March 15, 2022

CSH Policy Brief

Shocking Russia | How will economic sanctions affect the Russian economy, how will an oil and gas embargo play out, and how are sanction-imposing countries affected on the various industry sectors?

In response to the invasion of Ukraine, many countries implemented economic sanctions against Russia, the 11th largest economy in the world. These have significant impact of various types: financial, exports, mobility, FDIs, usability of SWIFT, and access to foreign exchange, possible failure on foreign debt, access to internet, access to assets in the West, etc. In this Policy Brief, we first focus on the direct and indirect effects of the imposed sanctions on Russia's real economy, in particular how a lack of availability of imports of primary and intermediary goods affects Russian domestic production. Second, we estimate the outcomes of a hypothetical scenario of sanctions against Russian oil and gas exports. Finally, we estimate the secondary economic effects of Russian production losses on the sanction-imposing countries. We provide an [interactive sanction calculator](), *where hypothetical sanctions of various countries in all industry sectors can be interactively implemented and the effects on Russia and the rest of the world is displayed.*

Effects on the Russian economy. We discuss the relative gross output change as a result of a lack of imported goods. It is expected that Russian imports of primary goods and intermediary products will reduce by 20% (direct effects) [1]. This will affect supply chains within Russia and lead to secondary effects that are expected to be of the order of 17% of the total output. The most affected industry sectors (direct and indirect effects) are the motor vehicle (−52%), electrical equipment (−39%) and machinery (−36%), followed by the manufacturing of other transport equipment (e.g., ships, airplanes) (−34%) and computer, electronic, and optical equipment (−33%).

Scenario fuel sanctions. There have been calls for sanctions against Russian fossil fuel exports [2,3]. A complete embargo on Russian oil and gas negatively affects every industry sector in Russia, and an additional reduction of gross national output of 12.4% is expected. Assuming that international demand for fuel remains constant and is satisfied from non-Russian sources, other oil- and gas-producing countries will benefit. For example, the Saudi Arabian extractive sector could grow by up to 6.9%.

Effects on sanction-imposing countries. In the sanction-imposing countries the export ban causes reduced demand for firms which sold goods to Russia before. This has little overall effect on gross output of sanction-imposing countries, but several sectors will experience output reductions. For example, German machinery will suffer a −2%, the Chinese computer, electronic and optical equipment sector will suffer −1.9%, and the French transport equipment manufacturers will experience a reduction of −1.7%.

We base our estimates on various methods, including IO analysis [4], a demand shock algorithm [5], and an algorithm for supply shocks [6]. We do not consider price effects or market mechanisms.

Background

In response to Russia's invasion of Ukraine, many countries imposed sanctions on Russian individuals, closed their airspace for Russian aircrafts and restricted exports to and imports from Russia. With Russia being the 11th largest economy in the world (measured by GDP) [7], the sanctions are expected to have strong effects on the global economy. The current economic sanctions focus on a range of high-tech products that are important for Russian intermediate demand, meaning that they cause strong secondary effects. There have been calls for, and announcements of new sanctions against Russia, in particular a reduction or stop of imports of Russian fossil fuels [1,2].

Russia's economy is strongly focused on the extraction of natural resources [8]. As shown in Fig. 1a, its most important export is petroleum oil, followed by natural gas and coal (brown block) that make up more than 56% of Russian exports, followed by metals (red, 9.7%) and agricultural products (yellow, 9.5%). While Russia exports mostly products of low economic complexity, it does import high-complexity products. Figure 1b shows that Russia's main imports are machinery (blue, 21.3%), chemicals (magenta, 17.7%), and cars and parts (purple, 13.0%).
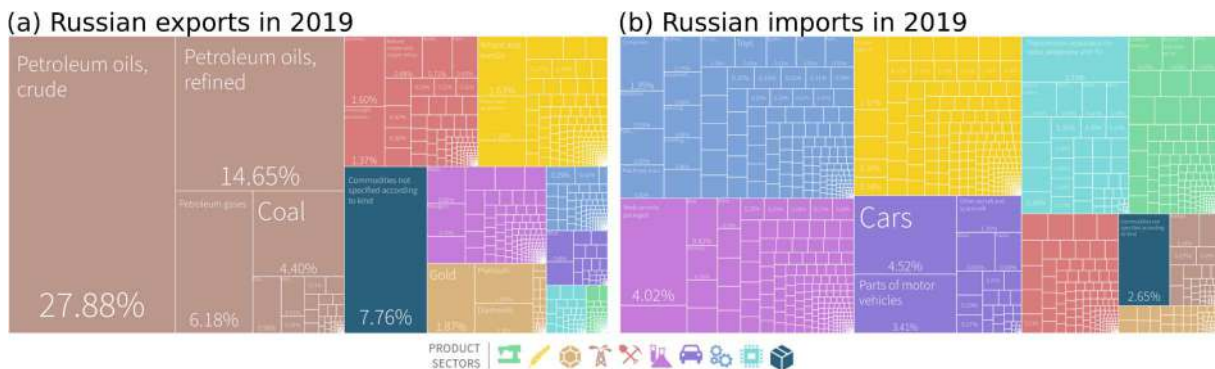

Figure 1. Russian foreign trade in 2019, excluding services. (a) Russian exports consisted mainly of low-complexity products such as minerals (brown), metals (red) and agricultural products (yellow). (b) Russian imports in 2019 consisted mainly of complex products, such as machinery (blue), chemicals (magenta), vehicles (purple), and electronics (turquoise), but also agricultural products (yellow) and garments (green) have a significant share. Source: Atlas of Economic Complexity [8].

The CSH perspective

Economic sanctions typically target a country's trade relations. Beyond the direct impact on the supply or demand of a sanctioned product, the consequences of trade barriers propagate up- and downstream the supply chains in the impacted industry sectors. In this CSH Policy Brief, we analyze the effect of economic sanctions against Russia with a special focus on indirect economic effects.

Methods. We use two types of methods. The first is a supply shock propagation model that assumes linear production functions for every sector and iteratively propagates shocks through the supply chains [6]. We use it to estimate the consequences of Russian import shortages. The second method is a linear-response model developed at CSH [5] to assess the effects of demand changes that result from the trade restrictions. Starting from external demand shocks, it returns predictions for output changes. It is similar to standard IO analysis (Leontief inverse) [4] and was used to estimate the effects of US tariffs on European steel and aluminum implemented in 2018. Here, we use it to assess the changes in gross output of the sanctioning countries resulting from trade sanctions against Russia.

Data. We use Inter-Country Input-Output (ICIO) tables provided by the Organization for Economic Co-operation and Development (OECD) [9]. The ICIO is a multi-regional input output table for 66 countries and 45 industries (based on ISIC Revision 4). We use data for the last available year, 2018.

Results

This policy brief discusses two specific scenarios. For arbitrary sanctions we provide an interactive tool that allows one to implement any sanction scenario, see https://vis.csh.ac.at/sanctions-on-russia/.

Scenario 1: Effects of current sanctions. We start with an assessment of the currently implemented sanctions. Most of these are imposed by Western countries, including the USA, Canada, the UK, and EU member states. They mainly target the sectors: electronic and optical equipment, machinery and equipment, motor vehicles, other transport equipment (ships, airplanes), and financial activities. We assume that the export of these products to Russia is no longer possible. In our baseline scenario, we assume that China and India adopt similar sanctions. We comment on the case where only Western countries put the described sanctions in place. Note that the current sanctions do not include trade restrictions for oil or gas. We discuss these in a separate Scenario 2 below.

Effects on Russian supply chains – supply shock. Overall, around 20% of Russian imports are affected by the sanctions [8]. Russia will consequently experience a supply shock in the sanctioned goods: primary and intermediate goods (for example machinery from Germany) are no longer available to Russian firms that need to reduce their production. This is particularly important because for complex goods Russia imports a large fraction of its intermediate inputs from abroad. For example, 42% of all intermediate inputs from "Computer, electronic and optical equipment" are imported. The "machinery" sector is affected strongly. There, 36% of all intermediate inputs are sourced abroad. For more details, see Appendix Tab. 1.

We calculate the indirect effects based on the assumption that a firm that lacks a fraction of its inputs has to reduce its own production accordingly. The reduced production now also affects this firm's customers – also their production needs to be reduced. The cascade is repeated iteratively until a new equilibrium is reached [6]. For the initial shock we assume that Russia can't import the sanctioned goods at all. The assumed input reductions are summarized in Appendix Tab. 1.

The direct and indirect effects sum up to a reduction of 17% of total output. The most affected industry sectors (direct plus indirect effects) are the motor vehicle (–52%), electrical equipment (–39%) and machinery (–36%) producers, followed by the manufacturing of other transport equipment (e.g., ships, airplanes) (–34%) and computer, electronic and optical equipment (–33%). Figure 2 shows the relative output reductions for the 25 largest sectors.

If only Western countries impose shocks on Russia, the total output is only reduced by 6%. However, the most affected sectors are still the motor vehicle production (–39%), machinery (–23%), electrical equipment (–23%).
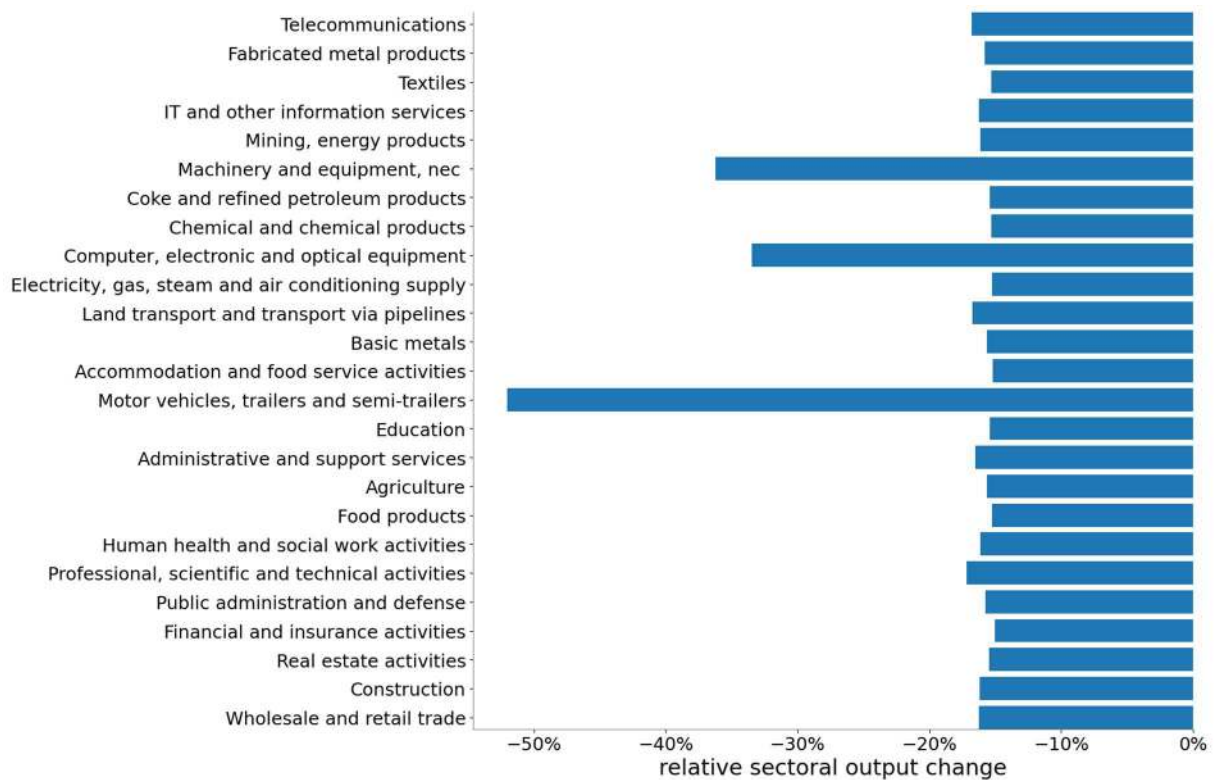
Figure 2. Effects of global sanctions on the Russian economy. We assume that the lack of supply caused by the sanctions of Western countries to the Russian economy (in the machinery, electrical equipment, and other sectors, see Appendix Tab. 1) cannot be compensated and propagates as a supply shock along Russian supply chains. We show the resulting (direct + indirect) relative output changes for each sector. The largest negative shock is experienced by the motor vehicle (D29, −52%), electrical equipment (D27, −39%) and machinery (D28, −36%) sectors. The total output of Russia is reduced by 17% (not shown).

Demand shock in sanction-imposing countries. Due to sanctions the demand from Russia for products produced in other countries diminishes. To estimate how the world is affected by the imposed loss of demand from Russia, we set Russian final and intermediate demand for sanctioned products in the sanction-imposing countries to zero. We then calculate direct and indirect effects on the gross output of all other countries. For the list of values used as inputs, see Appendix Table 2. In Fig. 3 we show the results of the 25 largest industry sectors in the 25 largest economies and Austria. For a complete list, see https://vis.csh.ac.at/sanctions-on-russia/. The total output change is relatively weak. For example, summing over all sectors, Germany only faces −0.3% of its total production output. Individual sectors can be affected more. The highest output reductions are observed in Germany with up to −2% in "Machinery", followed by China with −1.9% in "Computer, electronic and optical equipment", France with −1.7% in "Transport equipment", and Italy with −1.6% in "Machinery". Because those that are directly affected tend to have long and integrated supply chains, the indirect effects are strong and spread across many sectors.
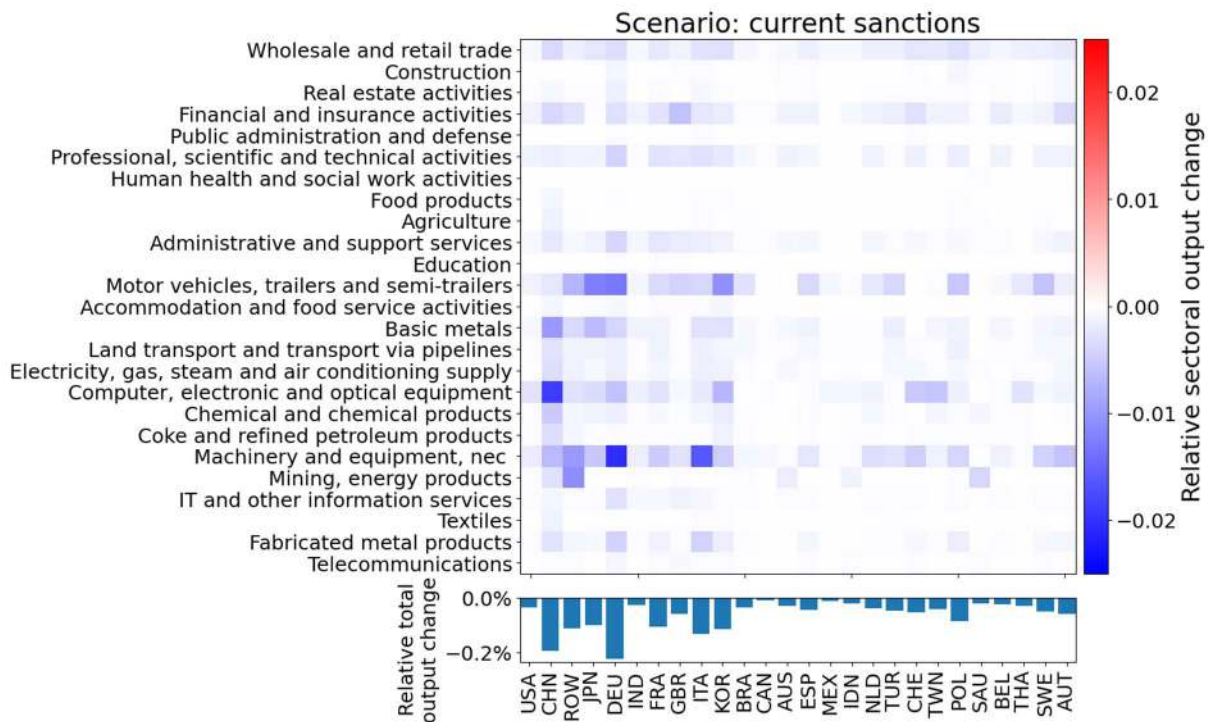
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Figure 3. Effects of the global sanctions against Russia on the sanction-imposing countries. We assume that no exports to Russia in the sanctioned sectors take place (e.g., machinery, electrical equipment, etc., see Appendix Tab. 1). This causes a demand shock to these sectors in the sanction-imposing countries, that will propagate upstream along global supply chains. We show the relative output change (direct + indirect) for the 25 largest sectors in the 25 largest economies (and Austria) that result from the sanctions as they are currently implemented. Some sectors suffer significant output losses, e.g., "Machinery" in Germany (−2%) or "Computer, electronic and optical equipment" in China (−1.9%). The lower panel shows the overall output reduction. It is comparably small with up to −0.3% total output loss in Germany.

Scenario 2: Sanctions on Russian fossil energy exports. Since fossil energy exports are Russia's main source of revenue, there have been calls to ban fossil fuel imports from Russia. On March 8, the European Commission outlined a Master Plan to reduce EU gas imports from Russia by more than two-third this year and to zero well before 2030 [2]. In the short term, the EU plans to increase natural gas imports from other countries, in the long run the dependence on fossil gas should be substituted by carbon neutral alternatives. An even larger portion of Russian exports is Petroleum oil. On March 8, US President Biden announced that the US will ban all imports of Russian oil and gas [3].

We now simulate expected short-term effects of sanctions on the Russian and global fossil fuel industry. We assume that in the short run there is no possible substitution for fossil fuels. An import ban of oil, gas, and coal constitutes a demand reduction for the Russian extractive sector, but a supply reduction for many countries. For the short- to medium-term we assume that the open demand is compensated proportionally by non-sanctioned countries. Hence, we apply a proportional, positive shock. We use the Linear Response model described in [5] to calculate the indirect effects of the negative and positive shocks, respectively. For details, see Appendix Tab. 3.

Figure 3 shows the model results for the 25 largest economies by sector. Note that relative shocks are 10 times larger than for the sanctions currently in place in Scenario 1.

It is clear the demand reduction for Russian oil and gas affects almost all industry sectors in Russia. Most affected are the (directly affected) mining (−77%) and refinery (−54%) sectors, followed by

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(indirectly affected) "Mining support activities" (–41%) and "Land transport and transport via pipelines" (–14%). These effects add to the output reductions due to the current sanctions presented in Scenario 1.

Who benefits? Countries that benefit most are Saudi Arabia, Norway, the USA, and Australia. Since supply chains for oil- and gas extraction are short, the increased demand in other countries does not produce sizable indirect effects. The largest increase is in the Saudi Arabian mining sector with a 6.9% increase of output, followed by the same sector in the USA with 6.7%, and China 6.4%.
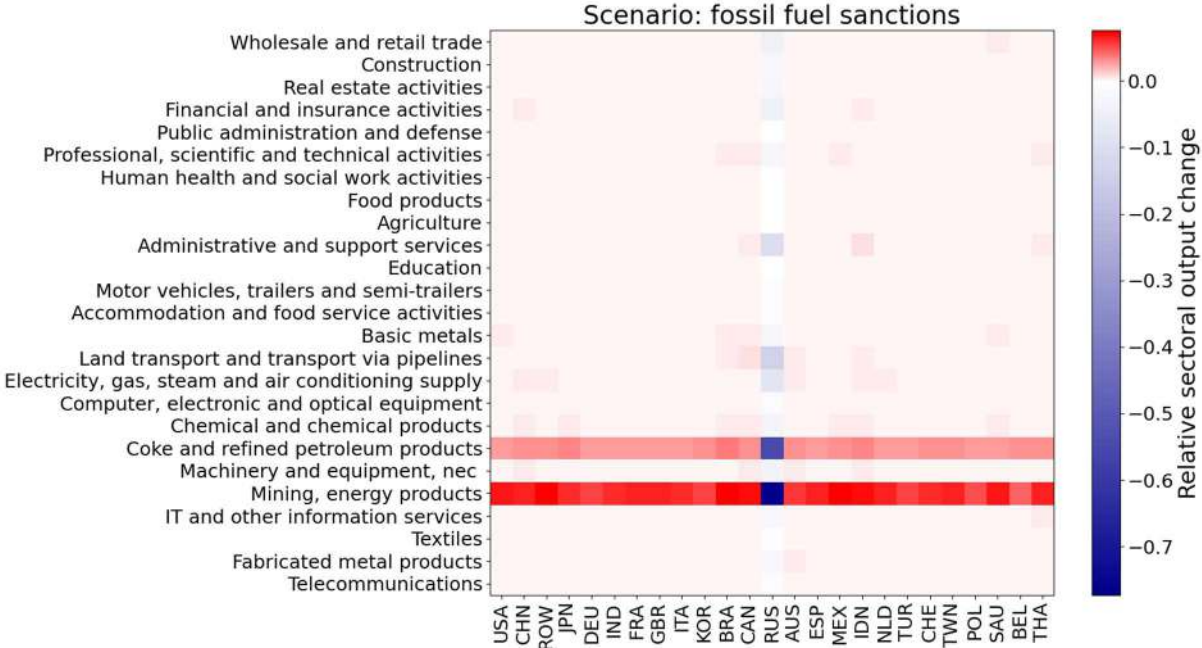

Figure 4. Effects of a global oil, gas and coal embargo against Russia. The heatmap shows the relative output change for the 25 largest sectors in the 25 largest countries that result from the sanctions against Russian oil, gas, and coal exports. We assume that Russia does not export any fossil fuels anymore. This represents a demand reduction for the Russian fossil fuel industry. The direct and indirect effects of the demand reduction are visible as a blue vertical line. Most affected are the Russian mining and refinery sectors (–77% and –54%, respectively). In the short- to medium-term, Russian oil, gas, and coal exports need to be compensated by other countries. We assume that every country increases its production proportionally to compensate for Russian exports. Most affected is again the mining sector, with values around 6% in most countries.

Conclusion

We discuss two scenarios, one where we assume that the current sanctions remain in place as they are, and a second one where we assume a global ban of oil, gas, and coal imports from Russia. We estimate the direct and indirect impact of these sanctions on the Russian economy and the sanction-imposing countries, respectively.

The sanctions currently in place will have a relatively minor effect on Western economies, where some industry sectors will be hit by up to 2% as a consequence of demand shocks. The effects are moderate in comparison to their effect on the Russian economy, which is about to suffer output losses of up to 17%.

In addition, sanctions on Russian fossil energy exports would have a large impact on the Russian economy. Our model predictions estimate an additional output reduction of 12.4% on top of the 17%.

If the fossil fuels were substituted by imports from other oil and gas producing countries (which might be hard because of infrastructural constraints), the effect on Western economies can be kept moderate; other exporting countries could benefit with increased sales of up to 7% in the extractive sector, for instance in Saudi Arabia.

The models used in this Policy Brief have several limitations. Our scenarios are based on assumptions that exclude important factors such as how government subsidies, price dynamics, the short-term availability of production capacities, and the increasing implementation of green technologies will influence the actual development of demand for Russian goods. However, our scenarios give a good impression to what extent Russia and other countries and sectors will be affected in unmitigated scenarios.

For other scenarios we provide an interactive visualization tool (scenario calculator) to explore effects of arbitrary sanction settings in various countries and industry sectors that can be defined by the reader; see our webpage https://vis.csh.ac.at/sanctions-on-russia/.

CSH scientists: Tobias Reisch, Liuhuaying Yang, Jan Hurt, Stefan Thurner

Sources

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About the CSH

The Complexity Science Hub Vienna was founded with the aim of using Big Data for the benefit of society. Among other things, the CSH systematically and strategically prepares large data sets so that they can be used in agent-based models. These simulations allow the effects of decisions in complex situations to be tested in advance and systematically assessed. Thus, the CSH provides fact-based foundations for evidence-based governance.

CSH Policy Briefs *present socially relevant statements that can be derived from CSH research results.*

Appendix

Appendix Table 1: Direct effects of the sanctions on Russia. The percentages show the supply reductions as a consequence of the direct shocks.

Code	Industry	Supply shock RUS
D26	Computer, electronic and optical equipment	−42%
D27	Electrical equipment	−16%
D28	Machinery and equipment, nec	−36%
D29	Motor vehicles, trailers and semi-trailers	−26%
D30	Other transport equipment	−18%
D31T33	Manufacturing nec; repair and installation	−11%
D64T66	Financial and insurance activities	−9%

Appendix Table 2: Detailed relative shock sizes for scenario 1, current sanctions. The scenario assumes that Russia loses all its foreign demand for the sectors specified below. This is inaccurate but assumed here for simplicity. Further, Russia experiences a supply shock, hence, the table does not contain a shock for Russia.

Code	Industry	Demand shock outside of RUS
D26	Computer, electronic and optical equipment	−100%
D27	Electrical equipment	−100%
D28	Machinery and equipment, nec	−100%
D29	Motor vehicles, trailers and semi-trailers	−100%
D30	Other transport equipment	−100%
D31T33	Manufacturing nec; repair and installation	−100%
D64T66	Financial and insurance activities	−100%

Appendix Table 3: Detailed relative shock sizes for scenario 2, fossil fuel sanctions. The scenario assumes that Russia loses all its foreign demand for products from the fossil fuel industry (oil, gas, coal) and the demand is satisfied by a proportional increase in all other countries.

Code	Industry	Demand change RUS	Demand change countries except RUS
D05T06	Mining, energy products	−100%	+11.7%
D19	Coke and refined petroleum products	−100%	+3.7%
D35	Electricity, gas, steam, and air conditioning supply	−100%	+0.05%