# Identifying the Effects of Sanctions on the Iranian Economy using Newspaper Coverage*

Dario Laudati

University of Southern California, USA

M. Hashem Pesaran

University of Southern California, USA, and Trinity College, Cambridge, UK

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**Abstract**

This paper focuses on the identification and quantitative estimation of sanctions on the Iranian economy over the period 1989–2019. It provides a new time series approach and proposes a novel measure of sanctions intensity based on daily newspaper coverage. In absence of sanctions, Iran's average annual growth could have been around 4-5 per cent, as compared to the 3 per cent realized. Estimates of the proposed sanctions-augmented structural VAR show that sanctions significantly decrease oil export revenues, result in substantial depreciation of Iranian rial, followed by subsequent increases in inflation and falls in output growth. Keeping other shocks fixed, two years of sanctions can explain up to 60 per cent of output growth forecast error variance, although a single quarter sanction shock proves to have quantitatively small effects.

**Keywords**: Measures of sanction intensity, direct and indirect effects of sanctions, sanctions-augmented structural VAR, impulse responses, forecast error variance decompositions.
**JEL Classifications**: C32, E31, E65, F43, F51, O11, O53

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# 1 Introduction

Over the past forty years Iran has been subject to varying degrees of economic and financial sanctions, and asset freezes, which began in November 1979 when the U.S. placed an embargo on Iranian oil trade and froze $12 billion of Iranian assets held outside Iran with the aim of securing the release of U.S. hostages. Although this particular sanction episode was successfully negotiated in January 1981, U.S. policy towards Iran became increasingly entrenched, aimed at curtailing the economic and political influence of Iran in the Middle East region and beyond; a process which escalated over Iran's nuclear program. As a result, the Iranian economy has been operating for a prolonged period under severe and often quite harsh international restrictions, perhaps unique for a sizeable economy with deep historical roots in the global economy. Given the uncertainty and durability of sanction regimes, it is also important to bear in mind that, besides the direct effects of sanctions (arising from loss of oil export revenues, loss of access to currency reserves and other trade-related losses), sanctions also result in important and lasting indirect effects, such as rent-seeking, resource allocation distortions, and general costs associated with efforts involved in mitigating and circumventing the sanctions regimes. These indirect effects are likely to be more serious the longer the sanctions are in place, particularly when the prospect of a sanctions free outcome seems very remote.

The focus of this paper is on the identification and quantitative evaluation of the direct and indirect effects of sanctions on the Iranian economy over the period 1989–2019, which intentionally excludes the period 1979–1988 due to the special circumstances of the 1979 Revolution, the hostage crises and the ensuing eight year war with Iraq, which ended in August 1988, as well as the post 2019 period to avoid the confounding effects of the Covid-19 pandemic. We are primarily concerned with economic rather than international political dimensions of the sanctions, and will not be addressing the issue of the efficacy of sanctions in achieving their political aims.[1]

Sanctions against Iran span a period of more than four decades over which the degree of sanctions intensity has varied considerably. There are no clear "sanctions on" and sanctions off" periods, required for application of comparative approaches used in the literature for policy evaluations, such as the synthetic control method (SCM) proposed by Abadie and Gardeazabal (2003), and the panel data approach proposed by Hsiao et al. (2012). These techniques require pre-policy intervention outcomes to estimate weighted averages of post

[1] The effectiveness of sanctions in achieving foreign policy goals has been studied extensively in the literature. Hufbauer et al. (1990) examine 116 case studies covering the period from the economic blockade of Germany during World War I through the U.N.-U.S. embargo of Iraq in 1990. Further overviews are provided in Morgan et al. (2014).and Doxey (1996). Critical assessments of sanctions as a policy tool are provided by Weiss et al. (1997), Pape (1997, 1998), Andreas (2005), and Peksen and Drury (2010). These studies highlight possible counterproductive effects of economic sanctions. Naghavi and Pignataro (2015) provide a game-theoretic analysis of sanctions and its application to Iran.

policy outcomes for a "pre-selected" control group to be used as the basis of comparisons. It is also unclear which countries should be included in the control group given the continued importance of the Iranian economy in the Middle East region.

In this paper we propose a time series approach that takes account of variations in sanctions intensity over the past forty years, without requiring an arbitrary classification of the time periods into sanctions on and sanctions off periods. To this end, we construct a time series index of sanctions intensity based on daily newspaper coverage of the sanctions, their imposition, the intensity of their use, as well as their occasional removal. Given the absence of clear "sanctions off" periods, it follows also that simple (0,1) dummy variables may not be sufficient to capture the rich variations in sanctions intensity that are observed over the past forty years.[2]

The idea of a newspaper coverage index was developed by Baker et al. (2016) for measurement of economic uncertainty, but to our knowledge it has not been utilized in the analysis of sanctions. As we shall see, the evolution of our proposed sanctions intensity index closely tracks the main sanctions time points.[3] See Figure 1. The sanctions intensity measure also correlates closely with the U.S. Treasury "Specially Designated Nationals and Blocked Persons List" (SDN) for Iran which has been publicly available since 1994, but with usable data on Iran only since 2006.

We augment a structural vector autoregressive (SVAR) model of the Iranian macroeconomy with our sanctions intensity variable to identify short run and long run effects of sanction shocks on oil export revenues, Iran's rial/USD exchange rate, money supply growth, inflation, and output growth, whilst controlling for foreign output growth, and other global factors such as global equity market volatility. We also consider the effects of sanction shocks when sustained over a prolonged period. This is particularly relevant to the case of Iran where government policy responses often have led to large fuel and food subsidies, multiple exchange rates, and lax budgetary and credit policies, which in turn have resulted in economic mismanagement and rent-seeking, and corruption on a large scale.[4] Seen from this more general perspective, in addition to direct (and

[2] To investigate the value added of our proposed measure of sanctions intensity, as suggested by a referee, we also considered dummy variables constructed based on historical narratives, as well as by a discretization of our own newspapers index. In all cases we found our sanction intensity variable performs much better than dummy variable measures in explaining the variations in key macroeconomic variables of the Iranian economy.

[3] The most notable are: the U.S. Iran and Libya Sanctions Act of 1996, the U.S. export ban in 1997, the U.S. investment bans and asset freezes in 2006 and 2007 ("Iran Freedom and Support Act", and Executive Order 13438), the United Nations nuclear Resolutions (1737, 1747) during 2006 and 2007, the U.S. Comprehensive Iran Sanctions, Accountability, and Divestment Act of 2010, the U.S. National Defence Authorization Act of 2012, the partial lifting of U.N. sanctions under the Joint Comprehensive Plan of Action (JCPOA) in 2015 and its subsequent implementation in January 2016, and finally President Trump's unilateral withdrawal from the JCPOA agreement in 2018.

[4] Subsidies on essential food items and energy (fuel as well as electricity) have created inefficiencies, smuggling, and damaging unintended consequences. Subsidies on electricity, for example, have led to excessive ground water withdrawals from electricity-powered irrigation wells, and more recently for mining crypto-currencies, one of the sources of Iran's worsening water shortages, and frequent electricity blackouts.

often immediate) effects of sanctions on oil exports and exchange rates, there are also indirect effects that result from government policy responses, some of which are inevitable as the government tries to come to terms with the adverse effects of the sanction, particularly on the economic conditions of the low income groups on fixed wages and salaries. Whilst we acknowledge such indirect effects of sanctions, it is beyond the scope of the present paper to disentangle the direct and indirect effects of the sanctions. This drawback particularly applies to the long run effects of the sanctions that move beyond the immediate effects on oil exports and exchange rates that are much easier to identify. At the same time, it is true that the Iranian economy would have been subject to distortions and economic mismanagement even in the absence of any sanctions, and it seems unlikely that one could separate sanctions-induced distortions from all other distortions. Therefore, the estimates we present can be viewed as measuring the combined effects of sanctions and sanctions-induced distortions, broadly defined.

We find that the sanctions intensity variable has highly statistically significant effects on oil exports revenues, exchange rates, inflation and output growth, but not on money supply growth. These estimates proved to be robust to alternative specifications and after allowing for a host of control variables. Our results also show that large reductions in oil exports, currency depreciations (with substantial overshooting), and high inflation are important channels through which sanctions affect the real economy. But we do not find monetary expansion to have an independent impact on the real economy, once we control for inflation and exchange rates.

Using impulse response analysis and forecast error variance decomposition, we also find a significant drop in oil exports, followed by an over-reaction of the rial to a positive sanctions shock, with a subsequent rise in inflation and a fall in output shortly after. The economy adapts reasonably quickly to sanction shocks, a property that has also been documented by Esfahani et al. (2013), who consider the effects of oil revenue shocks on output growth and inflation, but do not allow for changes in sanctions environment. Forecast error variance decompositions also show that, despite the inclusion of the sanctions intensity variable in the SVAR, around 80 per cent of variations in foreign exchange and 82 per cent of variations in output growth remain unexplained, and most likely relate to many other latent factors that drive the Iranian economy. These estimates relate to the effects of a single-period sanctions shock as it is standard in the empirical macro literature. The effects of sanctions on the economy become much more pronounced once we consider the effects of shocks that last for a consecutive number of periods. We find that such shock scenarios could explain up to 80 per cent of output growth variations after five years. We also estimate that in the absence of sanctions Iran's output growth on average could have been around 4–5 per cent per annum, as compared to the 3 per cent realized.

Sanctions have also had a number of positive unintended consequences. Interestingly, the Iranian economy at the onset of sanctions was as heavily dependent on oil exports as countries such as Saudi Arabia. Restricting oil exports over a relatively long time period has led to important structural transformations of the Iranian economy, with significant increases in non-oil exports, most notably petrochemicals, light manufacturing products and agricultural goods. In addition, it is likely that U.S. sanctions have been partly responsible for the rapid rise of high-tech and knowledge-based companies in Iran over the past decade.

Overall, there seems little doubt that sanctions have harmed the Iranian economy. But removal of sanctions on their own is unlikely to ensure a period of sustained growth and low and stable inflation, and many policy reforms are needed to address sanctions-induced price distortions as well as other distortions due to general economic mismanagement, poor governance, and the ambiguities that surround the relative roles of semi-government agencies and the private sector in the economy.

**Related literature**

Studies that are more closely related to our paper either consider a specific sub-period or use shocks to oil export revenues as representing a sanction shock. Gharehgozli (2017) considers the effects of sanctions just before the 2015 nuclear agreement, Joint Comprehensive Plan of Action (*JCPOA*), which we discuss in further detail in Section 4 below. Dizaji and van Bergeijk (2013) study the impact of economic sanctions via changes in oil revenues using an unrestricted VAR model. They show that sanctions have adverse output effects in the short-run but their effects fade with time. Similar results are reported by Esfahani et al. (2013), who find that shocks to foreign output and oil exports are rather short-lived for Iran. This is an important feature of the Iranian economy which is also confirmed by our analysis using the new sanctions intensity variable. Farzanegan et al. (2016) develop a Computable General Equilibrium model for Iran and conduct a number of different comparative static exercises, finding large effects of oil sanctions on the macro-economy and households welfare under their perfectly competitive set up.

Haidar (2017) uses micro-data over the period 2006–2011 to find that two-thirds of Iran's sanctioned non-oil exports were redirected to other non-sanctioning countries. It is also found that large exporters appear to be less affected by export sanctions. Popova and Rasoulinezhad (2016) find a similar geographical redirection of Iran's non-oil exports over the period 2006–2013 of trading partners away from Western economies to countries in the region (notably Iraq), China and other Asian economies. Farzanegan (2014) studies the role of military spending to explain output losses due to oil shocks. Farzanegan and Hayo (2019) analyze the effect of sanctions to expand the shadow economy. Although not strictly quantitative in nature, a number of studies maintained that the burden of economic sanctions for Iranian growth was high but not decisive to bring about political change in Iran. (Carswell (1981), Amuzegar (1997a), Amuzegar (1997b), Dadkhah and Zangeneh (1998), Downs and Maloney (2011) and Borszik (2016)).

Sanctions have also played an important role in shaping Iran's monetary and financial system. Mazarei (2019) analyzes the current state of the Iranian financial system and its fragility. Farzanegan and Markwardt (2009) focus on the extent to which Iran suffers from a form of "Dutch disease", thus advocating for a sovereign oil fund to mitigate inflationary pressures and risks of currency crises. Mazarei (2020) highlights the danger of inflation for Iran in the wake of sanctions and the pandemic. There are also several studies on the determinants of inflation in Iran (not related to sanctions), which could be of interest. See, for example, the studies by Liu and Adedeji (2000), Celasun and Goswami (2002), and Bonato (2008).

Sanctions have often led to the establishment of multiple exchange rate markets with important rent-seeking opportunities and related economic distortions. Currently, there are three different exchange rates for the rial.[5] Bahmani-Oskooee (1996) provides an earlier account of the gains obtainable in Iran from the black market premium, and the need to consider the free market rate rather than the official one when the Iranian money demand is to be assessed; we follow this approach when conducting our analyses and disregard the official rate. The economic implications of multiple exchange rates in Iran are discussed in Pesaran (1992), Farzanegan (2013) and Majidpour (2013).

Our contributions are both methodological, by expanding the program evaluation literature with a novel econometric approach, and empirical in terms of the measurement of sanction intensity using textual analysis and its incorporation in a quarterly macroeconometric model of Iran, which has not been done before.[6]

The rest of the paper is organized as follows. Section 2 offers an overview of the Iranian economy under sanctions. Section 3 explains how we construct the sanctions intensity index from six leading newspapers, and its comovements with historical events. Section 4 discusses alternative approaches to the analysis of policy interventions, and develops a framework with latent factors used to identify the effects of sanctions on the Iranian economy, as well as providing an estimate of sanctions-induced output losses. Section 5 reports estimates of sanctions-augmented SVAR models, and discusses the channels through which sanctions affect the Iranian economy. Impulse responses and error variance decompositions are presented and their robustness

[5] The three exchange rates are: (*i*) The official exchange rate to import essential items such as medicine, grain and sugar; (*ii*) The *Nima rate*, officially set at 2 per cent above the official rate by Bank Markazi daily, but in practice it is subject to much higher premiums and is reserved for non-oil exporters; (*iii*) The free market rate used for all other transactions.

[6] Also, we are not aware of any study that is able to use data at quarterly frequency for over thirty years to evaluate the long-run effect of sanctions. This is relevant for the dynamics of the SVAR model and increases the precision of our estimates.

to a different ordering of the variables in the SVAR model are discussed. Section 6 ends with some concluding remarks. An online supplement provides details on the construction of our sanctions intensity variable, the data sources, with further methodological notes and empirical results. The online supplement also contains a comprehensive list of economic and financial sanctions imposed against Iran over the past forty years.

# 2 Sanctions and the Iranian economy: an overview

The evolution of the Iranian economy over the past forty years has been largely shaped by the Revolution and the eight-years war with Iraq (1979-1988), prolonged episodes of economic and financial sanctions, and often very different policy responses to sanctions and economic management under the four presidents that have held office over the period 1989-2019. Initially, U.S. sanctions were much more clearly targeted. The goal of the 1980–81 sanctions was to negotiate the release of U.S. hostages, and the 1987 sanctions to end hostilities in the Persian Gulf and bring about an end to the war with Iraq. These sanctions aimed at limiting Iran's access to foreign exchange earnings through asset freezes and, more importantly, by reducing Iran's capacity and ability to produce and export oil.[7]

Iran's oil exports had been already cut by half from the pre-Revolution peak of 6 millions barrels per day (mb/d).[8] The first U.S. sanctions drove Iran's oil exports to the low of 700,000 b/d before recovering somewhat after the sanctions were lifted in January 1981. However, since the lifting of the sanctions coincided with the intensification of the war with Iraq, oil exports did not recover fully till after the war ended in 1988. From 1989 to 2005, with improvements in the diplomatic relationships between Iran and the U.S. and other Western countries, oil exports started to rise and stabilized to around 2.5 mb/d under the presidencies of Rafsanjani (1989q3–1997q2) and Khatami (1997q3–2005q2). Oil exports began to decline again from 2007 after the imposition of U.S. and U.N. sanctions in December 2006 aimed at halting Iran's uranium enrichment program which had gathered pace under the newly elected President Ahmadinejad (2005q3-2013q2). Initially, sanctions targeted investments in oil, gas and petrochemicals, and exports of refined products, but were later expanded to include banking, insurance and shipping. Additional financial sanctions were imposed on Iran from July 2013. The coverage of U.N. and U.S. sanctions increased well beyond the oil and gas sectors and affected all aspects of Iranian foreign trade and international finance, and even the international payment system of Bank Markazi (Iran's Central Bank). The extensive coverage of the sanctions, their multilateral nature, coupled with the start of President Rouhani's moderate administration (2013q3–2021q2), paved the way for the 2015 nuclear

[7] For an overview of U.S. sanctions against Iran see also Chapter 9 of Maloney (2015).

[8] See *Panel A* of Figure S.4 in the online supplement.

agreement (*JCPOA*), implemented in January 2016 which led to the easing of some of the U.S. sanctions and the lifting of U.N. and European Union sanctions against Iran. But the benefits of the JCPOA to Iran were limited, as many non-U.S. global companies and banks were hesitant to deal with Iran because of the remaining U.S. sanctions, as well as concerns over money laundering, opacity of ownership, and the fragility of the Iranian banking system. As it turned out, JCPOA was also short lived, with oil exports sharply declining after May 2018, when U.S. President Trump unilaterally withdrew from JCPOA, and adopted the policy of "maximum pressure" against Iran. With the election of President Biden in November 2020, there are negotiations for the U.S. to return to the 2015 nuclear agreement, although our analysis will be pre-dating these negotiations.

The U.S. sanctions against Iran were mainly of extra-territorial nature. Iran-U.S. trade had already been cut drastically after the Revolution and did not recover after the resolution of the hostage crisis. In response to sanctions, the Iranian government made concerted efforts to re-direct Iran's foreign trade from the West to the East and to the neighboring countries. The sources of foreign exchange were also diversified from oil to non-oil exports of goods and services. The share of oil and gas exports declined steadily from 96 per cent of total exports in 1979 to around 60 per cent in 2018, before the full impact of the U.S. withdrawal from Iran's oil exports.[9] Over the same period non-oil exports have increased from 753 million dollars to 37 billion dollars.

In contrast, Iran was not able to adapt to financial sanctions sufficiently quickly, resulting in large depreciations of the free market rate of the rial against the U.S. dollar, with the official rate lagging behind for a number of years, thus creating opportunities for rent-seeking and often corrupt business practices.[10] Given the relevance of imports in the Iranian economy, and the role of the U.S. dollar as the store of value and as a hedge against inflation for many Iranians, the fall in value of the rial quite rapidly translates into higher consumer prices, with the rise in prices somewhat moderated due to government imports of food and medicine at official rates. But as the gap between the official and market rates closes over time, consumer prices end up reflecting the full extent of depreciation of the rial on the free market.[11] As can be seen from Table 1, over the period 1989q1–2021q1 the free market rate has depreciated around 17.4 per cent per annum as compared to the average annual rate of inflation of around 18.3 per cent over the same period, representing a gap of around 1 per cent between the two series. But according to the Purchasing Power Parity (PPP), the difference between inflation and exchange rate depreciation should match the average annual U.S. inflation, which is estimated to

[9] See *Panel B* of Figure S.4 in the online supplement.

[10] See *Panel C* of Figure S.4 in the online supplement. The development of the free market exchange rate, also known as the 'black' market rate during the 1979-1988 period, is discussed in Pesaran (1992).

[11] The time profiles of free market rate and consumer prices (in log scales) are depicted in *Panel D* of Figure S.4 in the online supplement. As can be seen there is a very close association between the two series.

Table 1: Free market and official foreign exchange rate depreciation, inflation, real output growth, and sanctions intensity over the period 1979q3–2021q1

*Per cent per annum*

| Periods | Free FX depreciation | Official FX depreciation | Inflation | Output growth | Sanctions intensity (0,1) | |
|---|---|---|---|---|---|---|
| | | | | | Mean | Median |
| Revolution and Iran-Iraq War[1] (1979q3–1989q2) | 19.94 | 0.28 | 18.29 | -1.60 | 0.20 | 0.11 |
| Rafsanjani presidency (1989q3–1997q2) | 16.55 | 39.83 | 21.17 | 5.16 | 0.11 | 0.10 |
| Khatami presidency (1997q3–2005q2) | 7.90 | 20.34 | 14.53 | 4.72 | 0.15 | 0.13 |
| Ahmadinejad presidency (2005q3–2013q2) | 17.08 | 5.16 | 18.15 | 1.68 | 0.38 | 0.39 |
| Rouhani presidency[2] (2013q3–2021q2) | 25.34 | 14.66 | 19.61 | 0.61 | 0.34 | 0.27 |
| *Post-revolution full sample*[2] (1979q3–2021q1) | 17.39 | 15.30 | 18.34 | 1.98 | 0.23 | 0.15 |
| *Post-War full sample*[2] (1989q1–2021q1) | 17.38 | 19.88 | 18.30 | 3.08 | 0.24 | 0.16 |

**Notes**: *1.* Data on free market foreign exchange rate start in 1980q2. *2.* Data on foreign exchange rates (free market and official rate), and inflation end in 2021q1, data on output growth end in 2020q1, data on sanctions intensity end in 2020q3. See Section 3 of the paper for the sanctions intensity variable definition over the range (0,1). See Sections S.2.1, S.2.2, S.2.5, and S.2.6 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable, calendar conversions, and sources of the data used.

be around 2.5 per cent over the same period.[12]

It is also important to note that not all foreign exchange crises can be traced to the intensification of sanctions. Iran has witnessed major currency crises during all the four presidencies since 1989, whilst only the last two currency crises can be directly attributed to intensification of the sanctions. The currency crises during Rafsanjani and Khatami presidencies have domestic roots resulting from the rapid expansion of imports and low oil prices, coupled with accommodating fiscal and monetary policies.[13] As shown in Table 1, the average rate of inflation has been systematically high across all the four presidencies, and does not seem to correlate with changes in sanctions intensity. Even under Khatami's Presidency the average annual inflation still amounted to 14.5 per cent, despite his conciliatory foreign policy and a much lower rate of currency depreciation (7.9 per cent as compared to 17.4 per cent over the full sample).

Comparing Iran's output growth with that of world output growth over the 1989–2019 period[14] also suggests an output growth shortfall of around 1 per cent per annum, which could be contributed to the sanctions, although such a comparison does not take account of Iran's potential as an emerging economy. Even if we

[12] The PPP is a long-run relationship that relates the exchange rate between two currencies to their relative price of goods: $P_t = E_t P_t^*$, with $E_t$ being the exchange rate representing the number of domestic currency units that can be bought with one unit of foreign currency, $P_t$ and $P_t^*$ denote the domestic and foreign price levels.

[13] During the reconstruction period under President Rafsanjani imports of goods and services doubled over the period 1989–1991 rising from 13.5 to 25 billion dollars, and Iran's foreign debt rose to 23.2 billion dollars by the end of 1993. For further details of the developments that led to the currency crisis under President Rafsanjani, see Section 3 of Pesaran (2000).

[14] World output is computed as a weighted average of some of the largest 33 economies with details provided in the online supplement.

exclude the war periods, we also observe a much larger output growth volatility in Iran as compared to the volatility of world output growth volatility or a number of emerging economies of similar size to Iran, such as Turkey or Saudi Arabia. Iran's output growth volatility (as measured by standard deviations of output growth) was almost five times as large as the global output growth volatility (12.61 versus 2.69 per cent).[15] Comparing Iran and Turkey over the same period, we also find that Turkey grew at an average annual rate of 4 per cent with volatility of 10.8 per cent, a country also known for high inflation and repeated currency crises.[16] Finally, sanctions have most likely also contributed to the de-coupling of the Iranian economy from the rest of the world. Again comparing Iran and Turkey, we note that the correlation of Iran's output growth with the world output growth is around 0.12, barely statistically significant, as compared with a correlation of 0.33 for Turkey.

There seems to be little doubt that sanctions have adversely affected the Iranian economy, contributing to low growth, high inflation and increased volatility. What is less clear is how to carry out a quantitative evaluation and identification of channels through which sanctions have affected the Iranian economy over time, in particular the dynamics of responses and the time horizon over which the effects of sanctions filter out throughout the economy. To this end, a formal model is required where conditions under which the effects of sanctions can be identified are made explicit, and their dynamic implications are estimated and evaluated. It is to this task that we now turn in the rest of this paper.

## 3 Measures of sanctions intensity

Sanctions against Iran have been imposed with different degrees of intensity over the past forty years. To account for both the prolonged nature of sanctions and their time-varying intensity, we construct "sanctions on" and "sanctions off" measures based on newspaper coverage of the imposition and the occasional lifting of sanctions. Newspaper coverage has been used in the literature and was initially formalized by Baker et al. (2016) for measuring the effects of economic uncertainty on macroeconomic aggregates. But, to our knowledge, the idea of using newspaper coverage to quantify sanctions intensity is new.

We consider six of the world's major daily newspapers, namely the New York Times, the Washington Post, the Los Angeles Times and the Wall Street Journal in the U.S., and the Guardian and the Financial Times in the U.K.. We then count the number of articles published in these newspapers that deal with sanctions and Iran.[17]

[15] Mohaddes and Pesaran (2013) document the high volatility of Iran's oil export revenues as one of the factors behind Iran's low growth and high volatility. A large part of the volatility of Iran's oil export revenues is traced to high volatility of barrels of oil exported, largely due to vagaries of sanctions. By comparison the volatility of oil prices is of secondary importance. This contrasts to the volatility of Saudi Arabia oil revenues which is largely governed by changes in international oil prices.

[16] The average annual output growth of Saudi Arabia over the 2005-2019 period was also similar to Turkey and amounted to 4.3 per cent.

[17] The selected newspapers represent a sample of the most-read and well-informed articles over the past forty years, and provide a good blend of

We are careful not to confound our measures with articles that cover international sanctions against Iraq but also mention Iran. Sources and details of how the searches were carried out are provided in Section S.2.1 of the online supplement.

We also considered including Iranian newspaper sources in our textual analysis, but decided not to do so for three main reasons. First, newspaper articles written about sanctions in Iran have a political dimension (e.g. strengthen the theocracy by levering on the idea of the "resistance economy"), which does not necessarily relate to changes in sanctions intensity. Second, sanctions are announced, decided, and implemented by the U.S. and other major U.N. countries. Therefore, Western media offer a more accurate and timely changes in new and ongoing sanctions against Iran. Third, there are not many Iranian newspapers that reliably cover the whole forty years time period that we are considering, and including available data from Iranian newspapers could bias our sanctions indicator.

One can think of our approach as measuring a proxy for an underlying latent sanctions intensity process. The true process generates a signal, part of which is captured in daily articles published in the six newspapers under consideration. To be specific, let $n_{jdt}$ be the number of articles published about sanctions on Iran in newspaper $j$ during day $d$ of month $t$, and denote the true (latent) sanctions intensity variable during month $t$ by $s_t^*$. The relationship between $n_{jdt}$ and $s_t^*$ is specified as

$$n_{jdt} = \theta_j s_t^* + \zeta_{jdt}, \tag{1}$$

where $\theta_j > 0$ is loading of newspaper $j$ on the true signal, $s_t^*$, and $\zeta_{jdt}$ is an idiosyncratic serially uncorrelated error term assumed to be distributed independently of the true signal, $s_{dt}^*$, with zero means and finite variances. Equation (1) could be viewed as a single factor model where $\theta_j$ is the newspaper-specific factor loading. The number of articles published in newspaper $j$ correlates with the true signal depending on the size of $\theta_j$ and the variance of the idiosyncratic term. Clearly, not all published articles capture the true signals, but by averaging across newspapers and different days in a given month it is possible to reduce the effects of the noise, $\zeta_{jdt}$, and obtain a consistent estimator of $s_t^*$, up to a scalar constant. Both simple and weighted averages can be used. Taking a simple average across the $J$ newspapers and the number of days, $D_t$, in month $t$, we have $\overline{n}_t = \overline{\theta}_J s_t^* + \overline{\zeta}_t$, where $\overline{n}_t = J^{-1} D_t^{-1} \sum_{j=1}^{J} \sum_{d=1}^{D_t} n_{jdt}$, $s_t^* = D_t^{-1} \sum_{d=1}^{D_t} s_{dt}^*$, and $\overline{\theta}_J = J^{-1} \sum_{j=1}^{J} \theta_j$. We considered 6 newspapers ($J = 6$) over a number of publishing days per month $D_t$, typically 26 days, resulting in about 156 data points over which to average. This in turn ensures that the idiosyncratic errors get diversified, and as a

both generalist press and those that focus on economic-finance issues. Also, by including two different geographic regions, we hope to cover a more diversified sample.

result the average error, $\overline{\zeta}_t$, becomes reasonably small. Specifically

$$\overline{\zeta}_t = J^{-1}D_t^{-1}\sum_{j=1}^{J}\sum_{d=1}^{D_t}\zeta_{jdt} = O_p\left(J^{-1}D_t^{-1}\right),$$

and we have $s_t^* = \bar{\theta}_J^{-1}\overline{n}_t + o_p(1)$.These monthly measures can then be time aggregated further to obtain quarterly or annual series which are then used to identify the effects of $s_t^*$ (up to the scaling factor $\bar{\theta}_J^{-1}$) in our macro-econometric model. We could also consider a weighted average version of $\overline{n}_t$ along the lines suggested in the literature, where the number of newspaper articles (the raw count) is weighted by the inverse of their respective standard deviations, $\hat{\sigma}_{jT}$, computed over the full data set, using $\hat{\sigma}_{jT} = \sqrt{(T-1)^{-1}\sum_{t=1}^{T}\left(\overline{n}_{jt} - \overline{n}_j\right)^2}$, $\overline{n}_{jt} = D_t^{-1}\sum_{d=1}^{D_t} n_{jdt}$, and $\overline{n}_j = T^{-1}\sum_{t=1}^{T}\overline{n}_{jt}$. See Baker et al. (2016) and Plante (2019). But, as reported in Figure S.1 of the online supplement, the simple and weighted averages, after being suitably scaled, are very close in the case of our application.

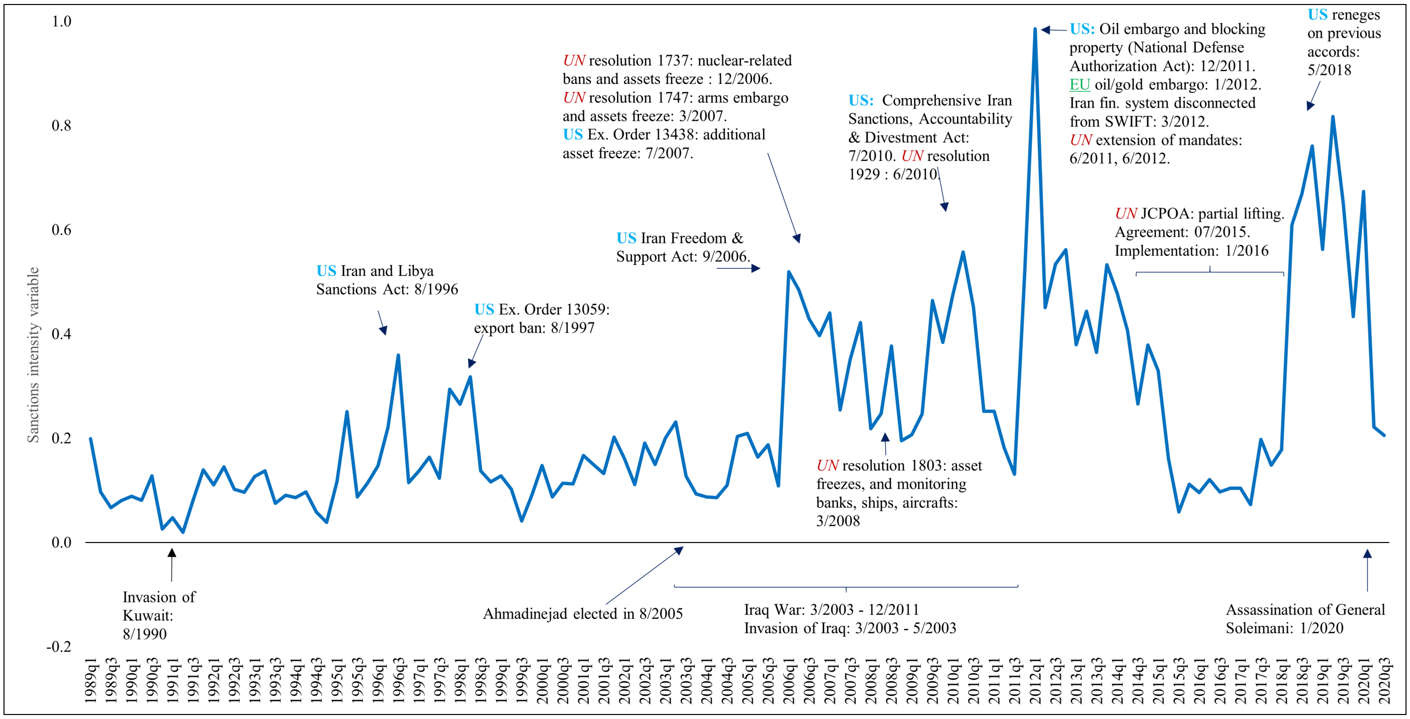
Although most sanctions news has been about imposing new or tightening old sanctions, there are some isolated periods where sanctions have been lifted, as in 1981 after the release of the U.S. hostages, and over the period 2016q1–2018q2 after the implementation of JCPOA. Accordingly, we construct two sanctions measures: an 'on' measure, denoted by $s_{t,on}$, and an 'off' measure, denoted by $s_{t,off}$, and we normalize them such that they both lie between 0 and 1, with 1 representing the maximum sanctions intensity over the full sample. We then define a net sanctions measure as $s_t = s_{t,on} - w \times s_{t,off}$, where $w > 0$ represents the weight attached to the sanctions off indicator compared to the sanctions on indicator. The weight, $w$, is estimated to be $\widehat{w} = 0.4$ using a grid search method over values of $w \in (0,1)$.[18]

Figure 1 displays the quarterly estimates of $s_t$ over the period from 1989q1 to 2020q3, which takes its maximum value at the end of 2011 when Iran was sanctioned simultaneously by the U.N., the U.S. and the E.U.. Important historical events are annotated in the lower part of the figure, while specifics of particular sanctions are shown on the upper part of the figure.

The fact that intensity of sanctions against Iran has been quite varied can be clearly seen from Figure 1. Most notably there are three major spikes in sanctions intensity. The first is in 2006 after Ahmadinejad was elected and Iran began its uranium enrichment program**,** when the U.S. passed the "Iran Freedom and Support Act", which extended the coercive measures against Iran – most notably secondary sanctions on non-U.S. corporations and institutions doing business with Iran and very strict sanctions related to investments in the energy sector. An even larger spike occurs between 2011 and 2012, when the Obama administration joined

[18] The grid search was performed by running the regressions: $\Delta y_t = \beta_0 + \beta_1\Delta y_{t-1} + \beta_2 s_{t-1}(w) + \varepsilon_t$, $w \in \{0.1, 0.2, ..., 0.9\}$ over the period 1989q1–2019q4, and $w$ selected by the maximum likelihood method. Further details are provided in Section S.2 of the online supplement.

Figure 1: Sanctions intensity variable over the period 1989q1–2020q3




**Notes**: Major events related to the Middle East are indicated by arrows below the *x*-axis. Major sanctions episodes related to Iran are indicated by arrows above the *x*-axis. See Sections S.2.1 and S.2.2 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable.

efforts with the United Nations and the European Union to tighten the sanctions even further with the aim of bringing Iran to negotiations over the nuclear program. The U.S. passed stiff measures at the end of December 2011 under the "National Defense and Authorization Act for Fiscal Year 2012", with Iran threatening to block oil shipments through the Strait of Hormuz as a response. At the same time, the E.U. initiated a total disconnect of Iranian financial institutions from the international payments system (*SWIFT*) in March 2012,[19] while the U.N. proceeded to extend the mandates of their previous resolutions between June 2011 and June 2012. The third, and most recent, spike is registered in 2018q2 after Trump decided to unilaterally withdraw the U.S. from the JCPOA accord and begin a strategy of "maximum pressure". There are also minor spikes in 1996 when the Clinton administration signed the "Iran and Libya Sanctions Act", and in 1997 when the U.S. introduced an export ban to reduce the threat of potential weapons of mass destruction being built, and in 2010 when the *CISADA* ("Comprehensive Iran Sanctions Accountability and Divestment Act") was signed into law and the U.N. Security Council passed the fourth round of sanctions against Iran with its 1929 resolution.

Lows of the sanctions intensity variable are recorded during the reconstruction period under President Rafsanjani and the pragmatic rule under Khatami's administration, and more recently over the period between the

[19] SWIFT stands for the "Society for Worldwide Interbank Financial Telecommunications", and it is a vast and secure network used by banks and other financial institutions to operate financial transactions across the globe.

JCPOA agreement in August 2015 and January 2018, when the U.S. unilaterally withdrew from the agreement. Table 2 provides summary statistics (minimum, median, mean, maximum and standard deviations) of $s_t$ over a number of sub-periods. A number of interesting observations follow from this table. First, the summary statistics for $s_t$ over the low sanctions periods under Rafsanjani and Khatami are very close to those recorded for the period 2015q1–2018q1 when sanctions were partially lifted after JCPOA. Second, the peak of sanctions occurred during the internationally coordinated efforts of 2011/2012 rather than after 2018, when the U.S. began their "maximum pressure" strategy under Trump and Bolton.[20] In the period after 2018q2, the degree of intensity of our indicator is 82 per cent of its peak in 2011. However, after 2018 the intensity of sanctions against Iran seems to have been much more persistent: the mean and median are higher during the 2018q2–2020q3 period than during 2012q1–2014q4. Finally, we notice that after the Iran-Iraq War, the median of the sanctions intensity has been only two thirds of the mean: 0.16 versus 0.24. This feature stems from the several tail events that characterize the series of sanctions against Iran, and as an overall measure the median is to be preferred to the mean.

For the analysis of the effects of sanctions on Iran, it is also important to note that $s_t$ shows a considerable degree of persistence over time. When sanctions are intensified they tend to remain high for some time before subsiding. Table S.6 in the online supplement provides estimates of first- and second-order autoregressive processes (AR) fitted to $s_t$, and shows that an AR(1) model captures well the sanctions intensity process, with a relatively large and highly significant AR coefficient, namely $0.743\ (0.059)$.

Table 2: Descriptive statistics of the sanctions intensity variable over relevant time periods

| | Time period | Min | Median | Mean | Max | St. Dev. |
|---|---|---|---|---|---|---|
| Rafsanjani & Khatami presidencies | 1989q3–2005q2 | 0.02 | 0.12 | 0.13 | 0.36 | 0.07 |
| Ahmadinejad presidency | 2005q3–2013q2 | 0.11 | 0.39 | 0.38 | 1.0 | 0.17 |
| U.N./U.S. max sanctions | 2012q1–2014q4 | 0.27 | 0.45 | 0.48 | 1.0 | 0.18 |
| JCPOA agreement | 2015q1–2018q1 | 0.06 | 0.11 | 0.14 | 0.33 | 0.07 |
| U.S. "maximum pressure" | 2018q2–2020q3 | 0.21 | 0.63 | 0.56 | 0.82 | 0.21 |
| *Full sample* (post Iran-Iraq War) | 1989q1–2020q3 | 0.02 | 0.16 | 0.24 | 1.0 | 0.19 |

**Notes:** See Sections S.2.1 and S.2.2 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable.

Finally, as a robustness check we also attempted to create an alternative measure of sanctions intensity based on the number of Iranian entities being sanctioned by the U.S.. We used the U.S. Treasury data set on entries and exits of sanctioned companies, individuals and vessels. We were able to build an indicator

[20] John Bolton served as the 26th United States National Security Advisor from April 2018 to September 2019 under the Presidency of Donald Trump. He has been a long-standing "policy hawk" advocating for regime change in several strategic countries not aligned with the U.S. such as Iran and North Korea, among others.

from 2006 to present. Although the two measures (newspaper coverage and U.S. Treasury data) capture the sanctions phenomenon from different perspectives, they correlate rather well at 38 per cent. For further details see Section S.2.3 of the online supplement.

# 4 Identification of sanctions effects: methodological issues

Identifying the effects of sanctions on the Iranian economy is challenging even if a reliable measure of sanctions intensity is available. As with all macro policy interventions, when identifying the effects of sanctions we also need to take account of confounding factors that are correlated with changes in sanctions intensity, and which at the same time have a causal influence on target variable(s) of interest such as output growth and inflation. In situations where a policy intervention has differential effects over time and across many different units such as households or firms, difference-in-difference techniques are used whereby changes in outcomes during policy on and policy off periods for those affected by the intervention are compared to corresponding changes in outcomes for a control group that is not directly affected by the intervention. This method is clearly not applicable to the analysis of policy interventions that target a particular entity such as a region or country, and a different approach is needed. Currently, there are two such approaches: the Synthetic Control Method (*SCM*) advanced by Abadie and Gardeazabal (2003) and the Panel Data Approach (*PDA*) proposed by Hsiao et al. (2012).[21] Both approaches compare outcomes for the country (region) subject to the intervention with a weighted average of outcomes from a control group. The former was originally applied to quantify the economic costs of political instability in the Basque Country in Spain, and the latter to evaluate the economic effects of the hand-over of Hong Kong to China in 1997. Both studies consider discrete policy interventions and do not allow for the policy intensity to vary over time. Perhaps most importantly they both use pre-policy outcomes to estimate the weights applied to the countries included in the control group. The main difference between the two approaches lies in way the weights are estimated.[22]

The application of these approaches to the case of Iran is complicated by the fact that imposition of sanctions coincided with the onset of the Revolution which renders the pre-sanctions period of limited relevance. Also, as noted earlier, the scope and intensity of sanctions against Iran have undergone considerable changes over the past forty years and there are no clear cut periods that one could identify as "sanctions on" periods to be compared to "sanctions off" periods, in which all sanctions were levied. There is also the additional challenge of identifying countries for inclusion in the control group.

[21] Further details and extensions of SCM are discussed in Abadie et al. (2010) and Doudchenko and Imbens (2016).

[22] Gardeazabal and Vega-Bayo (2017) provide a comparative simulation analysis of SCM and PDA, with a follow up critique by Wan et al. (2018).

To our knowledge, the only study that applies SCM to Iran is by Gharehgozli (2017), who considers the effects of the intensification of sanctions just before the JCPOA agreement in July 2015 on Iran's real GDP, treating the years 2011–2014 as the "sanctions on" period as compared to the preceding years 1995–2010 as the "sanctions off" period. She then selects 13 countries worldwide to mimic a "synthetic" Iran as a weighted average of GDP of these economies with their respective weights determined using the SCM based on seven different macroeconomic indicators. She concludes that the 2011–2014 sanctions resulted in Iran's real GDP to fall by as much as 17 per cent, as compared to the synthetic sanctions free Iran, with all the output short fall attributed to sanctions.

We depart from the mainstream literature reviewed above and consider the following reduced-form model for Iran's quarterly output growth

$$\Delta y_t = \alpha + \lambda \Delta y_{t-1} + \psi_0 s_t + \psi_1 s_{t-1} + \beta' \mathbf{x}_t + \gamma' \mathbf{f}_t + u_t, \tag{2}$$

where $\Delta y_t$ is the output growth, $s_t$ measures the intensity of sanctions against Iran, $\mathbf{x}_t$ and $\mathbf{f}_t$ are respectively observed and unobserved control variables, and $u_t$ is an idiosyncratic error term, distributed independently of $(s_t, \mathbf{x}_t, \mathbf{f}_t)$. It is assumed that part of the change in the intensity of sanctions affects Iran's output growth with a lag, thus distinguishing between short term, $\psi_0$, and long term, $\theta = (\psi_0 + \psi_1)/(1-\lambda)$, effects of sanctions. As discussed above, sanctions affect output growth through a number of channels, most importantly oil exports, exchange rate, liquidity, and inflation to be addressed in Section 5. However, here we are concerned with both direct and indirect effects of sanctions on output growth, and to avoid confounding these effects we will not be including contemporaneous values domestic variables in the output growth equation. For example, including changes in volume of oil exports in (2) will most likely result in under-estimating the effects of the sanctions, since one important aim of the sanctions is to reduce Iran's oil exports. The same also applies to other domestic variables, such as exchange rate or inflation, that are affected by sanctions and their inclusion bias the estimates of $\psi_0$ and $\psi_1$. But it is important that observed and unobserved external factors that are *not* affected by sanctions, but potentially can impact Iran's output growth are included in (2). One important example is changes in international oil prices, which affect Iran's output growth through changes in government foreign exchange revenues, but do not seem to have been affected by sanctions, particularly due the accommodating oil production and export policies followed by Saudi Arabia.[23] Accordingly, we include changes in international oil prices as an element of $\mathbf{x}_t$. We could not identify other observed external factors with obvious effects on the

[23] See Section 5.2 in Mohaddes and Pesaran (2016), where it is shown that an adverse shock to Iran's oil supply induces a rise in Saudi oil supplies. Another reason why sanctions against Iran have not led to important oil price rises is the prolonged nature of these sanctions, allowing the international oil market to adjust to reduced oil exports from Iran.

Iranian economy, and focussed on identification of unobserved common factors, $\mathbf{f}_t$. In this regard, our approach is closely related to the *PDA* (Hsiao et al. (2012)). To this end, we consider the following equations for output growth for the rest of the world[24]

$$\Delta y_{it} = \alpha_{iy} + \beta'_{iy}\mathbf{x}_{it} + \gamma'_{iy}\mathbf{f}_t + u_{y,it},\ i = 1,2,...,n, \tag{3}$$

where $\Delta y_{it}$ denotes output growth in country $i$ (excluding Iran), $\mathbf{x}_{it}$ is a $k \times 1$ vector of control variables specific to country $i$, and $\mathbf{f}_t$ is the $m \times 1$ vector of unobserved common factors, and $u_{y,it}$ are idiosyncratic shocks to output growth that are serially uncorrelated but could be weakly cross correlated.[25] By allowing the factor loadings, $\gamma_i$, to differ across countries, we do not assume that all economies are equally affected by the same factors, an assumption that underlies the DiD approach. We also depart from SCM and PDA and, unlike these approaches, we do not require a "donor pool" of countries to be selected for comparative analysis. Instead, we assume that $\mathbf{x}_{it}$ also follows similar multi-factor structures, and impose a rank condition which allows us to identify $\mathbf{f}_t$ as weighted averages of $\Delta y_{it}$ and $\mathbf{x}_{it}$ over $i$ (excluding Iran). Any granular weights can be used to construct these averages, such as simple averages. But in cases where $n$ is not sufficiently large and there are dominant economies such as the U.S., it is advisable to use output shares as weights. Accordingly, suppose that

$$\mathbf{x}_{it} = \alpha_{ix} + \Gamma'_{ix}\mathbf{f}_t + \mathbf{u}_{x,it},\ i = 1,2,...,n, \tag{4}$$

where $\Gamma_{ix}$ is a $k \times m$ matrix of factor loadings, and $\mathbf{u}_{x,it}$ is a $k \times 1$ vector that follows general stationary processes that are weakly cross-sectionally correlated. Combining (3) and (4) we have

$$\begin{pmatrix} 1 & -\beta'_{iy} \\ \mathbf{0} & \mathbf{I}_k \end{pmatrix} \mathbf{z}_{it} = \begin{pmatrix} \alpha_{iy} \\ \alpha_{ix} \end{pmatrix} + \begin{pmatrix} \gamma'_{iy} \\ \Gamma'_{ix} \end{pmatrix} \mathbf{f}_t + \begin{pmatrix} u_{y,it} \\ \mathbf{u}_{x,it} \end{pmatrix},$$

which yields $\mathbf{z}_{it} = \mathbf{c}_i + \mathbf{A}_i\mathbf{f}_t + \mathbf{B}_i\mathbf{u}_{it}$, where

$$\mathbf{c}_i = \begin{pmatrix} \alpha_{iy} + \beta'_i \\ \alpha_{ix} \end{pmatrix}, \mathbf{A}_i = \begin{pmatrix} \gamma'_{iy} + \beta'_{iy}\Gamma'_{ix} \\ \Gamma'_{ix} \end{pmatrix} \mathbf{f}_t, \text{ and } \mathbf{B}_i = \begin{pmatrix} 1 & \beta'_{iy} \\ \mathbf{0} & \mathbf{I}_k \end{pmatrix}.$$

Averaging $\mathbf{z}_{it}$ over $i$ using the weights $w_i$ we now have $\bar{\mathbf{z}}_{wt} = \bar{\mathbf{c}}_w + \overline{\mathbf{A}}_w\mathbf{f}_t + \sum_{i=1}^n w_i\mathbf{B}_i\mathbf{u}_{it}$, where $\bar{\mathbf{z}}_{wt} = \sum_{i=1}^n w_i\mathbf{z}_{it}$,

[24] It is assumed that sanctions against Iran have had only negligible impacts on the rest of the world economies.

[25] A set of random variables, $\{u_{it}, i = 1,2,...,n\}$ is said to be weakly cross correlated if $\sup_j \sum_{i=1}^n |Cov(u_{it}, u_{jt})| < C < \infty$. It then follows that $\sum_{i=1}^n w_i u_{it} = O_p(n^{-1/2})$, for any granular weights, $w_i$, such that $w_i = O(n^{-1})$ and $\sum_{i=1}^n w_i^2 = O(n^{-1})$. An obvious example is the simple weights $w_i = 1/n$. For further details see Chudik et al. (2011).

$\overline{\mathbf{c}}_w = \sum_{i=1}^n w_i \mathbf{c}_i$, and $\overline{\mathbf{A}}_w = \sum_{i=1}^n w_i \mathbf{A}_i$. Suppose now that the $(k+1) \times m$ matrix $\overline{\mathbf{A}}_w$ is full column rank (that requires $m \leq k+1$), and $\overline{\mathbf{A}}_w' \overline{\mathbf{A}}_w \rightarrow_p > 0$, as $n \rightarrow \infty$. Then $\mathbf{f}_t$ can be solved as[26]

$$\mathbf{f}_t = \overline{\mathbf{a}}_{wf} + \overline{\mathbf{H}}_w \overline{\mathbf{z}}_{wt} - \overline{\mathbf{H}}_w \left( \sum_{i=1}^n w_i \mathbf{B}_i \mathbf{u}_{it} \right),$$

where

$$\overline{\mathbf{a}}_{wf} = \left( \overline{\mathbf{A}}_w' \overline{\mathbf{A}}_w \right)^{-1} \overline{\mathbf{A}}_w' \overline{\mathbf{c}}_w \text{ and } \overline{\mathbf{H}}_w = \left( \overline{\mathbf{A}}_w' \overline{\mathbf{A}}_w \right)^{-1} \overline{\mathbf{A}}_w'.$$

Under the rank condition, the terms $\overline{\mathbf{a}}_{wf}$ and $\overline{\mathbf{H}}_w$ tend to finite limits, whilst under the assumptions that $\mathbf{u}_{it}$ are weakly cross correlated, the final term of $\mathbf{f}_t$ tends to zero for *any* choice of weights $w_i$ that are granular, $\mathbf{f}_t$ can be identified up to linear transformations in terms of $\overline{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt}, \overline{\mathbf{x}}_{wt}')' = (\sum_{i=1}^n w_i \Delta y_{it}, \sum_{i=1}^n w_i \mathbf{x}_{it}')'$. More specifically, $\sum_{i=1}^n w_i \mathbf{B}_i \mathbf{u}_{it} = O_p(n^{-1/2})$, and we have $\mathbf{f}_t = \overline{\mathbf{a}}_{wf} + \overline{\mathbf{H}}_w \overline{\mathbf{z}}_{wt} + O_p(n^{-1/2})$, which can be used to eliminate the unobserved factors, $\mathbf{f}_t$, from Iran's output growth equation. Specifically, we obtain

$$\Delta y_t = \alpha_{yw} + \lambda \Delta y_{t-1} + \psi_0 s_t + \psi_1 s_{t-1} + \beta' \mathbf{x}_t + \theta_{yw} \Delta \bar{y}_{wt} + \theta_{xw}' \overline{\mathbf{x}}_{wt} + u_t + O_p(n^{-1/2}). \tag{5}$$

Hence, for $n$ sufficiently large, and considering that the Iranian economy is quite small relative to the rest of the world, the sanctions coefficients $\psi_0$, and $\psi_1$ can be identified by augmenting the output growth equations with the rest of the world average output growth, $\Delta \bar{y}_{wt}$, and the weighted averages of the observed drivers of the rest of the world output growth, $\overline{\mathbf{x}}_{wt}$.

It is interesting to note that our approach does not require selecting a pool of countries that are close to Iran, but recommends including all countries, weighted for their relative importance in the world economy. Selecting specific countries could bias the results by restricting the number included in the construction of cross section averages. The rank condition, $rank\left( \overline{\mathbf{A}}_w' \overline{\mathbf{A}}_w \right) = m$, for a given $n$, and as $n \rightarrow \infty$, ensures that $\mathbf{f}_t$ has a reasonably pervasive effect on most economies which in turn allows us to use $\Delta \bar{y}_{wt}$, and $\overline{\mathbf{x}}_{wt}$ as reliable proxies for $\mathbf{f}_t$.

The analysis of sanctions effects can also be extended to other macro variables such as inflation and unemployment, and even to some key socioeconomic indicators such as life expectancy, death rate or educational achievement. See Section 7 in Laudati and Pesaran (2021).

Table 3: Estimates of the reduced form Iran's output growth equation estimated over the period 1989q1–2019q4

| | $\Delta y_t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $s_{t-1}(\beta_{s_{t-1}})$ | $-0.033^{**}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.034^{**}$ | $-0.034^{**}$ | $-0.034^{**}$ | $-0.035^{**}$ |
| | (0.016) | (0.016) | (0.016) | (0.016) | (0.016) | (0.016) | (0.016) |
| $\Delta y_{t-1}(\lambda_{\Delta y_{t-1}})$ | $-0.204^{**}$ | $-0.202^{**}$ | $-0.203^{**}$ | $-0.200^{**}$ | $-0.214^{**}$ | $-0.214^{**}$ | $-0.218^{**}$ |
| | (0.091) | (0.092) | (0.092) | (0.092) | (0.091) | (0.092) | (0.092) |
| $\Delta x^0_{t-1}$ | 0.016 | 0.016 | 0.016 | 0.017 | 0.014 | 0.014 | 0.015 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| $\Delta e_{f,t-1}$ | $-0.004$ | $-0.004$ | $-0.004$ | 0.0002 | 0.004 | 0.004 | 0.002 |
| | (0.033) | (0.033) | (0.034) | (0.034) | (0.033) | (0.034) | (0.034) |
| $\Delta m_{t-1}$ | $-0.028$ | $-0.037$ | $-0.041$ | $-0.032$ | $-0.053$ | $-0.056$ | $-0.063$ |
| | (0.100) | (0.102) | (0.104) | (0.104) | (0.103) | (0.104) | (0.106) |
| $\Delta p_{t-1}$ | $-0.239^{*}$ | $-0.234^{*}$ | $-0.232^{*}$ | $-0.246^{**}$ | $-0.268^{**}$ | $-0.273^{**}$ | $-0.274^{**}$ |
| | (0.122) | (0.123) | (0.123) | (0.124) | (0.123) | (0.125) | (0.125) |
| $\Delta \bar{y}_{wt}$ | | 0.228 | 0.160 | 0.215 | $-0.129$ | $-0.162$ | $-0.117$ |
| | | (0.553) | (0.602) | (0.604) | (0.625) | (0.635) | (0.643) |
| $\Delta \overline{req}_{wt}$ | | | 0.013 | 0.021 | 0.013 | 0.002 | $-0.0001$ |
| | | | (0.045) | (0.046) | (0.045) | (0.057) | (0.057) |
| $\Delta \bar{r}_{wt}$ | | | | $-4.518$ | $-4.311$ | $-4.474$ | $-3.490$ |
| | | | | (4.141) | (4.097) | (4.143) | (4.611) |
| $\Delta \bar{e}_{wt}$ | | | | | $-0.278^{*}$ | $-0.272^{*}$ | $-0.309^{*}$ |
| | | | | | (0.148) | (0.150) | (0.168) |
| $grv_t$ | | | | | | $-0.038$ | $-0.044$ |
| | | | | | | (0.114) | (0.115) |
| $\Delta p^0_t$ | | | | | | | $-0.012$ |
| | | | | | | | (0.024) |
| $\beta_{s_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ | $-0.027^{**}$ | $-0.027^{**}$ | $-0.027^{**}$ | $-0.028^{**}$ | $-0.028^{**}$ | $-0.028^{**}$ | $-0.028^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| Adjusted $R^2$ | 0.083 | 0.077 | 0.069 | 0.071 | 0.091 | 0.084 | 0.077 |

**Notes**: $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. $\beta_{s_{t-1}}$ and $\lambda_{\Delta y_{t-1}}$ are the coefficients of $s_{t-1}$ and $\Delta y_{t-1}$, respectively; $\beta_{s_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ represents the long run effect of sanctions on output growth. See Chapter 6 of Pesaran (2015). $\Delta x^0_t = (X^0_t - X^0_{t-1})/X^0_{t-1}$, $X^0_t$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran. $\Delta \bar{y}_{wt}$ is the quarterly world output growth, computed as $\bar{y}_{wt} = \sum_{i=1}^n w_i y_{it}$, with $\{y_{it}\}_{i=1}^n$ being the natural log of real output for 33 major economies, and $\{w_i\}_{i=1}^n$ are GDP-PPP weights. $\Delta \overline{req}_{wt}$ is the quarterly rate of change of the global real equity price index: $\overline{req}_{wt} = \sum_{i=1}^n w_i req_{it}$, $req_{it}$ is the natural log of the real equity price of country $i$ in quarter $t$. $\Delta \bar{r}_{wt}$ is the quarterly per cent change of the global nominal long term interest rate: $\bar{r}_{wt} = \sum_{i=1}^n w_i r_{it}$, $r_{it}$ is the long term nominal interest rate of country $i$ in quarter $t$. $\Delta \bar{e}_{wt}$ is the quarterly rate of change of the global real exchange rate vis-à-vis the U.S. dollar: $\bar{e}_{wt} = \sum_{i=1}^n w_i e_{it}$, $e_{it}$ is the natural log of the real exchange rate of country $i$ in quarter $t$. $grv_t$ is the quarterly global realized volatility. $\Delta p^0_t = \ln(P^0_t/P^0_{t-1})$, $P^0_t$ is the quarterly oil price (Brent crude). Numbers in parentheses are least squares standard errors. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
See Sections S.2.1, S.2.2, S.2.5, and S.2.6 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable, calendar conversions, and sources of the data used.

## 4.1 Estimates of sanctions-induced output losses

Initially, we report regression results for the reduced form output growth regressions set out in Equation (5), and focus on specifications with $s_{t-1}$ as the intervention variable. We favor this specification over the one that includes both $s_t$ and $s_{t-1}$ since "sanctions news" do not contain anticipatory effects, and one would not expect

[26] See Pesaran (2006) for further details in a related context.

contemporaneous changes in $s_t$ to affect output growth, as time is required for the real economy to adjust to sanctions news. [27] The estimates of the reduced form output growth equations computed over the period 1989q1–2019q4 are summarized in Table 3, where we report both the short- and long-run effects of sanctions on output growth, whilst allowing for a host of lagged values of domestic variables as well as contemporaneous foreign control variables and international oil price returns.[28] The parameter of interest is the long run effect of sanctions on output growth reported at the bottom panel of Table 3. It is estimated to be about $-0.027$ $(0.013)$, which is statistically significant and remarkably robust across the seven different specifications reported. The estimates suggest output growth losses of around 2 per cent per annum if we use the median value of $s_t$ over the sample under consideration, or 3 per cent if we use the mean value of $s_t$.[29] Due to the large outliers in the sanctions intensity variable, we favor the lower estimate of 2 per cent based on the median value of $s_t$, which in turn suggests that in the absence of sanctions and sanctions-induced mismanagement Iran's average annual growth over 1989q1–2019q4 could have been around $4-5$ per cent, as compared to the 3 per cent realized, a counterfactual outcome which is close to the growth of emerging economies such as Indonesia, South Korea, Thailand, and Turkey whose average annual growth rate over the same sample period amounted to 4.8, 4.5, 4.2 and 4.0 per cent, respectively. Similar estimates are obtained if both $s_t$ and $s_{t-1}$ are included in the regressions. See Table S.9 of the online supplement. Furthermore, Tables S.20 and S.21 of the online supplement show that similar results are obtained when we use heteroskedastic-consistent standard errors following the approach proposed by White (1980).

# 5 Sanctions-augmented structural VAR model for Iran

We now consider the main channels through which sanctions affect the Iranian economy, and provide estimates of the time profiles of their effects. Initially, U.S. sanctions targeted the Iranian oil industry with the aim of reducing oil exports and limiting Iran's capacity to produce oil. More recently, financial sanctions have been used more extensively. As a result new sanctions, or even their announcement, have invariably led to reduced oil exports, with a significant depreciation of the Iranian rial, followed by a sharp rise in price inflation and output losses within 3–6 months after the imposition of the new sanctions. We model the dynamic inter-

[27] We are grateful to Nick Bloom for drawing our attention to this point.

[28] Amongst the domestic variables, only lagged inflation has a statistically significant impact on output growth. The negative effect of inflation on output growth could be due to price distortions and allocation inefficiencies that are often associated with high and persistent levels of inflation, as has been the case in Iran. We find that global factors such as global volatility or output growth do not affect Iran's output growth, largely due to Iran's relative economic isolation. Amongst the global factors, the only factor with statistically significant impact on Iran's output growth turned out to be the global exchange rate variable. However, the negative effect of the global exchange rate variable on output growth is more difficult to rationalize.

[29] The median and mean values of $s_t$, are 0.16 and 0.24, respectively, as summarized in Table 2.

relationships of oil exports, exchange rate, money supply, inflation and output growth using a structural vector autoregressive (*SVAR* for short) model augmented with the sanctions intensity variable and the global control variables, denoted by $\bar{\mathbf{z}}_{wt}$ above.

We denote by $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t\right)'$ an $m \times 1$ (with $m = 5$) vector of endogenous domestic variables, where $\Delta x_t^0$ is the oil export revenues, $\Delta e_{ft}$ represents the rate of change of free market foreign exchange rate,[30] $\Delta m_t$ is the growth rate of money supply, $\Delta p_t$ is the rate of inflation, and $\Delta y_t$ is real output growth.

To distinguish between different types of shocks and their implications for the Iranian economy, in our SVAR we assume the direction of causality goes from $\Delta x_t^0$ to exchange rate depreciation, to money supply growth, to inflation, and then to output growth, as represented by the ordering of the five endogenous variables in $\mathbf{q}_t$. Under this causal ordering, we are able to distinguish changes in $\mathbf{q}_t$ that are due to variations in the intensity of sanctions from those that are the result of domestic policy shocks.[31] The assumed causal ordering can be justified in terms of relative speed with which the Iranian economy responds to crises. Oil exports are usually targeted by sanctions and their revenues fall immediately by design, then it is the value of the rial in free market that weakens, followed by a potential expansion of liquidity, a rise in the price of imported commodities, before the real economy starts to adjust to higher prices and interest rates. Due to the relatively underdeveloped nature of money and capital markets in Iran, monetary policy tends to be accommodating, typically allowing liquidity to rise in line with inflation.

We consider the following augmented SVAR model in $\mathbf{q}_t$

$$\mathbf{A}_0 \mathbf{q}_t = \mathbf{a}_q + \mathbf{A}_1 \mathbf{q}_{t-1} + \mathbf{A}_2 \mathbf{q}_{t-2} + \gamma_{0s} s_t + \gamma_{1s} s_{t-1} + \mathbf{D}_w \, \bar{\mathbf{z}}_{wt} + \varepsilon_t, \tag{6}$$

where as before $s_t$ is our measure of sanctions intensity, and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt}, \Delta \overline{req}_{wt}, \Delta \bar{r}_{wt}, grv_t, \Delta \bar{e}_{wt})'$ is a $k \times 1$ ($k = 5$) vector of control variables that includes: global output growth, $\Delta \bar{y}_{wt}$, global equity returns, $\Delta \overline{req}_{wt}$, global long term interest rates, $\Delta \bar{r}_{wt}$, global realized volatility, $grv_t$, and the rate of change of the global real exchange rate, $\Delta \bar{e}_{wt}$.[32] Given the assumed causal ordering, matrix $\mathbf{A}_0$ is restricted to have the following lower

[30] We also tried a weighted average of the free market and official exchange rates, but found that the free market rate provides a more accurate and timely measure of the exchange rate movements for Iran given its higher responsiveness to sanctions. The exchange rate variable is expressed as the number of Iranian rials per one U.S. dollar.

[31] It is also possible to use non-recursive identification schemes such as sign restrictions, or the more recently developed Bayesian approach by Baumeister and Hamilton (2015) to point identify and estimate contemporaneous effects in the SVAR model and associated impulse responses using priors. This could be the subject of future research. However, we do not expect that the main results of our paper that relate to the effects of sanctions to be much affected by such alternative identification schemes.

[32] Details on data sources and the computation of the global variables are given in Section S.2 of the online supplement.

triangular form

$$\mathbf{A}_0 = \begin{pmatrix} 1 & 0 & \cdots & & 0 \\ -a^0_{\Delta e,\Delta x_0} & \ddots & \ddots & & \vdots \\ -a^0_{\Delta m,\Delta x_0} & -a^0_{\Delta m,\Delta e} & & & \\ -a^0_{\Delta p,\Delta x_0} & -a^0_{\Delta p,\Delta e} & -a^0_{\Delta p,\Delta m} & 1 & 0 \\ -a^0_{\Delta y,\Delta x_0} & -a^0_{\Delta y,\Delta e} & -a^0_{\Delta y,\Delta m} & -a^0_{\Delta y,\Delta p} & 1 \end{pmatrix}, \tag{7}$$

where we expect $a^0_{\Delta p,\Delta e} \geq 0$, with inflation responding positively to a contemporaneous rise in $e_{ft}$ (rial depreciation), and $a^0_{\Delta y,\Delta x_0} \geq 0$, with output rising as a result of higher oil revenues. The signs of the contemporaneous impacts of $\Delta e_{ft}$, $\Delta m_t$ and $\Delta p_t$ on output growth are less clear cut. The structural shocks, $\varepsilon_t = (\varepsilon_{\Delta x_0,t}, \varepsilon_{\Delta e,t}, \varepsilon_{\Delta m,t}, \varepsilon_{\Delta p,t}, \varepsilon_{\Delta y,t})'$, are assumed to be serially uncorrelated with zero means, $\mathbb{E}(\varepsilon_t) = 0$, and mutually uncorrelated with the diagonal covariance matrix $\mathbb{E}(\varepsilon_t \varepsilon_t') = \Sigma = Diag\left(\sigma_{\Delta x_0,\Delta x_0}, \sigma_{\Delta e,\Delta e}, \sigma_{\Delta m,\Delta m}, \sigma_{\Delta p,\Delta p}, \sigma_{\Delta y,\Delta y}\right)$. Since we condition on sanctions intensity and global indicators, the structural shocks can be viewed as "domestic" shocks attributed to policy changes that are unrelated to sanctions. Specifically, it is assumed that $\varepsilon_t$ are uncorrelated with $s_t$ and $\bar{\mathbf{z}}_{wt}$. Under these assumptions it is now possible to distinguish between the effects of a unit change in the sanctions variable, from domestic policy changes initiated by a unit standard error change to the domestic shocks, $\varepsilon_t$. Specifically, for contemporaneous effects we have $\partial \mathbf{q}_t / \partial s_t = \mathbf{A}_0^{-1} \gamma_{0s}$, and $\partial \mathbf{q}_t / \partial \varepsilon_{jt} = \sqrt{\sigma_{jj}} \mathbf{A}_0^{-1} \mathbf{e}_j$ where $\mathbf{A}_0$ is given by (7), $\mathbf{e}_j$ ($j = \Delta x^0, \Delta e_f, \Delta m, \Delta p, \Delta y$) are the vectors of zeros except for their $j$-th component, which is one.

For the purpose of computing impulse responses and forecast error variance decompositions, we model $s_t$ and $\bar{\mathbf{z}}_{wt}$ as autoregressive processes:

$$s_t = a_s + \rho_s s_{t-1} + \eta_t, \tag{8}$$

$$\bar{\mathbf{z}}_{wt} = \mathbf{a}_{zw} + \mathbf{A}_{zw} \bar{\mathbf{z}}_{w,t-1} + \mathbf{v}_{wt}, \tag{9}$$

where the sanctions and global shocks, $\eta_t$ and $\mathbf{v}_{wt}$, are serially uncorrelated with zero means, and variances $\omega_s^2$ and $\Omega_w$. Combining equations (6), (8), and (9), we obtain the following SVAR model in $\mathbf{z}_t = (\mathbf{q}_t', s_t, \bar{\mathbf{z}}_{wt}')'$,

$$\Psi_0 \mathbf{z}_t = \mathbf{a} + \Psi_1 \mathbf{z}_{t-1} + \Psi_2 \mathbf{z}_{t-2} + \mathbf{u}_t, \tag{10}$$

where $\mathbf{a} = \left(\mathbf{a}'_q, a_s, \mathbf{a}'_{zw}\right)'$ and $\mathbf{u}_t = (\varepsilon'_t, \eta_t, \mathbf{v}'_{wt})'$, are $(m+k+1)\times 1$ vectors, and

$$\Psi_0 = \begin{pmatrix} \mathbf{A}_0 & -\gamma_{0s} & -\mathbf{D}_w \\ \mathbf{0} & 1 & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{I}_k \end{pmatrix}, \ \Psi_1 = \begin{pmatrix} \mathbf{A}_1 & \gamma_{1s} & \mathbf{0} \\ \mathbf{0} & \rho_s & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{A}_{zw} \end{pmatrix}, \ \Psi_2 = \begin{pmatrix} \mathbf{A}_2 & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & 0 & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} \end{pmatrix},$$

are $(m+k+1)\times(m+k+1)$ matrices. Standard techniques can now be applied to the SVAR model in (10) to obtain impulse response functions and error variance decompositions assuming the global shocks, $\mathbf{v}_{wt}$, are uncorrelated with domestic and sanctions shocks (namely $\varepsilon_t$, and $\eta_t$).[33] This is a standard small open economy assumption which applies to the Iranian economy in particular since its relative size in the world economy is small and has been declining over the past forty years.

## 5.1 Structural model estimation

We estimated the five equations of the augmented SVAR model in (6), experimenting with different sub-sets of the control variables: world output growth, global realized volatility, world real equity returns, changes in long term interest rates, and global real exchange rate changes against the U.S. dollar.[34] The full set of results are provided in Tables S.10a to S.10e of the online supplement.[35] As can be seen, with the exception of the world output growth, none of the other control variables play a significant role in the regressions for inflation and output growth. Accordingly, we consider a simplified specification and in Table 4 we provide estimates of the SVAR model including only the world output growth ($\Delta\bar{y}_{wt}$) as the control variable. As can be seen from this Table, the sanction variable is statistically significant for four out of the five domestic variables, with changes in oil exports and output growth being affected after one quarter. In contrast, exchange rate changes and inflation are affected significantly by the sanctions contemporaneously as well as with one quarter lag. The only variable which seems to be unaffected by the sanctions is the money supply growth. It is also worth noting that none of regressions in the SVAR model display residual serial correlation, which is an important consideration for impulse response and variance decomposition analyses that follow.

To assess the quantitative importance of the sanctions, we compute the effects of sanctions by multiplying the estimated coefficients of $s_t$ and $s_{t-1}$ by the median value of the sanctions variable, which is around 0.16.

[33] Further details are provided in Section S.3 of the online supplement.

[34] To take account of possible seasonal variations all regressions are also augmented with seasonal dummies which turn out to be highly significant in the money supply growth equation.

[35] The figures in parentheses in these tables report the least squares standard errors. But to check the robustness of our inference we also provide White (1980)'s heteroskedastic robust standard errors in Section S.4.8 of the online supplement. As to be expected the use of robust standard errors results in reduced level of statistical significance for most of the parameters, but as can be seen the differences are largely inconsequential. Further, we shall be using bootstrap standard error bands in our impulse response analyses and the bootstrap procedure will automatically account for possible heteroskedasticity and non-Gaussian errors.

See Table 2. The median presents a more robust measure of a central value for sanctions intensity as compared to the average which is likely to be sensitive to the outlier values of $s_t$ over time. Using the median we are able to provide an estimate of the effects of moving from a no sanction case (with $s_t = 0$) to a situation where $s_t$ is set to its median value. We refer to these estimates as (counterfactual) median estimates of the sanctions.

We now consider the results of the individual equations in the SVAR model. In the case of oil exports, we note that in addition to sanctions, changes in oil exports are also affected significantly by world output growth with some feedback effects from the exchange rate variable. The positive impact of world output growth on Iran's oil exports makes sense and suggests that sanctions have not been completely effective in making Iran's oil exports non-responsive to world economic conditions. The median estimate of the effects of sanctions on oil exports is around 4.6 per cent per quarter, or about 18.4 per year. See Table S.10a.

Turning to the estimates of the exchange rate equation (given in column 2 of Table 4), we first note that exchange rate changes have been moderately persistent with a coefficient of $0.350\ (0.094)$, which is statistically highly significant. In most developed markets, we do not expect exchange rate changes to be persistent, and the result for rial points to possible inefficiencies in Iran's foreign exchange market. [36] Second, we observe that the rial depreciates strongly in the same quarter in which sanctions are raised. The median fall in its value is around 4.9 per cent per quarter. However, there is a significant degree of overshooting, with the sanctions variable having the opposite effect on exchange rate after one quarter. The rial appreciates by about 3.7 per cent in the following quarter, resulting in a less pronounced overall impact of sanctions on the rial depreciation of around 1.2 per cent per quarter, or 4.8 per cent per annum, which is still quite substantial.[37] As can be seen from Table S.10b of the online supplement, these estimates are remarkably stable and statistically significant at the 1 per cent level across all specifications regardless of the number of global control variables included in the regression equation. In fact, none of the domestic variables (oil exports, inflation, money supply growth, and output growth) have a statistically significant effect on the exchange rate, and only global realized volatility and foreign output growth prove to be statistically significant at 10 per cent level but not robust across all specifications. The adjusted $R^2$ of the exchange rate equations with world output growth included is around 21 per cent. This is high by the standard of exchange rate equations, and is partly explained by the presence of the contemporaneous sanctions variable in the regression. Its use for prediction requires predicting the sanctions variable which adds another layer of uncertainty.

The estimates for the money supply growth ($\Delta m_t$) equation are summarized in column 3 of Table 4. As

[36] Note that the exchange rate is expressed as the number of Iranian rials per one U.S. dollar, and therefore a rise in the exchange rate variable corresponds to a depreciation of the rial.

[37] Such overshooting is well-known in the international finance literature. See, for example, Dornbusch (1976).

can be seen, only lagged money supply growth is statistically significant, and moderately persistent with a coefficient of 0.218 (0.096). Notably, we do not find any feedback effects from inflation to money supply growth, even when we include a second lag of inflation to the money supply growth equation.

The estimates for inflation ($\Delta p_t$) are summarized in column 4 of Table 4. As discussed in Section 2, inflation in Iran has been persistently high over the past forty years, and to capture its persistence it proved necessary to include $\Delta p_{t-2}$, as well as $\Delta p_{t-1}$ in the regression equation. It does not seem necessary to include second order lags of other variables in the inflation equation. [38] Perhaps not surprisingly, the estimates also show that exchange rate depreciation is an important determinant of inflation in Iran, a factor which is statistically significant and quantitatively important. The immediate effect of one per cent depreciation of the free market exchange rate is to raise prices by around 0.15 to 0.17 per cent, as many imported goods items tend to rise with the fall in exchange rate. Sanctions affect inflation indirectly through the exchange rate as well as directly, but the direct effects of sanctions do not last and the net direct effects of sanctions on inflation seem to be negligible. It is also interesting and quite surprising that money supply growth, oil exports, or lagged output growth do not seem to have any significant direct effects on inflation. But we do find some evidence of global output growth positively affecting inflation, a kind of international Phillips curve effect that leads to higher international prices that are in turn reflected in Iran's import prices and hence domestic inflation.

Finally, column 5 of Table 4 provides the results for real output growth. Output growth in Iran is negatively autocorrelated, with a coefficient estimated to be around $-0.22$ which is statistically significant. This contrasts the positively autocorrelated output growth observed for many other countries. The sanctions intensity variable affects output growth with a lag, as it takes a few months for different sectors of the economy to adjust to sanctions. After only one quarter, the effect of sanctions on output growth is statistically highly significant.[39] Within two quarters the regression predicts Iran's output growth to slow down by about 0.9 per cent per quarter (3.6 per cent per annum). In addition to this direct effect, sanctions also influence output growth through exchange rate depreciation, which is also highly statistically significant. This indirect effect amounts to around 0.14 per cent per quarter drop in output growth when the rial depreciates by one per cent. Output growth is also negatively affected by lower oil exports, and by lagged inflation, which highlights the adverse effects of high and persistent inflation on output growth, without any short term Phillips curve type of trade off between inflation and output growth. Interestingly enough, none of the global factors seem to have any significant effects on Iran's output growth, partly due to Iran's relative economic and financial isolation from the rest of

[38] See also Table S.10d of the online supplement where different sub-sets of control variables are also included in the regressions for the inflation equation.

[39] Table S.10e in the online supplement shows that the results are reasonably robust to different choices of control variables.

the global economy. See Table S.10e of the online supplement for further details.

Table 4: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ (1) | $\Delta e_{f,t}$ (2) | $\Delta m_t$ (3) | $\Delta p_t$ (4) | $\Delta y_t$ (5) |
|---|---|---|---|---|---|
| $s_t$ | 0.107 | 0.305*** | −0.002 | −0.033** | 0.029 |
| | (0.150) | (0.064) | (0.017) | (0.013) | (0.026) |
| $s_{t-1}$ | −0.288* | −0.233*** | 0.015 | 0.037*** | −0.056** |
| | (0.155) | (0.067) | (0.017) | (0.013) | (0.026) |
| $\Delta x_t^0$ | | 0.029 | 0.006 | −0.003 | 0.025* |
| | | (0.040) | (0.010) | (0.007) | (0.014) |
| $\Delta e_{f,t}$ | | | −0.007 | 0.163*** | −0.141*** |
| | | | (0.023) | (0.017) | (0.045) |
| $\Delta m_t$ | | | | −0.073 | 0.063 |
| | | | | (0.073) | (0.142) |
| $\Delta p_t$ | | | | | 0.387** |
| | | | | | (0.181) |
| $\Delta \bar{y}_{wt}$ | 8.406** | −2.639* | 0.233 | 0.865*** | −0.520 |
| | (3.649) | (1.590) | (0.389) | (0.298) | (0.592) |
| $\Delta x_{t-1}^0$ | −0.051 | 0.044 | −0.005 | −0.003 | 0.023* |
| | (0.090) | (0.038) | (0.009) | (0.007) | (0.014) |
| $\Delta e_{f,t-1}$ | −0.441** | 0.350*** | −0.025 | −0.009 | 0.041 |
| | (0.217) | (0.094) | (0.027) | (0.020) | (0.036) |
| $\Delta m_{t-1}$ | −0.715 | 0.149 | 0.218** | −0.025 | 0.046 |
| | (0.930) | (0.397) | (0.096) | (0.075) | (0.144) |
| $\Delta p_{t-1}$ | 0.052 | −0.341 | 0.167 | 0.488*** | −0.505*** |
| | (0.794) | (0.338) | (0.115) | (0.089) | (0.167) |
| $\Delta y_{t-1}$ | 0.122 | −0.145 | 0.025 | 0.042 | −0.221** |
| | (0.592) | (0.252) | (0.063) | (0.048) | (0.090) |
| $\Delta p_{t-2}$ | | | −0.070 | 0.183** | |
| | | | (0.104) | (0.079) | |
| Residual serial | 2.406 | 6.212 | 7.640 | 8.061 | 7.240 |
| correlation test | [0.662] | [0.184] | [0.106] | [0.089] | [0.124] |
| Adjusted $R^2$ | 0.122 | 0.209 | 0.466 | 0.659 | 0.124 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}$, $\Delta m_t$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. $\Delta \bar{y}_{wt}$ is the quarterly world output growth, computed as $\bar{y}_{wt} = \sum_{i=1}^n w_i y_{it}$, with $\{y_{it}\}_{i=1}^n$ being the natural log of real output for 33 major economies, and $\{w_i\}_{i=1}^n$ are GDP-PPP weights. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t\right)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are least squares standard errors, and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See Sections S.2.1, S.2.2, S.2.5, and S.2.6 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable, calendar conversions, and sources of the data used. Regressions results that include other global control variables (e.g. global realized volatility) are provided in Tables S.10a–S.10e in the online supplement.

Since – in the SVAR model – money supply growth plays a minimal role in the determination of inflation and exchange rate variations, and exchange rate remains the primary driver of inflation and output growth, we decided to simplify the model by dropping the money supply growth from the SVAR model. The estimation results for this simplified model are summarized in Tables S.11a to S.11e, and S.12a to S.12e of the online supplement.[40] As can be seen, the estimates for the four equations in the current SVAR model are very close to those in the model with money supply growth, confirming further that money supply growth is not essential for the analysis of the interrelationships of exchange rate, inflation and output growth in Iran, which is the primary concern of our analysis. It is also worth noting that our main findings are not much affected by re-ordering of the domestic variables. In Section S.4 of the online supplement we provide results of estimating the SVAR model in (6), with the following ordering of the domestic variables: $\{\Delta e_{ft}, \Delta x_t^0, \Delta m_t, \Delta p_t, \Delta y_t\}$. For this ordering, the foreign exchange is placed first and oil export revenues second to capture the idea that the rial may react even faster than $\Delta x_t^0$ to announcements of new sanctions. The results are summarized in Tables S.13a to S.13f, and – as aforementioned – they are largely not affected by this change. In Tables S.14a to S.14e, we consider the effects of re-ordering of the variables in the case of the simplified model without the money supply growth or seasonal dummies, and it is once again confirmed that the results are reasonably robust to the re-ordering of the variables under consideration.

Overall sanctions have affected Iran in a number of ways and through different direct and indirect channels, the most important of which are falls in oil export revenues and the exchange rate depreciation. The exchange rate depreciation itself could have its roots in persistently high levels of inflation, coupled with a reduction in oil revenues and anticipated decline in private sector activity. The currency depreciation in turn leads to higher import prices and lower economic growth. We also find that the *direct* effect of sanctions on inflation is rather small, compared to an average annual inflation norm of around 18 per cent in Iran (See Table 1).

Money supply growth seems to follow patterns which are neither related to sanctions nor to any of the domestic variables, notably inflation, which could be due to the underdevelopment of capital and money markets in Iran, as highlighted recently by Mazarei (2019). These results seem quite robust to other measures of liquidity such as M1 or private sector credit.[41]

## 5.2 Impulse response analysis

The estimates of the individual equations provided in Table 4 provide a snap-shot of how sanctions interact with some of the key macroeconomic variables. However, given the dynamic and simultaneous nature of the model, to fully understand and evaluate the nature and consequences of these interactions, we compute impulse response functions (*IRFs*) and forecast error variance decompositions (*FEVDs*) for the augmented SVAR model

[40] Dropping the money supply growth from the SVAR model, also renders the seasonal dummies statistically insignificant. Thus seasonal dummies are not included in the SVAR model that excludes the money supply growth variable.

[41] Estimates based on these alternative measures of liquidity are available upon request.

given by (6).[42] We have seen that money supply growth does not play much of a role in the determination of inflation and output growth, and is hardly affected by sanctions. Also, amongst the control variables, only foreign output growth seems to exert statistically significant effects on inflation and output growth. For these reasons, to compute IRFs and FEVDs we will be focussing on the SVAR model with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta p_t, \Delta y_t\right)'$, augmented with the sanction variables and $\Delta\bar{y}_{wt}$ as the foreign control variable. We also use AR(1) models for $s_t$ and $\Delta\bar{y}_{wt}$ to capture the dynamics of these exogenous processes.[43]

The IRFs for positive one standard error (s.e.) shocks to $s_t$ and $\mathbf{q}_t$ are displayed in Figure 2.[44] *Panel A* of this figure shows the results for the sanction shock. One standard deviation for $s_t$ is equal to 0.120, which represents half of the average sanctions intensity over the period considered ($\bar{s}_{1989q1-2019q4} = 0.24$).[45] A single quarter shock to sanctions intensity causes oil exports to decrease by almost 5 per cent after one quarter, with some reversal thereafter. But the negative effects of sanctions on oil export revenues continue to be important even after four quarters with losses that are still about 1 per cent. The positive shock to sanctions also causes the foreign exchange rate to depreciate by about 3 per cent in the same quarter, but its effects are rather short lived and become statistically insignificant two quarters after the shock. For inflation and output growth, the effects of the sanction shock last much longer. Its effects on inflation are particularly persistent and last at least for four years after the shock, although its magnitude is relatively small: 0.3 per cent increase per quarter in the first year. The effects of sanction shock on output growth, on the other hand, are much larger in size. A single period one standard error shock to sanctions causes output growth to fall by more than 0.4 per cent per quarter (1.6 per cent per annum). The loss in output growth is still close to 0.2 per cent per quarter two years after the shock.

*Panel B* of Figure 2 displays the results for a single quarter shock to oil revenues. The effect on oil export revenues themselves is very large and positive, although rather short-lived, reflecting the rather volatile nature of oil export revenues. The effects of oil revenue shock on foreign exchange rate is not that large, around 1.2 after one quarter, and then falling to zero after four quarters. Its effects on inflation is positive but quite small, around 0.2 per cent after two quarters. The positive shock to oil revenues induces a rise in output of around 0.5 per cent on impact which is statistically significant, but this effect is short lived and tends to zero quite rapidly.

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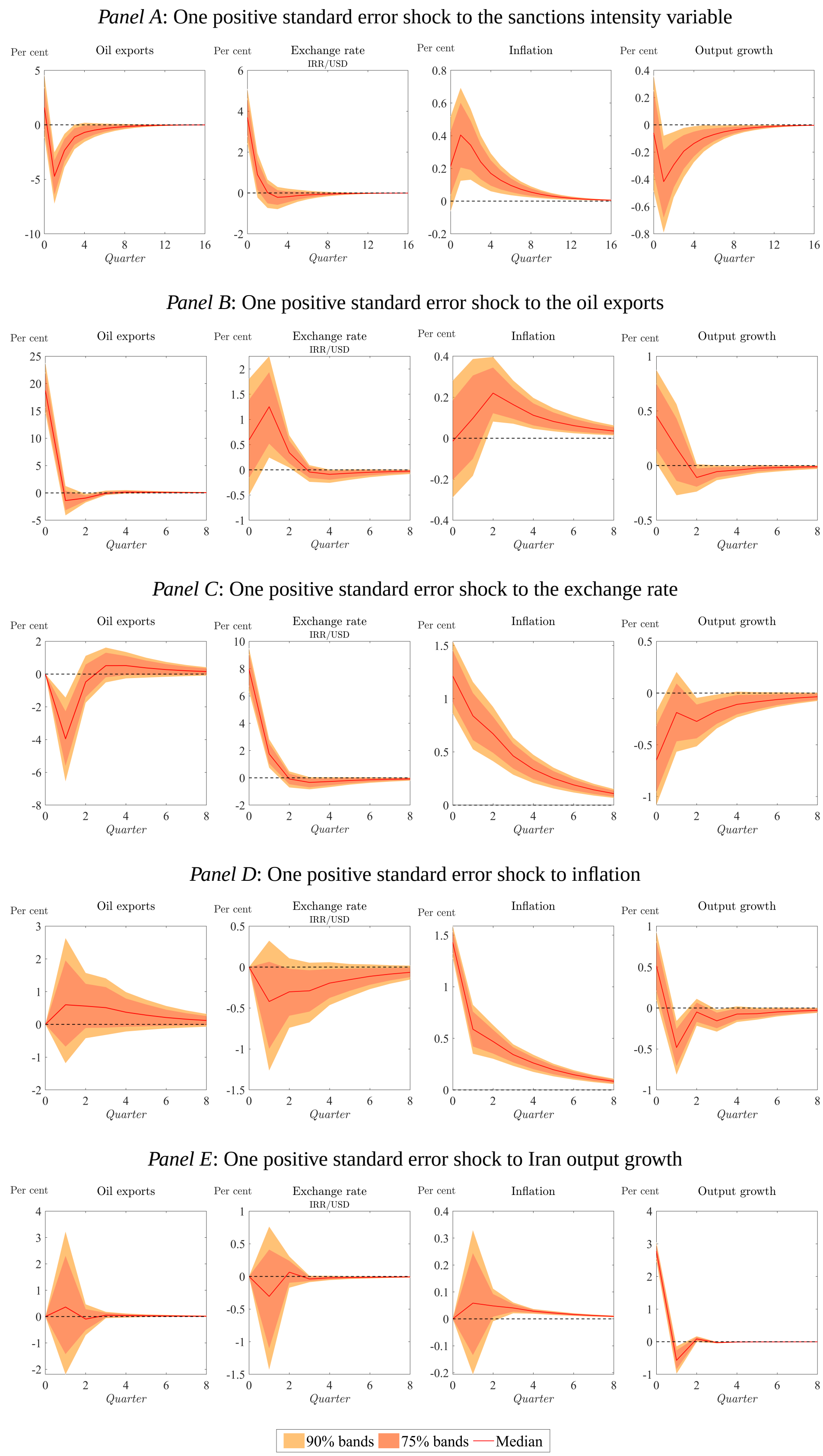
42 Detail of the derivations of IRFs and FEVDs are given in Sections S.3.1 and S.3.2 of the online supplement, respectively.

43 Time series evidence in support of our choice of AR(1) specifications for $s_t$ and $\Delta\bar{y}_{wt}$ are provided in Tables S.6 and S.7 of the online supplement. It is also worth noting that the assumed AR(1) processes for $s_t$ and $\Delta\bar{y}_{wt}$ only affect the IRFs and FEVDs, and do not affect the estimates of the SVAR model.

44 The error bands for the point estimates shown in these figures are computed using the bootstrap procedure described in Sub-section S.3.4 of the online supplement.

45 See Table 2 for the descriptive statistics of the sanctions intensity indicator, and note that one s.e. sanction shock is computed using the AR(1) specification assumed for $s_t$ – it is smaller than the one standard deviation of $s_t$. Information on the size of one standard error shock in the case of the endogenous variables in the SVAR model are provided in Table S.8 of the online supplement.

Figure 2: Impulse responses of the effects of sanctions and domestic shocks on oil exports, foreign exchange, inflation, and output growth



The results for the foreign exchange rate shock are given in *Panel C* of Figure 2. The effect of this shock on oil export revenues is negative and amounts to $-$ 4 per cent one quarter after the shock before reverting to zero thereafter. More interestingly, one quarter exchange rate shock induces a sizeable and precisely estimated effect (of around 8 per cent per quarter) on exchange rate, but similar to the effects of the sanction shock, it does not last long and its effects dissipate very quickly after two quarters. The exchange rate shock raises inflation on impact by around 1.2 per cent per quarter, and then starts to fall and vanishes completely after about two years. The same is not true of real output growth. The direct effects of foreign exchange shock on output growth are negative and statistically significant but small in magnitude, around $-0.50$ per cent on impact, which then moves towards zero very quickly.

*Panel D* of Figure 2 gives the results for an inflation shock (for example, due to a domestic expansionary policy). Again, because of the highly persistent nature of inflation in Iran, the most pronounced effects of the inflation shock is on inflation itself, raising inflation by 1.5 per cent per quarter on impact and then falling gradually to zero after two years. Interestingly, the effect of inflation shock on exchange rate is not statistically significant, suggesting that the causal link between them is from exchange rate to inflation and not *vice versa*. Compare the IRFs for exchange rate and inflation in Panels C and D of Figure 2. The effects of inflation shock on output growth are positive on impact but small in magnitude, and reverse quickly after one quarter, suggesting that it might not be possible to increase output by expansionary policies. The effects on oil export revenues do not appear to be statistically significant.

Finally, the IRFs of the effects of a positive shock to output growth are displayed in *Panel E* of Figure 2. A positive output shock could be due to technological advance or fundamental reforms that reduce economic distortions and enhance production opportunities. The output shock seems to have little impact (in short or medium term) on both oil exports and exchange rate, which seem to be primarily driven by sanctions and their own dynamics. The positive output shock also has a minimal effect on inflation, increasing inflation by less than 0.1 per cent per quarter after two quarters. The primary effects of the output shock are on output itself, raising output by 2.8 per cent per quarter on impact before losing momentum in less than a year. The initial very large increase in output is somewhat of an over-reaction which is then corrected slightly, yet providing a net 2 per cent rise in output within the year of the shock. Once again this result highlights the importance of supply side policies for improving Iran's output growth in the long run.[46]

The impulse response analysis confirms some of the preliminary conclusions set out in Section 5.1. Sanctions have their most impact on oil exports, free market exchange rate, and to a lesser extent on output growth.

[46] In the online supplement, we provide impulse responses for a positive shock to the world output growth in Figure S.5.

Inflation has its own dynamics and is hardly affected by sanctions. The roots of high and persistent inflation must be found in domestic economic mismanagement. Also, sanctions do adversely affect output growth after one quarter but such effects are short lived.

## 5.3 Forecast error variance decompositions

We now turn to a quantification of the relative importance of sanctions as compared to the four domestic shocks and the foreign output shock. Table 5 presents the results.[47] In *Panel A* we report estimates of the FEVDs of a unit shock to oil export revenues. As can be seen, around 96 per cent of the forecast error variance of oil export revenues is explained by the shock to oil revenues itself. Other factors come into play in subsequent quarters, but they explain only a small proportion of the total forecast error variance, with sanctions explaining 6 per cent, foreign exchange 2 per cent, and world output growth around 4 per cent. It is clear that a single isolated sanction shock is not enough to make a significant impact on oil export revenues, and a prolonged period of sanctions is required for sanction effects to cumulate and lead to a sizeable effect.

*Panel B* of Table 5 gives the results for the foreign exchange variable. Not surprisingly, foreign exchange shocks are the most important, and account for 82 per cent of forecast error variance on impact and decline only slightly, falling to 80 per cent after one quarter. Sanctions shock accounts for 17 per cent of the variance, with the other shocks contributing very little. Therefore, isolated sanctions do not drive Iran's exchange rate, and only become a dominant force if we consider prolonged periods over which sanction shocks are in place with the same intensity.

The FEVDs of inflation, reported in *Panel C* of Table 5, show that foreign exchange and inflation shocks account for the bulk of the variance, with sanction shocks accounting for the remainder. Oil exports, domestic and foreign output shocks make little contribution. On impact, inflation shock accounts for 55 per cent of the variance, flattening out at 42 per cent after six quarters. In contrast, the contribution of the foreign exchange shock rises from 43 per cent on impact to 50 per cent after three quarters. The contribution of the sanction shock is not particularly large, and starts at 1 per cent, but rises to 7 per cent after six quarters. Once again, we see that inflation and exchange rates in Iran are mainly driven by domestic factors. But sanctions effects could accumulate very quickly if we consider sanctions being in place over a prolonged period of time.

Finally, the FEVDs of output growth are reported in *Panel D* of Table 5. As can be seen, the output shock is by far the most important shock and accounts for 90 per cent of forecast error variance of output growth on impact and falls only slightly to 82 per cent after four quarters. In line with our estimates, sanctions shocks do

[47] FEVDs are computed using Equations (S.9), (S.10), and (S.11).

Table 5: Forecast error variance decomposition for domestic variables in the SVAR model with a single shock to sanctions

*Panel A*: FEVD for oil exports

| *Quarter ahead* | Proportion explained by a shock to: $s_t$ | $\Delta x_t^0$ | $\Delta e_{ft}$ | $\Delta p_t$ | $\Delta y_t$ | $\Delta \bar{y}_{wt}$ |
|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.96 | 0.00 | 0.00 | 0.00 | 0.03 |
| 1 | 0.04 | 0.90 | 0.02 | 0.00 | 0.00 | 0.04 |
| 2 | 0.05 | 0.89 | 0.02 | 0.00 | 0.00 | 0.04 |
| 3 | 0.06 | 0.88 | 0.02 | 0.00 | 0.00 | 0.04 |
| 4 | 0.06 | 0.88 | 0.02 | 0.00 | 0.00 | 0.04 |
| 5 | 0.06 | 0.88 | 0.02 | 0.00 | 0.00 | 0.04 |
| 6 | 0.06 | 0.88 | 0.02 | 0.00 | 0.00 | 0.04 |
| 7 | 0.06 | 0.88 | 0.02 | 0.00 | 0.00 | 0.04 |
| 8 | 0.06 | 0.88 | 0.02 | 0.00 | 0.00 | 0.04 |

*Panel B*: FEVD for exchange rate

| *Quarter ahead* | Proportion explained by a shock to: $s_t$ | $\Delta x_t^0$ | $\Delta e_{ft}$ | $\Delta p_t$ | $\Delta y_t$ | $\Delta \bar{y}_{wt}$ |
|---|---|---|---|---|---|---|
| 0 | 0.17 | 0.00 | 0.82 | 0.00 | 0.00 | 0.01 |
| 1 | 0.17 | 0.01 | 0.80 | 0.00 | 0.00 | 0.02 |
| 2 | 0.17 | 0.01 | 0.80 | 0.00 | 0.00 | 0.02 |
| 3 | 0.17 | 0.01 | 0.80 | 0.01 | 0.00 | 0.02 |
| 4 | 0.17 | 0.01 | 0.80 | 0.01 | 0.00 | 0.02 |
| 5 | 0.17 | 0.01 | 0.80 | 0.01 | 0.00 | 0.02 |
| 6 | 0.17 | 0.01 | 0.80 | 0.01 | 0.00 | 0.02 |
| 7 | 0.17 | 0.01 | 0.80 | 0.01 | 0.00 | 0.02 |
| 8 | 0.17 | 0.01 | 0.80 | 0.01 | 0.00 | 0.02 |

*Panel C*: FEVD for inflation

| *Quarter ahead* | Proportion explained by a shock to: $s_t$ | $\Delta x_t^0$ | $\Delta e_{ft}$ | $\Delta p_t$ | $\Delta y_t$ | $\Delta \bar{y}_{wt}$ |
|---|---|---|---|---|---|---|
| 0 | 0.01 | 0.00 | 0.43 | 0.55 | 0.00 | 0.01 |
| 1 | 0.04 | 0.00 | 0.48 | 0.48 | 0.00 | 0.01 |
| 2 | 0.05 | 0.00 | 0.49 | 0.45 | 0.00 | 0.01 |
| 3 | 0.06 | 0.00 | 0.50 | 0.43 | 0.00 | 0.01 |
| 4 | 0.06 | 0.00 | 0.50 | 0.43 | 0.00 | 0.01 |
| 5 | 0.06 | 0.00 | 0.50 | 0.43 | 0.00 | 0.01 |
| 6 | 0.07 | 0.00 | 0.50 | 0.42 | 0.00 | 0.01 |
| 7 | 0.07 | 0.00 | 0.50 | 0.42 | 0.00 | 0.01 |
| 8 | 0.07 | 0.00 | 0.50 | 0.42 | 0.00 | 0.01 |

*Panel D*: FEVD for output growth

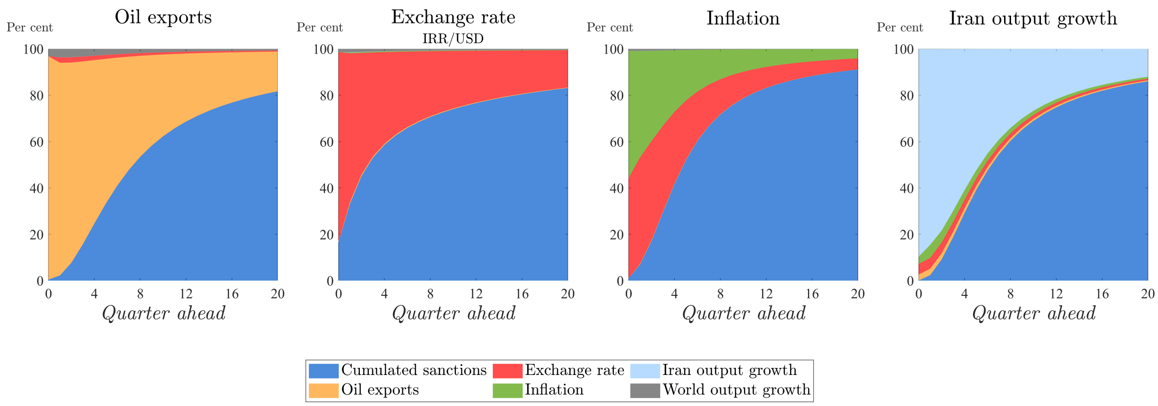
| *Quarter ahead* | Proportion explained by a shock to: $s_t$ | $\Delta x_t^0$ | $\Delta e_{ft}$ | $\Delta p_t$ | $\Delta y_t$ | $\Delta \bar{y}_{wt}$ |
|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.03 | 0.05 | 0.03 | 0.90 | 0.00 |
| 1 | 0.02 | 0.03 | 0.05 | 0.06 | 0.85 | 0.00 |
| 2 | 0.03 | 0.03 | 0.05 | 0.06 | 0.83 | 0.00 |
| 3 | 0.04 | 0.03 | 0.05 | 0.06 | 0.83 | 0.00 |
| 4 | 0.04 | 0.03 | 0.05 | 0.06 | 0.82 | 0.00 |
| 5 | 0.04 | 0.03 | 0.05 | 0.06 | 0.82 | 0.00 |
| 6 | 0.05 | 0.03 | 0.05 | 0.06 | 0.82 | 0.00 |
| 7 | 0.05 | 0.03 | 0.05 | 0.06 | 0.82 | 0.00 |
| 8 | 0.05 | 0.03 | 0.05 | 0.06 | 0.82 | 0.00 |

**Notes**: $s_t$ is the quarterly sanctions intensity variable. $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars. $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the Iran rial/U.S. dollar quarterly free market exchange rate. $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran. $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $\Delta \bar{y}_{wt}$ is the quarterly world output growth: $\bar{y}_{wt} = \sum_{i=1}^{n} w_i y_{it}$, with $\{y_{it}\}_{i=1}^{n}$ being the natural log of real output for 33 major economies, and $w_i$ the GDP-PPP weights.
See Sections S.2.1, S.2.2, S.2.5, and S.2.6 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable, calendar conversions, and sources of the data used.

not affect output growth on impact, and end up explaining only 5 per cent of the variance after six quarters. Foreign output shocks do not have any explanatory power for Iran's output growth. The other three domestic shocks (oil exports, inflation and exchange rate) together account for 14 per cent of forecast error variance of output growth after one quarter, and do not increase any further after that.

The outcome of FEVDs is very different if we consider the effects of a prolonged period of sanctions, namely if sanctions are imposed for over 2 or more years. The results are summarized in Figure 3. When sanctions are imposed with the same intensity for about two years, sanctions explain more than 70 per cent of the forecast error variance of inflation and around 60 per cent of the forecast error variance of output growth, keeping all other shocks fixed.

Figure 3: Forecast error variance decomposition for domestic variables in the SVAR model with a cumulative shock to sanctions, and domestic variables ordered as oil exports, exchange rate returns, inflation, and output growth




# 6 Concluding remarks

In this paper, using a novel measure of the intensity of sanctions based on newspaper coverage, we have quantified the effects of sanctions on oil exports, exchange rate, inflation, and output growth in Iran. In order to estimate the prolonged effect of sanctions on the Iranian economy, we faced several measurement and econometric challenges. Iran's recent history formed by the Islamic Revolution, hostage taking and the eight year war with Iraq, makes it hard to have a reliable "donor pool" of countries to construct a synthetic Iran. Furthermore, Dif-in-Dif methods cannot be applied because a relevant pre-sanctions episode is not available. Finally, the degree of intensity of sanctions imposed on Iran has varied considerably over time while never being completely lifted. For these reasons, a novel identification strategy was provided to overcome the difficulties that could not be addressed by using approaches such as the Synthetic Control Method and the Panel Data Approach (Hsiao et al. (2012)). In addition, we have proposed the first newspaper-based indicator to track sanctions intensity. In doing so, it was possible to solve the issue of not having a "sanction off" period, something impossible to capture with a dummy variable estimator. With a novel econometric strategy and a sanctions index at hand, we proceeded to analyze both the reduced-form long term effects of sanctions on Iranian output, and the channels through which such losses manifested.

When evaluating the direct and indirect costs of sanctions, we have followed the literature and attempted to control for possible confounders, namely external and domestic factors that affect the economy but are unrelated to sanctions, such as advances in technology, world output growth, and international prices. Using a reduced form regression of output growth on our sanctions intensity variable, we estimate Iran's output loss to be around 2 per cent per annum, which is considerable when cumulated over time. There is, of course, a high degree of uncertainty associated with such estimates which should be borne in mind. But – even if we compare Iran's growth performance over the 1989q1-2021q1 period with that of Turkey and other similar size emerging economies – we find that Iran's realized output growth of 3 percent still lies below the average growth of 4.4 per cent experienced by Indonesia, Turkey, South Korea and Thailand over the same period.[48]

A SVAR analysis augmented with the proposed sanctions variable as well as global factors, allows us to identify the channels of transmission of sanctions to the broader economy. Oil exports revenues drop first as a direct consequence of new sanctions, accompanied by an instantaneous depreciation of the Iranian rial *vis-à-vis* the U.S. dollar, which is subsequently translated into higher consumer prices, and slower economic growth. Monetary policy appeared to be passive, and accommodating the behavior of other macro-financial variables once we control for a number of factors. Overall, the economy appeared rather isolated from global factors.

There is no doubt that sanctions have harmed the Iranian economy, but one should not underestimate the damage done by years of economic mismanagement. Iran's low output growth relative to its potential, high inflation and excess output growth volatility cannot all be traced to sanctions and have domestic roots stemming from prolonged periods of economic mismanagement, distorted relative prices, rent seeking, a weak banking system and under-developed financial institutions. Sanctions have accentuated some of these trends and delayed the implementation of highly needed reforms.

A more comprehensive analysis of sanctions also requires detailed investigation into how sanctions and their variability over the past forty years have affected policy decisions at all levels, from monetary and fiscal policies to industrial, regional and social policies. It is generally agreed that, at times of increased sanctions intensity, governments fearful of political consequences are reluctant to curtail distortionary policies, such as large subsidies on food and energy, and they might even accentuate them, or resort to multiple exchange rates to reduce the inflationary effects of sanctions.

Sanctions have also led to some positive unintended effects. Non-oil exports have risen from $600 million before the Revolution to around $40 billion, resulting in greater foreign exchange diversification. The high-tech sector has seen exponential growth over the past 10 years and is now one of the regions' fastest growing sectors. Iran's major web-based companies have been protected by potential competition from their U.S. counterparts shown in brackets including: Digikala (Amazon), Aparat (YouTube), Cafe Bazaar (Google Play), Snapp (Uber), Divar (Craigslist). It is estimated that over 65 per cent of Iranian households are now

[48] If we take the 1990 value of GDP-PPP (constant international dollars) for Iran and cumulate the potential losses over the period until 2019, we reach a similar conclusion. In the conservative scenario in which Iran grows at 4.5 per cent per annum rather than 3.08, its output would be 18th in the world between Saudi Arabia and Thailand. By using a less conservative yet still plausible estimate – if Iran were to grow at 5.5 per cent, its output would be double the level experienced in 2019. It would be the 15th largest economy between South Korea and Spain – two developed countries by now. We thank an anonymous referee for this idea.

connected to the internet. This rapid expansion was facilitated by the government and security apparatus making affordable high-speed internet a reality in Iran. The Mobile Telecommunication Company of Iran, largely controlled by the Islamic Revolutionary Guard Corps now has over 43 million subscribers. Sanctions have also resulted in significant advances in the areas of missiles and other military-related technologies. It is estimated that IRGC control between 10-30 per cent of the economy, with large stakes in the oil and gas sectors, construction, telecom, banking, and tourism. One could argue that IRGC has been a major beneficiary of U.S. sanctions.

Our sample does not cover the period from January 2020 when Covid-19 effects started to be felt in Iran. However, it is clear Covid-19 could have important medium term consequences, particularly for the traditional service sector. The Covid shock has been truly global – it has hit almost 200 countries with different degrees of severity, with its effects magnified through global trade and financial linkages. The full economic impact of Covid-19 on the Iranian economy is unknown and requires further investigation.

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# Online supplement to "Identifying the Effects of Sanctions on the Iranian Economy using Newspaper Coverage"

Dario Laudati

University of Southern California

M. Hashem Pesaran

University of Southern California, USA, and Trinity College, Cambridge, UK

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## S.1 Introduction

This online supplement is composed of four main sections. Section S.2 gives details of data sources and construction of some of the key variables used in our analysis. Sub-sections S.2.1–S.2.4 provide details of how the proposed sanctions intensity variable and alternative sanction dummies are constructed. Sub-section S.2.5 gives information on conversion of data from the Iranian calender to the Gregorian calender. Sub-section S.2.6 provides details of data sources for the socioeconomic variables, and plots some of the main macroeconomic variables discussed in Section 2 of the paper. In Section S.3 we present details of the computation of impulse response functions (IRFs), forecast error variance decompositions (FEVDs), and the bootstrapping procedure used to obtain error bands for IRFs. Section S.4 reports other empirical results such as the AR specifications for the sanctions indicator variable and the world output growth. Additional results for the sanctions-augmented SVAR model, allowing for a number of controls are available in Sub-section S.4.6. Sub-section S.4.7 provides the estimates of the IRFs for a shock to the global output growth not presented in the main paper, and IRFs and FEVDs under a different ordering of the variables in the SVAR model. Finally, a comprehensive list of all major sanctions against Iran from November 1979 to January 2021 is provided in Table S.31.

## S.2 Data appendix

### S.2.1 Sanctions intensity variable

Our sanctions intensity variable, $s_t$, is based on newspapers coverage of sanction events against Iran. Articles were retrieved from the platform *ProQuest* (www.proquest.com) which covers the whole period of interest

1979q1–2020q3. ProQuest has detailed newspapers archives with good search capabilities. The only exception to ProQuest was the *Financial Times Historical Archive* accessed through *Gale Historical Newspapers* (www.gale.com/intl/primary-sources/historical-newspapers), which helped to fill a gap left by ProQuest for articles published in the Financial Times before 1996.

**Criteria of inclusion**

We focused on six major newspapers: the New York Times, the Washington Post, the Los Angeles Times, the Wall Street Journal, the Guardian, and the Financial Times. We only selected articles published in the newspapers print version thus disregarding blogs, websites and other digital formats which are only available more recently; however, we did allow for all types of articles to be included, e.g. we included both editorials and main articles.

ProQuest has both a general *ProQuest Central* database, holding information for the relatively more recent publications, and several historical newspaper-specific collections for the most highly printed world outlets, *ProQuest Historical Newspapers*, which proved useful in order to extend our series back to 1979. Accordingly, we used the ProQuest Central data for the maximum period available for each newspaper, and complemented each series with the *ad-hoc* historical data sets before such dates. See Table S.1 for details. As mentioned already, the only exception was the articles published in the Financial Times before 1996, for which there does not exist a historical archive on ProQuest, and instead Gale Historical Newspapers were used.

To create the index of sanctions imposed on Iran ("sanctions on"), articles were required to include the following terms: "economic*", "sanction*", "against", "Iran*", with the additional feature of excluding articles in which "lift*" was present. The star at the end of the previous words allowed the search engine to pick words beginning with the same initial letters thus including terms such as: "sanctioning", "Iranian", "lifting" etc.. Although the number of potential synonyms and keywords to describe the phenomenon is virtually very high, this set of words seemed to capture rather well the extent to which Iran was mentioned as target of international measures. We also found that further complicating the search did not produce sensible results, as the new commands often could not be recognized by the search engine.

The search was carried out for each newspaper series separately by specifying the name of the newspaper in the options list "Publication title – PUB". For some newspapers the search engine produced a handful of duplicates of the same articles despite the option "Exclude duplicate documents" under "Result page options" had being ticked. To address this issue, all articles were manually checked before starting the download in order to avoid double-counting of articles.[1]

For the period 1990q3–1991q2, the search commands for sanctions against Iran were updated to exclude also the word "Iraq". This adjustment was necessary in order to avoid confounding noise due to the events of the Iraq invasion of Kuwait in August 1990, and the subsequent Gulf War period, from January to February 1991. These events received massive press coverage, which led Iran to be mentioned for geopolitical reasons, not because of sanctions. Also, some newspapers reported two additional small spikes not strictly related to Iran: (*i*) For the terrorist attacks happened between December 1985 (in Rome and Vienna airports) and April 1986 (in a West Berlin discotheque); (*ii*) For the "1998 Coimbatore bombings" attacks in southern India. In both cases, Iran was not the target of new sanctions therefore a manual check deletion of these small number of occurrences had to be carried out.

The intensity variable to capture the partial lifting of sanctions ("sanctions off") included the words beginning with "economic*", "sanction*", "against", "Iran*" but now allowing also for *at least* one of the following words: "lift*", "waive*" and "accord*". An exception was made for the Historical Database of the Financial Times, which does not support sophisticated search structures. Therefore, a simple research allowing for "sanctions against Iran" and "deal*" was conducted to capture the highest number of articles, which were subsequently checked and skimmed manually to meet our criteria of inclusion.

A detailed chronological study of economic sanctions against Iran allowed us to restrict our search of "sanctions off" on two time periods only. First, in 1981 when the Algiers Accords were signed and the "Tehran hostage crisis" ended; second, from 2016q1 to 2018q2, when the Joint Comprehensive Plan of Action (*JCPOA*) was enacted by all world major powers before U.S. President Trump withdrew the country from the agreement. Accordingly, for construction of the sanction-off index we focussed on the periods 1981q1–1981q4 and 2015q1–2018q2 in order to avoid unnecessary noise for the time in between and after Trump's announcement. The "sanctions off" period of our indicator was extended to one year before the actual implementation of the JCPOA in order to allow for possible anticipatory effects.

[1] The extent of this technical hurdle varied considerably amongst outlets. It was particularly severe for journals such as the Los Angeles Times, while virtually non-existent for other newspapers such as the New York Times.

Table S.1: Sources of newspaper articles over the period 1979m1–2020m9

| | Period | |
|---|---|---|
| | Historical dataset | Modern dataset |
| New York Times | 1979m1–1980m12 | 1981m1–2020m9 |
| Los Angeles Times | 1979m1–1984m12 | 1985m1–2020m9 |
| Washington Post | 1979m1–2002m12 | 2003m1–2020m9 |
| Wall Street Journal | 1979m1–1983m12 | 1984m1–2020m9 |
| Guardian | 1979m1–1996m12 | 1997m1–2020m9 |
| Financial Times | 1979m1–1995m12 | 1996m1–2020m9 |

**Notes**: "Historical data set" is the *ProQuest Historical Newspapers* data set for all newspapers except the Financial Times, for which information have been retrieved from *Gale Historical Newspapers.* "Modern data set" is *ProQuest Central* database for all newspapers considered.

### S.2.2 Sanctions intensity variable construction

Having obtained a number of daily articles related to the sanctions imposed ("sanctions on") and lifted ("sanctions off"), we proceeded with the following steps in order to build our estimator, $s_t(w) = s_{t,on} - w \times s_{t,off}$. Here we focus on the construction of $s_{t,on}$. The same procedure was used to construct $s_{t,off}$.

First, we computed a monthly series for each of our $J$ newspapers ($J = 6$) by averaging our daily series over the number of articles per month. In turn, we carried out a simple average across newspapers, which led us to have a single monthly series of "sanctions on" articles; subsequently, we averaged the monthly observations over each quarter to obtain the quarterly series. The "sanctions on" average was then divided by its maximum value over the period 1989q1–2020q3 in order to obtain the indicator $s_{t,on}$; so that $s_{t,on}$ index was defined on the $(0,1)$ range. We obtained a second variable $s_{t,off}$ from our "sanctions off" raw count by following the same steps just described. Finally, we estimated the weight, $w \in (0,1)$, with a grid search in order to derive our final sanctions intensity variable $s_t = s_{t,on} - w \times s_{t,off}$. The grid search was performed by running the regressions:

$$\Delta y_t = \beta_0 + \beta_1 \Delta y_{t-1} + \beta_2 s_{t-1}(w) + \varepsilon_t, \tag{S.1}$$

over the period 1989q1–2019q4, with $\Delta y_t$ being Iran's quarterly real output growth, and with a step size of our grid equal to 0.1. The optimal weight was estimated as $\hat{w} = 0.4$, although the shape of the likelihood was rather flat. Table S.2 provides the values of the log-likelihood of Equation (S.1) estimated for different values of parameter $w$.

Table S.2: Quarterly estimates of the log-likelihood of Equation (S.1) estimated over the period 1989q1-2019q4 for values of $w \in \{0.1, 0.2, \ldots 0.9\}$

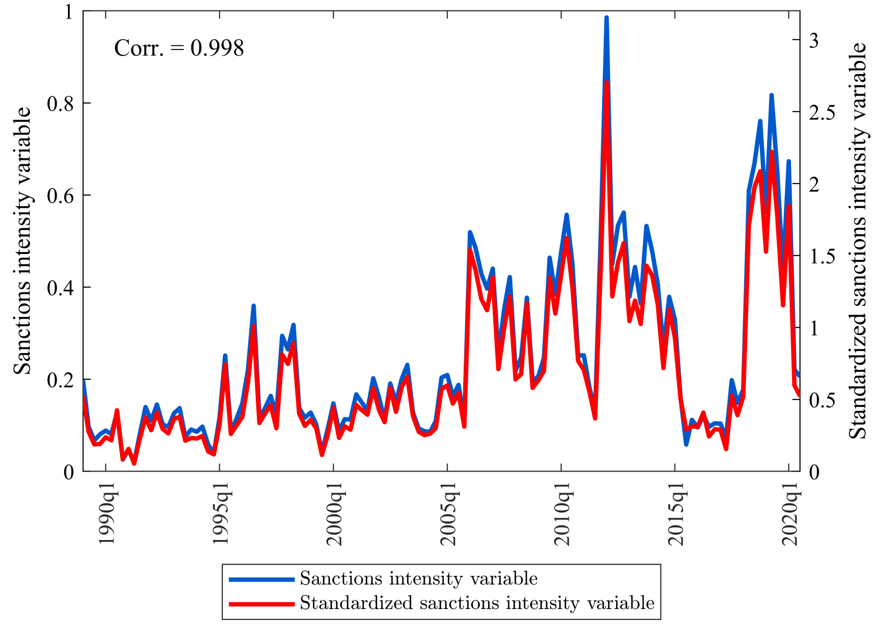
| Grid value, $w$ | Equation log-likelihood |
|---|---|
| 0.1 | 258.095 |
| 0.2 | 258.213 |
| 0.3 | 258.289 |
| 0.4 | 258.320 |
| 0.5 | 258.305 |
| 0.6 | 258.248 |
| 0.7 | 258.153 |
| 0.8 | 258.028 |
| 0.9 | 257.880 |

**Notes:** The values on the grid of $w$ have been used to construct different sanctions intensity indicators $s_t(w) = s_{t,on} - w \times s_{t,off}$. The maximum likelihood of Equation (S.1) across different grid values provided the specification for the optimal weight $\hat{w}$. See Sections S.2.1 and S.2.2 for details on the construction of $s_{on,t}$ and $s_{off,t}$.

As a robustness check, we created a standardized version of our indicator by following the approach advanced by Baker et al. (2016). We divided each of the $J$ newspapers monthly raw series by their respective standard deviations. [2] The final standardized intensity variable was obtained as before by averaging across newspapers at monthly frequency, taking the simple mean for each quarter (for both sanctions "on" and "off"), dividing each series by their respective maxima over the period 1989q1–2020q3, and subtracting the "standardized sanctions off" series from the "standardized sanctions on". We found these weighted "sanctions on" and "sanctions off" series to be very close to the ones based on simple averages, and as a result the grid search applied to the weighted series also resulted in the estimate $\hat{w} = 0.4$. Even though this procedure was meant to avoid newspapers with a larger number of articles per issue to carry unwarranted weight, the two series co-move almost perfectly $(\rho = 0.998)$. See Figure S.1. This finding is consistent with Plante (2019), who adjusts for the number of total articles per month and finds that his two measures correlate at 0.97.

[2] For a measure of "sanctions on", we considered the standard deviations over the entire period 1979m1–2020m9. For "sanctions off", the monthly raw counts during 1981m1–1981m12 and 2015m1–2018m6 were divided by the standard deviations over their respective periods.

Figure S.1: Sanctions intensity variable and standardized sanctions intensity variable over the period 1989q1–2020q3




**Notes**: See Section 3 of the paper for the sanctions intensity variable definition over the range (0,1). See Sections S.2.1 and S.2.2 in the data appendix of the online supplement for details on construction of both the sanctions intensity variables.

### S.2.3 U.S. Treasury sanctions variable construction

We also constructed a measure of sanctions intensity based on the U.S. Treasury "Specially Designated Nationals And Blocked Persons List (*SDN*)". The online database of the Treasury keeps track only of the entities *currently* sanctioned. To compile a complete time series list of all Iranian entities, individuals, and vessels being sanctioned by the U.S., we used yearly *pdf* files available in the online archive of the U.S. Treasury. In this way, we were able to follow over time each entity entering and exiting the database.[3] The list of sanctioned entities can be retrieved from 1994 onwards but the number of entries for Iran up to 2005 is negligible. This is in line with the historical record of U.S. sanctions against Iran. Therefore, we focussed on building our entry-exit matrix from 2006 onwards.

To construct the *U.S. Treasury sanctions variable,* we first summed the total number of Iranian entities, individuals, and vessels being hit by U.S. sanctions.[4] In the SDN lists, entities refer to companies (and institutions) of Iranian nationality, foreign companies having offices in Iran, and – in light of secondary sanctions – all other foreign companies doing business with sanctioned Iranian companies. Iranian individuals, or for-

[3] The documents specify the exact day in which entities enter/exit the list during the year considered.

[4] Notice that SDN lists specify to which sanctions programs each entry belongs. In other words, according to whether the aim is to hit entities related to Iran vis-à-vis other nations (say, North Korea) different codes are attached to them.

eigners doing business with sanctioned Iranians, were tracked by First and Last Name, and Passport number or National ID – when available. For vessels, we did not confine ourselves to vessels name or national flag given that these attributes were often changed. Instead, the International Maritime Organization (*IMO*) unique identification number proved to be important and completely reliable to follow vessels history.

The number of Iranian entries added to the SDN list allowed us to build an "SDN sanctions on" time series; similarly, the entries removed from the list provided the information for an "SDN sanctions off" index. We obtained our final "U.S. Treasury sanctions variable" by attaching a weight to the "SDN sanctions off" count equal to the newspaper-based indicator ($w = 0.4$) and subtracting it from the "SDN sanctions on" count. The final series was then re-scaled by dividing it for its maximum value. See Figure S.2. The correlation between the U.S. Treasury measure and $s_t$ is equal to 38 per cent over the period 2006q1–2020q3. Notice that the series based on SDN has inevitably negative values over the JCPOA period regardless of the weight one is willing to choose. This feature is due to the fact that no new Iranian entities were added, while a large number of previously sanctioned entities were removed.[5]

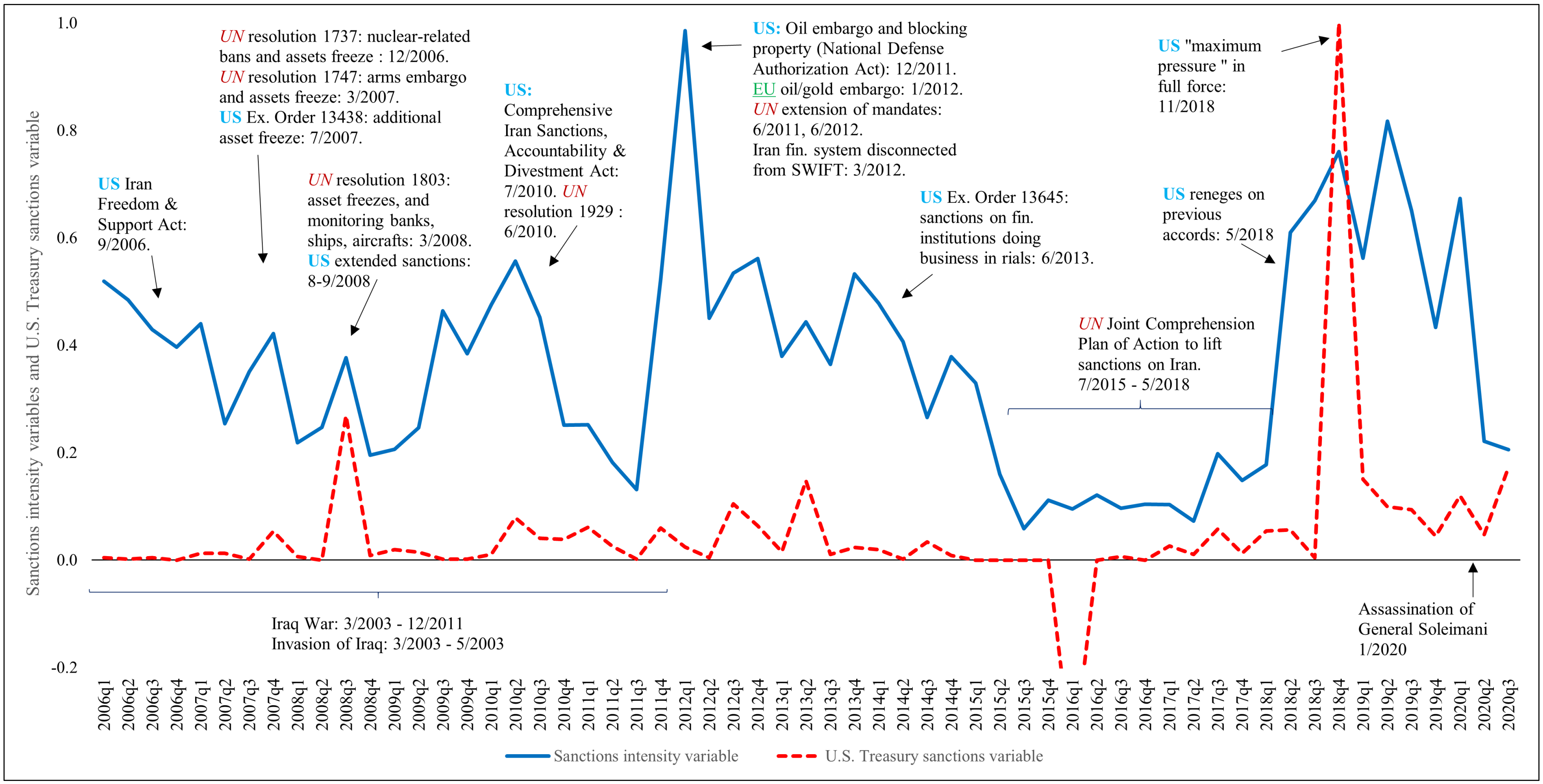
### S.2.4 Sanctions dummy variables

In many applications sanctions are characterized by dummy variables that take discrete values representing "sanctions on" and "sanctions off" periods. To evaluate the effectiveness of the sanctions intensity variable proposed in this paper (following a suggestion from a referee), we also consider two alternative sanctions dummy variables.

The first dummy variable is constructed based on historical narratives on major sanction events, as summarized in Table S.31. Accordingly, we consider the sanctions dummy variable, $d_t$, that takes the value of zero for $t \leq 2010q4$, the value of unity over the period $2011q1 - 2015q2$, the value of zero over the period $2015q3 - 2018q1$, and unity thereafter. The date 2015q3 coincides with new U.N. and U.S. sanctions in response to Iran's increased nuclear activity, 2015q2 is the date of the Joint Comprehensive Plan Of Action (*JCPOA*) agreement, representing a "sanctions off" period. In 2018q2 new sanctions were imposed on Iran unilaterally by the U.S. as a part of the "maximum pressure" strategy followed by the U.S. President Trump. See also Table S.3 where "sanctions on" and "sanctions off" periods are summarized.

[5] This could also be considered as a shortcoming of using such measure given that – in our framework – a negative value of the sanctions intensity variable means an attempt to subsidize the Iranian economy through transfers, something far from the actual process happening over the period 2016q1–2018q2.

Figure S.2: Sanctions intensity variable and the U.S. Treasury sanctions variable over the period 2006q1–2020q3




**Notes**: The U.S. Treasury sanctions variable is computed from the number of newly introduced and removed entries in the "Specially Designated Nationals And Blocked Persons List" (*SDN*) of the U.S. Department of the Treasury. Major sanctions-related historical events are indicated by arrows and brackets. See Sections S.2.1–S.2.3 for details of the construction of the sanctions variables.

Table S.3: Sanctions dummy variable description over the period 1989q1-2019q4

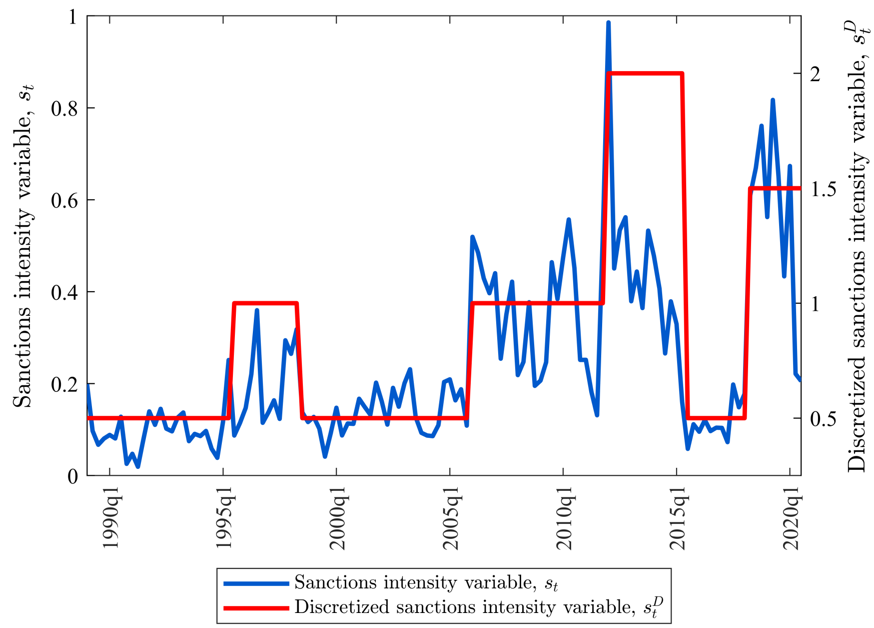
| *Historical period* | $d_t$ |
|---|---|
| 1989q1-2010q4 | 0 |
| 2011q1-2015q2 | 1 |
| 2015q3-2018q1 | 0 |
| 2018q2-2019q4 | 1 |

As a second dummy variable we consider a discretized version of our sanctions intensity variable, $s_t$, which we denote by $s_t^D$, taking the values of $0.5, 1.0, 1.5$, and $2.0$ in different sub-periods. The period $1989q1 - 1995q2$ was characterized as a very mild sanctions episode during the Presidency of Rafsanjani with $s_t^D$ set to 0.5. Following our newspapers sanctions intensity, and consistently with the historical narrative, we then set $s_t^D = 1$ over the period $1995q3 - 1998q2$ to reflect the U.S. President Clinton decisions to adopt slightly stricter measures under the Iran and Libya Sanctions Act of 1996, and the U.S. executive order 13059 of 1997. Tensions between U.S. and Iran abated somewhat under the Khatami's Presidency ($1998q3 - 2005q4$) with fewer sanctions, and to reflect this we set $s_t^D = 0.5$ over this period. But, with the election of President Ahmadinejad, tensions between Iran and the West started to rise and the U.S. and its allies incrementally increased their sanctions against Iran. Accordingly, we set $s_t^D$ equal to 1.0 and 2.0 over the sub-periods $2006q1 - 2011q4$ and $2012q1 - 2015q2$, respectively. We then set $s_t^D$ to 0.5 during $2015q3 - 2018q1$, which is the period marking the start of the JCPOA accord which, as noted above, ended with the re-introduction of "maximum pressure" sanctions in $2018q2$ by President Trump. To reflect this change, we increased $s_t^D$ to 1.5 over the period $2018q2 - 2019q4$. Table S.4 and Figure S.3 provide a summary and visual representation of $s_t^D$ in comparison to $s_t$. By construction, we expect $s_t^D$ and $s_t$ to be highly correlated, and our main purpose of considering $s_t^D$ is to see if much will be lost by discretization of $s_t$.

Table S.4: Discretized sanctions intensity variable description

| *Historical period* | $s_t^D$ |
|---|---|
| 1989q1-1995q2 | 0.5 |
| 1995q3-1998q2 | 1.0 |
| 1998q3-2005q4 | 0.5 |
| 2006q1-2011q4 | 1.0 |
| 2012q1-2015q2 | 2.0 |
| 2015q3-2018q1 | 0.5 |
| 2018q2-2019q4 | 1.5 |

Figure S.3: Sanctions intensity variable, and its descritized version, over the period 1989q1–2020q3




### S.2.5 Conversions from Iranian to Gregorian calendar

The data we use in our analysis are in Gregorian calendar. However, data retrieved from Iranian sources, namely from the Central Bank of Iran and the Statistical Center of Iran, follow the Iranian calendar format. The Iranian year starts on March 21$^{st}$ of the corresponding Gregorian year. Accordingly, we carried out three calendar conversions in order for the Iranian data to be in line with the ones in the Gregorian format. In the following expressions, $G_y, G_q$, and $G_m$ stand for the variables transformed in the Gregorian calendar at yearly, quarterly, and monthly frequencies, respectively, while $I_y, I_q$, and $I_m$ are the data in the original Iranian format. For annual statistics, the following formula was applied:[6] $G_y = \frac{80}{365} I_{y-1} + \frac{285}{365} I_y$. For quarterly data, we converted the Iranian series according to:[7] $G_q = \frac{8}{9} I_{q-1} + \frac{1}{9} I_q$. Finally, for the monthly time series – we applied the following transformation: $G_m = \frac{1}{3} I_{m-1} + \frac{2}{3} I_m$.

### S.2.6 Economic and socio-demographic variables

In this section, we will refer to some of the Iranian data as being retrieved from the "Quarterly Iran Data Set 2020". In this case, we extend and update the data for Iran in the GVAR Data Set compiled by Mohaddes and Raissi (2020) until 2018q2 (and available upon request); more recent observations for Iran were added by splicing forward the previously available series with new observations from Iranian sources. In this respect, the conversions mentioned in Section S.2.5 were applied. All data from the Central Bank of Iran (*CBI*) were obtained from the *Economic Time Series Database*. For global factors we will refer to the "GVAR Data Set 2020". In this case, we use the latest version of the GVAR Data Set provided by Mohaddes and Raissi (2020).

The quarterly real output of Iran was obtained by splicing forward the GVAR series in the Quarterly Iran Data Set 2020 available until 2018q2 with the "Iran's Quarterly National Accounts" released by the Statistical Center of Iran until 2020q1.

Iran's inflation was computed as first difference of the natural logarithm of Iran consumer price index (*CPI*). CPI data from the GVAR series in the Quarterly Iran Data Set 2020 available until 2018q2 were extended forward with data from the Statistical Center of Iran, which provides Iranian monthly inflation bulletins. After having converted the monthly series to the Gregorian calendar, it was possible to compute the quarterly inflation rate, and splice forward the Quarterly Iran Data Set until 2021q1. The CPI was then re-based to have value equal to 100 in 1979q2.

The *official* foreign exchange statistics from 1979q2 to 2020q3 were retrieved in quarterly format from Bank Markazi (Iran's Central Bank), and converted to the Gregorian calendar. The *free market* foreign exchange rate in quarterly format from 1979q2 to 2017q4 was also retrieved from Bank Markazi. For 2018 onward the series were spliced forward with data from *bonbast.com* – a highly cited website tracking the Iran's rial free market rate against all major currencies. In this regard, *bonbast.com* presents information for "buy" and "sell" rates at daily frequency. We used the average of buy and sell rates. In this way we were able to extend the historical series from Bank Markazi until 2021q1.

Data on oil exports revenues from 1999q1 to 2021q3 were retrieved from the CBI through Haver analytics,

[6] Eighty days of the Gregorian year (from Jan. 1st to Mar. 21st) were to be attributed to the previous Iranian year.

[7] In the following expression, 8/9 represents the eighty days out of the approximately ninety days within a given quarter.

and adjusted for the appropriate calendar conversion. Subsequently, the series was spliced backwards with the data from Esfahani et al. (2014). Esfahani et al. (2014) provide data on international oil price and Iran's quantity of oil exported (th. barrels/day) since 1979q1 therefore the two series were first multiplied to obtain oil revenues in millions of U.S. dollars.

Monetary statistics were also downloaded from the Bank Markazi website. The monetary aggregate $M2$ was computed as the sum of $M1$ and "quasi-money". Data were available at quarterly frequency, and – before converting them to the Gregorian calendar – the observations from 2015q2 onwards had to be multiplied by 1,000 given a change of format from billions to trillions of rials.

In order to account for global factors, we augmented our analyses with several variables. $\Delta p_t^0$ is the rate of change of the oil price (first difference of the natural logarithm). The oil price considered was the Brent crude (U.S. dollars/barrel). Data at quarterly frequency until 2020q1 were taken from the GVAR Data Set 2020. Observations for 2020q2 and 2020q3 were obtained by splicing the series with data from the U.S. Energy Information Administration (series name: "Europe Brent Spot Price FOB, Dollars per Barrel"). The E.I.A. provided information at monthly frequency therefore we first averaged the oil prices over each quarter, and then spliced forward our GVAR time series.

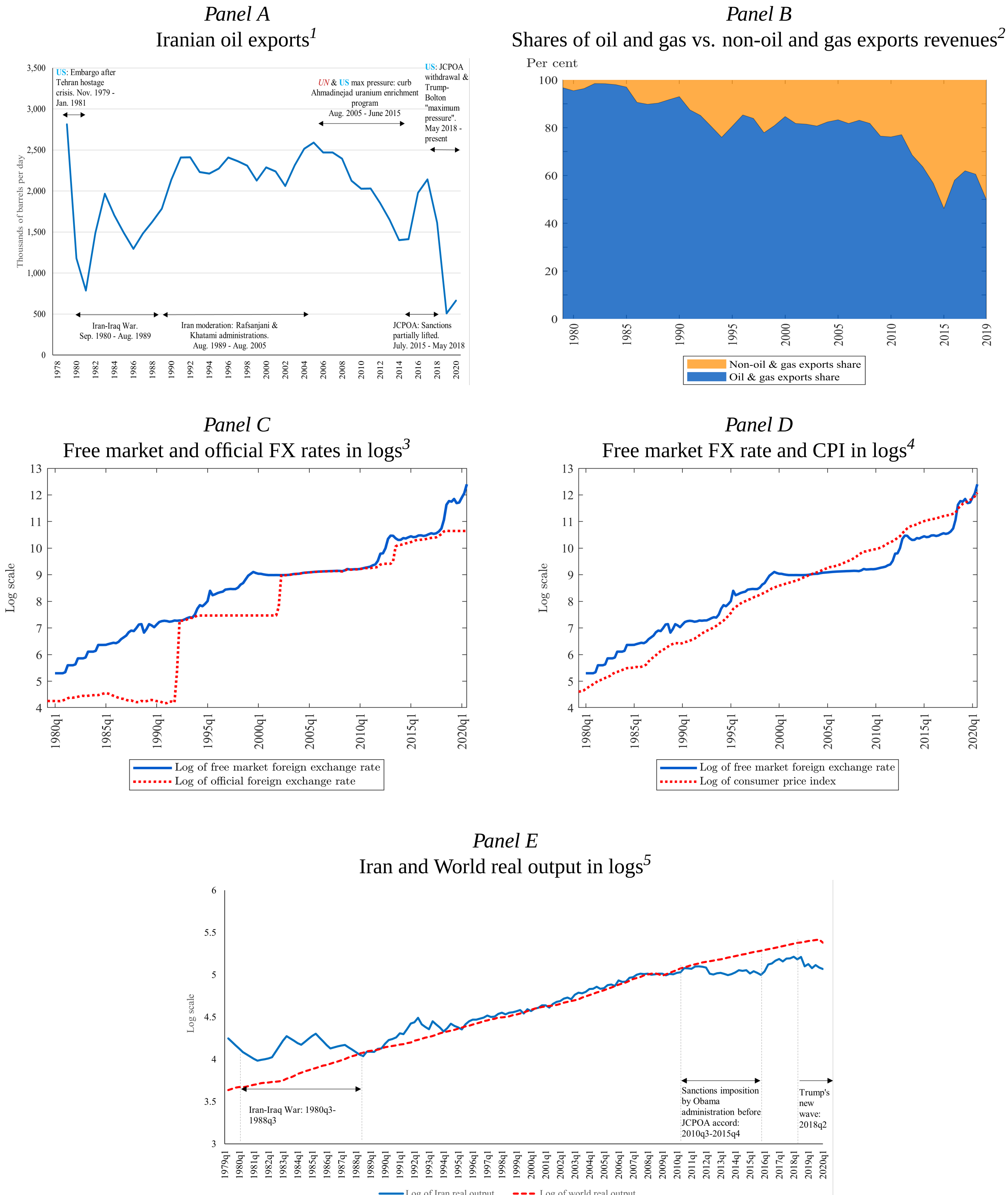
The quarterly global realized volatility, $grv_t$, was taken directly from the GVAR Data Set 2020 for the whole period 1979q2–2020q1; details about its construction can be found in Chudik et al. (2020).

We used the GVAR Data Set 2020 and followed the procedure indicated by Chudik et al. (2020) also for the construction of the other global factors. The factors we considered are: the world real output growth, $\Delta\bar{y}_{wt}$; the rate of change of the world real exchange rate against the U.S. dollar, $\Delta\bar{e}_{wt}$; the world real equity returns, $\Delta\overline{req}_{wt}$; and the per cent change of the world nominal long-term interest rate, $\Delta\bar{r}_{wt}$. These control variables were obtained by taking the first difference of the following weighted cross-sectional averages: $\bar{y}_{wt} = \sum_{i=0}^{n} w_i y_{it}$, $\bar{e}_{wt} = \sum_{i=0}^{n} w_i e_{it}$, $\overline{req}_{wt} = \sum_{i=0}^{n} w_i eq_{it}$, $\bar{r}_{wt} = \sum_{i=0}^{n} w_i r_{it}$, where $y_{it}, e_{it}$, $eq_{it}$, $r_{it}$ are: the log of real output, the log of the real exchange rate against the U.S. dollar, the log of real equity prices, and the nominal long term interest rates of country $i$ in quarter $t$. The sample included 33 of the world major economies, and the weights, $w_i$, were computed as the GDP-PPP average by country $i$ out of the overall world average output over the period 2014–2016:

$$w_i = \frac{\sum_{t=2014}^{2016} Y_{it}^{PPP}}{\sum_{i=0}^{n} \sum_{t=2014}^{2016} Y_{it}^{PPP}}. \tag{S.2}$$

The GDP-PPP measure allows for international comparisons, and it was retrieved at yearly frequency from

Figure S.4: Relevant Iran's and World macroeconomic and financial time series over the period 1979–2020




**Notes**: *1.* Annual data over the period 1979–2020. *2.* Annual data over the period 1979–2019. *3.* Quarterly data over the period 1979q2–2020q3. Foreign exchange rates are expressed as number of Iran's rials per U.S. dollars. *4.* Quarterly data over the period 1979q2–2020q3. CPI stands for Consumer Price Index, and it is equal to 100 in 1979q2. *5.* Quarterly data over the period 1979q2–2020q1. The world real output is a weighted average of the natural logarithm of real output for 33 major economies.
See Sections S.2.5 and S.2.6 in the data appendix of the online supplement for details on calendar conversions, and sources of the data.

the *World Bank Open Data* repository. The 33 countries are: Argentina, Australia, Austria, Belgium, Brazil, Canada, China, Chile, Finland, France, Germany, India, Indonesia, Italy, Japan, South Korea, Malaysia, Mexico, the Netherlands, Norway, New Zealand, Peru, the Philippines, South Africa, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, Thailand, Turkey, the U.K., and the U.S.A..

For some of the 33 countries, real equities returns, $eq_{it}$, and nominal long term interest rates, $r_{it}$, were not available. As such, to compute $\overline{req}_{wt}$ and $\bar{r}_{wt}$ we focussed on the countries for which we had information, and rescaled the weights accordingly. In particular, the historical real equity prices, $eq_{it}$, were available for 26 out of 33 countries (excluded were Brazil, China, Indonesia, Mexico, Peru, Saudi Arabia, and Turkey). For the long run interest rates, $r_{it}$, data were available for 18 of the 33 countries (excluded were Argentina, Brazil, China, Chile, Finland, India, Indonesia, Malaysia, Mexico, Peru, the Philippines, Saudi Arabia, Singapore, Thailand, and Turkey).

Table S.5: Sources of quarterly data

| **Data series** | **Source** |
|---|---|
| *Iranian variables*[1] | |
| Consumer price index | Quarterly Iran Data Set 2020 |
| Foreign exchange rate, Free Market | Central Bank of Iran and *bonbast.com* |
| Foreign exchange rate, Official rate | Central Bank of Iran |
| Money supply: M1 and Quasi-money | Central Bank of Iran |
| Oil export revenues | Quarterly Iran Data Set 2020 |
| Real output | Quarterly Iran Data Set 2020 |
| *Global control variables*[2] | GVAR Data Set 2020 and World Bank |

**Notes**: *1.* The Quarterly Iran Data Set 2020 extends and updates the GVAR Data Set compiled by Mohaddes and Raissi (2020), whose observations for Iran are available up to 2018q2. Such version of the data base including Iran is available upon request. The most recent observations for the consumer price index taken from the Statistical Center of Iran can be retrieved from the monthly inflation bulletins available at *www.amar.org.ir.* The data provided by the Central Bank of Iran on foreign exchange rates are available from the Economic Time Series Database: *tsd.cbi.ir,* under "External Sector/Value of Financial Assets (Exchange Rate and Coin Price)". Recent data on free market foreign exchange data can be retrieved from *www.bonbast.com*. Money supply statistics are available under "Monetary and Credit Aggregates" at *tsd.cbi.ir.* The updated data on oil export revenues were retrieved from the CBI through Haver analytics, and extended backwards by using the data set of Esfahani et al. (2014) available since 1979q1. The data used to extend the Iran's real output series are taken from the Statistical Center of Iran and can be retrieved under "Iran's Quarterly National Accounts (base year = 1390)" from *www.amar.org.ir.*
*2.* Raw data for each country composing the global averages were retrieved from the GVAR Data Set compiled by Mohaddes and Raissi (2020) and available at *www.mohaddes.org/gvar*. The World Bank data (*data.worldbank.org*) have been used to construct the GDP-PPP weights for each country (code indicator: "NY.GDP.MKTP.PP.CD"). The variables included in this set of controls are: global nominal long term interest rate, global real equity price, global real exchange rate, global real output, global realized volatility, and oil price (Brent crude). For oil price, the observations for 2020q2 and 2020q3 were obtained from the U.S. Energy Information Administration (series name: "Europe Brent Spot Price FOB, Dollars per Barrel") available at *www.eia.gov*. Information on the U.S. consumer price index was retrieved from the FRED data base *fred.stlouisfed.org* (series name: "Consumer Price Index: Total All Items for the United States, Index 2015=100, Quarterly, Seasonally Adjusted").
See Section S.2 for further details on variables construction.

## S.3 Computation of IRFs, FEVDs and their error bands by bootstrap

The SVAR model can also be used to compute the time profile of the responses of the economy to shocks (sanction, domestic and foreign) using impulse response functions (IRFs). For the purpose of computing IRFs, we drop money supply growth and foreign variables except the world output growth, as none of these variables will prove to be statistically significant.

### S.3.1 Impulse response analysis for SVAR model of the Iranian economy

#### S.3.1.1 IRFs for domestic shocks

Our starting point is Equation (6) where $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t\right)'$, and there are five domestic shocks $\varepsilon_t = (\varepsilon_{\Delta x_0,t}, \varepsilon_{\Delta e,t}, \varepsilon_{\Delta m,t}, \varepsilon_{\Delta p,t}, \varepsilon_{\Delta y,t})'$. The IRFs of one standard error shock to domestic shocks are given by

$$IRF_{\mathbf{q}}(h, \sqrt{\sigma_{jj}}) = E\left(\mathbf{q}_{t+h} \left| I_{t-1}, \varepsilon_{t,j} = \sqrt{\sigma_{jj}}\right.\right) - E\left(\mathbf{q}_{t+h} \left| I_{t-1}\right.\right), \text{ for } j = \Delta x^0, \Delta e_f, \Delta m, \Delta p, \Delta y,$$

where $h = 0, 1, 2..., H$, is the horizon of the IRFs, $\sigma_{jj} = Var\left(\varepsilon_{jt}\right)$, and $I_{t-1}$ is the information set at time $t-1$. The IRFs compare the expected outcome of the shock (intervention) to an alternative counterfactual in the absence of the shock. Using the reduced form version of (6), we have $IRF_{\mathbf{q}}(h, \sqrt{\sigma_{jj}}) = \sqrt{\sigma_{jj}}(\mathbf{G}_h \mathbf{A}_0^{-1} \mathbf{e}_j)$, where

$$\mathbf{G}_\ell = \Phi_1 \mathbf{G}_{\ell-1} + \Phi_2 \mathbf{G}_{\ell-2}, \text{ for } \ell = 1, 2, \ldots, \tag{S.3}$$

with $\mathbf{G}_{-1} = \mathbf{0}$, and $\mathbf{G}_0 = \mathbf{I}_m$, $\Phi_j = \mathbf{A}_0^{-1} \mathbf{A}_j$, for $j = 1, 2$, and $\mathbf{e}_j$ is a $m \times 1$ $(m = 5)$ selection vector of zeros except for its $j^{th}$ element which is unity. See Chapter 24 of Pesaran (2015). More specifically, the impulse response effects of a positive one standard error shock to the $j^{th}$ domestic variable, $\sqrt{\sigma_{jj}}$, on the $i^{th}$ variable at horizon $h = 0, 1, ..., H$, are given by $IRF_{ij}(h, \sqrt{\sigma_{jj}}) = \sqrt{\sigma_{jj}}(\mathbf{e}_i' \mathbf{G}_h \mathbf{A}_0^{-1} \mathbf{e}_j)$, for $i, j = \Delta x^0, \Delta e_f, \Delta m, \Delta p, \Delta y$.

#### S.3.1.2 IRFs for a shock to the sanctions intensity variable

Since global factors are assumed to be strictly exogenous to the Iranian economy and unrelated to sanctions, then without loss of generality the IRFs of sanction shocks can be obtained abstracting from the global shocks. Accordingly, using (6) and (8), the moving average (*MA*) representation of the domestic variables can be written as

$$\mathbf{q}_t = \mathbf{G}(1)\mathbf{A}_0^{-1}\left(\mathbf{a}_q + \frac{a_s}{1-\rho_s}\gamma_s\right) + \mathbf{b}(L)\eta_t + \mathbf{G}(L)\mathbf{A}_0^{-1}\varepsilon_t, \tag{S.4}$$

where $\gamma_s = \gamma_{0s} + \gamma_{1s}$, $\mathbf{b}(L) = \mathbf{G}(L)\mathbf{A}_0^{-1}(1-\rho_s L)^{-1}(\gamma_{0s} + \gamma_{1s}L)$, $\mathbf{G}(L) = \sum_{\ell=0}^{\infty} \mathbf{G}_\ell L^\ell$, and $\mathbf{G}_\ell$ is defined by the recursions in (S.3). Therefore, the responses of the $i^{th}$ domestic variable (the $i^{th}$ element of $\mathbf{q}_t$) to a positive one standard error shock to the sanctions intensity variable, $\omega_s$, are given by

$$IRF_i(h, \omega_s) = \omega_s(\mathbf{e}_i'\mathbf{b}_h),\ h = 0, 1, ..., H,\ i = \Delta x^0, \Delta e_f, \Delta m, \Delta p, \Delta y. \tag{S.5}$$

In the case where sanctions are imposed over $h$ periods, the cumulative IRFs (CIRFs) is given by

$$CIRF_{\mathbf{q}}(h, \omega_s) = E\left(\mathbf{q}_{t+h} \left| I_{t-1}, \mathbf{s}_{t,t+h} = \omega_s \tau_{h+1}\right.\right) - E\left(\mathbf{q}_{t+h} \left| I_{t-1}\right.\right)$$

where $\mathbf{s}_{t,t+h} = (s_t, s_{t+1}, ..., s_{t+h})'$ and $\tau_{h+1}$ is an $(h+1) \times 1$ vector of ones. The cumulative responses of the $i^{th}$ endogenous variable to sanctions shocks of size, $\omega_s$, that are sustained over $h$ periods are given by

$$CIRF_i(h, \omega_s) = \omega_s \left( \sum_{\ell=0}^{h} \mathbf{e}_i'\mathbf{b}_\ell \right), \mathit{for}\ h = 0, 1, ..., H,\ i = \Delta x^0, \Delta e_f, \Delta m, \Delta p, \Delta y.$$

#### S.3.1.3 IRFs for a global factor shock

As noted earlier, we only consider the shock to the world output growth, $\Delta\bar{y}_{wt}$, as the global factor in our analysis, and consider the following general linear process for $\Delta\bar{y}_{wt}$

$$\Delta\bar{y}_{wt} = g_0 + c(L)v_{\Delta\bar{y}_{wt}}. \tag{S.6}$$

Since the sanctions intensity variable and the world output growth are assumed to be uncorrelated, abstracting from the sanctions intensity variable we can re-write (6),

$$\mathbf{A}_0\mathbf{q}_t = \mathbf{a}_q + \mathbf{A}_1\mathbf{q}_{t-1} + \mathbf{A}_2\mathbf{q}_{t-2} + \delta_w \Delta\bar{y}_{wt} + \varepsilon_t.$$

By combining (S.6) with the moving average representation of the above equation we have

$$\mathbf{q}_t = \mathbf{G}(1)\mathbf{A}_0^{-1}(\mathbf{a}_q + \delta_w g_0) + \kappa(L)v_{\Delta\bar{y}_{wt}} + \mathbf{G}(L)\mathbf{A}_0^{-1}\varepsilon_t, \tag{S.7}$$

where $\kappa(L) = \sum_{\ell=\mathbf{0}}^{\infty} \kappa_\ell L^\ell = \mathbf{G}(L)\mathbf{A}_0^{-1}\delta_w c(L)$, and $\mathbf{G}(L)$ is as defined above. Hence, the impulse responses of the $i^{th}$ element of $\mathbf{q}_t$ to a single period shock to world output growth is then given by

$$IRF_i(h, \omega_{\Delta\bar{y}_w}) = \omega_{\Delta\bar{y}_w}(\mathbf{e}_i'\kappa_h),\ h = 0, 1, ..., H,\ i = \Delta x^0, \Delta e_f, \Delta m, \Delta p, \Delta y, \tag{S.8}$$

where $\omega^2_{\Delta\bar{y}_w}$ is the variance of $v_{\Delta\bar{y}_{wt}}$.

### S.3.2 Forecast error variance decompositions

Another useful measure of dynamic propagation of shocks is forecast error variance decompositions (FEVDs), which measure the proportion of forecast error variance of variable $q_{it}$ (say, output growth) which is accounted for by a particular domestic shock, $\varepsilon_{jt}$, at different horizons. We are particularly interested in estimating the relative importance of domestic shocks *vis-à-vis* sanctions or world output shocks in explaining output growth at different horizons. To obtain the FEVDs of both types of shocks, we first note that, by building on (S.4) and (S.7), the $n$-step ahead forecast errors for the vector of domestic variables, $\mathbf{q}_t$, is given by

$$\xi_t(n) = \sum_{\ell=0}^{n} \mathbf{b}_\ell \eta_{t+n-\ell} + \sum_{\ell=0}^{n} \kappa_\ell v_{\Delta\bar{y}_w,t+n-\ell} + \sum_{\ell=0}^{n} \mathbf{G}_\ell \mathbf{A}_0^{-1} \varepsilon_{t+n-\ell},$$

where, as before, $\varepsilon_t$ is a $m \times 1$ (with $m = 5$) vector of domestic shocks. Using standard results from the literature, the $h$-step ahead FEVD of the $i^{th}$ variable in $\mathbf{q}_t$ which is accounted by the domestic shock $\varepsilon_{jt}$ is given by

$$\theta_{ij}(h) = \frac{\sigma_{jj} \sum_{\ell=0}^{h} \left(\mathbf{e}_i' \mathbf{G}_\ell \mathbf{A}_0^{-1} \mathbf{e}_j\right)^2}{\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{G}_\ell \mathbf{A}_0^{-1} \Sigma \mathbf{A}_{\mathbf{0}}'^{-\mathbf{1}} \mathbf{G}_\ell' \mathbf{e}_i + \omega_s^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{b}_\ell \mathbf{b}_\ell' \mathbf{e}_i + \omega_{\Delta\bar{y}_w}^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \kappa_\ell \kappa_\ell' \mathbf{e}_i}, \tag{S.9}$$

for $i, j = \Delta x^0, \Delta e_f, \Delta m, \Delta p, \Delta y$, and $\Sigma = Diag(\sigma_{\Delta x_0 \Delta x_0}, \sigma_{\Delta e \Delta e}, \sigma_{\Delta m \Delta m}, \sigma_{\Delta p \Delta p}, \sigma_{\Delta y \Delta y})$. Similarly, the proportion of the forecast error variance of the $i^{th}$ variable due to sanctions intensity and world output growth shocks at horizon $h$ are given by

$$\theta_{is}(h) = \frac{\omega_s^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{b}_\ell \mathbf{b}_\ell' \mathbf{e}_i}{\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{G}_\ell \mathbf{A}_0^{-1} \Sigma \mathbf{A}_0'^{-1} \mathbf{G}_\ell' \mathbf{e}_i + \omega_s^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{b}_\ell \mathbf{b}_\ell' \mathbf{e}_i + \omega_{\Delta\bar{y}_w}^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \kappa_\ell \kappa_\ell' \mathbf{e}_i}, \tag{S.10}$$

and

$$\theta_{i\Delta\bar{y}_w}(h) = \frac{\omega_{\Delta\bar{y}_w}^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \kappa_\ell \kappa_\ell' \mathbf{e}_i}{\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{G}_\ell \mathbf{A}_0^{-1} \Sigma \mathbf{A}_0'^{-1} \mathbf{G}_\ell' \mathbf{e}_i + \omega_s^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{b}_\ell \mathbf{b}_\ell' \mathbf{e}_i + \omega_{\Delta\bar{y}_w}^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \kappa_\ell \kappa_\ell' \mathbf{e}_i}, \tag{S.11}$$

respectively. Since all the shocks are assumed to be orthogonal, then it follows that $\sum_{j=1}^{m} \theta_{ij}(h) + \theta_{is}(h) + \theta_{i\Delta\bar{y}_w}(h) = 1$.

In the case where the effects of sanctions shocks are cumulated keeping other shocks fixed, we have

$$\theta_{ij}(h) = \frac{\sigma_{jj} \sum_{\ell=0}^{h} \left(\mathbf{e}_i' \mathbf{G}_\ell \mathbf{A}_0^{-1} \mathbf{e}_j\right)^2}{\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{G}_\ell \mathbf{A}_0^{-1} \Sigma \mathbf{A}_{\mathbf{0}}'^{-\mathbf{1}} \mathbf{G}_\ell' \mathbf{e}_i + \omega_s^2 \left(\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{b}_\ell\right) \left(\sum_{\ell=0}^{h} \mathbf{e}_i \mathbf{b}_\ell\right)' + \omega_{\Delta\bar{y}_w}^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \kappa_\ell \kappa_\ell' \mathbf{e}_i}, \tag{S.12}$$

where $\theta_{ij}(h)$ is the $h$-step ahead FEVD of the $i^{th}$ variable in $\mathbf{q}_t$ which is accounted by the domestic shock $\varepsilon_{jt}$, for $i, j = \Delta x^0, \Delta e_f, \Delta m, \Delta p, \Delta y$, and $\Sigma = Diag(\sigma_{\Delta x_0 \Delta x_0}, \sigma_{\Delta e \Delta e}, \sigma_{\Delta m \Delta m}, \sigma_{\Delta p \Delta p}, \sigma_{\Delta y \Delta y})$. Similarly, the proportion of the forecast error variance of the $i^{th}$ variable due to a cumulated sanction intensity shock at horizon $h$ is given by:

$$\theta_{is}(h) = \frac{\omega_s^2 \left(\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{b}_\ell\right) \left(\sum_{\ell=0}^{h} \mathbf{e}_i \mathbf{b}_\ell\right)'}{\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{G}_\ell \mathbf{A}_0^{-1} \Sigma \mathbf{A}_0'^{-1} \mathbf{G}_\ell' \mathbf{e}_i + \omega_s^2 \left(\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{b}_\ell\right) \left(\sum_{\ell=0}^{h} \mathbf{e}_i \mathbf{b}_\ell\right)' + \omega_{\Delta \bar{y}_w}^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \kappa_\ell \kappa_\ell' \mathbf{e}_i}. \tag{S.13}$$

Finally, the contribution of world output growth shock to the forecast error variance of the $i^{th}$ variable in $\mathbf{q}_t$ can be written as:

$$\theta_{i\Delta \bar{y}_w}(h) = \frac{\omega_{\Delta \bar{y}_w}^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \kappa_\ell \kappa_\ell' \mathbf{e}_i}{\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{G}_\ell \mathbf{A}_0^{-1} \Sigma \mathbf{A}_0'^{-1} \mathbf{G}_\ell' \mathbf{e}_i + \omega_s^2 \left(\sum_{\ell=0}^{h} \mathbf{e}_i' \mathbf{b}_\ell\right) \left(\sum_{\ell=0}^{h} \mathbf{e}_i \mathbf{b}_\ell\right)' + \omega_{\Delta \bar{y}_w}^2 \sum_{\ell=0}^{h} \mathbf{e}_i' \kappa_\ell \kappa_\ell' \mathbf{e}_i}. \tag{S.14}$$

### S.3.3 IRFs and FEVDs alternative computation

To compute the IRFs and FEVDs, we provide an alternative computation approach with respect to the one described above. We confirm that we obtain the same numerical results using the formulae in Sub-sections S.3.1 and S.3.2, which we had included for pedagogic reasons.

Re-write Equation (S.15) as:

$$\widetilde{\mathbf{z}}_t = \widetilde{\Psi}_0^{-1} \left( \widetilde{\mathbf{a}} + \widetilde{\Psi}_1 \widetilde{\mathbf{z}}_{t-1} + \widetilde{\Psi}_2 \widetilde{\mathbf{z}}_{t-2} + \widetilde{\mathbf{u}}_t \right),$$

with $\widetilde{\mathbf{z}}_t = (\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t, s_t, \Delta \bar{y}_{wt})'$ and $\widetilde{\mathbf{u}}_t = (\varepsilon_{\Delta x_t^0}, \varepsilon_{\Delta e_{ft}}, \varepsilon_{\Delta m_t}, \varepsilon_{\Delta p_t}, \varepsilon_{\Delta y_t}, \varepsilon_{s_t}, \varepsilon_{\Delta \bar{y}_{wt}})'$. The IRF can be computed by following the approach described above as:

$$IRF_{\mathbf{z}}(h) = \sqrt{\sigma_{jj}} (\mathbf{F}_h \widetilde{\Psi}_0^{-1} \mathbf{e}_j),$$

where $\mathbf{e}_j$ is a $(m+2) \times 1$, with $m = 5$, selection vector of zeros except for its $j^{th}$ element, which is unity, and

$$\mathbf{F}_\ell = \widetilde{\Phi}_1 \mathbf{F}_{\ell-1} + \widetilde{\Phi}_2 \mathbf{F}_{\ell-2}, \text{ for } \ell = 1, 2, \ldots$$

where $\widetilde{\Phi}_1 = \widetilde{\Psi}_0^{-1} \widetilde{\Psi}_1$, $\widetilde{\Phi}_2 = \widetilde{\Psi}_0^{-1} \widetilde{\Psi}_2$, with $\mathbf{F}_{-1} = \mathbf{0}$, and $\mathbf{F}_0 = \mathbf{I}_{m+2}$. Consequently, the impulse response effects of a positive one standard error change in the $j^{th}$ domestic shock, $\varepsilon_{jt}$, on the $i^{th}$ variable (the $i^{th}$ element of $\widetilde{\mathbf{z}}_t$) are given by:

$$IRF_{ij}(h) = \sqrt{\sigma_{jj}} (\mathbf{e}_i' \mathbf{F}_h \widetilde{\Psi}_0^{-1} \mathbf{e}_j), \text{ for } h = 0, 1, \ldots, H, \; i, j = \Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t, s_t, \Delta \bar{y}_{wt}\ .$$

The forecast errors can be now written more succinctly as:

$$\widetilde{\xi}_t(n) = \sum_{\ell=0}^{n} \mathbf{F}_\ell \widetilde{\Psi}_0^{-1} \widetilde{\mathbf{u}}_{t+n-\ell},$$

where, as before, $\widetilde{\mathbf{u}}_t$ is a vector of $(m+2)\times 1$ shocks. Similarly, the proportion of the forecast error variance of the $i^{th}$ variable due to a shock to the $j^{th}$ variable at horizon $h$ is given by:

$$\theta_{ij}(h) = \frac{\sigma_{jj}\sum_{\ell=0}^{h}\left(\mathbf{e}_i'\mathbf{F}_\ell\widetilde{\Psi}_0^{-1}\mathbf{e}_j\right)^2}{\sum_{\ell=0}^{h}\mathbf{e}_i'\mathbf{F}_\ell\widetilde{\Psi}_0^{-1}\Sigma\widetilde{\Psi}_0'^{-1}\mathbf{F}_\ell'\mathbf{e}_i}, \text{ for } i,j = \Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t, s_t, \Delta\bar{y}_{wt} \ ,$$

with $\Sigma = Diag(\sigma_{\Delta x_0\Delta x_0}, \sigma_{\Delta e\Delta e}, ..., \sigma_{\Delta\bar{y}_w\Delta\bar{y}_w})$. It can be proved that $\sum_{j=1}^{m}\theta_{ij}(h)+\theta_{is}(h)+\theta_{i\Delta\bar{y}_w}(h) = 1$.

### S.3.4 Bootstrapping procedure

In order to compute the impulse response functions (IRFs) and the associated confidence bands, we followed a bootstrap procedure by simulating the in-sample values of $\mathbf{z}_t$ in Equation (10), which we report here for convenience:

$$\Psi_0\mathbf{z}_t = \mathbf{a}+\Psi_1\mathbf{z}_{t-1}+\Psi_2\mathbf{z}_{t-2}+\mathbf{u}_t. \tag{S.15}$$

In Equation (S.15), $\mathbf{z}_t = (\mathbf{q}_t, s_t, \bar{\mathbf{z}}_{wt})'$ is a vector of $m$ domestic policy variables ($\mathbf{q}_t$), the sanctions intensity variable ($s_t$), and the $k$ global factors ($\bar{\mathbf{z}}_{wt}$); $\mathbf{a}$ is a $(m+k+1)\times 1$ vector of constants, and $\mathbf{u}_t$ are the residuals of the system. In order to generate our bootstrap replications, we proceed as follows:

1. Generate the simulated residuals $\left\{\mathbf{u}_t^{(r)},\ r = 1,2,...,R\right\}$ by re-sampling with replacement from the estimated residuals of each equation separately $\{\widehat{\mathbf{u}}_t, t = 3,4,...,T\}$, where $R = 1,000$ is the number of random samples.

2. Let $\mathbf{z}_{1989q1}^{(r)} = \mathbf{z}_{1989q1},\ \ \mathbf{z}_{1989q2}^{(r)} = \mathbf{z}_{1989q2}\ \ \forall r$, and compute:

$$\mathbf{z}_t^{(r)} = \widehat{\Psi}_0^{-1}\left(\widehat{\mathbf{a}}+\widehat{\Psi}_1\mathbf{z}_{t-1}^{(r)}+\widehat{\Psi}_2\mathbf{z}_{t-2}^{(r)}+\mathbf{u}_t^{(r)}\right) \qquad t = 1989q3,...,2019q4$$

3. Use the data computed at point 2 to estimate the bootstrapped coefficients for each replication:

$$\mathbf{z}_t^{(r)} = \widehat{\Psi}_0^{-1,(r)}\left(\widehat{\mathbf{a}}^{(r)}+\widehat{\Psi}_1^{(r)}\mathbf{z}_{t-1}^{(r)}+\widehat{\Psi}_2^{(r)}\mathbf{z}_{t-2}^{(r)}+\mathbf{u}_t^{(r)}\right).$$

## S.4 Additional empirical results

In this section we provide additional supplementary results in support of our empirical results. Table S.6 provides estimates of AR(1) and AR(2) processes for the sanctions intensity index, $s_t$. As can be seen, an AR(1) model for $s_t$ is sufficient for modelling its persistence and higher order lags are not required. Table

S.7 gives the estimates of AR(1) and AR(2) processes for the world output growth, and shows that the AR(1) specification used in the paper provides a reasonable approximation.

### S.4.1 Reduced form output growth equation including current and lagged sanction variables

Table S.9 gives the estimates of the reduced form output growth equation given by Equation (5), where we include both current and lagged values of the sanctions intensity variable, $s_t$. As can be seen, the estimates are very close to the ones presented in the paper, which only includes $s_{t-1}$. Note that due to the persistence of the $s_t$ process, when including $s_t$ and $s_{t-1}$ in the regressions, one should consider the sum of the coefficients of $s_t$ and $s_{t-1}$ and its statistical significance.

### S.4.2 Re-ordering the variables in the SVAR model

In the main paper, we presented estimates of the SVAR model under our preferred ordering, namely with oil export revenues ($\Delta x_t^0$) included first, followed by the exchange rate variable ($\Delta e_{ft}$), money supply growth ($\Delta m_t$), inflation ($\Delta p_t$), and output growth ($\Delta y_t$), including the world output growth as control variable. Seasonal dummy variables were included in all regressions, which proved to be highly significant in the money supply growth equation. Tables S.10a to S.10e display the regression results including a host of additional control variables, and a number of their sub-sets. As can be seen, the estimates of the effects of sanctions on domestic variables are highly stable and consistent across all specifications. It is also worth noting that none of the global factors seem to have any significant impact on Iran's output growth, partly due to Iran's relative economic and financial isolation from the rest of the global economy.

Table S.11a includes the estimates of the SVAR model following the same ordering as our preferred specification in the paper but without money growth, which did not have any statistically significant impact on the rest of the domestic variables. The results are almost identical to the ones shown when money growth was included. Tables S.11b to S.11e present further results to check the robustness of our results.

In Table S.12a we show that including seasonal dummies are not required once money supply growth is dropped from the SVAR model. Results are in line with the ones in Table S.11a. Therefore, we proceeded with this specification when carrying out IRFs and FEVDs analyses. Tables S.12b to S.12e provide additional results on the robustness of our main findings.

Tables S.13a to S.13f present results of the SVAR model given by Equation (6) of the paper with the domestic variables re-ordered by placing the foreign exchange variable ($\Delta e_{ft}$) first, followed by oil export revenues ($\Delta x_t^0$), money supply growth ($\Delta m_t$), inflation ($\Delta p_t$), and output growth ($\Delta y_t$). The rationale for this ordering is that foreign exchange is a fast-moving variable, which could move on announcement even before oil exports are affected by sanctions. The results show that the differences with the ones presented in the paper are minimal. The only difference appears to be a less precise estimate of the effect of $s_{t-1}$ on oil export revenues. Also, once we drop the money supply growth from the model, $s_{t-1}$ become statistically significant again. Table S.14a give the estimates for the new ordering but without money supply growth, namely ($\Delta e_{ft}$, $\Delta x_t^0$, $\Delta p_t$, $\Delta y_t$), and without seasonal dummies. Further results are provided in Tables S.14b to S.14e for checking the robustness of the results when the ordering $\Delta e_{ft}$, $\Delta x_t^0$, $\Delta p_t$, $\Delta y_t$ is used.

### S.4.3 Using sanctions dummy variables

To investigate the value added of our continuous measure of sanctions intensity, $s_t$, here we present estimates of the reduced form output growth equation and the SVAR model using the two alternative sanction dummy variables (namely $d_t$ and $s_t^D$) considered in Sub-section S.2.4. Table S.15 reports the results for the output growth equation when the sanctions dummy variable, $d_t$, is used, and Table S.16 summarizes the results when the discretized sanctions intensity variable, $s_t^D$, is used. These results confirm the negative effects of sanctions on output growth, but yield less precise estimates as compared to the results reported in Table 3 when $s_t$ is used. This is also reflected in the better fit of the output growth equations with $s_t$ as compared with the two alternative sanctions dummy variables.

Table S.17 presents the estimates of the sanctions-augmented SVAR model when the proposed sanctions intensity estimator ($s_t$) is substituted with the sanctions dummy variable ($d_t$). As can be seen, $d_t$ and its lagged value are statistically significant in the oil export revenues equation, but do not show up significant in other equations. The fit of the exchange rate and output equations (as measured by $\bar{R}^2$) are around 0.083 and 0.101, when $d_t$ is used, as compared to 0.209 and 0.124, when $s_t$ is used. It is clear that overall $s_t$ is much better at identifying the effects of sanctions on the Iranian economy as compared to a $(0,1)$ dummy variable. See Table 4. The estimates based on the discretized version of $s_t$, namely $s_t^D$, are summarized in Table S.18. When using $s_t^D$ the results are only marginally better for inflation and output growth as compared to using $d_t$, but still less favorable as compared to using $s_t$.

### S.4.4 Additional IRFs and FEVDs

Additional results for IRFs and FEVDs analyses are provided in Sub-section S.4.7. Figure S.5 displays the IRFs for one positive standard error shock to the global output growth, and complements the IRFs results from our baseline SVAR model presented in Figure 2 of the paper.[8] Following one quarter shock to global output growth, Iran's oil exports increase by more than 3 per cent in the same quarter. The effects are still of the order of 1 per cent increase two quarters ahead before dissipating about one year after the shock. Iran's rial appreciates against U.S. dollar by about 1.5 per cent in the same quarter. However, the results are not particularly persistent and become quantitatively less important three quarters after the shock. The effects of global output growth on both inflation and Iran's output growth, on the other hand, are not statistically significant. These results are in line with Iran's relative economic isolation from the main advanced economies. Most of the global shocks are reflected in the movements of oil export revenues and free market foreign exchange rate, while domestic factors matter most for inflation and output growth.

As noted earlier, these results are not affected by using the alternative ordering $(\Delta e_{ft}, \Delta x_t^0, \Delta p_t, \Delta y_t)$. IRFs and FEVDs based on this ordering are given in Figures S.6a and S.6b, and Table S.19, respectively. As can be seen using this ordering of the variables in the SVAR has little impacts on IRFs and FEVDs. Figure S.7 also shows that the FEVDs results from a sustained shock to sanctions, keeping all other shocks fixed, is in line with the results presented in the paper for our base-line model. See Figure 3.

### S.4.5 Additional results with robust standard errors

The estimates of the reduced form regressions and sanctions-augmented SVAR models with White's heteroskedastic consistent standard (see White (1980)) are reported in Sub-section S.4.8. As to be expected the use of White's standard errors results in reduced level of statistical significance for most of the parameters, but the differences are largely inconsequential.

Table S.6: Quarterly estimates of the sanctions intensity variable AR(1) and AR(2) models over the period 1989q1–2020q3

| | $s_t$ | |
|---|---|---|
| | (1) | (2) |
| $s_{t-1}$ | 0.743*** | 0.639*** |
| | (0.059) | (0.089) |
| $s_{t-2}$ | | 0.139 |
| | | (0.089) |
| Constant | 0.063*** | 0.055*** |
| | (0.018) | (0.019) |
| Adjusted $R^2$ | 0.551 | 0.557 |
| S.E. of regression ($\hat{\omega}_s$) | 0.125 | 0.125 |

**Notes**: Numbers in parentheses are least squares standard errors. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. See Sections S.2.1 and S.2.2 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable.

[8] See also Equation (S.8) in the main paper.

Table S.7: Quarterly estimates of the world real output growth AR(1) and AR(2) models over the period 1989q1–2019q4

| | $\Delta\bar{y}_{wt}$ | |
|---|---|---|
| | (1) | (2) |
| $\Delta\bar{y}_{w,t-1}$ | $0.409^{***}$ | $0.393^{***}$ |
| | (0.082) | (0.091) |
| $\Delta\bar{y}_{w,t-2}$ | | 0.038 |
| | | (0.091) |
| Constant | $0.006^{***}$ | $0.006^{***}$ |
| | (0.001) | (0.001) |
| Adjusted $R^2$ | 0.161 | 0.155 |
| Residual Std. Error | 0.005 | 0.005 |

**Notes**: $\Delta\bar{y}_{wt}$ is the quarterly world output growth, computed as $\bar{y}_{wt} = \sum_{i=1}^{n} w_i y_{it}$, with $\{y_{it}\}_{i=1}^{n}$ being the natural log of real output for 33 major economies, and $\{w_i\}_{i=1}^{n}$ are GDP-PPP weights. See Section S.2.6 in the data appendix of the online supplement for details on the sources and construction of the data used.

Table S.8: Size of one standard error shock for the endogeneous variables used in the IRFs analyses in Figure 2

| Endogenous variable | Size of one SE shock |
|---|---|
| $s_t$ | 0.120 |
| $\Delta x_t^0$ | 0.197 |
| $\Delta e_{ft}$ | 0.083 |
| $\Delta p_t$ | 0.015 |
| $\Delta y_t$ | 0.029 |
| $\Delta\bar{y}_{wt}$ | 0.005 |

Table S.9: Estimates of the reduced form Iran's output growth equation including contemporaneous sanctions variable and estimated over the period 1989q1–2019q4

| | $\Delta y_t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $s_t(\beta_{s_t})$ | $-0.007$ | $-0.008$ | $-0.009$ | $-0.009$ | $-0.009$ | $-0.009$ | $-0.008$ |
| | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.024) |
| $s_{t-1}(\beta_{s_{t-1}})$ | $-0.027$ | $-0.026$ | $-0.025$ | $-0.027$ | $-0.027$ | $-0.028$ | $-0.029$ |
| | (0.024) | (0.024) | (0.024) | (0.024) | (0.024) | (0.024) | (0.024) |
| $\Delta y_{t-1}(\lambda_{\Delta y_{t-1}})$ | $-0.206^{**}$ | $-0.204^{**}$ | $-0.206^{**}$ | $-0.202^{**}$ | $-0.217^{**}$ | $-0.216^{**}$ | $-0.220^{**}$ |
| | (0.092) | (0.092) | (0.093) | (0.093) | (0.092) | (0.092) | (0.093) |
| $\Delta x^0_{t-1}$ | 0.016 | 0.015 | 0.016 | 0.017 | 0.014 | 0.014 | 0.015 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| $\Delta e_{f,t-1}$ | $-0.005$ | $-0.004$ | $-0.005$ | $-0.001$ | 0.003 | 0.003 | 0.002 |
| | (0.033) | (0.034) | (0.034) | (0.034) | (0.034) | (0.034) | (0.034) |
| $\Delta m_{t-1}$ | $-0.030$ | $-0.039$ | $-0.044$ | $-0.035$ | $-0.056$ | $-0.059$ | $-0.065$ |
| | (0.101) | (0.103) | (0.104) | (0.105) | (0.104) | (0.105) | (0.106) |
| $\Delta p_{t-1}$ | $-0.236^{*}$ | $-0.230^{*}$ | $-0.228^{*}$ | $-0.242^{*}$ | $-0.263^{**}$ | $-0.269^{**}$ | $-0.270^{**}$ |
| | (0.122) | (0.124) | (0.124) | (0.125) | (0.124) | (0.126) | (0.126) |
| $\Delta \bar{y}_{wt}$ | | 0.245 | 0.170 | 0.224 | $-0.120$ | $-0.151$ | $-0.111$ |
| | | (0.558) | (0.605) | (0.606) | (0.627) | (0.638) | (0.646) |
| $\Delta \overline{req}_{wt}$ | | | 0.015 | 0.023 | 0.015 | 0.004 | 0.002 |
| | | | (0.045) | (0.046) | (0.046) | (0.058) | (0.058) |
| $\Delta \bar{r}_{wt}$ | | | | $-4.500$ | $-4.291$ | $-4.447$ | $-3.537$ |
| | | | | (4.157) | (4.113) | (4.160) | (4.632) |
| $\Delta \bar{e}_{wt}$ | | | | | $-0.279^{*}$ | $-0.273^{*}$ | $-0.307^{*}$ |
| | | | | | (0.149) | (0.151) | (0.169) |
| $grv_t$ | | | | | | $-0.036$ | $-0.042$ |
| | | | | | | (0.115) | (0.116) |
| $\Delta p^0_t$ | | | | | | | $-0.011$ |
| | | | | | | | (0.025) |
| $\beta_{s_t}+\beta_{s_{t-1}}$ | $-0.035^{**}$ | $-0.034^{**}$ | $-0.034^{**}$ | $-0.036^{**}$ | $-0.037^{**}$ | $-0.037^{**}$ | $-0.036^{**}$ |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $(\beta_{s_t}+\beta_{s_{t-1}})/(1-\lambda_{\Delta y_{t-1}})$ | $-0.029^{**}$ | $-0.028^{**}$ | $-0.028^{**}$ | $-0.030^{**}$ | $-0.030^{**}$ | $-0.030^{**}$ | $-0.030^{**}$ |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| Adjusted $R^2$ | 0.076 | 0.069 | 0.062 | 0.064 | 0.084 | 0.077 | 0.070 |

**Notes**: $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. $\beta_{s_t}, \beta_{s_{t-1}}$ and $\lambda_{\Delta y_{t-1}}$ are the coefficients of $s_t, s_{t-1}$ and $\Delta y_{t-1}$, respectively; $(\beta_{s_t}+\beta_{s_{t-1}})/(1-\lambda_{\Delta y_{t-1}})$ represents the long run effect of sanctions on output growth. See Chapter 6 of Pesaran (2015). See the notes to Table 3 for further details on the sources and construction of data used. $\Delta x^0_t = (X^0_t - X^0_{t-1})/X^0_{t-1}$, $X^0_t$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran. $\Delta \bar{y}_{wt}$ is the quarterly world output growth, computed as $\bar{y}_{wt} = \sum_{i=1}^n w_i y_{it}$, with $\{y_{it}\}_{i=1}^n$ being the natural log of real output for 33 major economies, and $\{w_i\}_{i=1}^n$ are GDP-PPP weights. $\Delta \overline{req}_{wt}$ is the quarterly rate of change of the global real equity price index: $\overline{req}_{wt} = \sum_{i=1}^n w_i req_{it}$, $req_{it}$ is the natural log of the real equity price of country $i$ in quarter $t$. $\Delta \bar{r}_{wt}$ is the quarterly per cent change of the global nominal long term interest rate: $\bar{r}_{wt} = \sum_{i=1}^n w_i r_{it}$, $r_{it}$ is the long term nominal interest rate of country $i$ in quarter $t$. $\Delta \bar{e}_{wt}$ is the quarterly rate of change of the global real exchange rate vis-à-vis the U.S. dollar: $\bar{e}_{wt} = \sum_{i=1}^n w_i e_{it}$, $e_{it}$ is the natural log of the real exchange rate of country $i$ in quarter $t$. $grv_t$ is the quarterly global realized volatility. $\Delta p^0_t = \ln(P^0_t/P^0_{t-1})$, $P^0_t$ is the quarterly oil price (Brent crude). Numbers in parentheses are least squares standard errors. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

See Sections S.2.1, S.2.2, S.2.5, and S.2.6 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable, calendar conversions, and sources of the data used.

### S.4.6 Additional sanctions-augmented SVAR analyses

Table S.10a: Quarterly estimates of the equation for the oil export variable in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.144 | 0.107 | 0.104 | 0.087 | 0.088 | 0.088 |
| | (0.152) | (0.150) | (0.151) | (0.143) | (0.140) | (0.140) |
| $s_{t-1}$ | $-0.339^{**}$ | $-0.288^{*}$ | $-0.286^{*}$ | $-0.279^{*}$ | $-0.261^{*}$ | $-0.261^{*}$ |
| | (0.156) | (0.155) | (0.156) | (0.147) | (0.144) | (0.145) |
| $\Delta x_{t-1}^0$ | −0.035 | −0.051 | −0.050 | −0.077 | −0.088 | −0.088 |
| | (0.092) | (0.090) | (0.091) | (0.086) | (0.084) | (0.085) |
| $\Delta e_{f,t-1}$ | $-0.442^{**}$ | $-0.441^{**}$ | $-0.443^{**}$ | $-0.382^{*}$ | $-0.432^{**}$ | $-0.432^{**}$ |
| | (0.221) | (0.217) | (0.219) | (0.207) | (0.203) | (0.204) |
| $\Delta m_{t-1}$ | −0.128 | −0.715 | −0.744 | −1.214 | −1.141 | −1.143 |
| | (0.911) | (0.930) | (0.947) | (0.903) | (0.882) | (0.893) |
| $\Delta p_{t-1}$ | −0.156 | 0.052 | 0.060 | −0.213 | −0.041 | −0.043 |
| | (0.804) | (0.794) | (0.799) | (0.758) | (0.743) | (0.755) |
| $\Delta y_{t-1}$ | 0.087 | 0.122 | 0.116 | −0.062 | −0.103 | −0.103 |
| | (0.603) | (0.592) | (0.595) | (0.564) | (0.551) | (0.554) |
| $\Delta \bar{y}_{wt}$ | | $8.406^{**}$ | $8.132^{**}$ | 4.185 | 3.098 | 3.085 |
| | | (3.649) | (3.948) | (3.871) | (3.803) | (3.862) |
| $\Delta \overline{req}_{wt}$ | | | 0.056 | −0.046 | −0.154 | −0.158 |
| | | | (0.297) | (0.282) | (0.279) | (0.351) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.507^{***}$ | $-3.551^{***}$ | $-3.548^{***}$ |
| | | | | (0.923) | (0.901) | (0.911) |
| $\Delta \bar{r}_{wt}$ | | | | | $63.486^{**}$ | $63.416^{**}$ |
| | | | | | (25.058) | (25.373) |
| $grv_t$ | | | | | | −0.015 |
| | | | | | | (0.690) |
| Residual serial | 1.202 | 2.406 | 2.446 | 2.382 | 5.176 | 5.166 |
| correlation test | [0.878] | [0.662] | [0.654] | [0.666] | [0.270] | [0.271] |
| Adjusted $R^2$ | 0.089 | 0.122 | 0.115 | 0.210 | 0.247 | 0.240 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}$, $\Delta m_t$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t\right)'$. Numbers in parentheses are least squares standard errors, and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.10b: Quarterly estimates of the equation for exchange rate returns in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.295*** | 0.305*** | 0.302*** | 0.303*** | 0.303*** | 0.307*** |
| | (0.064) | (0.064) | (0.065) | (0.064) | (0.065) | (0.064) |
| $s_{t-1}$ | −0.221*** | −0.233*** | −0.230*** | −0.226*** | −0.226*** | −0.231*** |
| | (0.067) | (0.067) | (0.067) | (0.067) | (0.067) | (0.067) |
| $\Delta x_t^0$ | 0.014 | 0.029 | 0.028 | 0.047 | 0.048 | 0.048 |
| | (0.040) | (0.040) | (0.040) | (0.043) | (0.044) | (0.044) |
| $\Delta x_{t-1}^0$ | 0.038 | 0.044 | 0.045 | 0.051 | 0.051 | 0.047 |
| | (0.039) | (0.038) | (0.039) | (0.039) | (0.039) | (0.039) |
| $\Delta e_{f,t-1}$ | 0.344*** | 0.350*** | 0.348*** | 0.346*** | 0.348*** | 0.346*** |
| | (0.095) | (0.094) | (0.095) | (0.095) | (0.096) | (0.095) |
| $\Delta m_{t-1}$ | −0.037 | 0.149 | 0.121 | 0.209 | 0.209 | 0.110 |
| | (0.384) | (0.397) | (0.404) | (0.409) | (0.411) | (0.408) |
| $\Delta p_{t-1}$ | −0.278 | −0.341 | −0.333 | −0.291 | −0.295 | −0.397 |
| | (0.339) | (0.338) | (0.340) | (0.341) | (0.344) | (0.343) |
| $\Delta y_{t-1}$ | −0.133 | −0.145 | −0.151 | −0.125 | −0.124 | −0.120 |
| | (0.254) | (0.252) | (0.253) | (0.254) | (0.255) | (0.251) |
| $\Delta \bar{y}_{wt}$ | | −2.639* | −2.897* | −2.423 | −2.401 | −2.907 |
| | | (1.590) | (1.712) | (1.749) | (1.764) | (1.759) |
| $\Delta \overline{req}_{wt}$ | | | 0.053 | 0.068 | 0.071 | −0.121 |
| | | | (0.127) | (0.127) | (0.129) | (0.160) |
| $\Delta \bar{e}_{wt}$ | | | | 0.554 | 0.560 | 0.648 |
| | | | | (0.441) | (0.445) | (0.442) |
| $\Delta \bar{r}_{wt}$ | | | | | −1.633 | −4.492 |
| | | | | | (11.923) | (11.849) |
| $grv_t$ | | | | | | −0.625** |
| | | | | | | (0.313) |
| Residual serial | 5.972 | 6.212 | 5.961 | 7.940 | 8.059 | 5.259 |
| correlation test | [0.201] | [0.184] | [0.202] | [0.094] | [0.089] | [0.262] |
| Adjusted $R^2$ | 0.196 | 0.209 | 0.203 | 0.207 | 0.200 | 0.221 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.10c: Quarterly estimates of the equation for money supply growth in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta m_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | −0.0004 | −0.002 | −0.003 | −0.002 | −0.002 | 0.002 |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $s_{t-1}$ | 0.014 | 0.015 | 0.016 | 0.017 | 0.017 | 0.014 |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $\Delta x_t^0$ | 0.008 | 0.006 | 0.006 | 0.011 | 0.014 | 0.015 |
| | (0.009) | (0.010) | (0.010) | (0.010) | (0.011) | (0.010) |
| $\Delta e_{f,t}$ | −0.009 | −0.007 | −0.008 | −0.011 | −0.012 | −0.022 |
| | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) |
| $\Delta x_{t-1}^0$ | −0.005 | −0.005 | −0.005 | −0.003 | −0.002 | −0.003 |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| $\Delta e_{f,t-1}$ | −0.024 | −0.025 | −0.026 | −0.027 | −0.023 | −0.021 |
| | (0.026) | (0.027) | (0.027) | (0.027) | (0.027) | (0.026) |
| $\Delta m_{t-1}$ | 0.235** | 0.218** | 0.211** | 0.236** | 0.236** | 0.211** |
| | (0.092) | (0.096) | (0.098) | (0.099) | (0.099) | (0.098) |
| $\Delta p_{t-1}$ | 0.165 | 0.167 | 0.174 | 0.193 | 0.189 | 0.163 |
| | (0.115) | (0.115) | (0.117) | (0.117) | (0.117) | (0.115) |
| $\Delta y_{t-1}$ | 0.022 | 0.025 | 0.022 | 0.026 | 0.028 | 0.026 |
| | (0.063) | (0.063) | (0.063) | (0.063) | (0.063) | (0.062) |
| $\Delta p_{t-2}$ | −0.076 | −0.070 | −0.077 | −0.088 | −0.094 | −0.102 |
| | (0.103) | (0.104) | (0.105) | (0.105) | (0.105) | (0.103) |
| $\Delta \bar{y}_{wt}$ | | 0.233 | 0.152 | 0.260 | 0.304 | 0.134 |
| | | (0.389) | (0.421) | (0.427) | (0.427) | (0.425) |
| $\Delta \overline{req}_{wt}$ | | | 0.016 | 0.021 | 0.027 | −0.026 |
| | | | (0.031) | (0.031) | (0.031) | (0.038) |
| $\Delta \bar{e}_{wt}$ | | | | 0.146 | 0.160 | 0.191* |
| | | | | (0.107) | (0.108) | (0.106) |
| $\Delta \bar{r}_{wt}$ | | | | | −3.581 | −4.412 |
| | | | | | (2.850) | (2.815) |
| $grv_t$ | | | | | | −0.176** |
| | | | | | | (0.076) |
| Residual serial | 7.428 | 7.640 | 7.255 | 6.129 | 5.742 | 4.178 |
| correlation test | [0.115] | [0.106] | [0.123] | [0.190] | [0.219] | [0.382] |
| Adjusted $R^2$ | 0.469 | 0.466 | 0.462 | 0.467 | 0.470 | 0.491 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.10d: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.028^{**}$ | $-0.033^{**}$ | $-0.032^{**}$ | $-0.033^{**}$ | $-0.033^{**}$ | $-0.032^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $s_{t-1}$ | $0.032^{**}$ | $0.037^{***}$ | $0.036^{***}$ | $0.036^{***}$ | $0.036^{***}$ | $0.035^{**}$ |
| | (0.014) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $\Delta x_t^0$ | 0.001 | $-0.003$ | $-0.003$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.008) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) |
| $\Delta e_{f,t}$ | $0.155^{***}$ | $0.163^{***}$ | $0.164^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.163^{***}$ |
| | (0.018) | (0.017) | (0.018) | (0.018) | (0.018) | (0.018) |
| $\Delta m_t$ | $-0.061$ | $-0.073$ | $-0.070$ | $-0.058$ | $-0.057$ | $-0.070$ |
| | (0.076) | (0.073) | (0.073) | (0.074) | (0.075) | (0.077) |
| $\Delta x_{t-1}^0$ | $-0.001$ | $-0.003$ | $-0.003$ | $-0.004$ | $-0.004$ | $-0.005$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| $\Delta e_{f,t-1}$ | $-0.007$ | $-0.009$ | $-0.007$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.021) | (0.020) | (0.020) | (0.020) | (0.021) | (0.021) |
| $\Delta m_{t-1}$ | 0.035 | $-0.025$ | $-0.016$ | $-0.036$ | $-0.036$ | $-0.040$ |
| | (0.075) | (0.075) | (0.076) | (0.078) | (0.078) | (0.078) |
| $\Delta p_{t-1}$ | $0.480^{***}$ | $0.488^{***}$ | $0.478^{***}$ | $0.462^{***}$ | $0.462^{***}$ | $0.458^{***}$ |
| | (0.092) | (0.089) | (0.090) | (0.090) | (0.091) | (0.091) |
| $\Delta y_{t-1}$ | 0.033 | 0.042 | 0.045 | 0.042 | 0.042 | 0.042 |
| | (0.050) | (0.048) | (0.048) | (0.048) | (0.049) | (0.049) |
| $\Delta p_{t-2}$ | $0.162^{**}$ | $0.183^{**}$ | $0.192^{**}$ | $0.201^{**}$ | $0.202^{**}$ | $0.198^{**}$ |
| | (0.082) | (0.079) | (0.080) | (0.080) | (0.081) | (0.081) |
| $\Delta \bar{y}_{wt}$ | | $0.865^{***}$ | $0.971^{***}$ | $0.893^{***}$ | $0.889^{***}$ | $0.847^{**}$ |
| | | (0.298) | (0.322) | (0.327) | (0.330) | (0.335) |
| $\Delta \overline{req}_{wt}$ | | | $-0.021$ | $-0.024$ | $-0.025$ | $-0.039$ |
| | | | (0.023) | (0.024) | (0.024) | (0.030) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.102$ | $-0.104$ | $-0.093$ |
| | | | | (0.083) | (0.084) | (0.085) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.303 | 0.031 |
| | | | | | (2.210) | (2.242) |
| $grv_t$ | | | | | | $-0.048$ |
| | | | | | | (0.061) |
| Residual serial | 9.241 | 8.061 | 5.714 | 6.473 | 6.510 | 6.759 |
| correlation test | [0.055] | [0.089] | [0.222] | [0.166] | [0.164] | [0.149] |
| Adjusted $R^2$ | 0.635 | 0.659 | 0.658 | 0.660 | 0.656 | 0.655 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.10e: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.029 | 0.028 | 0.026 | 0.026 | 0.027 |
| | (0.025) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) |
| $s_{t-1}$ | $-0.051^{**}$ | $-0.056^{**}$ | $-0.055^{**}$ | $-0.055^{**}$ | $-0.055^{**}$ | $-0.056^{**}$ |
| | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) |
| $\Delta x_t^0$ | 0.023 | $0.025^{*}$ | $0.025^{*}$ | 0.020 | 0.025 | 0.026 |
| | (0.014) | (0.014) | (0.014) | (0.015) | (0.016) | (0.016) |
| $\Delta e_{f,t}$ | $-0.130^{***}$ | $-0.141^{***}$ | $-0.142^{***}$ | $-0.135^{***}$ | $-0.136^{***}$ | $-0.138^{***}$ |
| | (0.043) | (0.045) | (0.045) | (0.046) | (0.046) | (0.046) |
| $\Delta m_t$ | 0.052 | 0.063 | 0.062 | 0.078 | 0.054 | 0.037 |
| | (0.141) | (0.142) | (0.143) | (0.143) | (0.144) | (0.148) |
| $\Delta p_t$ | $0.348^{*}$ | $0.387^{**}$ | $0.390^{**}$ | $0.373^{**}$ | $0.373^{**}$ | $0.364^{**}$ |
| | (0.175) | (0.181) | (0.182) | (0.183) | (0.182) | (0.183) |
| $\Delta x_{t-1}^0$ | 0.022 | $0.023^{*}$ | $0.024^{*}$ | 0.022 | $0.023^{*}$ | 0.023 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| $\Delta e_{f,t-1}$ | 0.037 | 0.041 | 0.041 | 0.040 | 0.046 | 0.047 |
| | (0.036) | (0.036) | (0.036) | (0.036) | (0.036) | (0.036) |
| $\Delta m_{t-1}$ | 0.013 | 0.046 | 0.039 | 0.009 | 0.014 | 0.009 |
| | (0.139) | (0.144) | (0.147) | (0.150) | (0.149) | (0.150) |
| $\Delta p_{t-1}$ | $-0.466^{***}$ | $-0.505^{***}$ | $-0.505^{***}$ | $-0.506^{***}$ | $-0.519^{***}$ | $-0.523^{***}$ |
| | (0.161) | (0.167) | (0.168) | (0.168) | (0.167) | (0.168) |
| $\Delta y_{t-1}$ | $-0.218^{**}$ | $-0.221^{**}$ | $-0.223^{**}$ | $-0.230^{**}$ | $-0.225^{**}$ | $-0.224^{**}$ |
| | (0.090) | (0.090) | (0.090) | (0.091) | (0.090) | (0.091) |
| $\Delta \overline{y}_{wt}$ | | $-0.520$ | $-0.595$ | $-0.708$ | $-0.619$ | $-0.664$ |
| | | (0.592) | (0.637) | (0.647) | (0.647) | (0.655) |
| $\Delta \overline{req}_{wt}$ | | | 0.015 | 0.010 | 0.021 | 0.003 |
| | | | (0.045) | (0.045) | (0.046) | (0.058) |
| $\Delta \overline{e}_{wt}$ | | | | $-0.160$ | $-0.133$ | $-0.121$ |
| | | | | (0.160) | (0.161) | (0.163) |
| $\Delta \overline{r}_{wt}$ | | | | | $-6.160$ | $-6.499$ |
| | | | | | (4.239) | (4.305) |
| $grv_t$ | | | | | | $-0.060$ |
| | | | | | | (0.118) |
| Residual serial | 7.242 | 7.240 | 7.371 | 7.721 | 8.049 | 8.248 |
| correlation test | [0.124] | [0.124] | [0.118] | [0.102] | [0.090] | [0.083] |
| Adjusted $R^2$ | 0.126 | 0.124 | 0.117 | 0.117 | 0.126 | 0.120 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.11a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | $\Delta e_{f,t}$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $s_t$ | 0.119 | $0.302^{***}$ | $-0.033^{**}$ | 0.027 |
| | (0.149) | (0.063) | (0.013) | (0.026) |
| $s_{t-1}$ | $-0.308^{**}$ | $-0.229^{***}$ | $0.035^{***}$ | $-0.053^{**}$ |
| | (0.152) | (0.066) | (0.013) | (0.026) |
| $\Delta x_t^0$ | | 0.028 | $-0.003$ | $0.025^{*}$ |
| | | (0.040) | (0.007) | (0.014) |
| $\Delta e_{f,t}$ | | | $0.163^{***}$ | $-0.139^{***}$ |
| | | | (0.017) | (0.045) |
| $\Delta p_t$ | | | | $0.377^{**}$ |
| | | | | (0.179) |
| $\Delta \bar{y}_{wt}$ | $7.638^{**}$ | $-2.471$ | $0.800^{***}$ | $-0.428$ |
| | (3.503) | (1.520) | (0.284) | (0.561) |
| $\Delta x_{t-1}^0$ | $-0.053$ | 0.044 | $-0.003$ | $0.023^{*}$ |
| | (0.090) | (0.038) | (0.007) | (0.014) |
| $\Delta e_{f,t-1}$ | $-0.429^{**}$ | $0.347^{***}$ | $-0.007$ | 0.038 |
| | (0.216) | (0.094) | (0.020) | (0.035) |
| $\Delta p_{t-1}$ | 0.022 | $-0.335$ | $0.478^{***}$ | $-0.489^{***}$ |
| | (0.792) | (0.337) | (0.088) | (0.163) |
| $\Delta y_{t-1}$ | 0.132 | $-0.147$ | 0.039 | $-0.220^{**}$ |
| | (0.591) | (0.251) | (0.048) | (0.089) |
| $\Delta p_{t-2}$ | | | $0.182^{**}$ | |
| | | | (0.078) | |
| Residual serial | 2.027 | 5.689 | 7.970 | 6.703 |
| correlation test | [0.731] | [0.224] | [0.093] | [0.152] |
| Adjusted $R^2$ | 0.126 | 0.215 | 0.661 | 0.137 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta p_t, \Delta y_t\right)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are least squares standard errors, and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.11b: Quarterly estimates of the equation for the oil exports variable in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.146 | 0.119 | 0.119 | 0.112 | 0.111 | 0.111 |
| | (0.151) | (0.149) | (0.150) | (0.142) | (0.139) | (0.140) |
| $s_{t-1}$ | $-0.342^{**}$ | $-0.308^{**}$ | $-0.307^{**}$ | $-0.313^{**}$ | $-0.294^{**}$ | $-0.293^{**}$ |
| | (0.154) | (0.152) | (0.153) | (0.145) | (0.142) | (0.143) |
| $\Delta x_{t-1}^0$ | $-0.035$ | $-0.053$ | $-0.053$ | $-0.080$ | $-0.091$ | $-0.091$ |
| | (0.091) | (0.090) | (0.091) | (0.086) | (0.084) | (0.085) |
| $\Delta e_{f,t-1}$ | $-0.440^{**}$ | $-0.429^{**}$ | $-0.429^{*}$ | $-0.363^{*}$ | $-0.414^{**}$ | $-0.414^{**}$ |
| | (0.220) | (0.216) | (0.218) | (0.207) | (0.203) | (0.204) |
| $\Delta p_{t-1}$ | $-0.158$ | 0.022 | 0.024 | $-0.257$ | $-0.079$ | $-0.064$ |
| | (0.801) | (0.792) | (0.796) | (0.760) | (0.745) | (0.757) |
| $\Delta y_{t-1}$ | 0.089 | 0.132 | 0.131 | $-0.030$ | $-0.074$ | $-0.075$ |
| | (0.600) | (0.591) | (0.594) | (0.566) | (0.552) | (0.555) |
| $\Delta \bar{y}_{wt}$ | | $7.638^{**}$ | $7.545^{*}$ | 3.436 | 2.377 | 2.461 |
| | | (3.503) | (3.870) | (3.845) | (3.774) | (3.842) |
| $\Delta \overline{req}_{wt}$ | | | 0.017 | $-0.102$ | $-0.209$ | $-0.179$ |
| | | | (0.293) | (0.280) | (0.276) | (0.352) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.337^{***}$ | $-3.391^{***}$ | $-3.407^{***}$ |
| | | | | (0.918) | (0.896) | (0.907) |
| $\Delta \bar{r}_{wt}$ | | | | | $64.555^{**}$ | $64.968^{**}$ |
| | | | | | (25.121) | (25.418) |
| $grv_t$ | | | | | | 0.093 |
| | | | | | | (0.687) |
| Residual serial correlation test | 1.157 | 2.027 | 2.052 | 1.565 | 3.775 | 3.937 |
| | [0.885] | [0.731] | [0.726] | [0.815] | [0.437] | [0.415] |
| Adjusted $R^2$ | 0.097 | 0.126 | 0.118 | 0.205 | 0.243 | 0.236 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.11c: Quarterly estimates of the equation for exchange rate returns in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.296*** | 0.302*** | 0.300*** | 0.299*** | 0.299*** | 0.305*** |
| | (0.064) | (0.063) | (0.064) | (0.064) | (0.064) | (0.063) |
| $s_{t-1}$ | −0.222*** | −0.229*** | −0.227*** | −0.221*** | −0.221*** | −0.228*** |
| | (0.066) | (0.066) | (0.066) | (0.066) | (0.066) | (0.066) |
| $\Delta x_t^0$ | 0.014 | 0.028 | 0.027 | 0.044 | 0.045 | 0.046 |
| | (0.039) | (0.040) | (0.040) | (0.042) | (0.044) | (0.043) |
| $\Delta x_{t-1}^0$ | 0.038 | 0.044 | 0.046 | 0.051 | 0.051 | 0.047 |
| | (0.038) | (0.038) | (0.039) | (0.039) | (0.039) | (0.038) |
| $\Delta e_{f,t-1}$ | 0.345*** | 0.347*** | 0.345*** | 0.342*** | 0.344*** | 0.344*** |
| | (0.094) | (0.094) | (0.094) | (0.094) | (0.095) | (0.094) |
| $\Delta p_{t-1}$ | −0.278 | −0.335 | −0.327 | −0.284 | −0.289 | −0.395 |
| | (0.337) | (0.337) | (0.338) | (0.339) | (0.342) | (0.341) |
| $\Delta y_{t-1}$ | −0.132 | −0.147 | −0.153 | −0.130 | −0.129 | −0.123 |
| | (0.253) | (0.251) | (0.252) | (0.253) | (0.254) | (0.250) |
| $\Delta \bar{y}_{wt}$ | | −2.471 | −2.795* | −2.284 | −2.262 | −2.843 |
| | | (1.520) | (1.671) | (1.722) | (1.737) | (1.735) |
| $\Delta \overline{req}_{wt}$ | | | 0.059 | 0.077 | 0.080 | −0.120 |
| | | | (0.124) | (0.125) | (0.127) | (0.159) |
| $\Delta \bar{e}_{wt}$ | | | | 0.515 | 0.522 | 0.629 |
| | | | | (0.433) | (0.438) | (0.434) |
| $\Delta \bar{r}_{wt}$ | | | | | −1.651 | −4.548 |
| | | | | | (11.882) | (11.796) |
| $grv_t$ | | | | | | −0.636** |
| | | | | | | (0.310) |
| Residual serial | 6.132 | 5.689 | 5.541 | 7.009 | 7.125 | 4.742 |
| correlation test | [0.190] | [0.224] | [0.236] | [0.135] | [0.129] | [0.315] |
| Adjusted $R^2$ | 0.203 | 0.215 | 0.209 | 0.212 | 0.205 | 0.228 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.11d: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.029^{**}$ | $-0.033^{**}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.031^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $s_{t-1}$ | $0.032^{**}$ | $0.035^{***}$ | $0.034^{***}$ | $0.034^{**}$ | $0.034^{**}$ | $0.033^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $\Delta x_t^0$ | 0.001 | $-0.003$ | $-0.003$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) |
| $\Delta e_{f,t}$ | $0.156^{***}$ | $0.163^{***}$ | $0.164^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.165^{***}$ |
| | (0.018) | (0.017) | (0.017) | (0.018) | (0.018) | (0.018) |
| $\Delta x_{t-1}^0$ | $-0.0003$ | $-0.003$ | $-0.003$ | $-0.004$ | $-0.004$ | $-0.004$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| $\Delta e_{f,t-1}$ | $-0.005$ | $-0.007$ | $-0.005$ | $-0.005$ | $-0.005$ | $-0.005$ |
| | (0.021) | (0.020) | (0.020) | (0.020) | (0.020) | (0.021) |
| $\Delta p_{t-1}$ | $0.468^{***}$ | $0.478^{***}$ | $0.467^{***}$ | $0.454^{***}$ | $0.455^{***}$ | $0.451^{***}$ |
| | (0.090) | (0.088) | (0.089) | (0.089) | (0.089) | (0.090) |
| $\Delta y_{t-1}$ | 0.032 | 0.039 | 0.044 | 0.041 | 0.040 | 0.040 |
| | (0.049) | (0.048) | (0.048) | (0.048) | (0.048) | (0.048) |
| $\Delta p_{t-2}$ | $0.169^{**}$ | $0.182^{**}$ | $0.194^{**}$ | $0.200^{**}$ | $0.201^{**}$ | $0.199^{**}$ |
| | (0.081) | (0.078) | (0.079) | (0.079) | (0.080) | (0.080) |
| $\Delta \bar{y}_{wt}$ | | $0.800^{***}$ | $0.932^{***}$ | $0.842^{***}$ | $0.836^{**}$ | $0.803^{**}$ |
| | | (0.284) | (0.313) | (0.320) | (0.323) | (0.330) |
| $\Delta \overline{req}_{wt}$ | | | $-0.023$ | $-0.027$ | $-0.028$ | $-0.038$ |
| | | | (0.023) | (0.023) | (0.024) | (0.030) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.101$ | $-0.103$ | $-0.097$ |
| | | | | (0.080) | (0.081) | (0.082) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.501 | 0.356 |
| | | | | | (2.184) | (2.209) |
| $grv_t$ | | | | | | $-0.031$ |
| | | | | | | (0.059) |
| Residual serial | 11.263 | 7.970 | 5.559 | 6.203 | 6.210 | 6.281 |
| correlation test | [0.024] | [0.093] | [0.235] | [0.184] | [0.184] | [0.179] |
| Adjusted $R^2$ | 0.640 | 0.661 | 0.661 | 0.663 | 0.660 | 0.657 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.11e: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.027 | 0.027 | 0.025 | 0.025 | 0.027 |
| | (0.025) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) |
| $s_{t-1}$ | $-0.050^{*}$ | $-0.053^{**}$ | $-0.053^{**}$ | $-0.053^{**}$ | $-0.053^{**}$ | $-0.055^{**}$ |
| | (0.025) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) |
| $\Delta x_t^0$ | 0.023 | $0.025^{*}$ | $0.025^{*}$ | 0.020 | $0.026^{*}$ | $0.026^{*}$ |
| | (0.014) | (0.014) | (0.014) | (0.015) | (0.016) | (0.016) |
| $\Delta e_{f,t}$ | $-0.130^{***}$ | $-0.139^{***}$ | $-0.140^{***}$ | $-0.133^{***}$ | $-0.135^{***}$ | $-0.138^{***}$ |
| | (0.043) | (0.045) | (0.045) | (0.045) | (0.045) | (0.045) |
| $\Delta p_t$ | $0.344^{**}$ | $0.377^{**}$ | $0.381^{**}$ | $0.362^{**}$ | $0.365^{**}$ | $0.359^{**}$ |
| | (0.173) | (0.179) | (0.180) | (0.181) | (0.180) | (0.181) |
| $\Delta x_{t-1}^0$ | 0.022 | $0.023^{*}$ | $0.023^{*}$ | 0.022 | $0.023^{*}$ | $0.023^{*}$ |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| $\Delta e_{f,t-1}$ | 0.036 | 0.038 | 0.038 | 0.037 | 0.045 | 0.046 |
| | (0.035) | (0.035) | (0.036) | (0.036) | (0.036) | (0.036) |
| $\Delta p_{t-1}$ | $-0.458^{***}$ | $-0.489^{***}$ | $-0.489^{***}$ | $-0.489^{***}$ | $-0.507^{***}$ | $-0.516^{***}$ |
| | (0.158) | (0.163) | (0.164) | (0.164) | (0.163) | (0.165) |
| $\Delta y_{t-1}$ | $-0.216^{**}$ | $-0.220^{**}$ | $-0.221^{**}$ | $-0.227^{**}$ | $-0.223^{**}$ | $-0.223^{**}$ |
| | (0.089) | (0.089) | (0.090) | (0.090) | (0.089) | (0.090) |
| $\Delta \bar{y}_{wt}$ | | $-0.428$ | $-0.531$ | $-0.658$ | $-0.577$ | $-0.644$ |
| | | (0.561) | (0.618) | (0.631) | (0.630) | (0.641) |
| $\Delta \overline{req}_{wt}$ | | | 0.018 | 0.012 | 0.023 | 0.002 |
| | | | (0.044) | (0.045) | (0.045) | (0.057) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.155$ | $-0.131$ | $-0.118$ |
| | | | | (0.156) | (0.156) | (0.157) |
| $\Delta \bar{r}_{wt}$ | | | | | $-6.346$ | $-6.663$ |
| | | | | | (4.174) | (4.219) |
| $grv_t$ | | | | | | $-0.068$ |
| | | | | | | (0.113) |
| Residual serial | 6.974 | 6.703 | 6.911 | 7.426 | 7.684 | 8.064 |
| correlation test | [0.137] | [0.152] | [0.141] | [0.115] | [0.104] | [0.089] |
| Adjusted $R^2$ | 0.141 | 0.137 | 0.131 | 0.131 | 0.141 | 0.136 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.12a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ (1) | $\Delta e_{f,t}$ (2) | $\Delta p_t$ (3) | $\Delta y_t$ (4) |
|---|---|---|---|---|
| $s_t$ | 0.111 | 0.309*** | −0.033** | 0.028 |
| | (0.151) | (0.063) | (0.013) | (0.025) |
| $s_{t-1}$ | −0.305** | −0.235*** | 0.036*** | −0.054** |
| | (0.154) | (0.065) | (0.013) | (0.025) |
| $\Delta x_t^0$ | | 0.018 | −0.004 | 0.028** |
| | | (0.039) | (0.007) | (0.014) |
| $\Delta e_{f,t}$ | | | 0.162*** | −0.138*** |
| | | | (0.017) | (0.044) |
| $\Delta p_t$ | | | | 0.364** |
| | | | | (0.177) |
| $\Delta \bar{y}_{wt}$ | 7.674** | −2.452 | 0.808*** | −0.459 |
| | (3.556) | (1.517) | (0.280) | (0.556) |
| $\Delta x_{t-1}^0$ | −0.063 | 0.041 | −0.002 | 0.021 |
| | (0.090) | (0.038) | (0.007) | (0.013) |
| $\Delta e_{f,t-1}$ | −0.361 | 0.332*** | −0.006 | 0.041 |
| | (0.218) | (0.092) | (0.020) | (0.034) |
| $\Delta p_{t-1}$ | −0.059 | −0.338 | 0.477*** | −0.482*** |
| | (0.803) | (0.336) | (0.086) | (0.162) |
| $\Delta y_{t-1}$ | 0.125 | −0.135 | 0.040 | −0.223** |
| | (0.600) | (0.251) | (0.047) | (0.088) |
| $\Delta p_{t-2}$ | | | 0.184** | |
| | | | (0.077) | |
| Residual serial correlation test | 3.751 | 4.983 | 8.003 | 6.738 |
| | [0.441] | [0.289] | [0.091] | [0.150] |
| Adjusted $R^2$ | 0.097 | 0.214 | 0.668 | 0.152 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. Seasonal dummies are *not* included to allow for possible seasonality of the variables in the SVAR model. Numbers in parentheses are least squares standard errors, and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.12b: Quarterly estimates of the equation for the oil exports variable in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.136 | 0.111 | 0.109 | 0.106 | 0.104 | 0.104 |
| | (0.153) | (0.151) | (0.152) | (0.144) | (0.140) | (0.141) |
| $s_{t-1}$ | $-0.338^{**}$ | $-0.305^{**}$ | $-0.304^{*}$ | $-0.316^{**}$ | $-0.295^{**}$ | $-0.294^{**}$ |
| | (0.155) | (0.154) | (0.155) | (0.147) | (0.143) | (0.144) |
| $\Delta x_{t-1}^0$ | −0.043 | −0.063 | −0.061 | −0.094 | −0.103 | −0.103 |
| | (0.091) | (0.090) | (0.091) | (0.087) | (0.084) | (0.085) |
| $\Delta e_{f,t-1}$ | $-0.370^{*}$ | −0.361 | −0.362 | −0.305 | $-0.364^{*}$ | $-0.363^{*}$ |
| | (0.221) | (0.218) | (0.219) | (0.208) | (0.204) | (0.205) |
| $\Delta p_{t-1}$ | −0.243 | −0.059 | −0.054 | −0.327 | −0.123 | −0.116 |
| | (0.811) | (0.803) | (0.808) | (0.768) | (0.752) | (0.764) |
| $\Delta y_{t-1}$ | 0.083 | 0.125 | 0.121 | −0.056 | −0.107 | −0.108 |
| | (0.609) | (0.600) | (0.603) | (0.573) | (0.558) | (0.561) |
| $\Delta \bar{y}_{wt}$ | | $7.674^{**}$ | $7.463^{*}$ | 3.031 | 2.068 | 2.109 |
| | | (3.556) | (3.904) | (3.881) | (3.796) | (3.866) |
| $\Delta \overline{req}_{wt}$ | | | 0.039 | −0.069 | −0.196 | −0.182 |
| | | | (0.292) | (0.278) | (0.275) | (0.350) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.469^{***}$ | $-3.514^{***}$ | $-3.522^{***}$ |
| | | | | (0.922) | (0.898) | (0.910) |
| $\Delta \bar{r}_{wt}$ | | | | | $66.900^{***}$ | $67.105^{***}$ |
| | | | | | (24.886) | (25.204) |
| $grv_t$ | | | | | | 0.044 |
| | | | | | | (0.692) |
| Residual serial | 2.435 | 3.751 | 3.865 | 2.464 | 4.895 | 5.026 |
| correlation test | [0.656] | [0.441] | [0.425] | [0.651] | [0.298] | [0.285] |
| Adjusted $R^2$ | 0.068 | 0.097 | 0.089 | 0.183 | 0.225 | 0.218 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.12c: Quarterly estimates of the equation for exchange rate returns in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.302*** | 0.309*** | 0.305*** | 0.304*** | 0.304*** | 0.310*** |
| | (0.063) | (0.063) | (0.064) | (0.064) | (0.064) | (0.063) |
| $s_{t-1}$ | −0.229*** | −0.235*** | −0.232*** | −0.226*** | −0.226*** | −0.233*** |
| | (0.066) | (0.065) | (0.066) | (0.066) | (0.066) | (0.065) |
| $\Delta x_t^0$ | 0.005 | 0.018 | 0.017 | 0.034 | 0.033 | 0.033 |
| | (0.038) | (0.039) | (0.039) | (0.041) | (0.043) | (0.042) |
| $\Delta x_{t-1}^0$ | 0.035 | 0.041 | 0.044 | 0.050 | 0.050 | 0.045 |
| | (0.038) | (0.038) | (0.038) | (0.038) | (0.039) | (0.038) |
| $\Delta e_{f,t-1}$ | 0.331*** | 0.332*** | 0.330*** | 0.327*** | 0.326*** | 0.324*** |
| | (0.093) | (0.092) | (0.093) | (0.092) | (0.094) | (0.093) |
| $\Delta p_{t-1}$ | −0.282 | −0.338 | −0.329 | −0.287 | −0.284 | −0.384 |
| | (0.337) | (0.336) | (0.337) | (0.338) | (0.341) | (0.341) |
| $\Delta y_{t-1}$ | −0.121 | −0.135 | −0.142 | −0.118 | −0.119 | −0.114 |
| | (0.252) | (0.251) | (0.252) | (0.252) | (0.253) | (0.250) |
| $\Delta \bar{y}_{wt}$ | | −2.452 | −2.855* | −2.319 | −2.333 | −2.908* |
| | | (1.517) | (1.656) | (1.713) | (1.726) | (1.726) |
| $\Delta \overline{req}_{wt}$ | | | 0.075 | 0.090 | 0.088 | −0.104 |
| | | | (0.122) | (0.123) | (0.125) | (0.156) |
| $\Delta \bar{e}_{wt}$ | | | | 0.515 | 0.510 | 0.624 |
| | | | | (0.430) | (0.434) | (0.432) |
| $\Delta \bar{r}_{wt}$ | | | | | 1.170 | −1.757 |
| | | | | | (11.653) | (11.590) |
| $grv_t$ | | | | | | −0.621** |
| | | | | | | (0.309) |
| Residual serial correlation test | 5.353 | 4.983 | 4.839 | 6.292 | 6.236 | 4.234 |
| | [0.253] | [0.289] | [0.304] | [0.178] | [0.182] | [0.375] |
| Adjusted $R^2$ | 0.203 | 0.214 | 0.209 | 0.212 | 0.205 | 0.226 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.12d: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.029^{**}$ | $-0.033^{**}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.031^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $s_{t-1}$ | $0.032^{**}$ | $0.036^{***}$ | $0.035^{***}$ | $0.034^{**}$ | $0.034^{**}$ | $0.033^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $\Delta x_t^0$ | 0.0005 | $-0.004$ | $-0.003$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) |
| $\Delta e_{f,t}$ | $0.155^{***}$ | $0.162^{***}$ | $0.163^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.164^{***}$ |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $\Delta x_{t-1}^0$ | 0.001 | $-0.002$ | $-0.002$ | $-0.004$ | $-0.004$ | $-0.004$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| $\Delta e_{f,t-1}$ | $-0.005$ | $-0.006$ | $-0.004$ | $-0.004$ | $-0.005$ | $-0.004$ |
| | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) |
| $\Delta p_{t-1}$ | $0.466^{***}$ | $0.477^{***}$ | $0.465^{***}$ | $0.454^{***}$ | $0.454^{***}$ | $0.450^{***}$ |
| | (0.089) | (0.086) | (0.087) | (0.087) | (0.087) | (0.088) |
| $\Delta y_{t-1}$ | 0.033 | 0.040 | 0.044 | 0.041 | 0.040 | 0.040 |
| | (0.049) | (0.047) | (0.047) | (0.047) | (0.048) | (0.048) |
| $\Delta p_{t-2}$ | $0.172^{**}$ | $0.184^{**}$ | $0.196^{**}$ | $0.201^{**}$ | $0.201^{**}$ | $0.199^{**}$ |
| | (0.079) | (0.077) | (0.078) | (0.078) | (0.078) | (0.078) |
| $\Delta \bar{y}_{wt}$ | | $0.808^{***}$ | $0.952^{***}$ | $0.854^{***}$ | $0.850^{***}$ | $0.815^{**}$ |
| | | (0.280) | (0.306) | (0.314) | (0.317) | (0.324) |
| $\Delta \overline{req}_{wt}$ | | | $-0.026$ | $-0.029$ | $-0.030$ | $-0.040$ |
| | | | (0.022) | (0.023) | (0.023) | (0.029) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.103$ | $-0.105$ | $-0.098$ |
| | | | | (0.079) | (0.079) | (0.081) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.317 | 0.167 |
| | | | | | (2.114) | (2.138) |
| $grv_t$ | | | | | | $-0.032$ |
| | | | | | | (0.058) |
| Residual serial | 11.521 | 8.003 | 5.321 | 5.888 | 5.868 | 5.924 |
| correlation test | [0.021] | [0.091] | [0.256] | [0.208] | [0.209] | [0.205] |
| Adjusted $R^2$ | 0.647 | 0.668 | 0.669 | 0.671 | 0.668 | 0.666 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.12e: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.028 | 0.027 | 0.026 | 0.026 | 0.027 |
| | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) | (0.026) |
| $s_{t-1}$ | $-0.050^{**}$ | $-0.054^{**}$ | $-0.053^{**}$ | $-0.054^{**}$ | $-0.054^{**}$ | $-0.055^{**}$ |
| | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) | (0.026) |
| $\Delta x_t^0$ | $0.025^{*}$ | $0.028^{**}$ | $0.028^{**}$ | 0.023 | $0.028^{*}$ | $0.028^{*}$ |
| | (0.013) | (0.014) | (0.014) | (0.015) | (0.015) | (0.015) |
| $\Delta e_{f,t}$ | $-0.128^{***}$ | $-0.138^{***}$ | $-0.140^{***}$ | $-0.134^{***}$ | $-0.134^{***}$ | $-0.137^{***}$ |
| | (0.042) | (0.044) | (0.044) | (0.045) | (0.044) | (0.045) |
| $\Delta p_t$ | $0.328^{*}$ | $0.364^{**}$ | $0.371^{**}$ | $0.353^{*}$ | $0.355^{**}$ | $0.348^{*}$ |
| | (0.171) | (0.177) | (0.178) | (0.179) | (0.178) | (0.179) |
| $\Delta x_{t-1}^0$ | 0.019 | 0.021 | 0.022 | 0.020 | 0.021 | 0.021 |
| | (0.013) | (0.013) | (0.013) | (0.014) | (0.014) | (0.014) |
| $\Delta e_{f,t-1}$ | 0.038 | 0.041 | 0.041 | 0.040 | 0.047 | 0.047 |
| | (0.034) | (0.034) | (0.035) | (0.035) | (0.035) | (0.035) |
| $\Delta p_{t-1}$ | $-0.449^{***}$ | $-0.482^{***}$ | $-0.484^{***}$ | $-0.483^{***}$ | $-0.500^{***}$ | $-0.508^{***}$ |
| | (0.156) | (0.162) | (0.162) | (0.162) | (0.162) | (0.163) |
| $\Delta y_{t-1}$ | $-0.219^{**}$ | $-0.223^{**}$ | $-0.225^{**}$ | $-0.231^{**}$ | $-0.226^{**}$ | $-0.226^{**}$ |
| | (0.088) | (0.088) | (0.089) | (0.089) | (0.088) | (0.089) |
| $\Delta \bar{y}_{wt}$ | | −0.459 | −0.595 | −0.715 | −0.645 | −0.710 |
| | | (0.556) | (0.609) | (0.624) | (0.622) | (0.634) |
| $\Delta \overline{req}_{wt}$ | | | 0.024 | 0.019 | 0.031 | 0.011 |
| | | | (0.043) | (0.043) | (0.044) | (0.056) |
| $\Delta \bar{e}_{wt}$ | | | | −0.139 | −0.117 | −0.103 |
| | | | | (0.153) | (0.153) | (0.155) |
| $\Delta \bar{r}_{wt}$ | | | | | −5.988 | −6.293 |
| | | | | | (4.064) | (4.109) |
| $grv_t$ | | | | | | −0.066 |
| | | | | | | (0.112) |
| Residual serial | 7.054 | 6.738 | 6.977 | 7.483 | 7.876 | 8.205 |
| correlation test | [0.133] | [0.150] | [0.137] | [0.112] | [0.096] | [0.084] |
| Adjusted $R^2$ | 0.154 | 0.152 | 0.146 | 0.145 | 0.154 | 0.149 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.13a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{f,t}$ | $\Delta x_t^0$ | $\Delta m_t$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $s_t$ | 0.308*** | 0.058 | −0.002 | −0.033** | 0.029 |
| | (0.064) | (0.165) | (0.017) | (0.013) | (0.026) |
| $s_{t-1}$ | −0.241*** | −0.250 | 0.015 | 0.037*** | −0.056** |
| | (0.066) | (0.164) | (0.017) | (0.013) | (0.026) |
| $\Delta e_{f,t}$ | | 0.158 | −0.007 | 0.163*** | −0.141*** |
| | | (0.223) | (0.023) | (0.017) | (0.045) |
| $\Delta x_t^0$ | | | 0.006 | −0.003 | 0.025* |
| | | | (0.010) | (0.007) | (0.014) |
| $\Delta m_t$ | | | | −0.073 | 0.063 |
| | | | | (0.073) | (0.142) |
| $\Delta p_t$ | | | | | 0.387** |
| | | | | | (0.181) |
| $\Delta \bar{y}_{wt}$ | −2.399 | 8.786** | 0.233 | 0.865*** | −0.520 |
| | (1.550) | (3.696) | (0.389) | (0.298) | (0.592) |
| $\Delta e_{f,t-1}$ | 0.337*** | −0.495** | −0.025 | −0.009 | 0.041 |
| | (0.092) | (0.230) | (0.027) | (0.020) | (0.036) |
| $\Delta x_{t-1}^0$ | 0.042 | −0.058 | −0.005 | −0.003 | 0.023* |
| | (0.038) | (0.091) | (0.009) | (0.007) | (0.014) |
| $\Delta m_{t-1}$ | 0.129 | −0.735 | 0.218** | −0.025 | 0.046 |
| | (0.395) | (0.933) | (0.096) | (0.075) | (0.144) |
| $\Delta p_{t-1}$ | −0.339 | 0.106 | 0.167 | 0.488*** | −0.505*** |
| | (0.337) | (0.800) | (0.115) | (0.089) | (0.167) |
| $\Delta y_{t-1}$ | −0.142 | 0.144 | 0.025 | 0.042 | −0.221** |
| | (0.252) | (0.594) | (0.063) | (0.048) | (0.090) |
| $\Delta p_{t-2}$ | | | −0.070 | 0.183** | |
| | | | (0.104) | (0.079) | |
| Residual serial | 5.987 | 2.379 | 7.640 | 8.061 | 7.240 |
| correlation test | [0.200] | [0.666] | [0.106] | [0.089] | [0.124] |
| Adjusted $R^2$ | 0.212 | 0.119 | 0.466 | 0.659 | 0.124 |

**Notes**: The variables are ordered as: $\Delta e_{ft}$, $\Delta x_t^0$, $\Delta m_t$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta e_{ft}, \Delta x_t^0, \Delta m_t, \Delta p_t, \Delta y_t\right)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are least squares standard errors, and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.13b: Quarterly estimates of the equation for the exchange rate returns in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.297*** | 0.308*** | 0.305*** | 0.307*** | 0.307*** | 0.311*** |
| | (0.064) | (0.064) | (0.064) | (0.064) | (0.065) | (0.064) |
| $s_{t-1}$ | −0.226*** | −0.241*** | −0.238*** | −0.239*** | −0.239*** | −0.243*** |
| | (0.065) | (0.066) | (0.066) | (0.066) | (0.067) | (0.066) |
| $\Delta e_{f,t-1}$ | 0.338*** | 0.337*** | 0.335*** | 0.328*** | 0.327*** | 0.326*** |
| | (0.093) | (0.092) | (0.093) | (0.093) | (0.094) | (0.093) |
| $\Delta x^0_{t-1}$ | 0.038 | 0.042 | 0.044 | 0.047 | 0.047 | 0.043 |
| | (0.038) | (0.038) | (0.039) | (0.039) | (0.039) | (0.038) |
| $\Delta m_{t-1}$ | −0.039 | 0.129 | 0.100 | 0.153 | 0.154 | 0.055 |
| | (0.382) | (0.395) | (0.402) | (0.406) | (0.408) | (0.406) |
| $\Delta p_{t-1}$ | −0.280 | −0.339 | −0.332 | −0.301 | −0.297 | −0.399 |
| | (0.337) | (0.337) | (0.339) | (0.341) | (0.344) | (0.343) |
| $\Delta y_{t-1}$ | −0.132 | −0.142 | −0.148 | −0.128 | −0.129 | −0.125 |
| | (0.253) | (0.252) | (0.253) | (0.254) | (0.255) | (0.252) |
| $\Delta \bar{y}_{wt}$ | | −2.399 | −2.667 | −2.228 | −2.252 | −2.759 |
| | | (1.550) | (1.676) | (1.741) | (1.760) | (1.755) |
| $\Delta \overline{req}_{wt}$ | | | 0.054 | 0.066 | 0.063 | −0.129 |
| | | | (0.126) | (0.127) | (0.129) | (0.160) |
| $\Delta \bar{e}_{wt}$ | | | | 0.390 | 0.390 | 0.478 |
| | | | | (0.415) | (0.417) | (0.414) |
| $\Delta \bar{r}_{wt}$ | | | | | 1.417 | −1.456 |
| | | | | | (11.596) | (11.531) |
| $grv_t$ | | | | | | −0.626** |
| | | | | | | (0.314) |
| Residual serial correlation test | 5.781 | 5.987 | 5.734 | 7.126 | 7.058 | 4.946 |
| | [0.216] | [0.200] | [0.220] | [0.129] | [0.133] | [0.293] |
| Adjusted $R^2$ | 0.202 | 0.212 | 0.206 | 0.205 | 0.198 | 0.220 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.13c: Quarterly estimates of the equation for the oil export variable in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.119 | 0.058 | 0.056 | 0.017 | 0.019 | 0.016 |
| | (0.166) | (0.165) | (0.166) | (0.157) | (0.153) | (0.155) |
| $s_{t-1}$ | $-0.320^{*}$ | $-0.250$ | $-0.248$ | $-0.223$ | $-0.208$ | $-0.205$ |
| | (0.165) | (0.164) | (0.165) | (0.155) | (0.152) | (0.153) |
| $\Delta e_{f,t}$ | 0.082 | 0.158 | 0.157 | 0.230 | 0.224 | 0.232 |
| | (0.225) | (0.223) | (0.224) | (0.212) | (0.207) | (0.212) |
| $\Delta e_{f,t-1}$ | $-0.470^{**}$ | $-0.495^{**}$ | $-0.496^{**}$ | $-0.458^{**}$ | $-0.505^{**}$ | $-0.507^{**}$ |
| | (0.235) | (0.230) | (0.232) | (0.218) | (0.214) | (0.215) |
| $\Delta x_{t-1}^0$ | $-0.038$ | $-0.058$ | $-0.057$ | $-0.087$ | $-0.098$ | $-0.098$ |
| | (0.092) | (0.091) | (0.092) | (0.087) | (0.085) | (0.085) |
| $\Delta m_{t-1}$ | $-0.125$ | $-0.735$ | $-0.760$ | $-1.250$ | $-1.175$ | $-1.156$ |
| | (0.915) | (0.933) | (0.950) | (0.903) | (0.882) | (0.892) |
| $\Delta p_{t-1}$ | $-0.133$ | 0.106 | 0.112 | $-0.144$ | 0.026 | 0.049 |
| | (0.810) | (0.800) | (0.804) | (0.760) | (0.745) | (0.759) |
| $\Delta y_{t-1}$ | 0.097 | 0.144 | 0.139 | $-0.032$ | $-0.074$ | $-0.074$ |
| | (0.606) | (0.594) | (0.598) | (0.564) | (0.551) | (0.554) |
| $\Delta \bar{y}_{wt}$ | | $8.786^{**}$ | $8.551^{**}$ | 4.698 | 3.603 | 3.725 |
| | | (3.696) | (4.002) | (3.896) | (3.829) | (3.902) |
| $\Delta \overline{req}_{wt}$ | | | 0.047 | $-0.061$ | $-0.168$ | $-0.128$ |
| | | | (0.298) | (0.282) | (0.279) | (0.352) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.597^{***}$ | $-3.638^{***}$ | $-3.659^{***}$ |
| | | | | (0.926) | (0.904) | (0.916) |
| $\Delta \bar{r}_{wt}$ | | | | | $63.168^{**}$ | $63.754^{**}$ |
| | | | | | (25.040) | (25.351) |
| $grv_t$ | | | | | | 0.130 |
| | | | | | | (0.702) |
| Residual serial correlation test | 1.196 | 2.379 | 2.414 | 1.926 | 4.488 | 4.558 |
| | [0.879] | [0.666] | [0.660] | [0.749] | [0.344] | [0.336] |
| Adjusted $R^2$ | 0.082 | 0.119 | 0.111 | 0.212 | 0.249 | 0.242 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.13d: Quarterly estimates of the equation for money supply growth in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta m_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.0004$ | $-0.002$ | $-0.003$ | $-0.002$ | $-0.002$ | 0.002 |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $s_{t-1}$ | 0.014 | 0.015 | 0.016 | 0.017 | 0.017 | 0.014 |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $\Delta e_{f,t}$ | $-0.009$ | $-0.007$ | $-0.008$ | $-0.011$ | $-0.012$ | $-0.022$ |
| | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) |
| $\Delta x_t^0$ | 0.008 | 0.006 | 0.006 | 0.011 | 0.014 | 0.015 |
| | (0.009) | (0.010) | (0.010) | (0.010) | (0.011) | (0.010) |
| $\Delta e_{f,t-1}$ | $-0.024$ | $-0.025$ | $-0.026$ | $-0.027$ | $-0.023$ | $-0.021$ |
| | (0.026) | (0.027) | (0.027) | (0.027) | (0.027) | (0.026) |
| $\Delta x_{t-1}^0$ | $-0.005$ | $-0.005$ | $-0.005$ | $-0.003$ | $-0.002$ | $-0.003$ |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| $\Delta m_{t-1}$ | $0.235^{**}$ | $0.218^{**}$ | $0.211^{**}$ | $0.236^{**}$ | $0.236^{**}$ | $0.211^{**}$ |
| | (0.092) | (0.096) | (0.098) | (0.099) | (0.099) | (0.098) |
| $\Delta p_{t-1}$ | 0.165 | 0.167 | 0.174 | 0.193 | 0.189 | 0.163 |
| | (0.115) | (0.115) | (0.117) | (0.117) | (0.117) | (0.115) |
| $\Delta y_{t-1}$ | 0.022 | 0.025 | 0.022 | 0.026 | 0.028 | 0.026 |
| | (0.063) | (0.063) | (0.063) | (0.063) | (0.063) | (0.062) |
| $\Delta p_{t-2}$ | $-0.076$ | $-0.070$ | $-0.077$ | $-0.088$ | $-0.094$ | $-0.102$ |
| | (0.103) | (0.104) | (0.105) | (0.105) | (0.105) | (0.103) |
| $\Delta \bar{y}_{wt}$ | | 0.233 | 0.152 | 0.260 | 0.304 | 0.134 |
| | | (0.389) | (0.421) | (0.427) | (0.427) | (0.425) |
| $\Delta \overline{req}_{wt}$ | | | 0.016 | 0.021 | 0.027 | $-0.026$ |
| | | | (0.031) | (0.031) | (0.031) | (0.038) |
| $\Delta \bar{e}_{wt}$ | | | | 0.146 | 0.160 | $0.191^{*}$ |
| | | | | (0.107) | (0.108) | (0.106) |
| $\Delta \bar{r}_{wt}$ | | | | | $-3.581$ | $-4.412$ |
| | | | | | (2.850) | (2.815) |
| $grv_t$ | | | | | | $-0.176^{**}$ |
| | | | | | | (0.076) |
| Residual serial | 7.428 | 7.640 | 7.255 | 6.129 | 5.742 | 4.178 |
| correlation test | [0.115] | [0.106] | [0.123] | [0.190] | [0.219] | [0.382] |
| Adjusted $R^2$ | 0.469 | 0.466 | 0.462 | 0.467 | 0.470 | 0.491 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.13e: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.028^{**}$ | $-0.033^{**}$ | $-0.032^{**}$ | $-0.033^{**}$ | $-0.033^{**}$ | $-0.032^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $s_{t-1}$ | $0.032^{**}$ | $0.037^{***}$ | $0.036^{***}$ | $0.036^{***}$ | $0.036^{***}$ | $0.035^{**}$ |
| | (0.014) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $\Delta e_{f,t}$ | $0.155^{***}$ | $0.163^{***}$ | $0.164^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.163^{***}$ |
| | (0.018) | (0.017) | (0.018) | (0.018) | (0.018) | (0.018) |
| $\Delta x_t^0$ | 0.001 | −0.003 | −0.003 | −0.007 | −0.007 | −0.007 |
| | (0.008) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) |
| $\Delta m_t$ | −0.061 | −0.073 | −0.070 | −0.058 | −0.057 | −0.070 |
| | (0.076) | (0.073) | (0.073) | (0.074) | (0.075) | (0.077) |
| $\Delta e_{f,t-1}$ | −0.007 | −0.009 | −0.007 | −0.007 | −0.007 | −0.007 |
| | (0.021) | (0.020) | (0.020) | (0.020) | (0.021) | (0.021) |
| $\Delta x_{t-1}^0$ | −0.001 | −0.003 | −0.003 | −0.004 | −0.004 | −0.005 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| $\Delta m_{t-1}$ | 0.035 | −0.025 | −0.016 | −0.036 | −0.036 | −0.040 |
| | (0.075) | (0.075) | (0.076) | (0.078) | (0.078) | (0.078) |
| $\Delta p_{t-1}$ | $0.480^{***}$ | $0.488^{***}$ | $0.478^{***}$ | $0.462^{***}$ | $0.462^{***}$ | $0.458^{***}$ |
| | (0.092) | (0.089) | (0.090) | (0.090) | (0.091) | (0.091) |
| $\Delta y_{t-1}$ | 0.033 | 0.042 | 0.045 | 0.042 | 0.042 | 0.042 |
| | (0.050) | (0.048) | (0.048) | (0.048) | (0.049) | (0.049) |
| $\Delta p_{t-2}$ | $0.162^{**}$ | $0.183^{**}$ | $0.192^{**}$ | $0.201^{**}$ | $0.202^{**}$ | $0.198^{**}$ |
| | (0.082) | (0.079) | (0.080) | (0.080) | (0.081) | (0.081) |
| $\Delta \bar{y}_{wt}$ | | $0.865^{***}$ | $0.971^{***}$ | $0.893^{***}$ | $0.889^{***}$ | $0.847^{**}$ |
| | | (0.298) | (0.322) | (0.327) | (0.330) | (0.335) |
| $\Delta \overline{req}_{wt}$ | | | −0.021 | −0.024 | −0.025 | −0.039 |
| | | | (0.023) | (0.024) | (0.024) | (0.030) |
| $\Delta \bar{e}_{wt}$ | | | | −0.102 | −0.104 | −0.093 |
| | | | | (0.083) | (0.084) | (0.085) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.303 | 0.031 |
| | | | | | (2.210) | (2.242) |
| $grv_t$ | | | | | | −0.048 |
| | | | | | | (0.061) |
| Residual serial | 9.241 | 8.061 | 5.714 | 6.473 | 6.510 | 6.759 |
| correlation test | [0.055] | [0.089] | [0.222] | [0.166] | [0.164] | [0.149] |
| Adjusted $R^2$ | 0.635 | 0.659 | 0.658 | 0.660 | 0.656 | 0.655 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.13f: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.029 | 0.028 | 0.026 | 0.026 | 0.027 |
| | (0.025) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) |
| $s_{t-1}$ | $-0.051^{**}$ | $-0.056^{**}$ | $-0.055^{**}$ | $-0.055^{**}$ | $-0.055^{**}$ | $-0.056^{**}$ |
| | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) |
| $\Delta e_{f,t}$ | $-0.130^{***}$ | $-0.141^{***}$ | $-0.142^{***}$ | $-0.135^{***}$ | $-0.136^{***}$ | $-0.138^{***}$ |
| | (0.043) | (0.045) | (0.045) | (0.046) | (0.046) | (0.046) |
| $\Delta x_t^0$ | 0.023 | $0.025^{*}$ | $0.025^{*}$ | 0.020 | 0.025 | 0.026 |
| | (0.014) | (0.014) | (0.014) | (0.015) | (0.016) | (0.016) |
| $\Delta m_t$ | 0.052 | 0.063 | 0.062 | 0.078 | 0.054 | 0.037 |
| | (0.141) | (0.142) | (0.143) | (0.143) | (0.144) | (0.148) |
| $\Delta p_t$ | $0.348^{*}$ | $0.387^{**}$ | $0.390^{**}$ | $0.373^{**}$ | $0.373^{**}$ | $0.364^{**}$ |
| | (0.175) | (0.181) | (0.182) | (0.183) | (0.182) | (0.183) |
| $\Delta e_{f,t-1}$ | 0.037 | 0.041 | 0.041 | 0.040 | 0.046 | 0.047 |
| | (0.036) | (0.036) | (0.036) | (0.036) | (0.036) | (0.036) |
| $\Delta x_{t-1}^0$ | 0.022 | $0.023^{*}$ | $0.024^{*}$ | 0.022 | $0.023^{*}$ | 0.023 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| $\Delta m_{t-1}$ | 0.013 | 0.046 | 0.039 | 0.009 | 0.014 | 0.009 |
| | (0.139) | (0.144) | (0.147) | (0.150) | (0.149) | (0.150) |
| $\Delta p_{t-1}$ | $-0.466^{***}$ | $-0.505^{***}$ | $-0.505^{***}$ | $-0.506^{***}$ | $-0.519^{***}$ | $-0.523^{***}$ |
| | (0.161) | (0.167) | (0.168) | (0.168) | (0.167) | (0.168) |
| $\Delta y_{t-1}$ | $-0.218^{**}$ | $-0.221^{**}$ | $-0.223^{**}$ | $-0.230^{**}$ | $-0.225^{**}$ | $-0.224^{**}$ |
| | (0.090) | (0.090) | (0.090) | (0.091) | (0.090) | (0.091) |
| $\Delta \bar{y}_{wt}$ | | $-0.520$ | $-0.595$ | $-0.708$ | $-0.619$ | $-0.664$ |
| | | (0.592) | (0.637) | (0.647) | (0.647) | (0.655) |
| $\Delta \overline{req}_{wt}$ | | | 0.015 | 0.010 | 0.021 | 0.003 |
| | | | (0.045) | (0.045) | (0.046) | (0.058) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.160$ | $-0.133$ | $-0.121$ |
| | | | | (0.160) | (0.161) | (0.163) |
| $\Delta \bar{r}_{wt}$ | | | | | $-6.160$ | $-6.499$ |
| | | | | | (4.239) | (4.305) |
| $grv_t$ | | | | | | $-0.060$ |
| | | | | | | (0.118) |
| Residual serial | 7.242 | 7.240 | 7.371 | 7.721 | 8.049 | 8.248 |
| correlation test | [0.124] | [0.124] | [0.118] | [0.102] | [0.090] | [0.083] |
| Adjusted $R^2$ | 0.126 | 0.124 | 0.117 | 0.117 | 0.126 | 0.120 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.14a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{f,t}$ | $\Delta x_t^0$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $s_t$ | $0.311^{***}$ | 0.079 | $-0.033^{**}$ | 0.028 |
| | (0.063) | (0.166) | (0.013) | (0.025) |
| $s_{t-1}$ | $-0.241^{***}$ | $-0.280^{*}$ | $0.036^{***}$ | $-0.054^{**}$ |
| | (0.064) | (0.163) | (0.013) | (0.025) |
| $\Delta e_{f,t}$ | | 0.102 | $0.162^{***}$ | $-0.138^{***}$ |
| | | (0.223) | (0.017) | (0.044) |
| $\Delta x_t^0$ | | | $-0.004$ | $0.028^{**}$ |
| | | | (0.007) | (0.014) |
| $\Delta p_t$ | | | | $0.364^{**}$ |
| | | | | (0.177) |
| $\Delta \bar{y}_{wt}$ | $-2.316$ | $7.910^{**}$ | $0.808^{***}$ | $-0.459$ |
| | (1.482) | (3.605) | (0.280) | (0.556) |
| $\Delta e_{f,t-1}$ | $0.326^{***}$ | $-0.394^{*}$ | $-0.006$ | 0.041 |
| | (0.091) | (0.231) | (0.020) | (0.034) |
| $\Delta x_{t-1}^0$ | 0.040 | $-0.067$ | $-0.002$ | 0.021 |
| | (0.038) | (0.091) | (0.007) | (0.013) |
| $\Delta p_{t-1}$ | $-0.339$ | $-0.025$ | $0.477^{***}$ | $-0.482^{***}$ |
| | (0.335) | (0.810) | (0.086) | (0.162) |
| $\Delta y_{t-1}$ | $-0.133$ | 0.138 | 0.040 | $-0.223^{**}$ |
| | (0.250) | (0.602) | (0.047) | (0.088) |
| $\Delta p_{t-2}$ | | | $0.184^{**}$ | |
| | | | (0.077) | |
| Residual serial | 4.832 | 3.895 | 8.003 | 6.738 |
| correlation test | [0.305] | [0.420] | [0.091] | [0.150] |
| Adjusted $R^2$ | 0.219 | 0.091 | 0.668 | 0.152 |

**Notes**: The variables are ordered as: $\Delta e_{ft}$, $\Delta x_t^0, \Delta p_t$, and $\Delta y_t$, where: $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. Seasonal dummies are *not* included to allow for possible seasonality of the variables in the SVAR model. Numbers in parentheses are least squares standard errors, and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.14b: Quarterly estimates of the equation for exchange rate returns in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.303*** | 0.311*** | 0.307*** | 0.307*** | 0.307*** | 0.314*** |
| | (0.063) | (0.063) | (0.063) | (0.063) | (0.064) | (0.063) |
| $s_{t-1}$ | −0.231*** | −0.241*** | −0.238*** | −0.236*** | −0.235*** | −0.243*** |
| | (0.064) | (0.064) | (0.064) | (0.065) | (0.065) | (0.064) |
| $\Delta e_{f,t-1}$ | 0.329*** | 0.326*** | 0.323*** | 0.317*** | 0.314*** | 0.312*** |
| | (0.091) | (0.091) | (0.091) | (0.092) | (0.092) | (0.091) |
| $\Delta x^0_{t-1}$ | 0.035 | 0.040 | 0.043 | 0.047 | 0.046 | 0.041 |
| | (0.038) | (0.038) | (0.038) | (0.038) | (0.038) | (0.038) |
| $\Delta p_{t-1}$ | −0.284 | −0.339 | −0.330 | −0.298 | −0.288 | −0.388 |
| | (0.335) | (0.335) | (0.336) | (0.338) | (0.341) | (0.340) |
| $\Delta y_{t-1}$ | −0.121 | −0.133 | −0.140 | −0.120 | −0.122 | −0.118 |
| | (0.251) | (0.250) | (0.251) | (0.252) | (0.253) | (0.250) |
| $\Delta \bar{y}_{wt}$ | | −2.316 | −2.724* | −2.217 | −2.265 | −2.837 |
| | | (1.482) | (1.625) | (1.706) | (1.720) | (1.721) |
| $\Delta \overline{req}_{wt}$ | | | 0.076 | 0.088 | 0.082 | −0.110 |
| | | | (0.122) | (0.122) | (0.125) | (0.156) |
| $\Delta \bar{e}_{wt}$ | | | | 0.397 | 0.395 | 0.507 |
| | | | | (0.405) | (0.407) | (0.405) |
| $\Delta \bar{r}_{wt}$ | | | | | 3.363 | 0.477 |
| | | | | | (11.277) | (11.221) |
| $grv_t$ | | | | | | −0.619** |
| | | | | | | (0.308) |
| Residual serial correlation test | 5.198 | 4.832 | 4.686 | 5.847 | 5.717 | 4.179 |
| | [0.268] | [0.305] | [0.321] | [0.211] | [0.221] | [0.382] |
| Adjusted $R^2$ | 0.209 | 0.219 | 0.215 | 0.215 | 0.208 | 0.229 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.14c: Quarterly estimates of the equation for the oil exports variable in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.126 | 0.079 | 0.078 | 0.053 | 0.055 | 0.051 |
| | (0.168) | (0.166) | (0.167) | (0.158) | (0.154) | (0.156) |
| $s_{t-1}$ | $-0.330^{**}$ | $-0.280^{*}$ | $-0.280^{*}$ | $-0.274^{*}$ | $-0.257^{*}$ | $-0.253$ |
| | (0.165) | (0.163) | (0.164) | (0.155) | (0.152) | (0.153) |
| $\Delta e_{f,t}$ | 0.032 | 0.102 | 0.101 | 0.175 | 0.160 | 0.168 |
| | (0.225) | (0.223) | (0.225) | (0.213) | (0.208) | (0.213) |
| $\Delta e_{f,t-1}$ | $-0.381$ | $-0.394^{*}$ | $-0.395^{*}$ | $-0.360$ | $-0.414^{*}$ | $-0.416^{*}$ |
| | (0.234) | (0.231) | (0.232) | (0.219) | (0.214) | (0.216) |
| $\Delta x_{t-1}^0$ | $-0.044$ | $-0.067$ | $-0.066$ | $-0.102$ | $-0.111$ | $-0.110$ |
| | (0.092) | (0.091) | (0.092) | (0.087) | (0.085) | (0.086) |
| $\Delta p_{t-1}$ | $-0.234$ | $-0.025$ | $-0.021$ | $-0.275$ | $-0.077$ | $-0.051$ |
| | (0.817) | (0.810) | (0.814) | (0.772) | (0.756) | (0.769) |
| $\Delta y_{t-1}$ | 0.087 | 0.138 | 0.135 | $-0.035$ | $-0.088$ | $-0.088$ |
| | (0.612) | (0.602) | (0.606) | (0.574) | (0.560) | (0.562) |
| $\Delta \bar{y}_{wt}$ | | $7.910^{**}$ | $7.738^{*}$ | 3.419 | 2.430 | 2.585 |
| | | (3.605) | (3.965) | (3.915) | (3.832) | (3.919) |
| $\Delta \overline{req}_{wt}$ | | | 0.031 | $-0.085$ | $-0.209$ | $-0.164$ |
| | | | (0.294) | (0.280) | (0.276) | (0.351) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.538^{***}$ | $-3.577^{***}$ | $-3.607^{***}$ |
| | | | | (0.927) | (0.903) | (0.918) |
| $\Delta \bar{r}_{wt}$ | | | | | $66.363^{***}$ | $67.024^{***}$ |
| | | | | | (24.942) | (25.247) |
| $grv_t$ | | | | | | 0.148 |
| | | | | | | (0.706) |
| Residual serial | 2.461 | 3.895 | 4.005 | 2.396 | 4.791 | 5.085 |
| correlation test | [0.652] | [0.420] | [0.405] | [0.663] | [0.309] | [0.279] |
| Adjusted $R^2$ | 0.061 | 0.091 | 0.083 | 0.180 | 0.222 | 0.215 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.14d: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.029^{**}$ | $-0.033^{**}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.031^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $s_{t-1}$ | $0.032^{**}$ | $0.036^{***}$ | $0.035^{***}$ | $0.034^{**}$ | $0.034^{**}$ | $0.033^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $\Delta e_{f,t}$ | $0.155^{***}$ | $0.162^{***}$ | $0.163^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.164^{***}$ |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $\Delta x_t^0$ | 0.0005 | $-0.004$ | $-0.003$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) |
| $\Delta e_{f,t-1}$ | $-0.005$ | $-0.006$ | $-0.004$ | $-0.004$ | $-0.005$ | $-0.004$ |
| | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) |
| $\Delta x_{t-1}^0$ | 0.001 | $-0.002$ | $-0.002$ | $-0.004$ | $-0.004$ | $-0.004$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| $\Delta p_{t-1}$ | $0.466^{***}$ | $0.477^{***}$ | $0.465^{***}$ | $0.454^{***}$ | $0.454^{***}$ | $0.450^{***}$ |
| | (0.089) | (0.086) | (0.087) | (0.087) | (0.087) | (0.088) |
| $\Delta y_{t-1}$ | 0.033 | 0.040 | 0.044 | 0.041 | 0.040 | 0.040 |
| | (0.049) | (0.047) | (0.047) | (0.047) | (0.048) | (0.048) |
| $\Delta p_{t-2}$ | $0.172^{**}$ | $0.184^{**}$ | $0.196^{**}$ | $0.201^{**}$ | $0.201^{**}$ | $0.199^{**}$ |
| | (0.079) | (0.077) | (0.078) | (0.078) | (0.078) | (0.078) |
| $\Delta \bar{y}_{wt}$ | | $0.808^{***}$ | $0.952^{***}$ | $0.854^{***}$ | $0.850^{***}$ | $0.815^{**}$ |
| | | (0.280) | (0.306) | (0.314) | (0.317) | (0.324) |
| $\Delta \overline{req}_{wt}$ | | | $-0.026$ | $-0.029$ | $-0.030$ | $-0.040$ |
| | | | (0.022) | (0.023) | (0.023) | (0.029) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.103$ | $-0.105$ | $-0.098$ |
| | | | | (0.079) | (0.079) | (0.081) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.317 | 0.167 |
| | | | | | (2.114) | (2.138) |
| $grv_t$ | | | | | | $-0.032$ |
| | | | | | | (0.058) |
| Residual serial | 11.521 | 8.003 | 5.321 | 5.888 | 5.868 | 5.924 |
| correlation test | [0.021] | [0.091] | [0.256] | [0.208] | [0.209] | [0.205] |
| Adjusted $R^2$ | 0.647 | 0.668 | 0.669 | 0.671 | 0.668 | 0.666 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.14e: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.028 | 0.027 | 0.026 | 0.026 | 0.027 |
| | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) | (0.026) |
| $s_{t-1}$ | $-0.050^{**}$ | $-0.054^{**}$ | $-0.053^{**}$ | $-0.054^{**}$ | $-0.054^{**}$ | $-0.055^{**}$ |
| | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) | (0.026) |
| $\Delta e_{f,t}$ | $-0.128^{***}$ | $-0.138^{***}$ | $-0.140^{***}$ | $-0.134^{***}$ | $-0.134^{***}$ | $-0.137^{***}$ |
| | (0.042) | (0.044) | (0.044) | (0.045) | (0.044) | (0.045) |
| $\Delta x_t^0$ | $0.025^{*}$ | $0.028^{**}$ | $0.028^{**}$ | 0.023 | $0.028^{*}$ | $0.028^{*}$ |
| | (0.013) | (0.014) | (0.014) | (0.015) | (0.015) | (0.015) |
| $\Delta p_t$ | $0.328^{*}$ | $0.364^{**}$ | $0.371^{**}$ | $0.353^{*}$ | $0.355^{**}$ | $0.348^{*}$ |
| | (0.171) | (0.177) | (0.178) | (0.179) | (0.178) | (0.179) |
| $\Delta e_{f,t-1}$ | 0.038 | 0.041 | 0.041 | 0.040 | 0.047 | 0.047 |
| | (0.034) | (0.034) | (0.035) | (0.035) | (0.035) | (0.035) |
| $\Delta x_{t-1}^0$ | 0.019 | 0.021 | 0.022 | 0.020 | 0.021 | 0.021 |
| | (0.013) | (0.013) | (0.013) | (0.014) | (0.014) | (0.014) |
| $\Delta p_{t-1}$ | $-0.449^{***}$ | $-0.482^{***}$ | $-0.484^{***}$ | $-0.483^{***}$ | $-0.500^{***}$ | $-0.508^{***}$ |
| | (0.156) | (0.162) | (0.162) | (0.162) | (0.162) | (0.163) |
| $\Delta y_{t-1}$ | $-0.219^{**}$ | $-0.223^{**}$ | $-0.225^{**}$ | $-0.231^{**}$ | $-0.226^{**}$ | $-0.226^{**}$ |
| | (0.088) | (0.088) | (0.089) | (0.089) | (0.088) | (0.089) |
| $\Delta \bar{y}_{wt}$ | | −0.459 | −0.595 | −0.715 | −0.645 | −0.710 |
| | | (0.556) | (0.609) | (0.624) | (0.622) | (0.634) |
| $\Delta \overline{req}_{wt}$ | | | 0.024 | 0.019 | 0.031 | 0.011 |
| | | | (0.043) | (0.043) | (0.044) | (0.056) |
| $\Delta \bar{e}_{wt}$ | | | | −0.139 | −0.117 | −0.103 |
| | | | | (0.153) | (0.153) | (0.155) |
| $\Delta \bar{r}_{wt}$ | | | | | −5.988 | −6.293 |
| | | | | | (4.064) | (4.109) |
| $grv_t$ | | | | | | −0.066 |
| | | | | | | (0.112) |
| Residual serial | 7.054 | 6.738 | 6.977 | 7.483 | 7.876 | 8.205 |
| correlation test | [0.133] | [0.150] | [0.137] | [0.112] | [0.096] | [0.084] |
| Adjusted $R^2$ | 0.154 | 0.152 | 0.146 | 0.145 | 0.154 | 0.149 |

**Notes**: See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.15: Estimates of the reduced form Iran's output growth equation using a sanctions dummy variable estimated over the period 1989q1- 2019q4

| | $\Delta y_t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $d_{t-1}(\beta_{d_{t-1}})$ | $-0.014^{*}$ | $-0.014^{*}$ | $-0.014^{*}$ | $-0.014^{*}$ | $-0.013^{*}$ | $-0.013^{*}$ | $-0.013^{*}$ |
| | (0.007) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| $\Delta y_{t-1}(\lambda_{\Delta y_{t-1}})$ | $-0.207^{**}$ | $-0.206^{**}$ | $-0.208^{**}$ | $-0.205^{**}$ | $-0.214^{**}$ | $-0.215^{**}$ | $-0.218^{**}$ |
| | (0.092) | (0.092) | (0.093) | (0.093) | (0.092) | (0.093) | (0.093) |
| $\Delta x^0_{t-1}$ | 0.017 | 0.016 | 0.017 | 0.018 | 0.016 | 0.015 | 0.016 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| $\Delta e_{f,t-1}$ | $-0.013$ | $-0.013$ | $-0.013$ | $-0.010$ | $-0.007$ | $-0.008$ | $-0.009$ |
| | (0.033) | (0.033) | (0.033) | (0.033) | (0.033) | (0.033) | (0.033) |
| $\Delta m_{t-1}$ | $-0.042$ | $-0.048$ | $-0.053$ | $-0.046$ | $-0.066$ | $-0.071$ | $-0.078$ |
| | (0.100) | (0.102) | (0.103) | (0.104) | (0.104) | (0.105) | (0.106) |
| $\Delta p_{t-1}$ | $-0.214^{*}$ | $-0.212^{*}$ | $-0.209^{*}$ | $-0.222^{*}$ | $-0.245^{*}$ | $-0.252^{**}$ | $-0.253^{*}$ |
| | (0.124) | (0.125) | (0.125) | (0.126) | (0.126) | (0.127) | (0.128) |
| $\Delta \bar{y}_{wt}$ | | 0.156 | 0.058 | 0.107 | $-0.169$ | $-0.230$ | $-0.186$ |
| | | (0.561) | (0.611) | (0.613) | (0.633) | (0.645) | (0.653) |
| $\Delta \overline{req}_{wt}$ | | | 0.019 | 0.026 | 0.019 | $-0.0002$ | $-0.002$ |
| | | | (0.045) | (0.046) | (0.046) | (0.058) | (0.058) |
| $\Delta \bar{r}_{wt}$ | | | | $-4.060$ | $-3.838$ | $-4.120$ | $-3.154$ |
| | | | | (4.145) | (4.119) | (4.165) | (4.638) |
| $\Delta \bar{e}_{wt}$ | | | | | $-0.240$ | $-0.228$ | $-0.265$ |
| | | | | | (0.150) | (0.152) | (0.171) |
| $grv_t$ | | | | | | $-0.063$ | $-0.069$ |
| | | | | | | (0.116) | (0.117) |
| $\Delta p^0_t$ | | | | | | | $-0.012$ |
| | | | | | | | (0.024) |
| $\beta_{d_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ | $-0.012^{*}$ | $-0.011^{*}$ | $-0.011^{*}$ | $-0.012^{*}$ | $-0.010^{*}$ | $-0.011^{*}$ | $-0.011^{*}$ |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Adjusted $R^2$ | 0.078 | 0.070 | 0.064 | 0.063 | 0.076 | 0.070 | 0.064 |

**Notes**: $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $d_t$ is the sanctions dummy variable. $\beta_{d_{t-1}}$ and $\lambda_{\Delta y_{t-1}}$ are the coefficients of $d_{t-1}$ and $\Delta y_{t-1}$, respectively; $\beta_{d_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ represents the long run effect of sanctions on output growth. See Chapter 6 of Pesaran (2015).
See the notes to Table S.9 for further details on the sources and construction of data used. Details on the construction of $d_t$ are provided in Section S.2.4.

Table S.16: Estimates of the reduced form Iran's output growth equation using a discretized sanctions intensity variable estimated over the period 1989q1- 2019q4

| | $\Delta y_t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $s^D_{t-1}(\beta_{s^D_{t-1}})$ | $-0.010^*$ | $-0.010^*$ | $-0.010^*$ | $-0.010^*$ | $-0.009$ | $-0.009$ | $-0.009$ |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| $\Delta y_{t-1}(\lambda_{\Delta y_{t-1}})$ | $-0.202^{**}$ | $-0.201^{**}$ | $-0.202^{**}$ | $-0.199^{**}$ | $-0.209^{**}$ | $-0.209^{**}$ | $-0.214^{**}$ |
| | (0.092) | (0.092) | (0.093) | (0.093) | (0.092) | (0.093) | (0.093) |
| $\Delta x^0_{t-1}$ | 0.015 | 0.015 | 0.016 | 0.016 | 0.014 | 0.014 | 0.015 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| $\Delta e_{f,t-1}$ | $-0.016$ | $-0.015$ | $-0.016$ | $-0.013$ | $-0.010$ | $-0.010$ | $-0.012$ |
| | (0.033) | (0.033) | (0.033) | (0.033) | (0.033) | (0.033) | (0.033) |
| $\Delta m_{t-1}$ | $-0.032$ | $-0.039$ | $-0.044$ | $-0.037$ | $-0.058$ | $-0.061$ | $-0.069$ |
| | (0.100) | (0.103) | (0.104) | (0.105) | (0.105) | (0.106) | (0.107) |
| $\Delta p_{t-1}$ | $-0.226^*$ | $-0.222^*$ | $-0.220^*$ | $-0.233^*$ | $-0.255^{**}$ | $-0.261^{**}$ | $-0.261^{**}$ |
| | (0.123) | (0.124) | (0.125) | (0.126) | (0.126) | (0.127) | (0.128) |
| $\Delta \bar{y}_{wt}$ | | 0.182 | 0.095 | 0.144 | $-0.138$ | $-0.169$ | $-0.119$ |
| | | (0.560) | (0.610) | (0.613) | (0.633) | (0.643) | (0.651) |
| $\Delta \overline{req}_{wt}$ | | | 0.017 | 0.024 | 0.017 | 0.006 | 0.004 |
| | | | (0.045) | (0.046) | (0.046) | (0.058) | (0.058) |
| $\Delta \bar{r}_{wt}$ | | | | $-3.935$ | $-3.722$ | $-3.875$ | $-2.730$ |
| | | | | (4.153) | (4.126) | (4.172) | (4.645) |
| $\Delta \bar{e}_{wt}$ | | | | | $-0.243$ | $-0.237$ | $-0.279$ |
| | | | | | (0.151) | (0.153) | (0.171) |
| $grv_t$ | | | | | | $-0.036$ | $-0.044$ |
| | | | | | | (0.115) | (0.116) |
| $\Delta p^0_t$ | | | | | | | $-0.014$ |
| | | | | | | | (0.025) |
| $\beta_{s^D_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ | $-0.008^*$ | $-0.008^*$ | $-0.008^*$ | $-0.008^*$ | $-0.007$ | $-0.007$ | $-0.008$ |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Adjusted $R^2$ | 0.074 | 0.067 | 0.060 | 0.059 | 0.072 | 0.064 | 0.059 |

**Notes**: $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s^D_t$ is the discretized sanctions intensity variable. $\beta_{s^D_{t-1}}$ and $\lambda_{\Delta y_{t-1}}$ are the coefficients of $s^D_{t-1}$ and $\Delta y_{t-1}$, respectively; $\beta_{s^D_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ represents the long run effect of sanctions on output growth. See Chapter 6 of Pesaran (2015). See the notes to Table S.9 for further details on the sources and construction of data used. Details on the construction of $s^D_t$ are provided in Section S.2.4.

Table S.17: Quarterly estimates of the SVAR model of Iran using a sanctions dummy variable and with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | $\Delta e_{f,t}$ | $\Delta m_t$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $d_t$ | $0.290^{**}$ | 0.079 | 0.004 | 0.001 | $-0.014$ |
| | (0.116) | (0.056) | (0.013) | (0.010) | (0.019) |
| $d_{t-1}$ | $-0.357^{***}$ | $-0.040$ | $-0.002$ | 0.00002 | 0.003 |
| | (0.117) | (0.057) | (0.013) | (0.010) | (0.019) |
| $\Delta x_t^0$ | | 0.037 | 0.004 | $-0.005$ | $0.030^{**}$ |
| | | (0.044) | (0.010) | (0.008) | (0.015) |
| $\Delta e_{f,t}$ | | | $-0.010$ | $0.144^{***}$ | $-0.104^{**}$ |
| | | | (0.021) | (0.017) | (0.040) |
| $\Delta m_t$ | | | | $-0.061$ | 0.033 |
| | | | | (0.076) | (0.143) |
| $\Delta p_t$ | | | | | $0.298^{*}$ |
| | | | | | (0.176) |
| $\Delta \bar{y}_{wt}$ | $7.813^{**}$ | $-1.600$ | 0.229 | $0.758^{**}$ | $-0.390$ |
| | (3.592) | (1.718) | (0.390) | (0.308) | (0.590) |
| $\Delta x_{t-1}^0$ | $-0.043$ | 0.043 | $-0.006$ | $-0.002$ | 0.022 |
| | (0.088) | (0.041) | (0.009) | (0.007) | (0.014) |
| $\Delta e_{f,t-1}$ | $-0.556^{***}$ | $0.298^{***}$ | $-0.019$ | 0.007 | 0.023 |
| | (0.209) | (0.101) | (0.026) | (0.020) | (0.035) |
| $\Delta m_{t-1}$ | $-0.542$ | $-0.019$ | $0.232^{**}$ | $-0.002$ | 0.006 |
| | (0.910) | (0.427) | (0.097) | (0.079) | (0.147) |
| $\Delta p_{t-1}$ | 0.248 | $-0.302$ | 0.159 | $0.441^{***}$ | $-0.418^{**}$ |
| | (0.786) | (0.368) | (0.114) | (0.091) | (0.164) |
| $\Delta y_{t-1}$ | 0.193 | $-0.144$ | 0.024 | 0.049 | $-0.227^{**}$ |
| | (0.583) | (0.273) | (0.063) | (0.050) | (0.092) |
| $\Delta p_{t-2}$ | | | $-0.060$ | $0.221^{***}$ | |
| | | | (0.104) | (0.082) | |
| Residual serial | 1.889 | 5.847 | 7.734 | 5.096 | 6.274 |
| correlation test | [0.756] | [0.211] | [0.102] | [0.278] | [0.180] |
| Adjusted $R^2$ | 0.160 | 0.083 | 0.460 | 0.633 | 0.101 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $d_t$ is the sanctions dummy variable. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = (\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are least squares standard errors, and those in square brackets are p-values. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used. Details on the construction of $d_t$ are provided in Section S.2.4.

Table S.18: Quarterly estimates of the SVAR model of Iran using a discretized sanctions intensity variable and with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ (1) | $\Delta e_{f,t}$ (2) | $\Delta m_t$ (3) | $\Delta p_t$ (4) | $\Delta y_t$ (5) |
|---|---|---|---|---|---|
| $s_t^D$ | 0.124 | 0.073* | 0.006 | −0.011 | 0.013 |
| | (0.090) | (0.042) | (0.010) | (0.007) | (0.014) |
| $s_{t-1}^D$ | −0.200** | −0.060 | −0.002 | 0.014* | −0.021 |
| | (0.089) | (0.043) | (0.010) | (0.007) | (0.014) |
| $\Delta x_t^0$ | | 0.034 | 0.005 | −0.003 | 0.025* |
| | | (0.044) | (0.010) | (0.008) | (0.015) |
| $\Delta e_{f,t}$ | | | −0.011 | 0.148*** | −0.121*** |
| | | | (0.021) | (0.017) | (0.041) |
| $\Delta m_t$ | | | | −0.059 | 0.034 |
| | | | | (0.075) | (0.143) |
| $\Delta p_t$ | | | | | 0.338* |
| | | | | | (0.178) |
| $\Delta \bar{y}_{wt}$ | 7.778** | −1.903 | 0.238 | 0.793** | −0.443 |
| | (3.623) | (1.724) | (0.389) | (0.304) | (0.590) |
| $\Delta x_{t-1}^0$ | −0.075 | 0.035 | −0.005 | −0.0003 | 0.021 |
| | (0.090) | (0.042) | (0.009) | (0.007) | (0.014) |
| $\Delta e_{f,t-1}$ | −0.536** | 0.311*** | −0.019 | 0.008 | 0.019 |
| | (0.210) | (0.101) | (0.025) | (0.020) | (0.035) |
| $\Delta m_{t-1}$ | −0.565 | −0.015 | 0.225** | −0.020 | 0.045 |
| | (0.921) | (0.431) | (0.097) | (0.077) | (0.146) |
| $\Delta p_{t-1}$ | 0.109 | −0.302 | 0.151 | 0.453*** | −0.461*** |
| | (0.795) | (0.371) | (0.114) | (0.090) | (0.166) |
| $\Delta y_{t-1}$ | 0.120 | −0.187 | 0.027 | 0.046 | −0.216** |
| | (0.586) | (0.273) | (0.063) | (0.049) | (0.091) |
| $\Delta p_{t-2}$ | | | −0.062 | 0.213*** | |
| | | | (0.103) | (0.080) | |
| Residual serial | 2.613 | 2.834 | 7.270 | 6.829 | 5.194 |
| correlation test | [0.625] | [0.586] | [0.122] | [0.145] | [0.268] |
| Adjusted $R^2$ | 0.143 | 0.072 | 0.463 | 0.644 | 0.107 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t^D$ is the discretized sanctions intensity variable. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t\right)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are least squares standard errors, and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used. Details on the construction of $s_t^D$ are provided in Section S.2.4.

### S.4.7 Additional IRFs and FEVDs results

Figure S.5: Impulse responses of the effects of a world output shock on oil exports, foreign exchange, inflation, and output growth

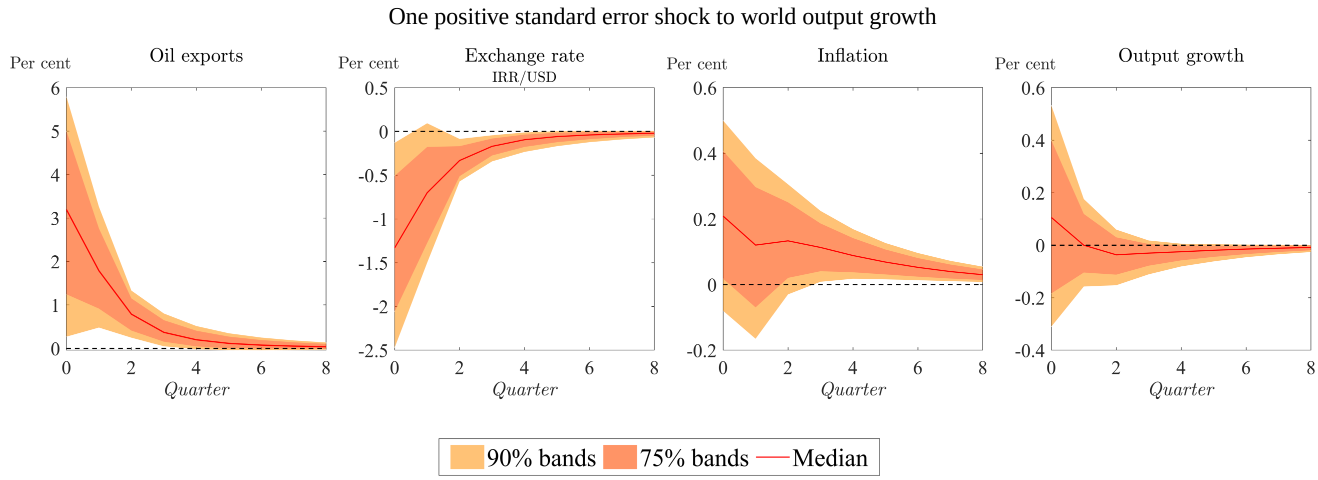


Figure S.6a: Impulse responses of the effects of sanctions and domestic shocks on foreign exchange, oil exports, inflation, and output growth

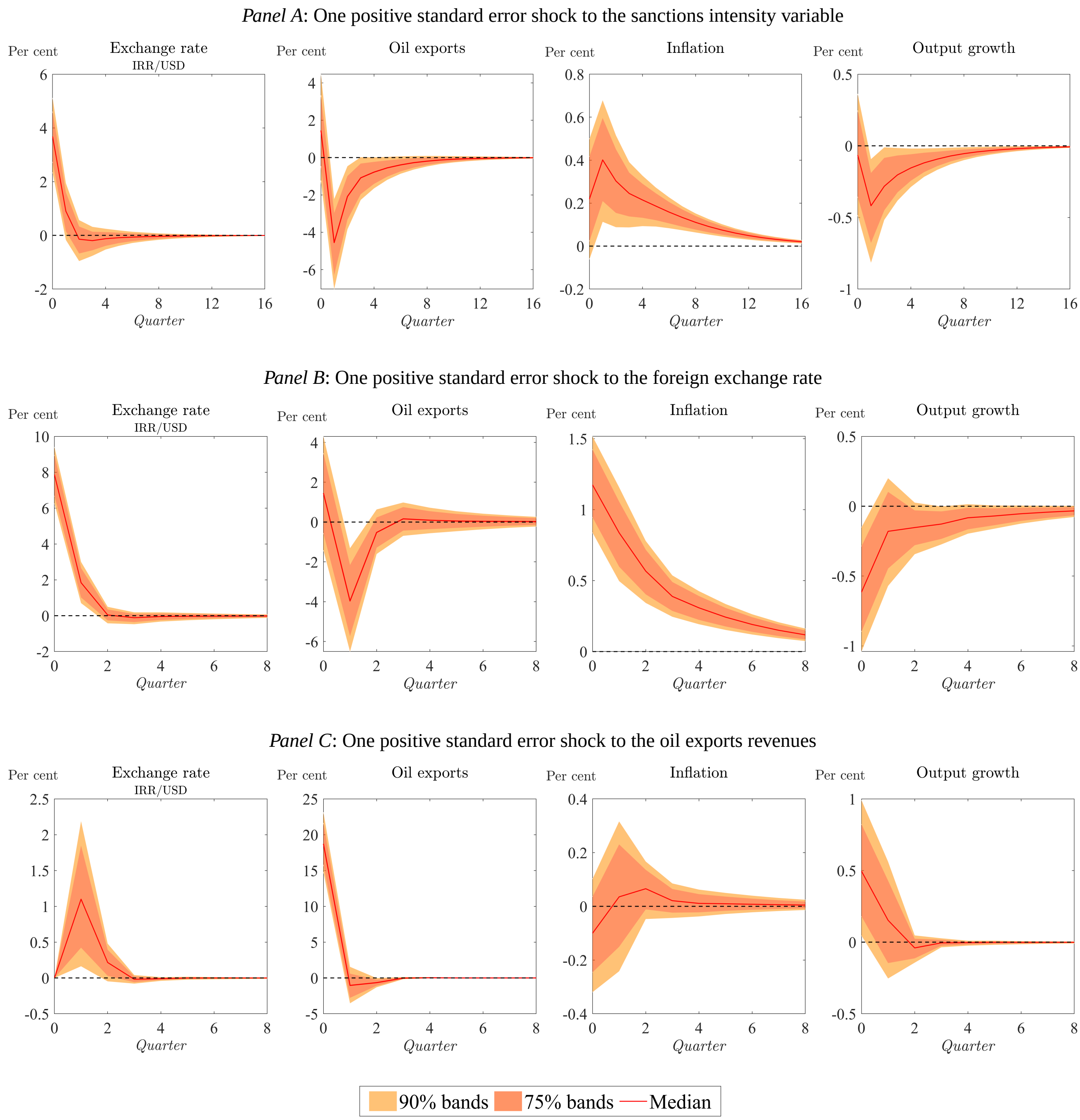
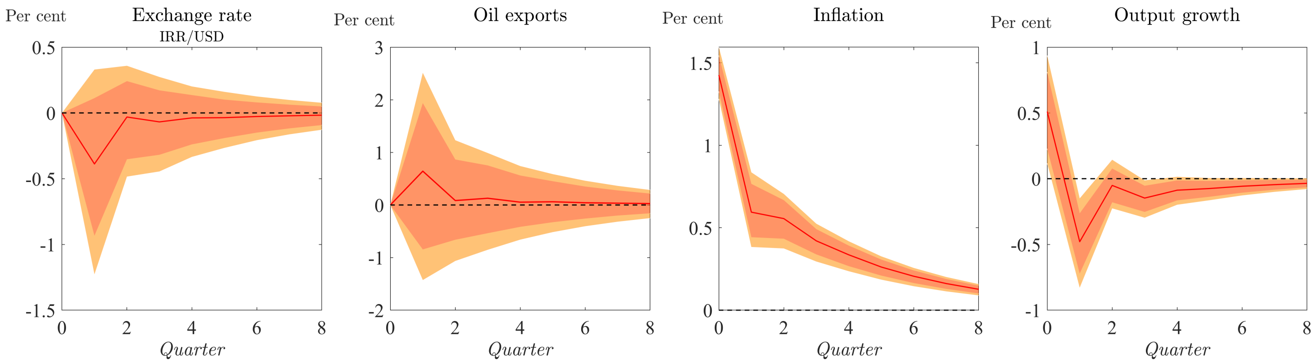
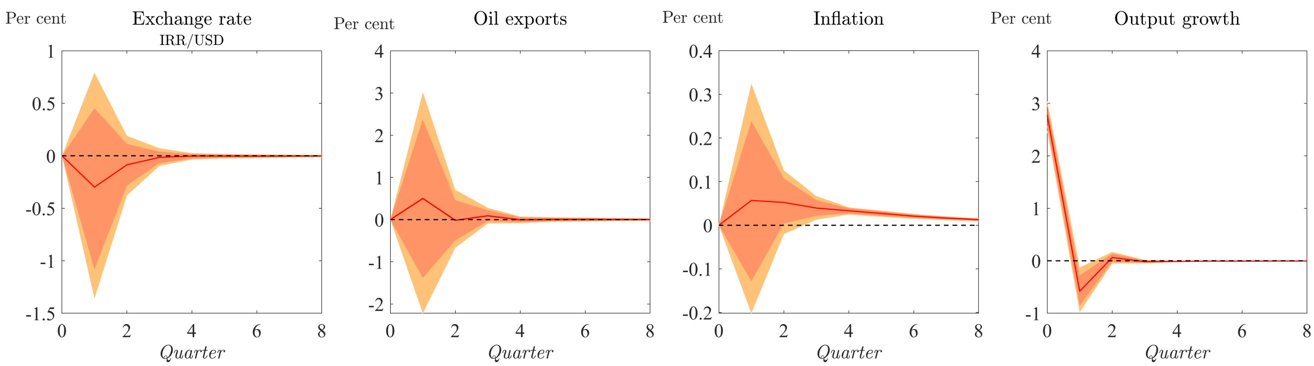


Figure S.6b: Impulse responses of the effects of sanctions and domestic shocks on foreign exchange, oil exports, inflation, and output growth

*Panel D*: One positive standard error shock to inflation




*Panel E*: One positive standard error shock to Iran output growth




*Panel F*: One positive standard error shock to world output growth

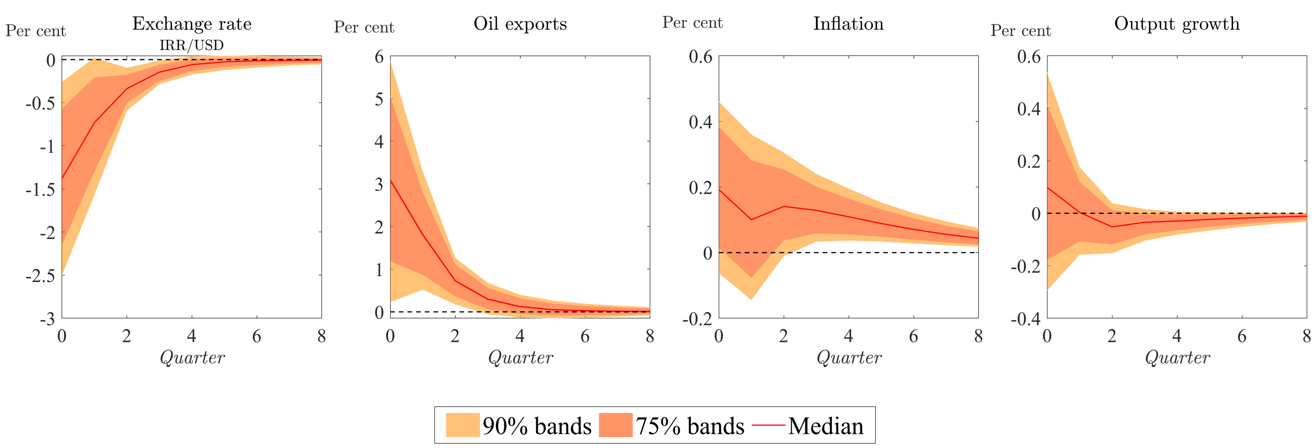


Table S.19: Forecast error variance decomposition in the SVAR model with domestic variables ordered as exchange rate returns, oil exports, inflation, and output growth

*Panel A*: FEVD for exchange rate

| *Quarter* | Proportion explained by a shock to: | | | | | |
|---|---|---|---|---|---|---|
| *ahead* | $s_t$ | $\Delta e_{ft}$ | $\Delta x_t^0$ | $\Delta p_t$ | $\Delta y_t$ | $\Delta \bar{y}_{wt}$ |
| 0 | 0.17 | 0.82 | 0.00 | 0.00 | 0.00 | 0.01 |
| 1 | 0.17 | 0.80 | 0.01 | 0.00 | 0.00 | 0.02 |
| 2 | 0.17 | 0.80 | 0.01 | 0.00 | 0.00 | 0.02 |
| 3 | 0.17 | 0.80 | 0.01 | 0.01 | 0.00 | 0.02 |
| 4 | 0.17 | 0.80 | 0.01 | 0.01 | 0.00 | 0.02 |
| 5 | 0.17 | 0.80 | 0.01 | 0.01 | 0.00 | 0.02 |
| 6 | 0.17 | 0.80 | 0.01 | 0.01 | 0.00 | 0.02 |
| 7 | 0.17 | 0.80 | 0.01 | 0.01 | 0.00 | 0.02 |
| 8 | 0.17 | 0.80 | 0.01 | 0.01 | 0.00 | 0.02 |

*Panel B*: FEVD for oil exports

| *Quarter* | Proportion explained by a shock to: | | | | | |
|---|---|---|---|---|---|---|
| *ahead* | $s_t$ | $\Delta e_{ft}$ | $\Delta x_t^0$ | $\Delta p_t$ | $\Delta y_t$ | $\Delta \bar{y}_{wt}$ |
| 0 | 0.00 | 0.00 | 0.96 | 0.00 | 0.00 | 0.03 |
| 1 | 0.04 | 0.02 | 0.90 | 0.00 | 0.00 | 0.04 |
| 2 | 0.05 | 0.03 | 0.88 | 0.00 | 0.00 | 0.04 |
| 3 | 0.06 | 0.03 | 0.88 | 0.00 | 0.00 | 0.04 |
| 4 | 0.06 | 0.03 | 0.88 | 0.00 | 0.00 | 0.04 |
| 5 | 0.06 | 0.03 | 0.88 | 0.00 | 0.00 | 0.04 |
| 6 | 0.06 | 0.03 | 0.88 | 0.00 | 0.00 | 0.04 |
| 7 | 0.06 | 0.03 | 0.87 | 0.00 | 0.00 | 0.04 |
| 8 | 0.06 | 0.03 | 0.87 | 0.00 | 0.00 | 0.04 |

*Panel C*: FEVD for inflation

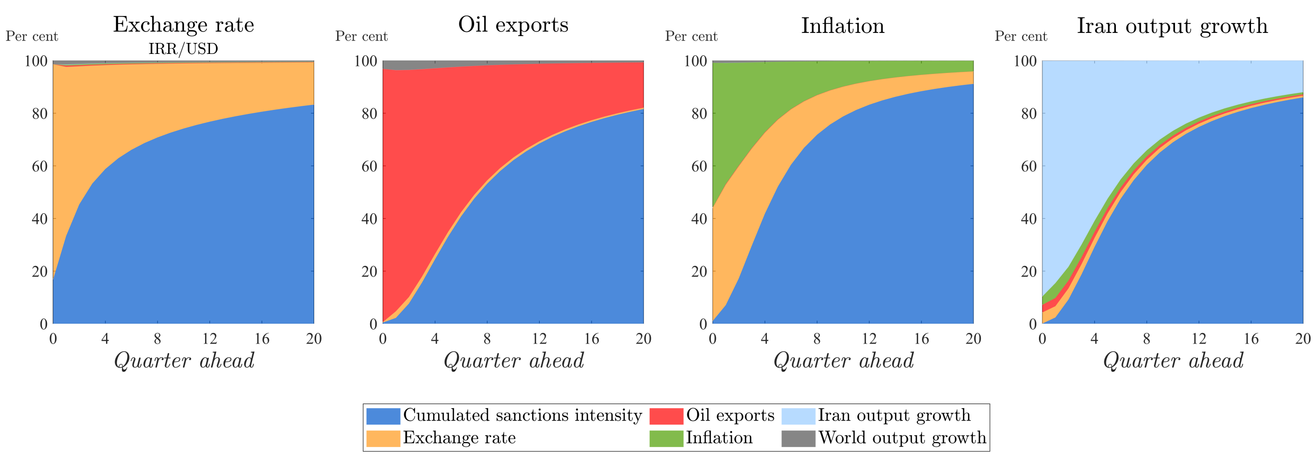
| *Quarter* | Proportion explained by a shock to: | | | | | |
|---|---|---|---|---|---|---|
| *ahead* | $s_t$ | $\Delta e_{ft}$ | $\Delta x_t^0$ | $\Delta p_t$ | $\Delta y_t$ | $\Delta \bar{y}_{wt}$ |
| 0 | 0.01 | 0.43 | 0.00 | 0.55 | 0.00 | 0.01 |
| 1 | 0.04 | 0.47 | 0.00 | 0.48 | 0.00 | 0.01 |
| 2 | 0.05 | 0.49 | 0.00 | 0.45 | 0.00 | 0.01 |
| 3 | 0.06 | 0.50 | 0.00 | 0.44 | 0.00 | 0.01 |
| 4 | 0.06 | 0.50 | 0.00 | 0.43 | 0.00 | 0.01 |
| 5 | 0.06 | 0.50 | 0.00 | 0.43 | 0.00 | 0.01 |
| 6 | 0.07 | 0.50 | 0.00 | 0.43 | 0.00 | 0.01 |
| 7 | 0.07 | 0.50 | 0.00 | 0.42 | 0.00 | 0.01 |
| 8 | 0.07 | 0.50 | 0.00 | 0.42 | 0.00 | 0.01 |

*Panel D*: FEVD for output growth

| *Quarter* | Proportion explained by a shock to: | | | | | |
|---|---|---|---|---|---|---|
| *ahead* | $s_t$ | $\Delta e_{ft}$ | $\Delta x_t^0$ | $\Delta p_t$ | $\Delta y_t$ | $\Delta \bar{y}_{wt}$ |
| 0 | 0.00 | 0.04 | 0.03 | 0.03 | 0.90 | 0.00 |
| 1 | 0.02 | 0.04 | 0.03 | 0.06 | 0.85 | 0.00 |
| 2 | 0.03 | 0.05 | 0.03 | 0.06 | 0.83 | 0.00 |
| 3 | 0.04 | 0.05 | 0.03 | 0.06 | 0.83 | 0.00 |
| 4 | 0.04 | 0.05 | 0.03 | 0.06 | 0.82 | 0.00 |
| 5 | 0.04 | 0.05 | 0.03 | 0.06 | 0.82 | 0.00 |
| 6 | 0.05 | 0.05 | 0.03 | 0.06 | 0.82 | 0.00 |
| 7 | 0.05 | 0.05 | 0.03 | 0.06 | 0.82 | 0.00 |
| 8 | 0.05 | 0.05 | 0.03 | 0.06 | 0.82 | 0.00 |

**Notes**: $s_t$ is the quarterly sanctions intensity variable. $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the Iran rial/U.S. dollar quarterly free market exchange rate. $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars. $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran. $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $\Delta \bar{y}_{wt}$ is the quarterly world output growth: $\bar{y}_{wt} = \sum_{i=1}^{n} w_i y_{it}$, with $\{y_{it}\}_{i=1}^{n}$ being the natural log of real output for 33 major economies, and $w_i$ the GDP-PPP weights.
See Sections S.2.1, S.2.2, S.2.5, and S.2.6 in the data appendix of the online supplement for details on the construction of the sanctions intensity variable, calendar conversions, and sources of the data used.

Figure S.7: Forecast error variance decomposition for domestic variables in the SVAR model with a cumulative shock to sanctions, and domestic variables ordered as exchange rate returns, oil exports, inflation, and output growth



### S.4.8 Additional analyses using heteroskedastic-consistent standard errors

Table S.20: Estimates of the reduced form Iran's output growth equation estimated over the period 1989q1–2019q4

| | $\Delta y_t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $s_{t-1}(\beta_{s_{t-1}})$ | $-0.033^{*}$ | $-0.032^{*}$ | $-0.032^{*}$ | $-0.034^{*}$ | $-0.034^{**}$ | $-0.034^{*}$ | $-0.035^{**}$ |
| | (0.018) | (0.018) | (0.018) | (0.018) | (0.017) | (0.018) | (0.018) |
| $\Delta y_{t-1}(\lambda_{\Delta y_{t-1}})$ | $-0.204^{*}$ | $-0.202^{*}$ | $-0.203^{*}$ | $-0.200^{*}$ | $-0.214^{*}$ | $-0.214^{*}$ | $-0.218^{*}$ |
| | (0.115) | (0.116) | (0.117) | (0.119) | (0.111) | (0.112) | (0.113) |
| $\Delta x^0_{t-1}$ | 0.016 | 0.016 | 0.016 | 0.017 | 0.014 | 0.014 | 0.015 |
| | (0.011) | (0.011) | (0.012) | (0.012) | (0.012) | (0.012) | (0.013) |
| $\Delta e_{f,t-1}$ | −0.004 | −0.004 | −0.004 | 0.0002 | 0.004 | 0.004 | 0.002 |
| | (0.039) | (0.039) | (0.039) | (0.038) | (0.038) | (0.038) | (0.038) |
| $\Delta m_{t-1}$ | −0.028 | −0.037 | −0.041 | −0.032 | −0.053 | −0.056 | −0.063 |
| | (0.098) | (0.102) | (0.103) | (0.107) | (0.103) | (0.105) | (0.111) |
| $\Delta p_{t-1}$ | $-0.239^{*}$ | −0.234 | −0.232 | $-0.246^{*}$ | $-0.268^{*}$ | $-0.273^{*}$ | $-0.274^{*}$ |
| | (0.145) | (0.148) | (0.148) | (0.143) | (0.147) | (0.146) | (0.146) |
| $\Delta \bar{y}_{wt}$ | | 0.228 | 0.160 | 0.215 | −0.129 | −0.162 | −0.117 |
| | | (0.381) | (0.426) | (0.430) | (0.476) | (0.475) | (0.493) |
| $\Delta \overline{req}_{wt}$ | | | 0.013 | 0.021 | 0.013 | 0.002 | −0.0001 |
| | | | (0.040) | (0.042) | (0.045) | (0.064) | (0.064) |
| $\Delta \bar{r}_{wt}$ | | | | −4.518 | −4.311 | −4.474 | −3.490 |
| | | | | (4.471) | (4.393) | (4.525) | (4.921) |
| $\Delta \bar{e}_{wt}$ | | | | | $-0.278^{*}$ | $-0.272^{*}$ | $-0.309^{*}$ |
| | | | | | (0.160) | (0.160) | (0.177) |
| $grv_t$ | | | | | | −0.038 | −0.044 |
| | | | | | | (0.116) | (0.118) |
| $\Delta p^0_t$ | | | | | | | −0.012 |
| | | | | | | | (0.025) |
| $\beta_{s_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ | $-0.027^{*}$ | $-0.027^{*}$ | $-0.027^{*}$ | $-0.028^{*}$ | $-0.028^{**}$ | $-0.028^{**}$ | $-0.028^{**}$ |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.014) | (0.014) | (0.014) |
| Adjusted $R^2$ | 0.083 | 0.077 | 0.069 | 0.071 | 0.091 | 0.084 | 0.077 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.21: Estimates of the reduced form Iran's output growth equation including contemporaneous sanctions variable and estimated over the period 1989q1–2019q4

| | $\Delta y_t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $s_t(\beta_{s_t})$ | $-0.007$ | $-0.008$ | $-0.009$ | $-0.009$ | $-0.009$ | $-0.009$ | $-0.008$ |
| | (0.024) | (0.024) | (0.024) | (0.024) | (0.023) | (0.024) | (0.023) |
| $s_{t-1}(\beta_{s_{t-1}})$ | $-0.027$ | $-0.026$ | $-0.025$ | $-0.027$ | $-0.027$ | $-0.028$ | $-0.029$ |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.025) | (0.026) | (0.026) |
| $\Delta y_{t-1}(\lambda_{\Delta y_{t-1}})$ | $-0.206^{*}$ | $-0.204^{*}$ | $-0.206^{*}$ | $-0.202^{*}$ | $-0.217^{*}$ | $-0.216^{*}$ | $-0.220^{*}$ |
| | (0.117) | (0.118) | (0.119) | (0.121) | (0.112) | (0.113) | (0.114) |
| $\Delta x^0_{t-1}$ | 0.016 | 0.015 | 0.016 | 0.017 | 0.014 | 0.014 | 0.015 |
| | (0.012) | (0.011) | (0.012) | (0.012) | (0.012) | (0.012) | (0.013) |
| $\Delta e_{f,t-1}$ | $-0.005$ | $-0.004$ | $-0.005$ | $-0.001$ | 0.003 | 0.003 | 0.002 |
| | (0.039) | (0.039) | (0.039) | (0.038) | (0.038) | (0.038) | (0.038) |
| $\Delta m_{t-1}$ | $-0.030$ | $-0.039$ | $-0.044$ | $-0.035$ | $-0.056$ | $-0.059$ | $-0.065$ |
| | (0.098) | (0.103) | (0.104) | (0.108) | (0.104) | (0.106) | (0.112) |
| $\Delta p_{t-1}$ | $-0.236$ | $-0.230$ | $-0.228$ | $-0.242^{*}$ | $-0.263^{*}$ | $-0.269^{*}$ | $-0.270^{*}$ |
| | (0.145) | (0.148) | (0.148) | (0.143) | (0.147) | (0.146) | (0.146) |
| $\Delta\bar{y}_{wt}$ | | 0.245 | 0.170 | 0.224 | $-0.120$ | $-0.151$ | $-0.111$ |
| | | (0.391) | (0.429) | (0.434) | (0.480) | (0.480) | (0.497) |
| $\Delta\overline{req}_{wt}$ | | | 0.015 | 0.023 | 0.015 | 0.004 | 0.002 |
| | | | (0.041) | (0.043) | (0.046) | (0.064) | (0.065) |
| $\Delta\bar{r}_{wt}$ | | | | $-4.500$ | $-4.291$ | $-4.447$ | $-3.537$ |
| | | | | (4.476) | (4.394) | (4.529) | (4.946) |
| $\Delta\bar{e}_{wt}$ | | | | | $-0.279^{*}$ | $-0.273^{*}$ | $-0.307^{*}$ |
| | | | | | (0.161) | (0.161) | (0.179) |
| $grv_t$ | | | | | | $-0.036$ | $-0.042$ |
| | | | | | | (0.116) | (0.118) |
| $\Delta p^0_t$ | | | | | | | $-0.011$ |
| | | | | | | | (0.025) |
| $\beta_{s_t}+\beta_{s_{t-1}}$ | $-0.035^{*}$ | $-0.034^{*}$ | $-0.034^{*}$ | $-0.036^{*}$ | $-0.037^{**}$ | $-0.037^{*}$ | $-0.036^{*}$ |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.018) | (0.019) | (0.018) |
| $(\beta_{s_t}+\beta_{s_{t-1}})/(1-\lambda_{\Delta y_{t-1}})$ | $-0.029^{*}$ | $-0.028^{*}$ | $-0.028^{*}$ | $-0.030^{**}$ | $-0.030^{**}$ | $-0.030^{**}$ | $-0.030^{**}$ |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) |
| Adjusted $R^2$ | 0.076 | 0.069 | 0.062 | 0.064 | 0.084 | 0.077 | 0.070 |

**Notes:** Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.22a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | $\Delta e_{f,t}$ | $\Delta m_t$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $s_t$ | 0.107 | $0.305^{***}$ | $-0.002$ | $-0.033^{***}$ | 0.029 |
| | (0.106) | (0.080) | (0.015) | (0.013) | (0.024) |
| $s_{t-1}$ | $-0.288^{**}$ | $-0.233^{***}$ | 0.015 | $0.037^{***}$ | $-0.056^{**}$ |
| | (0.136) | (0.065) | (0.018) | (0.012) | (0.028) |
| $\Delta x_t^0$ | | 0.029 | 0.006 | $-0.003$ | 0.025 |
| | | (0.041) | (0.007) | (0.008) | (0.016) |
| $\Delta e_{f,t}$ | | | $-0.007$ | $0.163^{***}$ | $-0.141^{***}$ |
| | | | (0.018) | (0.028) | (0.042) |
| $\Delta m_t$ | | | | $-0.073$ | 0.063 |
| | | | | (0.072) | (0.118) |
| $\Delta p_t$ | | | | | $0.387^{**}$ |
| | | | | | (0.173) |
| $\Delta y_{wt}$ | $8.406^{**}$ | $-2.639$ | 0.233 | $0.865^{***}$ | $-0.520$ |
| | (3.630) | (1.641) | (0.406) | (0.285) | (0.458) |
| $\Delta x_{t-1}^0$ | $-0.051$ | 0.044 | $-0.005$ | $-0.003$ | $0.023^{*}$ |
| | (0.107) | (0.036) | (0.007) | (0.008) | (0.012) |
| $\Delta e_{f,t-1}$ | $-0.441^{*}$ | $0.350^{**}$ | $-0.025$ | $-0.009$ | 0.041 |
| | (0.238) | (0.175) | (0.022) | (0.027) | (0.044) |
| $\Delta m_{t-1}$ | $-0.715$ | 0.149 | 0.218 | $-0.025$ | 0.046 |
| | (0.765) | (0.266) | (0.146) | (0.072) | (0.129) |
| $\Delta p_{t-1}$ | 0.052 | $-0.341$ | $0.167^{*}$ | $0.488^{***}$ | $-0.505^{***}$ |
| | (0.707) | (0.610) | (0.088) | (0.108) | (0.195) |
| $\Delta y_{t-1}$ | 0.122 | $-0.145$ | 0.025 | 0.042 | $-0.221^{**}$ |
| | (0.608) | (0.230) | (0.051) | (0.039) | (0.107) |
| $\Delta p_{t-2}$ | | | $-0.070$ | $0.183^{**}$ | |
| | | | (0.078) | (0.077) | |
| Residual serial | 2.406 | 6.212 | 7.640 | 8.061 | 7.240 |
| correlation test | [0.662] | [0.184] | [0.106] | [0.089] | [0.124] |
| Adjusted $R^2$ | 0.122 | 0.209 | 0.466 | 0.659 | 0.124 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}$, $\Delta m_t$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t\right)'$. Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980), and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.22b: Quarterly estimates of the equation for the oil export variable in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.144 | 0.107 | 0.104 | 0.087 | 0.088 | 0.088 |
| | (0.118) | (0.106) | (0.107) | (0.110) | (0.110) | (0.111) |
| $s_{t-1}$ | $-0.339^{**}$ | $-0.288^{**}$ | $-0.286^{**}$ | $-0.279^{**}$ | $-0.261^{**}$ | $-0.261^{**}$ |
| | (0.145) | (0.136) | (0.138) | (0.130) | (0.131) | (0.131) |
| $\Delta x_{t-1}^0$ | −0.035 | −0.051 | −0.050 | −0.077 | −0.088 | −0.088 |
| | (0.102) | (0.107) | (0.109) | (0.106) | (0.105) | (0.105) |
| $\Delta e_{f,t-1}$ | $-0.442^{**}$ | $-0.441^{*}$ | $-0.443^{*}$ | −0.382 | $-0.432^{*}$ | $-0.432^{*}$ |
| | (0.224) | (0.238) | (0.240) | (0.237) | (0.221) | (0.222) |
| $\Delta m_{t-1}$ | −0.128 | −0.715 | −0.744 | $-1.214^{*}$ | −1.141 | −1.143 |
| | (0.842) | (0.765) | (0.792) | (0.725) | (0.713) | (0.731) |
| $\Delta p_{t-1}$ | −0.156 | 0.052 | 0.060 | −0.213 | −0.041 | −0.043 |
| | (0.690) | (0.707) | (0.721) | (0.734) | (0.756) | (0.743) |
| $\Delta y_{t-1}$ | 0.087 | 0.122 | 0.116 | −0.062 | −0.103 | −0.103 |
| | (0.598) | (0.608) | (0.615) | (0.550) | (0.539) | (0.541) |
| $\Delta \bar{y}_{wt}$ | | $8.406^{**}$ | $8.132^{**}$ | 4.185 | 3.098 | 3.085 |
| | | (3.630) | (3.629) | (2.946) | (3.008) | (3.008) |
| $\Delta \overline{req}_{wt}$ | | | 0.056 | −0.046 | −0.154 | −0.158 |
| | | | (0.270) | (0.233) | (0.224) | (0.288) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.507^{***}$ | $-3.551^{***}$ | $-3.548^{***}$ |
| | | | | (0.958) | (0.936) | (0.962) |
| $\Delta \bar{r}_{wt}$ | | | | | $63.486^{**}$ | $63.416^{**}$ |
| | | | | | (26.040) | (26.307) |
| $grv_t$ | | | | | | −0.015 |
| | | | | | | (0.583) |
| Residual serial correlation test | 1.202 | 2.406 | 2.446 | 2.382 | 5.176 | 5.166 |
| | [0.878] | [0.662] | [0.654] | [0.666] | [0.270] | [0.271] |
| Adjusted $R^2$ | 0.089 | 0.122 | 0.115 | 0.210 | 0.247 | 0.240 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.22c: Quarterly estimates of the equation for exchange rate returns in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.295*** | 0.305*** | 0.302*** | 0.303*** | 0.303*** | 0.307*** |
| | (0.081) | (0.080) | (0.081) | (0.080) | (0.080) | (0.077) |
| $s_{t-1}$ | −0.221*** | −0.233*** | −0.230*** | −0.226*** | −0.226*** | −0.231*** |
| | (0.066) | (0.065) | (0.066) | (0.066) | (0.066) | (0.064) |
| $\Delta x_t^0$ | 0.014 | 0.029 | 0.028 | 0.047 | 0.048 | 0.048 |
| | (0.038) | (0.041) | (0.040) | (0.045) | (0.047) | (0.045) |
| $\Delta x_{t-1}^0$ | 0.038 | 0.044 | 0.045 | 0.051 | 0.051 | 0.047 |
| | (0.035) | (0.036) | (0.037) | (0.039) | (0.039) | (0.038) |
| $\Delta e_{f,t-1}$ | 0.344* | 0.350** | 0.348** | 0.346** | 0.348** | 0.346** |
| | (0.180) | (0.175) | (0.174) | (0.170) | (0.173) | (0.165) |
| $\Delta m_{t-1}$ | −0.037 | 0.149 | 0.121 | 0.209 | 0.209 | 0.110 |
| | (0.272) | (0.266) | (0.260) | (0.285) | (0.286) | (0.271) |
| $\Delta p_{t-1}$ | −0.278 | −0.341 | −0.333 | −0.291 | −0.295 | −0.397 |
| | (0.615) | (0.610) | (0.616) | (0.604) | (0.595) | (0.589) |
| $\Delta y_{t-1}$ | −0.133 | −0.145 | −0.151 | −0.125 | −0.124 | −0.120 |
| | (0.232) | (0.230) | (0.234) | (0.232) | (0.230) | (0.227) |
| $\Delta \bar{y}_{wt}$ | | −2.639 | −2.897 | −2.423 | −2.401 | −2.907* |
| | | (1.641) | (1.808) | (1.740) | (1.772) | (1.671) |
| $\Delta \overline{req}_{wt}$ | | | 0.053 | 0.068 | 0.071 | −0.121 |
| | | | (0.090) | (0.093) | (0.099) | (0.126) |
| $\Delta \bar{e}_{wt}$ | | | | 0.554 | 0.560 | 0.648 |
| | | | | (0.553) | (0.540) | (0.559) |
| $\Delta \bar{r}_{wt}$ | | | | | −1.633 | −4.492 |
| | | | | | (15.026) | (14.853) |
| $grv_t$ | | | | | | −0.625** |
| | | | | | | (0.305) |
| Residual serial | 5.972 | 6.212 | 5.961 | 7.940 | 8.059 | 5.259 |
| correlation test | [0.201] | [0.184] | [0.202] | [0.094] | [0.089] | [0.262] |
| Adjusted $R^2$ | 0.196 | 0.209 | 0.203 | 0.207 | 0.200 | 0.221 |

**Notes:** Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.22d: Quarterly estimates of the equation for money supply growth in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta m_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | −0.0004 | −0.002 | −0.003 | −0.002 | −0.002 | 0.002 |
| | (0.014) | (0.015) | (0.014) | (0.014) | (0.014) | (0.013) |
| $s_{t-1}$ | 0.014 | 0.015 | 0.016 | 0.017 | 0.017 | 0.014 |
| | (0.017) | (0.018) | (0.018) | (0.017) | (0.017) | (0.016) |
| $\Delta x_t^0$ | 0.008 | 0.006 | 0.006 | 0.011 | $0.014^{*}$ | $0.015^{*}$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) |
| $\Delta e_{f,t}$ | −0.009 | −0.007 | −0.008 | −0.011 | −0.012 | −0.022 |
| | (0.017) | (0.018) | (0.018) | (0.018) | (0.017) | (0.018) |
| $\Delta x_{t-1}^0$ | −0.005 | −0.005 | −0.005 | −0.003 | −0.002 | −0.003 |
| | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) | (0.008) |
| $\Delta e_{f,t-1}$ | −0.024 | −0.025 | −0.026 | −0.027 | −0.023 | −0.021 |
| | (0.022) | (0.022) | (0.022) | (0.022) | (0.021) | (0.021) |
| $\Delta m_{t-1}$ | $0.235^{*}$ | 0.218 | 0.211 | 0.236 | 0.236 | 0.211 |
| | (0.139) | (0.146) | (0.146) | (0.156) | (0.156) | (0.149) |
| $\Delta p_{t-1}$ | $0.165^{*}$ | $0.167^{*}$ | $0.174^{*}$ | $0.193^{**}$ | $0.189^{**}$ | 0.163 |
| | (0.089) | (0.088) | (0.090) | (0.094) | (0.093) | (0.100) |
| $\Delta y_{t-1}$ | 0.022 | 0.025 | 0.022 | 0.026 | 0.028 | 0.026 |
| | (0.051) | (0.051) | (0.051) | (0.050) | (0.051) | (0.050) |
| $\Delta p_{t-2}$ | −0.076 | −0.070 | −0.077 | −0.088 | −0.094 | −0.102 |
| | (0.079) | (0.078) | (0.079) | (0.082) | (0.086) | (0.088) |
| $\Delta \bar{y}_{wt}$ | | 0.233 | 0.152 | 0.260 | 0.304 | 0.134 |
| | | (0.406) | (0.441) | (0.464) | (0.457) | (0.506) |
| $\Delta \overline{req}_{wt}$ | | | 0.016 | 0.021 | 0.027 | −0.026 |
| | | | (0.026) | (0.027) | (0.029) | (0.039) |
| $\Delta \bar{e}_{wt}$ | | | | 0.146 | 0.160 | $0.191^{*}$ |
| | | | | (0.108) | (0.114) | (0.114) |
| $\Delta \bar{r}_{wt}$ | | | | | −3.581 | −4.412 |
| | | | | | (2.704) | (2.695) |
| $grv_t$ | | | | | | $-0.176^{**}$ |
| | | | | | | (0.078) |
| Residual serial | 7.428 | 7.640 | 7.255 | 6.129 | 5.742 | 4.178 |
| correlation test | [0.115] | [0.106] | [0.123] | [0.190] | [0.219] | [0.382] |
| Adjusted $R^2$ | 0.469 | 0.466 | 0.462 | 0.467 | 0.470 | 0.491 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.22e: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.028^{**}$ | $-0.033^{***}$ | $-0.032^{**}$ | $-0.033^{***}$ | $-0.033^{***}$ | $-0.032^{**}$ |
| | (0.012) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $s_{t-1}$ | $0.032^{***}$ | $0.037^{***}$ | $0.036^{***}$ | $0.036^{***}$ | $0.036^{***}$ | $0.035^{***}$ |
| | (0.012) | (0.012) | (0.012) | (0.013) | (0.013) | (0.013) |
| $\Delta x_t^0$ | 0.001 | $-0.003$ | $-0.003$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| $\Delta e_{f,t}$ | $0.155^{***}$ | $0.163^{***}$ | $0.164^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.163^{***}$ |
| | (0.029) | (0.028) | (0.028) | (0.028) | (0.028) | (0.028) |
| $\Delta m_t$ | $-0.061$ | $-0.073$ | $-0.070$ | $-0.058$ | $-0.057$ | $-0.070$ |
| | (0.076) | (0.072) | (0.071) | (0.072) | (0.074) | (0.075) |
| $\Delta x_{t-1}^0$ | $-0.001$ | $-0.003$ | $-0.003$ | $-0.004$ | $-0.004$ | $-0.005$ |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| $\Delta e_{f,t-1}$ | $-0.007$ | $-0.009$ | $-0.007$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.029) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| $\Delta m_{t-1}$ | 0.035 | $-0.025$ | $-0.016$ | $-0.036$ | $-0.036$ | $-0.040$ |
| | (0.074) | (0.072) | (0.074) | (0.077) | (0.078) | (0.079) |
| $\Delta p_{t-1}$ | $0.480^{***}$ | $0.488^{***}$ | $0.478^{***}$ | $0.462^{***}$ | $0.462^{***}$ | $0.458^{***}$ |
| | (0.113) | (0.108) | (0.108) | (0.107) | (0.108) | (0.110) |
| $\Delta y_{t-1}$ | 0.033 | 0.042 | 0.045 | 0.042 | 0.042 | 0.042 |
| | (0.041) | (0.039) | (0.040) | (0.039) | (0.039) | (0.039) |
| $\Delta p_{t-2}$ | $0.162^{**}$ | $0.183^{**}$ | $0.192^{**}$ | $0.201^{**}$ | $0.202^{**}$ | $0.198^{**}$ |
| | (0.080) | (0.077) | (0.078) | (0.079) | (0.080) | (0.080) |
| $\Delta \bar{y}_{wt}$ | | $0.865^{***}$ | $0.971^{***}$ | $0.893^{***}$ | $0.889^{***}$ | $0.847^{***}$ |
| | | (0.285) | (0.315) | (0.330) | (0.335) | (0.325) |
| $\Delta \overline{req}_{wt}$ | | | $-0.021$ | $-0.024$ | $-0.025$ | $-0.039$ |
| | | | (0.021) | (0.022) | (0.023) | (0.029) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.102$ | $-0.104$ | $-0.093$ |
| | | | | (0.088) | (0.091) | (0.091) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.303 | 0.031 |
| | | | | | (2.528) | (2.514) |
| $grv_t$ | | | | | | $-0.048$ |
| | | | | | | (0.056) |
| Residual serial | 9.241 | 8.061 | 5.714 | 6.473 | 6.510 | 6.759 |
| correlation test | [0.055] | [0.089] | [0.222] | [0.166] | [0.164] | [0.149] |
| Adjusted $R^2$ | 0.635 | 0.659 | 0.658 | 0.660 | 0.656 | 0.655 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.22f: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.029 | 0.028 | 0.026 | 0.026 | 0.027 |
| | (0.023) | (0.024) | (0.024) | (0.023) | (0.023) | (0.023) |
| $s_{t-1}$ | $-0.051^{*}$ | $-0.056^{**}$ | $-0.055^{**}$ | $-0.055^{**}$ | $-0.055^{**}$ | $-0.056^{**}$ |
| | (0.027) | (0.028) | (0.028) | (0.027) | (0.027) | (0.027) |
| $\Delta x_t^0$ | 0.023 | 0.025 | 0.025 | 0.020 | 0.025 | 0.026 |
| | (0.017) | (0.016) | (0.017) | (0.019) | (0.018) | (0.018) |
| $\Delta e_{f,t}$ | $-0.130^{***}$ | $-0.141^{***}$ | $-0.142^{***}$ | $-0.135^{***}$ | $-0.136^{***}$ | $-0.138^{***}$ |
| | (0.041) | (0.042) | (0.043) | (0.041) | (0.041) | (0.041) |
| $\Delta m_t$ | 0.052 | 0.063 | 0.062 | 0.078 | 0.054 | 0.037 |
| | (0.118) | (0.118) | (0.118) | (0.115) | (0.120) | (0.123) |
| $\Delta p_t$ | $0.348^{**}$ | $0.387^{**}$ | $0.390^{**}$ | $0.373^{**}$ | $0.373^{**}$ | $0.364^{**}$ |
| | (0.165) | (0.173) | (0.174) | (0.173) | (0.174) | (0.175) |
| $\Delta x_{t-1}^0$ | $0.022^{*}$ | $0.023^{*}$ | $0.024^{*}$ | $0.022^{*}$ | $0.023^{*}$ | $0.023^{*}$ |
| | (0.011) | (0.012) | (0.013) | (0.012) | (0.013) | (0.013) |
| $\Delta e_{f,t-1}$ | 0.037 | 0.041 | 0.041 | 0.040 | 0.046 | 0.047 |
| | (0.044) | (0.044) | (0.044) | (0.045) | (0.042) | (0.043) |
| $\Delta m_{t-1}$ | 0.013 | 0.046 | 0.039 | 0.009 | 0.014 | 0.009 |
| | (0.126) | (0.129) | (0.129) | (0.132) | (0.137) | (0.140) |
| $\Delta p_{t-1}$ | $-0.466^{**}$ | $-0.505^{***}$ | $-0.505^{***}$ | $-0.506^{**}$ | $-0.519^{***}$ | $-0.523^{***}$ |
| | (0.184) | (0.195) | (0.196) | (0.198) | (0.194) | (0.192) |
| $\Delta y_{t-1}$ | $-0.218^{**}$ | $-0.221^{**}$ | $-0.223^{**}$ | $-0.230^{**}$ | $-0.225^{**}$ | $-0.224^{**}$ |
| | (0.108) | (0.107) | (0.108) | (0.105) | (0.106) | (0.108) |
| $\Delta \bar{y}_{wt}$ | | $-0.520$ | $-0.595$ | $-0.708$ | $-0.619$ | $-0.664$ |
| | | (0.458) | (0.510) | (0.526) | (0.527) | (0.522) |
| $\Delta \overline{req}_{wt}$ | | | 0.015 | 0.010 | 0.021 | 0.003 |
| | | | (0.042) | (0.044) | (0.046) | (0.066) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.160$ | $-0.133$ | $-0.121$ |
| | | | | (0.175) | (0.174) | (0.174) |
| $\Delta \bar{r}_{wt}$ | | | | | $-6.160$ | $-6.499$ |
| | | | | | (4.596) | (4.779) |
| $grv_t$ | | | | | | $-0.060$ |
| | | | | | | (0.129) |
| Residual serial | 7.242 | 7.240 | 7.371 | 7.721 | 8.049 | 8.248 |
| correlation test | [0.124] | [0.124] | [0.118] | [0.102] | [0.090] | [0.083] |
| Adjusted $R^2$ | 0.126 | 0.124 | 0.117 | 0.117 | 0.126 | 0.120 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.23a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ (1) | $\Delta e_{f,t}$ (2) | $\Delta p_t$ (3) | $\Delta y_t$ (4) |
|---|---|---|---|---|
| $s_t$ | 0.119 | $0.302^{***}$ | $-0.033^{***}$ | 0.027 |
| | (0.102) | (0.079) | (0.013) | (0.024) |
| $s_{t-1}$ | $-0.308^{**}$ | $-0.229^{***}$ | $0.035^{***}$ | $-0.053^{*}$ |
| | (0.132) | (0.063) | (0.012) | (0.027) |
| $\Delta x_t^0$ | | 0.028 | $-0.003$ | 0.025 |
| | | (0.040) | (0.008) | (0.016) |
| $\Delta e_{f,t}$ | | | $0.163^{***}$ | $-0.139^{***}$ |
| | | | (0.028) | (0.042) |
| $\Delta p_t$ | | | | $0.377^{**}$ |
| | | | | (0.172) |
| $\Delta y_{wt}$ | $7.638^{**}$ | $-2.471$ | $0.800^{***}$ | $-0.428$ |
| | (3.472) | (1.572) | (0.289) | (0.428) |
| $\Delta x_{t-1}^0$ | $-0.053$ | 0.044 | $-0.003$ | $0.023^{*}$ |
| | (0.106) | (0.036) | (0.008) | (0.012) |
| $\Delta e_{f,t-1}$ | $-0.429^{*}$ | $0.347^{**}$ | $-0.007$ | 0.038 |
| | (0.236) | (0.173) | (0.026) | (0.044) |
| $\Delta p_{t-1}$ | 0.022 | $-0.335$ | $0.478^{***}$ | $-0.489^{**}$ |
| | (0.698) | (0.610) | (0.103) | (0.190) |
| $\Delta y_{t-1}$ | 0.132 | $-0.147$ | 0.039 | $-0.220^{**}$ |
| | (0.605) | (0.232) | (0.039) | (0.105) |
| $\Delta p_{t-2}$ | | | $0.182^{**}$ | |
| | | | (0.071) | |
| Residual serial | 2.027 | 5.689 | 7.970 | 6.703 |
| correlation test | [0.731] | [0.224] | [0.093] | [0.152] |
| Adjusted $R^2$ | 0.126 | 0.215 | 0.661 | 0.137 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta p_t, \Delta y_t\right)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980), and those in square brackets are p-values. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.23b: Quarterly estimates of the equation for the oil exports variable in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.146 | 0.119 | 0.119 | 0.112 | 0.111 | 0.111 |
| | (0.114) | (0.102) | (0.102) | (0.107) | (0.107) | (0.109) |
| $s_{t-1}$ | $-0.342^{**}$ | $-0.308^{**}$ | $-0.307^{**}$ | $-0.313^{**}$ | $-0.294^{**}$ | $-0.293^{**}$ |
| | (0.139) | (0.132) | (0.134) | (0.130) | (0.130) | (0.130) |
| $\Delta x_{t-1}^0$ | −0.035 | −0.053 | −0.053 | −0.080 | −0.091 | −0.091 |
| | (0.101) | (0.106) | (0.107) | (0.105) | (0.104) | (0.104) |
| $\Delta e_{f,t-1}$ | $-0.440^{**}$ | $-0.429^{*}$ | $-0.429^{*}$ | −0.363 | $-0.414^{*}$ | $-0.414^{*}$ |
| | (0.220) | (0.236) | (0.239) | (0.239) | (0.223) | (0.225) |
| $\Delta p_{t-1}$ | −0.158 | 0.022 | 0.024 | −0.257 | −0.079 | −0.064 |
| | (0.683) | (0.698) | (0.709) | (0.734) | (0.754) | (0.742) |
| $\Delta y_{t-1}$ | 0.089 | 0.132 | 0.131 | −0.030 | −0.074 | −0.075 |
| | (0.594) | (0.605) | (0.611) | (0.554) | (0.546) | (0.547) |
| $\Delta \bar{y}_{wt}$ | | $7.638^{**}$ | $7.545^{**}$ | 3.436 | 2.377 | 2.461 |
| | | (3.472) | (3.530) | (2.880) | (2.956) | (2.954) |
| $\Delta \overline{req}_{wt}$ | | | 0.017 | −0.102 | −0.209 | −0.179 |
| | | | (0.259) | (0.226) | (0.217) | (0.295) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.337^{***}$ | $-3.391^{***}$ | $-3.407^{***}$ |
| | | | | (0.937) | (0.919) | (0.951) |
| $\Delta \bar{r}_{wt}$ | | | | | $64.555^{**}$ | $64.968^{**}$ |
| | | | | | (26.212) | (26.557) |
| $grv_t$ | | | | | | 0.093 |
| | | | | | | (0.587) |
| Residual serial | 1.157 | 2.027 | 2.052 | 1.565 | 3.775 | 3.937 |
| correlation test | [0.885] | [0.731] | [0.726] | [0.815] | [0.437] | [0.415] |
| Adjusted $R^2$ | 0.097 | 0.126 | 0.118 | 0.205 | 0.243 | 0.236 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.23c: Quarterly estimates of the equation for exchange rate returns in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.296*** | 0.302*** | 0.300*** | 0.299*** | 0.299*** | 0.305*** |
| | (0.080) | (0.079) | (0.079) | (0.077) | (0.078) | (0.076) |
| $s_{t-1}$ | −0.222*** | −0.229*** | −0.227*** | −0.221*** | −0.221*** | −0.228*** |
| | (0.065) | (0.063) | (0.064) | (0.064) | (0.064) | (0.062) |
| $\Delta x_t^0$ | 0.014 | 0.028 | 0.027 | 0.044 | 0.045 | 0.046 |
| | (0.038) | (0.040) | (0.040) | (0.043) | (0.045) | (0.044) |
| $\Delta x_{t-1}^0$ | 0.038 | 0.044 | 0.046 | 0.051 | 0.051 | 0.047 |
| | (0.035) | (0.036) | (0.036) | (0.039) | (0.039) | (0.037) |
| $\Delta e_{f,t-1}$ | 0.345* | 0.347** | 0.345** | 0.342** | 0.344** | 0.344** |
| | (0.179) | (0.173) | (0.172) | (0.168) | (0.171) | (0.164) |
| $\Delta p_{t-1}$ | −0.278 | −0.335 | −0.327 | −0.284 | −0.289 | −0.395 |
| | (0.613) | (0.610) | (0.616) | (0.603) | (0.594) | (0.587) |
| $\Delta y_{t-1}$ | −0.132 | −0.147 | −0.153 | −0.130 | −0.129 | −0.123 |
| | (0.232) | (0.232) | (0.235) | (0.236) | (0.234) | (0.229) |
| $\Delta \bar{y}_{wt}$ | | −2.471 | −2.795 | −2.284 | −2.262 | −2.843* |
| | | (1.572) | (1.757) | (1.705) | (1.742) | (1.643) |
| $\Delta \overline{req}_{wt}$ | | | 0.059 | 0.077 | 0.080 | −0.120 |
| | | | (0.091) | (0.096) | (0.102) | (0.125) |
| $\Delta \bar{e}_{wt}$ | | | | 0.515 | 0.522 | 0.629 |
| | | | | (0.541) | (0.526) | (0.544) |
| $\Delta \bar{r}_{wt}$ | | | | | −1.651 | −4.548 |
| | | | | | (15.034) | (14.849) |
| $grv_t$ | | | | | | −0.636** |
| | | | | | | (0.310) |
| Residual serial | 6.132 | 5.689 | 5.541 | 7.009 | 7.125 | 4.742 |
| correlation test | [0.190] | [0.224] | [0.236] | [0.135] | [0.129] | [0.315] |
| Adjusted $R^2$ | 0.203 | 0.215 | 0.209 | 0.212 | 0.205 | 0.228 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.23d: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.029^{**}$ | $-0.033^{***}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.032^{**}$ | $-0.031^{**}$ |
| | (0.013) | (0.013) | (0.013) | (0.012) | (0.012) | (0.013) |
| $s_{t-1}$ | $0.032^{***}$ | $0.035^{***}$ | $0.034^{***}$ | $0.034^{***}$ | $0.034^{***}$ | $0.033^{***}$ |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) | (0.013) |
| $\Delta x_t^0$ | 0.001 | $-0.003$ | $-0.003$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| $\Delta e_{f,t}$ | $0.156^{***}$ | $0.163^{***}$ | $0.164^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.165^{***}$ |
| | (0.029) | (0.028) | (0.028) | (0.027) | (0.028) | (0.027) |
| $\Delta x_{t-1}^0$ | $-0.0003$ | $-0.003$ | $-0.003$ | $-0.004$ | $-0.004$ | $-0.004$ |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| $\Delta e_{f,t-1}$ | $-0.005$ | $-0.007$ | $-0.005$ | $-0.005$ | $-0.005$ | $-0.005$ |
| | (0.028) | (0.026) | (0.026) | (0.026) | (0.026) | (0.026) |
| $\Delta p_{t-1}$ | $0.468^{***}$ | $0.478^{***}$ | $0.467^{***}$ | $0.454^{***}$ | $0.455^{***}$ | $0.451^{***}$ |
| | (0.107) | (0.103) | (0.102) | (0.102) | (0.102) | (0.105) |
| $\Delta y_{t-1}$ | 0.032 | 0.039 | 0.044 | 0.041 | 0.040 | 0.040 |
| | (0.041) | (0.039) | (0.040) | (0.039) | (0.040) | (0.040) |
| $\Delta p_{t-2}$ | $0.169^{**}$ | $0.182^{**}$ | $0.194^{***}$ | $0.200^{***}$ | $0.201^{***}$ | $0.199^{***}$ |
| | (0.074) | (0.071) | (0.073) | (0.073) | (0.074) | (0.074) |
| $\Delta \bar{y}_{wt}$ | | $0.800^{***}$ | $0.932^{***}$ | $0.842^{**}$ | $0.836^{**}$ | $0.803^{**}$ |
| | | (0.289) | (0.321) | (0.337) | (0.340) | (0.339) |
| $\Delta \overline{req}_{wt}$ | | | $-0.023$ | $-0.027$ | $-0.028$ | $-0.038$ |
| | | | (0.021) | (0.022) | (0.023) | (0.029) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.101$ | $-0.103$ | $-0.097$ |
| | | | | (0.082) | (0.083) | (0.084) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.501 | 0.356 |
| | | | | | (2.435) | (2.425) |
| $grv_t$ | | | | | | $-0.031$ |
| | | | | | | (0.054) |
| Residual serial | 11.263 | 7.970 | 5.559 | 6.203 | 6.210 | 6.281 |
| correlation test | [0.024] | [0.093] | [0.235] | [0.184] | [0.184] | [0.179] |
| Adjusted $R^2$ | 0.640 | 0.661 | 0.661 | 0.663 | 0.660 | 0.657 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.23e: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.027 | 0.027 | 0.025 | 0.025 | 0.027 |
| | (0.023) | (0.024) | (0.024) | (0.023) | (0.023) | (0.023) |
| $s_{t-1}$ | $-0.050^{*}$ | $-0.053^{*}$ | $-0.053^{*}$ | $-0.053^{**}$ | $-0.053^{**}$ | $-0.055^{**}$ |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| $\Delta x_t^0$ | 0.023 | 0.025 | 0.025 | 0.020 | 0.026 | 0.026 |
| | (0.016) | (0.016) | (0.017) | (0.019) | (0.017) | (0.017) |
| $\Delta e_{f,t}$ | $-0.130^{***}$ | $-0.139^{***}$ | $-0.140^{***}$ | $-0.133^{***}$ | $-0.135^{***}$ | $-0.138^{***}$ |
| | (0.041) | (0.042) | (0.042) | (0.041) | (0.041) | (0.041) |
| $\Delta p_t$ | $0.344^{**}$ | $0.377^{**}$ | $0.381^{**}$ | $0.362^{**}$ | $0.365^{**}$ | $0.359^{**}$ |
| | (0.164) | (0.172) | (0.173) | (0.173) | (0.172) | (0.171) |
| $\Delta x_{t-1}^0$ | $0.022^{*}$ | $0.023^{*}$ | $0.023^{*}$ | $0.022^{*}$ | $0.023^{*}$ | $0.023^{*}$ |
| | (0.011) | (0.012) | (0.013) | (0.012) | (0.013) | (0.013) |
| $\Delta e_{f,t-1}$ | 0.036 | 0.038 | 0.038 | 0.037 | 0.045 | 0.046 |
| | (0.044) | (0.044) | (0.043) | (0.044) | (0.041) | (0.042) |
| $\Delta p_{t-1}$ | $-0.458^{**}$ | $-0.489^{**}$ | $-0.489^{**}$ | $-0.489^{**}$ | $-0.507^{***}$ | $-0.516^{***}$ |
| | (0.179) | (0.190) | (0.190) | (0.193) | (0.188) | (0.186) |
| $\Delta y_{t-1}$ | $-0.216^{**}$ | $-0.220^{**}$ | $-0.221^{**}$ | $-0.227^{**}$ | $-0.223^{**}$ | $-0.223^{**}$ |
| | (0.106) | (0.105) | (0.106) | (0.103) | (0.105) | (0.107) |
| $\Delta \bar{y}_{wt}$ | | −0.428 | −0.531 | −0.658 | −0.577 | −0.644 |
| | | (0.428) | (0.480) | (0.497) | (0.499) | (0.501) |
| $\Delta \overline{req}_{wt}$ | | | 0.018 | 0.012 | 0.023 | 0.002 |
| | | | (0.042) | (0.045) | (0.047) | (0.065) |
| $\Delta \bar{e}_{wt}$ | | | | −0.155 | −0.131 | −0.118 |
| | | | | (0.165) | (0.164) | (0.164) |
| $\Delta \bar{r}_{wt}$ | | | | | −6.346 | −6.663 |
| | | | | | (4.556) | (4.697) |
| $grv_t$ | | | | | | −0.068 |
| | | | | | | (0.121) |
| Residual serial | 6.974 | 6.703 | 6.911 | 7.426 | 7.684 | 8.064 |
| correlation test | [0.137] | [0.152] | [0.141] | [0.115] | [0.104] | [0.089] |
| Adjusted $R^2$ | 0.141 | 0.137 | 0.131 | 0.131 | 0.141 | 0.136 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.24a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | $\Delta e_{f,t}$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $s_t$ | 0.111 | $0.309^{***}$ | $-0.033^{***}$ | 0.028 |
| | (0.105) | (0.077) | (0.012) | (0.024) |
| $s_{t-1}$ | $-0.305^{**}$ | $-0.235^{***}$ | $0.036^{***}$ | $-0.054^{*}$ |
| | (0.129) | (0.066) | (0.012) | (0.027) |
| $\Delta x_t^0$ | | 0.018 | $-0.004$ | $0.028^{*}$ |
| | | (0.035) | (0.007) | (0.015) |
| $\Delta e_{f,t}$ | | | $0.162^{***}$ | $-0.138^{***}$ |
| | | | (0.027) | (0.040) |
| $\Delta p_t$ | | | | $0.364^{**}$ |
| | | | | (0.168) |
| $\Delta y_{wt}$ | $7.674^{**}$ | $-2.452$ | $0.808^{***}$ | $-0.459$ |
| | (3.771) | (1.550) | (0.293) | (0.418) |
| $\Delta x_{t-1}^0$ | $-0.063$ | 0.041 | $-0.002$ | $0.021^{*}$ |
| | (0.104) | (0.035) | (0.008) | (0.012) |
| $\Delta e_{f,t-1}$ | $-0.361$ | $0.332^{**}$ | $-0.006$ | 0.041 |
| | (0.249) | (0.169) | (0.027) | (0.043) |
| $\Delta p_{t-1}$ | $-0.059$ | $-0.338$ | $0.477^{***}$ | $-0.482^{**}$ |
| | (0.757) | (0.604) | (0.102) | (0.191) |
| $\Delta y_{t-1}$ | 0.125 | $-0.135$ | 0.040 | $-0.223^{**}$ |
| | (0.609) | (0.224) | (0.038) | (0.106) |
| $\Delta p_{t-2}$ | | | $0.184^{***}$ | |
| | | | (0.070) | |
| Residual serial | 3.751 | 4.983 | 8.003 | 6.738 |
| correlation test | [0.441] | [0.289] | [0.091] | [0.150] |
| Adjusted $R^2$ | 0.097 | 0.214 | 0.668 | 0.152 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. Seasonal dummies are *not* included to allow for possible seasonality of the variables in the SVAR model. Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980), and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.24b: Quarterly estimates of the equation for the oil exports variable in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.136 | 0.111 | 0.109 | 0.106 | 0.104 | 0.104 |
| | (0.117) | (0.105) | (0.105) | (0.108) | (0.106) | (0.108) |
| $s_{t-1}$ | $-0.338^{**}$ | $-0.305^{**}$ | $-0.304^{**}$ | $-0.316^{**}$ | $-0.295^{**}$ | $-0.294^{**}$ |
| | (0.137) | (0.129) | (0.131) | (0.127) | (0.124) | (0.125) |
| $\Delta x_{t-1}^0$ | −0.043 | −0.063 | −0.061 | −0.094 | −0.103 | −0.103 |
| | (0.098) | (0.104) | (0.106) | (0.106) | (0.108) | (0.108) |
| $\Delta e_{f,t-1}$ | −0.370 | −0.361 | −0.362 | −0.305 | −0.364 | −0.363 |
| | (0.232) | (0.249) | (0.250) | (0.254) | (0.238) | (0.240) |
| $\Delta p_{t-1}$ | −0.243 | −0.059 | −0.054 | −0.327 | −0.123 | −0.116 |
| | (0.748) | (0.757) | (0.767) | (0.799) | (0.815) | (0.808) |
| $\Delta y_{t-1}$ | 0.083 | 0.125 | 0.121 | −0.056 | −0.107 | −0.108 |
| | (0.596) | (0.609) | (0.616) | (0.546) | (0.542) | (0.543) |
| $\Delta \bar{y}_{wt}$ | | $7.674^{**}$ | $7.463^{**}$ | 3.031 | 2.068 | 2.109 |
| | | (3.771) | (3.617) | (2.877) | (2.933) | (2.925) |
| $\Delta \overline{req}_{wt}$ | | | 0.039 | −0.069 | −0.196 | −0.182 |
| | | | (0.283) | (0.237) | (0.232) | (0.300) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.469^{***}$ | $-3.514^{***}$ | $-3.522^{***}$ |
| | | | | (0.999) | (0.970) | (1.001) |
| $\Delta \bar{r}_{wt}$ | | | | | $66.900^{***}$ | $67.105^{***}$ |
| | | | | | (24.601) | (25.154) |
| $grv_t$ | | | | | | 0.044 |
| | | | | | | (0.590) |
| Residual serial correlation test | 2.435 | 3.751 | 3.865 | 2.464 | 4.895 | 5.026 |
| | [0.656] | [0.441] | [0.425] | [0.651] | [0.298] | [0.285] |
| Adjusted $R^2$ | 0.068 | 0.097 | 0.089 | 0.183 | 0.225 | 0.218 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.24c: Quarterly estimates of the equation for exchange rate returns in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $0.302^{***}$ | $0.309^{***}$ | $0.305^{***}$ | $0.304^{***}$ | $0.304^{***}$ | $0.310^{***}$ |
| | (0.079) | (0.077) | (0.077) | (0.076) | (0.076) | (0.074) |
| $s_{t-1}$ | $-0.229^{***}$ | $-0.235^{***}$ | $-0.232^{***}$ | $-0.226^{***}$ | $-0.226^{***}$ | $-0.233^{***}$ |
| | (0.067) | (0.066) | (0.066) | (0.067) | (0.067) | (0.065) |
| $\Delta x_t^0$ | 0.005 | 0.018 | 0.017 | 0.034 | 0.033 | 0.033 |
| | (0.033) | (0.035) | (0.034) | (0.039) | (0.040) | (0.039) |
| $\Delta x_{t-1}^0$ | 0.035 | 0.041 | 0.044 | 0.050 | 0.050 | 0.045 |
| | (0.034) | (0.035) | (0.036) | (0.039) | (0.039) | (0.037) |
| $\Delta e_{f,t-1}$ | $0.331^{*}$ | $0.332^{**}$ | $0.330^{**}$ | $0.327^{**}$ | $0.326^{*}$ | $0.324^{**}$ |
| | (0.175) | (0.169) | (0.168) | (0.163) | (0.168) | (0.160) |
| $\Delta p_{t-1}$ | −0.282 | −0.338 | −0.329 | −0.287 | −0.284 | −0.384 |
| | (0.608) | (0.604) | (0.610) | (0.599) | (0.591) | (0.582) |
| $\Delta y_{t-1}$ | −0.121 | −0.135 | −0.142 | −0.118 | −0.119 | −0.114 |
| | (0.225) | (0.224) | (0.227) | (0.226) | (0.223) | (0.218) |
| $\Delta \bar{y}_{wt}$ | | −2.452 | $-2.855^{*}$ | −2.319 | −2.333 | $-2.908^{*}$ |
| | | (1.550) | (1.720) | (1.670) | (1.692) | (1.586) |
| $\Delta \overline{req}_{wt}$ | | | 0.075 | 0.090 | 0.088 | −0.104 |
| | | | (0.086) | (0.087) | (0.095) | (0.124) |
| $\Delta \bar{e}_{wt}$ | | | | 0.515 | 0.510 | 0.624 |
| | | | | (0.542) | (0.529) | (0.552) |
| $\Delta \bar{r}_{wt}$ | | | | | 1.170 | −1.757 |
| | | | | | (14.412) | (14.384) |
| $grv_t$ | | | | | | $-0.621^{**}$ |
| | | | | | | (0.313) |
| Residual serial | 5.353 | 4.983 | 4.839 | 6.292 | 6.236 | 4.234 |
| correlation test | [0.253] | [0.289] | [0.304] | [0.178] | [0.182] | [0.375] |
| Adjusted $R^2$ | 0.203 | 0.214 | 0.209 | 0.212 | 0.205 | 0.226 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.24d: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.029^{**}$ | $-0.033^{***}$ | $-0.032^{**}$ | $-0.032^{***}$ | $-0.032^{***}$ | $-0.031^{**}$ |
| | (0.013) | (0.012) | (0.013) | (0.012) | (0.012) | (0.013) |
| $s_{t-1}$ | $0.032^{***}$ | $0.036^{***}$ | $0.035^{***}$ | $0.034^{***}$ | $0.034^{***}$ | $0.033^{***}$ |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) |
| $\Delta x_t^0$ | 0.0005 | $-0.004$ | $-0.003$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) |
| $\Delta e_{f,t}$ | $0.155^{***}$ | $0.162^{***}$ | $0.163^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.164^{***}$ |
| | (0.028) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| $\Delta x_{t-1}^0$ | 0.001 | $-0.002$ | $-0.002$ | $-0.004$ | $-0.004$ | $-0.004$ |
| | (0.009) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| $\Delta e_{f,t-1}$ | $-0.005$ | $-0.006$ | $-0.004$ | $-0.004$ | $-0.005$ | $-0.004$ |
| | (0.029) | (0.027) | (0.026) | (0.026) | (0.026) | (0.027) |
| $\Delta p_{t-1}$ | $0.466^{***}$ | $0.477^{***}$ | $0.465^{***}$ | $0.454^{***}$ | $0.454^{***}$ | $0.450^{***}$ |
| | (0.107) | (0.102) | (0.101) | (0.100) | (0.101) | (0.103) |
| $\Delta y_{t-1}$ | 0.033 | 0.040 | 0.044 | 0.041 | 0.040 | 0.040 |
| | (0.039) | (0.038) | (0.039) | (0.038) | (0.039) | (0.039) |
| $\Delta p_{t-2}$ | $0.172^{**}$ | $0.184^{***}$ | $0.196^{***}$ | $0.201^{***}$ | $0.201^{***}$ | $0.199^{***}$ |
| | (0.073) | (0.070) | (0.072) | (0.073) | (0.073) | (0.073) |
| $\Delta \bar{y}_{wt}$ | | $0.808^{***}$ | $0.952^{***}$ | $0.854^{**}$ | $0.850^{**}$ | $0.815^{**}$ |
| | | (0.293) | (0.322) | (0.338) | (0.340) | (0.337) |
| $\Delta \overline{req}_{wt}$ | | | $-0.026$ | $-0.029$ | $-0.030$ | $-0.040$ |
| | | | (0.020) | (0.021) | (0.022) | (0.027) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.103$ | $-0.105$ | $-0.098$ |
| | | | | (0.080) | (0.082) | (0.083) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.317 | 0.167 |
| | | | | | (2.317) | (2.313) |
| $grv_t$ | | | | | | $-0.032$ |
| | | | | | | (0.054) |
| Residual serial | 11.521 | 8.003 | 5.321 | 5.888 | 5.868 | 5.924 |
| correlation test | [0.021] | [0.091] | [0.256] | [0.208] | [0.209] | [0.205] |
| Adjusted $R^2$ | 0.647 | 0.668 | 0.669 | 0.671 | 0.668 | 0.666 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.24e: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: oil exports, exchange rate returns, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.028 | 0.027 | 0.026 | 0.026 | 0.027 |
| | (0.023) | (0.024) | (0.024) | (0.023) | (0.023) | (0.023) |
| $s_{t-1}$ | $-0.050^{*}$ | $-0.054^{*}$ | $-0.053^{**}$ | $-0.054^{**}$ | $-0.054^{**}$ | $-0.055^{**}$ |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.026) | (0.027) |
| $\Delta x_t^0$ | $0.025^{*}$ | $0.028^{*}$ | $0.028^{*}$ | 0.023 | $0.028^{*}$ | $0.028^{*}$ |
| | (0.015) | (0.015) | (0.016) | (0.017) | (0.016) | (0.016) |
| $\Delta e_{f,t}$ | $-0.128^{***}$ | $-0.138^{***}$ | $-0.140^{***}$ | $-0.134^{***}$ | $-0.134^{***}$ | $-0.137^{***}$ |
| | (0.039) | (0.040) | (0.040) | (0.039) | (0.039) | (0.039) |
| $\Delta p_t$ | $0.328^{**}$ | $0.364^{**}$ | $0.371^{**}$ | $0.353^{**}$ | $0.355^{**}$ | $0.348^{**}$ |
| | (0.161) | (0.168) | (0.170) | (0.169) | (0.167) | (0.166) |
| $\Delta x_{t-1}^0$ | $0.019^{*}$ | $0.021^{*}$ | $0.022^{*}$ | 0.020 | $0.021^{*}$ | 0.021 |
| | (0.011) | (0.012) | (0.012) | (0.012) | (0.013) | (0.013) |
| $\Delta e_{f,t-1}$ | 0.038 | 0.041 | 0.041 | 0.040 | 0.047 | 0.047 |
| | (0.043) | (0.043) | (0.043) | (0.043) | (0.041) | (0.041) |
| $\Delta p_{t-1}$ | $-0.449^{**}$ | $-0.482^{**}$ | $-0.484^{**}$ | $-0.483^{**}$ | $-0.500^{***}$ | $-0.508^{***}$ |
| | (0.181) | (0.191) | (0.191) | (0.193) | (0.188) | (0.185) |
| $\Delta y_{t-1}$ | $-0.219^{**}$ | $-0.223^{**}$ | $-0.225^{**}$ | $-0.231^{**}$ | $-0.226^{**}$ | $-0.226^{**}$ |
| | (0.108) | (0.106) | (0.107) | (0.104) | (0.106) | (0.108) |
| $\Delta \bar{y}_{wt}$ | | $-0.459$ | $-0.595$ | $-0.715$ | $-0.645$ | $-0.710$ |
| | | (0.418) | (0.478) | (0.498) | (0.501) | (0.504) |
| $\Delta \overline{req}_{wt}$ | | | 0.024 | 0.019 | 0.031 | 0.011 |
| | | | (0.041) | (0.044) | (0.046) | (0.064) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.139$ | $-0.117$ | $-0.103$ |
| | | | | (0.159) | (0.159) | (0.159) |
| $\Delta \bar{r}_{wt}$ | | | | | $-5.988$ | $-6.293$ |
| | | | | | (4.408) | (4.539) |
| $grv_t$ | | | | | | $-0.066$ |
| | | | | | | (0.117) |
| Residual serial | 7.054 | 6.738 | 6.977 | 7.483 | 7.876 | 8.205 |
| correlation test | [0.133] | [0.150] | [0.137] | [0.112] | [0.096] | [0.084] |
| Adjusted $R^2$ | 0.154 | 0.152 | 0.146 | 0.145 | 0.154 | 0.149 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.25a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{f,t}$ | $\Delta x_t^0$ | $\Delta m_t$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $s_t$ | $0.308^{***}$ | 0.058 | −0.002 | $-0.033^{***}$ | 0.029 |
| | (0.081) | (0.126) | (0.015) | (0.013) | (0.024) |
| $s_{t-1}$ | $-0.241^{***}$ | $-0.250^{*}$ | 0.015 | $0.037^{***}$ | $-0.056^{**}$ |
| | (0.067) | (0.151) | (0.018) | (0.012) | (0.028) |
| $\Delta e_{f,t}$ | | 0.158 | −0.007 | $0.163^{***}$ | $-0.141^{***}$ |
| | | (0.205) | (0.018) | (0.028) | (0.042) |
| $\Delta x_t^0$ | | | 0.006 | −0.003 | 0.025 |
| | | | (0.007) | (0.008) | (0.016) |
| $\Delta m_t$ | | | | −0.073 | 0.063 |
| | | | | (0.072) | (0.118) |
| $\Delta p_t$ | | | | | $0.387^{**}$ |
| | | | | | (0.173) |
| $\Delta y_{wt}$ | −2.399 | $8.786^{**}$ | 0.233 | $0.865^{***}$ | −0.520 |
| | (1.525) | (3.792) | (0.406) | (0.285) | (0.458) |
| $\Delta e_{f,t-1}$ | $0.337^{*}$ | $-0.495^{*}$ | −0.025 | −0.009 | 0.041 |
| | (0.177) | (0.261) | (0.022) | (0.027) | (0.044) |
| $\Delta x_{t-1}^0$ | 0.042 | −0.058 | −0.005 | −0.003 | $0.023^{*}$ |
| | (0.036) | (0.106) | (0.007) | (0.008) | (0.012) |
| $\Delta m_{t-1}$ | 0.129 | −0.735 | 0.218 | −0.025 | 0.046 |
| | (0.268) | (0.772) | (0.146) | (0.072) | (0.129) |
| $\Delta p_{t-1}$ | −0.339 | 0.106 | $0.167^{*}$ | $0.488^{***}$ | $-0.505^{***}$ |
| | (0.611) | (0.734) | (0.088) | (0.108) | (0.195) |
| $\Delta y_{t-1}$ | −0.142 | 0.144 | 0.025 | 0.042 | $-0.221^{**}$ |
| | (0.226) | (0.616) | (0.051) | (0.039) | (0.107) |
| $\Delta p_{t-2}$ | | | −0.070 | $0.183^{**}$ | |
| | | | (0.078) | (0.077) | |
| Residual serial | 5.987 | 2.379 | 7.640 | 8.061 | 7.240 |
| correlation test | [0.200] | [0.666] | [0.106] | [0.089] | [0.124] |
| Adjusted $R^2$ | 0.212 | 0.119 | 0.466 | 0.659 | 0.124 |

**Notes**: The variables are ordered as: $\Delta e_{ft}$, $\Delta x_t^0$, $\Delta m_t$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta e_{ft}, \Delta x_t^0, \Delta m_t, \Delta p_t, \Delta y_t\right)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980), and those in square brackets are p-values. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.25b: Quarterly estimates of the equation for the exchange rate returns in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $0.297^{***}$ | $0.308^{***}$ | $0.305^{***}$ | $0.307^{***}$ | $0.307^{***}$ | $0.311^{***}$ |
| | (0.081) | (0.081) | (0.081) | (0.080) | (0.081) | (0.078) |
| $s_{t-1}$ | $-0.226^{***}$ | $-0.241^{***}$ | $-0.238^{***}$ | $-0.239^{***}$ | $-0.239^{***}$ | $-0.243^{***}$ |
| | (0.068) | (0.067) | (0.068) | (0.068) | (0.069) | (0.068) |
| $\Delta e_{f,t-1}$ | $0.338^{*}$ | $0.337^{*}$ | $0.335^{*}$ | $0.328^{*}$ | $0.327^{*}$ | $0.326^{**}$ |
| | (0.182) | (0.177) | (0.176) | (0.171) | (0.173) | (0.166) |
| $\Delta x^0_{t-1}$ | 0.038 | 0.042 | 0.044 | 0.047 | 0.047 | 0.043 |
| | (0.035) | (0.036) | (0.036) | (0.038) | (0.038) | (0.036) |
| $\Delta m_{t-1}$ | −0.039 | 0.129 | 0.100 | 0.153 | 0.154 | 0.055 |
| | (0.270) | (0.268) | (0.263) | (0.283) | (0.281) | (0.266) |
| $\Delta p_{t-1}$ | −0.280 | −0.339 | −0.332 | −0.301 | −0.297 | −0.399 |
| | (0.612) | (0.611) | (0.617) | (0.607) | (0.597) | (0.591) |
| $\Delta y_{t-1}$ | −0.132 | −0.142 | −0.148 | −0.128 | −0.129 | −0.125 |
| | (0.230) | (0.226) | (0.230) | (0.225) | (0.223) | (0.220) |
| $\Delta \bar{y}_{wt}$ | | −2.399 | −2.667 | −2.228 | −2.252 | $-2.759^{*}$ |
| | | (1.525) | (1.690) | (1.670) | (1.707) | (1.615) |
| $\Delta \overline{req}_{wt}$ | | | 0.054 | 0.066 | 0.063 | −0.129 |
| | | | (0.090) | (0.093) | (0.096) | (0.122) |
| $\Delta \bar{e}_{wt}$ | | | | 0.390 | 0.390 | 0.478 |
| | | | | (0.516) | (0.515) | (0.530) |
| $\Delta \bar{r}_{wt}$ | | | | | 1.417 | −1.456 |
| | | | | | (14.685) | (14.625) |
| $grv_t$ | | | | | | $-0.626^{**}$ |
| | | | | | | (0.302) |
| Residual serial | 5.781 | 5.987 | 5.734 | 7.126 | 7.058 | 4.946 |
| correlation test | [0.216] | [0.200] | [0.220] | [0.129] | [0.133] | [0.293] |
| Adjusted $R^2$ | 0.202 | 0.212 | 0.206 | 0.205 | 0.198 | 0.220 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.25c: Quarterly estimates of the equation for the oil export variable in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.119 | 0.058 | 0.056 | 0.017 | 0.019 | 0.016 |
| | (0.140) | (0.126) | (0.128) | (0.128) | (0.126) | (0.129) |
| $s_{t-1}$ | $-0.320^{**}$ | $-0.250^{*}$ | $-0.248$ | $-0.223$ | $-0.208$ | $-0.205$ |
| | (0.161) | (0.151) | (0.153) | (0.140) | (0.142) | (0.142) |
| $\Delta e_{f,t}$ | 0.082 | 0.158 | 0.157 | 0.230 | 0.224 | 0.232 |
| | (0.207) | (0.205) | (0.204) | (0.190) | (0.177) | (0.179) |
| $\Delta e_{f,t-1}$ | $-0.470^{*}$ | $-0.495^{*}$ | $-0.496^{*}$ | $-0.458^{*}$ | $-0.505^{**}$ | $-0.507^{**}$ |
| | (0.251) | (0.261) | (0.262) | (0.252) | (0.234) | (0.234) |
| $\Delta x_{t-1}^0$ | $-0.038$ | $-0.058$ | $-0.057$ | $-0.087$ | $-0.098$ | $-0.098$ |
| | (0.101) | (0.106) | (0.108) | (0.106) | (0.105) | (0.105) |
| $\Delta m_{t-1}$ | $-0.125$ | $-0.735$ | $-0.760$ | $-1.250^{*}$ | $-1.175$ | $-1.156$ |
| | (0.845) | (0.772) | (0.797) | (0.731) | (0.720) | (0.734) |
| $\Delta p_{t-1}$ | $-0.133$ | 0.106 | 0.112 | $-0.144$ | 0.026 | 0.049 |
| | (0.716) | (0.734) | (0.746) | (0.755) | (0.770) | (0.763) |
| $\Delta y_{t-1}$ | 0.097 | 0.144 | 0.139 | $-0.032$ | $-0.074$ | $-0.074$ |
| | (0.602) | (0.616) | (0.623) | (0.560) | (0.547) | (0.549) |
| $\Delta \bar{y}_{wt}$ | | $8.786^{**}$ | $8.551^{**}$ | 4.698 | 3.603 | 3.725 |
| | | (3.792) | (3.764) | (3.061) | (3.142) | (3.111) |
| $\Delta \overline{req}_{wt}$ | | | 0.047 | $-0.061$ | $-0.168$ | $-0.128$ |
| | | | (0.270) | (0.231) | (0.226) | (0.296) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.597^{***}$ | $-3.638^{***}$ | $-3.659^{***}$ |
| | | | | (0.951) | (0.925) | (0.956) |
| $\Delta \bar{r}_{wt}$ | | | | | $63.168^{**}$ | $63.754^{**}$ |
| | | | | | (25.603) | (25.886) |
| $grv_t$ | | | | | | 0.130 |
| | | | | | | (0.597) |
| Residual serial | 1.196 | 2.379 | 2.414 | 1.926 | 4.488 | 4.558 |
| correlation test | [0.879] | [0.666] | [0.660] | [0.749] | [0.344] | [0.336] |
| Adjusted $R^2$ | 0.082 | 0.119 | 0.111 | 0.212 | 0.249 | 0.242 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.25d: Quarterly estimates of the equation for money supply growth in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta m_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.0004$ | $-0.002$ | $-0.003$ | $-0.002$ | $-0.002$ | 0.002 |
| | (0.014) | (0.015) | (0.014) | (0.014) | (0.014) | (0.013) |
| $s_{t-1}$ | 0.014 | 0.015 | 0.016 | 0.017 | 0.017 | 0.014 |
| | (0.017) | (0.018) | (0.018) | (0.017) | (0.017) | (0.016) |
| $\Delta e_{f,t}$ | $-0.009$ | $-0.007$ | $-0.008$ | $-0.011$ | $-0.012$ | $-0.022$ |
| | (0.017) | (0.018) | (0.018) | (0.018) | (0.017) | (0.018) |
| $\Delta x_t^0$ | 0.008 | 0.006 | 0.006 | 0.011 | $0.014^*$ | $0.015^*$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) |
| $\Delta e_{f,t-1}$ | $-0.024$ | $-0.025$ | $-0.026$ | $-0.027$ | $-0.023$ | $-0.021$ |
| | (0.022) | (0.022) | (0.022) | (0.022) | (0.021) | (0.021) |
| $\Delta x_{t-1}^0$ | $-0.005$ | $-0.005$ | $-0.005$ | $-0.003$ | $-0.002$ | $-0.003$ |
| | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) | (0.008) |
| $\Delta m_{t-1}$ | $0.235^*$ | 0.218 | 0.211 | 0.236 | 0.236 | 0.211 |
| | (0.139) | (0.146) | (0.146) | (0.156) | (0.156) | (0.149) |
| $\Delta p_{t-1}$ | $0.165^*$ | $0.167^*$ | $0.174^*$ | $0.193^{**}$ | $0.189^{**}$ | 0.163 |
| | (0.089) | (0.088) | (0.090) | (0.094) | (0.093) | (0.100) |
| $\Delta y_{t-1}$ | 0.022 | 0.025 | 0.022 | 0.026 | 0.028 | 0.026 |
| | (0.051) | (0.051) | (0.051) | (0.050) | (0.051) | (0.050) |
| $\Delta p_{t-2}$ | $-0.076$ | $-0.070$ | $-0.077$ | $-0.088$ | $-0.094$ | $-0.102$ |
| | (0.079) | (0.078) | (0.079) | (0.082) | (0.086) | (0.088) |
| $\Delta \bar{y}_{wt}$ | | 0.233 | 0.152 | 0.260 | 0.304 | 0.134 |
| | | (0.406) | (0.441) | (0.464) | (0.457) | (0.506) |
| $\Delta \overline{req}_{wt}$ | | | 0.016 | 0.021 | 0.027 | $-0.026$ |
| | | | (0.026) | (0.027) | (0.029) | (0.039) |
| $\Delta \bar{e}_{wt}$ | | | | 0.146 | 0.160 | $0.191^*$ |
| | | | | (0.108) | (0.114) | (0.114) |
| $\Delta \bar{r}_{wt}$ | | | | | $-3.581$ | $-4.412$ |
| | | | | | (2.704) | (2.695) |
| $grv_t$ | | | | | | $-0.176^{**}$ |
| | | | | | | (0.078) |
| Residual serial | 7.428 | 7.640 | 7.255 | 6.129 | 5.742 | 4.178 |
| correlation test | [0.115] | [0.106] | [0.123] | [0.190] | [0.219] | [0.382] |
| Adjusted $R^2$ | 0.469 | 0.466 | 0.462 | 0.467 | 0.470 | 0.491 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.25e: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.028^{**}$ | $-0.033^{***}$ | $-0.032^{**}$ | $-0.033^{***}$ | $-0.033^{***}$ | $-0.032^{**}$ |
| | (0.012) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| $s_{t-1}$ | $0.032^{***}$ | $0.037^{***}$ | $0.036^{***}$ | $0.036^{***}$ | $0.036^{***}$ | $0.035^{***}$ |
| | (0.012) | (0.012) | (0.012) | (0.013) | (0.013) | (0.013) |
| $\Delta e_{f,t}$ | $0.155^{***}$ | $0.163^{***}$ | $0.164^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.163^{***}$ |
| | (0.029) | (0.028) | (0.028) | (0.028) | (0.028) | (0.028) |
| $\Delta x_t^0$ | 0.001 | −0.003 | −0.003 | −0.007 | −0.007 | −0.007 |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| $\Delta m_t$ | −0.061 | −0.073 | −0.070 | −0.058 | −0.057 | −0.070 |
| | (0.076) | (0.072) | (0.071) | (0.072) | (0.074) | (0.075) |
| $\Delta e_{f,t-1}$ | −0.007 | −0.009 | −0.007 | −0.007 | −0.007 | −0.007 |
| | (0.029) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| $\Delta x_{t-1}^0$ | −0.001 | −0.003 | −0.003 | −0.004 | −0.004 | −0.005 |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| $\Delta m_{t-1}$ | 0.035 | −0.025 | −0.016 | −0.036 | −0.036 | −0.040 |
| | (0.074) | (0.072) | (0.074) | (0.077) | (0.078) | (0.079) |
| $\Delta p_{t-1}$ | $0.480^{***}$ | $0.488^{***}$ | $0.478^{***}$ | $0.462^{***}$ | $0.462^{***}$ | $0.458^{***}$ |
| | (0.113) | (0.108) | (0.108) | (0.107) | (0.108) | (0.110) |
| $\Delta y_{t-1}$ | 0.033 | 0.042 | 0.045 | 0.042 | 0.042 | 0.042 |
| | (0.041) | (0.039) | (0.040) | (0.039) | (0.039) | (0.039) |
| $\Delta p_{t-2}$ | $0.162^{**}$ | $0.183^{**}$ | $0.192^{**}$ | $0.201^{**}$ | $0.202^{**}$ | $0.198^{**}$ |
| | (0.080) | (0.077) | (0.078) | (0.079) | (0.080) | (0.080) |
| $\Delta \bar{y}_{wt}$ | | $0.865^{***}$ | $0.971^{***}$ | $0.893^{***}$ | $0.889^{***}$ | $0.847^{***}$ |
| | | (0.285) | (0.315) | (0.330) | (0.335) | (0.325) |
| $\Delta \overline{req}_{wt}$ | | | −0.021 | −0.024 | −0.025 | −0.039 |
| | | | (0.021) | (0.022) | (0.023) | (0.029) |
| $\Delta \bar{e}_{wt}$ | | | | −0.102 | −0.104 | −0.093 |
| | | | | (0.088) | (0.091) | (0.091) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.303 | 0.031 |
| | | | | | (2.528) | (2.514) |
| $grv_t$ | | | | | | −0.048 |
| | | | | | | (0.056) |
| Residual serial | 9.241 | 8.061 | 5.714 | 6.473 | 6.510 | 6.759 |
| correlation test | [0.055] | [0.089] | [0.222] | [0.166] | [0.164] | [0.149] |
| Adjusted $R^2$ | 0.635 | 0.659 | 0.658 | 0.660 | 0.656 | 0.655 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.25f: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.029 | 0.028 | 0.026 | 0.026 | 0.027 |
| | (0.023) | (0.024) | (0.024) | (0.023) | (0.023) | (0.023) |
| $s_{t-1}$ | $-0.051^{*}$ | $-0.056^{**}$ | $-0.055^{**}$ | $-0.055^{**}$ | $-0.055^{**}$ | $-0.056^{**}$ |
| | (0.027) | (0.028) | (0.028) | (0.027) | (0.027) | (0.027) |
| $\Delta e_{f,t}$ | $-0.130^{***}$ | $-0.141^{***}$ | $-0.142^{***}$ | $-0.135^{***}$ | $-0.136^{***}$ | $-0.138^{***}$ |
| | (0.041) | (0.042) | (0.043) | (0.041) | (0.041) | (0.041) |
| $\Delta x_t^0$ | 0.023 | 0.025 | 0.025 | 0.020 | 0.025 | 0.026 |
| | (0.017) | (0.016) | (0.017) | (0.019) | (0.018) | (0.018) |
| $\Delta m_t$ | 0.052 | 0.063 | 0.062 | 0.078 | 0.054 | 0.037 |
| | (0.118) | (0.118) | (0.118) | (0.115) | (0.120) | (0.123) |
| $\Delta p_t$ | $0.348^{**}$ | $0.387^{**}$ | $0.390^{**}$ | $0.373^{**}$ | $0.373^{**}$ | $0.364^{**}$ |
| | (0.165) | (0.173) | (0.174) | (0.173) | (0.174) | (0.175) |
| $\Delta e_{f,t-1}$ | 0.037 | 0.041 | 0.041 | 0.040 | 0.046 | 0.047 |
| | (0.044) | (0.044) | (0.044) | (0.045) | (0.042) | (0.043) |
| $\Delta x_{t-1}^0$ | $0.022^{*}$ | $0.023^{*}$ | $0.024^{*}$ | $0.022^{*}$ | $0.023^{*}$ | $0.023^{*}$ |
| | (0.011) | (0.012) | (0.013) | (0.012) | (0.013) | (0.013) |
| $\Delta m_{t-1}$ | 0.013 | 0.046 | 0.039 | 0.009 | 0.014 | 0.009 |
| | (0.126) | (0.129) | (0.129) | (0.132) | (0.137) | (0.140) |
| $\Delta p_{t-1}$ | $-0.466^{**}$ | $-0.505^{***}$ | $-0.505^{***}$ | $-0.506^{**}$ | $-0.519^{***}$ | $-0.523^{***}$ |
| | (0.184) | (0.195) | (0.196) | (0.198) | (0.194) | (0.192) |
| $\Delta y_{t-1}$ | $-0.218^{**}$ | $-0.221^{**}$ | $-0.223^{**}$ | $-0.230^{**}$ | $-0.225^{**}$ | $-0.224^{**}$ |
| | (0.108) | (0.107) | (0.108) | (0.105) | (0.106) | (0.108) |
| $\Delta \bar{y}_{wt}$ | | $-0.520$ | $-0.595$ | $-0.708$ | $-0.619$ | $-0.664$ |
| | | (0.458) | (0.510) | (0.526) | (0.527) | (0.522) |
| $\Delta \overline{req}_{wt}$ | | | 0.015 | 0.010 | 0.021 | 0.003 |
| | | | (0.042) | (0.044) | (0.046) | (0.066) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.160$ | $-0.133$ | $-0.121$ |
| | | | | (0.175) | (0.174) | (0.174) |
| $\Delta \bar{r}_{wt}$ | | | | | $-6.160$ | $-6.499$ |
| | | | | | (4.596) | (4.779) |
| $grv_t$ | | | | | | $-0.060$ |
| | | | | | | (0.129) |
| Residual serial | 7.242 | 7.240 | 7.371 | 7.721 | 8.049 | 8.248 |
| correlation test | [0.124] | [0.124] | [0.118] | [0.102] | [0.090] | [0.083] |
| Adjusted $R^2$ | 0.126 | 0.124 | 0.117 | 0.117 | 0.126 | 0.120 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.26a: Quarterly estimates of the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{f,t}$ | $\Delta x_t^0$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $s_t$ | $0.311^{***}$ | 0.079 | $-0.033^{***}$ | 0.028 |
| | (0.078) | (0.120) | (0.012) | (0.024) |
| $s_{t-1}$ | $-0.241^{***}$ | $-0.280^{**}$ | $0.036^{***}$ | $-0.054^{*}$ |
| | (0.069) | (0.139) | (0.012) | (0.027) |
| $\Delta e_{f,t}$ | | 0.102 | $0.162^{***}$ | $-0.138^{***}$ |
| | | (0.185) | (0.027) | (0.040) |
| $\Delta x_t^0$ | | | $-0.004$ | $0.028^{*}$ |
| | | | (0.007) | (0.015) |
| $\Delta p_t$ | | | | $0.364^{**}$ |
| | | | | (0.168) |
| $\Delta y_{wt}$ | $-2.316$ | $7.910^{**}$ | $0.808^{***}$ | $-0.459$ |
| | (1.450) | (3.858) | (0.293) | (0.418) |
| $\Delta e_{f,t-1}$ | $0.326^{*}$ | $-0.394$ | $-0.006$ | 0.041 |
| | (0.171) | (0.278) | (0.027) | (0.043) |
| $\Delta x_{t-1}^0$ | 0.040 | $-0.067$ | $-0.002$ | $0.021^{*}$ |
| | (0.035) | (0.103) | (0.008) | (0.012) |
| $\Delta p_{t-1}$ | $-0.339$ | $-0.025$ | $0.477^{***}$ | $-0.482^{**}$ |
| | (0.603) | (0.790) | (0.102) | (0.191) |
| $\Delta y_{t-1}$ | $-0.133$ | 0.138 | 0.040 | $-0.223^{**}$ |
| | (0.222) | (0.613) | (0.038) | (0.106) |
| $\Delta p_{t-2}$ | | | $0.184^{***}$ | |
| | | | (0.070) | |
| Residual serial | 4.832 | 3.895 | 8.003 | 6.738 |
| correlation test | [0.305] | [0.420] | [0.091] | [0.150] |
| Adjusted $R^2$ | 0.219 | 0.091 | 0.668 | 0.152 |

**Notes**: The variables are ordered as: $\Delta e_{ft}$, $\Delta x_t^0$, $\Delta p_t$, and $\Delta y_t$, where: $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t$ is the quarterly sanctions intensity variable. Seasonal dummies are *not* included to allow for possible seasonality of the variables in the SVAR model. Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980), and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.26b: Quarterly estimates of the equation for exchange rate returns in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta e_{ft}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.303*** | 0.311*** | 0.307*** | 0.307*** | 0.307*** | 0.314*** |
| | (0.079) | (0.078) | (0.078) | (0.077) | (0.077) | (0.075) |
| $s_{t-1}$ | −0.231*** | −0.241*** | −0.238*** | −0.236*** | −0.235*** | −0.243*** |
| | (0.070) | (0.069) | (0.069) | (0.069) | (0.070) | (0.069) |
| $\Delta e_{f,t-1}$ | 0.329* | 0.326* | 0.323* | 0.317* | 0.314* | 0.312* |
| | (0.176) | (0.171) | (0.170) | (0.165) | (0.168) | (0.160) |
| $\Delta x^0_{t-1}$ | 0.035 | 0.040 | 0.043 | 0.047 | 0.046 | 0.041 |
| | (0.034) | (0.035) | (0.036) | (0.038) | (0.038) | (0.035) |
| $\Delta p_{t-1}$ | −0.284 | −0.339 | −0.330 | −0.298 | −0.288 | −0.388 |
| | (0.604) | (0.603) | (0.609) | (0.601) | (0.591) | (0.582) |
| $\Delta y_{t-1}$ | −0.121 | −0.133 | −0.140 | −0.120 | −0.122 | −0.118 |
| | (0.224) | (0.222) | (0.225) | (0.221) | (0.219) | (0.214) |
| $\Delta \bar{y}_{wt}$ | | −2.316 | −2.724* | −2.217 | −2.265 | −2.837* |
| | | (1.450) | (1.617) | (1.626) | (1.652) | (1.551) |
| $\Delta \overline{req}_{wt}$ | | | 0.076 | 0.088 | 0.082 | −0.110 |
| | | | (0.085) | (0.086) | (0.091) | (0.121) |
| $\Delta \bar{e}_{wt}$ | | | | 0.397 | 0.395 | 0.507 |
| | | | | (0.496) | (0.495) | (0.513) |
| $\Delta \bar{r}_{wt}$ | | | | | 3.363 | 0.477 |
| | | | | | (14.007) | (14.068) |
| $grv_t$ | | | | | | −0.619** |
| | | | | | | (0.308) |
| Residual serial | 5.198 | 4.832 | 4.686 | 5.847 | 5.717 | 4.179 |
| correlation test | [0.268] | [0.305] | [0.321] | [0.211] | [0.221] | [0.382] |
| Adjusted $R^2$ | 0.209 | 0.219 | 0.215 | 0.215 | 0.208 | 0.229 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.26c: Quarterly estimates of the equation for the oil exports variable in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.126 | 0.079 | 0.078 | 0.053 | 0.055 | 0.051 |
| | (0.136) | (0.120) | (0.120) | (0.120) | (0.118) | (0.123) |
| $s_{t-1}$ | $-0.330^{**}$ | $-0.280^{**}$ | $-0.280^{**}$ | $-0.274^{**}$ | $-0.257^{*}$ | $-0.253^{*}$ |
| | (0.151) | (0.139) | (0.141) | (0.131) | (0.131) | (0.133) |
| $\Delta e_{f,t}$ | 0.032 | 0.102 | 0.101 | 0.175 | 0.160 | 0.168 |
| | (0.188) | (0.185) | (0.183) | (0.179) | (0.166) | (0.172) |
| $\Delta e_{f,t-1}$ | −0.381 | −0.394 | −0.395 | −0.360 | −0.414 | −0.416 |
| | (0.265) | (0.278) | (0.278) | (0.273) | (0.257) | (0.257) |
| $\Delta x_{t-1}^0$ | −0.044 | −0.067 | −0.066 | −0.102 | −0.111 | −0.110 |
| | (0.096) | (0.103) | (0.105) | (0.106) | (0.108) | (0.108) |
| $\Delta p_{t-1}$ | −0.234 | −0.025 | −0.021 | −0.275 | −0.077 | −0.051 |
| | (0.780) | (0.790) | (0.798) | (0.822) | (0.835) | (0.834) |
| $\Delta y_{t-1}$ | 0.087 | 0.138 | 0.135 | −0.035 | −0.088 | −0.088 |
| | (0.597) | (0.613) | (0.620) | (0.553) | (0.547) | (0.549) |
| $\Delta \bar{y}_{wt}$ | | $7.910^{**}$ | $7.738^{**}$ | 3.419 | 2.430 | 2.585 |
| | | (3.858) | (3.669) | (2.931) | (3.009) | (2.982) |
| $\Delta \overline{req}_{wt}$ | | | 0.031 | −0.085 | −0.209 | −0.164 |
| | | | (0.283) | (0.234) | (0.233) | (0.307) |
| $\Delta \bar{e}_{wt}$ | | | | $-3.538^{***}$ | $-3.577^{***}$ | $-3.607^{***}$ |
| | | | | (0.995) | (0.964) | (1.000) |
| $\Delta \bar{r}_{wt}$ | | | | | $66.363^{***}$ | $67.024^{***}$ |
| | | | | | (24.414) | (24.980) |
| $grv_t$ | | | | | | 0.148 |
| | | | | | | (0.618) |
| Residual serial correlation test | 2.461 | 3.895 | 4.005 | 2.396 | 4.791 | 5.085 |
| | [0.652] | [0.420] | [0.405] | [0.663] | [0.309] | [0.279] |
| Adjusted $R^2$ | 0.061 | 0.091 | 0.083 | 0.180 | 0.222 | 0.215 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.26d: Quarterly estimates of the equation for inflation in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta p_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | $-0.029^{**}$ | $-0.033^{***}$ | $-0.032^{**}$ | $-0.032^{***}$ | $-0.032^{***}$ | $-0.031^{**}$ |
| | (0.013) | (0.012) | (0.013) | (0.012) | (0.012) | (0.013) |
| $s_{t-1}$ | $0.032^{***}$ | $0.036^{***}$ | $0.035^{***}$ | $0.034^{***}$ | $0.034^{***}$ | $0.033^{***}$ |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) |
| $\Delta e_{f,t}$ | $0.155^{***}$ | $0.162^{***}$ | $0.163^{***}$ | $0.166^{***}$ | $0.166^{***}$ | $0.164^{***}$ |
| | (0.028) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| $\Delta x_t^0$ | 0.0005 | $-0.004$ | $-0.003$ | $-0.007$ | $-0.007$ | $-0.007$ |
| | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) |
| $\Delta e_{f,t-1}$ | $-0.005$ | $-0.006$ | $-0.004$ | $-0.004$ | $-0.005$ | $-0.004$ |
| | (0.029) | (0.027) | (0.026) | (0.026) | (0.026) | (0.027) |
| $\Delta x_{t-1}^0$ | 0.001 | $-0.002$ | $-0.002$ | $-0.004$ | $-0.004$ | $-0.004$ |
| | (0.009) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| $\Delta p_{t-1}$ | $0.466^{***}$ | $0.477^{***}$ | $0.465^{***}$ | $0.454^{***}$ | $0.454^{***}$ | $0.450^{***}$ |
| | (0.107) | (0.102) | (0.101) | (0.100) | (0.101) | (0.103) |
| $\Delta y_{t-1}$ | 0.033 | 0.040 | 0.044 | 0.041 | 0.040 | 0.040 |
| | (0.039) | (0.038) | (0.039) | (0.038) | (0.039) | (0.039) |
| $\Delta p_{t-2}$ | $0.172^{**}$ | $0.184^{***}$ | $0.196^{***}$ | $0.201^{***}$ | $0.201^{***}$ | $0.199^{***}$ |
| | (0.073) | (0.070) | (0.072) | (0.073) | (0.073) | (0.073) |
| $\Delta \bar{y}_{wt}$ | | $0.808^{***}$ | $0.952^{***}$ | $0.854^{**}$ | $0.850^{**}$ | $0.815^{**}$ |
| | | (0.293) | (0.322) | (0.338) | (0.340) | (0.337) |
| $\Delta \overline{req}_{wt}$ | | | $-0.026$ | $-0.029$ | $-0.030$ | $-0.040$ |
| | | | (0.020) | (0.021) | (0.022) | (0.027) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.103$ | $-0.105$ | $-0.098$ |
| | | | | (0.080) | (0.082) | (0.083) |
| $\Delta \bar{r}_{wt}$ | | | | | 0.317 | 0.167 |
| | | | | | (2.317) | (2.313) |
| $grv_t$ | | | | | | $-0.032$ |
| | | | | | | (0.054) |
| Residual serial | 11.521 | 8.003 | 5.321 | 5.888 | 5.868 | 5.924 |
| correlation test | [0.021] | [0.091] | [0.256] | [0.208] | [0.209] | [0.205] |
| Adjusted $R^2$ | 0.647 | 0.668 | 0.669 | 0.671 | 0.668 | 0.666 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.26e: Quarterly estimates of the equation for output growth in the SVAR model of Iran with domestic variables ordered as: exchange rate returns, oil exports, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta y_t$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $s_t$ | 0.024 | 0.028 | 0.027 | 0.026 | 0.026 | 0.027 |
| | (0.023) | (0.024) | (0.024) | (0.023) | (0.023) | (0.023) |
| $s_{t-1}$ | $-0.050^{*}$ | $-0.054^{*}$ | $-0.053^{**}$ | $-0.054^{**}$ | $-0.054^{**}$ | $-0.055^{**}$ |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.026) | (0.027) |
| $\Delta e_{f,t}$ | $-0.128^{***}$ | $-0.138^{***}$ | $-0.140^{***}$ | $-0.134^{***}$ | $-0.134^{***}$ | $-0.137^{***}$ |
| | (0.039) | (0.040) | (0.040) | (0.039) | (0.039) | (0.039) |
| $\Delta x_t^0$ | $0.025^{*}$ | $0.028^{*}$ | $0.028^{*}$ | 0.023 | $0.028^{*}$ | $0.028^{*}$ |
| | (0.015) | (0.015) | (0.016) | (0.017) | (0.016) | (0.016) |
| $\Delta p_t$ | $0.328^{**}$ | $0.364^{**}$ | $0.371^{**}$ | $0.353^{**}$ | $0.355^{**}$ | $0.348^{**}$ |
| | (0.161) | (0.168) | (0.170) | (0.169) | (0.167) | (0.166) |
| $\Delta e_{f,t-1}$ | 0.038 | 0.041 | 0.041 | 0.040 | 0.047 | 0.047 |
| | (0.043) | (0.043) | (0.043) | (0.043) | (0.041) | (0.041) |
| $\Delta x_{t-1}^0$ | $0.019^{*}$ | $0.021^{*}$ | $0.022^{*}$ | 0.020 | $0.021^{*}$ | 0.021 |
| | (0.011) | (0.012) | (0.012) | (0.012) | (0.013) | (0.013) |
| $\Delta p_{t-1}$ | $-0.449^{**}$ | $-0.482^{**}$ | $-0.484^{**}$ | $-0.483^{**}$ | $-0.500^{***}$ | $-0.508^{***}$ |
| | (0.181) | (0.191) | (0.191) | (0.193) | (0.188) | (0.185) |
| $\Delta y_{t-1}$ | $-0.219^{**}$ | $-0.223^{**}$ | $-0.225^{**}$ | $-0.231^{**}$ | $-0.226^{**}$ | $-0.226^{**}$ |
| | (0.108) | (0.106) | (0.107) | (0.104) | (0.106) | (0.108) |
| $\Delta \bar{y}_{wt}$ | | $-0.459$ | $-0.595$ | $-0.715$ | $-0.645$ | $-0.710$ |
| | | (0.418) | (0.478) | (0.498) | (0.501) | (0.504) |
| $\Delta \overline{req}_{wt}$ | | | 0.024 | 0.019 | 0.031 | 0.011 |
| | | | (0.041) | (0.044) | (0.046) | (0.064) |
| $\Delta \bar{e}_{wt}$ | | | | $-0.139$ | $-0.117$ | $-0.103$ |
| | | | | (0.159) | (0.159) | (0.159) |
| $\Delta \bar{r}_{wt}$ | | | | | $-5.988$ | $-6.293$ |
| | | | | | (4.408) | (4.539) |
| $grv_t$ | | | | | | $-0.066$ |
| | | | | | | (0.117) |
| Residual serial | 7.054 | 6.738 | 6.977 | 7.483 | 7.876 | 8.205 |
| correlation test | [0.133] | [0.150] | [0.137] | [0.112] | [0.096] | [0.084] |
| Adjusted $R^2$ | 0.154 | 0.152 | 0.146 | 0.145 | 0.154 | 0.149 |

**Notes**: Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980). See the notes to Table S.9 for further details on the sources and construction of data used.

Table S.27: Estimates of the reduced form Iran's output growth equation using a sanctions dummy variable estimated over the period 1989q1- 2019q4

| | $\Delta y_t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $d_{t-1}(\beta_{d_{t-1}})$ | $-0.014^{**}$ | $-0.014^{**}$ | $-0.014^{**}$ | $-0.014^{**}$ | $-0.013^{*}$ | $-0.013^{*}$ | $-0.013^{*}$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| $\Delta y_{t-1}(\lambda_{\Delta y_{t-1}})$ | $-0.207^{*}$ | $-0.206^{*}$ | $-0.208^{*}$ | $-0.205^{*}$ | $-0.214^{*}$ | $-0.215^{*}$ | $-0.218^{*}$ |
| | (0.115) | (0.116) | (0.117) | (0.118) | (0.111) | (0.113) | (0.114) |
| $\Delta x^0_{t-1}$ | 0.017 | 0.016 | 0.017 | 0.018 | 0.016 | 0.015 | 0.016 |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) | (0.013) |
| $\Delta e_{f,t-1}$ | −0.013 | −0.013 | −0.013 | −0.010 | −0.007 | −0.008 | −0.009 |
| | (0.041) | (0.042) | (0.041) | (0.040) | (0.040) | (0.040) | (0.041) |
| $\Delta m_{t-1}$ | −0.042 | −0.048 | −0.053 | −0.046 | −0.066 | −0.071 | −0.078 |
| | (0.099) | (0.104) | (0.105) | (0.108) | (0.106) | (0.107) | (0.113) |
| $\Delta p_{t-1}$ | −0.214 | −0.212 | −0.209 | −0.222 | −0.245 | $-0.252^{*}$ | $-0.253^{*}$ |
| | (0.150) | (0.152) | (0.152) | (0.148) | (0.153) | (0.151) | (0.151) |
| $\Delta \bar{y}_{wt}$ | | 0.156 | 0.058 | 0.107 | −0.169 | −0.230 | −0.186 |
| | | (0.361) | (0.412) | (0.416) | (0.461) | (0.463) | (0.480) |
| $\Delta \overline{req}_{wt}$ | | | 0.019 | 0.026 | 0.019 | −0.0002 | −0.002 |
| | | | (0.041) | (0.042) | (0.045) | (0.063) | (0.064) |
| $\Delta \bar{r}_{wt}$ | | | | −4.060 | −3.838 | −4.120 | −3.154 |
| | | | | (4.476) | (4.405) | (4.525) | (4.976) |
| $\Delta \bar{e}_{wt}$ | | | | | −0.240 | −0.228 | −0.265 |
| | | | | | (0.159) | (0.161) | (0.178) |
| $grv_t$ | | | | | | −0.063 | −0.069 |
| | | | | | | (0.114) | (0.117) |
| $\Delta p^0_t$ | | | | | | | −0.012 |
| | | | | | | | (0.026) |
| $\beta_{d_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ | $-0.012^{**}$ | $-0.011^{**}$ | $-0.011^{**}$ | $-0.012^{**}$ | $-0.010^{*}$ | $-0.011^{*}$ | $-0.011^{*}$ |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.005) | (0.006) | (0.006) |
| Adjusted $R^2$ | 0.078 | 0.070 | 0.064 | 0.063 | 0.076 | 0.070 | 0.064 |

**Notes**: $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $d_t$ is the sanctions dummy variable. $\beta_{d_{t-1}}$ and $\lambda_{\Delta y_{t-1}}$ are the coefficients of $d_{t-1}$ and $\Delta y_{t-1}$, respectively; $\beta_{d_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ represents the long run effect of sanctions on output growth. See Chapter 6 of Pesaran (2015). Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980).

See the notes to Table S.9 for further details on the sources and construction of data used. Details on the construction of $d_t$ are provided in Section S.2.4.

Table S.28: Estimates of the reduced form Iran's output growth equation using a discretized sanctions intensity variable estimated over the period 1989q1- 2019q4

| | $\Delta y_t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $s^D_{t-1}(\beta_{s^D_{t-1}})$ | $-0.010^*$ | $-0.010^*$ | $-0.010^*$ | $-0.010^*$ | $-0.009$ | $-0.009$ | $-0.009$ |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| $\Delta y_{t-1}(\lambda_{\Delta y_{t-1}})$ | $-0.202^*$ | $-0.201^*$ | $-0.202^*$ | $-0.199^*$ | $-0.209^*$ | $-0.209^*$ | $-0.214^*$ |
| | (0.115) | (0.115) | (0.117) | (0.118) | (0.111) | (0.112) | (0.113) |
| $\Delta x^0_{t-1}$ | 0.015 | 0.015 | 0.016 | 0.016 | 0.014 | 0.014 | 0.015 |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) | (0.013) |
| $\Delta e_{f,t-1}$ | $-0.016$ | $-0.015$ | $-0.016$ | $-0.013$ | $-0.010$ | $-0.010$ | $-0.012$ |
| | (0.043) | (0.043) | (0.043) | (0.041) | (0.042) | (0.042) | (0.042) |
| $\Delta m_{t-1}$ | $-0.032$ | $-0.039$ | $-0.044$ | $-0.037$ | $-0.058$ | $-0.061$ | $-0.069$ |
| | (0.098) | (0.103) | (0.104) | (0.108) | (0.105) | (0.107) | (0.113) |
| $\Delta p_{t-1}$ | $-0.226$ | $-0.222$ | $-0.220$ | $-0.233$ | $-0.255^*$ | $-0.261^*$ | $-0.261^*$ |
| | (0.151) | (0.153) | (0.153) | (0.149) | (0.154) | (0.152) | (0.152) |
| $\Delta \bar{y}_{wt}$ | | 0.182 | 0.095 | 0.144 | $-0.138$ | $-0.169$ | $-0.119$ |
| | | (0.377) | (0.425) | (0.427) | (0.470) | (0.475) | (0.493) |
| $\Delta \overline{req}_{wt}$ | | | 0.017 | 0.024 | 0.017 | 0.006 | 0.004 |
| | | | (0.041) | (0.042) | (0.045) | (0.064) | (0.064) |
| $\Delta \bar{r}_{wt}$ | | | | $-3.935$ | $-3.722$ | $-3.875$ | $-2.730$ |
| | | | | (4.457) | (4.381) | (4.500) | (4.934) |
| $\Delta \bar{e}_{wt}$ | | | | | $-0.243$ | $-0.237$ | $-0.279$ |
| | | | | | (0.159) | (0.160) | (0.178) |
| $grv_t$ | | | | | | $-0.036$ | $-0.044$ |
| | | | | | | (0.113) | (0.115) |
| $\Delta p^0_t$ | | | | | | | $-0.014$ |
| | | | | | | | (0.026) |
| $\beta_{s^D_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ | $-0.008^*$ | $-0.008^*$ | $-0.008^*$ | $-0.008^*$ | $-0.007$ | $-0.007$ | $-0.008$ |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Adjusted $R^2$ | 0.074 | 0.067 | 0.060 | 0.059 | 0.072 | 0.064 | 0.059 |

**Notes**: $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s^D_t$ is the discretized sanctions intensity variable. $\beta_{s^D_{t-1}}$ and $\lambda_{\Delta y_{t-1}}$ are the coefficients of $s^D_{t-1}$ and $\Delta y_{t-1}$, respectively; $\beta_{s^D_{t-1}}/(1-\lambda_{\Delta y_{t-1}})$ represents the long run effect of sanctions on output growth. See Chapter 6 of Pesaran (2015). Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980).
See the notes to Table S.9 for further details on the sources and construction of data used. Details on the construction of $s^D_t$ are provided in Section S.2.4.

Table S.29: Quarterly estimates of the SVAR model of Iran using a sanctions dummy variable and with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ | $\Delta e_{f,t}$ | $\Delta m_t$ | $\Delta p_t$ | $\Delta y_t$ |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $d_t$ | $0.290^{***}$ | 0.079 | 0.004 | 0.001 | $-0.014$ |
| | (0.096) | (0.078) | (0.007) | (0.018) | (0.016) |
| $d_{t-1}$ | $-0.357^{***}$ | $-0.040$ | $-0.002$ | 0.00002 | 0.003 |
| | (0.095) | (0.078) | (0.007) | (0.017) | (0.017) |
| $\Delta x_t^0$ | | 0.037 | 0.004 | $-0.005$ | $0.030^{*}$ |
| | | (0.046) | (0.008) | (0.008) | (0.017) |
| $\Delta e_{f,t}$ | | | $-0.010$ | $0.144^{***}$ | $-0.104^{***}$ |
| | | | (0.016) | (0.029) | (0.040) |
| $\Delta m_t$ | | | | $-0.061$ | 0.033 |
| | | | | (0.073) | (0.126) |
| $\Delta p_t$ | | | | | $0.298^{*}$ |
| | | | | | (0.174) |
| $\Delta y_{wt}$ | $7.813^{**}$ | $-1.600$ | 0.229 | $0.758^{**}$ | $-0.390$ |
| | (3.961) | (1.296) | (0.397) | (0.310) | (0.426) |
| $\Delta x_{t-1}^0$ | $-0.043$ | 0.043 | $-0.006$ | $-0.002$ | $0.022^{*}$ |
| | (0.104) | (0.037) | (0.007) | (0.008) | (0.012) |
| $\Delta e_{f,t-1}$ | $-0.556^{**}$ | 0.298 | $-0.019$ | 0.007 | 0.023 |
| | (0.220) | (0.185) | (0.022) | (0.026) | (0.046) |
| $\Delta m_{t-1}$ | $-0.542$ | $-0.019$ | 0.232 | $-0.002$ | 0.006 |
| | (0.732) | (0.294) | (0.148) | (0.073) | (0.124) |
| $\Delta p_{t-1}$ | 0.248 | $-0.302$ | $0.159^{*}$ | $0.441^{***}$ | $-0.418^{**}$ |
| | (0.691) | (0.701) | (0.087) | (0.109) | (0.206) |
| $\Delta y_{t-1}$ | 0.193 | $-0.144$ | 0.024 | 0.049 | $-0.227^{**}$ |
| | (0.622) | (0.249) | (0.051) | (0.040) | (0.107) |
| $\Delta p_{t-2}$ | | | $-0.060$ | $0.221^{***}$ | |
| | | | (0.071) | (0.073) | |
| Residual serial | 1.889 | 5.847 | 7.734 | 5.096 | 6.274 |
| correlation test | [0.756] | [0.211] | [0.102] | [0.278] | [0.180] |
| Adjusted $R^2$ | 0.160 | 0.083 | 0.460 | 0.633 | 0.101 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $d_t$ is the sanctions dummy variable. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t\right)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980), and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used. Details on the construction of $d_t$ are provided in Section S.2.4.

Table S.30: Quarterly estimates of the SVAR model of Iran using a discretized sanctions intensity variable and with domestic variables ordered as: oil exports, exchange rate returns, money supply growth, inflation, and output growth, estimated over the period 1989q1-2019q4

| | $\Delta x_t^0$ (1) | $\Delta e_{f,t}$ (2) | $\Delta m_t$ (3) | $\Delta p_t$ (4) | $\Delta y_t$ (5) |
|---|---|---|---|---|---|
| $s_t^D$ | 0.124** | 0.073 | 0.006 | −0.011 | 0.013 |
| | (0.059) | (0.066) | (0.005) | (0.011) | (0.010) |
| $s_{t-1}^D$ | −0.200*** | −0.060 | −0.002 | 0.014 | −0.021** |
| | (0.060) | (0.067) | (0.005) | (0.012) | (0.010) |
| $\Delta x_t^0$ | | 0.034 | 0.005 | −0.003 | 0.025 |
| | | (0.044) | (0.007) | (0.008) | (0.017) |
| $\Delta e_{f,t}$ | | | −0.011 | 0.148*** | −0.121*** |
| | | | (0.015) | (0.027) | (0.041) |
| $\Delta m_t$ | | | | −0.059 | 0.034 |
| | | | | (0.074) | (0.127) |
| $\Delta p_t$ | | | | | 0.338* |
| | | | | | (0.175) |
| $\Delta y_{wt}$ | 7.778** | −1.903 | 0.238 | 0.793** | −0.443 |
| | (3.887) | (1.459) | (0.389) | (0.311) | (0.440) |
| $\Delta x_{t-1}^0$ | −0.075 | 0.035 | −0.005 | −0.0003 | 0.021* |
| | (0.108) | (0.035) | (0.008) | (0.008) | (0.012) |
| $\Delta e_{f,t-1}$ | −0.536*** | 0.311* | −0.019 | 0.008 | 0.019 |
| | (0.190) | (0.189) | (0.022) | (0.025) | (0.046) |
| $\Delta m_{t-1}$ | −0.565 | −0.015 | 0.225 | −0.020 | 0.045 |
| | (0.751) | (0.302) | (0.146) | (0.073) | (0.127) |
| $\Delta p_{t-1}$ | 0.109 | −0.302 | 0.151* | 0.453*** | −0.461** |
| | (0.636) | (0.713) | (0.088) | (0.105) | (0.200) |
| $\Delta y_{t-1}$ | 0.120 | −0.187 | 0.027 | 0.046 | −0.216** |
| | (0.607) | (0.245) | (0.051) | (0.040) | (0.106) |
| $\Delta p_{t-2}$ | | | −0.062 | 0.213*** | |
| | | | (0.073) | (0.075) | |
| Residual serial | 2.613 | 2.834 | 7.270 | 6.829 | 5.194 |
| correlation test | [0.625] | [0.586] | [0.122] | [0.145] | [0.268] |
| Adjusted $R^2$ | 0.143 | 0.072 | 0.463 | 0.644 | 0.107 |

**Notes**: The variables are ordered as: $\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t$, and $\Delta y_t$, where: $\Delta x_t^0 = (X_t^0 - X_{t-1}^0)/X_{t-1}^0$, $X_t^0$ is the oil exports revenues in U.S. dollars; $\Delta e_{ft} = \ln(E_{ft}/E_{f,t-1})$, $E_{ft}$ is the quarterly rial/U.S. dollar free market exchange rate; $\Delta m_t = (M_{2t} - M_{2,t-1})/M_{2,t-1}$, $M_{2t}$ is the monetary aggregate $M2$ obtained by summing the aggregates $M1$ and "quasi-money"; $\Delta p_t = \ln(P_t/P_{t-1})$, $P_t$ is the quarterly consumer price index of Iran; $\Delta y_t = \ln(Y_t/Y_{t-1})$, $Y_t$ is the quarterly real output of Iran. $s_t^D$ is the discretized sanctions intensity variable. Seasonal dummies are included to allow for possible seasonality of the variables in the regressions of the SVAR model in Equation (6) with $\mathbf{q}_t = \left(\Delta x_t^0, \Delta e_{ft}, \Delta m_t, \Delta p_t, \Delta y_t\right)'$ and $\bar{\mathbf{z}}_{wt} = (\Delta \bar{y}_{wt})'$. Numbers in parentheses are heteroskedastic-consistent standard errors obtained following the approach of White (1980), and those in square brackets are p-values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "Residual serial correlation test" is the Breusch–Godfrey LM test of serially uncorrelated errors with lag order of the test set to 4.
See the notes to Table S.9 for further details on the sources and construction of data used. Details on the construction of $s_t^D$ are provided in Section S.2.4.

Table S.31: Chronology of major sanctions events against Iran over the period from November 1979 to January 2021

| **Date** | **Event** | **Diplomatic measures** | **Direction** | **Sanctioning entity** | **Additional notes** |
|---|---|---|---|---|---|
| Nov. 12, 1979 | "Tehran hostage crisis" | Oil embargo | On | U.S.A. | Proclamation 4702(1979) by U.S. President Carter |
| Nov. 14, 1979 | "Tehran hostage crisis" | Asset freeze of all Iranian government and Central Bank of Iran properties within U.S. jurisdiction | On | U.S.A. | U.S. Executive Order 12170 |
| Apr. 7, 1980 | "Tehran hostage crisis" | Sale and transportation of all goods to Iran forbidden. No credit and loans to Iran allowed | On | U.S.A. | U.S. Executive Order 12205 |
| Apr. 17, 1980 | "Tehran hostage crisis" | Ban on all imports from Iran. U.S. citizens prevented from traveling to Iran or conducting financial transactions in Iran | On | U.S.A. | U.S. Executive Order 12211 |
| Jan. 19, 1981 | Hostages release | Revocation of prohibitions against transactions involving Iran | Off | U.S.A. | U.S. Executive Order 12282 |
| Jan. 19, 1984 | 1983 U.S. embassy bombing in Beirut | Ineligibility for various forms of U.S. foreign assistance. Arms embargo. Imposition of miscellaneous financial restrictions | On | U.S.A. | "State Sponsor of Terror" designation |
| Oct. 29, 1987 | Support of international terrorism | No goods or services of Iranian origin allowed to be imported into the U.S.. Iranian oil refined in third countries allowed | On | U.S.A. | U.S. Executive Order 12613 |
| Oct. 23, 1992 | Iran-Iraq Arms Non-Proliferation Act | Measures to prevent transfer of goods or technology to Iraq or Iran to avoid acquisition of Weapons of Mass Destruction (WMD) | On | U.S.A. | U.S. Public Law 102-484 |
| Nov. 14, 1994 | Nuclear threat | Controls and restrictions on goods related to WMD technology | On | U.S.A. | U.S. Executive Order 12938 |
| Mar. 15, 1995 | Threat to national security | Ban U.S. investment in Iran's energy sector | On | U.S.A. | U.S. Executive Order 12957 |
| May 6, 1995 | Threat to national security | More comprehensive investment, trade, and financial restrictions | On | U.S.A. | U.S. Executive Order 12959 |
| Aug. 5, 1996 | Iran and Libya Sanctions Act (ILSA) | Two economic and/or financial sanctions (out of a list of 6) on U.S. and non-U.S. companies providing investments over $40 million in petroleum resources in Iran | On | U.S.A. | U.S. Public Law 104 - 172 |
| Nov. 22, 1996 | "Blocking regulation" following the U.S. ILSA | E.U. single member states encouraged to impose sanctions in compliance with the ILSA of 1996 | On | E.U. | Council Regulation 2271/96 |
| Aug. 19, 1997 | Nuclear threat | Trade sanctions previously in place largely expanded in scope | On | U.S.A. | U.S. Executive Order 13059 |

Table S.31: Chronology of major sanctions events against Iran over the period from November 1979 to January 2021

| Date | Event | Diplomatic measures | Direction | Sanctioning entity | Additional notes |
|---|---|---|---|---|---|
| Mar. 14, 2000 | Iran Nonproliferation Act | The President authorized to act against individuals or organizations known to provide material aid to WMD | On | U.S.A. | U.S. Public Law 106 -178 |
| Aug. 3, 2001 | ILSA Extension Act of 2001 | ILSA Renewed for 5 years. Extends the scope of previous sanctions. Max investments allowed from 40$to$20 millions | On | U.S.A. | U.S. Public Law 107-24 |
| Sep. 23, 2001 | Twin Towers attacks in New York City | Blocking property and prohibiting transactions with persons committing or supporting terrorism. Iranians marginally involved | On | U.S.A. | U.S. Executive Order 13224 |
| June 29, 2005 | Nuclear threat | Assets freeze of individual connected to Iran WMD proliferation and their supporters | On | U.S.A. | U.S. Executive Order 13382 |
| July 31, 2006 | Nuclear threat | Prohibits the transfer of any materials that could contribute to Iran's nuclear and ballistic missile programmes | On | U.N. | United Nations Security Council Resolution 1696 |
| Aug. 4, 2006 | ILSA Extension | The U.S. further extend ILSA until Sep. 29, 2006 | On | U.S.A. | U.S. Public Law 109-267 |
| Sep. 30, 2006 | Iran Freedom and Support Act (IFSA) | Secondary sanctions imposed. Oil-related investments banned. Support to "pro-democracy" groups opposed to Iran. | On | U.S.A. | U.S. Public Law 109-293 |
| Dec. 23, 2006 | Nuclear threat | Trade embargo on nuclear-related goods and technologies. Ban of financial support for nuclear projects. Assets freeze | On | U.S.A. | United Nations Security Council Resolution 1737 |
| Feb. 27, 2007 | Nuclear threat | Ban on export of nuclear technology, and financial assistance related to nuclear activities. Assets freeze and travel restrictions | On | E.U. | Council Common Position 2007/140/CFSP |
| Mar. 24, 2007 | Nuclear threat | Sanctions strengthened on individuals and arms related to the development of WMD | On | U.N. | United Nations Security Council Resolution 1747 |
| July 17, 2007 | Iraq War. Measures to increase isolation of Iraq | Assets freeze of people connected to Iraq War. Iranians marginally hit | On | U.S.A. | U.S. Executive Order 13438 |
| Mar. 3, 2008 | Nuclear threat | Ban on WMD technology transfers, financial restrictions, call to monitor Iranian institutions and individuals | On | U.N. | United Nations Security Council Resolution 1803 |
| Sep. 27, 2008 | Ongoing uranium-enrichment programs reported by IAEA | Re-affirm previous sanctions | On | U.N. | United Nations Security Council Resolution 1835 |
| June 9, 2010 | Nuclear threat | Restrictions related to ballistic programs and WMD technologies. Prohibits new banking relations | On | U.N. | United Nations Security Council Resolution 1929 |

Table S.31: Chronology of major sanctions events against Iran over the period from November 1979 to January 2021

| Date | Event | Diplomatic measures | Direction | Sanctioning entity | Additional notes |
|---|---|---|---|---|---|
| July 1, 2010 | Comprehensive Iran Sanctions, Accountability, and Divestment Act (CISADA) | Scope of previous sanctions expanded. Curb on import/export of petroleum. Extented FX, banking, and property transactions | On | U.S.A. | U.S. Public Law 111-195 |
| July 22, 2010 | Nuclear threat | Extra sanctions imposed by Canada (on top of the U.N. ones) under the "Special Economic Measures Act" – SEMA | On | CAN | SOR/2010 - 165 |
| July 26, 2010 | Nuclear threat | U.N. 1929(2010) resolution embedded in the E.U. framework. Additional economic, banking and financial restrictions imposed | On | E.U. | Council Decision 2010/413/CFSP |
| Sep. 28, 2010 | Human rights violations | Assets freeze and limits to transfers and donations | On | U.S.A. | U.S. Executive Order 13553 |
| Apr. 12, 2011 | Human rights violation | Travel restrictions and assets freeze of people related to human rights violations | On | E.U. | Council Decision 2011/235/CFSP |
| Apr. 29, 2011 | Human rights violation | Assets freeze of persons and entities involved with abuses. Donations prohibited | On | U.S.A. | U.S. Executive Order 13572 |
| May 23, 2011 | Nuclear threat | Enhanced sanctions from Iran Sanctions Act (ISA). No credit, no FX, property block from U.S. financial institutions, imports ban | On | U.S.A. | U.S. Executive Order 13574 |
| June 9, 2011 | Nuclear threat | Extended mandate of the "panel of experts" that supports the Iran Sanctions Committee for one year. | On | U.N. | U.N. Security Council Resolution 1984 |
| Nov. 20, 2011 | Threat to national security | Sanctions on entities and individuals helping the Iran’s energy and petrochemical sectors maintenance and expansion | On | U.S.A. | U.S. Executive Order 13590 |
| Dec. 31, 2011 | National Defence Authorization Act | Sanctions against banks dealing with Iranian financial institutions, Bank Markazi included. Restricted export of Iranian oil. | On | U.S.A. | U.S. NDAA 2012 - Sec. 1245 |
| Jan. 23, 2012 | Nuclear threat | Oil embargo, assets freeze of Central Bank of Iran (CBI). Embargo on gold, precious metals | On | E.U. | Council Decision 2012/35/CFSP |
| Feb. 5, 2012 | Anti-money laundering malpractice | Blocking property of the Government of Iran and Iranian financial institutions, Bank Markazi included | On | U.S.A. | U.S. Executive Order 13599 |
| Mar. 15, 2012 | Nuclear threat | Decision 2010/413/CFSP expanded with new but marginal financial restrictions | On | E.U. | Council Decision 2012/152/CFSP |

Table S.31: Chronology of major sanctions events against Iran over the period from November 1979 to January 2021

| Date | Event | Diplomatic measures | Direction | Sanctioning entity | Additional notes |
|---|---|---|---|---|---|
| Mar. 23, 2012 | Nuclear threat | Wide expansion of scope of import/export restrictions and banking and financial sanctions | On | E.U. | Council Regulation No. 267/2012 |
| Apr. 22, 2012 | Human right violations | Assets freeze of companies providing technology for human rights abuses. Donations prohibited to blocked entities and persons | On | U.S.A. | U.S. Executive Order 13606 |
| May 1, 2012 | Measures against sanctions evaders | Extra sanctions for entities and persons found to evade previously issued sanctions against Iran | On | U.S.A. | U.S. Executive Order 13608 |
| June 7, 2012 | Nuclear threat | Renewed the mandate of the Committee’s Panel of Experts to monitor Iran for 13 months | On | U.N. | U.N. Security Council Resolution 2049 |
| July 30, 2012 | Threat to national security | Sanctions on foreign institutions involved in deals with Iran’s energy and petrochemical sectors products. | On | U.S.A. | U.S. Executive Order 13622 |
| Aug. 10, 2012 | Iran Threat Reduction and Syria Human Rights Act | New multilateral sanctions on entities facilitating Iranian transactions (oil sector mostly); amends the ISA of 1996 | On | U.S.A. | U.S. Public Law 112-158 |
| Oct. 9, 2012 | Threat to national security | Expansion of assets freeze and financial restrictions | On | U.S.A. | U.S. Executive Order 13628 |
| Oct. 15, 2012 | Nuclear threat | Ban on trade and financial assistance to buy natural gas, a range of manufacturing and software products for ballistic missiles, and ship-building | On | E.U. | Council Decision 2012/635/CFSP |
| Jan. 2, 2013 | U.S. National Defense Authorization Act | Broad range of economic and financial sanctions expanded | On | U.S.A. | U.S. Public Law 112-239 |
| June 3, 2013 | Nuclear threat | Financial restrictions and assets freeze on foreign institutions doing business in rials or in automotive industry, among others | On | U.S.A. | U.S. Executive Order 13645 |
| July 20, 2015 | Joint Comprehensive Plan Of Action (JCPOA) | Agreement to schedule suspension and lift of U.N. sanctions | Off | U.N. | U.N. Security Council Resolution 2231 |
| Oct. 18, 2015 | JCPOA | E.U. intermediate steps towards application of JCPOA | Off | E.U. | Council Decision 2015/1863/CFSP |
| Jan. 16, 2016 | JCPOA | Implementiation day: The E.U., U.S., and U.N. suspend or terminate nuclear-related sanctions. A process of recovery of Iran’s assets for about $100 billions begins (never fully implemented) | Off | U.N. | U.N. Security Council Resolution 2231 implementiation |
| Jan. 17, 2016 | SWIFT re-activation | Iranian banks access to the SWIFT system. U.S. banks remain prohibited from doing business with Iran directly or indirectly | Off | World | SWIFT press release: "Update: Iran Sanctions Agreement" – Jan. 17th, 2016 |

Table S.31: Chronology of major sanctions events against Iran over the period from November 1979 to January 2021

| Date | Event | Diplomatic measures | Direction | Sanctioning entity | Additional notes |
|---|---|---|---|---|---|
| Dec. 1, 2016 | U.S. renews ISA for 10 years | U.S. renew the sanctions going on since 1996 on Iran | On | U.S.A. | U.S. Congress Issue H.R. 6297, Vote n. 155 |
| May 8, 2018 | JCPOA reduction of scope | U.S. announcement of withdrawal from JCPOA | On | U.S.A. | See Wikipedia page on "United States withdrawal from the Joint Comprehensive Plan of Action" |
| Aug. 6, 2018 | U.S. "maximum pressure" | Re-impose all sanctions lifted or waived by JCPOA | On | U.S.A | U.S. Executive Order 13846 |
| Nov. 5, 2018 | U.S. "maximum pressure" | Largest ever single-day action targeting the Iranian regime. More than 700 individuals, entities, aircrafts and vessels hit | On | U.S.A. | U.S. Treasury Statement 541 of Nov. 5 2018 |
| Nov. 9, 2018 | Financial system stability and integrity protection | SWIFT restrictions | On | U.S.A. | www.swift.com/about-us/legal/compliance-0/swift-and-sanctions |
| May 8, 2019 | Threat to national security | Sanctions on iron, steel, aluminum, and copper sectors of Iran | On | U.S.A. | U.S. Executive Order 13871 |
| June 24, 2019 | Support of terrorist militias in the Middle East | Further assets freeze, secondary sanctions on financial institutions | On | U.S.A. | U.S. Executive Order 13876 |
| Jan. 10, 2020 | Support of terrorist militias in the Middle East | Assets freeze related to entities and individuals trading in the manufacturing sector, among others. Restrictions on immigrants | On | U.S.A. | U.S. Executive Order 13902 |
| Sep. 21, 2020 | Threat to national security | Sanctions related to the trade and financially support arms trade | On | U.S.A. | U.S. Executive Order 13949 |
| Oct. 8, 2020 | JCPOA withdrawal | 18 Iranian banks hit by further sanctions | On | U.S.A. | U.S. Treasury Statement 1147 of Oct. 8 2020 |
| Dec. 16, 2020 - Jan. 5, 2021 | Support of "destabilizing activities" in the Middle East | Sanctions on companies supporting: metal, steel, petroleum and petrochemical sectors | On | U.S.A. | U.S. Treasury Statements 1214, and 1226 |
| Jan. 13, 2021 | Entities designated pursuant to Executive Order 13876, | Sanctions on two organizations controlled by the Supreme Leader | On | U.S.A. | U.S. Treasury Statement 1234 of Jan. 13, 2021 |

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