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Send correspondence to:
Mohammad Reza Farzanegan
Philipps-University Marburg
farzanegan@uni-marburg.de

[1] CNMS, Philipps-Universität Marburg; Germany; CESifo (Munich) & ERF (Cairo)
[2] University of Freiburg, Freiburg, Germany; CESifo (Munich)

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Abstract

We study the responses of income inequality to positive per capita oil and gas revenues shocks in Iran. Using historical data from 1973 to 2016 and vector autoregression (VAR) -based impulse response functions, we find a positive and statistically significant response of income inequality to oil booms. Our analysis can help policymakers evaluate and accommodate the possible positive or negative effects on inequality in Iran resulting from the 2016 lifting of the embargo against the country.

JEL Classification: Q33; Q38; D63
Keywords: oil revenues; inequality; VAR; sanctions; Iran

ملخص

ندرس في بحثنا الحالي استجابات عدم المساواة في الدخل لصدمات إيجابية في نصيب الفرد من النفط والغاز في إيران. باستخدام البيانات التاريخية من عام 1973 حتى عام 2016 ونموذج الإنحدار الذاتي للمتجهات القائم على وظائف الاستجابة التلقائية ، نجد استجابة إيجابية وذات دلالة إحصائية لعدم مساواة الدخل في طفرات النفط. يمكن أن يساعد تحليلنا صانعي السياسات على تقييم واستيعاب التأثيرات الإيجابية أو السلبية المحتملة لعدم المساواة في إيران الناتجة عن رفع الحظر عن البلاد في عام 2016.

1. Introduction

We study how the income gap between the rich and the poor in Iran may be affected by oil and gas revenues,[3] and how positive changes in the latter might shape the future distribution of income in Iran. The research question is motivated by an expected increase in oil rents resulting from the removal of energy and economic sanctions following the *Iran Nuclear Deal*.[4]

On January 16, 2016, the *International Atomic Energy Agency* (IAEA) confirmed that the *Islamic Republic of Iran* fully met its internationally stipulated nuclear commitments. Accordingly, the EU lifted its sanctions on a number of Iranian industries, most notably its oil, gas, and petrochemical sectors. The United States also lifted sanctions on the financial, banking**,** insurance, energy, petrochemical, shipping, port, metals, and automotive sectors in Iran.[5] According to earlier estimates, the costs to Iran of US sanctions alone amounted to up $2.6 billion per year (Torbat, 2005). Additionally, different versions of the UN Security Council sanctions on Iran terminated, subject to re-imposition if Iran ceases cooperation.[6]

Lifting these sanctions allows Iran to re-enter the global economy and reestablish traditional business relations, thereby providing the country with the benefits of international labor division and access to all relevant markets in the industrialized world. Most importantly, Iranian authorities aim to increase oil production and exports to pre-sanction levels. Iran's Oil Minister, Bijan Zanganeh, announced a plan to reclaim Iran's share of global crude oil and to encourage international oil companies to invest in Iranian oil projects.[7] Reconnection to international banking and access to the worldwide transaction network SWIFT is likely to increase foreign exchange revenues. Already, Iran has regained access to approximately 100 billion euros in assets previously frozen under the international sanctions.[8] According to the IMF (2015: 82), additional sources of possible benefits to the country may arise from opening up the Iranian economy to the sale, supply of parts, and transfer of goods and services to the automotive and air transportation sectors, along with the associated foreign investment.

Lifting the sanctions should therefore have three main economic effects (IMF, 2015): first, a positive external demand shock, both for oil and non-oil exports; second, a positive terms-of-trade shock from a dramatic decline in the cost of external trade and financial transactions (mainly through a lowering of the price of imports and an increase in the price of exports);

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[3] While in our empirical analysis we use oil and gas export revenues (in 2010 US$) per capita throughout this study, we use the terms oil revenues and oil rents interchangeably. This is justified because we will argue that oil (and gas) revenues accrues to certain groups in society as a rent (in economic terms, not strictly in terms of data definitions).

[4] See http://www.bbc.com/news/world-middle-east-33521655.

[5] In May 2018, Mr Trump pulled out the US from an Obama-era nuclear agreement with Iran. The US Treasury announced that sanctions would be re-imposed on the industries mentioned in the 2015 deal, including Iran's oil sector, aircraft exports, precious metals trade, and Iranian government attempts to buy US dollar banknotes. Despite the US' threat to penalize European companies doing business in Iran, the European Union on its Sofia summit meeting declared that it would not withdraw its release of sanctions. It would rather compensate European companies in case they face penalties by the US. That is, while the US decision may limit Iran's re-integration into the world market, it will not come to a complete halt.

[6] More information at: https://www.lawfareblog.com/comprehensive-timeline-iran-deal.

[7] See http://www.ft.com/cms/s/0/ea34e566-7641-11e5-933d-efcdc3c11c89.html#axzz40w9izt4B. According to the U.S. Energy Information Administration (EIA, 2017), total petroleum and other liquids production in Iran reduced from 4,215,000 barrels per day in 2011 (before oil embargo of 2012) to 3,194,000 barrels per day in 2013. Following lifting of sanctions in Jan 2016, the Iranian oil production has reached its earlier levels of production (4,138,000 barrels per day).

[8] http://www.euronews.com/2016/02/01/swift-return-to-international-bank-transfers-for-iran-s-banks/.

third, a wealth effect through restored access to foreign assets and higher oil exports. The IMF (2015: 82) predicts "*these three shocks are likely to create a significant improvement in the outlook for the Iranian economy in the years ahead, outweighing the adverse effects from the sharp decline in global oil prices over the past year.*"

Despite this promising outlook, one should not underestimate the potential detrimental effects that these shocks could bring about. The positive economic shocks may have severe political repercussions. Specifically, we take a closer look in our paper at the development of the income gap between the rich and the poor in Iran. Based on relative deprivation theory,[9] income inequality, especially when it rises (quickly), has been shown to have a destabilizing effect on societies and political regimes (Sigelman and Simpson, 1977; Alesina and Perotti, 1996). Krieger and Meierrieks (2016a), in an analysis of 114 countries from 1985 to 2012, show a robust association between higher levels of income inequality and terrorism. Farzanegan and Witthuhn (2017) also find a consistent negative effect of higher income inequality on political stability in their panel of more than 100 countries from 1984 to 2012. For the case of Iran, we can trace a continuous increase of income inequality (based on an estimate of the Gini index of household income inequality) prior to the Islamic Revolution. Figure 1 shows the association between the Gini index (a higher index indicates more income inequality) and oil and gas export revenues per capita (in real 2010 US$) in Iran. There is a strong correlation (0.78) between these two key variables, which is also statistically significant at 99% confidence interval.

In this paper, we investigate the extent to which the positive shock to Iranian oil rents affects the income gap between the rich and the poor. We ask whether lower income groups may experience benefits from increased foreign trade in their daily lives, or whether the gap between the rich and the rest of society is likely to widen. We do so by using historical information on past positive oil and gas revenues shocks to simulate the response of income inequality following such shocks.

Our analysis proceeds as follows. After a thorough review of the related literature and the derivation of our hypotheses in Section 2, we turn to methodological and data issues in Section 3. Section 4 presents our empirical findings. Section 5 concludes.

2. A review of the literature: Theoretical mechanisms and empirical evidence

As our introduction has illustrated, three distinct effects of lifting the sanctions can be expected (IMF, 2015): a positive external demand shock; a positive terms-of-trade shock; and a positive wealth effect. We first investigate how these effects may affect income and wealth inequality, before turning to a brief discussion of the potential effects of rising inequality on Iranian society.[10]

We start our theoretical reasoning by providing the benchmark case of *inclusive growth* (IMF, 2015: 83). Let us assume that (i) regaining access to the world market will indeed yield a strong growth dividend for Iran, (ii) domestic and international market reactions are

[9] Relative deprivation theory posits that members of a society evaluate their economic position relative to reference groups (Gurr, 1970; Yitzhaki, 1979). It argues further that members of society develop feelings of discontent and frustration when their economic position compares unfavorably to a reference group (i.e., when they are relatively deprived).

[10] In our analysis, we refer to measured (or actual) inequality rather than on perceived inequality as we rely on official statistics rather than on survey data. The distinction between perceived and measured inequality has recently attracted some attention in the literature, see, e.g., Gimpelson and Treisman (2015), as some people may base their policy demands on perceived inequality, even if there is no measureable change of inequality.

undistorted, and (iii) domestic macroeconomic policy responses are appropriate to achieve national economic policy goals such as low inflation, steady growth and a competitive exchange rate. Under these circumstances, we may expect economic benefits to accrue to all groups in society without changing the income distribution too strongly (i.e., growth is indeed inclusive). Even if the oil-producing sector is the forerunner in terms of experiencing additional rents, there are at least two reasons why the rest of society nevertheless ought to catch up quickly. First, trickle-down effects (for instance, through oil workers' additional demand for commodities from other sectors) will benefit other sectors of the economy as well as workers from the different parts of society. Second, there will likely be intersectoral movements of workers into the oil industry. The consequent adjustment of the capital-labor ratio in the affected sectors would lead to higher wages beyond the oil sector.[11]

Real-world adjustment processes are, however, rarely as smooth as described before, and growth is not always inclusive. Two important strands of the literature, the first one on the Dutch disease and the second one on institutional capture, may explain this observation.

Let us start by looking at the Dutch disease argument. Iran, as a resource-rich country, is a prime candidate for the Dutch disease (Gregory, 1976; Corden and Neary, 1982). Following the lifting of sanctions, the increase in global demand for Iranian oil – and a likely subsequent rise in oil prices – may trigger a sharp rise in oil exports, arguably much sharper than hoped for by the Iranian government. This would cause an appreciation of the local currency, which in turn would harm the competitiveness of other tradable goods sectors like agriculture and manufacturing. As a result, employment in agriculture and manufacturing might decline following a boom in the Iranian oil sector (cf. Bhattacharyya and Williamson, 2016). This development may be so strong that it increases inequality significantly in the short run, as neither trickle-down effects nor intersectoral labor mobility are sufficiently able to counter the emerging income inequality. These market processes may only restore the previous equilibrium in the medium or long run, if at all. In fact, Farzanegan and Markwardt (2009) provide empirical evidence on the Dutch disease in Iran in past decades, in which oil revenues shocks could be observed. Interestingly, Bhattacharyya and Williamson (2016: 223-4) find that "surprisingly little is known about [resource booms'] distributional impact (…) and the empirical literature on this topic is surprisingly thin". It is indeed surprising that, while the Dutch disease suggests clear employment effects, its distributional effects attract relatively little attention despite their importance in resource-rich countries.

The second strand of the literature rests on the observation that many resource-rich countries are not known for having particularly sound institutions. Rather, these countries suffer from weak institutions,[12] which originate from, e.g., earlier colonization policies following the model of "extractive states"[13] (Acemoglu et al., 2001). Even in countries without a colonial

[11] Note that there might be an intertemporal pattern of inequality between sectors. First, wages rise in the oil industry, while other sectors follow only later.

[12] The catch-all-phrase "weak institutions" includes, among other things, a high risk of government expropriation as well as a lack of independent judiciary, property rights enforcement, and institutions providing equal access to education and ensuring civil liberties. Together, these characteristics lead to weak incentives for investment and ultimately low economic growth and development (Acemoglu et al., 2001).

[13] The main purpose of an "extractive state" was to transfer as much of the resources of the colony to the colonizer (Acemoglu et al., 2001).

history (such as Iran) we may observe corruption,[14] rent-seeking activities by large companies (such as state oil companies) and political instability as signs of deeply rooted institutional dysfunction and which are at least partly related to resource abundance, as Mehlum et al. (2006) argue. In their analysis, Mehlum et al., suggest that "*more natural resources push aggregate income down, when institutions are grabber friendly, while more resources raise income, when institutions are producer friendly*". In their theoretical model, entrepreneurs can allocate their resources between production and unproductive rent extraction (i.e., grabbing). Whether the availability of resources with high rents (such as oil and gas) may or may not push the entrepreneurs to growth-harming grabbing activities depends ultimately on the quality of institutions. More specifically, they show that the resource curse only appears in countries with inferior institutions and provide empirical evidence for this effect in a set of cross-country regressions. Interestingly, Mehlum et al. differ explicitly from other influential works on the resource curse by Sachs and Warner (1995, 1997, 2001). While Mehlum et al. find the deterioration of institutions to be an important driver of weak development, Sachs and Warner argue instead that Dutch-disease effects are responsible.

Acemoglu et al. (2005) and Acemoglu and Robinson (2006) provide convincing explanations for the observation that weak institutional settings in a country often correlate with high levels of inequality (for empirical evidence, see, e.g., Krieger and Meierrieks, 2016b). They argue that the arrangement of economic institutions is determined by the exercise of political power by different societal groups, where groups with more power are more likely to shape economic institutions in their favor. Acemoglu et al. (2005) differentiate between *de facto* and *de jure* political power. De jure political power stems from the design of a country's political institutions. De facto power refers to political power that individuals exercise thanks to their economic might,[15] and is ultimately rooted in a society's distribution of resources. Past resource rents shape the initial conditions of a society's wealth distribution and economic power, which in turn influences political institutions up to the present. These institutions then further support income and wealth inequality in the long-run future (Acemoglu and Robinson, 2006). In Iran, elites with close ties to the oil and gas sector accumulated economic and political clout in the past and remain in prominent positions today. Thus, any new and sudden oil and gas revenues following the lifting of sanctions would only serve to strengthen their position further, as most of these resources tend to be appropriated by such elites. As a result, inequality is likely to rise further. Unless threatened by the possibility of losing these rents, due to a revolution (such as the Iranian revolution of 1979), trickle-down effects to the rest of society are likely to remain negligible.[16]

While the Iranian society may have lived with a certain level of inequality during the period in which sanctions were imposed, lifting them has changed the situation significantly. The common argument that economic downturn – and, possibly, a certain level of inequality –

[14] Iran is ranked 131th out of 176 countries on Transparency International's Corruption Perception Index (Transparency International 2017).

[15] The economic elite always has the most to offer (the biggest bribes, the largest political contributions etc.) to politicians, bureaucrats and other public officials acting as selfish maximizers of their own (rather than social) utility (Holcombe, 2015; Acemoglu et al., 2005). These circumstances can be described as "political capitalism" (Holcombe, 2015: 41), "captured democracy" (e.g., Acemoglu and Robinson, 2008: 283) or "economic-elite domination" (Gilens and Page, 2014: 566).

[16] Note that there might even be detrimental effect to economic activity when economic elites ("industrial incumbents") actively oppose more liberal economic policies because such policies would threaten the incumbents' market position (cf. Rajan and Zingales, 2003; Sokoloff and Engerman, 2000).

were in fact a result of the sanctions, seems to have convinced the poorer parts of society. This was especially convincing because elites often placed the blame for many of the country's problems on its foreign enemies. With Iran re-entering the global economy and with newly increasing oil and gas revenues, however, this argument may prove less convincing to the population, and inequality, especially in terms of relative deprivation, may be felt more directly. The so-called *relative deprivation theory* posits that members of society evaluate their economic position relative to a reference group (Gurr, 1970; Yitzhaki, 1979). It argues further that members of society develop feelings of discontent and frustration when their economic position compares unfavorably to this reference group (i.e., when they are relatively deprived). The theory postulates that these feelings matter strongly to the genesis of political violence: Inequality induces frustration, which provokes an aggressive response to vent one's frustration (Muller and Weede, 1994). This relationship is called the "frustration-aggression mechanism" (e.g., Gurr, 1979; Muller and Weede, 1994).[17]

According to Krieger and Meierrieks (2016a), relative deprivation theory as a specific representation of the inequality problem in a society has been used to explain such diverse phenomena as social deviance, protest and political violence. This includes, e.g., crime (Kawachi et al., 1999; Wilkinson and Pickett, 2007); support for revolutions (MacCulloch, 2005); riots (Chandra and Williams Foster, 2005); terrorism (Krieger and Meierrieks, 2016a; Piazza, 2006); as well as civil wars and rebellions (Gurr, 1970; Muller and Weede, 1994).[18]

Whether or not the probability of such negative effects increases in the Iranian society depends primarily on whether increasing oil and gas revenues after lifting sanctions do in fact lead to higher inequality. In the sanction years, the Gini index already increased slightly from 0.38 in 2012 (the year of imposition of sanctions) to 0.40 in 2016 (the year of removal of sanctions). This development had apparently already some political consequences. One of the main drivers of country-wide protests in Iran at the end of 2017 and early 2018 was indeed the frustration of people with increasing inequality and corruption (Cockburn, 2018).

After these theoretical considerations, let us turn to an overview of the sparse empirical literature. As stated above, according to Bhattacharyya and Williamson (2016) there is little empirical literature on the distributional effects of sudden increases of oil revenues in oil-rich countries in general, and even less so on this development in the Iranian context. Hence, our analysis aims at providing new insights into this issue. Let us summarize the mixed empirical findings on the nexus between resource rents and income inequality in the following.

Carmignani (2013) uses cross-sectional data from approximately 84 countries dating from 1970 to 2010. He finds that resource abundance *increases* income inequality in a country while simultaneously reducing human development. The latter effect is likely to introduce further inequality at the socio-economic level, thereby directly feeding back to feelings of relative deprivation. Similarly, Bhattacharyya and Williamson (2016) show that all top income groups in Australia benefit from resource booms in the short and long term. They conclude therefore that resource booms tend to *exacerbate* inequality in Australia. Fum and

[17] The direct link between the genesis of organized political violence and the frustration and discontent due to relative deprivation is explicitly stated by Gurr (1970: 12-13): "The primary causal sequence in political violence is first the development of discontent, second the politicization of that discontent, and finally its actualization in violent action against political objects and actors. Discontent arising from the perception of relative deprivation is the basic, instigating condition for participants in collective violence."

[18] A more general discussion of the socio-economic impacts of income inequality can be found in Thorbecke and Charumilind (2002).

Hodler (2010) show in a cross-country analysis that resource rents *increase* inequality in countries with high ethnical fractionalization and *reduce* inequality in ethnically homogenous societies.

However, these results cannot be confirmed in other contexts. Davis and Vásquez Cordano (2013) use income growth data by quintiles in 57 developed and developing countries. They find neither evidence for positive nor negative effects of extraction-led growth on the poor, i.e., the poor do not catch up to the rich nor do they fall back further. In other words, inequality remains *unaffected*.

Howie and Atakhanova (2014) examine the effect of resource booms on income inequality in Kazakhstan by using panel data at regional, urban, and rural levels. They find that resource booms have a *decreasing* effect on inequality in Kazakhstan, and suggest that this result can be linked to a larger non-tradable sector following a resource boom and a higher share of unskilled labor in that sector. Goderis and Malone (2011) examine the relatively unskilled labor-intensive non-tradables sectors in 90 countries between 1965 and 1999 and find that inequality *falls in the short run* but *eventually increases* over time following oil and mineral booms. Kim and Lin (2017) find a *decreasing* effect of oil abundance and oil dependency on income inequality in a sample of developing and developed countries. The main channel in their analysis is better education attainment and improved health conditions following oil booms.

Positive shocks in oil revenues and their possible effects on income inequality can be better understood by examining different oil revenues distribution policies. Farzanegan and Habibpour (2017), while presenting a review of the related literature on the nexus between oil rents distribution policies and inequality, investigate how income inequality and poverty at the household level respond to different distributional policies with respect to oil rents in Iran. Using a sample of 36,000 urban and rural Iranian households in 2009, they show that the resource dividend policy with a subsequent direct income taxation has a significant decreasing effect on the household Gini index. In other words, they emphasize the important role of taxation as a means of reducing income inequality, which may result from an unequal distribution of oil rents in Iran. Without a well-functioning tax system, distributed oil rents may increase the income gap between the well-connected richer classes of society and the disadvantaged poorer ones.[19]

3. Data and Methodology

3.1 Data

To measure income inequality, we use the Gini index[20] (which ranges from 0 to 1, with higher values indicating higher levels of income inequality) from the Annual Household Income and Expenditure Surveys from the Central Bank of Iran (CBI, 2018). As an alternative to the Gini index, we also employ the *decile dispersion ratio* which is the ratio of the average consumption (or income) of the richest 10 percent of the population to the average consumption (or income) of the poorest 10 percent. The Central Bank of Iran reports the ratio of expenditures of the 10^{th} decile to that of the 1^{st} decile. We use this ratio to measure the

[19] Note that they are not examining the dynamic response of income inequality to positive shocks in oil and gas rents. For an analytical study of poverty, economic growth and redistribution in Iran during the 1980s and 1990s, see Assadzadeh and Paul (2004).

[20] As shown by Yitzhaki (1979), higher levels of income inequality measured by the Gini coefficient mean higher levels of relative deprivation.

intensity and the dynamics of the income gap between the rich and the poor.[21] The income inequality indicators of Iran are available from 1970s to 2016.

As our main explanatory variable, we use Iran's oil and gas export revenues per capita (2010 US$) which is available from 1973 to 2016. Data on oil and gas export revenues (in current US$) is from the Ministry of Petroleum of Iran and reported in CBI (2018). We use the US consumer price index (from the World Bank, 2018) for the calculation of oil and gas revenues in 2010 US$.[22] We follow Ross (2012) and Farzanegan et al. (2018) in using *per capita* oil and gas revenues.

Besides oil and gas revenues and income inequality, which are our key variables of interests, we also control for important transmission channels potentially running from these revenues to household income.

We control for the tax revenues per capita (in Iranian *rial*, IRR), which is adjusted for inflation. Data on tax revenues is taken from CBI (2018). It measure the capacity of the state in the distribution of oil and gas revenues and the funding of public projects via the tax system. Farzanegan and Habibpour (2017) in a simulation analysis of a household survey in 2009 show that a resource dividend policy with subsequent direct income taxation has a significant decreasing effect on the household Gini index.

The overall state of economic development, measured by the logarithm of real GDP per capita (in IRR) from the World Bank (2018), is also controlled for in our estimations. According to Kuznets' (1955) hypothesis, income inequality increases alongside rising income per capita. After a threshold point in income per capita, additional development reduces income inequality.[23] Several studies have explored the Kuznets hypothesis. For example, Williamson (1991) suggests that technological change initially increases income inequality, which declines, however, when skills related to new technology become available to a larger share of population. Aghion and Bolton (1997) refer to credit market imperfections over the course of economic development. One of their conclusions implies that the process of capital accumulation initially has the effect of widening inequalities but eventually reduces them by lowering interest rates. Farzanegan and Markwardt (2009) find a strong positive relationship between positive oil price changes and industrial output growth in Iran. Such a growth in economic output following positive oil shocks may have significant implications on the income distribution as well.

Our period of analysis covers several political changes such as the transition from a monarchy to an Islamic republic, and different governments in the post-revolution period. Factionalism in post-revolution Iranian politics and its destructive effects on economic growth under increasing oil rents has been investigated by Bjorvatn et al. (2013). Therefore, we control for

[21] Note that the decile dispersion ratio does not consider information about incomes in the middle of the income distribution. Farzanegan et al. (2017) have investigated how the size of middle class in Iran reacts to positive changes in oil revenues.

[22] In earlier versions of this paper, we used the value added of oil and gas per capita from the National Accounts of Iran, which is available only until 2012. In the current study, we have extended the sample period to 2016 and now use oil and gas export revenues per capita given their better data availability. Another reason for replacing the value added as a measure of oil rent (e.g., Bjorvatn et al., 2012) is that relative prices in Iran have changed substantially over the years, mainly because of significant distortions caused by nonmarket fuel prices (we thank Shahrokh Fardoust in drawing our attention to this important point). Note that our results do not qualitatively differ after this change.

[23] The square of GDP per capita works better for a cross-section of countries in a given year than for inequality within countries over time (Li et al., 1998).

different forms of political institutions by using the POLITY2 index from Marshall et al. (2017). It measures the quality of institutional democracy captured by the competitiveness and openness of executive recruitment; constraints on chief executive; and the competitiveness of political participation. The "Polity Score" captures the quality of political institutions on a 21-point scale ranging from -10 (hereditary monarchy) to +10 (consolidated democracy). The Polity data include information only on the institutions of the central government and on political groups acting, or reacting, within the scope of that authority. There is negative and statistically significant correlation (–0.30 with *t* statistics of –2.04) between the Polity index and the Gini index in Iran in our period of analysis (1973-2016). One channel through which the flow of oil and gas revenues may damage income equality is through the negative effect on the quality of political institutions (Ross, 2012).

Finally, the 8-year war with Iraq is controlled for by using a dummy variable equaling one for 1980-1988. The leftist economic policies of former Prime Minister Mousavi during the eight years' war with Iraq resulted in the nationalization of private enterprises and the introduction of ration cards. The goal was to control consumer prices, support the poor and vulnerable layers of society, and promote social justice as the main concern of 1979 Islamic revolution.[24]

3.2 The unrestricted VAR model

We use the *unrestricted VAR model* to estimate the interconnections between our main variables, oil and gas revenues and inequality, in order to investigate the effects of oil booms on the income gap between the rich and the poor in Iran. The VAR approach has previously been employed by Farzanegan and Markwardt (2009) and Farzanegan (2011) among others to examine the effect of oil shocks on selected macroeconomic indicators (such as industrial production, imports, inflation, the real effective exchange rate, and government spending behavior) in Iran.

Within a multivariate framework, the VAR model relates changes in a particular variable (e.g., income inequality) to changes in its own lags and to changes in (the lags of) other variables (e.g., oil and gas revenues):

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B x_t + \varepsilon_t$$

where y_t is a vector of k endogenous variables, x_t is a vector of d exogenous variables, $A_1, \cdots, A_p$ and B are matrices of coefficients, and ε_t is a vector of innovations that may be contemporaneously correlated, but uncorrelated both with their own lagged values and with the right-hand side variables. The optimum lag of one year is based on the Schwarz information (SC), Hannan-Quinn information (HQ), the sequential modified LR test statistic (LR) and Final Prediction Error (FPE) criterion (results are available upon request). All main variables are endogenous in our VAR framework.

We use the following variables in our VAR system: the logarithm of oil and gas export revenues per capita, the logarithm of tax revenues per capita, the logarithm of real GDP per capita, the Polity index, and the logarithm of the Gini index. We control for Iran's 8-year war with Iraq (1980-1988) and include a constant term (exogenous variables). The period of analysis is from 1973 to 2016.[25]

[24] https://www.forbes.com/2009/06/17/iran-election-khamenei-opinions-contributors-mir-hossein-mousavi.html#23f0a5466242

[25] Our period of analysis ends in 2016 since this is the latest year in which there is official data on income inequality from the Iranian Central Bank.

The ADF test (Dickey and Fuller, 1979) and the Phillips-Perron test (Phillips and Perron, 1988) show that all endogenous variables are integrated of first order (I(1)). To answer the question of whether there is a long-run relationship among I(1) variables, we employ Johansen's (1991, 1995) VAR-based cointegration tests and include the exogenous war dummy variable, while setting the optimum lag length to one. The unrestricted cointegration rank test (Trace) shows that there is at least one cointegrated relationship among our variables (results are available upon request). In this case, differencing will lead to the loss of useful long-run information in our data. Sims (1980) and Sims et al. (1990) argue against differencing cointegrated variables, instead suggesting the use of a VAR model in levels. We follow other related studies such as Farzanegan and Markwardt (2009), Farzanegan (2011, 2014), Farzanegan and Raeisian Parvari (2014), and Dizaji et al. (2016), and apply the unrestricted VAR model in the levels of variables. After all, we are interested in applying tools such as the impulse-response analysis rather than aiming at interpreting each coefficient of the VAR model.

To identify the response of income inequality in Iran to positive shocks to oil revenues per capita, we apply the Cholesky *impulse-response function* (IRF) based on our estimated unrestricted VAR model. The ordering of variables in the VAR model is as follows: log of oil revenues per capita, log of tax revenues per capita, log of real GDP per capita, Polity index, and log of the Gini index. The first variable in the Cholesky ordering is the most exogenous one (oil and gas revenues) and affects other variables in the VAR system contemporaneously, but gets affected by them only with some lags. The last variable in the system (the Gini index) is the most endogenous one and is affected by all other variables contemporaneously. However, its changes will also influence other variables with some time lag.[26]

The IRF indicates the direction, size, and statistical significance of responses following an initial shock to the log of oil and gas revenues per capita. Following Sims and Zha (1999) and Stock and Watson (2001), we report one standard deviation for error bands in the IRFs (68% confidence intervals). The impulse response is statistically significant when the error bands exclude the horizontal zero line. Before investigating the IRF, however, we need to check the stability of the estimated VAR model. According to Lütkepohl (1991), an estimated VAR model is stable (stationary) if its root reciprocals are less than one, that is, when they are located within the unit circle. If the VAR is not stable, the impulse-response standard errors are not valid (IHS, 2016, p. 646). Table 1 shows that our estimated VAR is stable, i.e., the influence of a shock on all variables decreases over time.

In addition to the stability condition test, we need to examine the properties of the residuals from our estimated VAR model. For this purpose, we use the autocorrelation Lagrange Multiplier (LM) test, which reports the multivariate LM test statistics for residual serial correlation up to a specified order (up to three years in our case). The test statistic for lag order $h = 3$ is calculated by estimating an auxiliary regression of the residuals u_t on the original right-hand regressors and the lagged residual u_{t-h} , where the missing first h values of u_{t-h} are filled with zeros (for more details, see Johansen, 1995). The null hypothesis under the autocorrelation LM Test is "*no serial correlation of order h*". Table 2 shows that our

[26] We also applied the *Generalized Impulse Response* method introduced by Pesaran and Shin (1998), which is not sensible to the specific ordering of variables in the VAR system. It does not change our results in a neither quantitative nor qualitative way.

estimated VAR model is also immune against serial correlation in residuals up to the order of three years.

4. Results

Figure 2 shows the impulse response of income inequality to a positive shock in the log of oil and gas export revenues per capita. After an unexpected positive shock to these revenues, income inequality increases for the first two years following the shock. The increase is statistically significant for the first year after the initial shock. The peak positive response of income inequality is seen within the first year after the shock. These results are obtained by controlling for other channels connecting oil and gas revenues and inequality.

Our results differ from Goderis and Malone (2011), who suggest a short-term reduction of inequality following oil booms, but they are perfectly in line with the findings by Fum and Hodler (2010) and Bhattacharyya and Williamson (2016). Recall that Fum and Hodler (2010) argue that increasing oil rents can increase inequality when a country has relatively high ethnolinguistic diversity. According to Montalvo and Reynal-Querol's (2005) indicator of ethnic fractionalization and polarization, Iran is among the most fractionalized countries worldwide. It has a score of 0.60 in ethnic polarization and 0.76 in ethnic fractionalization (the scale ranges from 0 to 1). As we theorized above, one of the dangers of a sudden resource boom is that it may trigger conflict induced by higher relative deprivation. Often, inequality runs along an urban-rural divide or ethnic lines, with ethnic minorities being particularly deprived, which may increase ethnic tensions. Combining Fum and Hodler's (2010) and our findings indicates a potential vicious circle in Iran: The expected boom following the lifting of sanctions occurs in a highly fractionalized country that is particularly prone to increasing inequality. The increase in inequality may result in an even greater economic division of ethnic groups, making any future booms even more dangerous, as relative deprivation increases further. Arguably, at some sufficiently high level of relative deprivation (or intergroup income inequality), political instability and conflict may result, especially if Iran's institutional setting does not improve in the meantime to accommodate these potential conflicts.

Figure 3 shows the response of the ratio of expenditures of the 10^{th} decile to the 1^{st} decile (i.e., the gap between the rich and the poor) to a positive shock in oil and gas revenues per capita. This simulation is based on a VAR model with optimal lag length of one year, controlling for the same variables as in Figure 2. Both stability and residual serial autocorrelation tests are satisfactory. The figure confirms the previous findings. The income gap between the richest 10 percent and the poorest 10 percent, i.e., the decile dispersion ratio, increases after an unexpected positive shock to per capita oil and gas revenues in Iran and remains positive within five years after the shock. It reaches its peak in the first year after the shock and remains statistically significant for the first two years following the initial oil and gas revenues shock.

How much of the variance in income inequality (measured by the Gini index and the decile dispersion ratio) is explained by shocks in oil and gas revenues per capita, and how much is explained by shocks to other variables? The variance decomposition (VDC) results in Tables 3 and 4 show the variance of income inequality from each source of shocks. The first vertical

column indicates the number of years following a shock to which the decomposition applies, and the row figures give the fraction of variance explained by the shock source.
Table 3 shows that in the first year after the shock approx. 50 percent of the changes in the log of the Gini index are explained by its own past lags. The shocks to oil revenues per capita explain 16 percent of the variance of inequality in the first year following the shock. Indeed, oil and gas revenues show a strong power in explaining the fluctuations of income inequality in short term. Another important variable in fluctuations of income inequality is real GDP per capita. The relative importance of economic development in explaining fluctuations of income inequality is increasing from 17% in first year to 36% within the first 10 years after the shock. The relative importance of oil and gas revenues per capita in predicting the variance of the Gini index decreases over time, stabilizing itself around 8 percent after 10 years. The role of the Polity index as a measure of the quality of political institutions in explaining the distribution of income is also considerable and comparable to the role of oil and gas revenues. The least important variable in predicting the variance of income inequality is tax revenues. This observation may be due to the marginal role of taxation in funding government budget since 1970s, which is also a symptom of the resource curse and the weak quality of political institutions in oil-based economies (Ross, 2012).
Table 4 indicates that the use of the decile dispersion ratio as an alternative measure of inequality yields very similar results. The most important variable in explaining the variance of income inequality is related to the shocks in oil and gas revenues per capita. It explains 18% of the fluctuations of income inequality within the first year. The next most important variable in explaining the variance of income inequality within the first year is related to the shocks in the quality of political institutions. As before, the importance of shocks in real GDP per capita in the fluctuations of the gap between the rich and the poor is increasing from 10% in first year to 27% in the 10^{th} year after the shock.

5. Conclusion

Despite the recent cancellation of the *Iran Nuclear Deal* through the United States, Iran is set to become an (almost) full-fledged member of the global economy again, after most of the sanctions related to the country's nuclear weapons program have been lifted and continue to remain lifted. Our paper simulates the effect of the end of sanctions, and the expected subsequent rise of income and wealth from oil and gas revenues, on income inequality. More specifically, we predict the response of income inequality to a positive shock in oil and gas export revenues per capita, employing VAR based impulse responses and historical data from 1973 to 2016 in Iran.

We find that oil booms have repeatedly worsened the income distribution in Iran, i.e., incomes became less equally distributed once additional oil and gas revenues, and thus rents in the oil and gas business, were available. Based on an impulse response as well as a variance decomposition analysis, we show that the response of income inequality to positive per capita oil and gas revenues shocks is positive and statistically significant for the first two years following a shock. Our results are robust to controlling for other possible channels affecting the income distribution in Iran, such as the real GDP per capita, the quality of political institutions, per capita tax revenues, and a dummy variable for the 8-year war with Iraq.

The recent protests across Iran (in December 2017, January 2018 and August 2018) reflect the frustration of the public with income inequality and corruption. This is reminiscent of earlier events in the modern history of Iran. More specifically, the 1979 Islamic revolution was partly rooted in very high levels of income inequality following the significant increase of oil revenues in the second half of 1970s under the Pahlavi administration. According to Farzanegan and Alaedini (2016, p.3), "*the main message of the 1979 Revolution incorporated the goals of social justice, addressing the plight of the downtrodden, and representing the lower social strata in the government*". The task of the Iranian government (also in its own self-interest to stay in power) will be to deal with the increase of inequality following oil booms in a way that leads to inclusive growth, i.e., that benefits broader parts of society and not only small elites. For instance, redistributive policies toward rural regions or across ethnic lines could be one strategy to avoid future conflict (see Farzanegan et al., 2018, for supportive arguments). Whether an elite-dominated government is likely to choose this strategy is a different matter.

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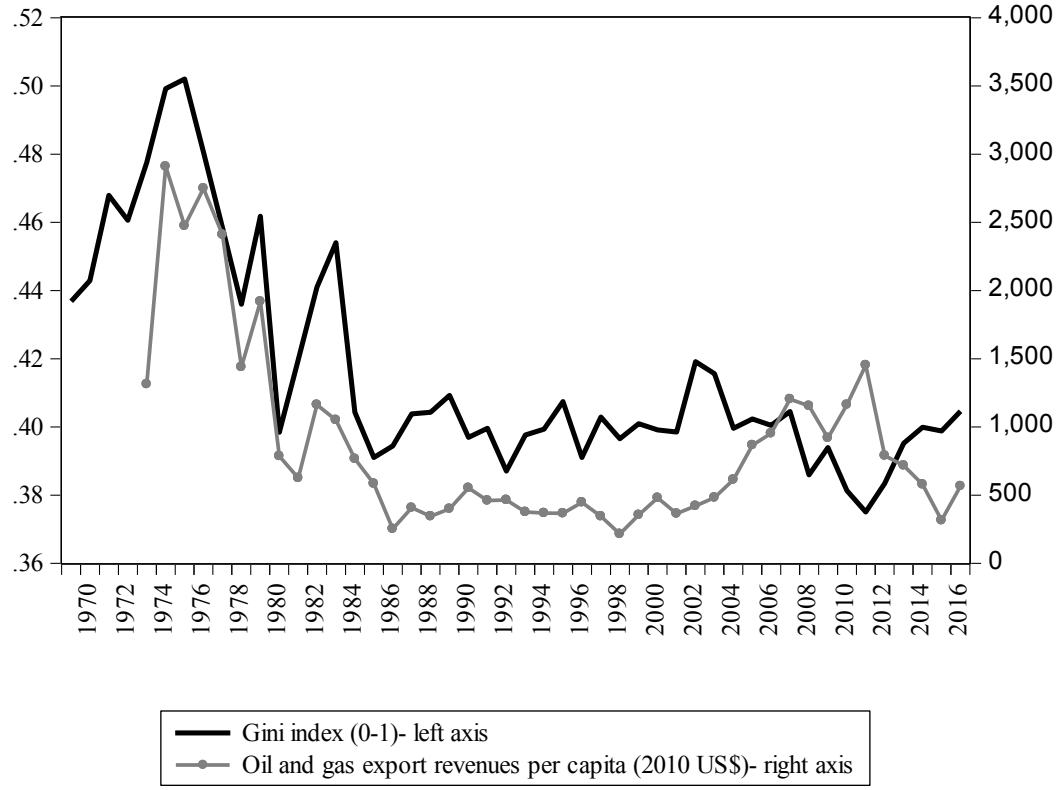
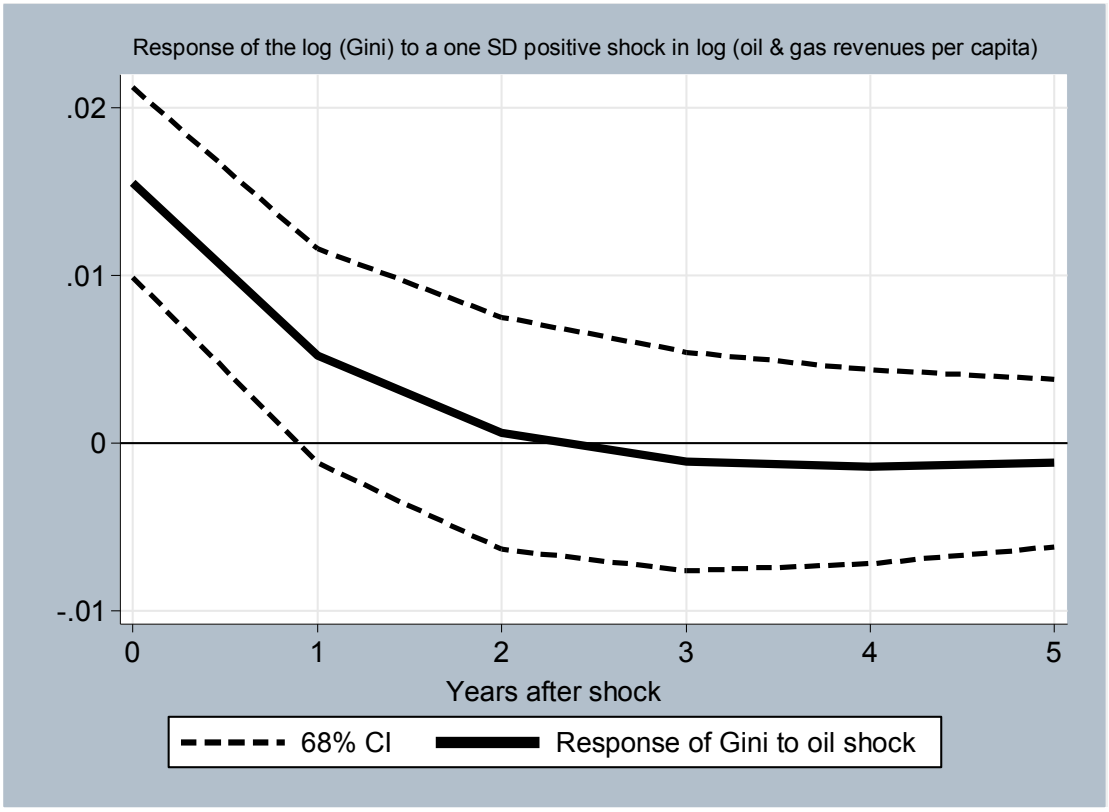
Figure 1. Co-movement of oil and gas export revenues per capita and income inequality in Iran



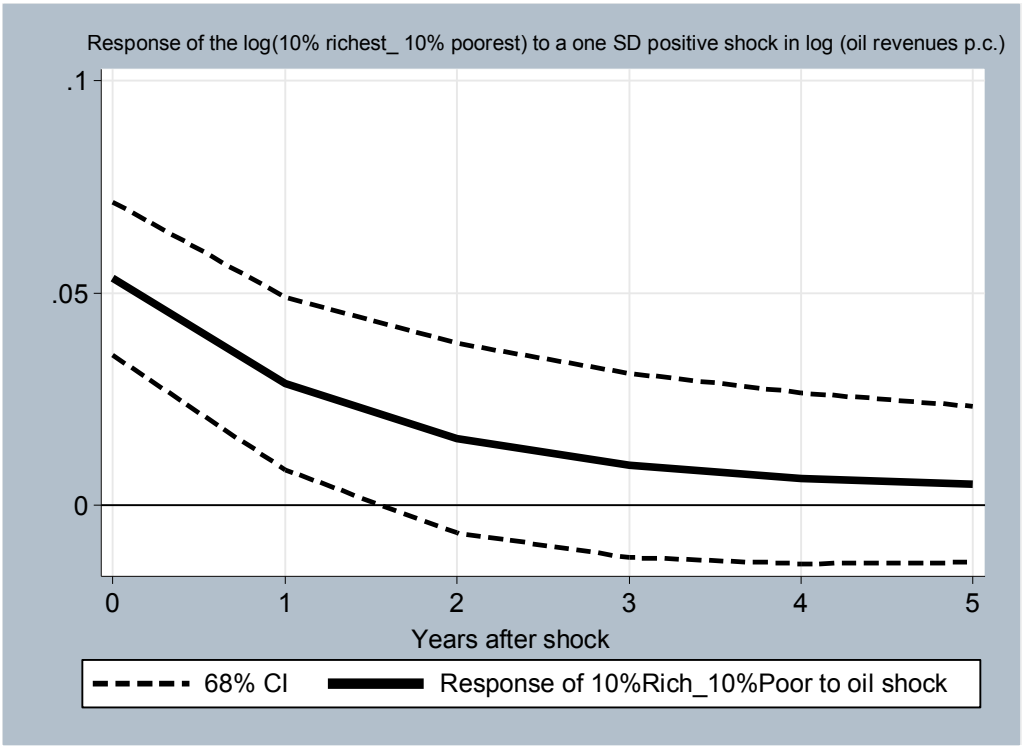
Source: CBI (2018) and own calculation. The nominal oil and gas export revenues (US$) are adjusted for inflation using consumer price index of the US (2010=100) from the World Bank (2018).

Figure 2. Response of the log of Gini to a positive shock in the log of oil and gas revenues per capita



Note: The graph shows the impulse responses of income inequality (log of Gini) to a one-standard-deviation shock in the log of oil and gas export revenues per capita. One SD of the log of oil and gas export revenues per capita (2010 US$) in our sample is 0.66 (minimum of 5.36 and maximum of 7.97). Dummy variable for Iran-Iraq war (1980-88) included. The dotted lines represent ±1 standard deviation (68% CI). The deviation from the baseline scenario without 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 3. Response of the gap between the 10% richest and the 10% poorest to a positive shock in oil revenues per capita



Note: The graph shows the impulse responses of the income gap between the richest and the poorest Iranians (in logs) to a one-standard-deviation shock in the log of oil and gas export revenues per capita. One SD of the log of oil and gas export revenues per capita (2010$) in our sample is 0.66 (minimum of 5.36 and maximum of 7.97). Dummy variable for Iran-Iraq war (1980-88) included. The dotted lines represent ±1 standard deviation (68% CI). The deviation from the baseline scenario without 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 1. Stability of the VAR model

Roots of Characteristic Polynomial
Endogenous variables: log_oil revenues per capita; log_tax revenues per capita; log_GDP per capita; Polity; log_Gini

Exogenous variables: Constant; war dummy (1980-1988)
Lag specification: 1 1

Root	Modulus
0.880066	0.880066
0.82371	0.82371
0.607202 - 0.065292i	0.610703
0.607202 + 0.065292i	0.610703
0.246574	0.246574

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 2. Autocorrelation LM Test

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order 3
Sample: 1959 2016
Included observations: 43

Lags	LM-Stat	Prob
1	29.22	0.25
2	22.63	0.60
3	34.19	0.10

Probs from chi-square with 25 df.

Table 3. Variance decomposition of the log of the Gini index for the first 20 years after the shock

Period	log (oil revenues per capita)	log (tax revenues per capita)	log (GDP per capita)	Polity	log (Gini)
1	16.02	0.00	16.86	13.68	53.44
5	8.51	0.08	34.32	8.11	48.98
10	7.84	0.11	35.95	9.74	46.36
15	7.76	0.13	35.92	10.22	45.97
20	7.75	0.14	35.90	10.29	45.92

Table 4. Variance decomposition of the ratio of expenditures of the 10th decile to the 1st decile

Period	log (oil revenues per capita)	log (tax revenues per capita)	log (GDP per capita)	Polity	log (rich10%_poor10%)
1	18.27	0.09	10.53	17.96	53.15
5	11.86	0.25	25.31	10.44	52.13
10	10.41	0.23	27.66	11.85	49.85
15	10.17	0.23	27.76	12.71	49.14
20	10.12	0.22	27.75	12.93	48.97