality from the military spending growth rate to the economic growth rate. The response of income growth to increasing shocks in the military budget is positive and statistically significant.

Keywords: Military spending, Economic growth, VAR model, Impulse Response, Sanctions, Iran

JEL classification: C22, H56, H50

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 WDI (2012), 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 the 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 3 times that of Saudi Arabia and more than 10 times that of the UAE, 35 times that of Kuwait and 37 times that of Bahrain. In 2007, Iran was the 15th top country in the world in terms of absolute value of military spending in PPP (purchasing power parity and constant prices) (Askari et al., 2009, pp. 25 and 72).

It is interesting to consider the trend of budget allocation into different groups of spending within the Iranian government after the war with Iraq. Since the country began with the reconstruction of the 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 52% in 2006 (CBI, 2012). 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. While 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 the 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 scarce economic resources which are spent in the military fields could be invested in other more productive fields, reducing the inefficiencies and waste. On the other side, if there are technological spillovers from the military sector to other parts of the economy, then a boosting military industry can foster economic growth and the increase of human capital (Malizard, 2010 and Ram, 1993). On the demand side, increasing government spending on military affairs may increase new employment and disposable income of households as discussed in the Keynesian theory.

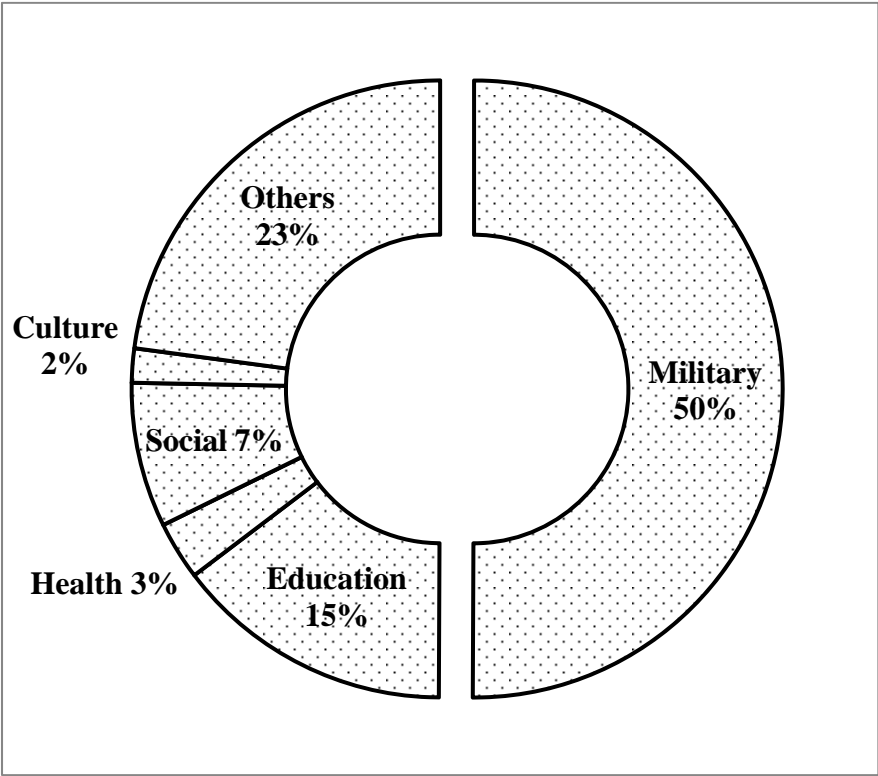


Figure 1. Budget allocation to different spending categories in Iran (2007)

Source: CBI (2012) and author’s calculations

The current United States and the European Union pressures on the energy industry of Iran aim to affect the Iranian military ambitions and its financial sources. President Obama

signed the Comprehensive Iran Sanctions, Accountability, and Divestment Act of 2010, emphasizing energy sanctions.¹ For the first time, 32 countries representing more than a billion consumers have taken action against Iran: the European Union, Canada, Australia, Japan and South Korea among others.² 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, a major portion of government spending finances through oil rents. Farzanegan (2011) shows that military and domestic security expenditures of the Iranian government are the only category which respond statistically significantly to asymmetric shocks in oil prices or oil revenues³. 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 the Iranian energy sector may indeed affect the military programs of the Iranian government.

Our goal in the 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 will it have for the economic growth? Are economic development responses to shocks in military budget statistically significant? Is there a causal relationship between these two variables? In the case of a lack of significant feedback from the Iranian gross domestic product (GDP), the targeted sanctions can only affect the military budget without causing economic slowdown. However, in the case of significant interconnections between GDP 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

¹ For more details see <http://thomas.loc.gov/cgi-bin/query/D?c111:6:./temp/~c1114E4uug> (Access: 14.04.2012)

² For more details see <http://www.defenddemocracy.org/issues/iran-sanctions/> (Access: 14.04.2012)

³ 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).

Analysis (VDA), using annual observations on GDP per capita and military spending burden from 1959 to 2007. Our main results show that the response of economic growth to increasing shocks in the growth rate of military expenditures is positive and statistically significant. This finding has an 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 the military spending of Iran significantly (see Farzanegan, 2011) or even the undergoing direct sanctions on the Iranian military complex can also lead to economic stagnation and an additional burden for the Iranian economy. This is mainly due to strong forward and backward linkages of the military in the national economy of Iran.

To set the scene, the next section provides some background information on the role of military forces in the post-revolution Iranian economy. The section after presents a brief review of literature on the growth-military spending nexus. The fourth section presents the data and the empirical method. The fifth section explains the results. The final section 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.⁴ 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: Ground Force, Air Force, Navy, the Basij militia, and the Qods Force special operations. The legal basis of this military establishment in the economy is the 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.”*

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.⁵ 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.⁶ 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

⁴ <http://www.bbc.co.uk/news/world-middle-east-10743580> (Access: 14.04.2012)

⁵ <http://sg.news.yahoo.com/irans-revolutionary-guard-gets-gas-project-085035621.html> (Access: 14.04.2012)

⁶ http://www.bbc.co.uk/persian/iran/2011/02/110226_ka_sepah_khatam_oil.shtml (In Farsi, Access: 14.04.2012)

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.⁷

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.⁸ 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 key gas treatment projects in South Pars in July 2010.⁹ The IRGC has also established its own banks such as Ansar Bank¹⁰ and Mehr Finance and Credit Institution.¹¹ The IRGC is rapidly expanding its influence on different aspects of the formal and informal Iranian economy.¹²

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 a positive nexus between military spending and growth, the others refer to a 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

⁷ http://www.bbc.co.uk/persian/business/2010/06/100605_l01_elec_anniv_khatam.shtml (In Farsi, Access: 14.04.2012)

⁸ http://zamaaneh.com/news/2009/12/post_11607.html (In Farsi, Access: 14.04.2012)

⁹ <http://www.washingtonpost.com/wp-dyn/content/article/2010/07/22/AR2010072203933.html> (Access: 14.04.2012)

¹⁰ <http://www.ansarbank.com/> (Access: 14.04.2012)

¹¹ <http://www.mebank.ir/> (Access: 14.04.2012)

¹² 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.

between military spending and growth. Atesoglu (2002) uses 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 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 the positive effect of changing the 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 points 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 the 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 the 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 the first difference of logarithmic transformation is used in the subsequent analysis. We use the share of military spending in total government spending and in GDP as well as per capita spending as proxies for the defense burden in the economy. The

share of military spending in total government spending measures the portion of a government expenditure that is devoted to defense. Habibi (1994) argues that policy makers are more concerned regarding the share of allocated budget for a specific group of spending as a share in total spending rather than in GDP (see Farzanegan, 2011; Fosu, 2007; Mahdavi, 2004; and Habibi, 1998 for a similar view). Another common proxy for the military burden is the share of military spending in GDP. This proxy measures the portion of a country's overall economy that is devoted to defense. Gupta et al. (2001) use both shares of military spending in GDP and in total government spending for their analysis. For robustness, we also use per capital military spending. This proxy measures how much a country devotes itself to defense relative to the size of its population.

The military spending of the Iranian government covers the payrolls to military personnel (current spending) as well as equipment and exercise spending (non-current spending)¹³. The sample comprises of annual observations from 1959-2007¹⁴. The source of variables is the Annual National Accounts of Iran published by the Central Bank of Iran (CBI, 2012). The Iranian National Accounts report government expenditures on the basis of different functions and ministries including the Defence Ministry. There are two groups of military forces under the control of the Ministry of Defense and Armed Forces Logistics (*MODAFL*): the regular army (*Artesh*) and the Iranian Revolutionary Guard Corps (*IRGC*). Both the regular military and IRGC are subordinate to the *MODAFL*.¹⁵ Thus, the government expenditures for the Ministry of Defense in the National Accounts cover both *Artesh* and

¹³ Of course, some parts of the military budget may be also spent on special forms of education and training which military organizations design for their current and future personnel. However, this does not mean that the military section is responsible for mass education as may be seen in other countries like in Egypt (thanks to the referee for raising this issue). Iranian military bodies have some universities in which they train their own forces. These centers invest most of their funds in advanced military projects and technologies which has less to do with mass public education. Separation of current and capital (or development) spending in the 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.

¹⁴ Higher frequency data (e.g. quarterly or monthly) may produce more precise results than annual data on some special occasions. The National Accounts of Iran (produced by the Central Bank of Iran) only present annual figures on government expenditures based on different kinds of functions. The quarterly data is only available for aggregated general government expenditures from 1988 onwards.

¹⁵ For more details see <http://www.globalsecurity.org/military/world/iran/mod.htm> (Access: 14.04.2012)

IRGC. Of course, there may be some ‘off-budget’ military spending which is classified and cannot be assessed in this analysis.

Furthermore, we take the effects of the Iran-Iraq war (1980-1988) and the post-11th September 2001 events into account by using dummies as exogenous variables. Using the Iranian National Accounts provided the largest sample size for our analysis. There is another international source of information for the military spending of Iran published by the Stockholm International Peace Research Institute (SIPRI). The military spending by the SIPRI is provided in the local currency, at current prices; in US dollars, at constant (2009) prices and exchange rates, and as a share (%) of gross domestic product (GDP). The main shortcoming of this database for our specific time series analysis is its low sample size (1988-2008). Our VAR model’s power of estimation will reduce significantly in the case of using SIPRI. However, it is important to cross-check the Iranian National Accounts data on military spending with the SIPRI information. In the case of significant correlation between these two sources, we may be more assured of the reliability of the Iranian National Accounts information. According to the SIPRI suppliers, SIPRI data reflects the official data reported by governments. As a general rule, SIPRI takes national data to be accurate until there is convincing information to the contrary.¹⁶ Therefore, the main source of SIPRI for the Iranian military is also obtained from the Iranian official sources such as the Central Bank of Iran. We noticed that the military spending of Iran reported by the Central Bank is usually higher than the SIPRI data. Our investigation shows that the SIPRI figures for Iran do not include spending on paramilitary forces such as the Islamic Revolutionary Guards Corps.

Figure 2 shows the co-movement of share of military spending in GDP according to the Central Bank of Iran (CBI) and SIPRI. The correlation between these two time series is 0.45 (with *t-statistics* of 2.16, *p-value* of 0.04 which is an indicator of significant correlation).

¹⁶ For more details on the sources and method see http://www.sipri.org/databases/milex/sources_methods (Access: 14.04.2012)

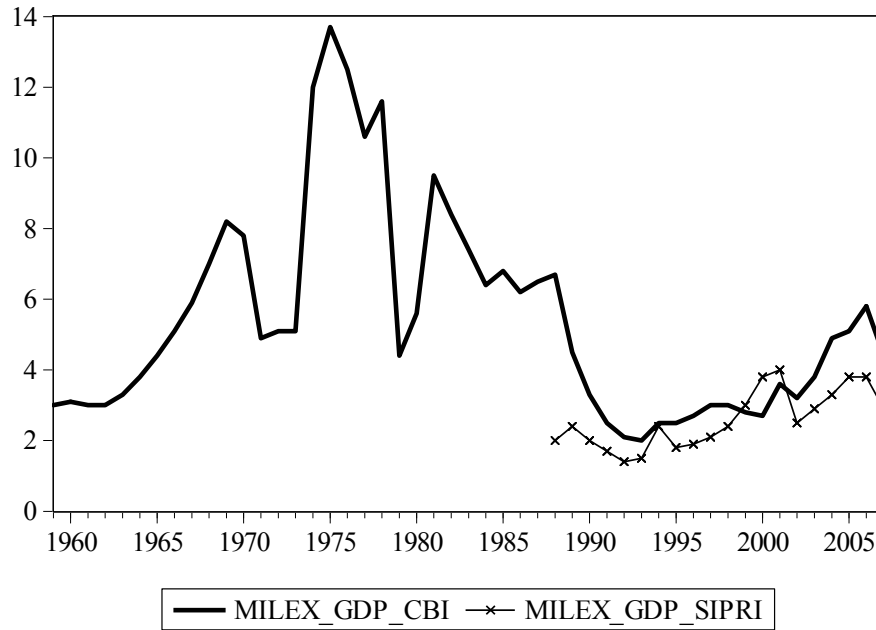


Figure 2. Co-movement of military spending (% of GDP) variables

Source: *MILEX_GDP_CBI* (share of military spending in GDP) is from CBI (2012) and *MILEX_GDP_SIPRI* is from SIPRI (2010).

There is also a high correlation (0.98, with *t-statistics* of 24.2) between per capita military spending on the basis of the Central Bank of Iran and the SIPRI data. Finally, the correlation between the share of military spending as a share of total government spending on the basis of CBI and SIPRI is statistically significant (0.52). Their close co-movement is shown in Figure 3.

For robustness check, we also re-estimate our Granger causality models (see section *Granger causality test* and Appendix A) using the SIPRI and the World Bank data.

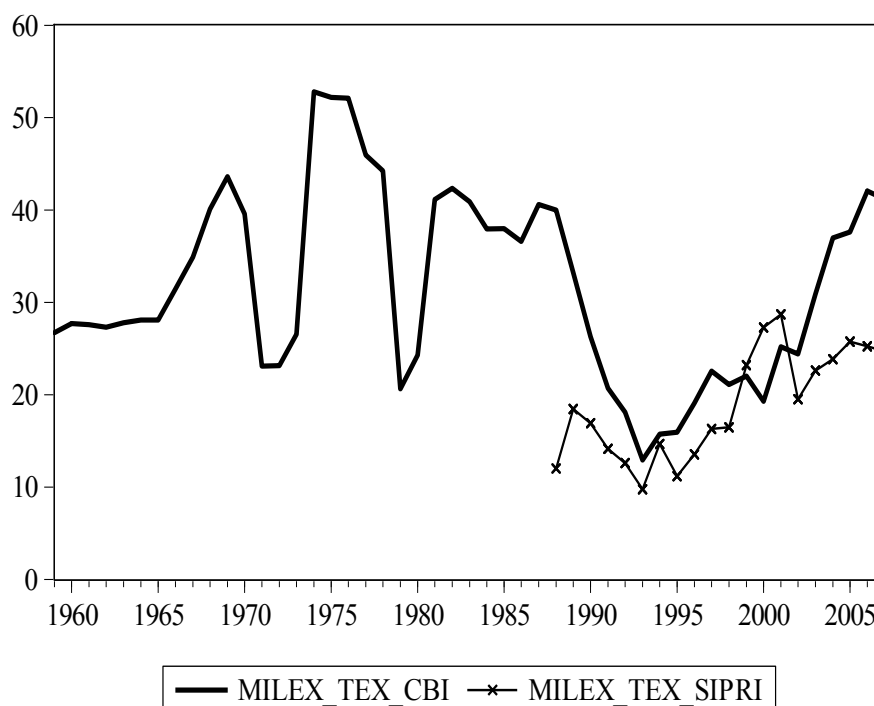


Figure 3. Co-movement of military spending (% of total government spending) variables

Source: *MILEX_TEX_SIPRI* (share of military spending in total spending) is from SIPRI (2010) and *MILEX_TEX_CBI* is from the CBI (2012).

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 variables 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 scarce 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).¹⁷

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 the quality of institutions. This positive development may lead to a lower demand for investing in weapon and other military capacities.¹⁸ 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 the knowledge of past values of 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

¹⁷ 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).

¹⁸ Mbaku (1991) finds a positive and statistically significant effect of income per capita on military expenditures. He uses per capita income as a proxy for technological sophistication in a country. He argues that “as countries get richer, we should see a greater willingness, on the part of citizens, to support a better equipped and more technologically-sophisticated defense force”.

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 variables (e.g. income growth).

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

$$y_t = \sum_{i=1}^p A_i \cdot y_{t-i} + B \cdot X_t + e_t \quad (1)$$

where y_t is a vector of endogenous variables, X_t is a vector of exogenous variables whose values are determined outside of the VAR system (e.g. there are no 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:

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

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

The vector of exogenous variables is as follows:

$$X_t = [\textit{constant}, w1, w2] \quad (3)$$

where w1 and w2 control the special situation under the Iran-Iraq war (1980-1988) and post 11th September 2001 events.

5- Results

Our empirical analysis includes three steps: First, we do a Granger causality investigation between income per capita growth and military spending (as a share of total spending, GDP as well as per capita) growth following an estimation of the 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 (Granger, 1969). Therefore, as a first step we carry out the unit root tests: ADF test (Dickey 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:

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

For 3 optimum numbers of lags, we model:

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

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*):

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

If the λ 's are jointly significant then we have an 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 the prediction of the 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 military and security expenditures of the Iranian government significantly (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 the 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 the 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) shows 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 the stability of the 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.

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 the 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 the estimated VAR model.

Table 3. Granger causality tests

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

Prior to estimate and interpret the impulse responses, we need to investigate the stability of the 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 4 shows that no roots of characteristic polynomial lie outside of the circle and our estimated VAR model satisfies the stability conditions. 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.

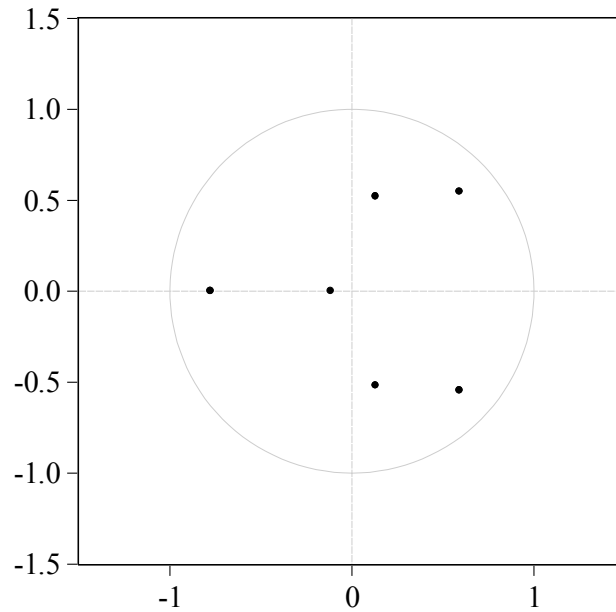


Figure 4. Stability of VAR model

To do this test, we need to specify a factorization of the residuals. We use the inverse square root of the 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 the estimated VAR are multivariate normal (Joint p -value: 0.28). Finally, the 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.¹⁹ In Appendix A we also use the methodology of Toda and Yamamoto (T-Y) (1995) to test the Granger causality between real GDP per capita and real military spending (per capita, % of total spending and % of GDP). The results of T-Y Granger causality show a unidirectional causality from the logarithm of level of military spending (% of total spending) to the logarithm of level of real GDP per capita. However, we notice bidirectional causality between military spending (per capita and % of GDP) and real GDP per capita.

¹⁹ We also checked these diagnostic indicators for the models with the per capita of military spending instead of the share in total spending. We noticed satisfactory performance in all criteria.

5.2. Impulse response functions (IRF)

The impulse response functions trace out the response of current and future values of the Iranian military spending growth (economic growth) to a one standard deviation increase in the current value of economic growth (military spending growth). Runkle (2002) 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 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 growth (economic growth) to a one standard deviation shock in economic growth (military spending growth). 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 growth (economic growth) shocks” on the economic growth (military spending growth) 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 5 and 6 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 growth (economic growth) for the period of 1959-2007 with a uniform lag order of 3. The military spending growth (economic growth) shock was identified on the basis of a standard Cholesky factorization, ordering military spending growth first followed by real GDP per capita growth.

From Figure 5 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 the 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 5 shows

that growth of military spending can foster and drive economic growth in Iran for the short and middle run.

Therefore, a negative shock in the military budget growth 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 6 shows the response of military budget growth to a shock in economic growth. There is no immediate effect. The response of military budget growth to an increasing shock in economic growth is also increasing for the first three years after the shock but this is not statistically significant for the first 2 years following the initial shock. This response is only statistically significant in the 3rd year after the shock. When comparing Figures 5 and 6, we notice that the shocks to military budget growth are more important in terms of statistical significance for the 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).

In Appendix B, we also re-estimate the VAR model and the IRF analysis on the basis of level of variables instead of growth rates.

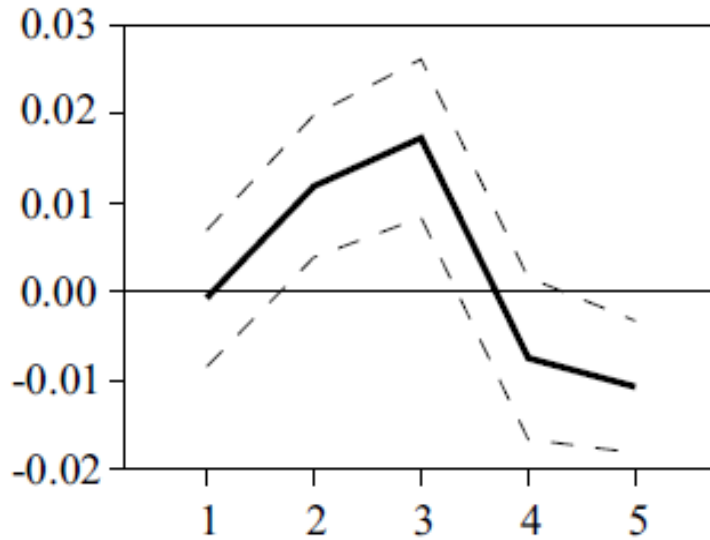


Figure 5. Response of *GDP p.c. growth* to a shock in *military spending share growth*

Note: The graph displays the impulse response 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.

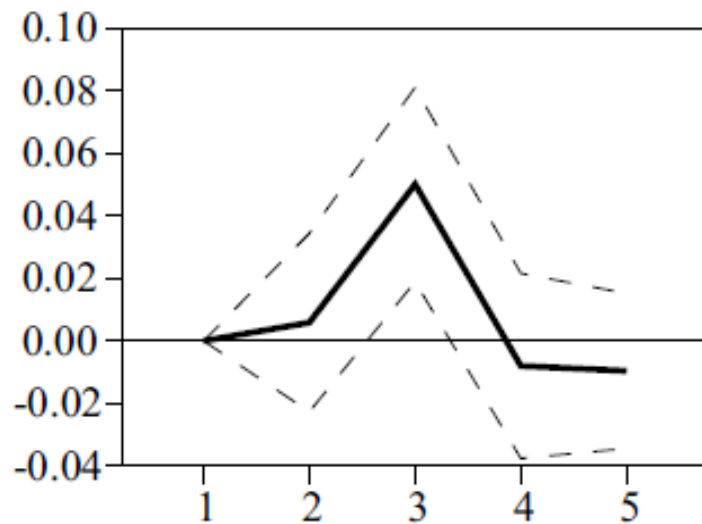


Figure 6. Response of *military spending share growth* to a shock in *GDP p.c. growth*

Note: The graph displays the impulse response 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.

5.3. Variance decomposition analysis

What is the relative importance of military spending growth rate shocks in changes economic growth rates and *vice versa*? To reply to 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 variables. The higher the share of explanation of error variance, the more important that variable is for the other variables in the system. For calculating VDA, we follow the Cholesky ordering which was presented in the previous section for the IRFs analysis (*Impulse response functions*). Table 4 presents the variance decomposition analysis results 20 years after the initial shock. We can see that the 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.

5.4. Using per capita military spending

As an alternative specification, we use the per capita of military spending growth rate instead of its growth rate of relative share in budget in our impulse response analysis. How innovations in the growth rates of real per capita military spending 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 the 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 the robustness analysis, we use generalized impulses as the decomposition method instead of the Cholesky method. The ordering of variables in the VAR system is important in order to calculate the IRFs and VDA analyses. A 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 Figure 7, 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 2nd and 3rd year after the initial shock. Although the response of military spending per capita growth to a shock in economic growth is positive, as

shown in Figure 8, 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 the variance decomposition from the 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 the share of total spending. More than 8% of volatility of growth in this first year after the 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 the shock is 0. After 5 years from the initial shock, military spending per capita growth rates can explain up to 40% of volatility of per capita income growth. 10 years after 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 the variance of military spending per capita growth in the long run.

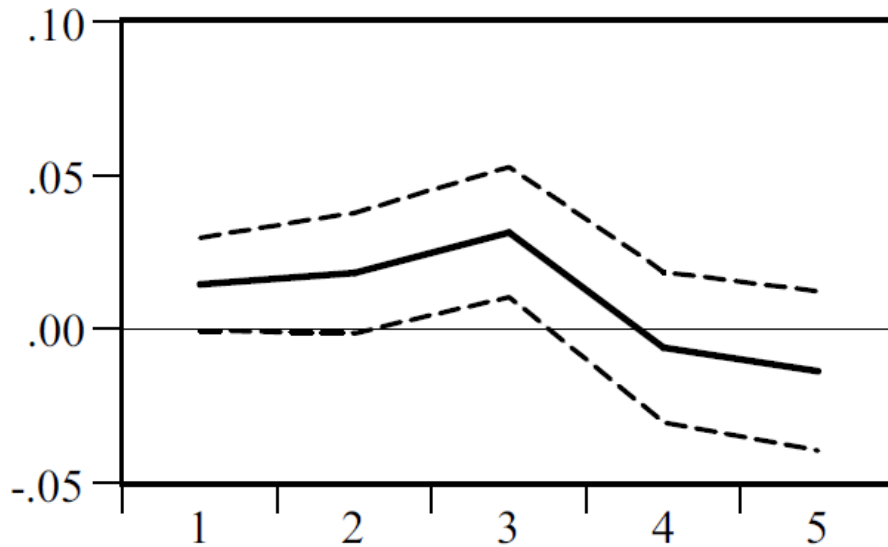


Figure 7. Response of *GDP p.c. growth* to a shock in *military spending p.c. growth* - Generalized Impulses

Note: The graph displays impulse response 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.

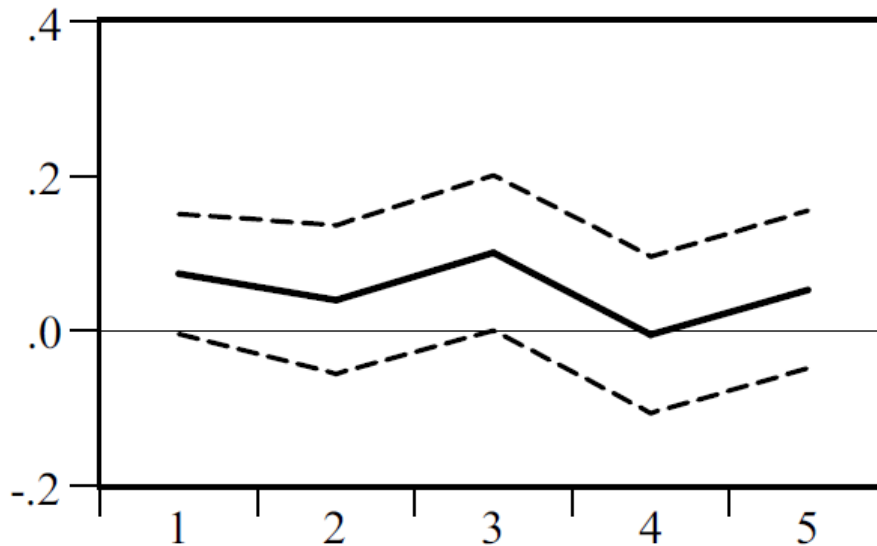


Figure 8. Response of *military spending p.c. growth* to a shock in *GDP p.c. growth* - Generalized Impulses

Note: The graph displays the impulse response 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 government. Current studies such as Farzanegan (2011) show that negative oil revenue shocks due to increasing sanctions 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 Granger causality, impulse response functions and variance decomposition tools to trace the effects of shocks on the macroeconomic performance of Iran. The period of analysis covers 1959 to 2007. Our results show that past information on the military spending (as a share of total spending, GDP or in per capita) growth rates is useful to explain the future developments of economic growth in Iran.

There is a statistically significant unidirectional causality from military spending growth to economic growth. A different approach suggested by Toda and Yamamoto, T-Y, (1995) is also used for Granger causality of variables in levels (see Appendix A). The T-Y Granger causality shows also a unidirectional causality of the level of military spending (% of total spending) to the level of real GDP per capita. Our additional analyses through IRFs and VDA also highlight the importance of military budget shocks in explaining volatility in the Iranian economic growth in the future. There are strong forward and backward linkages between the Iranian military industry and the overall output of the economy. The strong presence of the military forces such as 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 the response of economic growth to a one standard deviation increasing shock in the military spending growth rates is positive and statistically significant for the short and middle run.

The policy implications of these results are straightforward. There have been two broad groups of sanctions on Iran. The first group has been focused on the trade and banking sectors. The second and more recent sanctions are targeted on the energy industry, oil production and export capacities of Iran. The intended objective of the sanctions is said to control the military ambitions of the Iranian government, especially regarding nuclear programs. Our analysis shows that the historical data over the past 50 years show one way Granger causality from military spending to economic growth. This means that sanctions such as limitations on free trade and banking transactions which initially affect the macroeconomy of Iran do not necessarily shape the future military budget of Iran. They increase transaction costs, lowering economic growth, but according to our analysis, they will have no meaningful effect on military spending. This is indeed a new finding which has not been studied in previous empirical and policy works on Iran.

Another implication of our analysis is the possible crucial effects of energy sanctions. Farzanegan (2011) shows that the response of military spending is significant to oil revenues

shocks of Iran, while the response of other groups of spending such as education and health are not significant. Our analysis shows that such energy sanctions and recent direct military sanctions not only may limit the military spending of the Iranian state but will also dampen the economic growth, i.e., two goals with one shot.²⁰ This is mainly due to one way Granger causality which exists from military spending towards economic growth (also shown in IRF analysis).

Appendix A. Toda and Yamamoto granger causality

In the case of using levels of real GDP per capita and military spending (per capita, % of total spending or % of GDP) instead of their growth rates we can follow the Toda and Yamamoto (1995) (T-Y) procedure to test Granger causality. To test T-Y Granger causality we carry out the following steps: First, we test our variables in log-level to determine their order of integration. In order to test the unit root, we use the ADF test (Dickey and Fuller, 1979), the PP test (Phillips and Perron, 1988). All unit root tests show that the logarithm of real GDP per capita is I(1) while its first difference term is I(0). We notice the same result for military spending (per capita, % of total spending or % of GDP). Thus, the maximum order of integration for our variables is $m=1$. Secondly, we set up a VAR model in level and determine the appropriate maximum lag length for the variables in the VAR (p) using the usual information criteria. Thirdly, we check for the stability of the estimated VAR model, ensuring that there is no serial correlation in the residuals. Fourthly, we check whether there is a cointegration relationship between our variables in the VAR. Regardless of the existence of a cointegration vector, we can proceed for T-Y Granger causality by using the preferred VAR model, adding in m additional lags (the highest degree of integration which is 1 in our case) of each of the variables into each of the equations. These extra m lags will be included in the vector of exogenous variables besides a dummy variable for the Iran-Iraq war (1980-1988).

²⁰ The direct sanctioning of the military complex of Iran has already started. See: <http://www.defenddemocracy.org/media-hit/sanctioning-irans-military-industrial-complex/>

The inclusion of extra m lag aims to fix the asymptotic. The Wald test statistics will be asymptotically chi-square distributed with p d.o.f., under the null hypothesis of no Granger causality. We set up a VAR model with the logarithm of real GDP per capita and the logarithm of military spending (% of total spending). Almost all information criteria indicate that the optimum lag length is 2. This estimated model is also dynamically stable. There is no special problem with residual autocorrelation according to the LM test. In most cases, the Johansen cointegration test shows that there is a long run relationship. As $m = 1$, we now re-estimate the levels VAR with one extra lag of each variable in each equation. The T-Y Granger causality test shows that military spending (% of total spending) Granger causes the GDP per capita at 10% but not vice versa. Alternatively, we set up a VAR model using the logarithm of real military spending per capita and the logarithm of real GDP per capita. The optimum lag length on the basis of FPE and AIC criteria is 4. Using this optimum lag, the model satisfies the stability condition and the residual autocorrelation LM test shows no significant problem. We now re-estimate the VAR with one extra lag of each variable in each equation, including the exogenous vector. The T-Y test shows that there is bi-directional Granger causality between these two variables. The Granger causality from military spending per capita to GDP per capita is stronger and significant at the 1% level while the Granger causality from GDP per capita to military spending per capita is significant at the 5% level. Finally, we estimate a VAR including the logarithm of real military spending (% of GDP) and the logarithm of real GDP per capita. The optimum lag number based on the LR and HQ criteria is 3. The estimated VAR model is dynamically stable and there is no specific problem with residual autocorrelation. The Johansen cointegration test shows that there is at least 1 long run relationship. Re-estimating the VAR model with an extra lag ($p+m=3+1$) as exogenous variables, we apply the T-Y test. It shows bidirectional Granger causality. However, the Granger causality from military spending (% of GDP) to GDP per capita is significant at 1% while the other direction is significant at the 10% level.

To summarize, following the T-Y Granger causality procedure we have found some statistical evidence on bi-directional causality between the logarithm of real GDP per capita and the logarithm of military spending (per capita and % of GDP). Table A1 shows the T-Y Granger causality results.

Table A1. T-Y Granger causality

	Null Hypothesis	Chi-sq.	probability
<i>a</i>	Log level of real military spending (% of total spending) <i>does not Granger Cause</i> Log level of real GDP per capita	5.23	0.07
	Log level of real GDP per capita <i>does not Granger Cause</i> Log level of real military spending (% of total spending)	3.27	0.19
<i>b</i>	Log level of real military spending per capita <i>does not Granger Cause</i> Log level of real GDP per capita	17.09	0.00
	Log level of real GDP per capita <i>does not Granger Cause</i> Log level of real military spending per capita	9.58	0.04
<i>c</i>	Log level of real military spending (% of GDP) <i>does not Granger Cause</i> Log level of real GDP per capita	17.11	0.00
	Log level of real GDP per capita <i>does not Granger Cause</i> Log level of real military spending (% of GDP)	7.10	0.06

For robustness check we also re-estimate the Granger causality relationship between military spending and GDP per capita using an internationally recognized database of SIPRI. As we showed in the data section, there is a high correlation between the military spending in the Iranian National Accounts and in the SIPRI. Table A2 shows the T-Y Granger causality results using SIPRI military spending figures. We test this relationship by using two proxies of the military spending burden: per capital military spending and the share of military spending in GDP. In this robustness test, we only use international sources for military spending and economic growth for the case of Iran. As is evident in Table A2, we have strong evidence for the T-Y Granger causality from military spending (in per capita or as a share of GDP) to GDP per capita (in constant prices of 2000 US\$ or PPP (constant 2005 international \$)), but not *vice versa*. This finding, using the SIPRI military data and the World Bank GDP

per capita data for the case of Iran, is in line with our previous findings using the Iranian National Accounts data published by the Iranian Central Bank.

Table A2. T-Y Granger causality (using international sources of data)

	Null Hypothesis	Chi-sq.	probability
<i>a</i>	level of real military spending per capita <i>does not Granger Cause</i> level of real GDP per capita	12.48	0.00
	level of real GDP per capita <i>does not Granger Cause</i> level of real military spending per capita	0.56	0.75
<i>b</i>	level of real military spending (% of GDP) <i>does not Granger Cause</i> level of real GDP per capita	2.91	0.08
	level of real GDP per capita <i>does not Granger Cause</i> level of real military spending (% of GDP)	0.39	0.52

Source: military spending (in constant prices of 2008 US dollars) is from SIPRI (2010), total population and GDP per capita (constant 2000 US dollars) are from the WDI (2012). *Note:* sample period is from 1988-2008. A total observation is 17 (after adjustments). Lag length is 2 (based on LR, FPE, AIC, SC, and HQ). We have also controlled for the effects of post- 11th September 2001 by using a dummy variable equals 1 for post 2001 period and 0 otherwise as a exogenous variable.

Appendix B. Impulse response functions- levels of variables

We re-estimate the VAR and IRFs using the level of variables instead of their growth rates. The level of variables are I(1) and there is at least 1 cointegration relationship between them. One area of debate in literature in such a situation is whether an unrestricted VAR model should be used or a VECM. In a Monte Carlo experiment, Naka and Tufte (1997) shows that the impulse response functions of the two models (VAR and VECM) are similar at short horizons. However, at short horizons, VECM models perform poorly relative to those from unrestricted VAR models. Other studies such as Engle and Yoo (1987), Clements and Hendry (1995), and Hoffman and Rasche (1996) showed that an unrestricted VAR is superior (in terms of forecast variance) to a restricted VEC model on short horizons when the restriction is

true. Farzanegan and Markwardt (2009) and Farzanegan (2011) also use unrestricted VAR instead of VECM to examine the effects of oil shocks on the Iranian economy.

In our VAR model, we use the logarithm of level of real military spending per capita and the logarithm of level of real GDP per capita as endogenous variables and a dummy variable for the Iran-Iraq war (1980-1988) and an optimum lag length of 4. The related IRFs are shown in Figures B1 and B2. Figure B1 shows that the response of GDP per capita to a one standard deviation increasing shock in military spending per capita is positive, reaching its maximum in the 3rd year after the initial shock. This response remains positive till the 5th year after the shock to the level of military spending per capita. For the whole 5 years after shock this positive response of GDP per capita is also statistically significant. Figure B2 shows the response of per capita military spending to an increasing shock in per capita GDP. The immediate response of military spending is almost zero and statistically insignificant. The response of level of per capita military budget starts to increase from the 2nd year after the initial shock and this is also statistically significant from the 3rd to 5th year after the shock. This finding is in line with our expectations. The military industry has strong forward and backward linkages with the Iranian economy as discussed in the second section.

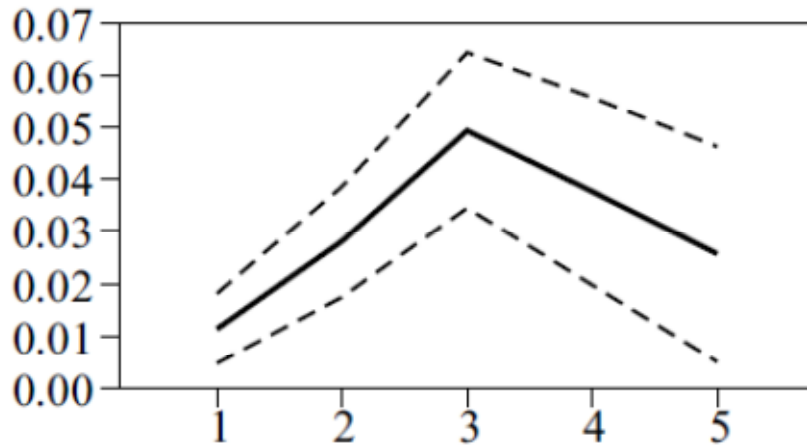


Figure B1. Response of Log of level of *GDP p.c.* to a shock in Log of level of *military spending p.c.*

Note: The graph displays the impulse response of the logarithm of level of real GDP per capita to one-standard-deviation shocks in the logarithm of level of real military spending per capita. 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.

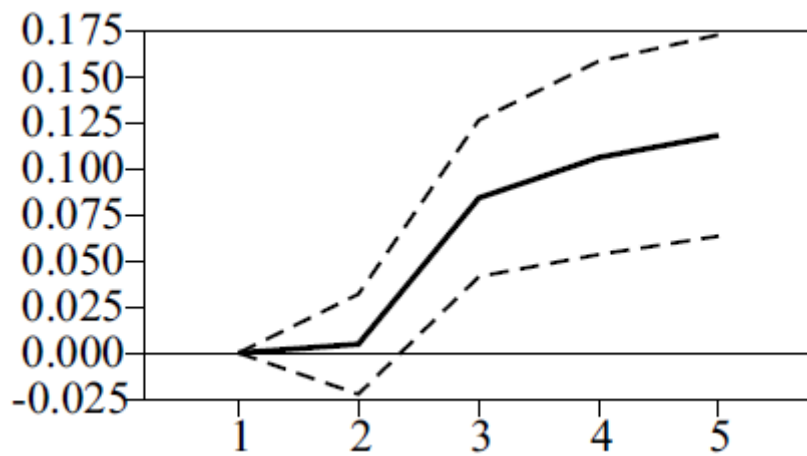


Figure B2. Response of Log of level of *military spending p.c.* to a shock in Log of level of *GDP p.c.*

Note: The graph displays the impulse response of the logarithm of level of real military spending per capita to one-standard-deviation shocks in the logarithm of level of real GDP per capita. 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 response.

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