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Abstract

We study the short and long run responses of income inequality to positive per capita oil and gas rent shocks in Iran. Using historical data from 1973 to 2012 and vector autoregression (VAR)-based impulse response functions, we find a positive and statistically significant response of income inequality to oil rent booms within 4 years of the shock. In addition, the Autoregressive-Distributed Lag (ARDL) results show that in the long run, a 10-percent increase in oil and gas rents per capita leads to an approximately 1.4-percent increase in income inequality. The results are robust to controlling for different channels potentially affecting the income distribution in Iran. 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 rents; inequality; VAR; ARDL; sanctions; Iran

1. Introduction

We study how the income gap between the rich and the poor in Iran may be affected by oil and gas rents, 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*.[1]

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 host 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.[2] 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 ceased cooperation.[3]

Lifting these sanctions allows Iran to re-enter the global economy as a full-fledged member, 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.[4] Reconnection to international banking and access to the worldwide transaction network SWIFT is likely to increase foreign exchange revenues. Already, Iran has access to approximately 100 billion euros in assets previously frozen under

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

[2] In 2017, Donald Trump 'decertifies' 2015 Nuclear Agreement with Iran, shifting the final decision to the US Congress: http://www.aljazeera.com/news/2017/10/iran-nuclear-deal-donald-trump-decertifies-2015-pact-171012101055479.html

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

[4] 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).

the international sanctions.[5] The IMF (2015: 82) represents an additional source of possible benefits to the country by enabling 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); third, a wealth effect through restored access to foreign assets and higher oil exports. The IMF (2015: 82) predicts that "*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 political repercussions that could turn out to be highly problematic. In our paper, we take a closer look at the development of the income gap between the rich and the poor in Iran. Based on relative deprivation theory[6], 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.

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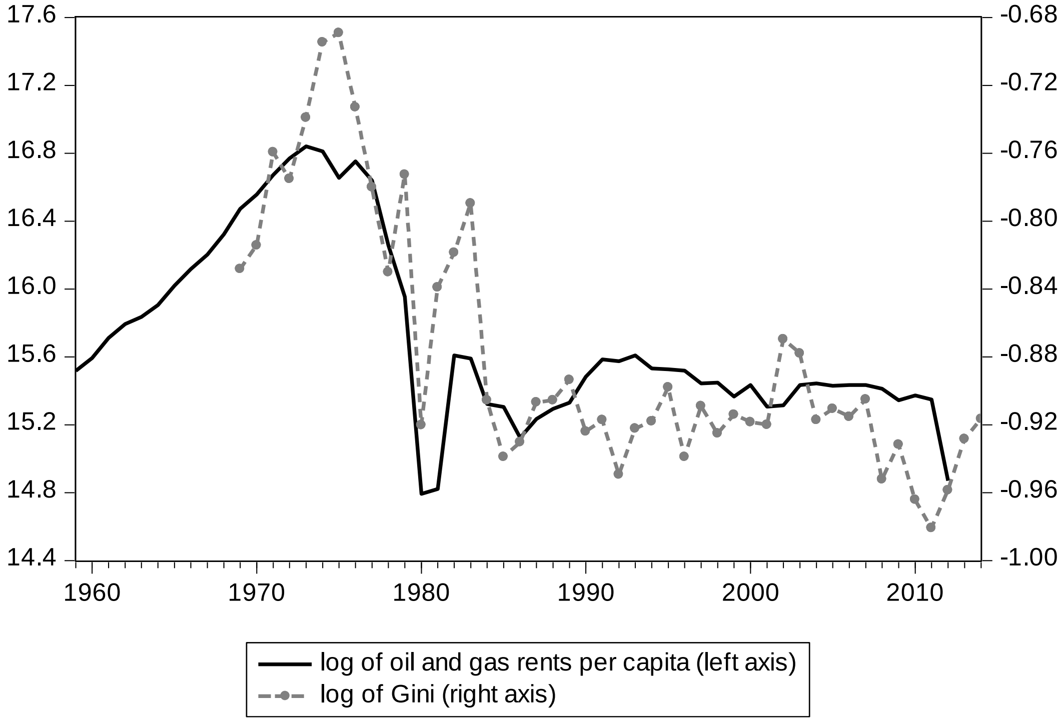
[5] http://www.euronews.com/2016/02/01/swift-return-to-international-bank-transfers-for-iran-s-banks/.

[6] 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).

Figure 1 shows the association between the Gini index (a higher index indicates more income inequality) and per capita oil and gas rents (both in log) in Iran. There is a strong correlation (0.83) between these two key variables, which is also statistically significant at 1% level. [7]

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



Source: CBI (2017) and own calculation

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 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 a derivation of our hypotheses in Section 2, we turn to methodological and data issues in Section

[7] The updated data on Gini index by the Iran's Central Bank shows an increase from 0.38 in 2012 (the peak of oil and banking sanctions) to 0.40 in 2016 over the period of sanctions removal.

3. Section 4 presents our empirical findings, followed by a discussion of these results and some concluding remarks in Section 5.

2. A review of the literature

As our introduction showed, 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. In the following, 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.

At first glance, lifting sanctions should not overly affect – perceived or actual (i.e., measured)[8] – income inequality in Iran. If we expect a growth dividend to occur from regaining access to the world market, and if the domestic macroeconomic policy response is appropriate to achieve national economic policy goals (such as low inflation, steady growth and a competitive exchange rate), we may expect economic benefits across all groups in society, i.e., *inclusive* growth (IMF, 2015: 83). Even if the oil-producing sector is the forerunner in terms of experiencing additional rents, we may expect broad benefits for all of society. This can happen in two ways: eventual trickle-down effects (for instance, through oil workers' additional demand for commodities from other sectors), or an intersectoral movement 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, thereby offsetting any initial rise in income inequality.

Economic theory shows, however, that reality is typically not so simple. As a resource-rich country, Iran 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

[8] The distinction between perceived and measured inequality has recently attracted some attention in the literature, see, e.g., Gimpelson and Treisman (2015). In our analysis, we will refer to measured or actual inequality as we rely on official statistics rather than on survey data.

likely subsequent rise in oil prices – may trigger a sharp rise in oil exports, just as hoped for by the Iranian government. This would cause an appreciation of local currency which in turn would harm the competitiveness of other tradable 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 is 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.

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, of whom many are not known for having particularly sound institutions. Rather, these countries suffer from weak institutions[9] which originate from, e.g., earlier colonization policies following the model of "extractive states"[10] (Acemoglu et al., 2001). Even in countries without a colonial history (such as Iran) we may observe corruption,[11] 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

[9] The catch-all-phrase "weak institutions" includes, among others, 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).

[10] 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).

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

resource abundance, as Mehlum et al. (2006) show.[12] Often, weak institutional settings in a country correlate with high levels of inequality (Krieger and Meierrieks, 2016b).

Acemoglu et al. (2005) and Acemoglu and Robinson (2006) provide convincing explanations for this observation. 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,[13] 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 sector accumulated economic and political clout in the past and remain in prominent positions today. Thus, any new and sudden rents 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.[14]

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[12] Interestingly, Mehlum et al. (2006) 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 an important driver of weak development, Sachs and Warner argue instead that Dutch-disease effects are responsible.

[13] 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).

[14] 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).

While 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 – 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 rents, however, this argument may prove less convincing to the population, and inequality, especially in terms of relative deprivation, may be felt more directly. Inequality, in turn, has been shown to induce frustration and anger, which provokes an aggressive response to vent such frustration (e.g., Muller and Weede, 1994). Gurr (1970) calls this relationship the "frustration-aggression mechanism".[15]

As shown by 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, political violence such as crime (e.g., Kawachi et al., 1999; Wilkinson and Pickett, 2007), support for revolutions (MacCulloch, 2005), riots (e.g., Chandra and Williams Foster, 2005), terrorism (e.g., Krieger and Meierrieks, 2016a; Piazza, 2006) as well as civil wars and rebellions (e.g., Gurr, 1970; Muller and Weede, 1994).[16]

Whether or not such negative effects occur in Iranian society depends primarily on whether increasing oil rents after lifting sanctions do in fact lead to higher inequality. As stated above, according to Bhattacharyya and Williamson (2016) there is little empirical literature on this issue so far, and it is the primary goal of our analysis to provide additional new insights into the distributional effects of a sudden increase of oil rents in a specific oil-rich country,

[15] 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."

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

namely Iran. Let us summarize the existing empirical findings on the nexus between resource rents and income inequality in the following. Overall, this literature provides mixed results.

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 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.

These results cannot be confirmed in other contexts, however. Davis and Vásquez Cordano (2013) use income growth data by quintile in 57 developed and developing countries. They do not find evidence for either positive or 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*.

Quite the opposite is observed in Kazakhstan in a study by Howie and Atakhanova (2014). They examine the effect of resource booms on income inequality 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 the results 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-traded sector in 90 countries between 1965 and 1999 and find that inequality *falls in the short term* 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 attainments and improved health condition following oil booms.

Positive shocks in oil rents and their possible effects on income inequality can be better understood by examining the different rent distribution policies. Farzanegan and Habibpour (2017), while presenting a review of related literature on oil rents distribution policies and inequality nexus, investigate how income inequality and poverty at the household level respond to different distributional policies of 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 tax 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 rich classes of society and the disadvantaged poor ones.[17]

3. Data and Methodology

3.1 Data

To measure income inequality, we use the Gini index[18] (ranging from 0 to 1, with higher values indicating higher income inequality) from the Annual Household Income and Expenditure Surveys from the Central Bank of Iran. As an alternative to the Gini index, we also employ the ratio of expenditures of the 10th decile to that of the 1st decile, indicating the intensity and the dynamic of the income gap between the rich and the poor.

We use the logarithm of the value added of different oil products (crude petroleum, gas, and refined products) in constant prices divided by total population as a proxy for oil and gas

[17] 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 retribution in Iran during 1980s and 1990s see Assadzadeh and Paul (2004).

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

rents per capita. The value added of oil is the difference between the output value of the oil groups and their intermediate consumption. This data is available from the Iran Annual National Accounts published by the Central Bank.[19] Farzanegan (2011) and Dizaji et al. (2016) use this variable as a proxy for oil rents in their case studies of Iran. As argued by Ross (2012), the value of oil production (in our case we also subtract production costs) is a better proxy for the size of oil rents than measures such as oil exports, which do not take into account the value of domestically consumed oil products. Ignoring this consumption would be problematic, as there is a high level of subsidization of domestic consumption of different energy carriers in Iran. In 2007, for example, Iran was the largest fossil-fuel subsidizing country in the world with subsidies amounting to $56 billion per year (Farzanegan and Markwardt, 2012).

Besides oil rents and income inequality, which are our key variables of interests, we also control for important transmission channels potentially running from oil rents to household income. One of these channels relates to government spending. Obviously, higher oil rents may increase state revenues from, e.g., taxing oil firms, thereby allowing the provision of more public goods (including the military) or redistribution to poorer people. Therefore, we control for military and education spending as a share of total government spending. Farzanegan (2014) provides a review of the nexus between economic growth and military spending in Iran, showing that the military budget Granger-causes economic growth. He also shows that the response of income growth to shocks in the military budget is positive and statistically significant in Iran. However, unlike education expenditure, military spending may not benefit the majority of population (Dizaji et al, 2016). Government spending on education can provide educational coverage and build up an educational infrastructure, thus contributing to human

[19] http://www.cbi.ir/simplelist/5796.aspx.

capital formation. The latter is critical to increasing the skills of the labor force and reducing the income gap between high and low skilled labor.[20]

We also control for the share of tax revenues in total government revenues, which is another channel of redistributing oil rents across society. The overall state of economic development, measured by the logarithm of real GDP per capita, is also controlled for in our estimations.[21] Our analysis period 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). We control for different forms of political instabilities and conflicts by using the logarithm of a weighted measure of conflict drawn from the Cross-National Time-Series Data Archive (CNTS) of Databanks International (Banks and Wilson, 2015). The conflict measure covers assassinations, strikes, guerrilla warfare, government crises, purges, riots, revolutions, and anti-government demonstrations. Finally, the 8-year war with Iraq is controlled for by using a dummy variable equaling one for 1980-1988. Except for the conflict measure, all other variables are taken from Central Bank of Iran database (CBI, 2017).

3.2 The unrestricted VAR model

We use the *unrestricted VAR model* to estimate the interconnections between our main variables, oil rents 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

[20] We acknowledge that higher education spending by government might not automatically lead to higher job market relevant skills. The latter depends on the quality of education system. In a cross country analysis, Farzanegan and Thum (2017) show that oil rents dependency is negatively and significantly associated with quality of education at primary and lower secondary levels.

[21] 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).

macroeconomic indicators (industrial production, imports, inflation, the real effective exchange rate, and government spending behavior) in Iran after oil shocks.

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 rents):

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

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 are uncorrelated both with their own lagged values and with all of the right-hand side variables. The optimum lag of one year is based on the Schwarz information (SC) and the Hannan-Quinn information (HQ) criterion (see Table A1 in Appendix A). All main variables are endogenous in our VAR framework.

We use the following variables in our VAR system: the logarithm of oil and gas rents per capita, military spending as a percentage of total government spending, education spending as a percentage of total government spending, tax revenues as a percentage of total government revenues, the logarithm of real GDP per capita, the logarithm of the Gini index, and the logarithm of a weighted measure of conflict. We control for Iran's 8-year war with Iraq (1980-1988) and include a constant term (exogenous variables).

The ADF test (Dickey and Fuller, 1979) and Phillips-Perron test (Phillips and Perron, 1988) show that all of the endogenous variables (except for the conflict data) are integrated of first order (I(1)). In addition, the Zivot-Andrews unit root test (Zivot and Andrews, 1992), which controls for possible breaks in data, shows that all of our variables are either I(1) or I(0). 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 results (available upon request) show that there is at least one cointegrated relationship among our variables. 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), Farzanegan and Raeisian Parvari (2014), and Dizaji et al. (2016) and apply the unrestricted VAR model in the level of variables. After all, we are interested in applying tools such as impulse-response analysis rather than aiming at interpreting each coefficient of the VAR model.

To trace back the response of income inequality in Iran to positive shocks to oil and gas rents per capita, we apply the generalized impulse-response function (IRF) on the basis of our estimated unrestricted VAR model. The IRF shows the direction, size, and statistical significance of responses following an initial shock to oil rents. Before investigating the IRF, 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 in 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 LM test which reports the multivariate LM test statistics for residual serial correlation up to a specified order (up to 4 years in our case). The test statistic for lag order $h = 4$ 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 estimated VAR model is also immune against serial correlation in residuals up to the order of 4 years.

Table 1. Stability of the VAR model

Root	Modulus
Roots of the Characteristic Polynomial	
Endogenous variables: oil rents per capita; military spending; education spending; taxation; GDP per capita; GINI; conflict	
Exogenous variables: constant; Iran-Iraq war dummy (1980-88)	
Lag specification: 1 1	
Root	**Modulus**
0.959671	0.960
0.901557	0.902
0.533507 - 0.173379i	0.561
0.533507 + 0.173379i	0.561
0.340821	0.341
0.098056	0.098
0.002762	0.003
No root lies outside of the unit circle.	
VAR satisfies the stability condition.	

Table 2. Autocorrelation LM Test

Lags	LM-Stat.	Prob.
VAR Residual Serial Correlation LM Tests		
Null Hypothesis: no serial correlation at lag order *h*		
Sample: 1959-2014		
Included observations: 42		
Lags	**LM-Stat.**	**Prob.**
1	63.841	0.076
2	54.703	0.267
3	48.872	0.478
4	50.535	0.413
Probs. from chi-square with 49 degrees of freedom		

Another issue in VAR modelling and the subsequent IRF analysis is the ordering of variables in the VAR system. The first variable in the ordering is the most exogenous one that instantly affects other variables in the system, but gets affected by them with some time lag. The last variable in the ordering is the most endogenous variable. At best, economic theory should guide us in selecting the ordering of variables. When theory is not conclusive about the ordering, we need to show that the IRF results are at least robust to different orderings of variables.[22] For this reason, we use the generalized impulse response[23] introduced by Pesaran and Shin (1998) and report in the following section the derived confidence bands at the 95 percent confidence intervals for impulse responses.[24]

3.3 The ARDL model

In addition to the VAR estimation, we also apply the *Autoregressive Distributed Lag (ARDL) model* (Pesaran and Shin, 1999). An ARDL is a least squares regression including lags of the dependent and explanatory variables. We use the ARDL method to estimate the long-term response of income inequality to a positive change in oil and gas rents per capita in Iran, controlling for other drivers of inequality. The ARDL model has certain advantages over other cointegration regression models such as Fully Modified OLS or Dynamic OLS. The latter models require either all variables to be I(1), or prior knowledge and specification of which variables are I(0) and which ones are I(1) (IHS, 2016). ARDL eliminates this problem, as it allows the variables in the cointegrated relationship to be either I(0) or I(1) – thus, there is no need to pre-specify which variables are I(0) or I(1). According to Pesaran and Shin (1999), the ARDL also does not require symmetry in lag lengths, so that each variable can have a different number of lag terms.

In summary, we compare both short term results from the VAR models and the long-term response of income inequality to positive changes in oil rents based on ARDL approach.

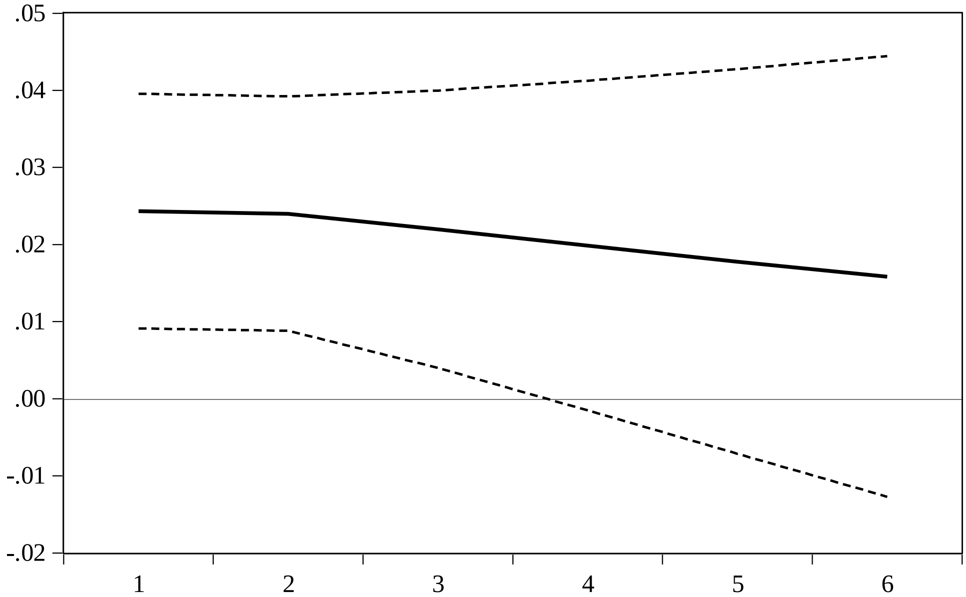
[22] One of the strategies to select the ordering of variables in the VAR system is to use the Granger causality test results (see Farzanegan and Markwardt, 2009, for a similar approach). Table A2 in the Appendix shows the results for the VAR Granger causality / Block exogeneity Wald test.
[23] The generalized IRF constructs an orthogonal set of innovations that does not depend on the VAR ordering.
[24] These intervals are built using 1,000 Monte Carlo simulations.

4. Results

Figure 2 shows the impulse response of income inequality to a positive shock in oil and gas rents per capita. It shows that after an unexpected positive shock to per capita oil and gas rents in Iran, income inequality increases. The increase is statistically significant for the first four years following an initial shock. The peak positive response of income inequality is seen within the first two years after the shock. These results are obtained by controlling for other channels connecting oil rents and inequality, such as spending on education and the military, a measure of conflict and political instability, the relative share of tax revenues in the government budget, GDP per capita, and the war with Iraq.

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 Holder (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 results 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.

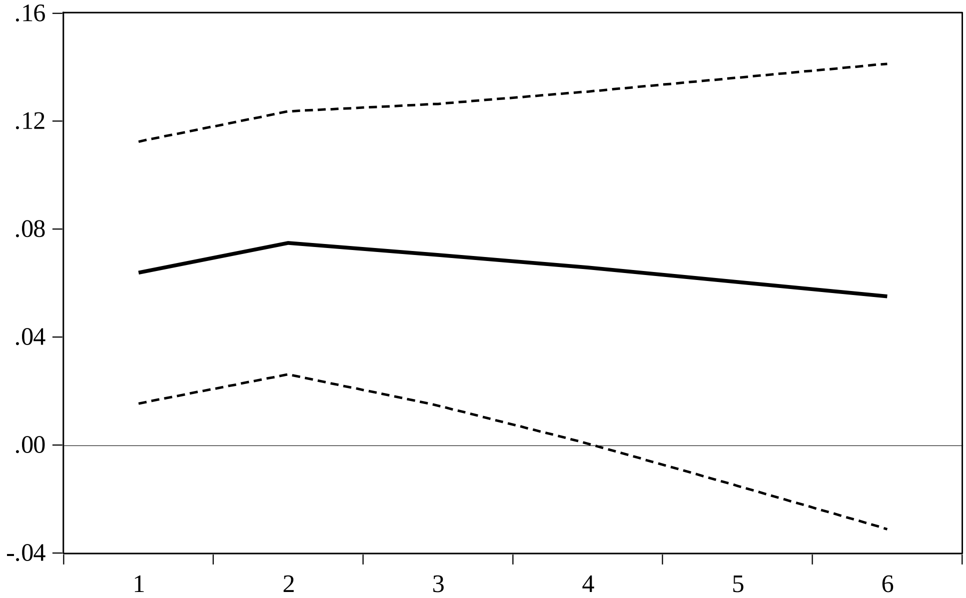
Figure 2. Response of inequality to a shock in oil and gas rents per capita



Note: The graph shows the generalized impulse responses of income inequality (log of GINI) to a one-standard-deviation shock in the log of oil and gas rents per capita. One SD of the log of oil and gas rents per capita in our sample is 0.53 (minimum of 14.79 and maximum of 16.84). Dummy variable for Iran-Iraq war (1980-88) is included. The dotted lines represent ±2 standard deviations (95% CI). 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 3 shows the response of the ratio of expenditures of the 10th decile to the 1st decile (i.e., the gap between the rich and the poor) to a positive shock in oil and gas rents per capita. This simulation is based on a VAR model with optimal lag length of one year, controlling for the same variables as in the case of Figure 2. Both stability and residual serial autocorrelation tests are satisfactory. The figure reconfirms the previous findings (Figure 2). The income gap between the richest 10 percent and the poorest 10 percent increases after an unexpected positive shock to per capita oil rents in Iran. It reaches its peak in the second year after the shock and remains statistically significant for the first 4 years following the initial oil rents shock.

Figure 3. Response of the gap between the rich and the poor to a shock in oil and gas rents per capita



Note: The graph shows the generalized impulse responses of income gap between the richest and the poorest (in log) to a one-standard-deviation shock in the log of oil and gas rents per capita. One SD of the log of oil and gas rents per capita in our sample is 0.53 (minimum of 14.79 and maximum of 16.84). Dummy variable for Iran-Iraq war (1980-88) is included. The dotted lines represent ±2 standard deviations (95% CI). 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.

How much of the variance in income inequality (measured by the Gini index) is explained by shocks in oil and gas rents per capita, and how much is explained by shocks to other variables? The variance decomposition (VDC) results in Table 3 show the variance of income inequality from each source of shock. 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 approximately 50 percent of the changes in income inequality are explained by its own past lags. The shocks to oil and gas rents explain about 30 percent of the variance of inequality in the first year following the shock. The relative importance of oil rent shocks in explaining the fluctuation of income inequality increases constantly over the time, reaching its maximum of 45 percent in the 6th year after the initial shock.

Table 3. Variance decomposition of GINI index

Period	oil and gas rents per capita	conflict	military spending	tax revenues	GDP per capita	education spending	Gini
1	31	5	3	2	0	6	53
2	38	8	2	2	0	9	41
3	41	8	2	1	0	11	36
4	43	8	2	1	1	13	32
5	44	8	3	1	1	14	29
6	45	8	3	1	2	14	28
7	45	7	3	1	2	15	26
8	45	7	4	1	3	15	25
9	45	7	4	1	3	15	24
10	45	7	4	1	4	16	24

Cholesky Ordering: oil and gas rents per capita; conflict; military spending; tax revenues; GDP per capita; education spending; Gini index

The next important variable in explaining the variance of inequality is the share of government spending on education in total government spending. It explains about 15 percent of the inequality fluctuations in the medium and long term. Finally, the conflict and instability measures explain approximately 7 percent of the variation of inequality in Iran.

Let us now analyze the long run response of inequality to a positive change in oil and gas rents per capita, controlling for the aforementioned variables. As explained above, we use the ARDL approach which is particularly useful for this purpose. It explains income inequality in terms of past values of inequality, as well as the current and past values of other variables in the model, including oil and gas rents per capita. We set the maximum number of lags for the dependent (Gini) and independent variables to 4. The lag length (which can be different for each variable in ARDL) that minimizes the model's Akaike information criterion (AIC) is selected. We control for the constant term and Iran-Iraq war dummy (1980-88) as fixed regressors in our ARDL specification and report heteroskedasticity- and autocorrelation-consistent (HAC) standard errors. Among 12,500 evaluated models, we select ARDL(2, 4, 2, 3, 3, 1) based on AIC.[25] The effective sample period is 1973-2012.

It is important that the errors of this model are serially independent. Otherwise, the parameter estimates will not be consistent.[26] Table A3 in the Appendix shows correlograms of residuals and the Breusch-Godfrey Serial Correlation LM Test. The results are satisfactory, implying that errors are serially independent and we can use the estimation results for testing the long run relationship between income inequality and oil rents in Iran. In addition, we examine the stability of the ARDL model by using the "Regression Specification Error Test" (RESET test) proposed by Ramsey (1969). Table A4 shows the results of the Ramsey test. The RESET F-statistic has a p-value of 0.62. Therefore, we cannot reject the null hypothesis that the functional form of the ARDL model is correctly specified.

Estimating an ARDL model provides a basis for using the Bounds test, which examines the existence of long run relationship among variables of interest (Pesaran et al., 2001). The null hypothesis under the Bounds Test is that there is no long-run relationship between the variables under consideration. Table A5 in the Appendix shows the results of the Bounds test. We see that the F statistic for the Bounds test is 3.95, which exceeds even the 2.5-percent critical value for the upper bound (3.73). Thus, we can strongly reject the null hypothesis of "no long-run relationship" among the included variables.

Finally, we estimate the long-run response of income inequality to a positive change in oil and gas rents and other variables, controlling for the 8-year war with Iraq. The results are shown in Table 4. We can see that a 10-percent change in the oil and gas rents per capita result in a long-run change of approximately 1.4 percent in income inequality as measured by the Gini index. This long-run effect is statistically significant at the 1% level. This thus confirms our

[25] We can also see how well some of the other specifications perform in terms of minimizing AIC. See Figure A1 in Appendix A.

[26] Inclusion of conflict variable in the ARDL specification leads to rejection of null hypothesis of no serial correlation in estimation residuals. Therefore, we re-specified the model by excluding it before using ARDL model for hypothesis tests.

earlier findings from the VAR model. In addition to oil rents, government spending on education (as a percentage of total government spending) has a decreasing long-run effect on income inequality in Iran.

Table 4. Long run response of income inequality to positive changes in oil rents; ARDL results

	Dep. Variable: log (Gini)			
Variable	Coefficient	Robust Std. Error	t-Statistic	Prob.
log (oil and gas rents per capita)	0.135***	0.022	6.18	0.00
military spending (% government spending)	-0.001	0.002	-0.79	0.43
tax revenues (% of government revenues)	0.002	0.002	1.05	0.30
log (GDP per capita)	-0.035	0.060	-0.59	0.56
education spending (% of government spending)	-0.008**	0.004	-2.16	0.04
constant	-2.606	0.589	-4.42	0.00

***, ** indicate statistical significance at 1% and 5 % levels, respectively. Iran-Iraq war dummy is controlled.

5. Conclusion

Iran is set to become a full-fledged member of the global economy again, after most of the sanctions related to the country's nuclear weapons program have been lifted. Our paper simulates the effect of the end of sanctions, and the expected subsequent rise of income and wealth from oil rents, on income inequality. More specifically, we study the short- and long-run responses of income inequality to a positive change in oil and gas rents per capita from 1973 to 2012 in Iran.

We find that oil booms have repeatedly worsened the income distribution in Iran, i.e., incomes became more unequally distributed once additional rents 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 rent shocks is positive for the first 4 years following a shock, and is statistically significant at a 95-percent confidence level.

Additionally, we show that approximately 45 percent of the variance of inequality is explained by shocks to per capita oil and gas rents in Iran in the middle and long run. The ARDL estimations indicate a significant long run response of income inequality to a positive change in oil rents per capita. A 10-percent increase in oil and gas rents per capita leads to an approximately 1.4-percent increase in income inequality. Our results are robust to controlling for other possible channels affecting the income distribution in Iran, such as government spending on education and the military, income per capita, a measure of conflict, the share of tax revenues in the government budget, and a dummy variable for the 8-year war with Iraq.

Our predictions augur significant threats to the Middle East region. As the oil boom is likely to result in increasing inequality caused by, e.g., elite-domination in the distribution of new oil income, and as Iran is prone to inequality-induced conflict, there is a real danger of internal conflict in Iran, which may then spread to other countries in the region. The significant increase of income inequality prior to the 1979 Islamic Revolution is a tangible example of such a threat. 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 accommodate the increase of inequality. Redistributive policies toward rural regions or across ethnic lines could be one strategy to avoid future conflict (see Farzanegan et al. 2017 for supportive arguments). Whether an elite-dominated government is likely to choose this strategy is a different matter. Any country interested in peaceful development in the Middle East should at least keep an eye on the development of inequality in Iran.

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Appendix A

Table A1. VAR Lag Order Selection Criteria for the VAR model

Endogenous variables: oil and gas rents per capita; conflict; military spending; tax revenues; GDP per capita; education spending; income inequality

Exogenous variables: constant; war dummy

Sample: 1959 2014

Included observations: 41

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-416.2059	NA	3.06809	20.98565	21.57077	21.19872
1	-276.6304	217.8739	0.038892	16.56734	19.20039*	17.52615*
2	-215.8739	74.09326*	0.028284*	15.99385*	20.67483	17.6984

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Table A2. VAR Granger Causality/Block Exogeneity Wald Tests

Sample: 1959 2014

Included observations: 42

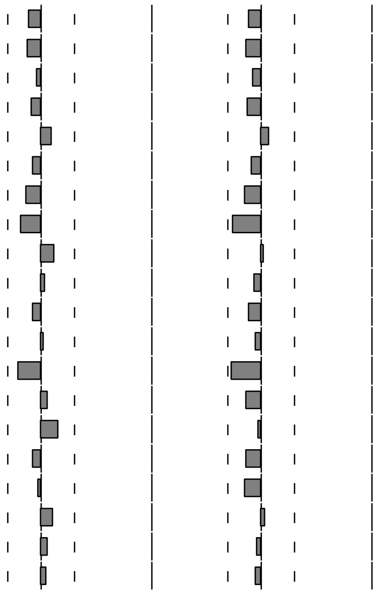
Dependent variable: oil and gas rents per capita				*Dependent variable: conflict*			
Excluded	Chi-sq	d	Prob	Excluded	Chi-sq	d	Prob
conflict	0.01	1	0.92	oil and gas rents per capita	1.68	1	0.19
military spending	0.51	1	0.47	military spending	0.02	1	0.90
tax revenues	1.40	1	0.24	tax revenues	0.22	1	0.64
GDP per capita	2.90	1	0.09	GDP per capita	8.87	1	0.00
education spending	2.01	1	0.16	education spending	2.67	1	0.10
GINI	2.43	1	0.12	GINI	0.79	1	0.37
All	13.96	6	0.03	All	12.63	6	0.05
Dependent variable: military spending				*Dependent variable: tax revenues*			
Excluded	Chi-sq	d	Prob	Excluded	Chi-sq	d	Prob
oil and gas rents per capita	5.48	1	0.02	oil and gas rents per capita	0.02	1	0.89
conflict	2.07	1	0.15	conflict	0.18	1	0.67
tax revenues	0.14	1	0.71	military spending	2.32	1	0.13
GDP per capita	5.46	1	0.02	GDP per capita	0.83	1	0.36
education spending	0.11	1	0.74	education spending	0.93	1	0.33
GINI	3.10	1	0.08	GINI	5.04	1	0.02
All	12.14	6	0.06	All	11.46	6	0.08

Dependent variable: GDP per capita				*Dependent variable: education spending*			
Excluded	Chi-sq	d	Prob	Excluded	Chi-sq	d	Prob
oil and gas rents per capita	4.94	1	0.03	oil and gas rents per capita	0.92	1	0.34
conflict	0.02	1	0.89	conflict	2.31	1	0.13
military spending	0.24	1	0.63	military spending	0.00	1	0.94
tax revenues	2.36	1	0.12	tax revenues	0.14	1	0.71
education spending	0.95	1	0.33	GDP per capita	1.16	1	0.28
GINI	5.28	1	0.02	GINI	0.22	1	0.64
All	10.48	6	0.11	All	5.31	6	0.51
Dependent variable: GINI							
Excluded	Chi-sq	d	Prob				
oil and gas rents per capita	1.83	1	0.18				
conflict	0.52	1	0.47				
military spending	0.05	1	0.82				
tax revenues	0.00	1	0.99				
GDP per capita	1.20	1	0.27				
education spending	1.14	1	0.29				
All	3.73	6	0.71				

Table A3. Correlogram of residuals of estimated ARDL

Sample: 1959 2014
Included observations: 40
Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation | Partial Correlation



	AC	PAC	Q-Stat	Prob*
1	-0.109	-0.109	0.5087	0.476
2	-0.126	-0.139	1.2088	0.546
3	-0.034	-0.067	1.2613	0.738
4	-0.090	-0.125	1.6432	0.801
5	0.105	0.066	2.1771	0.824
6	-0.071	-0.086	2.4269	0.877
7	-0.135	-0.150	3.3613	0.850
8	-0.181	-0.264	5.0805	0.749
9	0.128	0.029	5.9681	0.743
10	0.035	-0.059	6.0378	0.812
11	-0.076	-0.118	6.3751	0.847
12	0.029	-0.044	6.4272	0.893
13	-0.220	-0.276	9.4380	0.739
14	0.062	-0.145	9.6845	0.785
15	0.167	-0.017	11.551	0.713
16	-0.066	-0.146	11.860	0.754
17	-0.031	-0.150	11.930	0.804
18	0.122	0.035	13.060	0.788
19	0.063	-0.036	13.377	0.819
20	0.044	-0.047	13.542	0.853

*Probabilities may not be valid for this equation specification.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.55	Prob. F(2,16)	0.58
Obs*R-squared	2.57	Prob. Chi-Square(2)	0.27

Null hypothesis: no serial correlation in residuals of estimated ARDL

Table A4. Ramsey Stability Test

Null hypothesis: functional form of the model is correctly specified

	Value	df	Probability
t-statistic	0.49	17	0.62
F-statistic	0.24	(1, 17)	0.62

Table A5. Bounds Test

Null hypothesis: no long run relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.95	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Figure A1. ARDL model selection summary