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Decoupling from Russia

Monitoring supply chains adjustment in the EU

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Decoupling from Russia

Monitoring supply chains adjustment in the EU

Francesco Di Comite[1] and Paolo Pasimeni[1, 2]

Abstract

This paper analyses the economic implications for the European Union (EU) of the Russian invasion of Ukraine, and of the following developments. It illustrates the challenges faced by the European economy at the moment of the invasion and the massive, on-going adjustment since then. The paper starts with a comprehensive description of the structural exposures and dependencies of the EU, first at macroeconomic and then at product level. It then uses high-frequency customs data to track how such exposures and dependencies developed in recent months and how the economy is trying to adjust. At the moment of the invasion, the EU was highly exposed to the import of Russian commodities, notably fossil fuels and critical raw materials, but it has gradually managed to reduce this exposure in the course of 2022. We document a sizeable reduction of EU exports to Russia, due to export restrictions, but at the same time, since imports of energy fossil fuels and critical raw materials were less elastic to prices, and prices for these goods have increased, the value of EU imports from Russia has increased. This has led to the EU accumulating an additional bilateral trade deficit vis-à-vis Russia of roughly €67bn in 2022, compared with the same period in 2021. Such additional trade surplus for Russia corresponds to roughly 3.7% of its GDP and is likely to be one of the driving factors of the strengthening of its currency, the rouble. Nevertheless, in the most recent months, the EU has managed to stop the accumulation of this trade deficit, by reducing imports. The EU was dependent on Russia for a number of critical commodities, including energy products. For the majority of these key industrial inputs, imports from Russia have been falling significantly in the course of the year, signalling a reconfiguration of supply chains in favour of alternative sources.

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[1] European Commission. The views expressed in this paper are the authors' alone and cannot be attributed to the European Commission. The authors are grateful to Román Arjona, Paolo Casini, William Connell-García, Maria Garrone, Martijn Haas, Cristina Herghelegiu, Kerstin Jorna, Josefina Monteagudo, Ralph Schmitt-Nilson, Outi Slotboom, Stefano Vannini, and Luís Varela-Irmía, for their data support and for useful comments on previous versions of the paper, while remaining the sole responsible for any remaining error in this document. The cut-off date of the monitoring of all short-term indicators used in this paper is 31/12/2022.

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1. Introduction

In the past four decades, the global economy has experienced a significant wave of integration, spurred by institutional and technological change,[3] in addition to a sharp decline in transport costs; this has increased global trade to unprecedented levels (Hummels, 2007). In an increasingly interdependent world, the European Union (EU) has integrated fast in international value chains, reaping the benefits in terms of higher productivity and growth. The growing interdependence has been accompanied by a generalised underestimation of risks related to supply chain management (in particular with respect to "just-in-time" inventory management and limited alternative supply options).[4] The extent of such risk has become apparent in the past few years, with the emergence of major global crises.

The overlap of two recent shocks has indeed put the volatility of our broad economic context under the spotlight. The pandemic, with its related containment measures, caused unprecedented disruptions to economic activity and supply chains in 2020 and 2021. Then, in early 2022, at a time when the European economy was still recovering from the impact of the pandemic, the Russian invasion of Ukraine has triggered new economic disruptions, reminding us of the importance of exposure to geopolitical risks and that the widespread reliance on global supply chains, beyond known benefits, was also amplifying risks and becoming a source of vulnerability.

The Russian invasion of Ukraine called for an immediate reaction,[5] followed by sanctions.[6] By December 2022, the EU had adopted nine rounds of sanctions against Russian businesses and citizens.[7] In this period, trade linkages between the EU and Russia had shrunk to less than half of their levels at the beginning of 2022 (from more than €6bn weekly to less than €3bn).

This economic shock induced by the Russian invasion of Ukraine contributed to strain already distressed supply chains and caused a steep rise in the price of energy commodities, for European firms and consumers. This is very likely to hit the EU economy in a structural way, with additional implications in terms of adjustments in capital and trade flows. The combination of these shocks is bringing the economy towards the unpleasant situation of accelerating inflation in a context of decelerating growth.

A number of recent studies have analysed the implications of the sanctions and post-invasion disruptions in Russia (Demertzis et al., 2022) and across the globe (Borin et al, 2022a; Langot et al, 2022; Attinasi et al, 2022a; Ruta, 2022; OECD (2022a, 2022b, 2022c); and IMF, 2022). This paper focuses on the impact on the European economy. We illustrate the large ongoing adjustments in trade flows and in the price of imported commodities,

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3 For the specific technological and organizational changes spurring globalization, see Bernhofen et al. (2016).

4 For an analysis and quantification of supply chain risks, see Benoit et al. (2022).

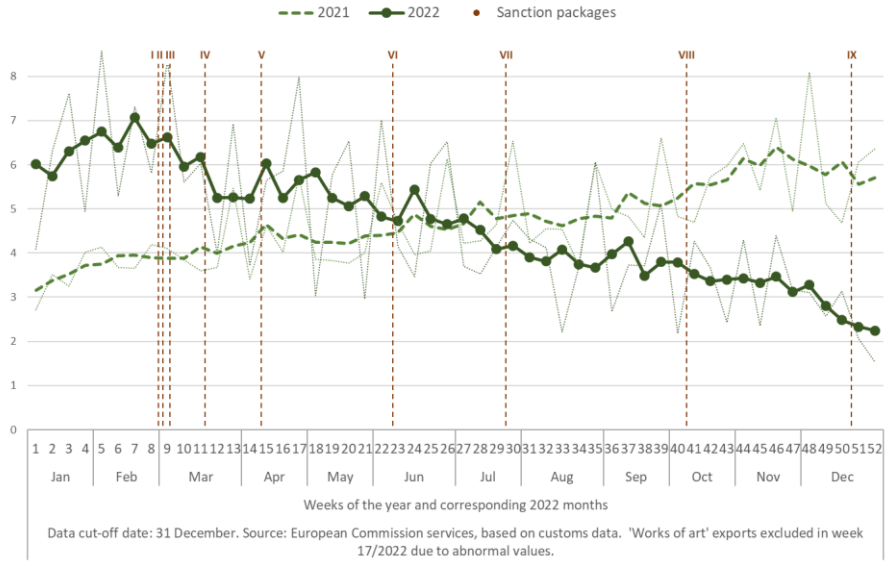
5 European Council conclusions, 24 February 2022, see https://www.consilium.europa.eu/en/press/press-releases/2022/02/24/european-council-conclusions-24-february-2022/.

6 Council Decision (CFSP) 2022/337 of 28 February 2022 amending Decision 2014/145/CFSP concerning restrictive measures in respect of actions undermining or threatening the territorial integrity, sovereignty and independence of Ukraine, see http://data.europa.eu/eli/dec/2022/337/oj. They built upon the already ongoing sanctions decided in 2014: Council Decision (CFSP) 2014/145 and Council Decision (CFSP) 2014/386.

7 Amendments to Council Regulation (EU) No 833/2014 of 31 July 2014: Official Journal of the European Union (OJEU), L 042I on 23/02/2022; OJEU, L050, L051, L052, L053, L054 on 25/02/2022; OJEU, L057, L058, L059, L060, L061 on 28/02/2022, L062, L063, L065, L066, L067 on 3/03/2022; OJEU, L081, L082 on 9/03/2022; OJEU, L087I on 15/03/2022; OJEU, L110, L111 on 8/04/2022; OJEU, L153 on 3/06/2022; OJEU, L193, L194 on 21/07/2022; OJEU, L204I on 4/08/2022; OJEU, L259I on 6/10/2022; OJEU, L311I on 3/12/2022; OJEU, L322I on 16/12/2022.

describing the specific exposures of the European economy. We look at these structural exposures from a risk assessment perspective, i.e. focusing on dependencies and related vulnerabilities, especially on the import side. We document the exposure of the Russian economy to the EU as well, to have an indication of the potential impact of European sanctions.

Chart 1: Weekly trade flows between the EU and Russia, 2021 and 2022



Note: the chart shows values in EUR billions, the bolder lines show 5-week moving averages, the lighter ones show the raw data.

Energy prices have increased considerably in the EU, even more than in other economies, putting strain on energy-intensive industries (Ferriani and Gazzani, 2022). Together with the price increase of critical raw materials and of products for which the EU has a dependency on Russia, this is contributing to inflationary pressures (Afunts et al, 2022; Bonatti and Tamborini, 2022; Feveile Adolfsen et al, 2022). The Member States of the EU have stepped in with sizeable fiscal measures to mitigate some impacts, mainly to curb the rise in energy costs, to address the refugee crisis, and to extend liquidity support in the form of guarantees (Checherita-Westphal et al, 2022). However, the Russian invasion of Ukraine will probably have more relevant implications in the long-term that in the short-term. De Jong et al. (2022) document the wider financial implications of the current crisis, and Bobasu and De Santis (2022) highlight the impact of the "uncertainty channel" resulting from the invasion. Di Bella et al. (2022) stress the need for alternative energy sources and for new critical infrastructure.

EU leaders committed[8] to reducing energy dependencies, notably "on Russian gas, oil and coal imports as soon as possible." This commitment was reinforced by the European Council in March.[9] In the case of coal, imports ended in August 2022 and seaborne crude oil deliveries stopped in December 2022. Beyond energy, EU leaders identified other sensitive areas in which strategic dependencies could be problematic, such as critical raw materials, semi-conductors, health, digital, and food supply chains.

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8 Versailles declaration available on https://www.consilium.europa.eu/media/54773/20220311-versailles-declaration-en.pdf

9 European Council conclusions available on

The rest of the paper is structured as follows: section 2 focuses on trade at the sectoral level, by looking at (i) bilateral trade flows and (ii) trade in value added to capture local income generation in a value chain perspective and the overall reliance at the sectoral level in terms of upstream sourcing relations. Section 3 then zooms into the product level to identify "exposures" of EU companies. The concept of "exposures" is upgraded to "dependencies" when a high level of exposure is combined with difficulties in reallocating sourcing options due to high levels of concentration at the global level.[10] Section 4 presents high-frequency data on customs, prices, and trade flows, to track the evolution of such exposures and dependencies vis-à-vis Russia, since the beginning of the invasion. Section 5 provides a summary of the results and of the implications of such trends.

The main findings of the paper are that: (I) EU exports to Russia have quickly fallen in volume and value, right after the first packages of sanctions; (II) EU imports have fallen in volume, but their value has increased, due to the rise in energy prices; (III) the combination of these two trends has created an additional bilateral trade surplus for Russia in 2022, which has strengthened its currency; (IV) in the most recent weeks, nevertheless, the accumulation of this bilateral trade deficit by the EU has stopped, thanks to the sizeable effort to further reduce imports from Russia; (V) pipeline gas imports from Russia into the EU are being substituted by LNG imports, mainly from the US.

While it is still too early to fully assess the impact of the sanctions, this paper documents in detail the ongoing trends. On the one side, the European economy is performing a sizeable adjustment in its supply chains, mainly but not only in the case of energy sources. On the other side, the Russian economy is gradually losing one of its main foreign sources of income. To what extent Russia can substitute the EU with other trade partners remains an open question.

2. EU exposures at macroeconomic level

This section studies the structural exposure of the European Union at the sectoral level, in terms of bilateral trade in final goods and services, but also looking at intermediate products and services, traded in international value chains. It assesses the position of the EU in trade networks from a risk assessment perspective.

2.1. Bilateral trade

Russia has been a significant trade partner for the EU, and vice versa. In 2021, Russia was the fifth largest partner for EU exports of goods (4.1%)[11] and the third largest partner for EU imports of goods (7.5%)[12]. Half of Russian overall exports to the rest of the world consist of

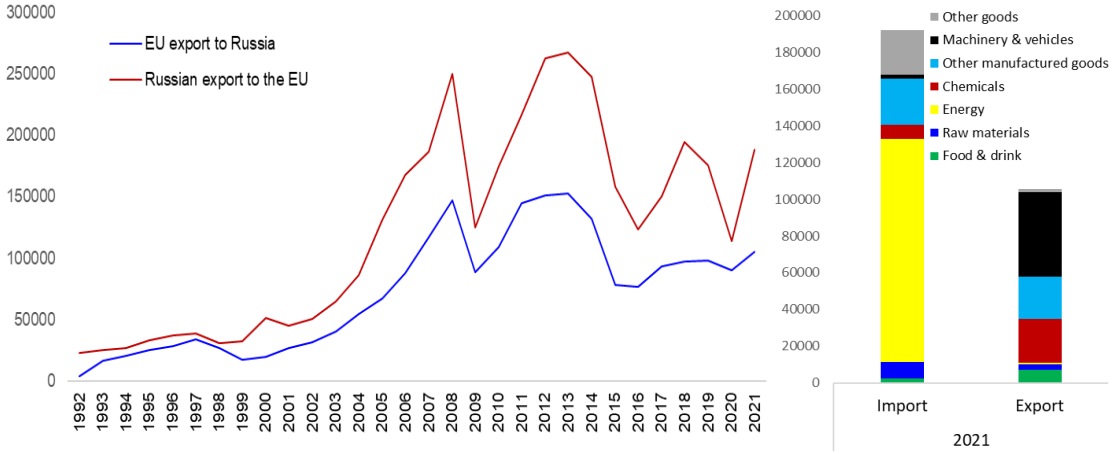
[10] For a more extensive reflection on the concept and the underlying methodology, see EC SWD(2022) 41. It builds upon the European Commission Communication COM(2021)350. Further fine-tuning of the methodology, in the context of the resilience of supply chains in the energy technology domain, in particular spelling out the concepts of "strategic" and "critical" supply chains is provided in Gérard et al. (2021).

[11] Preceded by the United States (18.3%), the United Kingdom (13.0%), China (10.2%) and Switzerland (7.2%). Source: Eurostat.

[12] Preceded by China (22.4%) and the United States (11.0%) and followed by the United Kingdom (6.9%) and Switzerland (5.9%). Source: Eurostat.

minerals, mainly petroleum but also gas and coal, while on the import side it mainly buys services (tourism), machinery and chemicals. Half of the entire Russian trade (for both export and import) used to take place with the EU. China is the second most important trade partner for Russia (accounting for 15% of total Russian exports and 22% of total imports). In contrast, Russian trade with the United States is very small in comparison with European or Asian countries.

Chart 2: EU-Russia bilateral trade



Source: European Commission services, based on IMF and Eurostat data. Note: the left hand pane shows the evolution of bilateral trade between the EU and Russia (in current prices, million USD); the right hand pane shows the specific composition of EU bilateral exports and imports from Russia in 2021 (in current prices, million USD).

While the overall trend between the EU and Russia has experienced some fluctuations[13], Russian exports to the EU have consistently exceeded imports, leading to a sustained Russian bilateral trade surplus. The composition of trade in the two directions is significantly different. Russia mostly exports commodities to the EU, and in particular extractive raw materials, whereas the EU exports investment goods (machinery and equipment), pharmaceutical products, and a whole range of differentiated consumer goods. As a result, trade in the two directions is subject to different levels of volatility, with relatively more stable EU exports to Russia and highly volatile values of Russian exports to the EU, closely following commodity prices fluctuations (

Chart **2**).

The largest trade flows of Russia with the EU are exports to the Netherlands, Germany, and Italy, and imports from Germany. The long-term trends confirm that Russian exports to the EU are much more volatile than imports, probably linked to the variation of energy prices, given that energy accounts for the majority of Russian exports to the EU (see Annex I).

Russia is an important source of raw materials for the EU, especially in the metallurgic, automotive, and chemicals sectors. Several shortages and disruptions in international supply chains were already visible before the start of the Russian invasion of Ukraine, due to the consequences of the pandemic and related containment measures. The invasion has contributed to intensifying such disruptions.

[13] Trade between the EU and Russia increased considerably between the collapse of the Soviet Union in the early 90's and the Great Financial Crisis of 2008. An abrupt fall ensued in 2009, followed by a robust recovery until 2014, when the illegal annexation of Crimea and the corresponding sanctions caused another sharp decrease in bilateral trade.

Table 1: Total EU countries' imports from and exports to Russia, in 2021

Importer	*Share of Russia in total imports*	*Share of Russia in total exports*
European Union	3.0%	1.7%
Austria	2.1%	1.3%
Belgium	1.9%	1.0%
Bulgaria	8.1%	1.3%
Croatia	1.8%	1.1%
Cyprus	1.1%	2.0%
Czechia	1.7%	1.9%
Denmark	1.9%	1.0%
Estonia	10.6%	4.2%
Finland	12.7%	5.8%
France	1.5%	1.3%
Germany	2.6%	2.0%
Greece	6.7%	0.5%
Hungary	3.7%	1.5%
Ireland	0.6%	0.3%
Italy	3.2%	1.6%
Latvia	9.6%	10.9%
Lithuania	12.1%	10.8%
Luxembourg	0.1%	1.2%
Malta	0.2%	0.3%
Netherlands	4.3%	1.2%
Poland	6.2%	3.0%
Portugal	1.3%	0.3%
Romania	3.4%	1.4%
Slovakia	5.2%	1.7%
Slovenia	0.9%	1.9%
Spain	1.7%	0.7%
Sweden	1.3%	1.5%

Source: European Commission services, based on Eurostat COMEXT data. Note: data include intra-EU trade.

At country level, Latvia and Lithuania are the most exposed to trade with Russia, which accounted for about 10% of their total exports and imports in 2021. Finland, Estonia and Bulgaria follow as the next most exposed countries (Russia is an important source of raw materials for the EU, especially in the metallurgic, automotive, and chemicals sectors. Several shortages and disruptions in international supply chains were already visible before the start of the Russian invasion of Ukraine, due to the consequences of the pandemic and related containment measures. The invasion has contributed to intensifying such disruptions.

Table 1).

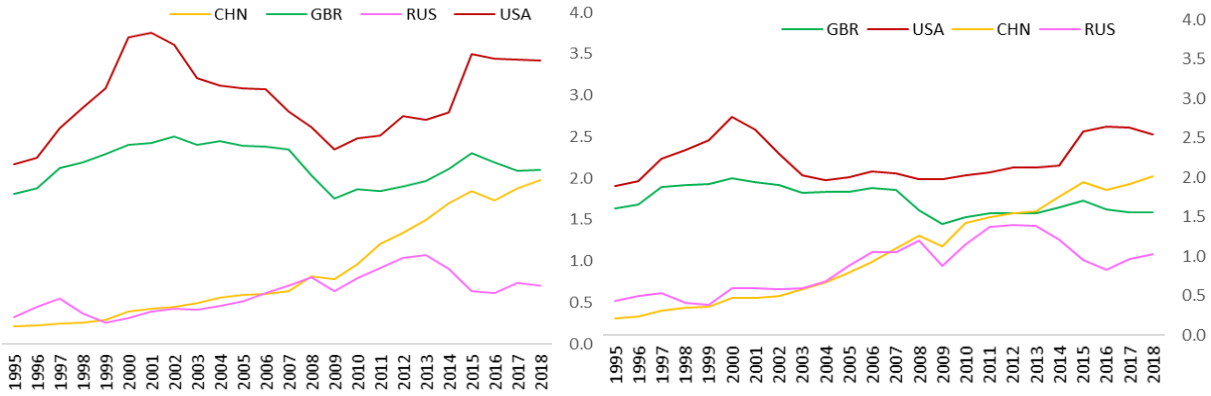
2.2. Trade in value added

In order to better disentangle the actual international exposures in terms of local income generation, it is worth looking at trade in value added, considering not only EU-Russia flows, but also other major global trade partners of the EU. In the case of supply chains, the most relevant indicator of exposure refers to the share of total value added produced by the country which is due to inputs provided by the counterpart. In the case of demand, the relevant indicator of exposure refers to the share of total income in one country which is due to the demand originating in the counterpart. In each case, we analyse both ways, i.e. the

exposure of other regions to Russia and of Russia to those regions. We replicate the analysis for each Member State of the European Union. This allows us to draw a more precise picture of trade dependencies.

The main trade partner for the EU is the US, which accounts for roughly 3.5% of total final demand for the EU production and contributes to about 2.5% of value added produced by the EU. The second main partner is the United Kingdom, and also in this case its relevance is mainly as final market for EU products than as provider of intermediate inputs for production (Chart 3).

Chart 3: The EU's exposure to main partners: final demand (left) and supply inputs (right) – 1995-2018



Source: European Commission services, based on OECD TiVA data. Note: the chart on the left shows the share of each trade partner in the total final demand for the EU production. The chart on the right shows the share of EU value added due to intermediate products originating from the trade partners through supply chains.

The most relevant trend we can observe over the past twenty years is the growing importance of China and Russia as trade partners. Russia and China are important providers of production inputs through supply chains. This is contrary to the nature of European trade with the US and UK, which are important export markets. Comparatively, the relevance of China and Russia is therefore more visible on the supply than on the demand side.

The EU is by far the most important trade partner for Russia. Russian exposure to the EU, however, has been consistently decreasing since the early 2000s (see Annex II). Over the past few years, China has gradually replaced the US as Russia's second major trading partner, both on the supply and on the demand side. The UK remains a very distant and not-so-relevant trade partner for Russia.

The EU is exposed to Russian inputs of intermediate products for 1.0% of the total value added it produces, while Russian final demand accounts for 0.7% of total EU value added (i.e., income from salaries, profits). On the opposite side, however, Russia is much more dependent on the EU: 7.4% of total Russian demand is due to direct inputs originating from the EU, and the EU final demand absorbs 9.4% of the total Russian value added. No other region is as important for Russia as the EU.

At the level of individual EU Member States, we see large differences in bilateral exposures (**Error! Not a valid bookmark self-reference.**). Cyprus, Lithuania, Latvia, Estonia and Bulgaria are the Member States for which Russian demand is the highest as a share of GDP, amounting to 2% of GDP or more. On the supply side, Lithuania, Bulgaria, Cyprus and Latvia are the most exposed Member States to Russian value added, which contribute to more than

4% of their total demand. Among the largest economies, Germany is the most exposed to Russian inputs (see Annex II, for more details).

Table 2: Cross exposure with Russia, origins of value added in final demand, 2018

	EXPOSED TO RUSSIA		*RUSSIA EXPOSED TO*	
	SUPPLY	*DEMAND*	*SUPPLY*	*DEMAND*
European Union	1.0%	0.7%	7.4%	9.4%
Austria	0.9%	0.8%	0.2%	0.2%
Belgium	0.9%	0.5%	0.2%	0.3%
Bulgaria	5.7%	2.0%	0.1%	0.2%
Croatia	1.2%	0.9%	0.0%	0.0%
Cyprus	4.4%	5.6%	0.1%	0.1%
Czechia	2.0%	1.3%	0.2%	0.3%
Denmark	0.9%	0.5%	0.1%	0.2%
Estonia	3.8%	2.1%	0.0%	0.1%
Finland	2.2%	1.6%	0.3%	0.4%
France	0.6%	0.5%	0.9%	1.0%
Germany	1.0%	0.7%	1.9%	2.2%
Greece	1.9%	0.9%	0.1%	0.2%
Hungary	2.6%	1.0%	0.1%	0.2%
Ireland	0.6%	1.4%	0.4%	0.1%
Italy	0.9%	0.6%	0.8%	1.0%
Latvia	4.1%	2.1%	0.1%	0.1%
Lithuania	6.2%	2.4%	0.1%	0.2%
Luxembourg	0.6%	0.8%	0.0%	0.0%
Malta	1.4%	0.8%	0.0%	0.0%
Netherlands	1.0%	0.6%	0.4%	0.5%
Poland	2.3%	1.0%	0.4%	0.8%
Portugal	0.7%	0.4%	0.1%	0.1%
Romania	1.6%	0.7%	0.1%	0.2%
Slovak Republic	3.1%	1.4%	0.1%	0.2%
Slovenia	1.3%	1.5%	0.1%	0.0%
Spain	0.5%	0.5%	0.5%	0.4%
Sweden	1.0%	0.6%	0.2%	0.3%
Japan	0.4%	0.2%	0.7%	1.1%
China	0.5%	0.4%	3.3%	4.2%
Turkey	1.9%	1.1%	0.6%	0.9%
United Kingdom	0.6%	0.3%	0.7%	1.0%
United States	0.2%	0.1%	1.7%	2.4%

Source: European Commission services, based on OECD TiVA 2018 data. Note: the first two columns show the relevance of Russia as a source of value added (supply) and income (demand) for each EU Member State. The last two columns show the relevance of each EU Member State as a source of value added (supply) and income (demand) for Russia.

2.3. Sectoral exposures

We then look at the EU exposure to Russia and vice versa in international supply chains from a sectoral perspective. The EU industry is exposed to Russian inputs for 3% of total value added produced, which is considerably more than the exposure to other major partners, while Russian industry is exposed to the EU's inputs for almost 11% of the total value added produced, more than to any other country, even if Russian exposure to Chinese inputs is also quite high (See Table 3). The exposures of the EU industry concentrate in the

energy intensive sectors (see Annex III, Table A), while Russian exposures concentrate in machinery, motor vehicles, equipment, and pharmaceuticals.[14]

Table 3: Cross bilateral exposures vis-à-vis Russia in integrated value chains

Exposure to Russia				Sector	Russia exposed to			
EU	UK	US	CN		EU	UK	US	CN
1.0	0.6	0.2	0.5	TOTAL ECONOMY	7.4	0.7	1.7	3.3
3.0	1.8	0.6	0.9	Total industry (mining, manufactures and utilities)	10.8	0.6	2.2	7.1
0.5	0.3	0.1	0.3	Total services (incl. construction)	6.3	0.7	1.6	1.8
0.5	0.3	0.1	0.3	Total services	6.8	0.8	1.8	2.0
0.4	0.3	0.1	0.2	Information, finance, real estate and other business services	8.1	1.3	2.8	2.0
0.4	0.2	0.1	0.1	Information industries	13.5	1.6	5.7	8.3

Source: European Commission services, based on OECD TiVA data. Note: in the first 4 columns, the table shows the share of foreign value added (VA) in Russian final demand (including consumption and investments) in terms of local total value added. The last 4 columns show Russian value added in foreign final demand as a share of Russian total VA. Data refer to the last available year: 2018.

Looking at the specific sectoral exposure to Russia, the sector with the highest share of Russian value added in EU final demand is “Mining and quarrying, energy producing products”, where one unit of demand incorporates on average 18.5% of value added generated in Russia, with Member States exposures ranging between 7.1% and 62.7% (Chart 4). “Coke and refined petroleum products” feature a similar level of exposure to Russian value added as “Mining and quarrying, energy producing products” at the EU level, but with a narrower range between the most exposed (47%) and the least exposed (9.1%) Member State. “Mining support service activities” follow, with an exposure of 12.5% at the EU level (Member States ranging between 6.2% and 42.6%). The other sectors are all below 10% at the EU level, but with relevant cross-country differences.

[14] For more information on the pairwise correlations between the four major economic regions, see Annex IV.

Chart 4: Exposure to Russian value added in final demand (the EU and Member States)

Source: European Commission services, based on OECD TiVA tables (2021 version). Note: The total content of energy in each sector is decomposed into its domestic and its foreign shares. Data refer to the latest available year: 2018.

3. EU exposures and dependencies at product level

While sector-level exposures provide an indication of the potential presence of dependencies and difficulties to replace sourcing partners, for a fully-fledged analysis of exposures and dependencies we focus on the product level[15]. In order to monitor EU vulnerabilities in the domain of trade with Russia, there are three categories of product that deserve attention:

- Main traded products, in terms of values of imports and exports, due to their potential macroeconomic and systemic relevance;
- Products on which the EU has a "dependency" vis-à-vis Russia (i.e., the EU imports a significant amount and Russia has a significant global share of the exports);
- Products that are critical for key industrial processes and are globally scarce, including those identified in the European Commission list of critical raw materials[16].

This allow us to see not only how much of a given product the EU is purchasing from Russia, but also the global shares of the top 5 exporters of such products.[17]

[15] For this analysis, we use the World Customs Organization's Harmonized System (HS) at 6 digits level (or HS6) because that is the most fine-grained level of product aggregation for which data is consistently classified by customs in the world.

[16] COM(2020) 474).

[17] In order to get consistent figures about trade flows, we use the CEPII BACI dataset, where the values of the bilateral import and export declarations are reconciled across all countries of the world.

3.1. Product-level exposures to Russia

EU imports from Russia are concentrated in energy-producing commodities, the most imported products being fossil fuels (oils, natural gas and coal), as shown in Table 4. The only non-fossil fuel import among the first five ones is “copper”, a non-energy producing commodity. The highest import values are for oils and petroleum (the top two products amount to roughly $98.4bn combined), followed by natural gas ($12.4bn). Overall, the sum of the value of the five largest imports (€117.6bn) accounted for more than 80% of all EU imports in goods from Russia (€144.9bn) in 2019.

Table 4: Main EU imports from Russia, 2019

HS6 Code	*Product Description*	*EU Import Value from Russia ($M)*	*Total extra-EU import value ($M)*	*Russia's share in extra-EU import*	*Top 5 world exporters*
270900	**Oils**	61,200	228,000	27%	Saudi Arabia (15%), Russia (13%), Iraq (8%), Canada (7%), UAE (6%)
271000	**Petroleum oils and oils from bituminous minerals, not crude**	37,200	89,400	42%	US (14%), EU (13%), Russia (11%), Singapore (7%), India (7%)
271121	**Natural gas**	12,400	35,000	36%	Norway (23%), Russia (19%), Turkmenistan (9%), Canada (8%), US (7%)
270112	**Coal**	4,311	12,700	34%	Australia (44%), Russia (15%), US (11%), Indonesia (7%), Canada (6%)
740311	**Copper**	2,497	6,392	39%	Chile (27%), Russia (8%), Dem. Rep. of Congo (7%), Japan (6%), EU (5%)
270799	**Oils, other products of the distillation of high temperature coal tar**	2,001	2,940	68%	Russia (42%), EU (19%), US (7%), India (5%), Indonesia (5%)
710231	**Diamonds**	1,840	6,021	31%	EU (25%), UAE (20%), (12%), Russia (10%), Angola (5%)
271111	**Liquefied, natural gas**	1,569	15,500	10%	Australia (26%), Qatar (21%), Malaysia (8%), US (8%), Russia (6%)
760110	**Aluminium: unwrought, (not alloyed)**	1,369	5,705	24%	Russia (16%), India (14%), Canada (14%), Australia (11%), Iceland (6%)
720712	**Semi-finished products of iron or non-alloy steel**	1,270	2,808	45%	Russia (32%), Brazil (26%), Ukraine (13%), Japan (10%), Mexico (5%)

Source: European Commission services, based on CEPII BACI (2019) database.

Turning to EU exports to Russia (Table 5), we see that chemical and pharmaceutical products and investment goods are the main ones. However, EU exports to Russia are highly differentiated, and even the product with the highest value did not reach $6bn in export value in 2019. Overall, the 5 most exported EU products to Russia amounted to just €10.2bn in 2019, which was less than 12% of the total (€87.8bn). It should be noted that these specialised, differentiated products feature a much lower substitutability than commodities because they embed technical and innovation expertise that cannot be easily replicated in the short term (e.g., aircrafts, data processing machines, or vehicle parts).

Table 5: Main EU exports to Russia, 2019

HS6 Code	*Product Description*	*EU export value to Russia ($M)*	*Total extra-EU export value ($M)*	*Russia's share in extra-EU export*	*Top 5 world exporters*
300490	**Medicaments for therapeutic or prophylactic uses**	5,716	98,900	6%	EU (44%), Switzerland (18%), US (11%), UK (7%), India (6%)
870323	**Vehicle with only spark-ignition internal combustion**	1,762	77,600	2%	EU (31%), Japan (22%), Mexico (12%), US (8%), Rep. of Korea (8%)
880240	**Aeroplanes and other aircraft exceeding 15,000kg**	1,052	55,000	2%	EU (51%), US (31%), Canada (5%), Brazil (3%), Kuwait (2%)
300215	**Immunological products**	893	30,200	3%	EU (43%), Switzerland (29%), US (19%), UK (3%), Japan (3%)
870829	**Vehicles parts and accessories**	831	10,100	8%	EU (21%), US (19%), Mexico (14%), China (11%), Canada (9%)
848180	**Taps, cocks, valves and similar appliances**	809	11,800	7%	EU (27%), China (25%), US (15%), Japan (5%), Mexico (4%)
870120	**Tractors**	801	6,238	13%	Mexico (45%), EU (27%), US (12%), China (4%), Turkey (4%)
847989	**Machines and mechanical appliances**	647	10,700	6%	EU (29%), Japan (15%), China (12%), Rep. of Korea (12%), US (11%)
870710	**Vehicles: bodies (including cabs) for the motor vehicles**	631	1,791	35%	EU (56%), US (22%), Russia (6%), Rep. of Korea (5%), Japan (4%)
847150	**Units of automatic data processing machines**	626	6,659	9%	Mexico (40%), China (25%), US (9%), EU (9%), N/A (5%)

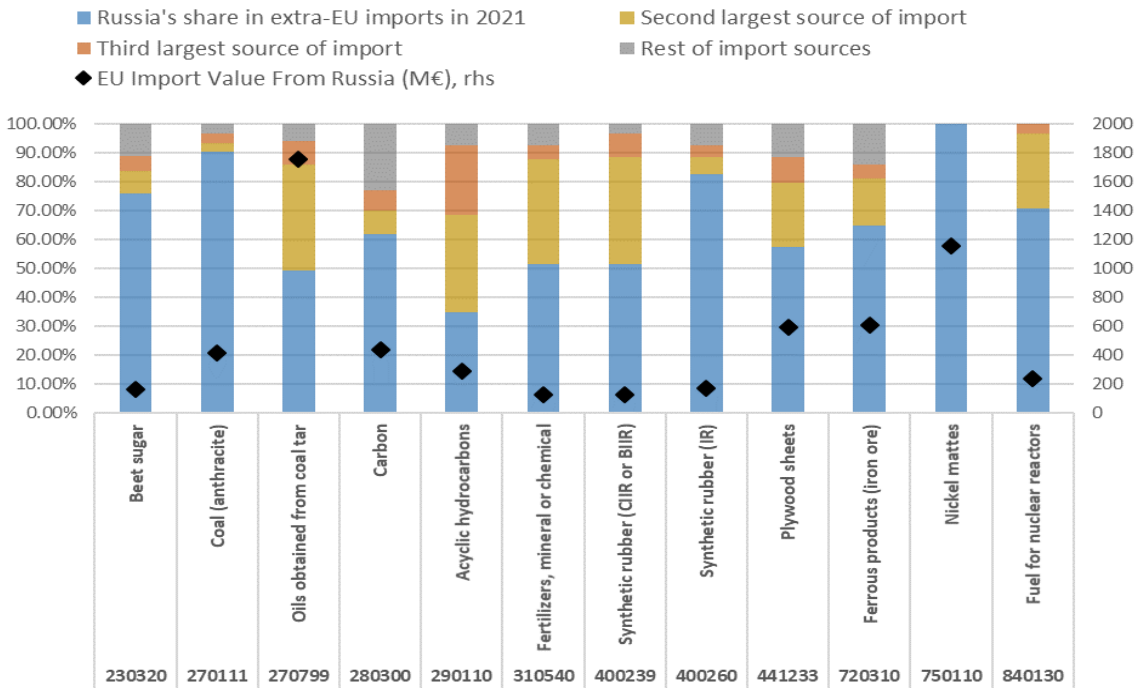
Source: European Commission services, based on CEPII BACI (2019) database.

3.2. Product-level dependencies from Russia

Recent analyses (Winkler et al, 2022) show that the impact of Russia's war through its participation in global value chains relates to its 'upstream' position. Those value chains that are more reliant on products from Russia with fewer substitutes, such as rare metals, are therefore more exposed. For this reason, we track the set of products for which the EU has a dependency on Russia. The selection of products is based on the European Commission methodology[18]. Strategic dependencies are defined as combinations of high exposure (imports from extra-EU), concentration of imports (Herfindahl index),[19] and availability of domestic substitutes.

[18] Presented in SWD(2021) 352.
[19] For a detailed explanation of the index and of its construction, see Hirschman (1964).

Chart 3: Imports from Russia on which the EU had a dependency in 2021



Source: European Commission services, based on customs data.

Chart 3 shows the imports for which the EU had a dependency on Russia in 2021, for bilateral import flows above €100M, with information on the share of the second and third largest sources of imports into the EU of the selected products. It shows shares in total extra-EU import and the EU import value of imports from Russia, and provides an idea of the level of concentration of import origins, making it easier to understand where the vulnerability of supply originates. It shows, for example, that for products such as acyclic hydrocarbons (e.g., propene, ethylene), the market share of Russian imports is just below 35%, but the US and Norway have a combined 61%, so these three countries alone cover almost the entirety of EU imports.[20]

3.3. Critical Raw Materials

Finally, we identify critical raw materials on which the EU has an exposure vis-à-vis Russia, together with Russia's share in total extra-EU import in 2021 and its ranking among exporters to the EU of such raw materials.[21]

[20] The figures used for Chart 3 are reported in Annex V, Table 10, which reports the list of products for which the EU has a dependency on Russia, for bilateral import flows above €100M, indicating the EU import value from Russia, Russia's share in total extra-EU import in 2021, Russia's share in total extra-EU import since the 2022 Russian invasion of Ukraine, and the shares of the top 5 countries origin for each product in 2021. Note that Table 5 and Table /Chart 3 are based on different reference years because they are derived from different datasets. Table 5 is based on the CEPII BACI reconciling all bilateral trade flows in the year 2019 (i.e., ensuring that imports and export declarations from any country pair match, which is never the case in non-adjusted trade datasets). Table is based on EU customs declarations in 2021, without a reconciliation with the customs declaration of trade counterparts. Small differences such as in "270799 - Oils" (€2bn in BACI vs 1.8bn in customs data) is due to these differences.

[21] Among the products present in the public list of critical raw materials presented in COM(2020)474. Note that raw materials are often spread across several trade product codes. For the current exercise, all the product codes associated with each raw material have been combined, with homogeneous weights.

Table 6: List of critical raw materials imported in the EU from Russia

Critical raw material imported from Russia	*Russia's share of EU imports (%, 2021)*	*Russia's ranking among countries of origins*
Aluminium and bauxite	7.1%	3
Cobalt	0.02%	8
Coking coal	11.6%	3
Germanium	0.2%	9
Platinum	10.5%	4
Palladium (platinum-group element)	37.4%	1
Rhodium (platinum-group element)	15.3%	3
Other platinum-group elements (iridium, osmium, ruthenium)	8.6%	4
Magnesium	1.1%	4
Natural graphite	1.4%	11
Phosphate rock	40.7%	1
Rare earth elements	0.9%	8

Source: European Commission services, based on customs data.

Table 7 presents a list of additional selected raw materials imported from Russia, not officially classified as critical, but with great significance for the EU industry. It can be noted that export of some of these commodities has been banned or restricted by the Russian authorities as part of their countermeasures in reaction to EU sanctions, as for example inert gases (helium, neon, krypton, xenon) and potash.

Table 7: List of selected raw materials imported in the EU from Russia

Selected raw materials	*Russian import share (%, 2021)*	*Russia's ranking among countries of origins*
Cadmium	13.8%	2
Copper	36.6%	1
Helium	1.0%	6
Iron	12.7%	5
Manganese	1.2%	8
Molybdenum	1.9%	8
Neon, krypton, xenon	20.3%	3
Nickel	54.3%	1
Potash	23.3%	3
Selenium	31.0%	1

Source: European Commission services, based on customs data.

Among the critical and selected raw materials listed in Tables 7 and 8, Russia is the main supplier of palladium, phosphate rocks, copper, nickel and selenium, reaching very high imports shares in the EU in cases such as nickel (more than 50%), phosphate rock (more than 40%) and palladium (more than 37%), in 2019.[22]

[22] A methodological approach to track the evolution of supply chain distress at the product and sectoral levels, with a particular focus on raw material sourcing, can be found in Amaral et al. (2022).

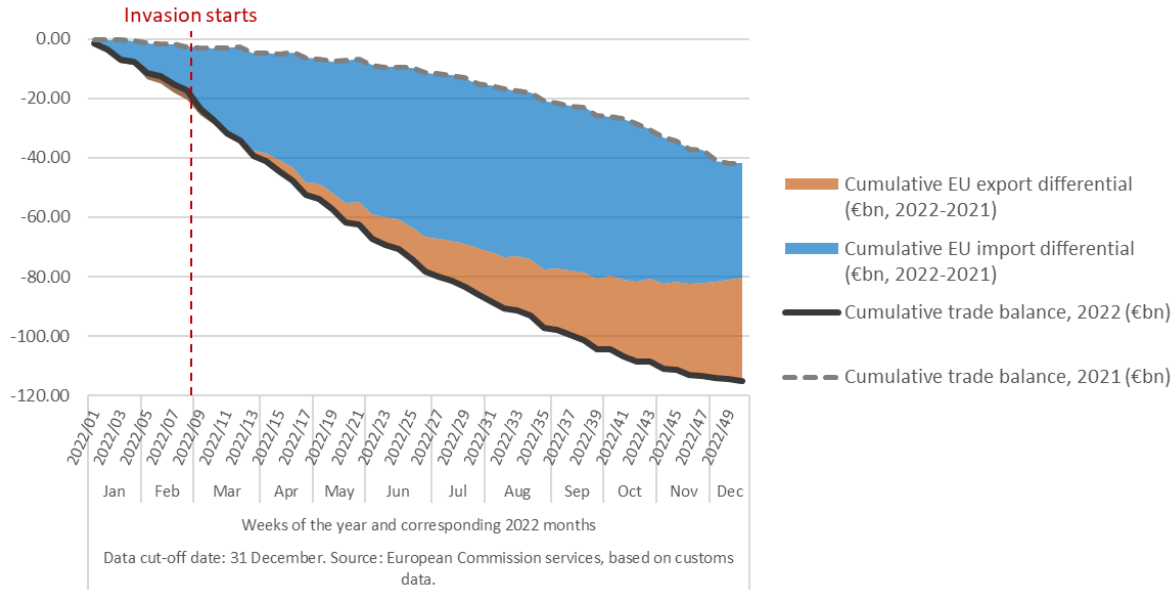
4. Monitoring recent trends

One of the most relevant implications of the Russian invasion of Ukraine and subsequent developments refers to the evolution of the trade balance. Thanks to the availability of real-time trade data, we can compare the evolution of aggregate trade flows between the EU and Russia since the beginning of the invasion with the same period in the previous year (Chart 4). As a consequence of the invasion, and of the progressive decoupling between the two economies, we would expect a large reduction of bilateral trade. At the same time, however, the price of many items has considerably increased, therefore the final value of imports and exports may have not decreased as one would expect.

4.1. Gross trade flows

When we compare the period since the beginning of the invasion (end-February to end-December) with the same months in 2021, we see that the total value of EU exports to Russia has decreased by 45.7% (€39bn). This result is consistent with an estimation of the reduction in exports to Russia calculated with a synthetic control method used by Borin et al. (2022b), who estimate a 40% decrease. On the other side, the total value of EU imports from Russia has increased by 10% (€13bn).

Chart 4: Bilateral trade balance of the EU with Russia, in comparison with 2021 (€bn)

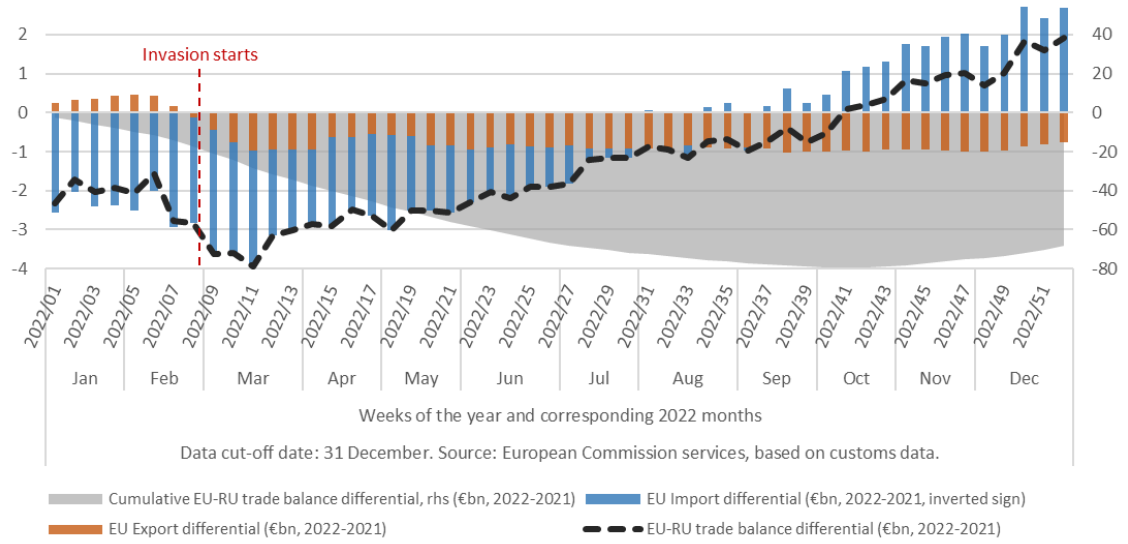


Overall, since the beginning of 2022, the EU has accumulated an additional trade deficit vis-à-vis Russia with respect to the previous year. This additional trade deficit amounts to roughly €67bn (about 3.7% of Russia's 2021 GDP). The first €20bn of this additional deficit are entirely due to higher imports between the beginning of 2022 and the invasion, which happened at the end of February. A further €20bn were accumulated in the course of March due to a steep increase in fossil fuels import prices. The pace of deficit accumulation

gradually slowed down in the subsequent months, as the reduction in imports from Russia has eventually outpaced the reduction in EU exports to Russia.[23]

In particular, after the Russian invasion of Ukraine EU exports to Russia suddenly contracted and remained roughly €1bn/week below 2021 levels (see *Chart 5*). This contraction was due to the EU export restrictions on military, industrial and technological products that could be used for military capability enhancement, in addition to luxury goods.[24] Imports from Russia adjusted more gradually, due to the high share of energy products (oil, gas and coal accounted for 85% of EU imports from Russia) and the difficulty to find alternative sources.[25]

Chart 5: Contribution of exports, imports to EU-Russia trade balance (€bn, 2022-2021, 5-week moving average)



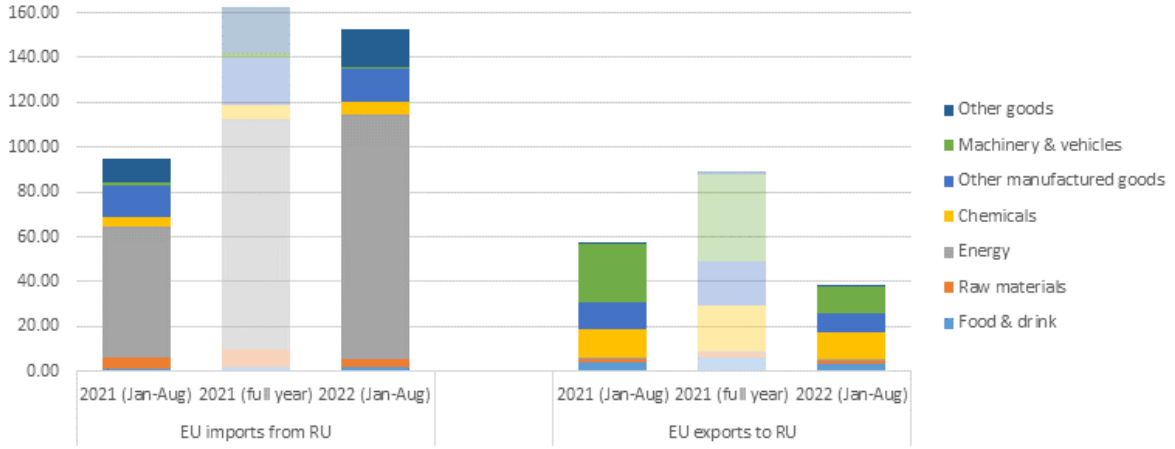
One way to understand the different trends of EU exports and imports vis-à-vis Russia is to observe the adjustment in the composition of trade flows in the first eight months of 2022. **Error! Reference source not found.** shows that while the value of energy imports from Russia in the first eight months of 2022 is almost twice as much as in the same period of 2021, the EU exports to Russia contracted almost exclusively in the area of "machinery and vehicles", which were the focus of export restrictions. This is also due to lower volatility of prices for differentiated goods trade, as opposed to commodities (and fossil fuels in particular).

[23] The cut-off date of this analysis is 31 December 2022.

[24] Specialised services such as accounting and insurance were also included in the export restrictions, but our analysis focuses only on trade in goods, for which real-time data can be directly obtained (as opposed to survey-based information on trade in services, which is elaborated with a significant time lag).

[25] These figures are based on customs data collected by the European Commission's Directorate General for Taxation and Custom Union (TAXUD), hence the exact timing of reporting reflects firm invoicing. As consistency check, in Annex I this data is compared with ENTSOG data on physical flows into EU gas pipelines, as collected and aggregated by Bruegel. Physical flow data confirms the insights from customs invoicing data.

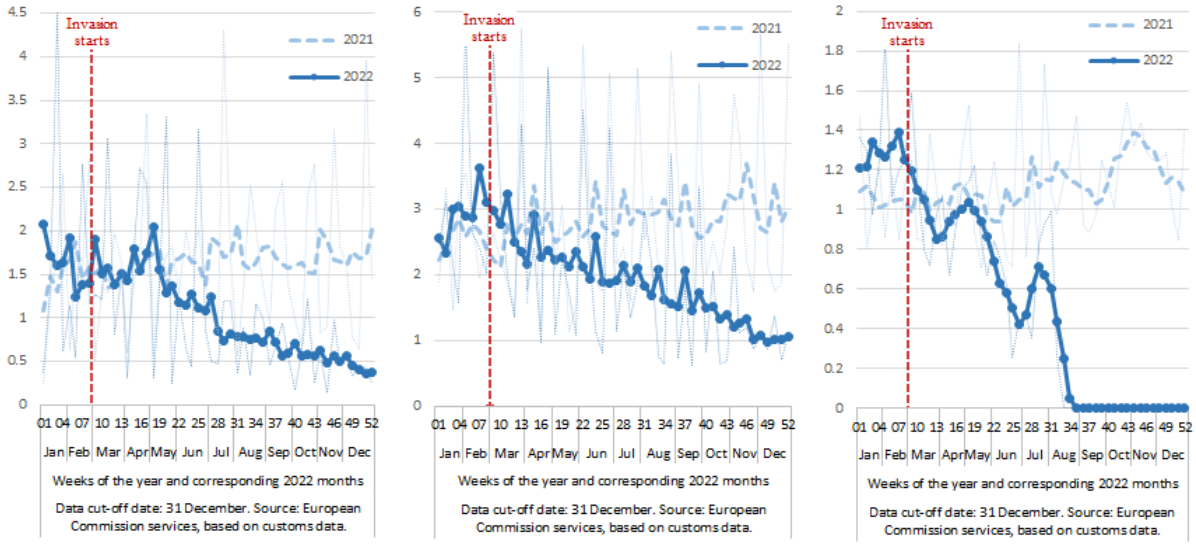
Chart 6: EU trade with Russia, change in the composition of imports and exports between 2021 and 2022 (€bn)



Source: European Commission, based on Eurostat COMEXT data, SITC product classification.

After a sudden decrease of export to Russia (week 8), export in goods to Russia stabilised at 50% of the pre-invasion level of the beginning of 2022. The value of EU imports from Russia has been gradually decreasing since February 2022, notwithstanding higher import prices of fossil fuel imports in the first half of 2022. In terms of volumes (Chart 7), by end-December gas and oil imports were less than 1/3 of pre-invasion levels, while imports of coal stopped altogether since the entry into force of related sanctions on 10 August.

Chart 7: Weekly EU imports fossil fuels (gas, oil, coal) from Russia, volumes



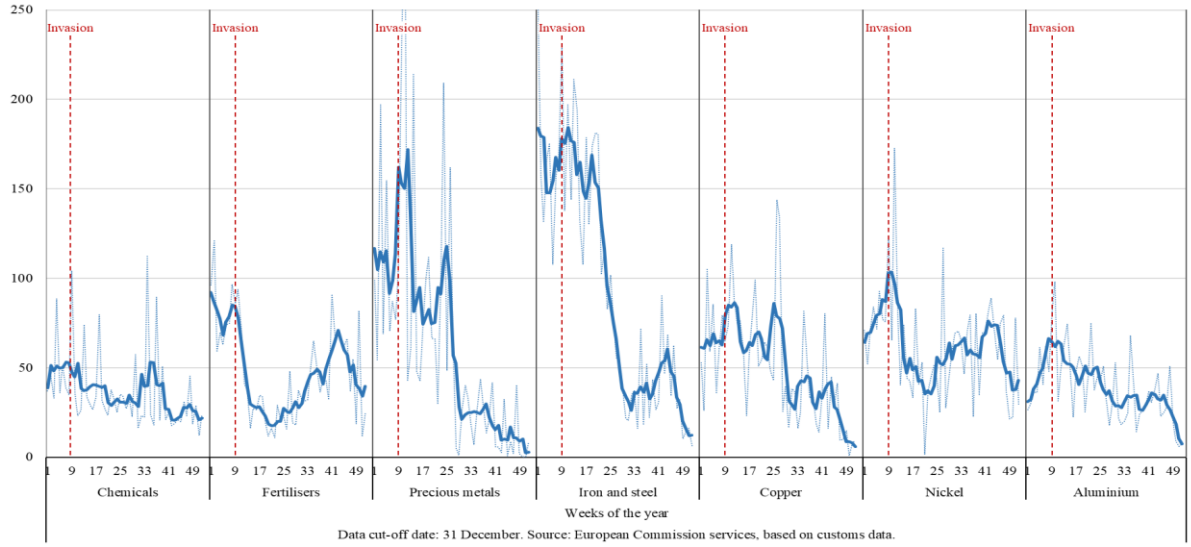
4.2. Trade flows at product level

We then focus on the bilateral EU-Russia trade at the product level, in this way complementing the work by Attinasi et al. (2022b), who look at Russian trade developments with a larger set of trading partners, and Darvas and Martins (2022), who track Russian external trade developments by monitoring flows with main trading partners. We monitor

exports and imports almost in real time, by using data of national customs authorities in the EU.[26]

Looking at main imports, excluding the fossil fuels, analysed in the previous section, we can note that imports of non-energy raw materials decreased since the invasion (see Chart 8). Some decreases are due to Russian countermeasures (such as the ban on exports on some type of fertilisers, wood and steel products in the first weeks after the invasion). Others are due to EU import restrictions, such as on precious metals and coal.

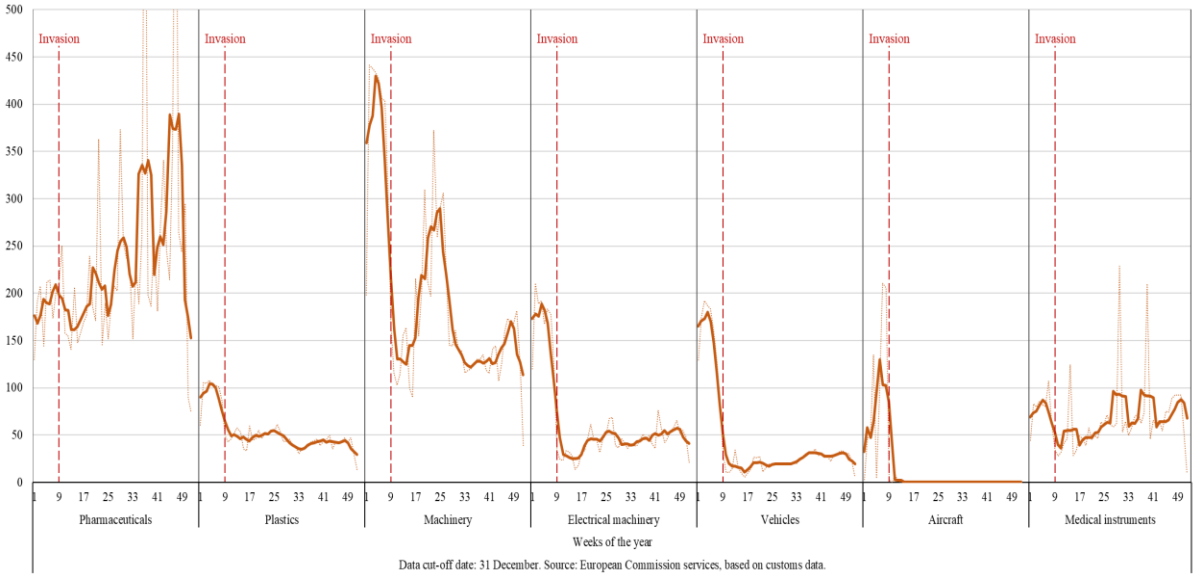
Chart 8: Most important Chapters of import from Russia (€M, 5-week moving average)



Almost all main EU exports to Russia have decreased substantially since mid-February. While the overall trend is probably driven by disruptions linked financial sanctions (*de-Swifting* of important Russian banks), certain EU exports to Russia have been particularly affected by trade restrictions. This is in particular the case of industrial, investment and high-tech goods, in addition to products that could be used as input for the military industry, such as vehicles and aircraft.

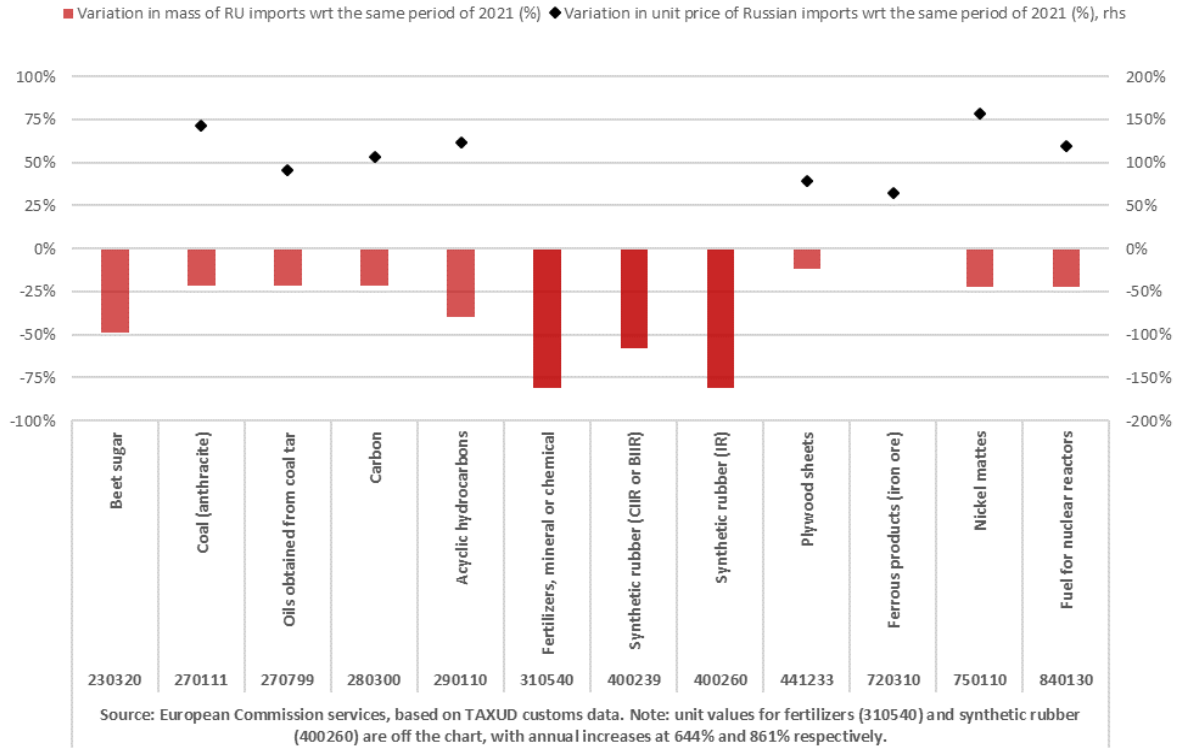
[26] We monitor the evolution of trends in relevant products, such as the main imports and exports; goods on which the EU has exposures or dependencies vis-à-vis Russia; and critical raw materials. The data is transmitted daily to the European Commission's Directorate General for Taxation and Custom Union (TAXUD). However, a couple of weeks are needed for corrections to be applied and the data to stabilise, before it is consolidated and released to the public through the Eurostat Comext dataset.

Chart 9: Most important Chapters of export to Russia (€M, 5-week moving average)



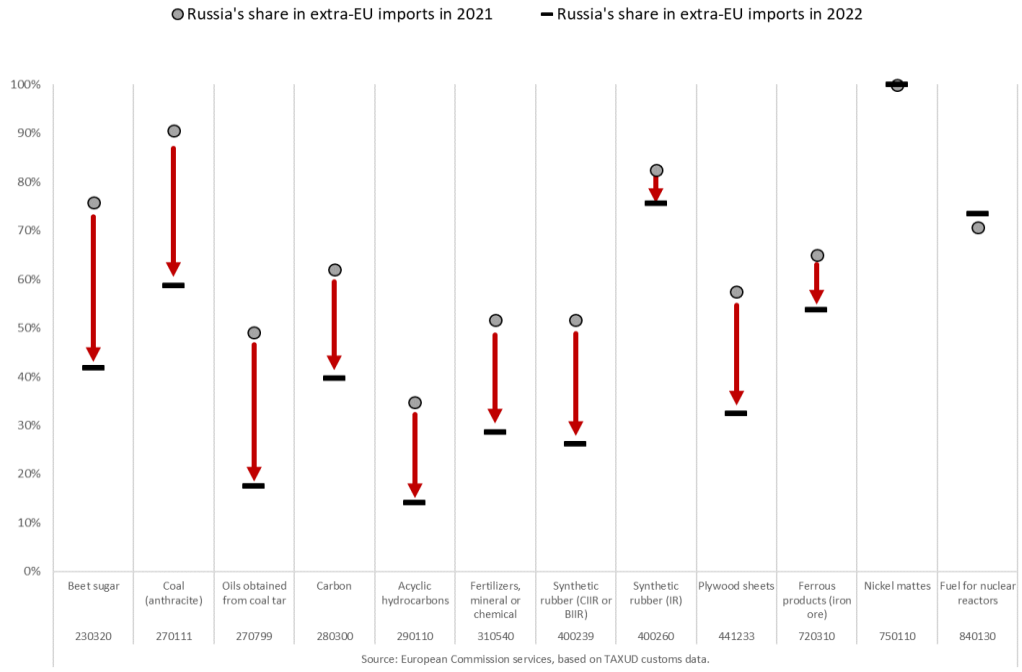
We then monitor the evolution of trade in those specific products imported from Russia for which the EU has a dependency. The supply from Russia has not been disrupted for most of these products; large contractions in terms of volume (of 50% or more) occurred only in the case of fertilisers and synthetic rubbers. Import prices of the Russian products on which the EU had dependencies grew significantly in 2022, consistently with the increase in commodity prices observed in the course of the year.

Chart 10: Trade developments in products where the EU had an import dependency on Russia (percentage changes between 2021 and 2022)



However, data show that the EU firms have been able to diversify significantly their import sources away from Russia, in the products for which we could identify a "dependency" in 2021. With the exceptions of nickel mattes, fuel for nuclear reactors, ferrous products and synthetic rubber, the shares of Russian imports for most products on which the EU had a dependency decreased by roughly 20% between 2021 and 2022. This is a significant adjustment for sensitive inputs in such a short period of time.[27]

Chart 11: Variation in Russian shares of EU imports (2022 vs 2021)



If we restrict the focus on critical raw materials, we see that the import of many of them (coking coal, germanium, phosphate rock, natural graphite and rare earth elements) decreased by more than half. The supply of natural graphite and rare earth elements, in particular, has been almost completely halted. We observe similar patterns for other significant raw materials: the supply of Russian cadmium, molybdenum, and inert gases (neon, krypton, xenon) stopped completely in 2022, while that of iron and potash decreased by more than half (Chart 12).[28] These reductions were partly due to disruptions in logistics and the payment system, caused by EU and international sanctions, and partly to other countermeasures taken by the Russian government, from export bans (e.g., for inert gases and some types of wood) to quotas (e.g., on fertilisers). Trade flows are thus not expected to restart soon.

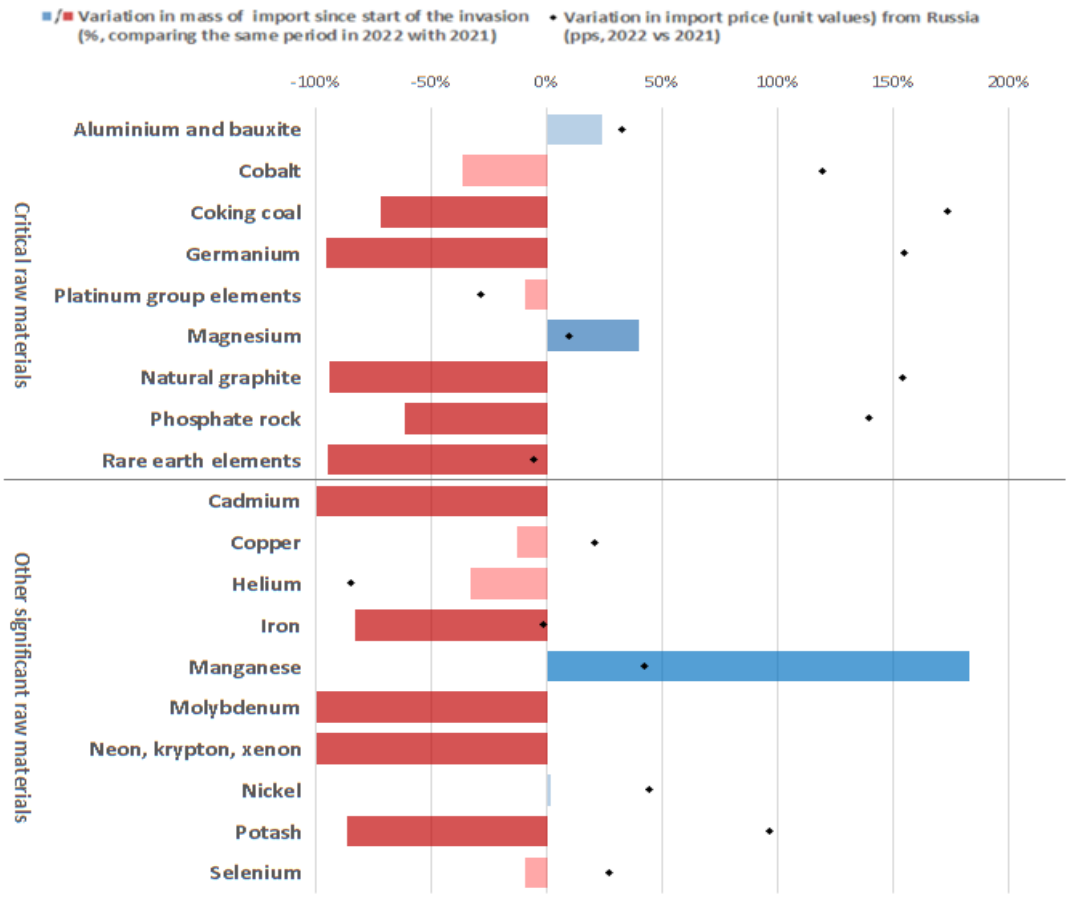
The sudden decrease in supply of some critical raw materials, and the significant increase in price for those still available, have been a challenge for a large number of EU manufacturing firms, which are currently in the process of adjusting their sourcing partners. As an example, we can observe the reallocation of import market shares in the sourcing of cadmium, a component used for the production of products such as batteries or solar panels. Flows

[27] The figures used for this Chart are reported in Annex VI.

[28] The figures used for this Chart are reported in Annex VI.

coming from Russia and Hong Kong stopped, while those from China decreased by 37% in volume and by 40% in value. To compensate, only imports from the US grew, by 240% in volume and by 192% in value, however they were not enough to fully compensate the reduction in imports from other sources.

Chart 12: Trade developments in critical and selected raw materials imported in the EU from Russia



Source: European Commission, based on customs data. Note: data show the variation between end of February 2022 and the end of the year.

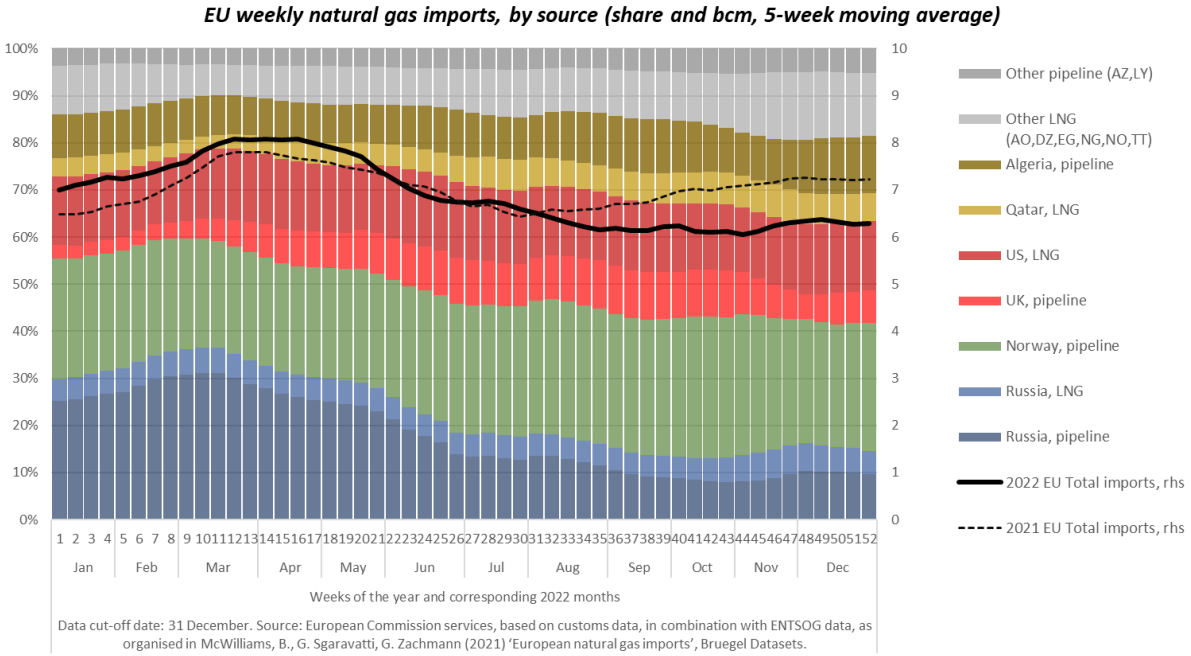
4.3. Focus on gas: trade flows, sourcing and prices

The economic relevance of gas stems from its downstream impact on other sectors of the economy. This section therefore uses the information about physical gas flows to show the adjustment that has taken place in the past months in Europe. It also looks at the price of gas imports from Russia and how it relates to spot gas prices and to the overall electricity bill of the European firms and citizens.

At the beginning of 2022, Russian pipeline and LNG gas together represented roughly 30% of total EU gas import, with a peak of 37% at the beginning of March. Since then, a constant adjustment has taken place, reallocating market shares towards alternative sources such as

the UK,[29] Algeria and Norway. By end-August, weekly gas imports from Russia had fallen to around 15% of all EU gas imports. While the share of Russian LNG imports remained stable over time (3% to 4% of total gas imports), pipeline gas flows substantial decreased (from 30% to 10%).

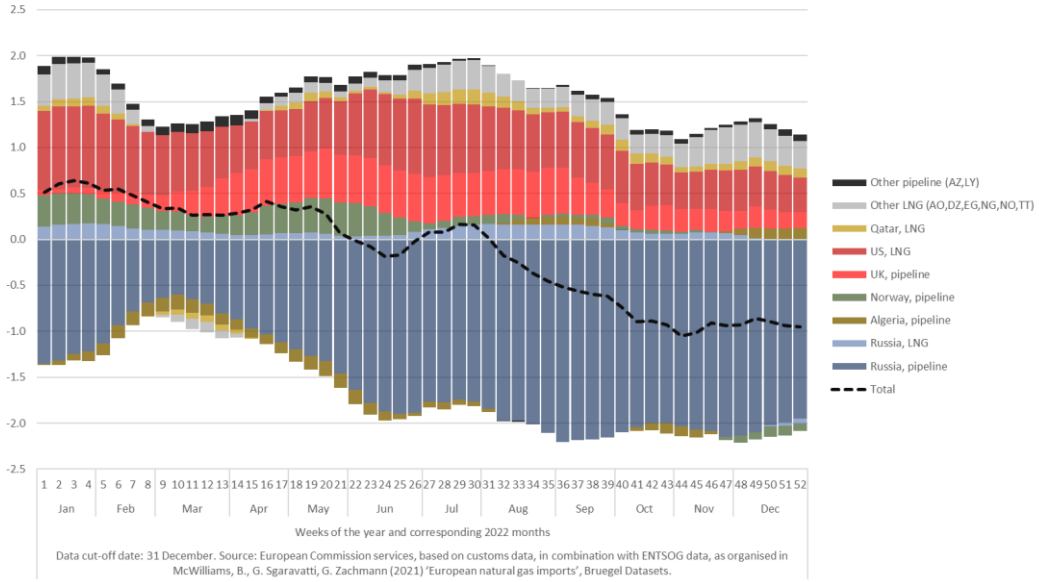
Chart 13: Natural gas import in the EU by source (5-week moving average)



The reduction in sourcing from Russia has been partly offset by increases in pipeline flows from the UK and increases in LNG, mostly from the US. When comparing the gas flows in 2022 with those in 2021, total gas imports increased in the first half of 2022. Higher volumes combined with reduction in consumption, due to high prices and energy saving policies, has allowed natural gas storage in the EU to reach the historically high level of 95% of capacity by the end of the summer, when flows started falling below 2021 levels due to the high level of storage achieved in the first part of the year. The main source of additional gas inflows for the EU is the US, through additional direct LNG shipments (see Chart 14). US LNG accounted for almost the entire additional supply of LNG to the EU in June 2022 and more than 60% of the total when looking at the full year. The flip side of such rapid replacement of Russian pipeline gas with US LNG is the increase in the concentration of suppliers of LNG: 40% now comes from the US, with peaks of 50% in some periods.

[29] Tracking the ultimate origin of flows of LNG is not always straightforward. In the absence of sufficient LNG capacity in the EU, some neighbouring countries provide a platform for LNG that is later sent to the EU through pipelines. This is notably the case of UK pipeline flows towards the EU, which are in significant part deriving from US LNG shipments. Hence, part of UK pipeline flows to the EU are in fact a bridge for US LNG flows.

Chart 14: Differences in gas inflows with respect to the same weeks of 2021, by source (bcm, 5-week moving average)

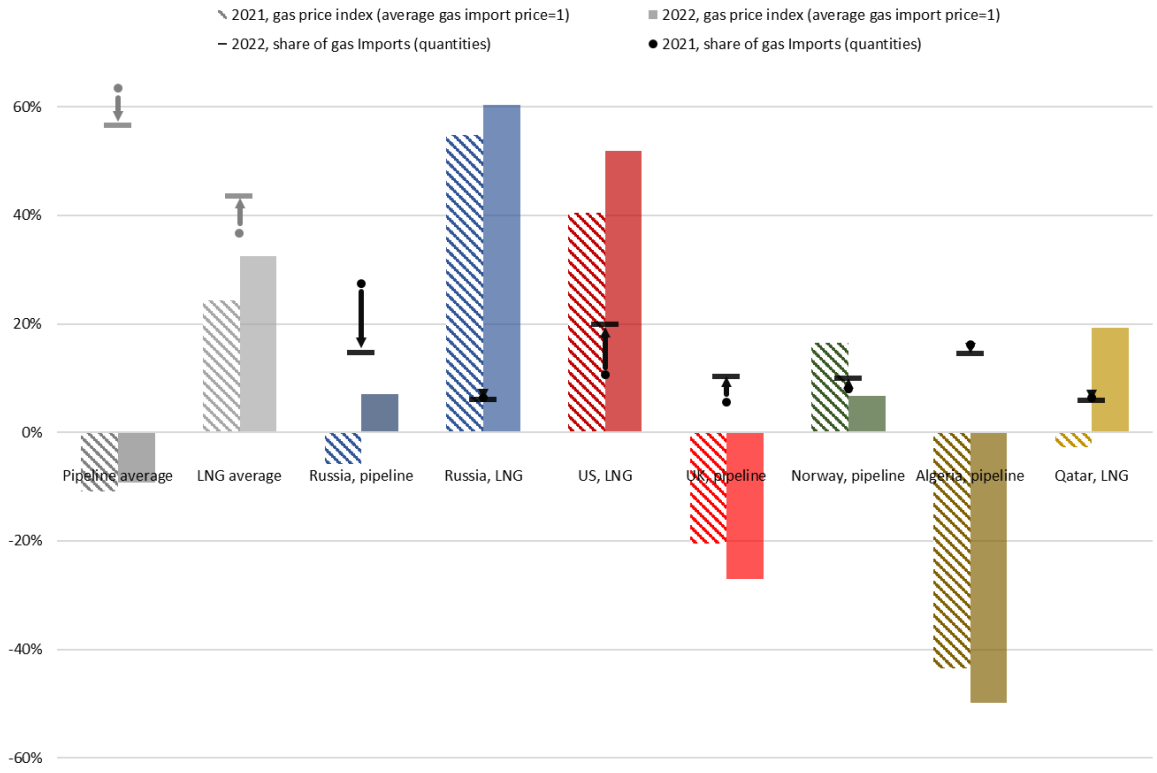


Data cut-off date: 31 December. Source: European Commission services, based on customs data, in combination with ENTSOG data, as organised in McWilliams, B., G. Sgaravatti, G. Zachmann (2021) 'European natural gas imports', Bruegel Datasets.

Unfortunately, the shift from pipeline to LNG sources of gas is likely to result in a permanent increase in gas prices for EU companies. In fact, LNG import prices are significantly higher than pipeline gas prices (33% higher in 2021, 24% in 2022) and US LNG shipments in particular are 52% more expensive than the average gas import into the EU (see Chart 15). US LNG experienced the highest increase in market share between 2021 and the first 9 months of 2022, absorbing more than 70% of the loss in market share of the Russian pipeline gas (-10.4% the latter, +7.5% the former). However, it should be noted that the import price of Russian LNG shipments is even higher than the US (60% higher than the average EU gas import price), so EU companies appear to have clear incentives to shift sources away from Russian LNG. The cheapest source of gas into the EU was pipeline gas shipped from Algeria, but with little or no spare capacity to increase flows in the short term. UK pipeline gas (which includes a significant share of US LNG shipments) is a relatively affordable source of gas as well, and has featured the second largest increase in market shares between 2021 and the first 9 months of 2022.

Gas prices are closely linked to EU competitiveness because gas is not only a key energy input for direct use, but it also plays a key role as marginal element of supply balance in the EU energy system. Hence, its price evolution determines the prices of the entire EU energy and electricity systems, with important implications for the overall inflation rate (Afunts et al, 2022; Feveile Adolfsen et al, 2022).

Chart 15: Gas import in the EU by source: changes in volumes and prices



Source: European Commission services, based Eurostat COMEXT data. Note: the chart shows the variation between 2021 and 2022 in terms of volumes of gas imports (dot and line, shares of total EU gas imports), and in terms of prices (columns).

5. Conclusions

This paper has documented the large adjustment the European economy is going through, as a consequence of the Russian invasion of Ukraine, and of the following developments. Decoupling from a structurally important trade partner requires multiple efforts.

The analysis of structural exposures shows that the significance of Russia as a trade partner for the EU is amplified by the concentration of its input in key areas for the EU economy. These are energy-producing commodities and other critical raw materials, with a low degree of substitutability. At the same time, there are significant differences in the specific bilateral exposures among the Member States of the EU. On the Russian side, instead, the EU is a major trade partner. The sectoral structure of trade suggests that China represents for Russia a possible alternative to the EU.

Real-time custom data show that the EU has been gradually reducing its exposure to Russia, through a decrease in the volume of trade in most categories of goods, in the context of steep increases in prices. We document a sizeable reduction of EU exports to Russia, but at the same time, since imports of energy fossil fuels and critical raw materials are relatively inelastic to prices, and prices for these goods have increased, the value of EU imports from Russia has increased. This has led to the EU accumulating an additional bilateral trade deficit vis-à-vis Russia of roughly €67bn in 2022, compared with the same period in 2021.

Such additional trade surplus for Russia corresponds to roughly 3.7% of its GDP and is likely to be one of the driving factors of the strengthening of its currency, the rouble.

Despite the relatively low substitutability of energy import from Russia, the steep increase in prices of energy commodities, and the strong dependency, the EU has managed to stop this deficit accumulation, to the point that in recent months the reduction in imports from Russia has eventually outpaced the reduction in EU exports to Russia. The total volume of pipeline gas import from Russia, in particular, has fallen by one third, in 2022, compared to 2021. At the same time, higher prices have almost doubled the total value of gas imports. However, the massive efforts to cut consumption and to find alternative sources have produced tangible results since November 2022: since then, the volume of imported pipeline gas from Russia has fallen by three quarters and the value by half, compared to the same period of 2021.

Higher energy prices, and of gas in particular, spill over to the rest of the economy and may cause a loss of competitiveness with respect to the main trading partners. Since February 2022, industrial production in energy-intensive sectors has been falling constantly. These sectors have lost almost 10% of their production, while less energy intensive sectors have increased it. Business confidence in industry is progressively deteriorating, but the decoupling between energy intensive and non-energy intensive sectors is apparent.

This major shock is leading to a permanent adjustment of supply chains, with a progressive decoupling of the European and Russian economies. On the one side, the Russian economy is gradually losing one of its main foreign sources of income. To what extent Russia can substitute the EU with other trade partners remains an open question. On the other side, the European economy is performing a sizeable adjustment in its supply chains, mainly but not only in the case of energy sources. The cost and speed of such adjustment will depend on the capacity of EU businesses to find alternative suppliers and of EU institutions to facilitate such differentiation through dialogue with the EU's trade partners.

The unprecedented nature of this shock has prompted a reflection in terms of resilience, of business models, and of supply chains, that is not limited to short-term fixes. This crisis is stress-testing the resilience and sustainability of the European industry, which is nevertheless showing its ability to adjust. This paper has described the sizeable adjustment process and has proposed specific monitoring tools. These tools can be deployed to identify vulnerabilities, in terms of structural exposures and degrees of dependency, and to track their evolution in the context of a major crisis.

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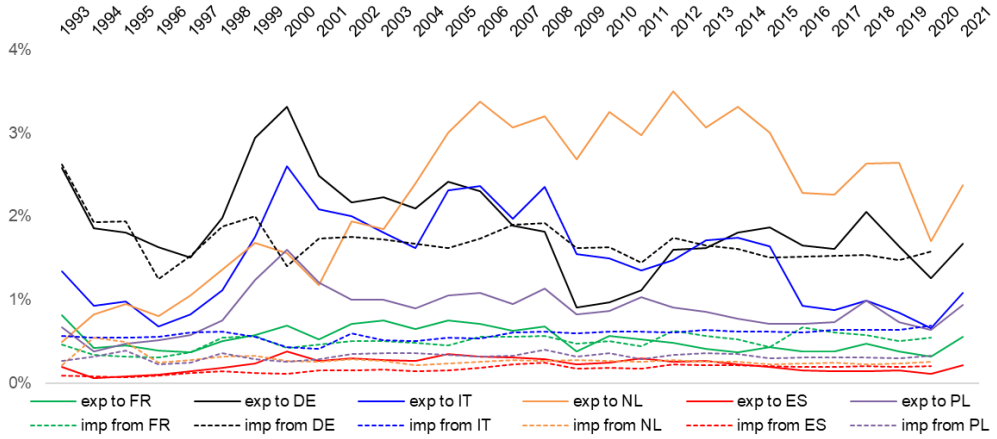
ANNEX I – Russia's trade developments with the largest EU economies

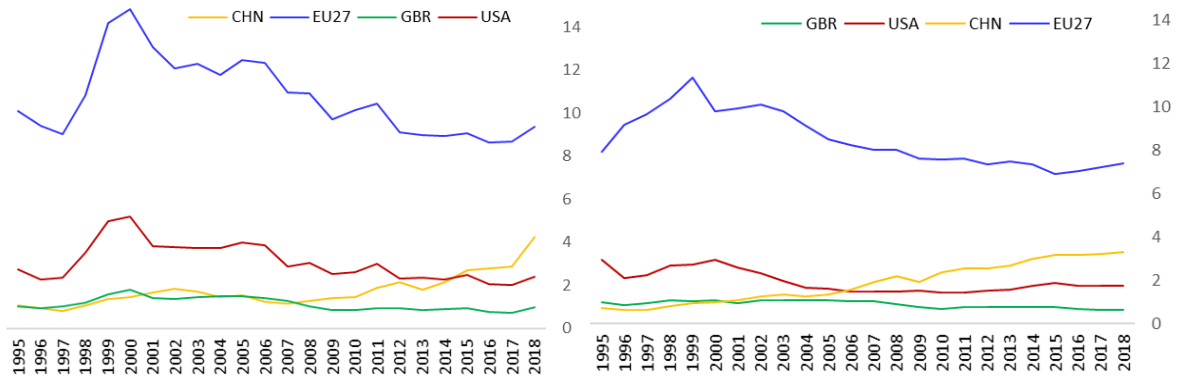
Chart A: Russian exports and imports to the largest EU economies (normalised in % of Russian GDP)



Source: own elaboration on the basis of IMF data.

ANNEX II - Russia's exposure to main trading partners

Chart B: Russia's exposure to main partners: final demand (left) and supply inputs (right) – 1995-2018



Source: own elaboration on the basis of OECD TiVA data. Note: the left chart shows the share of each trade partner in the total final demand for the Russian production; while the right chart shows the share of Russian value added which is due to intermediate products originating from the trade partners through supply chains.

ANNEX III - Exposure to Russian value added in the final demand of EU Member States

Table A: Exposure to Russian value added in the final demand of EU Member States

Exposure to Russia's inputs through international supply chains

	EU27	ES	LU	IE	FR	PT	IT	AT	BE	DK	NL	SE	DE	HR	SI	MT	RO	EL	CZ	FI	PL	HU	SK	EE	LV	CY	BG	LT
TOTAL	1.0	0.5	0.6	0.6	0.6	0.7	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.2	1.3	1.4	1.6	1.9	2.0	2.2	2.3	2.6	3.1	3.8	4.1	4.4	5.7	6.2
Total industry (mining, manufactures and utilities)	3.0	1.4	2.1	1.3	2.2	1.9	2.7	2.0	2.6	3.0	3.3	3.0	2.7	2.6	2.9	3.0	3.8	6.0	4.7	6.3	5.3	6.6	7.7	7.4	10.1	6.5	14.4	13.0
Total services	0.5	0.2	0.4	0.4	0.3	0.3	0.4	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.8	1.1	0.9	0.9	1.1	1.2	1.2	1.2	1.6	2.9	2.4	4.2	2.6	4.0
Information industries	0.4	0.2	0.4	0.2	0.2	0.2	0.2	0.9	0.4	0.3	0.5	0.7	0.4	0.4	0.8	1.2	0.8	0.4	0.8	0.7	0.5	0.5	0.9	2.2	2.6	4.9	0.8	1.9
Agriculture, hunting, forestry	0.4	0.3	0.6	0.5	0.3	0.3	0.3	0.3	0.9	0.9	0.4	0.6	0.5	0.2	0.2	0.5	0.2	1.0	0.4	1.4	0.5	0.2	0.3	2.4	4.3	1.5	0.6	2.0
Fishing and aquaculture	0.8	0.3	1.0	0.9	0.6	0.4	0.6	2.5	0.9	0.8	0.8	0.5	1.2	0.2	1.0	1.6	0.4	0.6	1.7	1.4	1.5	1.9	2.2	4.4	3.8	3.2	2.7	6.0
Mining and quarrying, energy producing products	19.5	7.1	10.8	9.6	13.1	9.9	16.9	14.0	9.0	14.9	18.2	21.2	18.2	21.2	20.3	14.0	30.7	21.5	36.9	42.2	31.2	44.3	53.7	28.3	51.8	20.3	62.7	47.1
Mining and quarrying, non-energy producing products	5.6	2.3	4.6	2.9	4.1	2.7	4.7	4.9	9.3	5.5	4.9	3.1	5.7	3.0	4.1	3.3	8.6	5.9	7.1	7.8	5.5	6.6	13.5	7.5	7.9	7.5	5.3	38.9
Mining support service activities	12.5	6.2	7.4	8.3	9.2	8.1	11.4	9.7	7.5	9.7	9.4	13.9	14.3	10.2	15.0	9.9	15.6	25.8	19.2	25.4	23.7	18.7	18.7	31.7	37.5	21.9	42.6	32.0
Food products, beverages and tobacco	0.2	0.1	0.6	0.2	0.3	0.3	0.2	0.1	0.3	0.5	0.2	0.2	0.2	0.1	0.1	0.3	0.1	0.4	0.3	0.7	0.3	0.2	0.3	1.6	1.3	0.8	0.3	1.6
Textiles, wearing apparel, leather and related products	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.3	0.1	0.2	0.2	0.6	0.3	0.2	0.2	2.2	1.4	1.2	0.3	0.9
Wood and products of wood and cork	1.1	0.6	0.9	1.2	0.9	0.6	0.7	0.6	1.2	1.6	1.3	0.9	1.1	0.5	1.0	1.2	1.3	2.2	1.1	4.1	1.3	1.3	0.8	8.8	3.5	1.9	2.1	4.1
Paper products and printing	0.6	0.3	0.6	0.5	0.4	0.3	0.5	0.6	0.6	0.7	0.6	0.5	0.5	0.5	0.7	0.9	1.2	0.9	1.0	1.3	0.9	0.8	0.8	4.0	3.3	3.4	1.6	2.5
Coke and refined petroleum products	19.5	10.2	10.9	9.1	13.9	13.2	15.5	12.0	14.1	26.7	16.3	22.9	21.9	9.2	18.3	18.2	12.4	38.3	22.6	22.4	26.0	24.5	27.9	38.9	37.7	22.6	47.0	33.8
Chemical and chemical products	1.6	0.9	1.2	0.7	1.1	1.1	0.8	1.1	1.2	1.3	1.1	3.2	1.2	2.0	1.1	1.2	2.4	1.7	2.9	7.4	3.5	3.5	4.3	13.6	8.5	2.4	3.4	6.6
Pharmaceuticals, medicinal chemical and botanical products	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.3	1.1	0.1	0.2	0.1	0.1	0.3	0.2	0.2	0.2	0.8	0.5	0.5	0.3	0.6
Rubber and plastics products	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.6	0.3	0.2	0.2	0.3	0.5	0.5	0.5	1.9	0.5	0.4	0.7	1.7	1.6	1.2	1.0	1.5
Other non-metallic mineral products	0.5	0.3	0.4	0.3	0.3	0.2	0.4	0.3	0.5	0.4	0.4	0.5	0.4	0.3	0.6	0.5	1.0	0.8	0.9	1.8	0.9	0.7	0.9	3.3	2.9	1.5	2.3	3.5
Basic metals	5.0	2.8	3.3	3.7	4.0	3.7	4.7	4.3	5.9	6.6	5.3	4.2	5.1	4.4	4.0	4.8	3.9	8.4	5.3	12.4	7.1	5.1	5.6	15.2	20.8	10.1	9.5	18.6
Fabricated metal products	0.4	0.2	0.4	0.4	0.2	0.2	0.2	0.5	0.4	0.3	0.4	0.4	0.3	0.3	0.5	0.5	0.6	0.8	0.6	1.6	0.8	0.5	0.8	3.1	3.3	2.4	3.2	2.5
Computer, electronic and optical products	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.3	0.2	0.2	0.3	0.7	0.3	0.4	0.2	0.3	0.4	0.4	0.4	1.2	1.2	2.7	1.0	1.1
Electrical equipment	0.3	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.4	0.6	0.5	0.3	0.8	0.5	0.3	0.5	1.6	2.0	2.2	0.8	1.5
Machinery and equipment n.e.c	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.2	0.3	0.4	0.3	0.3	1.2	1.1	1.6	0.7	1.2
Motor vehicles, trailers and semi-trailers	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.4	0.6	0.2	0.2	0.2	0.4	0.7	0.7	0.5	1.2
Other transport equipment	1.5	0.5	1.0	0.3	1.3	0.8	0.6	1.4	1.7	1.0	1.5	0.9	1.2	2.1	2.8	0.7	1.3	1.2	2.2	2.9	8.3	1.3	5.0	17.4	4.2	10.2	5.9	9.6
Manufacturing nec; repair, installation of machinery & equipment	0.4	0.2	0.6	0.2	0.3	0.3	0.3	0.4	1.5	0.4	0.4	0.5	0.4	0.5	0.5	0.6	0.6	1.1	0.7	1.1	0.7	1.0	0.9	2.2	2.8	3.3	2.0	2.5
Electricity, gas, steam and air conditioning supply	1.2	0.5	1.1	1.0	0.7	0.6	1.1	1.0	1.3	1.4	1.5	1.0	1.0	0.6	1.2	2.2	1.3	1.3	1.5	4.5	2.1	2.7	2.1	3.9	8.6	4.6	4.2	11.4
Water supply; sewerage, waste mgmt, remediation activities	0.4	0.2	0.3	0.3	0.3	0.2	0.3	0.4	0.4	0.3	0.5	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.5	1.1	0.6	0.6	0.7	2.2	1.6	1.4	1.2	1.7
Construction	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.3	0.2	0.9	0.3	0.3	0.3	0.4	0.4	0.5	0.6	0.7	1.2	0.9
Wholesale and retail trade; repair of motor vehicles	1.3	0.5	0.8	1.2	0.9	0.7	1.0	1.0	1.1	1.3	1.2	1.3	1.3	1.2	1.5	1.3	1.7	2.2	2.4	3.2	2.1	3.0	3.6	4.7	4.1	3.3	5.4	4.7
Land transport and transport via pipelines	2.5	1.3	1.7	2.0	1.7	1.7	1.7	3.1	2.3	3.1	2.8	2.2	2.6	2.7	2.4	3.8	2.3	5.4	4.1	5.1	3.6	4.9	4.5	7.5	7.4	14.2	8.9	10.4
Water transport	1.0	0.6	1.0	0.7	0.9	0.8	0.6	2.1	0.7	0.4	0.6	0.6	1.0	0.6	0.9	2.7	1.1	0.7	2.3	1.6	2.4	1.8	2.7	3.3	4.3	1.3	2.8	7.1
Air transport	2.2	0.8	1.8	1.6	1.3	0.9	1.7	4.1	1.2	1.9	1.6	2.5	2.3	1.8	1.8	7.7	3.2	3.4	3.9	5.5	3.8	1.6	4.6	10.6	10.7	27.7	5.8	15.6
Warehousing and support activities for transportation	2.0	0.8	1.9	1.8	1.4	0.9	1.2	2.4	1.5	3.0	2.0	1.6	1.7	1.8	1.5	3.1	2.6	3.2	3.0	4.7	3.0	3.8	3.5	6.5	4.4	17.6	8.4	16.9
Postal and courier activities	0.4	0.2	0.3	0.3	0.4	0.3	0.5	0.6	0.3	0.3	0.9	0.7	0.2	0.3	0.3	0.5	0.8	0.4	0.8	0.8	0.6	0.6	0.5	4.6	2.1	2.3	0.7	3.9
Accommodation and food service activities	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.9	0.4	0.2	0.4	6.0	2.2	1.5	0.5	2.6
Publishing, audiovisual and broadcasting activities	0.3	0.2	0.3	0.2	0.2	0.1	0.3	0.4	0.2	0.2	0.6	0.1	0.3	0.5	2.8	0.7	0.3	0.4	0.5	1.4	0.4	0.6	1.0	3.0	6.6	4.5	0.7	1.7
Telecommunications	0.4	0.1	0.3	0.2	0.3	0.1	0.3	0.6	0.4	0.3	0.5	0.7	0.3	0.2	0.4	0.4	0.4	0.2	0.8	0.7	0.5	0.3	0.4	3.8	1.4	2.0	0.5	2.6
Computer programming, consultancy, information services	0.5	0.3	0.4	0.3	0.2	0.2	0.2	1.5	0.5	0.4	0.4	0.9	0.5	0.5	0.5	2.3	1.3	0.8	1.1	0.7	0.6	0.7	1.5	1.8	3.1	7.8	0.9	2.0
Financial and insurance activities	0.5	0.2	0.2	0.3	0.3	0.3	0.3	0.6	0.4	0.4	0.3	0.5	0.5	0.4	0.6	0.8	1.0	0.8	0.8	1.1	0.9	1.1	1.3	3.1	2.7	9.8	1.5	4.4
Real estate activities	0.3	0.1	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.8	0.5	0.3	0.6	0.6	1.2	0.9	0.9	1.9	1.2	2.1	1.5	3.3
Professional, scientific and technical activities	0.5	0.2	0.4	0.4	0.3	0.3	0.3	0.8	0.3	0.4	0.5	0.4	0.5	1.1	1.5	0.8	0.7	0.9	1.0	1.0	0.9	1.0	1.2	2.7	2.2	6.0	2.6	2.6
Administrative and support services activities	0.5	0.3	0.3	0.4	0.3	0.4	0.5	0.6	0.4	0.6	0.4	0.6	0.5	0.9	1.0	1.1	1.0	1.6	1.4	1.4	1.4	1.3	1.7	3.3	3.3	7.0	3.4	4.3

Source: GROW.A1 elaborations on OECD data (TiVA).

ANNEX IV - Cross bilateral exposures in integrated value chains

Looking at the relations among the four major economic regions of the world, Table shows the share of total value added produced in one economy that is generated using value added provided by selected partners. Columns show the exposure of the EU, the US, Russia, and China. Rows show the specific sectoral detail.

Through pairwise correlations, we can identify the most similar sectoral exposures in the structure of trade relations among these four economies. The EU and US reliance on China comes on top, together with the EU and Russia's reliance on the US. This second one may represent an opportunity of substitutability for the EU, although the absolute values are quite small.

The most relevant observation is that China and the EU have a very similar exposure to Russian inputs, and also Russia and the EU have a very similar exposure to China. This feature points to a high degree of substitutability between the EU and China as key trading partner for Russia.

Focusing then on the specific bilateral reciprocal exposures, EU-Russia and US-China are the two pairs with the lowest correlation coefficients. In a comparative advantage theory of trade framework, these would be the most complementary trade partners and the most profitable trade flows.

Table B: Cross bilateral exposures in integrated value chains

	USA from CHN	USA from RUS	USA from EU27	CHN from USA	CHN from RUS	CHN from EU27	RUS from USA	RUS from CHN	RUS from EU27	EU27 from USA	EU27 from CHN	EU27 from RUS
TOTAL ECONOMY	2.2	0.2	2.5	1.7	0.5	2.2	1.7	3.3	7.4	2.5	2.0	1.0
Agriculture, hunting, forestry	9.5	0.2	2.5	0.7	0.2	0.5	0.3	4.5	2.7	1.1	5.0	0.4
Fishing and aquaculture	11.1	1.1	3.5	0.9	0.4	0.1	0.2	4.5	0.8	4.8	6.5	0.8
Mining and quarrying, energy producing products	2.6	2.5	0.3	2.0	6.0	0.1	0.9	2.4	0.6	3.4	3.0	18.5
Mining and quarrying, non-energy producing products	6.3	1.6	1.8	1.0	1.1	0.9	0.8	4.2	2.1	2.6	6.0	5.6
Mining support service activities	0.5	0.7	0.4	1.6	3.7	0.9	1.0	0.6	2.3	4.3	2.1	12.5
Food products, beverages and tobacco	3.0	0.1	3.1	0.6	0.2	1.4	0.3	2.7	5.3	0.7	2.0	0.2
Textiles, wearing apparel, leather and related products	29.9	0.1	5.0	0.4	0.0	2.5	0.5	24.6	11.3	0.6	15.3	0.2
Wood and products of wood and cork	8.0	0.3	3.9	1.7	1.7	2.3	1.2	7.5	12.9	1.5	4.6	1.1
Paper products and printing	5.1	0.1	4.4	1.8	0.5	2.5	2.1	6.2	15.4	3.0	3.9	0.6
Coke and refined petroleum products	3.7	2.6	2.2	1.8	2.8	1.0	0.8	2.6	2.3	4.7	5.5	18.5
Chemical and chemical products	10.0	0.5	8.4	2.5	0.3	3.4	3.7	13.8	20.0	5.3	9.3	1.6
Pharmaceuticals, medicinal chemical and botanical products	1.7	0.0	18.0	2.6	0.0	6.1	5.8	2.9	29.5	10.3	2.0	0.1
Rubber and plastics products	9.1	0.1	6.4	1.5	0.1	4.2	2.1	11.1	23.7	2.0	5.5	0.3
Other non-metallic mineral products	11.0	0.1	4.6	0.3	0.0	0.6	0.6	9.3	8.4	1.4	6.4	0.5
Basic metals	17.4	2.4	6.6	1.0	0.6	1.3	1.3	10.2	5.9	4.0	14.1	5.0
Fabricated metal products	7.6	0.1	7.1	1.6	0.1	5.3	2.1	9.6	20.7	1.9	4.8	0.4
Computer, electronic and optical products	13.2	0.1	3.9	4.4	0.1	3.2	7.0	22.9	11.0	11.0	14.9	0.3
Electrical equipment	17.3	0.1	8.9	1.0	0.1	4.2	2.3	19.0	25.1	2.3	10.3	0.3
Machinery and equipment n.e.c	6.7	0.1	12.6	1.8	0.1	6.5	4.2	10.7	38.2	3.0	4.3	0.2
Motor vehicles, trailers and semi-trailers	3.2	0.0	9.9	0.9	0.0	4.9	2.1	4.9	24.5	1.2	1.6	0.1
Other transport equipment	1.2	0.3	5.0	17.1	0.5	9.5	14.3	2.2	10.6	21.0	3.0	1.5
Manufacturing nec; repair, installation of machinery & equipment	9.4	0.2	9.0	1.4	0.4	5.5	1.7	6.5	17.4	2.6	4.2	0.4
Electricity, gas, steam and air conditioning supply	3.5	0.3	2.3	0.7	0.5	1.4	0.4	2.5	3.5	1.0	2.5	1.2
Water supply; sewerage, waste mgmt, remediation activities	2.6	0.3	5.2	0.5	0.3	3.4	0.5	2.9	11.3	0.4	1.0	0.4
Construction	0.0	0.0	0.7	0.1	0.1	0.4	0.1	0.0	1.6	0.2	0.0	0.2
Wholesale and retail trade; repair of motor vehicles	3.0	0.3	3.3	2.4	0.8	3.4	1.6	3.5	8.1	2.6	2.4	1.3
Land transport and transport via pipelines	5.5	0.6	4.7	1.9	1.0	3.4	1.1	4.2	8.4	2.5	3.9	2.5
Water transport	8.0	0.3	11.6	0.9	0.4	8.9	0.9	8.7	23.6	1.1	5.8	1.0
Air transport	2.0	0.2	3.9	8.7	0.7	5.2	9.8	4.3	18.4	13.4	3.7	2.2
Warehousing and support activities for transportation	2.4	0.6	7.8	3.4	1.8	10.3	1.4	1.9	12.8	2.1	1.2	2.0
Postal and courier activities	2.3	0.1	2.4	3.3	0.1	2.8	5.3	6.3	13.3	8.0	2.2	0.4
Accommodation and food service activities	0.8	0.0	2.2	2.8	0.1	2.0	2.5	2.9	19.0	1.5	0.8	0.1
Publishing, audiovisual and broadcasting activities	0.3	0.0	1.8	10.7	0.2	7.8	14.3	1.4	20.6	12.9	1.1	0.3
Telecommunications	0.5	0.0	1.2	1.8	0.1	1.7	1.5	1.1	6.2	3.1	0.8	0.4
Computer programming, consultancy, information services	1.3	0.1	2.4	2.5	0.1	4.0	4.8	3.7	19.3	4.3	2.4	0.5
Financial and insurance activities	1.7	0.1	1.6	1.5	0.1	1.0	2.9	4.1	5.9	5.7	2.5	0.5
Real estate activities	0.3	0.1	0.7	1.1	0.2	1.2	0.8	0.6	3.0	1.0	0.3	0.3
Professional, scientific and technical activities	0.7	0.1	3.3	6.7	0.4	6.7	4.5	1.4	11.7	5.6	0.8	0.5
Administrative and support services activities	1.7	0.1	3.4	2.5	0.3	4.3	4.1	3.9	17.0	4.1	1.5	0.5
Public administration and defence; compulsory social security	0.0	0.0	0.3	0.4	0.0	0.4	0.2	0.0	0.8	0.5	0.0	0.0
Education	0.0	0.0	0.4	2.5	0.0	0.5	0.6	0.1	1.8	0.7	0.0	0.0
Human health and social work activities	0.0	0.0	0.1	0.2	0.0	0.3	0.1	0.1	0.8	0.1	0.0	0.0
Arts, entertainment and recreation	0.2	0.0	1.2	1.4	0.1	2.2	0.9	0.7	5.2	1.1	0.3	0.1
Other service activities	0.6	0.0	0.9	0.3	0.0	0.6	0.6	1.9	6.2	0.4	0.5	0.0
Activities of households as employers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total industry (mining, manufactures and utilities)	7.0	0.6	5.9	1.7	0.9	2.7	2.2	7.1	10.8	3.3	5.2	3.0
Total services (incl. construction)	1.0	0.1	1.7	1.8	0.3	2.1	1.6	1.8	6.3	2.4	1.1	0.5
Total services	1.1	0.1	1.8	2.1	0.3	2.4	1.8	2.0	6.8	2.5	1.1	0.5
Information, finance, real estate and other business services	0.9	0.1	1.9	2.4	0.2	2.5	2.8	2.0	8.1	3.9	1.2	0.4
Information industries	3.3	0.1	2.4	3.8	0.1	3.6	5.7	8.3	13.5	6.9	4.0	0.4

Source: own elaboration on the basis of OECD TiVA data. Note: the table shows the share of local value added due to in foreign countries' final demand (including consumption and investments), for different country pairs.

ANNEX V – Products for which the EU has a dependency on Russia

Table C: List of HS6 products for which the EU has a dependency on Russia - values above €100M

HS6 Code	*EU Import Value From Russia (M€)*	*Russia's share in total extra-EU import (2021)*	*Top 5 origin country (2021)*
230320 - Beet sugar	161.2	75.85%	RU (76%), EG (8%), XS (5%), US (4%), BY (3%)
270111 - Coal (anthracite)	415.3	90.55%	RU (91%), GB (3%), KZ (3%), CN (2%), US (1%)
270799 - Oils obtained from coal tar	1,755.2	49.12%	RU (49%), GB (37%), NO (8%), CH (2%), US (1%)
280300 - Carbon	434.6	62.04%	RU (62%), US (8%), UA (7%), EG (6%), JP (3%)
290110 - Acyclic hydrocarbons	285.8	34.69%	US (37%), RU (34%), NO (24%), GB (1%), BY (1%)
310540 - Fertilizers, mineral or chemical	128.1	51.68%	RU (52%), MA (36%), CN (5%), TN (3%), XS (3%)
400239 - Synthetic rubber (CIIR or BIIR)	126.3	51.66%	RU (52%), GB (37%), SA (8%), US (2%), SG (1%)
400260 - Synthetic rubber (IR)	169.0	82.51%	RU (83%), US (6%), TW (4%), JP (4%), TH (1%)
441233 - Plywood sheets	595.4	57.53%	RU (58%), CN (22%), UA (9%), BY (8%), NO (1%)
720310 - Ferrous products (iron ore)	611.2	65.02%	RU (65%), US (16%), LY (5%), VE (5%), CA (3%)
750110 - Nickel mattes	1,154.6	99.98%	RU (100%), GB (0%), CN (0%), US (0%), IN (0%)
840130 - Fuel for nuclear reactors	238.3	70.70%	RU (71%), GB (26%), US (4%), JP (0%), CN (0%)

Source: Source: TAXUD customs data. Elaborated by GROW A1, jointly with TAXUD and TRADE.

ANNEX VI – Trade developments on EU dependencies and critical/significant raw materials imported from Russia

Table D for Chart 10: Trade developments in products where the EU has an import dependency vis-à-vis Russia

HS6 Code and product	*Variation in RU shares of EU imports since the invasion, wrt the same period of 2021 (pps)*	*Variation in value of import since start of the invasion (%, wrt the same period in 2022 with 2021)*	*Variation in unit price of Russian imports wrt the same period of 2021 (%)*
230320 - Beet sugar	-31.0%	75.9%	156.0%
270111 - Coal (anthracite)	-28.9%	90.6%	144.3%
270799 - Oils obtained from coal tar	-29.5%	49.1%	91.2%
280300 - Carbon	-21.2%	62.0%	107.7%
290110 - Acyclic hydrocarbons	-20.3%	34.7%	88.4%
310540 - Fertilizers, mineral or chemical	-23.4%	51.7%	643.5%
400239 - Synthetic rubber (CIIR or BIIR)	-25.3%	51.7%	212.7%
400260 - Synthetic rubber (IR)	-4.9%	82.5%	860.6%
441233 - Plywood sheets	-22.5%	57.5%	20.2%
720310 - Ferrous products (iron ore)	-5.6%	65.0%	65.0%
750110 - Nickel mattes	0.0%	100.0%	138.6%
840130 - Fuel for nuclear reactors	0.8%	70.7%	103.7%

Source: Own elaborations on TAXUD customs data.

ANNEX VII – Gas flows datasets

First of all, we proceed to ensure that trade data based on customs invoicing is consistent with other sources of information on gas flows into the EU. Invoicing figures may thus not fully reflect the exact time of shipment, but can be affected by business practices (e.g., reporting monthly or every fortnight to minimise administrative burden).

To that end, we compare the European Commission customs data, used in the previous sections, with the information on physical flows into the EU gas networks as reported by European gas infrastructure operators to the European Network of Transmission System Operators for Gas (ENTSOG). ENTSOG provides data at the level of each node of the network, but this information needs to be aggregated and organised in a way to correctly capture direct and indirect shipments by source country (e.g., EU receives gas from Russia both directly and from pipelines running through Belarus, Ukraine and Turkey)[30]. To that end, we rely on Bruegel's dataset collecting and organising such information (McWilliams et al., 2021).

Chart C: Gas imports from Russia, customs and physical flows data (5-week moving average)

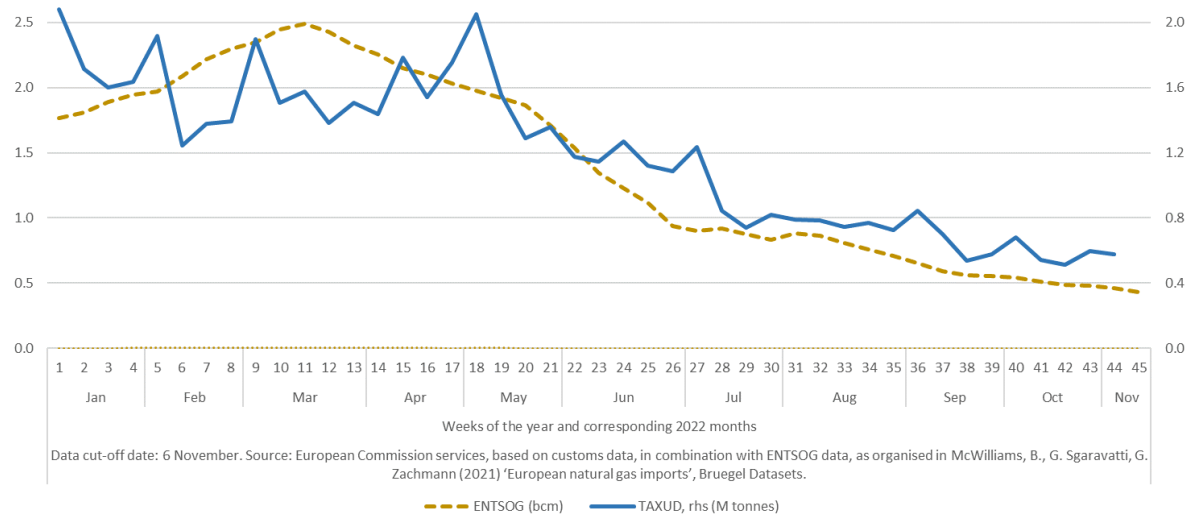


Chart confirms the robustness of the timing information that can be derived from customs data. The correlation between the two series is 81.5% over the first 37 weeks of 2022 (which rises to 85% when the first two weeks of the year are not considered, when invoicing may be more linked to accounting practices and refer to shipments received at the end of the previous year).

We can then rely of information on the physical flow of gas derived from the Bruegel/ENTSOG dataset to analyse the structural adjustments occurring in the gas sourcing decisions of EU actors.

[30] It is less straighforward to track the ultimate origin of flows that reach EU neighbouring countries as LNG and are later sent to the EU through pipelines. That is notably the case for UK pipeline flows towards the EU, which are in significant part deriving from US LNG shipments, but the exact quantification cannot be easily derived. Hence, UK pipeline flows to the EU are shown in the charts of this paper as if they originated in the UK, with caveats in the accompanying text.

Table E: Variation in Russian shares of EU imports, in values (pps)

HS6 Code and product	*Russia's share in total extra-EU imports in 2021*	*Russia's share in extra-EU imports in 2022*	*Variation in RU shares of EU imports since the invasion, wrt the same period of 2021 (pps)*
230320 -Beet sugar	75.85%	44.90%	-31.0%
270111 -Coal (anthracite)	90.55%	61.70%	-28.9%
270799 -Oils obtained from coal tar	49.12%	19.60%	-29.5%
280300 -Carbon	62.04%	40.80%	-21.2%
290110 -Acyclic hydrocarbons	34.69%	14.40%	-20.3%
310540 -Fertilizers, mineral or chemical	51.68%	28.30%	-23.4%
400239 -Synthetic rubber (CIIR or BIIR)	51.66%	26.40%	-25.3%
400260 -Synthetic rubber (IR)	82.51%	77.60%	-4.9%
441233 -Plywood sheets	57.53%	35.00%	-22.5%
720310 -Ferrous products (iron ore)	65.02%	59.40%	-5.6%
750110 -Nickel mattes	99.98%	100.00%	0.0%
840130 -Fuel for nuclear reactors	70.70%	71.50%	0.8%

Source: Own elaborations on TAXUD customs data.

Table F: Trade developments in critical raw materials imported in the EU from Russia

Critical raw material imported from Russia	*Variation in mass of import since start of the invasion (%, comparing the same period in 2022 with 2021)*	*Variation in import price (unit values) from Russia (pps, 2022 vs 2021)*
Aluminium and bauxite	38.1%	36.1%
Cobalt	-1.3%	114.2%
Coking coal	-67.7%	191.3%
Germanium	-79.7%	-6.4%
Platinum group elements	-33.5%	-2.4%
Magnesium	133.7%	61.0%
Natural graphite	-94.3%	182.5%
Phosphate rock	-64.0%	150.6%
Rare earth elements	-95.6%	-4.5%

Source: Own elaborations on TAXUD customs data.

Table G: Trade developments in selected raw materials imported in the EU from Russia

Selected raw materials	*Variation in mass of import since start of the invasion (%, comparing the same period in 2022 with 2021)*	*Variation in import price (unit values) from Russia (pps, 2022 vs 2021)*
Cadmium	-100.0%	
Copper	-9.8%	22.9%
Helium	-32.9%	-84.5%
Iron	-83.9%	-3.7%
Manganese	190.9%	41.5%
Molybdenum	-99.9%	
Neon, krypton, xenon	-100.0%	
Nickel	19.4%	38.9%
Potash	-85.1%	114.8%
Selenium	-9.6%	28.0%

Source: Own elaborations on TAXUD customs data.

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