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INTERNATIONAL ECONOMIC SANCTIONS: MULTIPURPOSE INDEX MODELING IN THE UKRAINIAN CRISIS CASE

Introduction

International economic sanctions are a common tool used by governments in order to assert their diplomatic will. Who has never heard of sanctions against such-or-such country, in the context of this or that diplomatic crisis? At the time of writing, it is easy to find several examples of these coercive measures. Iran since its nuclear program became public. Cuba even if sanctions have been recently lightened. Venezuela regarding the "*Government of Venezuela's erosion of human rights guarantees, persecution of political opponents, curtailment of press freedoms, use of violence and human rights violations,* […]" as stated in the Executive Order 13692[1]. Russia on the basis of events resulting from the Ukrainian Crisis, and so on. Yet, are they working? And even if they do, are they efficient? Are there externalities –positive or negative- induced by their implementation? These questions cannot find reliable answers without a strong quantitative analysis. The econometric tool is a must, in hopes of measuring sanctions' effects.

A reasonable number of economists have been studying these punitive measures since the 70s. From Doxey (1971), to Hufbauer et al. (1990), or Pape (1997, 1998), a significant amount of work has been done. Although authors regularly disagree[2] on terms and definitions, most of them agree on the fact that sanctions do not work. Moreover, these coercive measures often have unpredictable effects that are, paradoxically, in the very interest of targeted countries. However, econometric models used in the studying of sanctions aren't numerous. Most of the time, economists use gravity models. This tool is interesting as it allows us to appreciate changes in trade due to sanctions. To do so, diplomatic measures are modeled through a dummy variable equal to 0 if there aren't sanctions, and to 1 if sanctions are implemented. Then, historical data without sanctions are compared to data with sanctions. This method reveals all changes that happened after the arrival of sanctions. But it doesn't allow us to isolate variations that are only due to sanctions. Rose et al. (2001), Clyde et al. (2003), Caruso (2003), or Askari et al. (2003) — to mention a few-, have all used Gravity models in their papers.

Notwithstanding the interest of Gravity models, another kind of model seems to be more appropriate in the study of sanctions. Vector Autoregressive models (SVAR, TAR, STAR, SETAR, etc.), provide a brand-new way of seeing things. They allow us to measure the variation of one variable due to its past value, or to the past value of another factor. In other words, we are now able to isolate the economic impact of sanctions from other causes (inflation, oil price, and so on). This being said, it

[1] U. S. Department of The Treasury, March 8, 2015.https://www.treasury.gov/resource-center/sanctions/Programs/Documents/13692.pdf

[2] George et al. (1971) have updated Doxey's definition (1971), Pape (1997) have vehemently argued the findings of Hufbauer et al. (1990), et cetera.

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is important to bear in mind that this kind of model requires a proper sanctions modeling. It means that we must, first of all, be able to transform these punitive diplomatic measures into algorithm. Secondly, it also means that our results robustness and reliability will mostly depend on sanctions algorithm. If it doesn't reflect the economic reality stemmed from these measures, the model will probably lead to biased results. Knowing that, we can easily understand that our best efforts must be put toward sanctions modeling.

To our best knowledge, Dreger et al. (2015) were the first who used a Vector autoregressive model to study sanctions. In their paper, they tried to find if the Russian ruble collapse was mainly due to sanctions or to the decline in oil prices. In order to answer this question, they ran a model in which these punitive measures were integrated. They succeed in building a "Sanction Index" simulating the economic impact of diplomatic measures implemented during the Ukrainian Crisis. One year later this index was updated by Kholodilin and Netšunajev (2016). However, their index requires serious modifications in order to give a faithful and clear picture of reality. This paper is dedicated to the conception of a new sanction index. It will not only be more robust or reliable to simulate sanctions in the Ukrainian Crisis case, but it will also be a multipurpose index, with a general shape that can be adapted to any case study. To that end, the first part of this paper will be dedicated to the mathematical formalization of our index. The second part will then use this formalization in the context of the Ukrainian Crisis case, in order to demonstrate changes brought by our new index.

Mathematical Formalization

This part focuses on describing the previous sanction index from Dreger et al. (2015), and our new sanction index. Our goal is to have a better understanding of their differences, in order to assess the advantages of one versus the other.

Previous Composite Index

Dreger *et al.* (2015) have established a sanction index for the Ukrainian crisis case. This index has been expanded by Kholodilin and Netsunajev (2016). This composite index is the aggregation of dummy variables over time. The dummy can be equal to 1, 2 or 3, depending on the sanction type. Then, the dummy's value is weighted by the issuing country's share in the target's foreign trade, see fig. 1. This index is far from perfect, but it is the first to illustrate sanctions within the framework of vector autoregressive models (to our best knowledge). However, although it simulates rather well the arrival of international punitive measures, we can see that its value either grows over incoming new sanctions, or stagnates if nothing is happening. It never decreases over time. This implies that the economic impact of diplomatic measures — that is the economic pressure applied on their target — is sustainable and invariable.

A sanction applied in September 2014 will impose at least — if not more — the same pressure in September 2015, September 2016, and so on. Obviously, one doesn't have to be a sanction expert to understand that this postulate does not reflect reality. In addition, this index doesn't treat sanctions independently of each other. A bonus or a penalty cannot be applied to one sanction without affecting another. *In fine*, it is also impossible to know which measure cost more to a country (e.g. what is the most effective between American and European sanction regimes?). For these reasons, we aim to create a new index that is able to simulate effects of coercive measures more faithfully.

New Composite Index

Our index is also the aggregation of sanctions over time. Yet, we have decided to handle sanctions independently from each other. Each sanction has its own identity, allowing us to specify its own parameters. Our sanction index is defined as:

$$S_{t,k} = \sum_i S_{t,k,i}, \tag{1}$$

With ***s*** a sanction of identity ***i***, imposed by a country ***k*** in period ***t***. By doing so, if one sanction varies, or, if the economic pressure inflicted by the sanction changes, other sanctions won't be affected. However, parameters defining a sanction identity are many, and authors had to focus on the more viable and workable ones.

Sanction Type

The first parameter that can be specified in order to define a sanction's identity is the sanction type. Is the coercive measure against an individual? A company? An entire economic sector? *Et cetera*. The idea behind this is that economic pressure applied by diplomatic measures depends on the sanction type. Indeed, a sanction targeting individuals will not have the same economic consequences as one concerning a whole economic sector. This being said, measuring the degree of economic pressure applied by this or that type of sanction on a case-by-case basis is a long and difficult task — if not impossible. Moreover, there is no guarantee that the outcomes of such a research would drastically change the model's results. This is why it has been decided to use a heuristic to simulate the economic pressure inflicted, depending on the sanction's type. Thus, the sanction type parameter can be written as:

$$\alpha_{t,k,i}, \tag{2}$$

where $\alpha_{t,k,i}$ is a constant for which the value depends on the type of sanction, see table 1. Authors are perfectly aware that this manner is not optimal, and all values can be modified upon request, in order to fit other studies.

Table 1

Values of the "Sanction Type" parameter

α Value	Description
0	Absence of sanctions
1	Sanction against an individual
10	Official announcement of sanctions
100	Sanction against a company
1,000	Sanction against an economic sector
3,000	Embargo

$$E = \{0,1,10,100,1000,3000\}$$

$$\{\alpha_{t,k,i} \mid E(\alpha_{t,k,i})\}$$

The Economic Leverage

The second parameter is the economic leverage, which describes the ability of the sanction sender to apply economic pressure on its target. To assess this ability, two main components are considered. Firstly, the trade intensity between the sanction sender and its target:

$$A_{t,k,j} = \frac{T_{t,k,j}}{T_{t,j}}, \tag{3}$$

with $T_{t,k,j}$ the total exports of *j* to *k*, and $T_{t,j}$ country *j* total foreign trade. Here we consider that exports are beneficial to the considered economy, while imports are a burden. For this reason, only exports are accounted in $A_{t,k,j}$. Yet, it is also possible in some specific cases to see imports as vital resources for the country, since it might not be able to obtain by itself these goods. If so, $T_{t,k,j}$ could be the total exports and imports of *j* to *k*.

Therefore, $A_{t,k,j}$ defines the fact that if the sanction sender (*k*) and the target (*j*) do not trade with each other, it is highly unlikely that any punitive economic measures will be effective and $T_{t,k,j} \to 0^+$. On the contrary, if players have a strong trade relationship and $A_{t,k,j} \to 1$, sanctions will have the wherewithal to exert economic pressure. Secondly, the weighting of foreign trade in the target's economy:

$$B_{t,j} = \frac{T_{t,j}}{Y_{t,j}} \tag{4}$$

with $Y_{t,j}$ the GDP of country *j*. This component witnesses the fact that even if players do have a strong economic relationship (i.e. $A_{t,k,j} \to 1$), sanctions might remain poorly effective if target's foreign trade accounts for a very small share of its economy ($B_{t,j} \to 0^+$). Oppositely, if the under-sanction country's economy highly depends on foreign trade ($B_{t,j} \to 1$), coercive measures have good prospects of success. After all, the economic leverage can be defined as:

$$\beta_{t,k,j,i} = A_{t,k,j} \cdot B_{t,j}. \tag{5}$$

Thus, for the economic leverage to be fully effective ($\beta_{t,k,j,I} \to 1$), players must be in a strong trade relationship ($A_{t,k,j} \to 1$), and the target's economy must be highly dependent on foreign trade ($B_{t,j} \to 1$). Finally, the last important point to consider is that trade relationship integrated in equations (4) and (5) should focus on economic sectors under sanctions. Indeed, if players mostly trade goods that aren't targeted by sanctions, coercive measures won't be able to apply such a great economic pressure.

Time Factor

The third and last parameter gathers unconsidered factors that have a negative effect on the economic pressure applied by punitive measures. It witnesses the effect of time on the economic pressure induced by a sanction. Thus, it reflects the fact that a penalty issued in $\boldsymbol{t}$ will not have similar economic effects in $\boldsymbol{t+1}$ or in $\boldsymbol{t+20}$, for example. In other words, it is the required time for an economy to adjust to sanctions. This parameter is written as:

$$\chi_{k,i,u} = \left(1 - \frac{u_{k,i}}{U_{k,i}}\right)^{o_{k,i}}, \tag{6}$$

where, $\boldsymbol{k}$ and $\boldsymbol{i}$ remain as defined before, but with $\boldsymbol{u}$ representing an instant from a different timeline than $\boldsymbol{t}$. Indeed, while $\boldsymbol{t}$ is defined depending on the series' timeline (expressed in months, quarters, and so on), $\boldsymbol{u}$ is expressed in periods ($\boldsymbol{u} \in \mathbb{R}$) and depends on the sanction's issuing date. Meaning that $\boldsymbol{u}$ can perfectly evolve independently from $\boldsymbol{t}$. $\boldsymbol{U}$ is the ending date of the considered sanction $\boldsymbol{i}$. Finally, $\boldsymbol{o}$k,i defines the slope of $\boldsymbol{\chi}_{k,i,u}$. The lower $\boldsymbol{o}_{k,i}$ is, the more horizontal the slope will be, and the lesser the time factor will negatively impact the sanction's ability to apply economic pressure. Reversely, the higher the value of $\boldsymbol{o}_{k,i}$ is, the more vertical the slope will be. In other words, $\boldsymbol{o}_{k,i}$ is allowing us to calibrate the time factor intensity and behavior.

When the sanction has been implemented ($u = 0$), economic pressure brought by the punitive measure is total and $\boldsymbol{\chi_{k,i,0} = 1}$. On the contrary, when the sanction's ability to inflict economic pressure is completely void $\boldsymbol{\chi_{k,i,0} = 0}$. Meaning that:

$$\{\chi_{k,i,u} \in \mathbb{R} \mid 0 \leqslant \chi_{k,i,u} \leqslant 1\}.$$

Naturally, $\boldsymbol{\chi}_{k,i,u}$ and $\boldsymbol{o}_{k,i}$ will be easier to calibrate in a past and ended sanction regime, than in a present case study-mostly because it will be possible to assess how fast sanctions have lost their efficiency over time. Reversely, if the sanction regime isn't over at the time of studying, some arbitrary choices will need to be made. However, as each coercive measure is unique, this calibration will have to be done on a case-by-case basis, depending mostly on exogenous factors and results of statistical investigations. In the end, the new sanction index shall be equal to:

$$S_{t,k} = \sum_i S_{t,k,i} = \sum_i \left(\alpha_{t,k,i} \cdot \beta_{t,k,j,i} \cdot \chi_{k,i,u}\right) \tag{7}$$

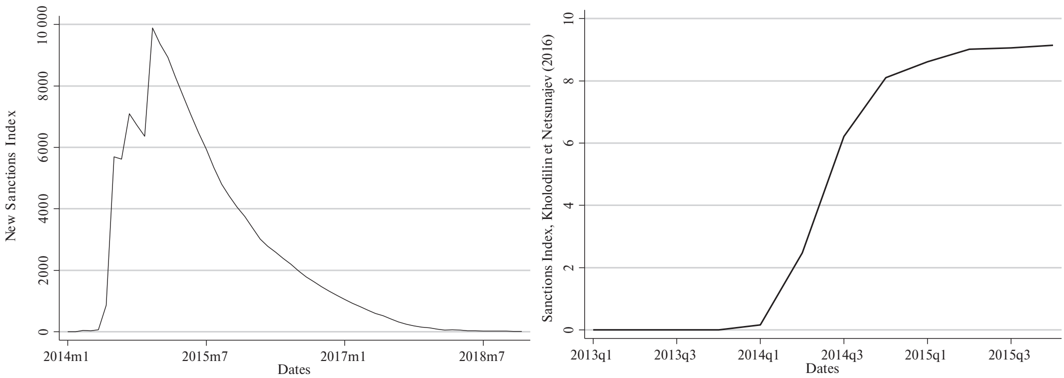

Fig. 1. New sanctions index vs previous sanction index

Notes: The new sanctions index is in blue color, and the previous sanction index is in black color. The new sanctions index is the sum (as explained in equation 7) of all European sanctions against Russia from March 2014 to March 2018. Parameters' specification is available on request. Data used for the New sanctions index are in Annex III, and data used for the previous sanction index are in Dreger et al. (2015).

Empirical Analysis

In this section, our main objective is to proceed an empirical check of our index, in comparison to the index of Kholodilin and Netšunajev (2016) (that we will call "previous index"). In order to highlights differences between indexes, our main strategy is based on the use of SVAR model — mostly because we can focus on effects of implemented idiosyncratic shocks through our endogenous variables across time. To be precise, results of Orthogonalized Impulse-Response functions (OIRFs) and Variance decomposition of forecast errors (FEVD) will be studied to highlight differences between the new and the previous sanction indexes. For consistency of comparison, four-country SVAR models based on the Ukrainian crisis case will be run. The goal is to assess sanctions impact on Russian GDP, represented in this paper by the Industrial Price Index as proxy[1]. However, differences between sanction indexes will be studied in two distinct parts. Firstly, with two initial SVAR country models (A) and (B), regulated by two control variables, and secondly, through two extended SVAR country models (C) and (D), integrating this time two additional control variables. Through those econometric models, we aim to assess the overall effectiveness of our sanction approach compared to the previous index.

[1] As GDP data are not expressed in monthly frequency, it has been decided to use the Industrial Price Index instead.

Initial SVAR Country Model

In this first SVAR modeling, two initial country SVAR models are run for purposes of studying dynamics of sanctions indexes on the Russian economy. Our goal is to demonstrate improvements brought by the new sanction index. To do so, a model (A) integrating the new sanction index will be compared to a model (B) that uses the previous sanction index. These models' OIRFs and FEVDs will be compared.

Database

To illustrate consequences of sanctions on the Russian economy, data have been collected from January 2010 to July 2018 on a monthly frequency. Most of our variables are linearized except for the new and previous sanction index. Unit root tests have been done and show that our variables are stationary in first difference, except for the new sanction index that is stationary at level.

(1) *st*: New sanction index in raw value.
(2) *d_sww*: Previous sanction index.
(3) *dln_eru*: Ruble Real effective exchange rate (RREER), from the IMF.
(4) *dln_oilp*: Brent oil price, from Intercontinental Exchange.
(5) *dln_ipi*: Russian industrial price index, ROSTAT.

Model's Frame

As explained, two models are used in order to assess new features of our sanction index. According to the Cholesky ordering, our vector of endogenous variables is defined either as model (A) with the new sanction index, or as model (B) with the previous one.

$$y = \left(d\_st\, dln\_eru\, dln\_oilp\, dln\_ipi\right) \tag{A}$$

$$y = \left(d\_sww\, dln\_eru\, dln\_oilp\, dln\_ipi\right) \tag{B}$$

This paper follows the Cholesky identification method. In this identification, the ordering matters and depends on our assumptions. In this paper, we assume that international economic sanctions affect negatively or positively the Russian GDP. Yet, as sanctions are not the main determinant of Russian GDP, oil prices and RREER are integrated. For these reasons, the causal ordering of variables will be:

$$d\_st \rightarrow dln\_eru \rightarrow dln\_oilp \rightarrow dln\_ipi \tag{A}$$

$$d\_st \rightarrow dln\_eru \rightarrow dln\_oilp \rightarrow dln\_ipi \tag{B}$$

By doing so, sanction index is ordered first and acts as causal variable, meaning that it contemporaneously influences other variables, without being impacted by them. Defined as our variable of interest, industrial price index is affected by all variables, without influencing them. Finally, both ruble real effective exchange rate and oil price are control variables, as they have contemporaneous effects on our variable of interest.

New Sanction Index

Firstly, the analysis of Impulse-Response functions shows that a positive shock of sanctions induces negative effects on ruble real effective exchange rate. These effects take place over the short-term and are introduced by the sanction index's restrictions. They may lessen the ruble's demand, and in turn depreciate it. Moreover, as the Russian economy is a commodity export-led economy, any negative RREER variations should make oil or commodity production profitable, mostly as the combination of a transitory sanction shock and RREER variation shall decrease oil price over the short-term. Finally, the sanction's shock has negative outcomes on Russian production as its negative effects last for up to three months after the transitory positive shock. From a statistical viewpoint, both RREER and oil price variables reacts significantly to a positive shock of sanctions in the short-term. Respectively, it happens during the first and second months for both variables, as confidence intervals does not include the zero line. It means that sanctions affect both variables negatively on the short-term. Nevertheless, results on our variable of interest are unclear. As previously noticed, a sanctions' shock has a persistent negative effect on the Russian GDP, even if not significant. This can mostly be explained by the economy adjustment hypothesis, based on both import-substitution strategy of Russia and changes in Russian international trade structure.

Secondly, the Variance decomposition of forecast errors (FEVD) shows that the variability of our endogenous variables follows main results of our OIRFs, mostly as both RREER and oil price variations over time are explained by sanctions variations (respectively for 7.5% and 11.7%). Finally, results show that up to 5% of Russian GDP variability over time is explained by the new sanctions index. Yet, as we noticed earlier on OIRFs results, sanctions do not affect effectively the evolution of Russian production.

Table 2

FEVD: % change of variables explained by the new sanction index

Variables	1 month	5 months	10 months	20 months
$reer_t$	7.0	7.0	7.2	7.5
$oilprice_t$	5.0	8.9	10.3	11.7
gdp_t	1.7	5.0	5.0	5.0

Previous Sanction Index

This subsection is dedicated to model (B), which is based on the previous sanction index. To get started, OIRFs results reveal that general trends previously noticed in model (A) remain. Indeed, both RREER and oil price react negatively to a transitory positive sanctions shock. Nevertheless, unlike previous results, RREER and oil price suffer from a lack of significance. Regarding Russian GDP, results show that a positive sanctions shock induces contradictory consequences on Russian production. It seems to, over the short-term, stimulate domestic production positively rather than negatively. However, as the previous index does not take into account the adaptability of Russian's economy, it appears that effects on variables last longer over time. Certainly, because outcomes on oil price continues from 5 to 6 months for RREER and oil price variables, and up to 5 months for Russian's GDP. Finally, FEVD results imply inconsistent outcomes through a reduction of explanatory power of sanction innovations on other variables variations. Indeed, only 4.4%, 4.1% and 0.6% are explained by fluctuations of the sanction index over time (respectively for RREER, Oil price and Russian GDP).

Table 3

FEVD: % change of variables explained by the previous sanction index

Variables	1 month	5 months	10 months	20 months
$reer_t$	0.3	4.3	4.4	4.4
$oilprice_t$	0.0	4.1	4.1	4.1
gdp_t	0.0	0.6	0.6	0.6

Comparison

As our main goal is to compare outcomes on our main dependent variable –Russian GDP- through models (A) and (B), comparison analysis focuses on both models' FEVD results.

Table 4

FEVD: comparison between models A and B (%)

Steps/months	Impulse (st) Response (ipi) Model (A)	Impulse (sww) Response (ipi) Model (B)
1	1.7208	4.60E-07
5	5.0401	0.6945
10	5.0536	0.6966
15	5.0541	0.6967
20	5.0541	0.6967

What do FEVD results say? It seems that using the new sanction index enhances models' explanatory power. For instance, sanctions in model (A) reach more than 5% of explanatory power, while sanctions in model (B) remain on the ground with less than 1%. This means that the new sanction index is able to justify Russian GDP's variation at least five times more than the previous sanction index. These results show that the new sanction index developed in this paper improves models' accuracy. To be precise, it affects Russian production variations on the short-term more sharply than the previous sanction index. In order to ensure the reliability of our initial result regarding our index improvements, a second extended model is introduced in the next section.

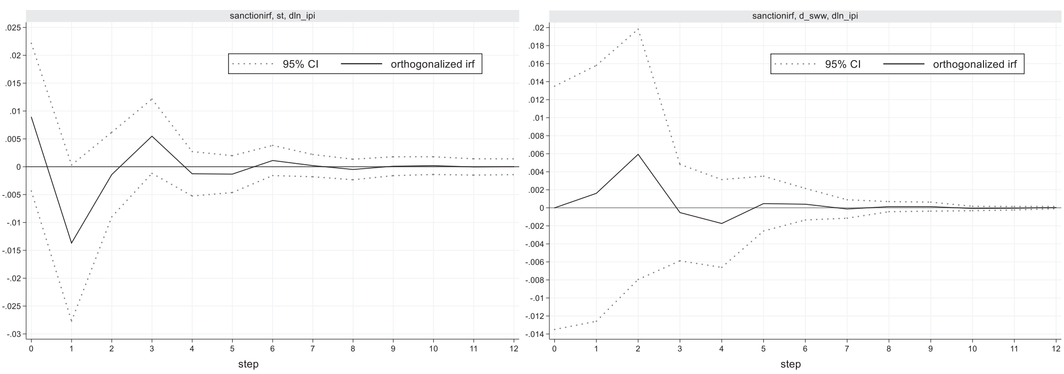

Fig. 2. Orthogonalized impulse-response function, comparison (A) vs (B)

Notes: Figures are the industrial price index implied responses to a sanction shock in model (A) on the left, and in model (B) on the right.

Extended SVAR country models

Previous section allowed us to put forward key results regarding differences between the new and previous sanction indexes. It is nonetheless important to run two additional models in order to confirm previous improvements. Some might be willing to consider this section as a robustness test. Thus, two extended country SVAR models will be studied in this section. Indeed, model (C) and (D) are augmented by the arrival of two additional control variables: domestic capital flows and exports.

Data Base

Models developed in this section are based on previous implementations, with two additional control variables. In addition, period span and frequency remain as in the initial SVAR country model. Russian exports variable is linearized and turned in first-difference to ensure stationarity, while capital flows are transformed in growth rates.

(1) *g_cf*: Capital flows balance, as a grow rate for consistency purposes, from the Bank of International Settlements.

(2) *dln_xru*: Russian exports, from ROSTAT.

Model's Frame

Adding two additional control variables naturally leads us to a six endogenous variables country SVAR model. As before and for the same reasons, Cholesky decomposition ordering is used in this section. This time, our vector of endogenous variables is defined either as in model (C) with the new sanction index, or (D) with the previous sanction index.

$$y = (d\_st \; dln\_eru \; dln\_oilp \; dln\_xru \; g\_cf \; dln\_ipi) \quad \text{(C)}$$

$$y = (d\_sww \; dln\_eru \; dln\_oilp \; dln\_xru \; g\_cf \; dln\_ipi) \quad \text{(D)}$$

The ordering of endogenous variables follows the same logic as earlier. It is assumed that economic sanctions have an impact on Russian industrial price index. Thus, two additional control variables are added in order to increase the robustness of our results.

$$d\_st \rightarrow dln\_eru \rightarrow dln\_oilp \rightarrow dln\_xru \rightarrow g\_cf \rightarrow dln\_ipi \quad \text{(C)}$$

$$d\_sww \rightarrow dln\_eru \rightarrow dln\_oilp \rightarrow dln\_xru \rightarrow g\_cf \rightarrow dln\_ipi \quad \text{(D)}$$

Thus, industrial price index is now contemporaneously impacted by sanctions (our causal variable), as well as four other control variables. This means that an impulse of sanctions with a response of industrial price index will include effects of REER, oil price, Russian exports, and capital flights.

New Sanction Index

According to OIRFs results, the introduction of two complementary variables leads to mixed results. Indeed, a transitory sanction's shock induces similar results as models (A) and (B). As previously discovered, a transitory shock of the new sanctions index induces negative outcomes on RREER and oil price over the period following the transitory shock. In addition, such a shock seems to impact our complementary variables negatively. Yet, Russian exports decrease more clearly over the short-term than capital flows. Moreover, capital flows are not effectively affected by sanctions. Finally, our variable of interest follows previous models' trends as OIRFs reveal that Russian GDP reacts negatively to sanctions' shock. Nevertheless, from a statistical perspective, it is vital to bear in mind that OIRFs results are significant for oil price and exports, but not for Russian GDP.

Table 5

FEVD: % change of variables explained by the new sanction index

Variables	1 month	5 months	10 months	20 months
$reer_t$	5.9	6.1	6.3	6.6
$oilprice_t$	5.2	8.5	9.9	11.2
$export_t$	0.2	4.4	4.8	5.2
$capflows_t$	0.2	0.4	0.5	0.5
gpd_t	1.0	4.7	4.8	4.8

The FEVD analysis shows important differences regarding endogenous variables variability explained by the sanctions variable. Indeed, up to 6.6%, 11.2% and 4.8% of respectively RREER, oil price and Russian GDP variations are explained by sanctions. It means that the introduction of complementary variables reduces sanctions explanatory power.

Previous Sanction Index

Regarding OIRFs, only oil price reacts significantly to a transitory positive shock of the original sanction index, while all remaining variables are not significant. Our main dependent variable also shows contradictory results as the transitory shock induces positive outcomes instead of reducing Russian production over the short-term. Moreover, results regarding Russian GDP also suffer from a lack of significance.

Table 6

FEVD: % change of variables explained by the previous sanction index

Variables	1 month	5 months	10 months	20 months
$reer_t$	0.0	3.3	3.4	3.4
$oilprice_t$	0.0	3.7	3.9	3.9
$export_t$	0.0	3.7	3.6	3.6
$capflows_t$	1.2	3.8	3.8	3.8
gpd_t	0.0	0.6	0.7	0.7

According to FEVD table, two trends emerge from our results. Firstly, the introduction of complementary variables decreases the explanatory power of sanctions comparatively to models (A) and (B), especially for oil price and RREER variables. Secondly, we confirm that results regarding our main dependent variable follow findings of model (B) since only 0.7% of the original sanction index explains Russian GDP variations (in accordance with last section findings).

Comparison

Table 7

FEVD: comparison between model C and D, %

Steps/months	Impulse (st) Response (ipi) Model (C)	Impulse (sww) Response (ipi) Model (D)
1	1.0724	0.0413
5	4.7352	0.6737
10	4.8014	0.7434
15	4.8015	0.7453
20	4.8018	0.7453

According FEVD, model (C) has a stronger explanatory power than model (D). Indeed, while the new sanction index can explain 4.8% of Russian GDP variations, the previous one crawls to 0.7%, reinforcing our sanction index preponderance.

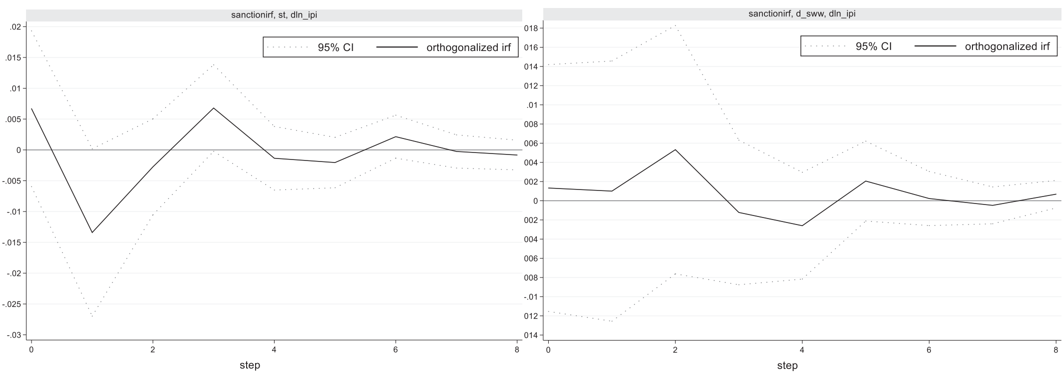

Fig. 3. Orthogonalized impulse-response function, comparison (C) vs (D)

Notes: Figures are the industrial price index implied responses to a sanction shock in model (C) on the left, and in model (D) on the right.

Conclusion

In order to assess improvements brought by our new sanctions Index, four-country SVAR have been run. The first section "Initial SVAR Country Model" focused on four variables SVAR models. Sanction indexes as causal variable were ordered first, RREER and Brent oil price were second (as control variables), and Russian industrial price index was last. Russian industrial price index (as a proxy of Russian GDP) was our most endogenous variable, and consequently our variable of interest. Model (A) was integrating the new sanction index, while model (B) used the previous sanction index. The second section "Extended SVAR country models" followed first section's structure, but witnessed the arrival of two additional control variables: domestic capital flows and exports. Naturally, it led to the run of models (C) and (D); the first one using the new sanctions index, and the second one the previous sanctions index. That being said, results of the first section –with two control variables- reveal that the new sanction index has a 4% points stronger explanatory power than the previous one. Also, it seems that our index affects short-term Russian production variations more sharply than its predecessor. Improvements of the explanatory power are confirmed by the second section, supporting our index relevance.

Even if improvements made regarding Variance decomposition of forecast errors are already a huge step forward, it is better to reiterate another relevant point. The fact that the lack of significance illustrated by confidence-intervals values, which could at first glance appear as a negative point, is in fact a very positive one. It means that sanctions do not significantly influence Russian GDP. Hence, our study also emphasizes that sanctions have a residual impact on Russia's production. Several recent papers confirm this intuition, spotlighting that oil price is the main determinant of Russian production (e.g. Korhonen et al. (2018), Tyll et al. (2018), et cetera). However, none should be troubled that if our index formalization was used in the Iranian case (for example), it would certainly lead to highly significant Orthogonalized Impulse-Response functions (even if this is only an intuition). To conclude, it seems that our new sanction index can be used as a real econometric tool to assess sanctions impacts, even if it is true that it still has several limits, such as the heuristic on which basic values are built.

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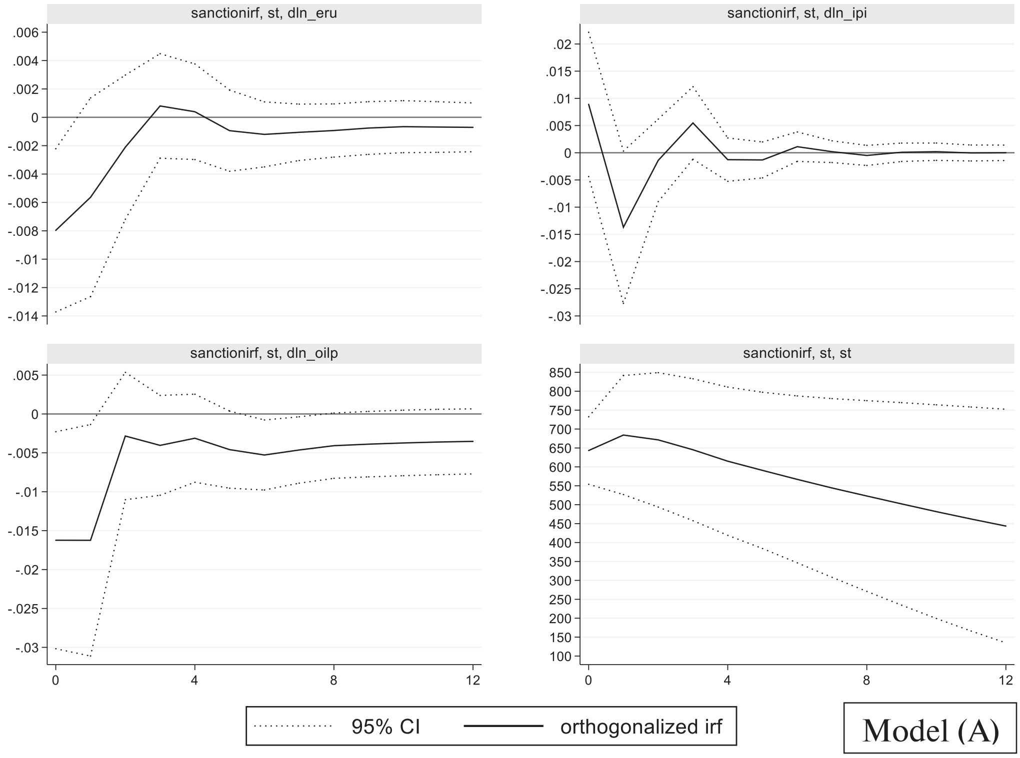
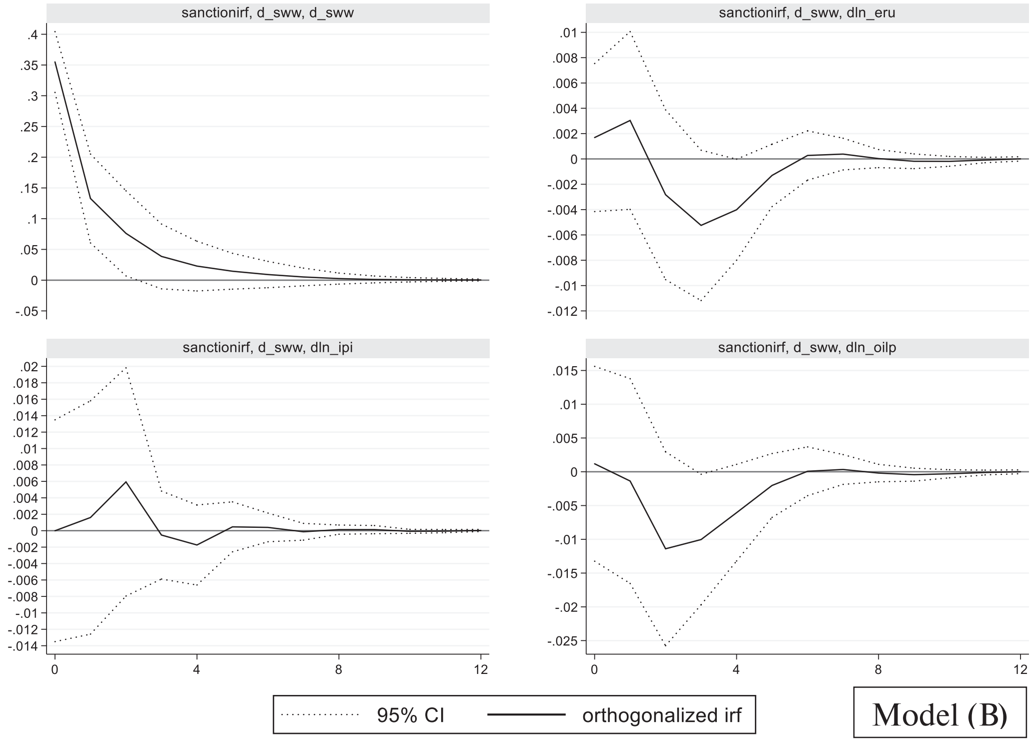
Annexes

Annex i

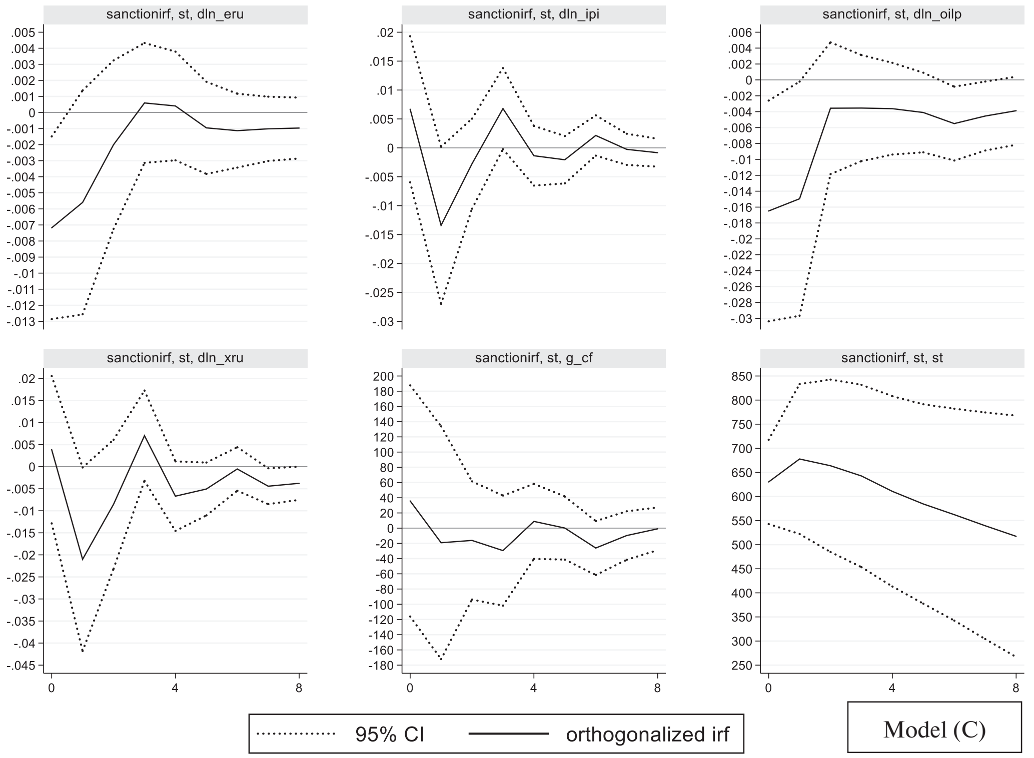
Orthogonalized Impulse-Response Functions, Model (A) and (B)

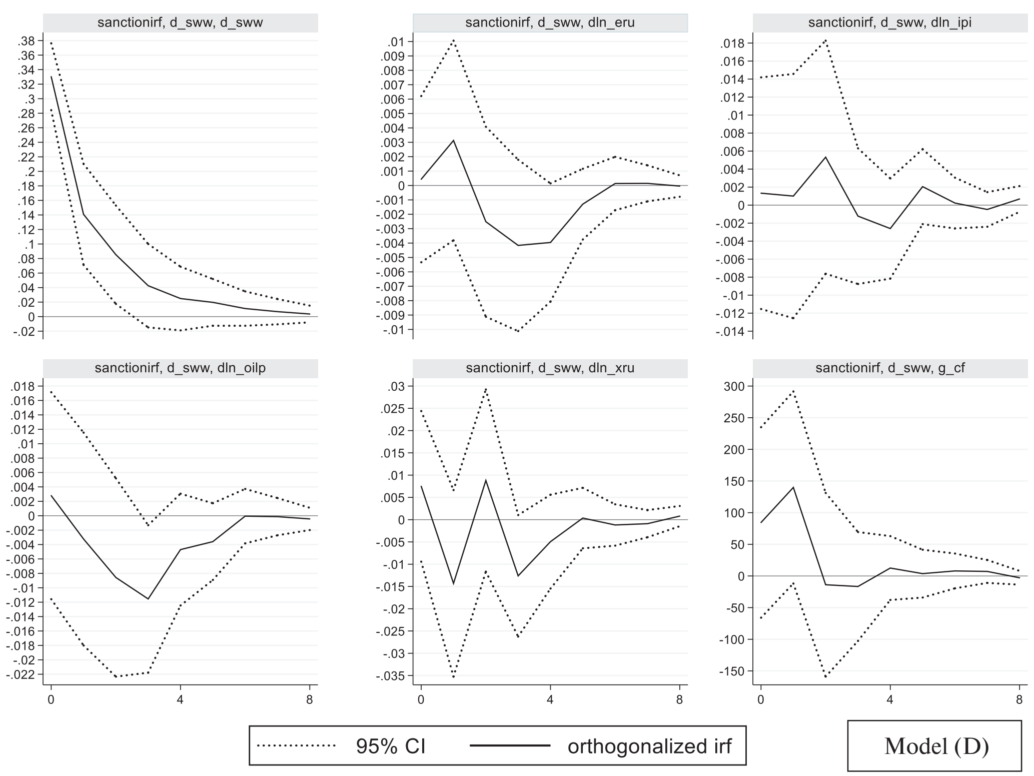




Annex II

Orthogonalized Impulse-Response Functions, Model (C) and (D





Annex iii

Data used for the New sanctions index

Dates	New sanctions index's values	Dates	New sanctions index's values	Dates	New sanctions index's values
2010 m1	0	2013 m7	0	2017 m1	1048.72
2010 m2	0	2013 m8	0	2017 m2	922.37
2010 m3	0	2013 m9	0	2017 m3	820.91
2010 m4	0	2013 m10	0	2017 m4	705.89
2010 m5	0	2013 m11	0	2017 m5	594.59
2010 m6	0	2013 m12	0	2017 m6	517.03
2010 m7	0	2014 m1	0	2017 m7	412.05
2010 m8	0	2014 m2	0	2017 m8	316.26
2010 m9	0	2014 m3	42.29	2017 m9	242.64
2010 m10	0	2014 m4	33.9	2017 m10	190.73
2010 m11	0	2014 m5	66.31	2017 m11	145.17
2010 m12	0	2014 m6	859.26	2017 m12	122.82
2011 m1	0	2014 m7	5691.14	2018 m1	86.23
2011 m2	0	2014 m8	5615.26	2018 m2	52.49
2011 m3	0	2014 m9	7090.49	2018 m3	60.29
2011 m4	0	2014 m10	6722.84	2018 m4	51.08
2011 m5	0	2014 m11	6359.19		
2011 m6	0	2014 m12	9888.54		
2011 m7	0	2015 m1	9365.03		
2011 m8	0	2015 m2	8926.36		
2011 m9	0	2015 m3	8294.5		
2011 m10	0	2015 m4	7672.33		
2011 m11	0	2015 m5	7074.26		
2011 m12	0	2015 m6	6480.26		
2012 m1	0	2015 m7	5931.04		
2012 m2	0	2015 m8	5341.02		
2012 m3	0	2015 m9	4804.72		
2012 m4	0	2015 m10	4418.26		
2012 m5	0	2015 m11	4055		
2012 m6	0	2015 m12	3744.65		
2012 m7	0	2016 m1	3389.33		
2012 m8	0	2016 m2	3010.38		
2012 m9	0	2016 m3	2782.31		
2012 m10	0	2016 m4	2595.97		
2012 m11	0	2016 m5	2388.09		
2012 m12	0	2016 m6	2193.91		
2013 m1	0	2016 m7	1980.24		
2013 m2	0	2016 m8	1780.53		
2013 m3	0	2016 m9	1623.34		
2013 m4	0	2016 m10	1460.89		
2013 m5	0	2016 m11	1319.56		
2013 m6	0	2016 m12	1181.77		

Notes: As there is a need to limit the number of pages, the exact sanction list is available on request.