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Geoeconomic Fragmentation: What's at Stake for the EU

Chikako Baba, Ting Lan, Aiko Mineshima, Florian Misch, Magali Pinat, Asghar Shahmoradi, Jiaxiong Yao and Rachel van Elkan

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ABSTRACT: Geoeconomic fragmentation (GEF) is becoming entrenched worldwide, and the European Union (EU) is not immune to its effects. This paper takes stock of GEF policies impinging on—and adopted by—the EU and considers how exposed the EU is through trade, financial and technological channels. Motivated by current policies adopted by other countries, the paper then simulates how various measures—raising costs of trade and technology transfer and fossil fuel prices, and imposition of sectoral subsidies—would affect the EU economy. Due to its high-degree of openness, the EU is found to be exposed to GEF through multiple channels, with simulated losses that differ significantly across scenarios. From a welfare perspective, this suggests the need for a cautious approach to GEF policies. The EU's best defence against GEF is to strengthen the Single Market while advocating for a multilateral rules-based trading system.

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Glossary

CESEE	Central, Eastern, and Southeastern Europe
EU	European Union
FDI	Foreign Direct Investment
GEF	Geoeconomic Fragmentation
GFC	Global Financial Crisis
GTAP	Global Trade Analysis Project
IP	Intellectual Property
MP	Multinational Production

Introduction

Geoeconomic fragmentation (GEF)—a policy-driven reversal of global economic integration—is becoming a reality, and the European Union (EU) is not exempt from these developments. The number of restrictions worldwide with effects on cross-border trade and foreign direct investment (FDI) have risen sharply in recent years. Investment and financial flows are increasingly driven by geopolitical alignment, rather than economic distance. Some trade is being re-routed through third countries, and production is beginning to relocate as companies grow increasingly concerned about the reliability of foreign links in their supply chains. The EU is not immune to these trends. Russia's invasion of Ukraine highlighted the national security implications of concentrated sourcing of key imports. Domestic competitiveness, supply chain resilience and climate change are also driving the global increase in GEF policies. From the perspective of the EU—a large, diverse and highly-open region—this paper considers the extent of exposure to geoeconomic fragmentation risk across several dimensions and the potential economic consequences it could bring.

The EU economy and its population have prospered as an open economic region, underpinned by liberal frameworks for trade and capital flows. Measured as the sum of exports and imports of goods and services, the EU is more outwardly-oriented than the US or China, despite being of a broadly similar economic size. (Including intra-EU trade between member states, which accounts for over half of trade, the EU is markedly more open.) And while trade openness in China has declined sharply since the mid-2000s, as GDP rose faster than trade, and edged down in the US over the past decade, it has continued to rise in the EU. Similarly, the EU's stock of foreign direct investment as a share of GDP—both inward and outward—is high relative to other countries and regions. Openness, together with an internally competitive environment, was affirmed in the 2005 Lisbon agenda as the EU's preferred strategy for boosting growth, jobs and social cohesion.[2]

Figure 1. Openness

Sources: Eurostat, OECD, and IMF staff calculations.

Sources: IMF Coordinated Direct Investment Survey, WEO, and IMF staff calculations.
1/ Including extra-EU FDI only. Excluding Romania for which data on outward FDI are missing.

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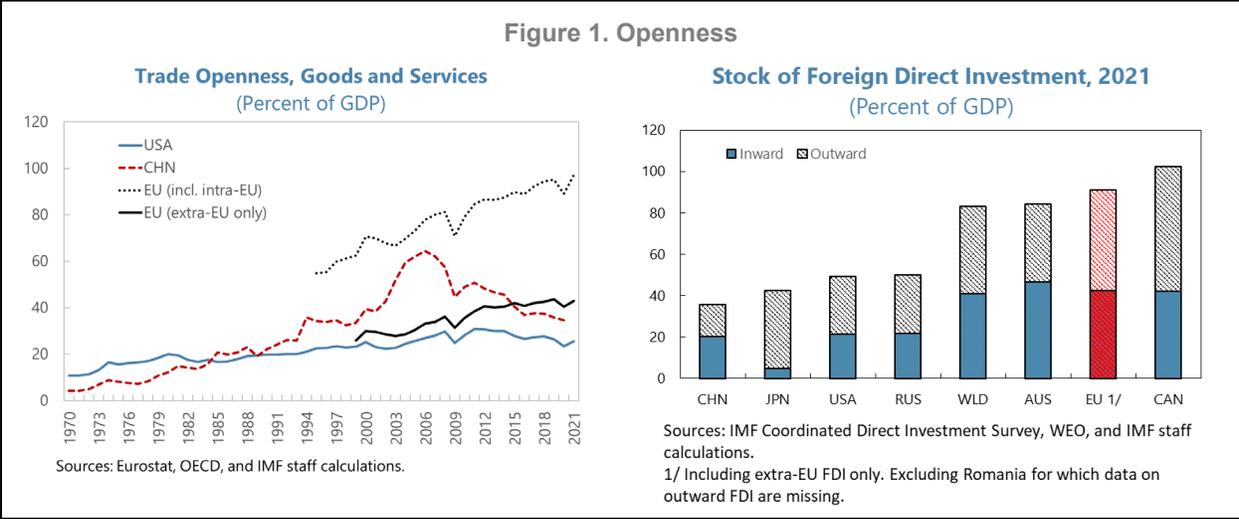
[2] Lisbon Strategy 2005, as discussed in Euopean Commission (2006).

The EU liberalized trade restrictions earlier and to a greater extent than did other regions. The global economy underwent around 30 years of deep and substantive liberalization, beginning around the 1970s and ending in the early 2000s, during which advanced and emerging market economies—including China—lowered barriers and the former Soviet bloc was integrated into the global economic system.[3] For the EU, this period included several waves of enlargement, where accession required new members to liberalize their economic relations with countries outside the bloc while adopting the EU's internal Single Market for goods, services, capital and labor. The EU has been a strong supporter of the multilateral trading system, with the WTO at its center, although it has also advocated for some reforms, including in the areas of health, energy, e-commerce, facilitating investments, and industrial subsidies.

Figure 2. Trade Restrictions
(Percent of trade)

Legend: Africa; Asia-Pacific; Europe; Middle East and North Africa; Americas

Source: "Measurement of Aggregate trade Restrictions and Their Economic Effects," Estefania-Flores and others.
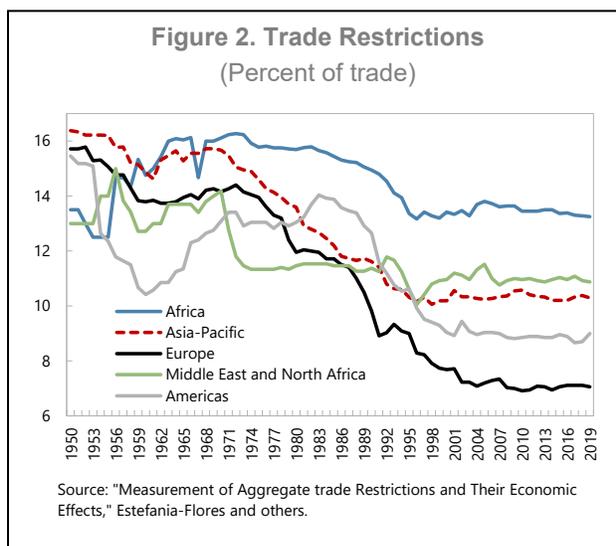
The benefits for the EU economy of external and internal openness are well-documented. Openness to imports is found to have increased real incomes in the EU by 7¾ percent (€1.2 trillion) compared to a situation without imports (EC 2020). Small and medium-sized enterprises engaging in extra- and intra-EU trade employ over 13 million workers, with more than 615,000 (87 percent of total exporting EU companies) selling outside the EU and over 1 million firms exporting within the EU (accounting for 35 percent of the total value of intra-EU exports). About half the related jobs are in the service sector.

Global FDI peaked on the eve of the global financial crisis, while global trade has undergone a "slowbalization" since then. The different pattern of FDI and trade reflects in part that plateauing global trade has reduced demand for new cross-border direct investment,[4] but once such investments are in place, production and trade are to a large extent locked in. Stabilizing global trade has been attributed

Figure 3. Global Slowbalization
Trade and Investment
(Percent of GDP)

Legend: Trade in goods and services; Gross foreign direct investment (RHS)

Sources: IMF, WEO; and IMF staff estimates.

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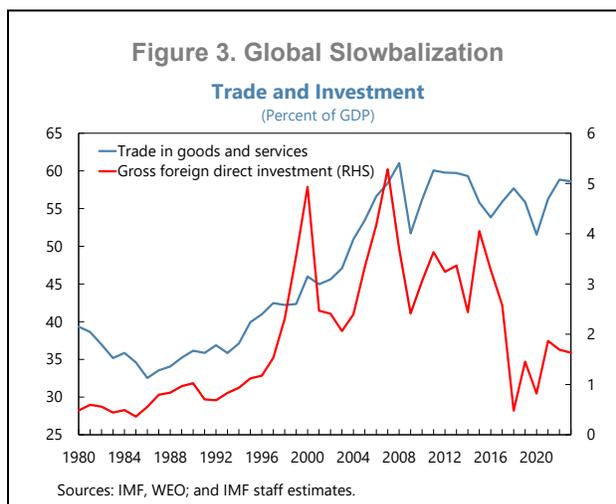
[3] According to Baier and Bergstrand (2001), liberalization accounted for most of the increase in trade during this period. The World Trade Organization (WTO), established in 1995, became the new multilateral institution overseeing trade agreements and facilitating negotiations and dispute settlement. Alongside the expansion in trade, cross-border capital flows—FDI, bank lending, portfolio investment—surged, and the global financial system became increasing complex and interconnected (IMF 2023a).

[4] In addition, FDI declined sharply from 2017 following the introduction of the US corporate tax reform (2017 US Tax Cut and Jobs Act) and, to a lesser extent, the OECD initiative to counter base erosion and profit shifting (IMF 2023a). This led to the repatriation of US direct investment held abroad by US multinationals (but round-tripped into US financial instruments) and the subsequent unwinding of related financial holding companies, which—in the EU—were primarily located in Luxembourg and the Netherlands.

to: (i) reduced potential for further liberalization as many trade barriers had already approached their lower bound (e.g., many tariffs fell to zero); (ii) the fact that transition economies had largely completed their transformation into market-based economies; (iii) the moderation of commodity price developments (particularly energy); and (iv) the weaker pace of global growth reduced demand for heavily-traded consumer durables and investment goods.[5] Moreover, unit labor costs in developing economies have increased, including China, while robotics and other technologies have reduced the labor intensity of advanced manufacturing.[6] In addition, China's share of global trade has moderated.

Attention is increasingly focused on geopolitical tensions as a factor in fragmenting cross-border economic relations. GEF, defined as policy-induced reversal of international economic integration,[7] has been fueled in recent years by several events, including the COVID-19 pandemic and Russia's invasion of Ukraine. Important commodities, such as energy, grains, and rare earth minerals, as well as advanced technologies (including vaccines and computer chips) and potential dual-use products have been subjected to restrictions or sanctions. Inward and outward direct investment is increasingly exposed to official review or prohibited. Motivations for such policies include national security, economic security—including the wish for greater economic autonomy and to improve resilience, and are often aimed at reducing linkages to countries with different geopolitical views. A potential consequence of external fragmentation could be a significant "turning-inward" by countries, accompanied by a proliferation of industrial polices to support the reshoring of output and employment.

A more fragmented world could affect the highly-open and globally integrated EU economy through numerous channels, with potentially sizable effects. At the macroeconomic level, GEF policies can affect: (i) trade and supply chain partnerships; (ii) destinations and sources of direct investment and financial flows; and (iii) incentives for innovation and access to technologies. It can also impact specific sectors, notably energy, semiconductors and rare earth minerals, that—in turn—have implications for downstream production along value chains.

The number of studies analyzing the economic impact of GEF is expanding rapidly.[8] Estimated impacts on global and European GDP vary widely, depending on the channels and the fragmentation scenarios considered. IMF (2023a) finds that if the world were to splinter into US- and China-centered blocs, but with other large countries and regions remaining nonaligned (and hence able to trade with both of the two blocs), long-term global output would decrease by 2 percent. Output losses would generally be larger in the China-centered bloc as much of foreign-sourced investment would fall away. Using a gravity approach, IMF (2023b) finds that increased geopolitical distance, reflecting divergent UN voting behavior by the US and China, is associated with a 15 percent reduction in cross-border portfolio flows and bank claims. IMF (2023c) finds that fragmentation of world supply and demand for key mined commodities into a "China/Russia+" bloc and a "US/EU+" bloc would lower world GDP by a modest ¼ percent, with a significantly larger output loss for the "China/Russia+" bloc, but with a sizable effect on inflation in the "US/Europe+" bloc, driven by oil and gas prices. In addition, segmenting markets for minerals critical to the green transition is found to lower global investment in renewables and EVs by 30 percent. Focusing on the EU, Attinasi and others (2023) quantify the

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[5] For example, Darvas (2020). However, Baldwin and others (2023a) point to the recent acceleration in cross-border trade in services fueled by digitalization, and predict that services—rather than goods—will drive future trade.

[6] Dadush (2022).

[7] See Aiyar, Ilyina, and others (2023) for a discussion of what types of measures and actions constitute GEF.

[8] See, for example, Aiyar, Presbitero, and Ruta (eds.) (2023) for a collection of recent studies on the economic implications of fragmentation and potential areas for future research.

economic costs of fragmentation scenarios using the multi-country, multi-sector model of Baqaee and Farhi (2023). They find that trade decoupling would reduce EU output and trade and raise prices, and while welfare losses in all but the most extreme decoupling scenario are generally muted in the long run as economies adjust over time, they are up to five times larger in the short term when prices, inputs and factors of production are rigid.

This paper adds to the literature by focusing specifically on implications of GEF for the European Union. The next section documents the number, type and motivations for cross-country policy restrictions, focusing in particular on the EU, US, and China. It then takes stock of the EU's exposure to GEF through various channels. Using two models that focus on different aspects of fragmentation—innovation with technology diffusion and energy—the paper then simulates the possible long-term effects of GEF, allowing for substitution and adaptation within global general equilibrium frameworks that could partially cushion the impacts. A final section offers policy considerations as the EU navigates a world where geopolitical tensions have become more prominent.

GEF Policies Adopted by the EU and Others

Alongside a sharp rise globally, the number of restrictions on trade and FDI received by and imposed on the EU is also growing. Almost 3000 new harmful restrictions on trade or FDI were implemented worldwide in 2023 nearly three times of the number of such restrictions introduced in 2019, and far exceeding the number of liberalizing measures.[9] This increase in global harmful restrictions mirrors the increase in trade tensions between the US and China since 2018-19, the COVID pandemic and Russia's war in Ukraine (Aiyar and others, 2023). Similarly, new measures imposed on the EU and its members have trended up since the mid-2010s, mainly concentrated on goods trade. Restrictions by the EU on other countries have also risen, including in response to Russia's annexation of Crimea and—more recently—its invasion of Ukraine. The EU's outward restrictions cover goods, services and FDI. It is noteworthy that the EU's effective tariff rate has nonetheless remained stable and low,

Figure 4. Number of Newly Implemented Trade or FDI Measures 1/

Source: Global Trade Alert.
1/ Including restrictions imposed by supra-national, national, and subnational governments, international financial institutions; and national financial institutions.
2/ Cutoff date as of November 22.

highlighting the importance of "behind-the-border" restrictions. For example, mechanisms for screening inward

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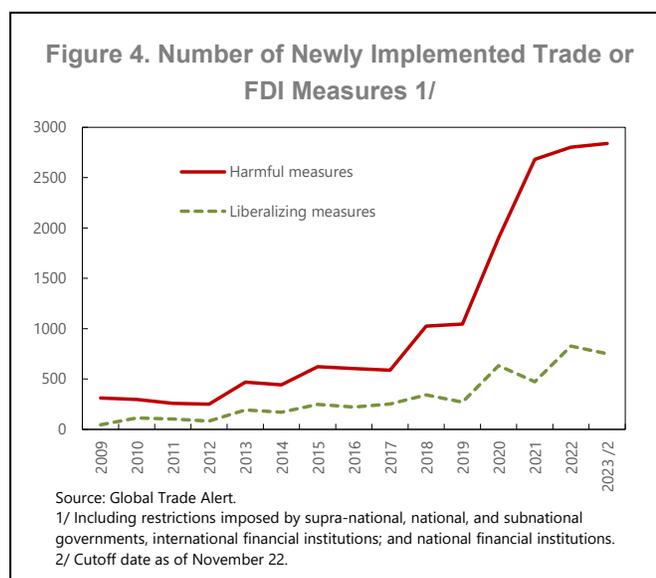
[9] Based on the number of measures, without accounting for their economic significance.

FDI were introduced or expanded by individual EU countries, and an EU-wide cooperation mechanism has existed since 2020 (Annex I), focusing on critical inputs, infrastructure and technology.[10]

Figure 5. Restrictions Affecting/Imposed By the EU

Restrictions on Trade and FDI Affecting EU Countries 1/
(Number of new restrictions)

Sources: Global Trade Alert and IMF staff calculations
1/ The figure shows supranational- and national-level new restrictions implemented in each year that affect EU countries and remain in effect. The matric does not account for intensity or economic effect of restrictions.

Restrictions on Trade and FDI Imposed by EU Countries 1/
(Number of new restrictions)

Sources: Global Trade Alert and IMF staff calculations
1/ The figure shows supranational- and national-level new restrictions implemented in each year that affect EU countries and remain in effect. The matric does not account for intensity or economic effect of restrictions.

Financial support to producers is the most common form of restriction, including by the EU, rather than direct trade-related measures. For China and EU countries at the national level, financial support—which includes equity injections, subsidies and tax relief—accounts for more than 90 percent of all measures (left, Figure 6). In the case of the US and the EU at the supranational level, financial support measures account for a smaller share but still comprise more than half of the number of restrictions imposed. Given its purview over the bloc's trade policy, measures by the EU at the supranational level also directly target trade, including though tariffs, and anti-dumping and subsidy measures. Financial aid is dominant at the EU national level despite the existence of State Aid rules to limit unfair competition within the Single Market. The on- and off-budget fiscal cost of state aid in the EU is sizeable, averaging 1 percent of countries' GDP even prior to COVID and the energy price shock, with a wide variation across countries (right, Figure 6).

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[10] The EU FDI Screening Regulation establishes a framework for EU members to screen inward FDI on the grounds of security or public order. By 2022, 18 members had a screening mechanism. Areas covered include critical infrastructure (e.g., energy, transport, financial infrastructure), critical technologies and dual-use items (artificial intelligence, robotics, semiconductors, cybersecurity, quantum technology, aerospace, nanotechnologies, biotechnologies), critical inputs, access to sensitive information (including personal data), and media. Investment thresholds that trigger screening differ across member countries. According to the EC's 2023 Annual Report on the Screening of FDI, 55 percent of requests for FDI authorization in 2022 were formally screened, 9 percent of which were approved subject to conditions or mitigating measures, while only 1 percent of formally screened investment requests were blocked.

Figure 6. Types of Restrictions and EU State Aid

Type of Trade and FDI Restrictions, 2008-22
(Percent)

Legend:
- Others
- Public procurement and local content 2/
- Financial support 1/
- Anti-dumping, anti-subsidy, safeguard
- Export restrictions 3/
- FDI
- Import tariff

Sources: Global Trade Alert, and IMF staff calculations.
1/ Capital injection and equity stakes (including bailouts), financial grant, import incentive, interest payment subsidy, price stabilization, production subsidy, state aid, state loan, and tax of social insurance relief.
2/ Public procurement access/localization/preference margin, local content incentive/requirement, local labor requirement, and local operations requirement.
3/ Export ban/licensing requirement/quota/tax, export-related non-tariff measure, financial assistance in foreign market, other export incentive, tax-based export incentive, trade finance.

Total Approved State Aid by Instrument, 2019
(Percent of GDP)

Legend:
- Direct Subsidies
- Financial
- Tax & Social Security Contributions
- Other

Sources: Eurostat, WEO, and IMF staff calculations.

The EU's Potential GEF Exposure

EU bilateral trade in goods is heavily concentrated among EU members and with other geopolitically-aligned countries. More than half of EU direct exports are destined for other EU members. An additional quarter of EU direct exports (about 3 percent of EU GDP) is absorbed by non-EU countries that voted in favor of the 2022 UN Resolution on Ukraine.[11] Direct exports of goods to countries that did not support the UN Resolution (comprising countries that were against the resolution, abstained from voting or were absent—the "AAA" bloc) are modest as a share of GDP. Regarding cross-bloc imports into the EU, those originating from the non-EU "in favor" bloc are larger than from the "AAA" bloc, with both being relatively small. Thus, on the face of it, the geographic structure of direct bilateral trade across all goods seems to suggest limited exposure to fragmentation risk.

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[11] UN Resolution ES-11/1 of March 18, 2022 on Russia's aggression against Ukraine. The number of "in favor" countries increased marginally based on voting in a subsequent 2023 UN resolution on Ukraine.

Figure 7. Direct Goods Trade Within and Between Blocs
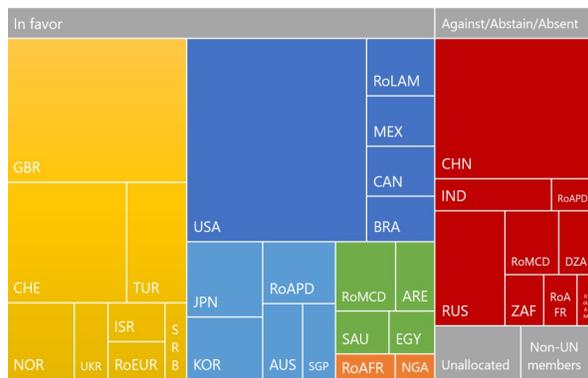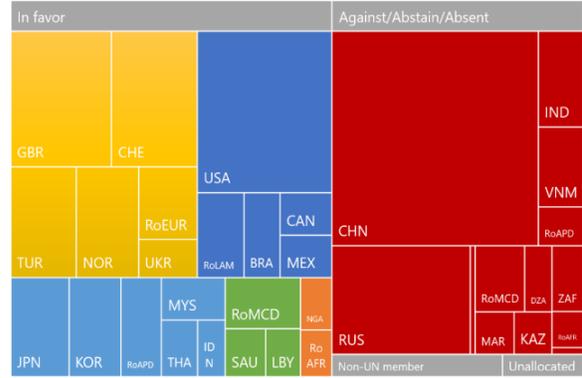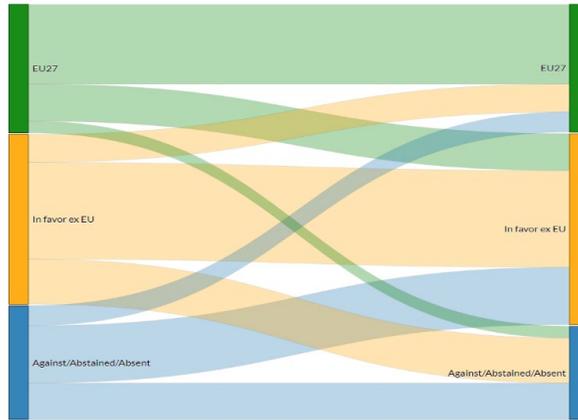
Sources: IMF Direction Trade Statistics and IMF staff calculations.

However, patterns of trade reliance can differ significantly once indirect imports and exports are also considered. On the import side, goods received from a direct trade partner may include inputs supplied by third countries. On the export side, products sold to one country could be used as an input to production and sold on to third countries. Looking through potentially long and complex supply networks reveals a country's or region's ultimate trade reliance on others.

Including indirect trade to and from third countries indicates the EU's reliance on the "AAA" bloc is generally larger than suggested by direct bilateral trade. Two measures based on global input-output tables are considered:[12]

▪ Participation metrics indicate the foreign dependence of a country's global value chains.[13] Backward participation, which measures the share of foreign value added embedded in gross domestic exports (i.e., the foreign value added that is re-exported), is relatively high for the EU at 16 percent, and larger than for the US (around 10 percent of gross exports), but less than the 17 percent for China (Figure 8, top left panel).

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[12] As discussed in Baldwin and others (2023b), foreign dependence can be measured in alternative ways, with the scenario of interest helping to define the appropriate concept.

[13] OECD Trade in Value Added and Wang et al. (2017).

Most of the EU's backward participation is sourced from the non-EU "in favor" bloc, with only about 5 percentage points coming from the "AAA" bloc. Forward participation—the share of domestic value added embedded in the gross exports of downstream trading partners—is around 15 percent for the EU, with the majority of EU value added being used in the gross exports of the non-EU "in favor" bloc.

- An alternative measure seeks to capture the ultimate foreign exposure of domestic production and final demand. This is done by "looking through" direct bilateral trade to identify the ultimate countries of origin and destination.[14] On the input (sourcing) side, the EU's foreign input reliance for the whole economy rose from around 12 percent of domestic value added in 2004 to 18 percent by 2011, driven mainly by increasing reliance on the "AAA" bloc (although the share from the non-EU "in favor" bloc is large). Foreign input reliance is even greater for the manufacturing sector, where the EU's ultimate reliance on foreign inputs rose from 19 percent of manufacturing GDP in 2004 to 28 percent, also driven by increasing reliance on the "AAA" bloc (bottom left), and where dependence on a single country (i.e., China) is more concentrated. On the selling (export) side, ultimate foreign market reliance has also risen over time, mainly due to greater dependence on the "AAA" bloc. The EU's ultimate dependence on the "AAA" bloc is larger on the sourcing side than on the final market side, especially for manufacturing.

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[14] The concepts of participation and ultimate foreign dependence share important similarities, including that they are based on global input-output tables and are derived from the corresponding inverse Leontief matrix. As highlighted by Baldwin and others (2023b), they differ however, in that participation excludes imports used for final domestic demand as well as exported domestic value added to meet final demand of the immediate trade partner (i.e., participation considers only goods that cross an international border at least twice). Particpation is also based on value added, while—as used here—ultimate foreign dependence is based on gross production.

Figure 8. Value Chain Linkages and Foreign Input and Market Reliance

GVC Backward Participation 1/
(Percent of gross exports)

Legend: EU; In favor (non-EU); Against/abstained/absent; ROW
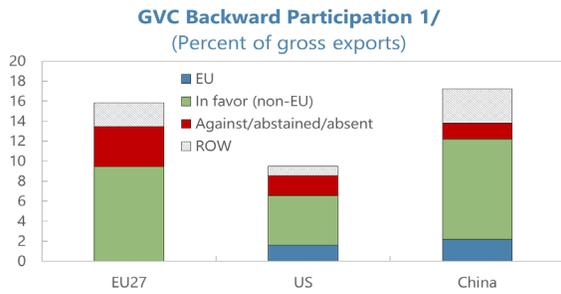
Sources: OECD Tiva and IMF staff calculations.
1/ Backward participation is foreign value added embedded in gross exports. Data is as of 2018. Non-EU countries are grouped into the "in favor" bloc and the "against/abstained/absent" bloc: the former supported UN Resolutions ES-11/1 while the latter was against/abstained/absent. For the countries that the OECD Tiva database reports only on an aggregate base as "rest of the world" are shown "ROW."

GVC Forward Participation 1/
(Percent of source region/country's gross exports)

Legend: EU; In favor; Against/abstained/absent; ROW
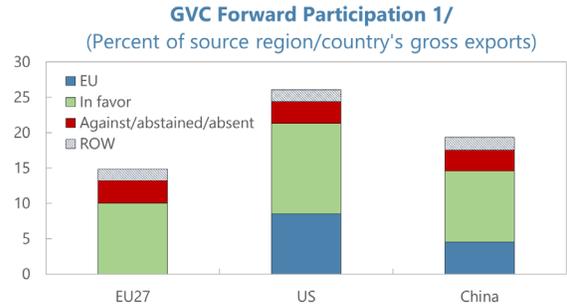
Sources: OECD Tiva and IMF staff calculations.
1/ Forward participation is defined as domestic value-added embedded in trading partners' gross exports. Data is as of 2018. "Source region/country" refers to the source region/country of domestic value-added." Non-EU countries are grouped into the "in favor" bloc and the "against/abstained/absent" bloc: the former supported UN Resolutions ES-11/1 while the latter was against/abstained/absent. For the countries that the OECD Tiva database reports only on an aggregate base as "rest of the world" are shown "ROW."

EU Foreign Input Reliance, Total Economy
(Percent of GDP)
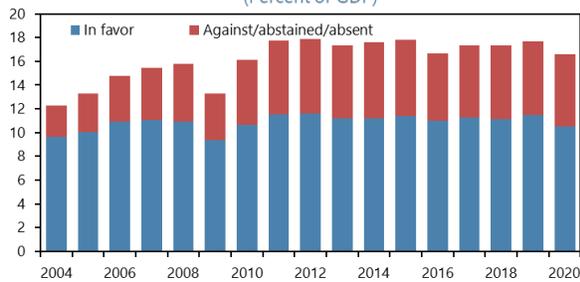
Legend: In favor; Against/abstained/absent

Sources: OECD Inter-Country Input-Output Tables and IMF staff calculations

EU Foreign Market Reliance, Total Economy
(Percent of GDP)

Legend: In favor; Against/abstained/absent
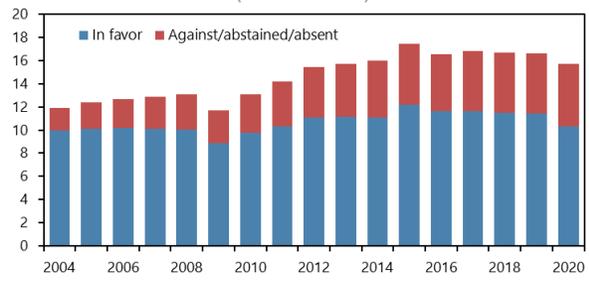
Sources: OECD Inter-Country Input-Output Tables and IMF staff calculations

EU Foreign Input Reliance, Manufacturing
(Percent of manaufacturing GDP)
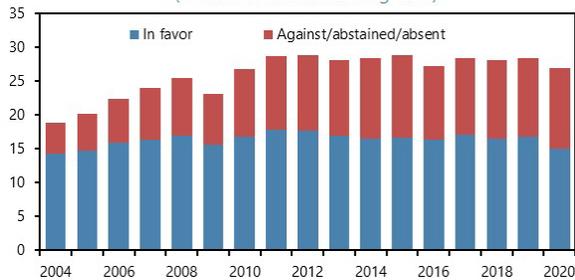
Legend: In favor; Against/abstained/absent

Sources: OECD Inter-Country Input-Output Tables and IMF staff calculations

EU Foreign Market Reliance, Manufacturing
(Percent of manufacturing GDP)

Legend: In favor; Against/abstained/absent
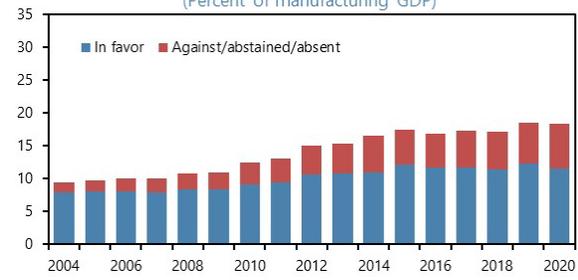
Sources: OECD Inter-Country Input-Output Tables and IMF staff calculations

Trade-related fragmentation risk may also arise when imported goods are difficult to substitute. Two aspects seem particularly relevant in this regard: (i) how readily specific goods can be replaced in production (technological substitutability) and (ii) whether it is feasible to shift to alternative suppliers (supplier substitutability). The European Commission identifies raw materials as critical if they meet minimum thresholds on both concepts.[15] An input's economic importance is based on the value added of the products generated with that material, adjusted for its technical substitutability in production and the cost of alternatives. The extent

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[15] European Commission (2021) "Strategic Dependencies and Capacities."

of supply risk considers the concentration of global supply and the governance performance of producing countries. All told, the EC identifies 34 raw materials as critical for the EU.[16]

Following the approach of Korniyenko, Pinat, and Dew (2017), another way to quantify which intermediate goods are difficult to substitute is to look at "fragile" supply (see below and Annex II for details). A sizable share of extra-EU imports, including those from the "AAA" bloc, seem to fall in this category. An intermediate good is defined as fragile if there is only one or a small number of central providers in the supply network and if the potential to replace existing suppliers is low. Fragile intermediates can encompass raw materials and transformed goods. Based on the characteristics of the supply networks of more than 5,000 individual 6-digit traded products, fragile intermediate goods represent on average about 40 percent of extra-EU imports by value, of which around half are supplied by countries in the "AAA" bloc, and mainly consist of transformed goods. Extra-EU imports of fragile intermediate goods are more exposed to the "AAA" bloc than are the US's fragile imports.

Figure 9. Extra-EU Imports of Fragile Intermediate Goods
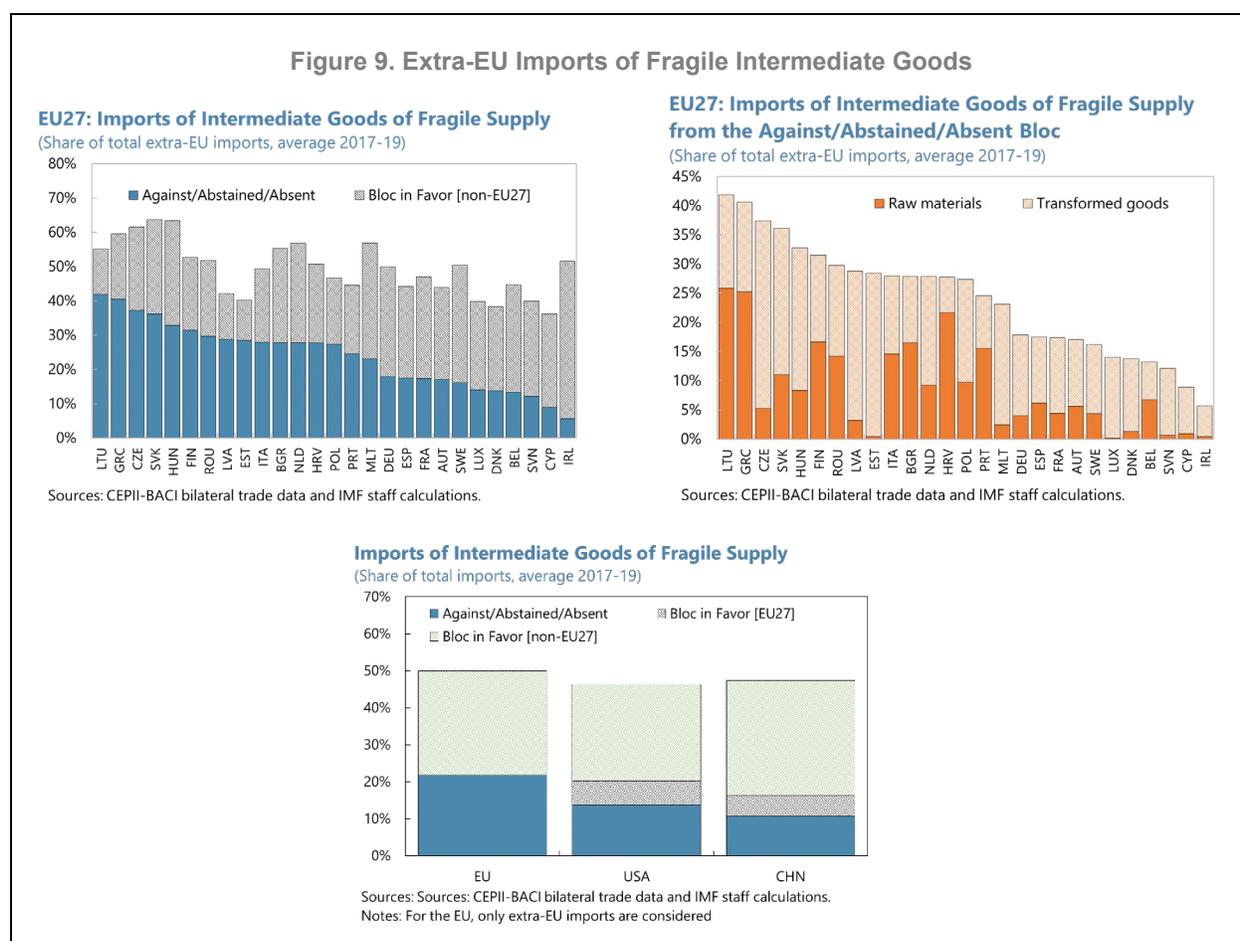
The EU's trade in services is heavily focused on countries that are geo-politically aligned with the EU, suggesting that services trade poses little fragmentation risk (Figure 10). Exports and imports of services by EU countries are mainly directed to other EU members (around half the total) and with other "in favor" countries (accounting for around 37 percent), including European financial centers outside the EU. On the other hand,

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[16] Critical raw materials (europa.eu)

services trade with the AAA bloc is modest. While EU cross-border trade in services has grown rapidly, the respective shares of country groups has remained quite stable.

Figure 10. EU Commercial Services Trade

EU Commercial Services Exports by Partner (Billion of US dollars)

Sources: WTO; and IMF staff estimates.

EU Commercial Services Imports by Partner (Billion of US dollars)

Sources: WTO; and IMF staff estimates.
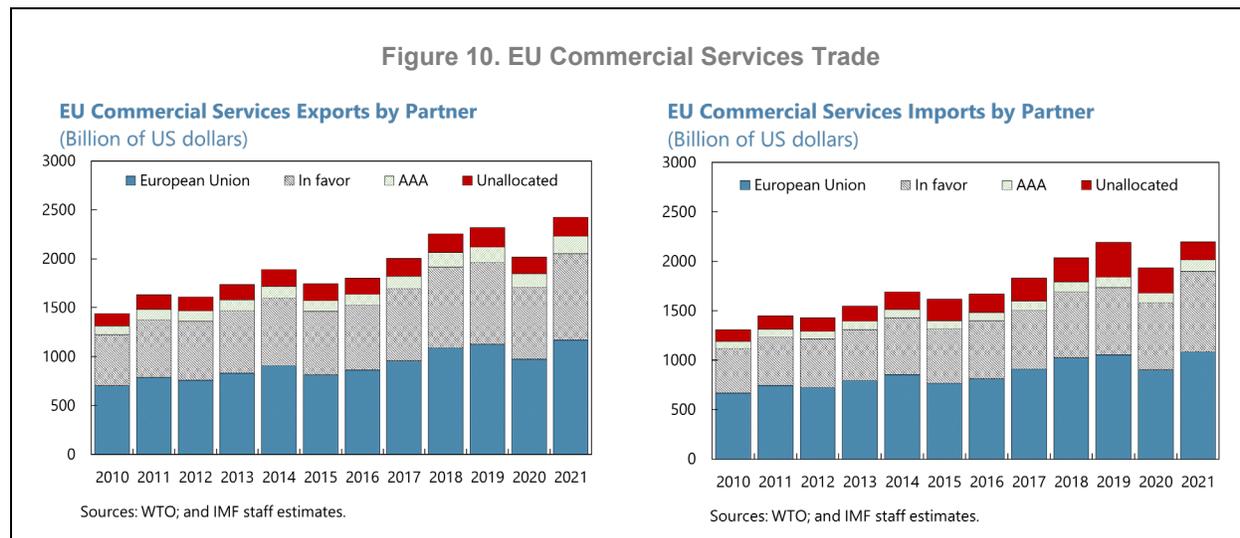
Looking at financial reliance, the EU's exposure to the "AAA" bloc does not appear to be large at the aggregate level. Global financial integration increased sharply in the run-up to the global financial crisis (GFC), but the momentum has slowed since then (Figure 11, left). Reduced cross-border capital movements since the GFC largely reflect a decline in banking flows owing to retrenchment by global banks from foreign jurisdictions (Lane and Milesi-Ferretti 2018). However, other factors, such as an increase in official restrictions on capital flows for geopolitical purposes, may also have played a role. In terms of stocks of foreign liabilities, the EU's financial exposure to the "other" bloc is relatively small: 3 percent of portfolio investment, 4 percent of FDI, and 2 percent of bank assets are in the "AAA" bloc. However, the true extent of financial linkages may be obscured by the presence of financial centers, multinational holding companies, and the establishment of resident companies owned by foreign entities, including those located within the EU.[17]

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[17] The Global Capital Allocation Project seeks to trace financial ownership chains from investing countries to their ultimate destination by looking through financial centers and tax havens. For example, Coppola and others (2021) find that official data on foreign bond and equity holdings significantly understate the amount of financing provided by developed market investors to firms in large emerging markets.

Figure 11. Financial Exposure to Fragmentation Risk

Global Financial Integration, Advanced Economies
(Percent of advanced economy GDP)

Sources: IMF Balance of Payments Statistics and 2023 April Global Financial Stability Review.
1/ The sum of advanced economies' external assets and liabilities as a percent of the sum of advanced economies' GDP.
2/ The sum of advanced economies' total liability flows (positive values indicate nonresident capital inflows) as a percent of the sum of advanced economies' GDP.

Financial Linkages by Types and Region, 2021
(Assets/claims of regions shown in columns; in percent)

Sources: IMF coordinated direct investment survey, IMF coordinated portfolio investment survey, BIS location banking statistics, and IMF staff calculations.
Note: Data for portfolio investment and FDI are for 2021 while those for Banks are for end-2022.

At the same time, based on a comprehensive world dataset of FDI projects by country pairs (fDi Markets), we find that FDI activity from the EU appears to be increasingly driven by geopolitical alignment rather than geographic distance or other economic considerations. Based on data on greenfield FDI projects (which abstracts from direct investment flows for tax and financial-engineering purposes), about two-thirds of EU outward FDI projects over the past two decades went to countries in the top two quintiles in terms of geopolitical proximity to the EU. The EU's outward FDI is found to have become even more responsive to geopolitical distance since 2017, after controlling for host-country per capita income, and time and source-country fixed effects.[18] In fact, FDI fragmentation began soon after the euro debt crisis, when inward and outward extra-EU FDI with the non-EU "in favor" bloc recovered strongly, both in terms of number of projects and their value. On the other hand, EU FDI integration with the "AAA" bloc has remained weak. And the EU's outward FDI to Russia has been halted since the start of the war in Ukraine.

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[18] Geopolitical distance as used here is measured by ideal point distance, which is based on long-term voting patterns at the UN to assign a voting distance between country pairs. An alternative approach is to rely on information on bilateral armaments transfers data, compiled by the Stockholm International Peace Research Initiative (for example, Fletcher and others 2023). Using this alternative measure of geopolitical distance yields similar empirical results for EU FDI.

Figure 12. EU Foreign Direct Investment Linkages

EU's Outward FDI by Region
(Number of projects, 4-q moving average)

Legend:
- In favor (excl. EU)
- Against/abstained/absent
- EU
- In favor (excl. EU) (pre-COVID avg.)
- Against/abstained/absent (pre-COVID avg.)
- EU (pre-COVID avg.)

EU's Inward FDI by Region
(Number of projects, 4-quarter moving average)

Legend:
- In favor (excl. EU)
- Against/abstained/absent
- EU
- In favor (excl. EU) (pre-COVID avg.)
- Against/abstained/absent (pre-COVID avg.)
- EU (pre-COVID avg.)

EU's Outward FDI by Region
(Billion USD, 4-quarter moving average)

Legend:
- In favor (excl. EU)
- Against/abstained/absent
- EU
- In favor (excl. EU) (pre-COVID avg.)
- Against/abstained/absent (pre-COVID avg.)
- EU (pre-COVID avg.)

EU's Inward FDI by Region
(Billion USD, 4-quarter moving average)

Legend:
- In favor (excl. EU)
- Against/abstained/absent
- EU
- In favor (excl. EU) (pre-COVID avg.)
- Against/abstained/absent (pre-COVID avg.)
- EU (pre-COVID avg.)

EU's Outward FDI by Geopolitical Distance
(Number of projects, sum for 2003-22)

Legend:
- FDI in strategic sectors
- FDI in other sectors

Note: Geopolitical distance is based on the Ideal Point Distance proposed by Bailey, Strezhnev, and Voeten (2017), which measures geopolitical distance based on the voting behavior in the United Nations General Assembly (UNGA). Countries in the 1st (5th) quintile are geopolitical closest to (farthest from) the EU. The definition of strategic sectors follows IMF (2023a).

EU's Outward FDI and Geopolitical Distance

Legend:
- Period: 2003-2016
- Period: 2017-2022

X-axis: Ideal point distance from EU27 countries
Y-axis: FDI outflows (number of projects)

Note: Binscatter chart. "FDI outflows" in the y-axis are after controlling for geographical distance, real per capita GDP in the destination country, and year and source country fixed effects. "Ideal point distance from EU27 countries" in the x-axis is based on Bailey, Strezhnev, and Voeten (2017), which measures geopolitical distance based on the voting behavior in the United Nations General Assembly (UNGA).

Sources: fDi Markets; Aiyar and others (2023); Bailey, Strezhnev, and Voeten (2017); and IMF staff calculations.

Turning to energy trade, Russia's invasion of Ukraine precipitated a rapid reorientation of natural gas purchases by the EU, resulting in a sharp reduction in supplier concentration. Prior to the invasion, Russia provided about one-fifth of EU gas in 2020. As a result, as natural gas stopped flowing from Russia, EU gas prices (as measured by prices in the Netherland's Title Transfer Facility (TTF) virtual gas trading hub) soared to many multiples of previous levels and a large gap with wholesale gas prices elsewhere opened up. Following successful efforts to diversify suppliers, and facilitated by the much higher EU prices that diverted shipments of

liquid natural gas to Europe, the EU's reliance on Russian piped gas has fallen to around 5 percent by H1:2023. Wholesale prices remain considerably higher in the EU and Asia than previously and than in the US.

Figure 13. Fragmentation and Energy Markets

EU27's Extra-EU Natural Gas Imports
(Percent)

EU27's Extra-EU Oil Imports
(Percent)

Note: 2023 data up to 2023M5

Sources: Eurostat and IMF staff calculations.

Sources: Eurostat and IMF staff calculations.

Natural Gas Prices
(US$/Metric Million British Thermal Unit)

- Netherlands TTF 1/
- LNG -- Northeast Asia 1/
- US Henry Hub 1/

Sources: IMF Primary Commodity Price System and IMF staff calculations.
1/ Average of daily quotations.

Energy intensive sectors, which play an important role in EU economies, have been adversely affected by the surge in gas prices. In 2019, 1.7 percent of the EU's domestic value added was derived from energy intensive manufacturing,[19] but the share was considerably higher in several Central, Eastern and South-Eastern European (CESEE) economies, including Slovenia, Czech Republic and Bulgaria. Energy intensive sectors tend to be less labor intensive than the overall economy, yet still employ a non-negligible share of workers, accounting for 1.2 percent of total employment in 2019, with much higher shares in several CESEE countries. Since the onset of the war in Ukraine, output of energy-intensive manufacturing has been considerably weaker than other sectors.

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[19] Energy intensive manufacturing is defined as paper and paper products, chemicals and chemical products, other non-metallic mineral products, and basic metals.

Figure 14. Economic Importance of Energy Intensive Sectors

Share of Value Added of Energy Intensive Manufacturing Sectors vs Energy Import Dependency (Percent)
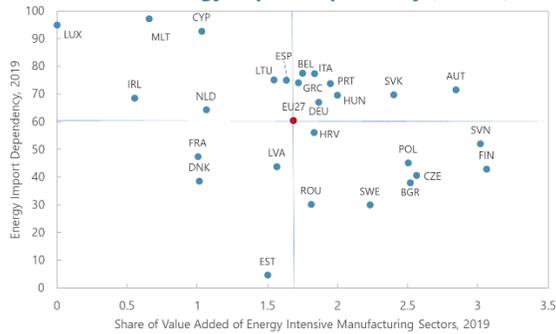
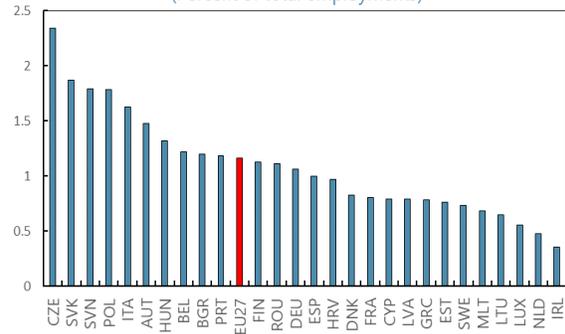Workers in Energy Intensive Manufacturing Sectors, 2019 (Percent of total employments)

Sources: Eurostat and IMF staff calculation

Sources: Eurostat and IMF staff calculations.

Note: Energy intensive manufacturing sectors include paper and paper products, chemicals and chemical products, other non-metallic mineral products, and basic metals.

Possible Implications of Geopolitical Tensions for EU Economies: Key Stylized Facts

In this section we simulate the potential effects of geopolitical tensions on the EU economy, focusing on several channels through which fragmentation could affect the economy. Two quantifiable general equilibrium models of global production and trade are calibrated to simulate the long-term effects of GEF due to policies that, respectively, raise the cost of offshore production that relies on firms' proprietary knowledge (multinational production) and increase the EU's cost of fossil fuels.

GEF IN THE CONTEXT OF INNOVATION AND MULTINATIONAL PRODUCTION

Global income receipts and payments related to intellectual property (IP) indicate that the EU is the second-largest exporter of ideas, surpassed only by the US. Both the US and the EU receive large IP payments from other regions. In general, the US is a large net IP exporter, while China is a large net IP importer from all major regions.[20] More than half of EU IP receipts originate from countries within the EU, reflecting mainly payments from EU countries that are more intensive in goods production (henceforth denoted "EUG") to the more knowledge-intensive EU countries (denoted "EUK") (top left chart). The EU also relies on IP imports from the US, but much less so from China. Within the EU, there is a strong bifurcation of net IP flows, with Germany and the Nordics as net recipients as compensation for IP exports, while Ireland is a large net payer/importer (bottom chart).

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[20] Data on IP payments and receipts may not fully capture flows between countries that occur within multinational firms.

Figure 15. Intellectual Property Trade and Comparative Advantage in Innovation Relative to Manufacturing

Intellectual Property Trade, avg. 2015-19

Exporters: EUK, EUG, USA, CHN, ROW
Importers: EUK, EUG, USA, CHN, ROW
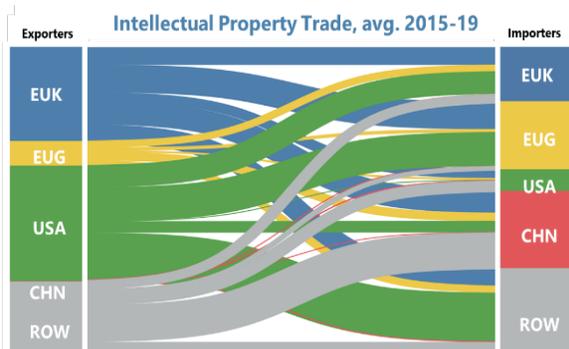
Sources: UNCTAD and IMF staff calculations.
Notes: Intellectual property trade comprises charges for the use of intellectual property n.i.e.; franchises and trademarks licensing fees; licenses for the use of outcomes of research and development; licenses to reproduce and/or distribute computer software; licenses to reproduce and/or distribute audio-visual and related products; licenses to reproduce and/or distribute audio-visual products; and licenses to reproduce and/or distribute other related audio-visual products. EUK refers to European Union innovators, including BEL, NLD, LUX, DNK, FIN, FRA, and DEU; E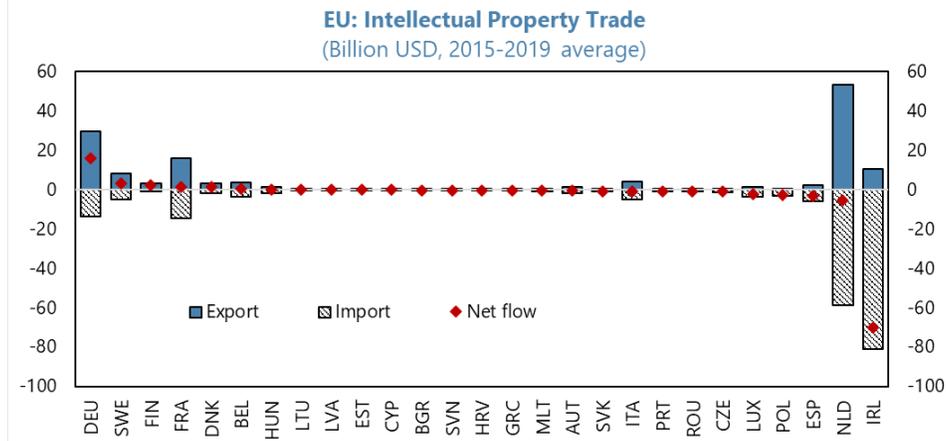UG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to all the non-EU, USA, and CHN countries in our sample, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

R&D Intensity in Manufacturing
(Manufacturing R&D in percent of manufacturing value added)

Legend: 2008, 2018

EU members: SWE, BNX, DEU, AUT, DNK, FIN, FRA, ITA, HUN, ESP, PRT, GRC, POL, IRL
Others: KOR, USA, JPN, CHN, AUS, GBR, CAN, TUR, MEX
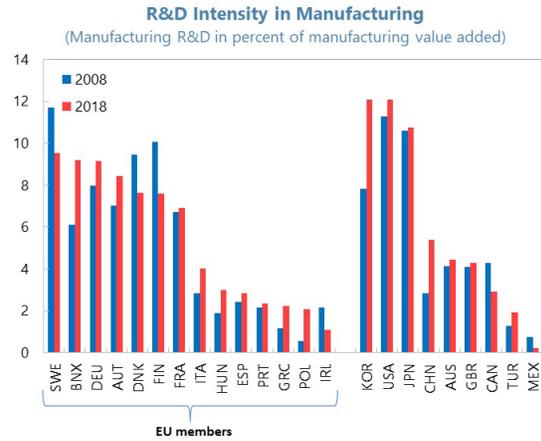
Sources: OECD STAN; OECD ANBERD; and IMF staff estimates.
Note: United Kingdom 2018 data is 2013. France 2018 data is 2017. Denmark and Ireland 2008 data are 2009. Greece 2008 data is 2011.

EU: Intellectual Property Trade
(Billion USD, 2015-2019 average)

Legend: Export, Import, Net flow

Countries: DEU, SWE, FIN, FRA, DNK, BEL, HUN, LTU, LVA, EST, CYP, BGR, SVN, HRV, GRC, MLT, AUT, SVK, ITA, PRT, ROU, CZE, LUX, POL, ESP, NLD, IRL

Sources: UNCTAD and IMF staff calculations.

Countries' comparative advantage in innovation, which accords well with international IP payment flows, indicates that EU members include economies that tend to specialize in innovation and those that tend to specialize in manufacturing. R&D intensity in manufacturing (measured as spending on manufacturing R&D as a share of manufacturing value added)—a proxy for comparative advantage in innovation relative to goods manufacturing—is highest in Korea and the US, followed closely by Japan. Based on the same metric, while China has significantly increased its manufacturing R&D, it retains an advantage in manufacturing. The EU includes countries that channel significant amounts of resources into manufacturing R&D relative to the size of the sector, in addition to those where R&D is more modest. This wide spectrum of comparative advantage suggests that the EU forms an innovation-production ecosystem that distinguishes it from the US (which is more specialized on innovation) and China (which remains more focused on manufacturing).

We now explore how GEF-related frictions on trade and multinational production could affect the EU economy.

Mobility of IP enables goods to be produced in countries distinct from where the innovation occurs.[21] Multinational production (MP) occurs when both activities take place within a single firm that operates in more than one country. Following the quantifiable global model of innovation and MP by Arkolakis and others (2018), firm-level innovation is assumed to generate proprietary blueprints for unique differentiated goods that are then produced and sold in monopolistically competitive world markets. These multinational firms can choose to locate production of

Multinational Production Framework

Innovation
i

Consumption
n

Idea/
blueprints

Production
l

Goods

Source: Adapted from Arkolakis et al. "Innovation and Production in the Global Economy" (2018)
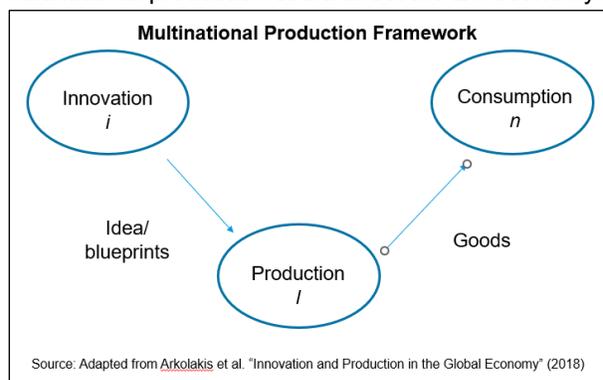
their good anywhere in the world, specifically in their home country (*i*), the country of final demand (*l*), and/or in a third production-platform country (*n*). Allowing firms to produce outside their home country allows countries to adjust their degree of specialization in innovation and in the manufacturing of goods. Profits flow between countries as payments for the use of other countries' blueprints. Hence, more innovative countries tend to export ideas and import goods. With cross-border trade encompassing goods and blueprints (i.e., the knowledge needed to manufacture specific goods), GEF policies could therefore target both these flows— separately or jointly—with different channels of transmission than when only goods are traded.

Scope for MP allows additional channels through which openness can affect countries' welfare. In addition to the standard (non-negative) gains from trade associated with an increased share of imports in total expenditure, in the presence of innovation, this *direct* channel also includes gains from expanding the range of available varieties of goods. An *indirect* effect of openness—which could be positive or negative—is related to the net flow of profits due to MP under monopolistic competition. Countries that are more intensive in innovation have net outward MP and receive net profit inflows, while countries that are more intensive in manufacturing send net profits abroad.

We next use this model to simulate illustrative scenarios of how the EU would be affected by various GEF policies, and consider the consequences of the EU standing by or participating in measures adopted by other countries.[22] Relative to a baseline calibrated to goods trade and MP behavior of OECD countries, four sets of policies are explored:[23] (i) rising international tensions; (ii) liberalizing MP by other countries; (iii) supporting innovation; and (iv) strengthening intra-EU integration. In each scenario, as illustrated in the diagram below, GEF policies extend beyond standard trade restrictions, consistent with the types of restrictions on cross-

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[21] Given data limitations on multinationals' innovation, production and trade in services, the focus here is on goods.

[22] The simulations compare the equilibrium without cross-border measures to the one with measures. The model permits technology diffusion across countries only through MP, thereby precluding technology spillovers to domestic firms in the host country. In reality, other channels of technology transfer are possible, including through licensing.

[23] Parameterization of the global model follows Arkolakis and others (2018). Calibration relies on gravity model estimations to obtain individual countries' trade elasticities for goods and IP (both for trade by multinational firms and for overall goods trade). The grouping of EU countries into EUK and EUG is based on these trade elasticities. Countries that are R&D intensive, but do not have large cross-border IP flows (suggesting that their innovation is used in domestic production), are classified as EUG. The authors find that the calibrated baseline model provides an overall good fit of the corresponding global bilateral trade data, capturing more than 90 percent of the variation in bilateral trade and MP shares.

border movements of technology and subsidies to reshoring of goods manufacturing that several countries have adopted.

Trade tension scenarios (increase MP and/or goods trade costs)

	Autarky		EU as bystander						EU as participant	
	1a	1b	2a		2b		2c		3	
	I/O MP	I/O T	O MP	I/O T	O MP	I/O T	O MP	I/O T	O MT	I/O T
US	x	x	.	x	x	.	x	x	x	x
CHN	x	x	.	x	.	.	x	x	x	x
EU	x	x	.	.	.	.	.	.	x	x
ROW	x	x	.	.	.	.	.	.	.	.

Note: I/O MP refers to inward/outward MP costs, O MP refers to outward MP cost, and I/O T refers to inward/outward goods trade cost.

Subsidizing domestic production
(reduce inward MP costs)

	4a	4b
US	x	x
CHN	.	
EU	.	x
ROW	.	.

Subsidizing R&D
(raise domestic innovation productivity)

	5a	5b
US	x	x
CHN	.	
EU	.	x
ROW	.	.

Deeper EU integration
(reduce intra-EU MP/trade costs)

	6
US	.
CHN	.
EU	x
ROW	.

Segmenting the world into four autarkic blocs would result in heavy output losses for the EU and all other regions. Deep fragmentation (scenario 1a) would preclude all trade in goods and knowledge between the US, China, EU and the rest of the world (ROW). Resulting output losses would be large and vary by region, between 5-10 percent.[24] Goods-related losses are large because, under autarky, all goods must be produced locally, generally at higher cost, and the available variety of goods within each bloc would be reduced. In addition, blocs with a comparative advantage in innovation would forgo net profit income (e.g., the US), while those with a comparative advantage in production (e.g., China) would benefit from not paying royalties abroad. For the EU, goods-related losses of around 9 percent of GDP dominate, while the loss of profit is small due to the relatively limited net MP activity outside the region (Figure 16, left panel). Expanding the EU-centered bloc to include Türkiye and the UK (scenario 1b) reduces the bloc's welfare loss under strict autarky given the greater diversity of comparative advantage within the enlarged bloc and the larger market size, which increases returns to innovation (right panel).

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[24] The welfare loss from strict autarky is comparable to findings in other studies that also assume the world segments into narrow blocs. However, as summarized in IMF (2023a), losses are generally considerably smaller when separate blocs coexist with a sizable group of "non-aligned" countries that can trade freely with the blocs, thereby allowing for some of the gains from trade to be realized.

Figure 16. The World Divides into Four Autarkic Blocs

1a. Impact of the World Splitting into 4 Blocs – China, the US, the EU, and ROW (Percent of GDP)
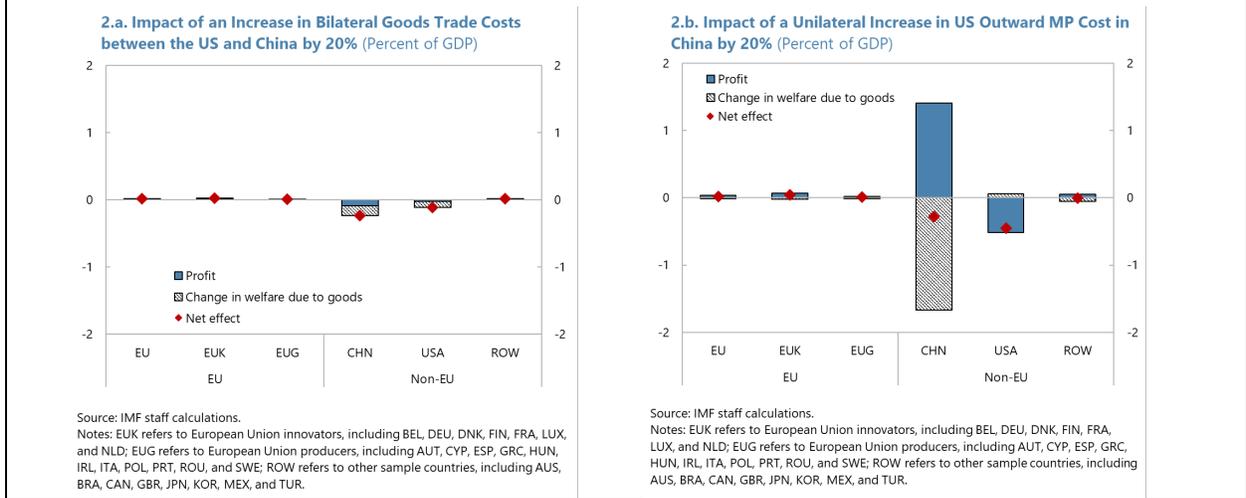
1b. Output Loss When the World Falls into 4 Blocks – China, the US, Expanded-EU, and ROW (Percent of GDP)

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

Source: IMF staff calculations.
Notes: The expanded-EU refers to European Union (EU) members plus GBR and TUR. EUK refers to expanded-EU innovators, including BEL, DEU, DNK, FIN, FRA, LUX, NLD, and GBR; EUG refers to expanded-EU manufacturers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, SWE, and TUR; ROW refers to other sample countries, including AUS, BRA, CAN, JPN, KOR, and MEX.

We next consider how the EU would be affected by bilateral tensions between the US and China under various GEF policy configurations, with the EU either standing by or partaking in GEF policies. Four cases, where different cross border flows are targeted and with different responses by the EU, are examined.

- Increasing bilateral costs of goods trade between the US and China (scenario 2a) is found to generate only modest welfare costs because, although one channel for obtaining goods has become more expensive, the bilateral MP channel remains unaffected (Figure 17, left panel). Therefore, China would remain an MP hub for US-created blueprints to meet final demand from the rest of the world, and final goods demand by the US could be met by shifting some MP to other locations, including greater homeshoring.

- If outward MP costs for US multinationals producing in China were raised (scenario 2b), China would use fewer US-generated blueprints. This reduces royalty payments from China to the US, generating a loss for the US and a gain for China. In addition, some Chinese workers would shift from manufacturing (where they are more efficient) to innovation to replace part of the blueprints previously sourced from the US, raising the cost of manufacturing in China. The impact on the EU is, again, limited because EU multinationals generally remain close to home given the combination of lower MP and trade costs from producing within the EU Single Market and producing close to their final customer base. In particular, the relatively low cost of MP within the EU compared, say, to locating MP in China reflects membership in the Single Market, which shortens the *economic* distance between member countries.

Figure 17. Spillover Effects from US-China Tensions

2.a. Impact of an Increase in Bilateral Goods Trade Costs between the US and China by 20% (Percent of GDP)

- Profit
- Change in welfare due to goods
- ◆ Net effect

EU | EUK | EUG | CHN | USA | ROW
EU | | | Non-EU | |

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, and TUR.

2.b. Impact of a Unilateral Increase in US Outward MP Cost in China by 20% (Percent of GDP)

- Profit
- Change in welfare due to goods
- ◆ Net effect

EU | EUK | EUG | CHN | USA | ROW
EU | | | Non-EU | |

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

- If the US and China were to raise the cost of importing each other's goods and increase the cost of outward MP into the other's country (scenario 2c), the results are similar—but somewhat larger—than in the previous scenario. China benefits from smaller royalty payments but loses from less specialization in manufacturing. The US loses mainly from lower royalties. The EU is little affected, reflecting the "home bias" in MP decisions as a result of the Single Market and lower trade costs due to shorter physical distances.

Figure 18. US-China Tensions, with EU as Bystander or Participant

2.c. Impact of an Increase in Bilateral Goods Trade and MP Costs between the US and China by 20% (Percent of GDP)

- Profit
- Change in welfare due to goods
- ◆ Net effect

EU | EUK | EUG | CHN | USA | ROW
EU | | | Non-EU | |

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

3. Impact of an Increase in Bilateral Goods Trade and MP Costs between the US/EU and China by 20% (Percent of GDP)

- Profit
- Change in welfare due to goods
- ◆ Net effect

EU | EUK | EUG | CHN | USA | ROW
EU | | | Non-EU | |

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.
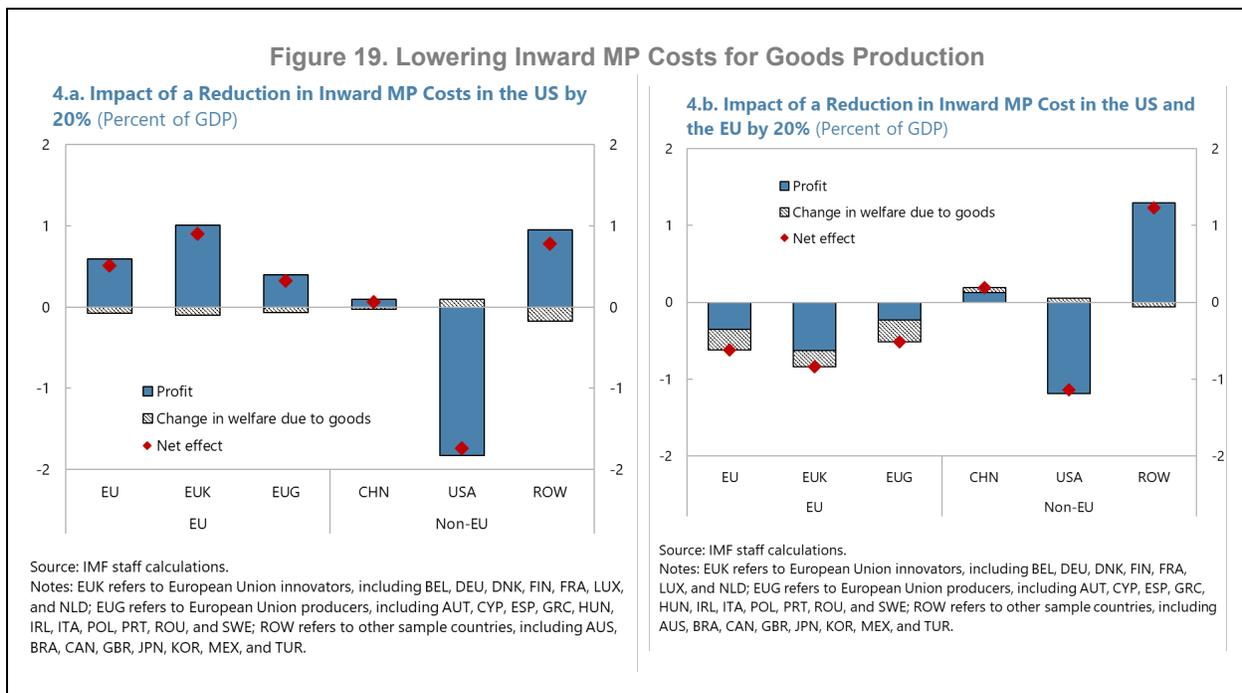
- In these highly stylized scenarios, compared to remaining on the sidelines, the costs for the EU are larger if it replicates the US' trade and MP measures on China, and if China reciprocates also toward the EU (scenario 3). Relative to the previous scenario where the EU stood by, welfare losses for China are now larger as more countries/regions introduce trade and MP restrictions. For the EU, losses are also noticeably larger, at around ¼ - ½ percent of GDP. These EU losses reflect smaller MP profit receipts from China as well as

some reshoring of manufacturing, which is more costly than freely sourcing through trade and MP with China.

Behind-the-border industrial policies, including those adopted by non-EU countries, are found to have much larger effects on the EU than the restrictions on goods trade and MP considered above.

- If the US were to subsidize the cost of inward MP to encourage domestic manufacturing (scenario 4a), the EU would experience a welfare gain while the US would experience a loss. With the US having a strong comparative advantage in innovation, incentivizing manufacturing encourages US workers into an activity in which they are less productive and reduces the variety of US goods available. As result, US real income declines by around 1¾ percent, mostly on account of falling profits. However, the EU gains by around ¾ – 1 percent of GDP on the now-greater innovation opportunities it faces (Figure 19, left panel). However, if the EU were to also subsidize inward MP (scenario 4b), the EU would lose through forgone royalties and the higher cost and fewer varieties of goods. Losses would be larger for more innovative EU countries (right panel). This implies the best response for the EU is to not replicate other's MP subsidies.

Figure 19. Lowering Inward MP Costs for Goods Production

4.a. Impact of a Reduction in Inward MP Costs in the US by 20% (Percent of GDP)

4.b. Impact of a Reduction in Inward MP Cost in the US and the EU by 20% (Percent of GDP)

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

- Were the US—with its advantage in innovation—to subsidize R&D (scenario 5a), the US and all other countries/regions would generally benefit, but through different channels (Figure 20, left panel).[25] With the US creating more blueprints to be used to manufacture novel varieties of goods through MP, global goods producers tend to gain—including in the EU—even though they pay higher royalties to the US. However, other innovative countries—including EU knowledge producers—would experience a welfare loss. If the EU were to also subsidize innovation (scenario 5b), it would gain from higher royalties but lose from diverting resources from away from manufacturing, with the welfare effects netting out.

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[25] Net gains for the US could be smaller if the public finance costs of the subsidies were factored in.

Figure 20. Subsidizing Innovation Activities

5.a. Impact of Subsidizing Domestic Innovation Activities in the US (Percent of GDP)
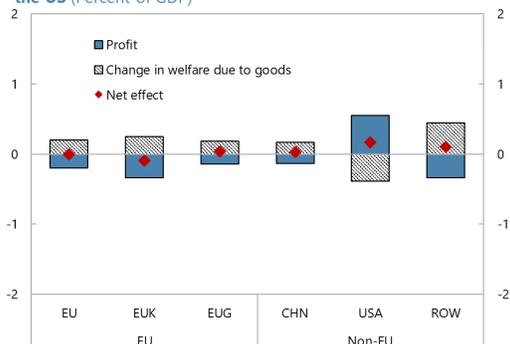
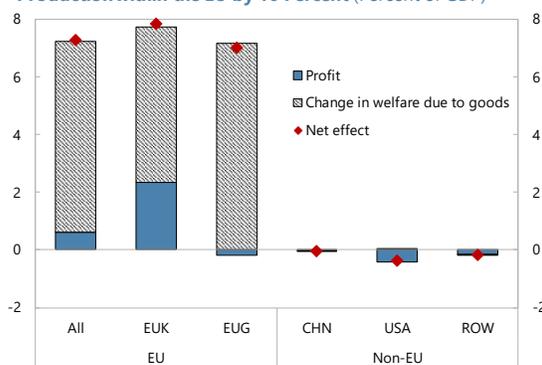- Profit
- Change in welfare due to goods
- Net effect

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

5.b. Impact of Subsidizing Domestic Innovation Activities in the US and EU (Percent of GDP)
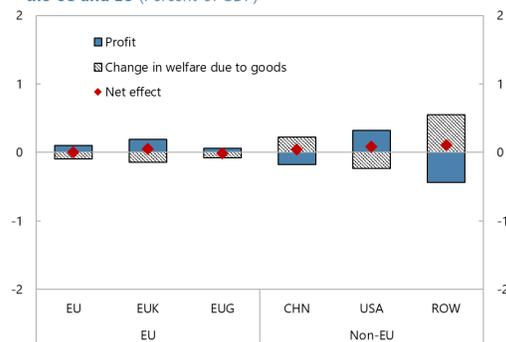
- Profit
- Change in welfare due to goods
- Net effect

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

Deepening EU integration by reducing remaining barriers within the Single Market would generate large welfare gains for the EU. Ample scope exists to strengthen intra-EU integration by lowering remaining cross-border frictions—for example, by completing the banking and capital markets unions, through greater harmonization of national rules on taxes and subsidies, improving insolvency regimes in some countries, and reducing administrative burdens. Reducing these frictions would be analogous to lowering remaining bilateral MP and goods trade costs among EU members, which we reduce by 10 percent (scenario 6). As a result, a country's comparative advantage would more fully determine how resources are allocated, leading to greater specialization within each country. More innovation and lower trade costs would support production of a wider variety of goods within the EU. Welfare gains would be large—on the order of 7 percent of GDP—and would accrue to both EU innovating and manufacturing countries. Moreover, spillovers to other regions and countries outside the

Figure 21. Deepening EU Integration

6. Impact of Reducing Cost of Trade and Multinational Production within the EU by 10 Percent (Percent of GDP)

- Profit
- Change in welfare due to goods
- Net effect

Source: IMF staff calculations.
Notes: EUK refers to European Union innovators, including BEL, DEU, DNK, FIN, FRA, LUX, and NLD; EUG refers to European Union producers, including AUT, CYP, ESP, GRC, HUN, IRL, ITA, POL, PRT, ROU, and SWE; ROW refers to other sample countries, including AUS, BRA, CAN, GBR, JPN, KOR, MEX, and TUR.

EU would be limited. In particular, small spillovers to China reflect that EU firms' production in China is mainly to cater to final demand in the region. A more integrated EU would therefore not lead to substantial reallocation of production or trade diversion to the EU.

IMPACT OF AN ENERGY PRICE WEDGE

EU firms could face persistently higher fossil fuel prices compared to the period before Russia's invasion of Ukraine, leading to a positive price wedge relative to some peer regions, with implications for economic activity.

Energy intensive production in the EU declined sharply in 2022—the height of the energy crisis—even as activity in other industrial sectors continued to grow. While wholesale gas prices have since moderated significantly, energy-intensive production remains weaker than other industries.

Surveys reveal that EU firms responded to the jump in gas prices in several ways. A majority of firms passed through the higher costs to their customers, while also investing in energy efficiency, switching to other energy sources and adapting their production methods. According to the European Investment Bank's 2022 Investment Survey, around 60 percent of EU firms viewed energy costs as a long-term barrier to

Figure 22. EU27: Production of Energy Intensive Industries (SWDA, 2015=1)

- IP energy intensive industries, relative to non-energy intensive industries
- TTF Gas Prices (rhs)

Sources: Bloomberg, Eurostat, Haver Analytics, and IMF staff calculations.

investment, relative to 30 percent in the US. Concerns about energy costs are on a par with skill shortages and considerably higher than worries about access to digital infrastructure. In Germany, 12.5 percent of manufacturers were planning to—or had taken action to—relocate production.
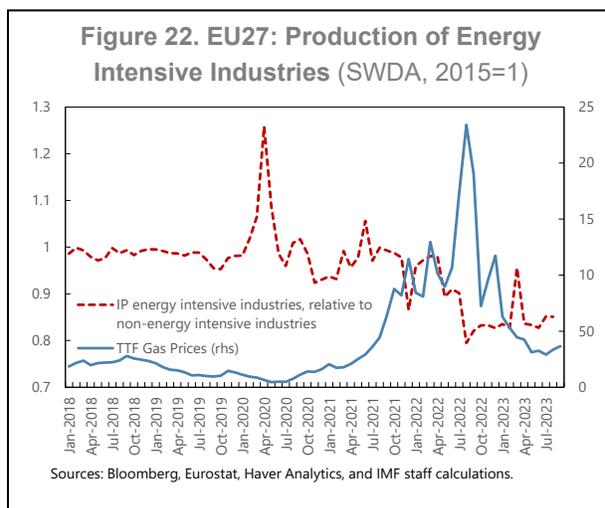
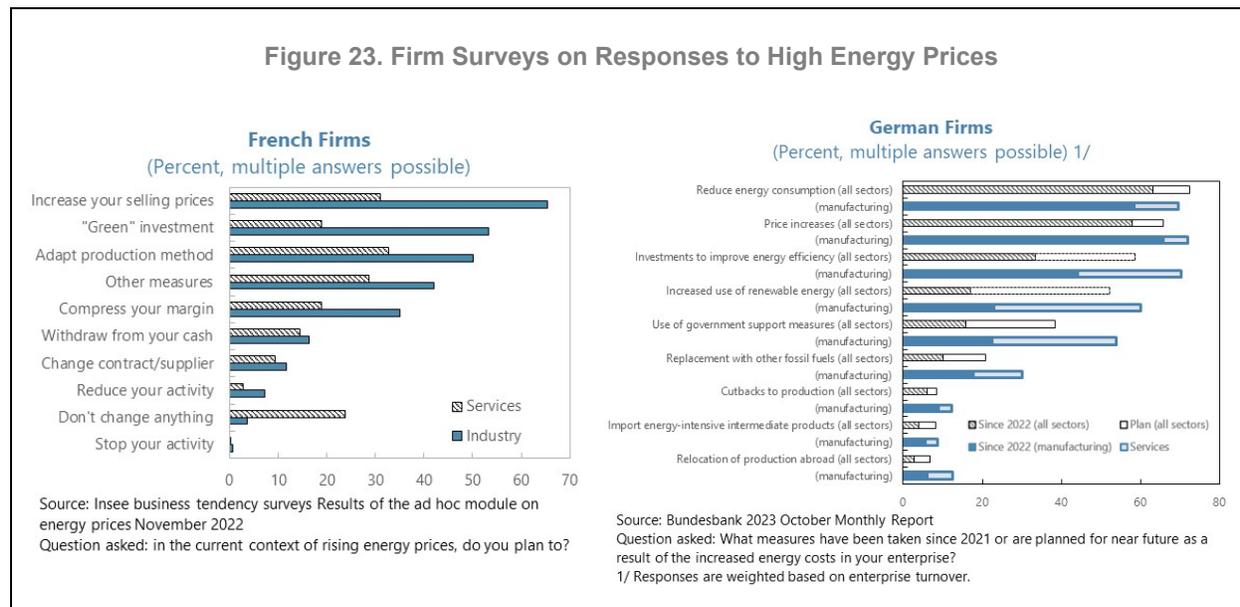**Figure 23. Firm Surveys on Responses to High Energy Prices**

French Firms
(Percent, multiple answers possible)

- Increase your selling prices
- "Green" investment
- Adapt production method
- Other measures
- Compress your margin
- Withdraw from your cash
- Change contract/supplier
- Reduce your activity
- Don't change anything
- Stop your activity

Services / Industry

Source: Insee business tendency surveys Results of the ad hoc module on energy prices November 2022
Question asked: in the current context of rising energy prices, do you plan to?

German Firms
(Percent, multiple answers possible) 1/

- Reduce energy consumption (all sectors) (manufacturing)
- Price increases (all sectors) (manufacturing)
- Investments to improve energy efficiency (all sectors) (manufacturing)
- Increased use of renewable energy (all sectors) (manufacturing)
- Use of government support measures (all sectors) (manufacturing)
- Replacement with other fossil fuels (all sectors) (manufacturing)
- Cutbacks to production (all sectors) (manufacturing)
- Import energy-intensive intermediate products (all sectors) (manufacturing)
- Relocation of production abroad (all sectors) (manufacturing)

Since 2022 (all sectors) / Plan (all sectors) / Since 2022 (manufacturing) / Services

Source: Bundesbank 2023 October Monthly Report
Question asked: What measures have been taken since 2021 or are planned for near future as a result of the increased energy costs in your enterprise?
1/ Responses are weighted based on enterprise turnover.

Figure 23. Firm Surveys on Responses to High Energy Prices (Concluded)

Italian Firms
(Percent, multiple answers possible)

- Non-energy intensive (plan for the next 6 months)
- Non-energy intensive (measures adopted in the first 9 months of 2022)
- Energy intensive (plan for the next 6 months)
- Energy intensive (measures adopted in the first 9 months of 2022)

Source: Bank d'Italia

Share of Firms Citing Long-term Barriers to Investment, by Barriers
(Percent)

Source: EIB

A global multi-sector computational general equilibrium (CGE) model is used to analyze the impact of a permanent increase in EU energy prices in a fragmented world market. We rely on an augmented version of the standard Global Trade Analysis (GTAP) model designed to analyze effects of climate mitigation policies.[26] This GTAP-E model incorporates interactions between the energy sector and the macroeconomy through derived demand for energy as a factor of production, and includes global production and trade for multiple types of energy, and allows substitution between different forms of energy, making it well-suited for analyzing the effects of energy price shifts. As in the standard GTAP model, the economy is perfectly competitive, all production is constant returns to scale, and includes the Armington assumption that at least one good is uniquely produced in each country. Trade and production include intermediate goods, while primary factors (labor, physical capital, and land) are nontradable. Simultaneous clearing of all goods and factor markets determines the vector of equilibrium prices. Model calibration is based on input-output tables covering 141 countries and 65 sectors.

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[26] For a comprehensive description, see The Standard GTAP Model, Version 7 | Journal of Global Economic Analysis (jgea.org), chapter 12 of GTAP Data Bases: GTAP 11 Data Base Documentation (purdue.edu) for a discussion of the energy and emissions database, and van der Mensbrugghe "The Environmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) model" (2019) for an application of the model. Our simulations are based on a calibration of the model to 2017, which is used as the reference year.

Our scenario assumes a permanent increase in world fossil fuel prices relative to pre-Russia invasion levels, with a larger increase for gas in the EU. With the oil market well-integrated globally, we assume a relatively uniform increase in world oil prices. However, as shown previously, wholesale prices of natural gas have historically tended to differ across regions. While prices in the European wholesale gas market (the marginal source of supply) tended to exceed those in the US, European buyers often received lower average gas procurement prices through long-term contracts with Russia. With the EU now much more integrated into the global gas market since the start of the war in Ukraine, we assume the EU faces a larger gas price increase than other regions. We model these assumptions as: (i) a permanent reduction in Russian energy exports to world

Figure 24. Energy Price Shocks Relative to 2017
(Base: energy price shocks in percent change)

Source: IMF staff calculations
1/ REE: Energy Producing Economies. ROA: Rest of Asia, ROW: Rest of the World.

markets, which raises average world prices for fossil fuels; and (ii) a price wedge in world gas markets that keeps the price in the EU (and elsewhere) above that in the US.[27] The resulting regional gas prices are consistent with prevailing levels.
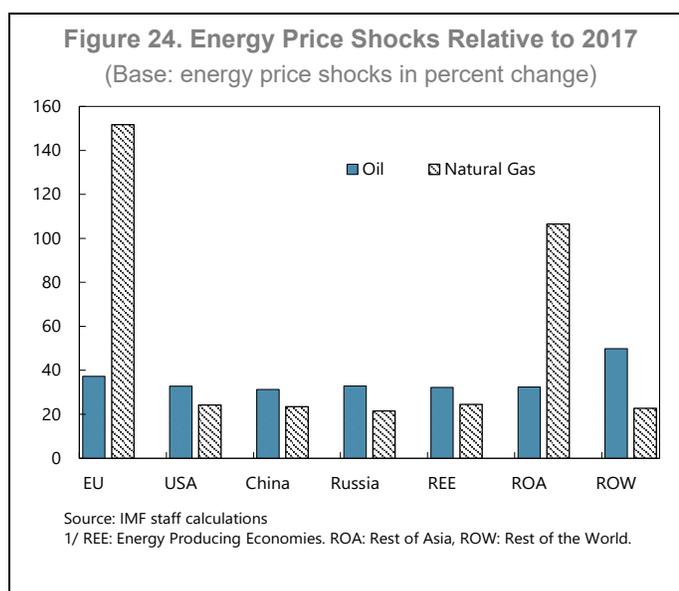
These persistent—and in the case of gas—differentiated increases in fossil fuel prices are found to permanently reduce EU value-added by about 4 percent per year. Global energy exporters gain, while energy importers lose from the energy shock. Russia, in particular, benefits from the increase in energy prices that more than offsets the fall in its energy exports. Effects in the US are modest, consistent with its more closed energy markets. The EU suffers the largest decline in value added on drops in energy-intensive manufacturing, but also services, reflecting both the sizable services-input into manufacturing and less spending on services (the largest sector in the economy) induced by the fall in income. Non-energy-intensive manufacturing increases modestly on average on the fall in the real exchange rate, while mining and extraction respond positively to higher prices. Variation within the EU is sizable, with more fossil-fuel intensive countries (including in CEE) generally among the most affected. Services in Greece are found to be heavily affected, likely reflecting the importance of commodity shipping in its GDP.

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[27] The gas price wedges are modeled as region-specific iceberg tariffs, such that any revenue collected is discarded.

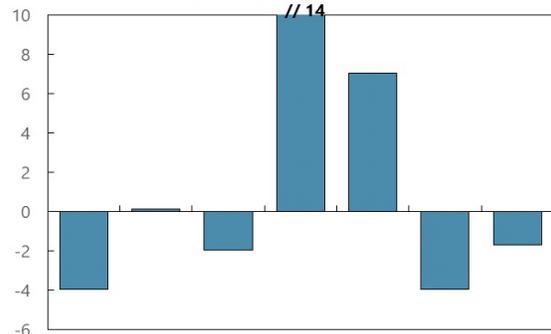## Figure 25. Impact of a Persistent Energy Price Wedge

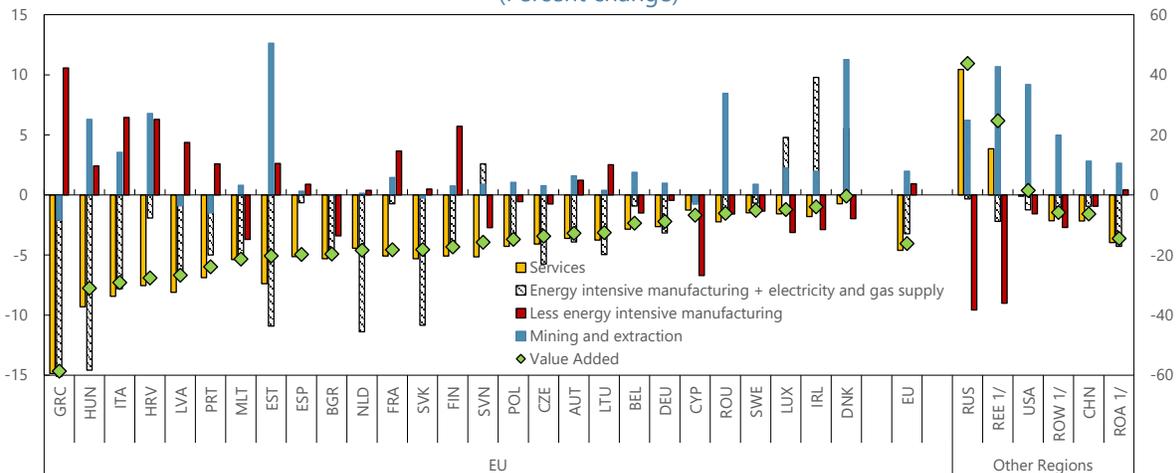### Change in Rates of Return on Primary Factors
(Percent)

Legend: Unskilled Labor, Skilled Labor, Capital

Categories: EU, USA, China, Russia, REE, ROA, ROW
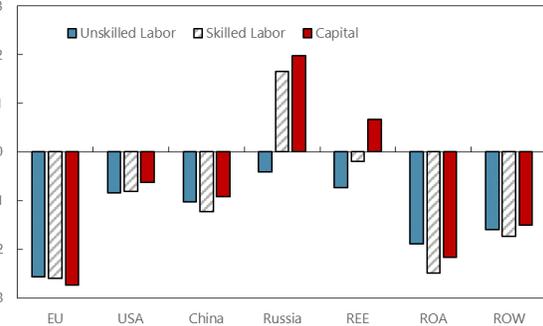
Source: IMF staff estimates.

Change in the Value of Factor Income
(Percent change compared to pre-shock level, net of capital

// 14

Categories: EU, USA, China, Russia, Other energy exporters, Asia (excl. China), Rest of the world

Impact on Sectoral Value Added
(Percent change)

Legend:
- Services
- Energy intensive manufacturing + electricity and gas supply
- Less energy intensive manufacturing
- Mining and extraction
- Value Added

EU countries: GRC, HUN, ITA, HRV, LVA, PRT, MLT, EST, ESP, BGR, NLD, FRA, SVK, FIN, SVN, POL, CZE, AUT, LTU, BEL, DEU, CYP, ROU, SWE, LUX, IRL, DNK, EU

Other Regions: RUS, REE 1/, USA, ROW 1/, CHN, ROA 1/

Source: IMF staff calculations
1/ REE refers to the rest of energy exporters, ROA refers to the rest of Asia, and ROW refers to the rest of the world.

Summary of Main Findings and Policy Considerations

We have shown that the EU is exposed to geoeconomic fragmentation, perhaps more so than some other regions and large countries. This largely reflects the EU's high degree of openness to goods trade. Intermediate goods sourced from countries that are not closely aligned geo-politically with the EU, and that may be difficult to source from alternative suppliers, comprise a sizable share of extra-EU imports, and some of these products are important for the climate and digital transitions. In addition, the EU is integrated into global supply chains, relying both on foreign intermediate goods and final markets. Given the complex structure of value chain networks and multinational production, the EU's ultimate foreign trade linkages with countries that may not share similar geopolitical views is considerably larger—and more concentrated—than suggested by

data on direct bilateral trade. Given the concentration of EU trade in services as well as cross-border FDI with geopolitically-aligned countries, these areas appear less vulnerable to fragmentation risk. In the case of financial investment, direct exposure to geopolitically-distant countries is limited, but deeper indirect integration could be partly obscured by global and regional financial centers.

Our simulations provide a number of important stylized facts. First, evaluated on their own and irrespective of their possible benefits in terms of economic security, adopting protectionist policies would bring economic losses for the EU. Deep fragmentation into a handful of strict autarkic blocs would be very costly for the EU and other regions by cutting off cross-bloc exchanges of goods and knowledge and precluding multinational production. Refraining from taking action as others restrict trade or subsidize domestic manufacturing would be less costly for the EU than replicating those measures. Second, persistently higher fossil fuel prices would cause a sizable drop in EU GDP, with energy-intensive activities most impacted. And third, deepening the EU's Single Market by lowering the costs of cross-border trade and multinational production could confer a large increase in GDP that benefits EU innovators and manufacturers.

The EU cannot ignore the economic security risks arising from GEF, but these results suggest that their policy response has to be carefully considered.[28] With its large population and high per capita income, the EU is one of the three leading global markets for final demand. However, the EU is unique on the supply side, with strengths in both innovation and manufacturing that allow it to form a relatively self-contained supply chain ecosystem. The EU also faces unique challenges, including persistently more expensive fossil fuels following Russia's war in Ukraine and maneuvering between rising world geopolitical tensions. This suggests the EU can and should chart its own course on dealing with fragmentation.

The EU should support an open, rules-based trading system and, wherever possible, address concerns within that framework. As a major trading region, the EU has benefited greatly from a multilateral, equitable and rules-based system. Making sure that its climate-related policies, including the new Carbon Border Adjustment Mechanism—are compliant with World Trade Organization rules is therefore important, including as an example for other countries. In the case of FDI, where fragmentation has already set in, restrictions should be narrowly targeted. On the other hand, protectionism is unlikely to strengthen economic security because EU members would be more exposed to localized shocks and the size of foreign markets for EU products would be reduced.

Some reconfiguration of trade and FDI may be needed to protect economic security given the changing geopolitical landscape, provided it is done judiciously. The EU's strategy of "targeted de-risking" rather than "outright decoupling" is a sound approach, underpinned by detailed assessments of economic security risks and taking pre-emptive action to mitigate areas of high risk. Individual firms may not appreciate the full extent or cost of disruption risk if they are a small part of a larger supply chain, suggesting a natural role for governments to work with the private sector to identify critical dependencies. Responses could include diversifying suppliers, holding inventories, improving recycling or, where feasible, some homeshoring the most essential products. However, the bar for intervention should be set high, conditional on meeting several relevant criteria, including low technical substitutability, lack of suppliers from less-risky regions, and provided that disruptions in the availability of a particular good or input would be socially harmful (such as with certain medical products). Broadening trade and development partnerships with countries associated with less

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[28] See also the discussion by Gopinath (2023).

geopolitical risk is also advised, including through comprehensive trade agreements and the EU's Global Gateway Initiative.

Protecting and deepening the Single Market would strengthen the ability of the EU economy to withstand fragmentation pressures. Removing remaining internal barriers would increase mobility of capital, labor, and services, making it easier to transition to new technologies and increasing scope for risk sharing in response to shocks. Completing the capital markets union would help to mobilize sufficient funding to finance the EU's enormous climate and digital investment needs and keep the EU globally competitive and at the technology forefront. Concluding the banking union would raise competition and allow bank capital to be used more efficiently. Better harmonizing taxes and subsidies across countries would boost investment in cross-border infrastructure and discourage "state aid shopping." Making it easier to supply services across borders and reciprocal recognition of qualifications earned in one member country by others would enhance competition, lower prices, and reduce the cost of adapting to economic shocks.

To protect the level playing field with a strengthened Single Market, any recourse to industrial policies should be restricted to addressing externalities and market distortions, and be time-bound. The aim is to correct market failures while allowing the market to allocate resources where it can do so efficiently. Avoiding government capture and rent seeking implies that any industrial policies should be technology neutral, avoid favoring incumbent firms over new entrants, or giving preference to domestic over foreign firms, and be well targeted.

Annex I. Select Policy Measures Adopted by the EU, US, and China

Country/Region	Measure	Date	Target	Type of intervention	Stated purpose
EU	Recovery and Resilience Facility (EUR 672.5 billion)	No inception date (announced on 2/18/2021)	Unspecified	Financial grant; state loan	Sectoral support, including climate
	Price cap mechanism for Russian crude oil and petroleum products	12/5/2022	Russia	Controls on commercial transactions and investment instruments; export-related non-tariff measure	Sanction on Russia
	The Netherlands to restrict sales of advanced microchip manufacturing equipment to China	1/27/2023	China	Export restrictions; licensing requirement; controls on commercial transaction and investment instruments	National security
	The EU investment screening framework	10/11/2020	Unspecified	FDI: Entry and ownership rules	National security
	European Chips Act	Not yet legislated (EC proposal on 2/8/2022)	Unspecified	State aid	Sectoral support
	EU Carbon Border Adjustment	10/1/2023	Unspecified	Import tariffs	Level playing field for environmental purposes
US	Inflation Reduction Act ($369 billion for energy security and climate change)	8/16/2022, 1/1/2023, 1/1/2024, 1/1/2025	Unspecified	Tax or social insurance relief, Local content incentive, Local operations incentive, Local content incentive, State aid, Financial grant, State loan	Sectoral support
	Price cap mechanism for Russian crude oil	12/5/2022	Russia	Controls on commercial transactions and	Sanction on Russia

	and petroleum products			investment instruments, Export-related non-tariff measure	
	CHIPS and Science Act of 2022	8/9/2022 – 9/30/2026	Unspecified	State loan, Loan guarantee, Tax or social insurance relief, State aid	Sectoral support
	Foreign Investment Risk Review Modernization Act	8/13/2018	Unspecified	FDI: Treatment and operations Export-related non-tariff measure, Public procurement	National security
	Export restrictions on advanced computing and semiconductor manufacturing items to China	10/7/2022	China	Export licensing requirement, Controls on commercial transactions and investment instruments	National security
	Maximizing Use of American-Made Goods, Products, and Materials	No inception date (Executive Order dated 7/18/2019)	Unspecified	Public procurement localization	Maximize the use of goods, products, and materials produced in the United States
China	"Made in China 2025" plan	5/19/2015	Unspecified	Subsidies and state aid, FDI: Entry and ownership rule; treatment and operations	Sectoral support
	New Foreign Investment Law	1/1/2020	Unspecified	FDI: Treatment and operations	National security
	Export Control Law	12/1/2020	Unspecified	Export-related non-tariff measure	National security

Annex II. Identifying Fragile Intermediate Goods

Intermediate goods are categorized as fragile following an updated version of the Korniyenko, Pinat, and Dew (2017) procedure. The comprehensive BACI bilateral trade database, covering 200 countries and 5,039 individual products at the 6-digit product level, is used.[29] We exclude from our analysis final consumption goods (defined according to UN BEC classification), and restrict our focus to intermediate goods that are used as inputs into downstream production, and where disruptions in product availability have the potential to generate adverse effects on output. The dataset includes 3,783 individual types of intermediate goods.

The methodology is based on the features of the trade network for each individual good. Using information for 2017-19, the network for each good is characterized by the aggregate value of world exports, and the amount imported by each bilateral country pair. Adopting concepts and terminology from network analysis, countries are represented as nodes, and exports are represented as directed ties that link pairs of nodes. Based on the methodology described below, 650 individual types of goods are identified as fragile.

THE TWO COMPONENTS OF PRODUCT FRAGILITY

For each intermediate product in the sample, its supply fragility is calculated based on the following two characteristics:

PRESENCE OF CENTRAL PLAYERS

The first characteristic identified as significant for identifying whether a good is fragile is the presence of central players in the trade network. Central players play a role in the extent to which microeconomic shocks explain aggregate fluctuations (Gabaix, 2011). Relying on network analysis measures of centrality, products with central exporters so crucial that a shock to their supply may disrupt importers' production are identified. In network analysis terms, the focus is on a network represented by a star shape where a central node connects unidirectionally only to the extremities, as distinct from a well inter-connected network. Star-shaped networks pose greater risk from the importer's perspective.

The standard deviation of weighted outdegree centrality (i.e., the share of country i's exports of good j in each other countries' imports of good j) is employed to assess the presence of central players.[30] First, the weighted outdegree centrality is computed for each country within each product network. Weighted outdegree centrality quantifies a country's exports' strength relative to the total value of its partners' imports of the product. It is defined as the sum of ties that a node directs outward to other nodes as a proportion of the total number of other nodes. This measure incorporates weights (accounting for the ties' values) and adheres to Barrat and others' (2004) definition. The mathematical expression for the directed weighted centrality of each country within each product network is:

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[29] CEPII - BACI. The data is derived from UN Comtrade, and relies on the harmonized system of 2007 (HS2007) classification.

[30] Variants of this measure have been applied in the sociology literature, notably Bonacich (1972) and Katz (1953), in computer science with Google's PageRank algorithm (Brin and Page, 1998), or in social networks literature within economics (for example, Ballester et al. 2006).

$$C_i^{out} = \sum_{j=1}^{n-1} \frac{w_{ij}}{\langle wj \rangle}$$

where C_i^{out} is the weighted outdegree centrality of country i, n is the total number of nodes in the network, w_{ij}, the value of the exports of country i to country j, and $\langle wj \rangle$ the average value of j 's imports. Formally, $\langle wj \rangle$ is defined for each product by:

$$\langle wj \rangle = \frac{\sum_i w_{ij}}{k_j}$$

where k_j is the number of nodes j imports from, and w_{ij} the value of the tie between j and i.

The standard deviation of outdegree centrality is used to measure each product's fragility arising from having a few very central exporters. Formally:

$$Centrality_k = \sqrt{\frac{C_{ik}^{out} - \overline{C_k^{out}}}{n-1}}$$

where $\overline{C_k^{out}}$s the average centrality of countries for product k.

A higher standard deviation of weighted outdegree centrality is associated to a higher vulnerability of the network pertaining to that good.

INTERNATIONAL SUBSTITUTABILITY

The second component involves assessing the degree of international substitutability for the product. This concept is based on the assumption put forth by Armington (1969) that internationally traded products are distinguished by their country of origin. Consequently, when a major supplier experiences a shock, the extent of the spillover hinges on the availability of substitutes from international markets for the affected good. If there are no close substitutes available in the short term, disturbances in the source country will impact every user. Unfortunately, data on the Armington elasticity of each product is unavailable. We therefore employ a proxy indicator inspired by the Revealed Factor Intensity (RFI) developed by Shirotori and others (2010). For each product, our interest lies in the human capital level of each exporting country and its distribution. In the event of a temporary supply shock, the importing country will seek alternative suppliers with similar characteristics to those that provided the temporarily unavailable product. Dispersion of human capital levels among countries exporting a particular product is defined as:

$$International\ Sustituability_k = \sqrt{\frac{\sum_{i=1}^{n} \left(L_i^k - \overline{L^k} \right)^2}{n-1}}$$

where L_i^k is the level of human capital of country i exporter of product k. The 'wider' the distribution of human capital of exporting countries, the more heterogeneous are the available production methods for a product, adding to the vulnerability for importers of that good as other suppliers may not be able to provide a close match to the variety that is temporarily unavailable.

CLASSIFYING OVERALL PRODUCT FRAGILITY

To classify products into fragility groups, the values of the two components discussed in the preceding sections are first normalized by calculating z-scores for each component and product as follows:

$$z(c_k) = \frac{c_k - \bar{c}}{\sigma(c_k)}$$

where $z(c_k)$, the z-score for component c and product k is calculated as the raw score for each component and product, c_k, minus the average score for all products in that year, $\bar{c}$, divided by the standard deviation of the raw score, $\sigma(c_k)$.

Next, cluster analysis (the k-median procedure) partitions products into mutually exclusive groups, based on their standardized scores for the two components.[31] The algorithm seeks to maximize the variation between clusters and minimize the within-cluster variation. To reach this goal, the algorithm iterates the minimization of the following equation:

$$\sum\sum |X_{ck} - \overline{x_C}|^2$$

where X_{ck} is the value of the component c of product k, and $|X_{ck} - \overline{x_C}|$ is the distance between each product and the "center" of the cluster, in this case the median of the current product in the cluster.

After categorizing products into clusters of various degrees of supply fragility, we can identify the importers of fragile intermediate good by looking at their share in total imports of a country's import basket.

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[31] Note that the partition is not hierarchized. Nonetheless, one group emerges naturally from maximizing the value of each of the components.

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