



Norway's strategic dependencies in global supply chain networks

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1. Introduction

Economic interdependence and global supply chains are being investigated anew. For a long time, a belief in the ability of growing economic ties to foster cooperation, dampen conflict, and enhance prosperity was predominant in academic and political thinking alike. Put simply, the globalization of modern economies was treated as a net positive not only for economic growth, but for the security of individual countries and the stability of the international system. Recently, these assumptions have proven to be half-truths at best. Rather than dampen conflict, the asymmetries of global supply chains have turned them into coercive tools for the powerful to wield against the powerless (Farrell and Newman 2019). Through sanctions and export controls, states controlling vital chokepoints in global economic networks can cause harm in targeted states, and through controlling the nodes of information highways, intelligence agencies can gain access to sensitive information leveraging the key position of their domestic companies.

For states with small, open economies, this development poses a thorny problem: the toolbox for realigning global supply chains is limited, but reliance on supply chains beyond national control is extensive. The problem is not limited to being in a position of dependence, however. For smaller states, being in control over global assets, or being a key provider of a product or resource others depend on can be a double-edged sword. As economic coercion becomes more widely deployed, the impetus for protecting and securing assets increases, and the risk that they might drag smaller states into geopolitical contests grows. Addressing these concerns, it is vital to develop tools, frameworks, and methodologies for assessing supply chains from a national perspective, with a focus on how economic interdependence might introduce geopolitical risks.

Against this background, this report builds on recent theoretical and methodological developments for analyzing global supply chains in light of their potential for geopolitical weaponization. More precisely, it will study Norway's position in global value chains by combining recent methodological developments on the network analysis of supply chains (Elliot, Golub, and Leduc 2022; MacCarthy et al. 2022) and recent analysis of country-level aggregated analysis of supply dependencies (European Commission 2021; Vicard and Wibaux 2023). This allows for a study of supply chains as networks of economic relations, in which the position of different national economies contains both strategic capacities, or assets, by being central supplier on which other countries depend, and vulnerabilities, by depending heavily on other countries. The report thus uses network analysis to identify Norway's positions and their related strategic vulnerabilities and assets.

We structure the analysis of Norway's geopolitical risks in global supply chain networks through three types of positions. Each of these pose different implications for Norwegian policy, requiring different sorts of interventions and raising different sets of questions surrounding the type of politics that are possible and likely to achieve outcomes. The first position concerns Norway's own centrality in supply chains, that is, the existence of global chokepoints or strategic dependencies related to products produced in the country. On the one hand, this can be thought of as a form of strategic asset or capacity. As economic interdependencies are weaponized, being centrally placed grants a potential source of power and influence vis-à-vis other actors. On the other hand, controlling such chokepoints can under certain circumstances be thought of as a risk. Both as potential targets for espionage, and through being unwittingly embroiled in increasing tensions, being centrally placed vis-à-vis others raises a different set of political risks. This is not a new phenomenon, but the consequences of the full-scale

Russian invasion of Ukraine for Norwegian gas exports to European energy markets is a current example of how changes in the political environment raises new questions relating to what it means to be a key exporter (Pettrém 2022).

While such dependencies at the macro-level can be captured by trade data, it offers a limited insight into the wider landscape. In hyper-centralized and globalized supply chains, niche suppliers can play a key role. Work on mapping the global supply chain for semiconductors, as one example where detailed mappings exists (See: ETO 2023), highlights how concentration exists at multiple stages of the supply chain. As semiconductors have emerged as a key contested supply chain globally, the lack of such granular data is an important caveat. Mapping and identifying such strategic niche suppliers require a different type of methodological toolbox than this report can offer, but it can nevertheless be important.

The second position stems from the potential strategic vulnerability in Norwegian imports rather than its exports. It concerns situations where Norway is dependent on imports, who that dependence is on, and the extent to which there exists alternative suppliers. There are multiple political and societal developments sparking a re-engagement with import dependencies as a possible vulnerability. Covid-19 highlighted the fragility of global supply chains in the face of sudden and unexpected shocks to global trade (Gereffi 2020). It also highlighted the many ways in which global politics is changing as a consequence of multiple decades of economic globalization (McNamara and Newman 2020). Beyond unintended shocks and events, the increasing use of economic coercion and changing ideas about the extent to which states intervene in markets to further their strategic interests raises a different set of questions. The possible weaponization of key supply chains can pose problems for small, open economies like Norway if the target is hard-to-replace dependencies.

The third position also pertains to Norway's imports but goes beyond direct supplier relationships. One key characteristic of contemporary supply chains is the existence of complex and interdependent procurement relationships. In this sense, Norway's economic output does not depend solely on its direct pool of suppliers, but also on the imports that those suppliers have themselves with other parties. To capture the strategic vulnerabilities stemming from these indirect supply relationships, we look at the network formed by the dependencies of the countries on which Norway itself depends. As such, it considers dependencies as not only a question of immediate economic partners, but how the broader ecosystem of allies and trading partners might have shared dependencies that only becomes visible once indirect relationships are considered.

Within the strategic vulnerabilities stemming from both direct and indirect dependencies, we can differentiate among two subsets of products. One subset of these dependencies concerns products where Norway's concentration of imports is above the global average. For these dependencies, there might be greater room for maneuvering and intervening at the national level, as there exists alternative suppliers globally to consider. However, a key question is whether such global alternatives can be established on short notice, or whether it is worth investing in building relationships and trust prior to a possible incident.

The other subset of dependencies is systemic and indicates products where Norwegian dependency is either below or on par with the global average. Looking towards goods where Norwegian diversity outperforms the global average indicates that national action might have reached a ceiling. Moreover, in outperforming global levels of diversification, these respective

sectors might hold broader lessons for other sectors on how to build resilience towards global supply shocks. Yet, it also indicates a broader systemic fragility, as the high concentration of goods globally puts a strain on the ability to address these challenges at the national level. Small, open economies like Norway are vulnerable to disruptions to global trade, and the growing politicization of key supply chains poses a challenge. This is not just because of the possible implications, but because the national ability to address the lack of alternative suppliers at a global and systemic level is limited.

Collectively, these different positionalities and types of dependencies are all tied to and relevant for geopolitical risk in various ways. They highlight dependencies that might be politicized and dragged into political conflicts which can become targets for efforts at bolstering resilience, both at a national level and through broader coalitions of economic partners. They can also highlight dependencies where national efforts are able to contribute. Building on this systematization, this report distinguishes between three broad types of interventions that might be relevant: i) Mapping strategic capacities to ensure there is prior knowledge about assets that might require improved security, ii) addressing dependencies where Norwegian levels are higher than the global average, and iii) working with partners and allies to manage critical global dependencies that are beyond the scope of national capacities.

2. Background

The use of economic dependencies as coercive tools in war and conflict is by no means new. Both the notion that the structure of global markets can have great political implications and favor some states and corporations over others (Strange 1989), and that interdependence is interwoven with power (Hirschman 1980; Keohane and Nye 1977) has long been acknowledged. Being overly dependent on other states for essential goods has for a long time been fraught with security concerns and perceived as a position of vulnerability. In the interwar period, the belief in the utility of economic coercion as an alternative means to war was widespread, drawing on lessons from the First World War and the mobilization of economic dependencies to hasten the end of the war (Mulder 2022).

With this in mind, the resurgence of interest in the use of economic dependencies is not an aberration. Throughout the preceding decade, scholars have foregrounded the mechanisms allowing for states to turn economic interdependence into geopolitical tools (Farrell and Newman 2019), and the increasingly strategic use of such tools (Farrell and Newman 2023). As progressively more states recognize the utility and perils of global economic networks consolidating in the hands of the few, regulatory innovations and the re-discovery of existing mechanisms has further expanded the coercive utility of such networks. As a result, over the past decade global supply chains have turned from a purely economic matter to being increasingly viewed through the prism of geopolitics, national security, and risk.

A key illustration of this weaponization of economic interdependence has been the U.S. use of financial chokepoints, leveraging the fear of secondary sanctions to enforce compliance across the globe (Drezner 2015; Mallard and Sun 2022). The awareness of the geopolitical risk associated with critical economic infrastructures is also at the heart of the unease in Western states over dependence on Huawei for next-generation telecommunications technologies (Friis and Lysne 2021), as well as the more recent attempts by the Biden Administration to strangle the Chinese semiconductor industry's access to foundational U.S. technologies (Schneider and Zhang 2022). These examples illustrate different ways in which economic dependencies

are becoming recast as strategic assets and geopolitical risks. Resultingly, states and corporations that previously primarily thought about economic imperatives of efficiency and cost, are having to grapple with how to manage the demand for greater market resilience.

The developments outlined above have led to calls to reinvestigate global supply chains, driven also by the increasingly fraught geopolitical climate and growing use of coercive and strategic tools falling below the threshold of war (Leonard 2021). Rather than only thinking about supply chains in terms of random shocks, such as fragility for natural disasters and other unpredictable events, they are being considered as strategic resources of increasing geopolitical importance. To improve the ability to prepare and foster resilience, states and corporations alike are re-assessing their strategic dependencies and the geopolitical risks involved.

Doing such assessments are arguably of even greater importance for small, highly globalized states like Norway. Their ability to influence global markets is limited, while their dependence on imports for crucial technologies and commodities is great. For Norway, the dangers of economic dependencies have already been illustrated by the sanctions following in the wake of awarding Liu Xiaobo the Nobel Peace Prize (Chen and Garcia 2016). Threats associated with supply chains may also arise from the spill-over effects of geo-economic contests, since Norway's position as a crucial supplier of products like oil and gas can drag it into great power conflicts.

Enhancing the resilience of global economic networks and supply chains, however, requires obtaining an accurate depiction of what they look like and identifying potential fragilities. Doing so is a challenging task, with different types of mapping at various levels requiring different data sources and approaches (MacCarthy et al. 2022). Based on the hierarchy of supply chain mapping suggested by MacCarthy et al. 2022, our framework of analysis takes as its starting point supply chain dependencies at the national level. Thus, it looks at the dependencies for Norway as a whole, broken down into various product types, to map both direct and indirect dependencies. Through this mapping, the report highlights two dimensions of supply chain dependencies, examining both strategic capacities (i.e. being central to global supply chains) and strategic vulnerabilities (i.e. being peripheral) as potential geopolitical risks. Overall, both the mapping and the methodological framework is intended as a toolbox for policymakers to conduct an initial sweep of supply chain dependencies, helping better inform subsequent mappings and interventions using more granular approaches.

3. Methodology

This report studies Norway's position in global value chains by combining recent methodological developments on the network analysis of supply chains (Elliot, Golub, and Leduc 2022; MacCarthy et al. 2022) and recent analysis of country-level aggregated analysis of supply dependencies (European Commission 2021; Vicard and Wibaux 2023). Global supply chains are here understood as complex networks of inter- and intra-firm relations. Making sense of such relations, their internal hierarchies and points of vulnerability entails slicing and aggregating those relations into analytically relevant units of analysis (MacCarthy et al. 2022). This analytical slicing and aggregation can be conducted for mapping the direct and indirect suppliers of a single firm, but also be extended to analyzing country import and export relationships.

Given our goal of mapping Norwegian positionalities in global supply chains, we opted to focus on networks of country import-export flows grouped by products. Commodity trade data – made available by the UN Statistics Office at the COMTRADE database – has nested levels of product aggregation of bilateral country transactions and are more frequently updated, allowing for a very thorough comparative assessment of supply concentration across markets. Building on previous research on the European Union supply chain vulnerabilities (European Commission 2021; Vicard and Wibaux 2023), we adopted an inductive approach for identifying bilateral trade relationships that could be associated with asymmetric dependencies of a given country.

3.1 Data

Our data is derived from the UN Statistics Office at the COMTRADE database, which is one of the most reliable sources of trade data available. We identify supply relationships by looking at imports reported by countries in 2012, 2015, 2018 and 2021. We analyze the supply of products grouped at the 6-digit level in the Harmonized System. The Harmonized System is an international standard for classifying traded products, regularly updated by the World Customs Organization, and widely used by countries to record their foreign trade (<https://www.wcoomd.org/>). The system groups products into nested aggregation levels starting from 21 two-digits sections, then 96 two-digit Chapters, and progressively disaggregated into four-digit positions and eventually about five thousand products at the 6-digit level. Beyond this internationally agreed standard, countries may have even more disaggregated classifications at the national level, e.g. the EU currently has about 16000 products at the 10-digit level of classification.

3.2 Identifying Chokepoints in Supply Chain Networks

This approach is comprised of three successive steps. First, we identified for a given country, the products whose supply can be considered highly concentrated. This concentration is calculated through the Herfindahl-Hirschman Index (HHI)—see box—and takes into consideration the market share of suppliers of a given product. Following the literature benchmark (CEPII), a HHI superior to 0.4 was used as first threshold indicating products whose supply is concentrated in imports from only a few countries. To select which products to keep, we calculated for each country the HHI in the supply of all 5205 HS 2012 6-digit list of products and only kept those over 0.4.

Criteria for Identifying Supply Chain Chokepoints:

Step 1: High Supply Concentration

- HHI > 0.4
- HHI is an index of market concentration calculated from the distribution of market shares according to the following formula:

$$HHI = S_1^2 + S_2^2 + \dots + S_n^2$$

Step 2: Domestic Non-Substitutability

- Imports > Exports
- Imports greater than exports are an indicator of limited domestic substitutability.

Step 2: Supplier Abnormal Market Share (MS)

- MS > 2 Standard Deviations from the Global Mean MS
- Supply relations abnormally high indicate can select suppliers driving market concentration.

Second, for each country, we excluded from the universe of dependencies products in which the given country's export was larger than its imports. This was conducted in order to exclude from the analysis products where the country could have a higher level of supply self-sufficiency. Our third and final criteria focuses on identifying the suppliers upon which the respective countries depend on. To that end, we established a threshold based on the global distribution of exporter market share across all bilateral trade following all products in the database. We only kept bilateral relations where the individual supply share was two standards deviation over

the average, and thus abnormally high. Across the years studied in this report, that threshold meant a market share of around 45% in the provision of any single product to another country. This threefold criterion allows for the identification of the countries any given economy is dependent upon and upon which products that dependency lies. These webs of dependencies can then be analyzed as networked structures producing multiple positionalities with different strategic implications. The strategic capacity of distinct countries in these networks can be assessed as a function of centrality in those networks, that is, the numbers of other markets that depend on its supply of any products. In turn, the strategic dependency of any individual country is a function of its peripherality, more specifically its reliance on a small pool of suppliers or on suppliers who are themselves highly dependent.

3.3 Analyzing Product Aggregates

A more precise identification of chokepoints demands a significant level of disaggregation of products in order to best locate the specific products whose pool of suppliers is limited. However, analytically, re-aggregating levels of concentration by sector can be useful to understand the broader economic and strategic implications of those chokepoints. For this reason, we selected two sectoral aggregations.

The first one includes all sectors and is built as an additional aggregation layer on top of the Harmonized System (HS) 2012 twenty-one sections. As Table 1 shows, we grouped these sections into four broad categories. The first is comprised of Advanced Industrial Products, which are mostly finished products and components, often upward positioned in the value chains and are associated with higher levels of technology. The second group of Basic Industrial Products comprises a more varied group of goods that are used as intermediary or basic inputs across several supply chains but have varying level of technological complexity. Consumer Manufactures groups mostly finished products tailored toward final individual consumers, and often with lower level of technological complexity. The category of food, animal, and vegetable products also includes a broad category of both basic and finished goods.

Table 1 – Aggregation of Harmonized System 2012 Sections in Broad Economic Sectors

Advanced Industrial Products	16-Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts, and accessories of such articles 17-Vehicles, aircraft, vessels, and associated transport equipment 18-Optical, photographic, cinematographic, measuring, checking, precision, medical, or surgical instruments and apparatus; clocks and watches; musical instruments; parts and accessories thereof 19-Arms and ammunition; parts and accessories thereof
Basic Industrial Products	5-Mineral products 6-Products of the chemical or allied industries 7-Plastics and articles thereof; rubber and articles thereof 13-Articles of stone, plaster, cement, asbestos, mica, or similar materials; ceramic products; glass and glassware ¹⁴ 14-Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewelry; coin 15-Base metals and articles of base metal

Consumer Manufactures	8-Raw hides and skins, leather, furskins, and articles thereof; saddlery and harness; travel goods, handbags, and similar containers; articles of animal gut (other than silkworm gut) 11-Textiles and textile articles 12-Footwear, headgear, umbrellas, sun umbrellas, walking sticks, seat-sticks, whips, riding crops, and parts thereof; prepared feathers and articles made therewith; artificial -flowers; articles of human hair 20-Miscellaneous manufactured articles 21-Works of art, collectors' pieces, and antiques
Food, Animal, and Vegetables Products	1-Live animals; animal products 2-Vegetable products 3-Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes 4-Prepared foodstuffs; beverages, spirits, and vinegar; tobacco and manufactured tobacco substitutes 9-Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto, or of other plaiting materials; basket ware and wickerwork 10-Pulp of wood or other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard; paper and paperboard and articles thereof

Our second grouping of products zooms into products that have are more closely associated with strategic sectors of the economy. We identify these products based on a recently published list by the United States International Trade Administration of critical products in strategic sectors.¹ The list is intended to help inform Executive Order 14017 of February 24, 2021, “Executive Order on America’s Supply Chains”, which outlines U.S. policy objectives with respect to strengthening the resilience of American supply chains. It includes a non-exhaustive list of Critical Materials and Minerals, as well as goods critical to three other sensitive sectors: Energy, Public Health, and Information and communications technology (ICT). The list, produced for the purpose of identifying supply chains’ strategic vulnerabilities, allows for further qualifying the strategic nature of potential chokepoints in supply chain networks.

3.4 Analyzing Norway’s Positionalities

The analysis that follows describes Norway’s strategic capacity and vulnerabilities based on its position in those abnormal dependency networks identified in the trade of 5,205 products grouped across four years (2012, 2015, 2018, 2021).² It focuses on analyzing Norway’s “ego” supply chain network, that is, the closer set of relations linking Norway with the global supply chains. In the next section, we discuss the products of which Norway is a central supplier, the economic sectors to which they belong, and identify the countries that depend on the Norwegian supply. In the section after that, we focus on Norway’s dependency relations. We first discuss Norway’s direct abnormal dependency on other countries as well as its indirect ones, stemming from the dependencies that Norway’s key suppliers themselves have. In both cases, we will examine Norway’s dependence on products, economic sectors, and supplying country.

1. ITA Federal Register Notice on Draft List of Executive Order 14017 on Critical Supply Chains. <https://www.trade.gov/data-visualization/draft-list-critical-supply-chains>

2. <https://unstats.un.org/wiki/pages/viewpage.action?pagelD=6325129#:~:text=The%202012%20edition%20of%20the,to%20ensure%20its%20uniform%20application.>

4. Norway Centrality in Global Supply Chains

The first dimension we map concerns the centrality of Norway in global supply chains. That is, for what type of products is there a large number of countries dependent on Norwegian products? While such a position of centrality can be thought of as a strategic capacity or asset, there are potential risks involved as well. Smaller states occupying central positions within global economic networks risk becoming entangled in geopolitical crises, or collateral damage of de-risking policies or economic coercion. Both types of risks can have economic and societal ramifications or require investments in security measures beyond what is required for the national context. For example, in the case of Ireland, its position as a key hub for European data centers has demanded greater investments into the country's maritime security capacity to manage the heightened risks stemming from this position (McCabe and Flynn 2023). Mapping where Norway is a central supplier therefore helps identify sectors that might become exposed to external pressure in the future.

4.1 Centrality by product type

Norway's centrality in global supply chains has been concentrated around a stable set of products in the period of analysis. Out of 5,205 analyzed products, Norway was a key supplier of 738 different products, indicating that there is a substantial number of products where at least one country relied abnormally on Norwegian exports. Each of these products were identified on average in two out of the four years, with 138 appearing in all years and 324 appearing only in one year. The supply of these products comprised 795 bilateral dependency ties of other countries in Norway in 2012, 835 in 2015, 845 in 2018, and 835 in 2021.

When we look at the groups of products of the economy where these ties are concentrated, two groups stand out: Basic Industrial Products and Food, Animal and Vegetable Products. As Table 2 shows, Norway had at least one dependency registered in around 9% of Basic Industrial Products and over 10% of products tied to the Food, Animal and Vegetables sector. This amounted to around 300 dependency ties yearly related to the first, and over 400 related to the latter in most years, as shown in Figure 1.

Table 2 – Products with Dependencies on Norway (% of total products by sectors)

Year	Advanced Industrial Products	Basic Industrial Products	Consumer Manufactures	Food, Animal and Vegetable Products
2012	6 %	9 %	3 %	10 %
2015	7 %	9 %	3 %	11 %
2018	7 %	9 %	3 %	10 %
2021	7 %	9 %	3 %	11 %

In the annex, Table A1 further details the products comprising dependencies, by showing the top 10 products most countries have dependency ties to Norway across sectors. Among the Advanced Industrial Products, the vessel industry stands out, even though the number of dependency ties on each product is rather small (between 2 and 5 countries per year). In terms of consumer products, dependencies on Norway are mostly associated with the textile industry, but Norwegian centrality there is considerably smaller. In the Food, Animal and Vegetable product group, Norway's centrality is also concentrated in one industry, namely seafood. Yet, Norway is a global hub for the seafood industry, amassing multiple dependency ties in multiple

products across years. In contrast, Norway's position as a provider of Basic Industrial Products appears more diversified. Thus, while several countries depend on Norwegian export, it is only for seafood that we can ascertain any real global-level dependency. For the other products, at least at the aggregated level of product types, most countries would be able to find an alternative supplier if needed.

For products with more immediate relevance to Norway's strategic capacity, it is worth examining its position as a supplier of products in critical sectors. As Table 3 shows, Norwegian exports are central for a substantial percentage of Critical Materials and products relevant to the Energy sector. Figure 2 further shows that Norway is most central in the supply of Critical Mineral and Materials (despite a reduction from a maximum in 2012), amounting to over 45 dependency ties yearly. It has also maintained over 30 dependency ties annually on products in the Energy sector and close to 20 ties on products in the Public Health sector.

Table 3 – Products with Dependencies on Norway (% of total products by sectors)

Year	Critical Minerals and Materials	Energy	ICT	Public Health
2012	17 %	10 %	3 %	3 %
2015	12 %	8 %	6 %	4 %
2018	13 %	9 %	9 %	4 %
2021	12 %	8 %	6 %	4 %

Comparing Norwegian Basic Industrial Products with the criticality for these strategic sectors provides a better picture. As we detail in Table A1 and A2 in the annex, some of the basic industrial input previously listed are in fact critical components of these strategic sectors. While this illustrates that some of Norwegian exports are tied into key strategic sectors, the majority of the exports where Norway is central is not related to any strategic sector, thus diminishing their importance as strategic assets and risks.

4.2 Centrality by Trading Partner

Another prism to investigate Norwegian centrality is considering who trading relations are formed with. Below, Figures 1 and 2 show the 10 partners with most dependency ties to Norway by sector. As we observe the countries that depend on Norway at the most are its Nordic and EEA partners. This pattern holds true across different sectors. In some sectors, such as seafood, public health and critical materials, Norway's centrality is more global as other economies including Turkey, Nigeria, Brazil, and Cote D'Ivoire are featured on the list. It is also important to notice that larger powers such as China, Russia, and the U.S. do not feature strong among the countries with greater dependencies on Norway. Considering the importance of China-U.S. tensions as the rationale for most economic coercive measures seen to date, this might indicate that these types of products accompany a smaller risk.

Figure 1 – Dependency Ties on Norway by partner (Top 20 partners)

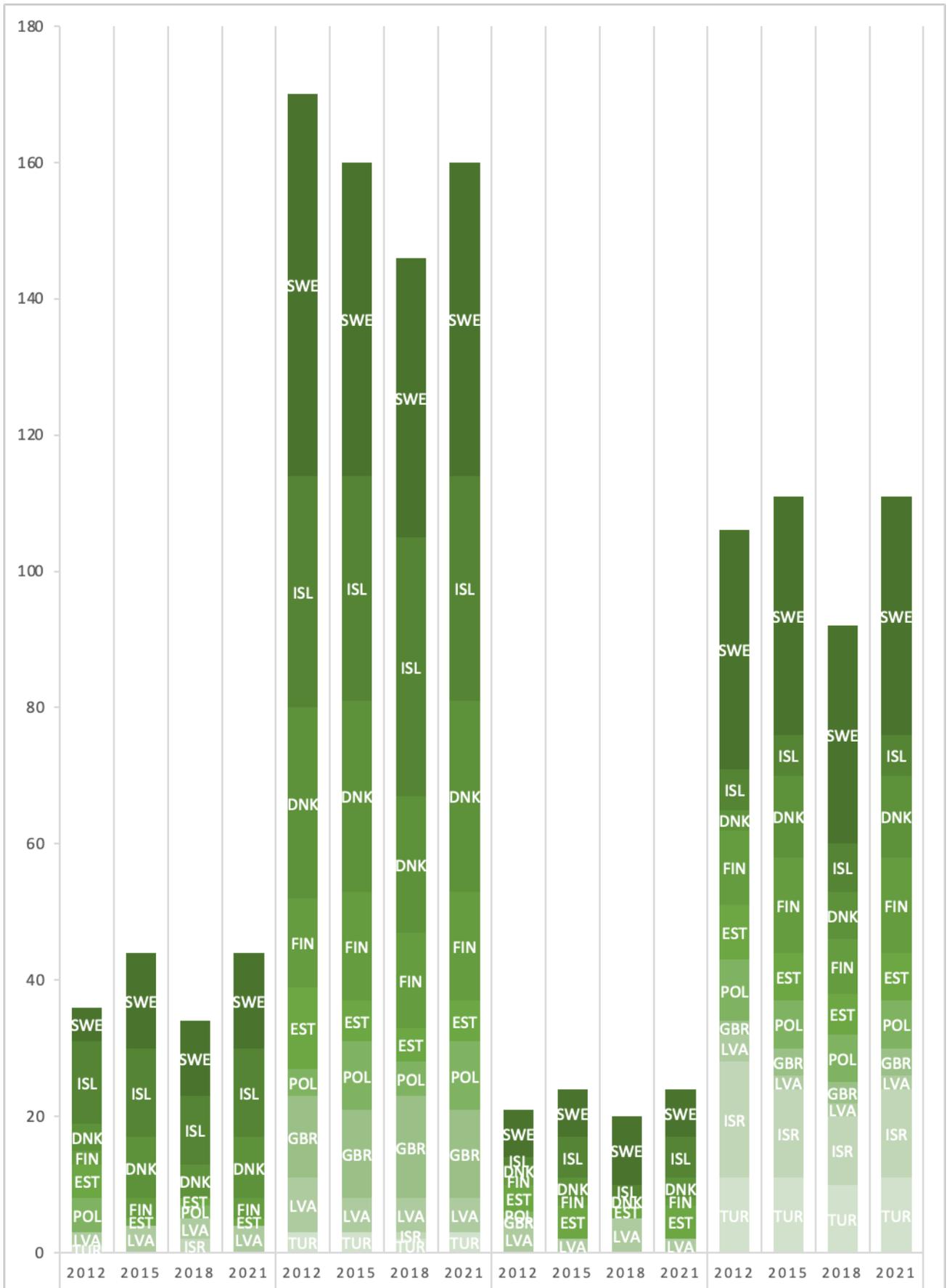
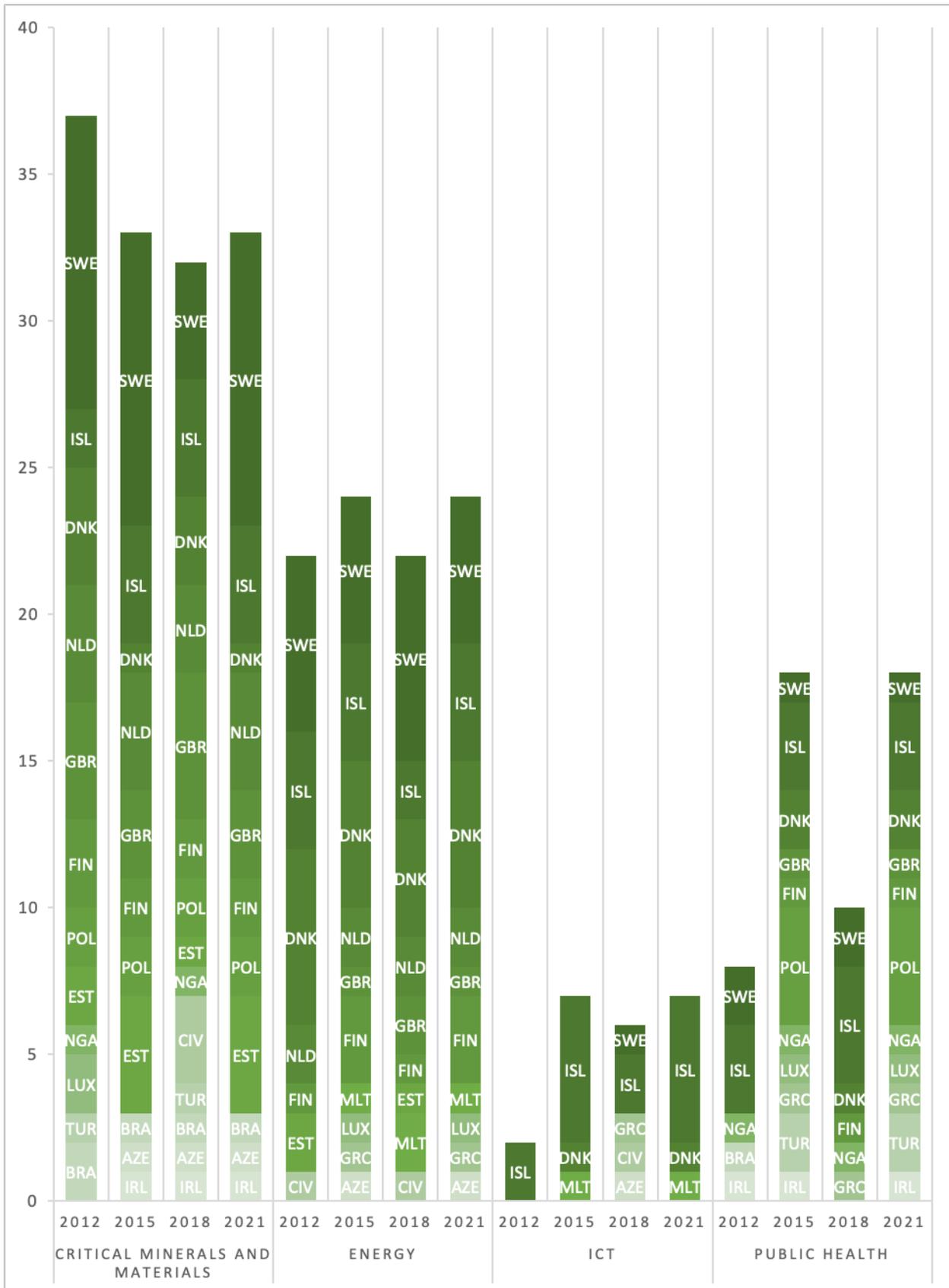


Figure 2 – Dependency Ties on Norway by partner (Top 20 partners)



All in all, we observe that Norway's strategic capacity in supply chains is mostly geographically restricted, largely involving neighbors and European allies, and concentrated around a relatively small number of products. For that reason, it seems at face value to have limited potential for geopolitical implications. Two caveats to this picture should be noted. The first is Norway's position as a key provider of a considerable number of critical materials, which appears to be largely regional and not part of a wider global dependence. However, investments in mining capabilities and a push for greater European self-reliance for critical materials (European Commission 2023) makes this an area to follow more closely in the years to come. The second obvious caveat to this picture is Norway's position as a key supplier of European gas, which does not stand out in the analysis. As gas exports are tied to physical infrastructures, limiting the exports to the handful of states to whom gas pipelines have been constructed, our analysis undersells the importance of Norwegian gas. As a key sector where Norway has obvious strategic importance for the EU writ large, it is largely acknowledged and addressed by policymakers making its exclusion less problematic.

5. Norway Vulnerabilities in Global Supply Chains

While the first dimension concerned Norwegian centrality in global supply chains, the second-dimension concerns products where Norwegian imports are centralized. Here, the strategic vulnerabilities associated with this type of dependency are more immediate, highlighted both by the unexpected shock to supply chains by Covid-19 (McNamara and Newman 2020) and the geopolitical developments outlined in the analytical framework. Within this dimension, we focus primarily on two subsets of dependencies.

One depicts a situation where Norway's concentration of imports on a given product is above the global average. That is, for a subset of the products mapped in this report Norwegian imports are more concentrated than what is commonly the case. For these dependencies, there might be greater room for maneuver and interventions at the national level, as there exists alternative suppliers globally to consider. The second type of dependencies are dependencies that are systemic, and where Norwegian dependency is either below the global average or on par. For those where Norwegian diversity outperforms the global average it is indicated that there is little room for improvement through national action, and that these sectors might hold lessons on successfully diversifying for others. Yet it also indicates a broader systemic fragility, as the high concentration of products globally puts a strain on the ability to address these challenges at the national level. Small, open economies like Norway are vulnerable to disruptions to global trade, and the growing politicization of key supply chains poses a challenge. Not just because of the possible implications, but because the national ability to address the lack of alternative suppliers at a global and systemic level is limited.

Mapping out these types of dependencies is done through two steps. The first looks at direct dependencies, or the countries that sell products directly to Norway. These types of dependencies are the most obvious and easiest to locate. However, in indirect dependencies we go one step further to also examine the second-order indirect dependencies. Put simply, who supplies our suppliers? By going one step further, we can dig deeper into global supply chains to identify a larger subset of possible dependencies.

5.1 Direct Dependencies

Norway's dependencies on other countries in global supply chains are considerably larger than its centrality. Each year, the Norwegian economy was dependent on between 1,371 and 1,428

products out of the 5,205 that have been analyzed. Among those, 977 commodities have been comprising dependencies in all four years of the analysis. With regards to sectors, as Table 4 shows, Norway is dependent on around 30% of products across most sectors, with lower percentages on Advanced Industrial Products as well as in the Energy and ICT sectors. Among the strategic sectors, Critical Materials and Public Health stand out as sectors where Norway has a significant number of dependency ties.

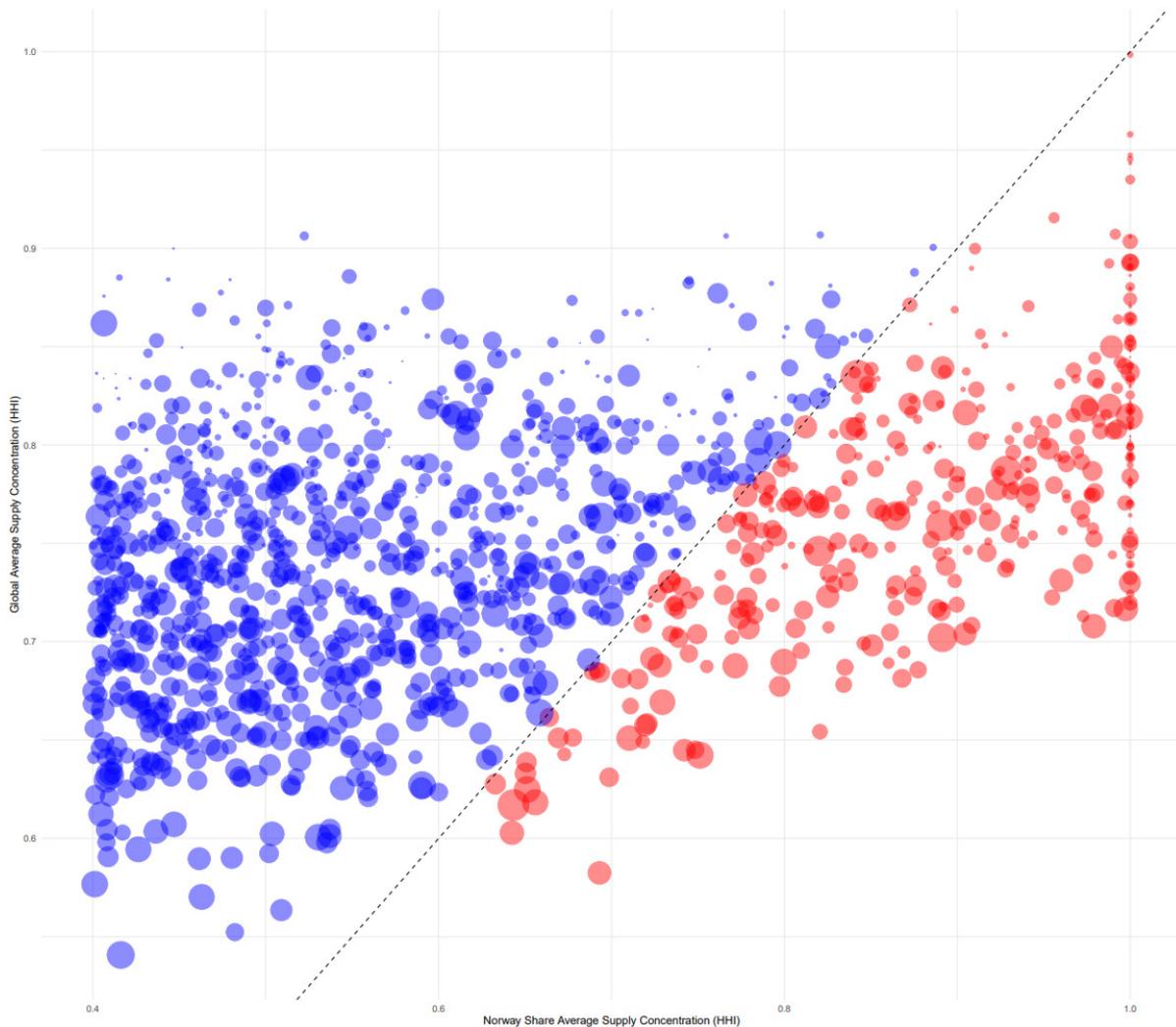
Table 4 – Products with Dependencies on Norway (% of total products by sectors)

	Advanced Industrial Products	Basic Industrial Products	Consumer Manufactures	Food, Animal and Vegetables Products
2012	17 %	30 %	29 %	34 %
2015	18 %	29 %	30 %	33 %
2018	18 %	29 %	30 %	32 %
2021	20 %	29 %	32 %	32 %
	Critical Minerals and Materials	Energy	ICT	Public Health
2012	32 %	15 %	13 %	24 %
2015	28 %	13 %	21 %	23 %
2018	35 %	16 %	15 %	21 %
2021	31 %	16 %	16 %	25 %

5.1.2 National and systemic direct dependencies

Making sense of the strategic nature of these dependencies, we further compare the extent of Norwegian dependencies to the global average. As an example, Figure 3 shows these values by all products in which Norway had a dependency on in the year of 2021. Points below the diagonal line (in red) show products where Norway's supply concentration measured by HHI is higher than the global average, whereas the blue points above the diagonal show the opposite. The latter set of dependencies, where global supply concentration is higher on average, may reflect sectors where there are few alternative suppliers available and thus less room for diversification. Sectors where Norway already has a higher concentration than the global one, in turn, may indicate a larger possibility of diversification.

Figure 3 – Supply Concentration by product in Norway and Global



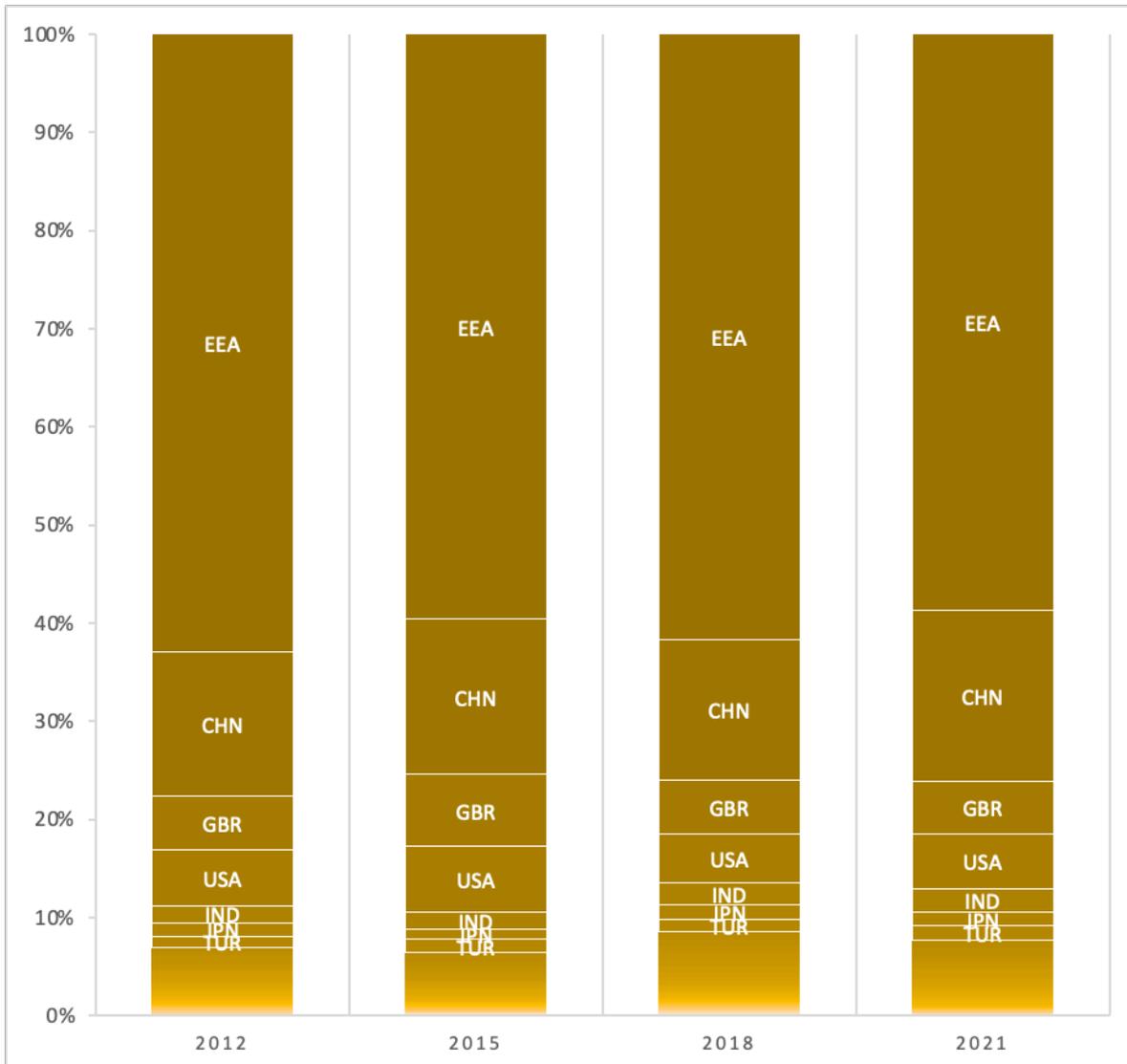
In Table A3 in the annex, we detail the products where Norwegian dependency is significantly larger than the global average. Most products have little to no strategic value, such as artificial flowers or tobacco. However, others can be crucial inputs for Norway's own strategic capacity. Calcium Carbide, for instance, is an input in the processing of hydrogen gas, ammonia, and methanol. Moreover, several advanced industrial sectors, such as thread rolling, grinding, and drilling machines are important industrial capital goods. Focusing only on the selected strategic sectors, Table A4 in the annex provides a similar result. Here, the products where Norwegian dependency more consistently underperforms the global average are concentrated in Critical Material and Mineral as well as in the Public Health sectors.

5.1.2 Norway's Direct Dependencies by Supplier

With regards to trading partners, there are some clear overlaps between the countries Norway depend on and the countries that depend on Norway, implying close trading relationships rather than any strategic concerns. However, while many Nordic partners feature among the main sources of dependencies for Norway, important extra-regional economies such as China and the U.S. are also very central in Norway's direct supply network. China in particular has had some increase in its centrality, as Figure 4 shows. Figures A1 and A2 in the annex show that this growth has been spread across different industries. China's centrality is particularly salient in

consumer manufactures. Among strategic goods, China is most central in the provision of ICT, but has had a substantial growth in the provision public health inputs.

Figure 4 – Norway Dependency by Country (number of dependency ties)



However, taking into account the difference between Norwegian dependency on China and the global average, a clearer picture emerges as illustrated in Figures 5 and 6. For the products upon which Norway is more dependent than the global average, these dependencies are primarily towards EEA partners, with an outsized importance of Scandinavian countries such as Sweden and Denmark. Looking at the picture writ large, Norway has to a great extent already “friendshored” its supply chains as the dependencies towards non-aligned states are systemic rather than bilateral. On the one hand, this indicates that national action to increase diversification and supply chain resilience has already progressed fairly far. On the other hand, it implies that dependencies on Chinese products in particular are systemic for the wider global economy and therefore challenging to address at the national level.

Figure 5 – Norway Dependency by Country (number of dependency ties) – products with supply concentration superior to global average

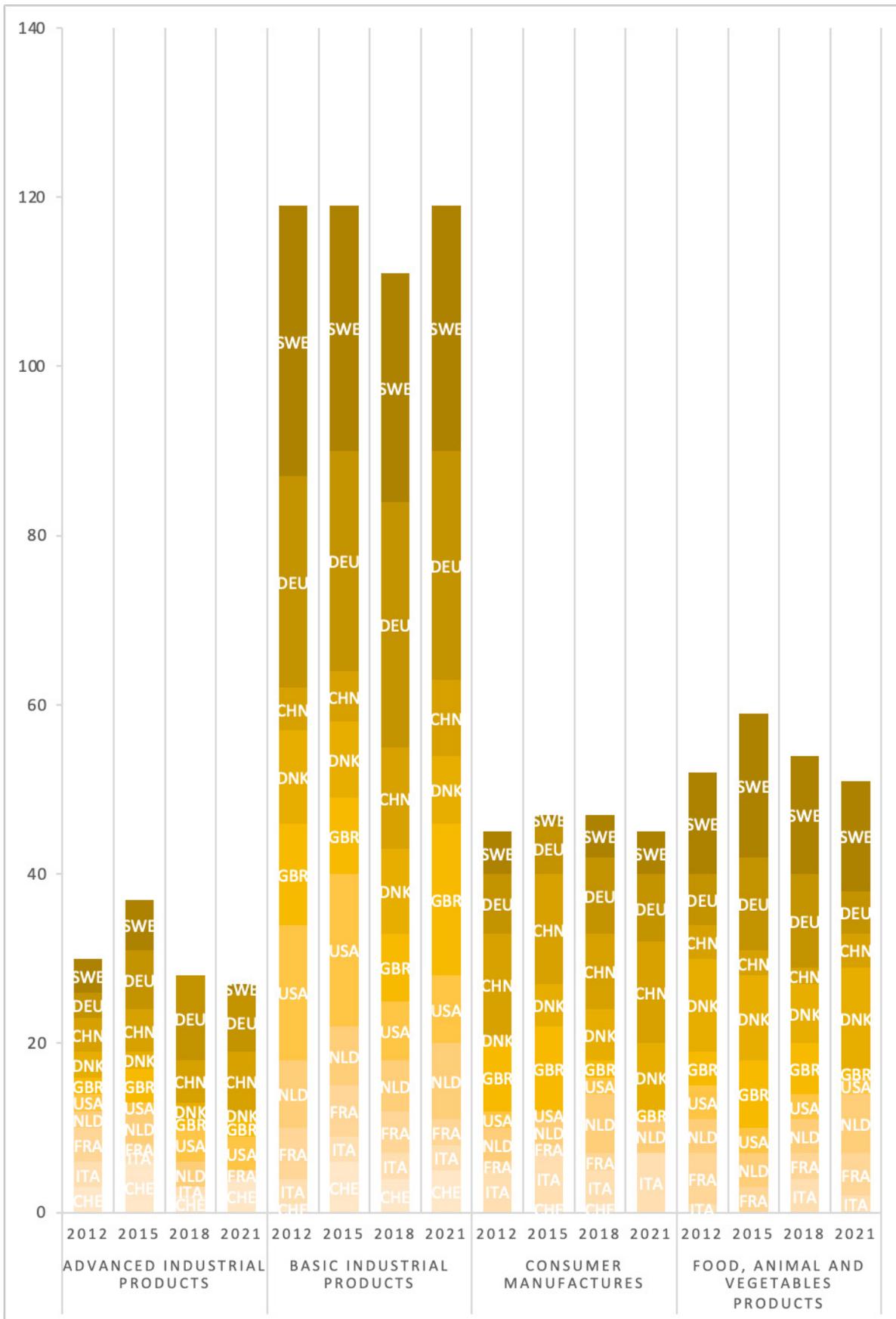
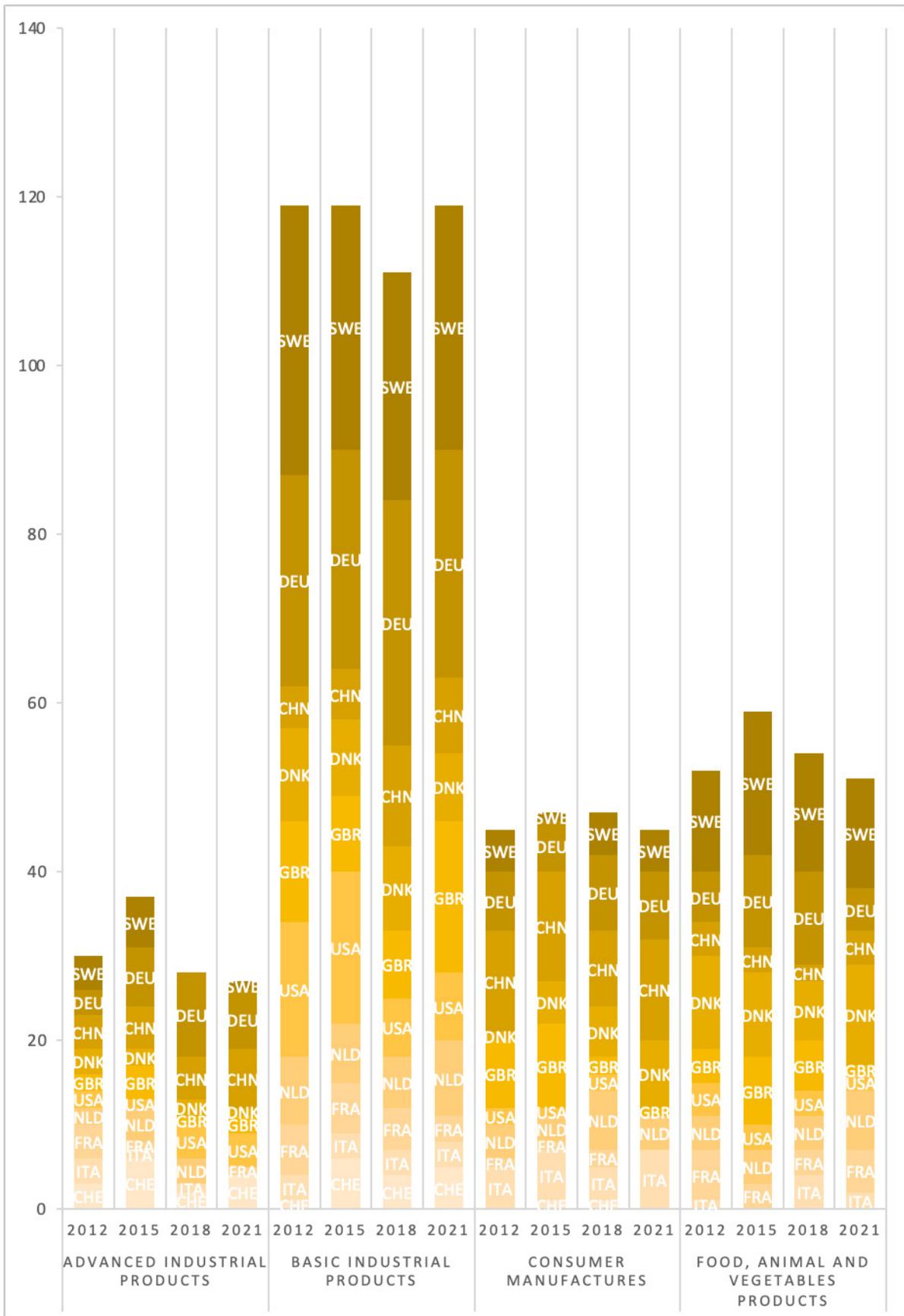


Figure 6 – Norway Dependency by Country (number of dependency ties) – products with supply concentration superior to global average



Diving deeper into this issue, we can zoom into the actual products imported by non-EEA states where Norway has the greatest difference in concentration of supply in comparison to global averages. Tables A5 and A6 in the annex details these products. What we see there is that dependence on China is concentrated on products with reduced strategic relevance, with NATO-allies such as the UK and the U.S. being the source of dependency on most of those products. Still, when we look at products in strategic sectors, China is nearly the sole provider of important ICT components as well as critical materials such as rare-earth metals, where China also has a strong global supply concentration. Thus, this further stresses how the main strategic vulnerabilities to non-EEA partners, and China in particular, stem from products where concentration is global and the room for alternative provision is very limited.

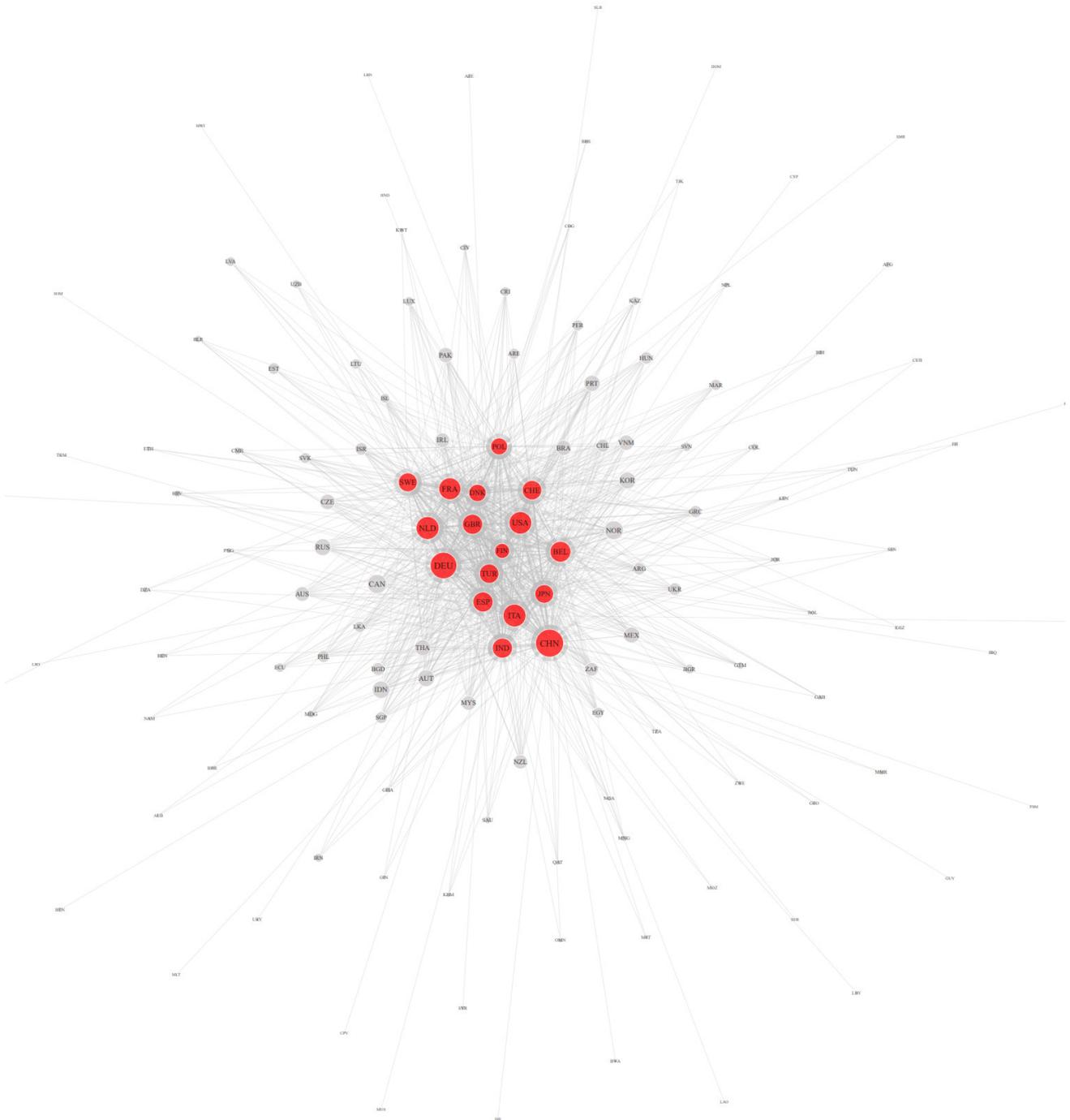
5.2 Indirect Dependencies

One of the key aspects of supply chains in our globalized world is that dependencies are weaved in broad complex interdependence relations. In this sense, to fully grasp Norway's position and its associated vulnerabilities, we must also understand how its key partners are themselves positioned in supply chains. While Norway may have limited exposure to geopolitical risks, it can still suffer from the reverberation of shocks that its partners are exposed to. Hence, we turn our attention in the second part of this section to Norway's indirect dependencies in supply chain networks.

We map those dependencies by looking at the network formed by the dependency ties of Norway's main partners. We identify those partners by measuring the overall strength of the bilateral dependency among countries as the sum of the number of goods in each country depends on another for supply weighed by their markets share. In this sense, a strength of 10 means dependencies on at least 10 products with 100% market share, or on more products with a smaller market share. We defined Norway's key partners as those whose strength of dependency was in the top 25% of the global distribution. This meant a strength between 11 and 13, depending on the year.

Table 5 shows the final list of key partners for Norway in each year. Most countries recur across years, with few exceptions: Finland, Poland and Japan are not in the 2015 network, nor Poland in 2012. The combined dependencies of those partners then formed the network of Norway's indirect dependencies. Figure 7 show the networks for each year, with countries which Norway has direct dependencies in red at the center. Network plots for previous years are depicted in the annex of this report.

Figure 7 – Norway Indirect Dependency Network in 2021



As shown in Table A7 in the annex, the Norwegian indirect ego-network structure remains very stable across the periods, implying that the overall pattern of trade is fairly consistent. The main change is in the number of indirect partners in the network that has had some relevant growth from 2012, which also corresponds to the number of dependency ties in the network. The level of clustering and centralization remains relatively stable, in contrast. High centralization indicates that dependency ties are concentrated in a few suppliers. This centrality is concentrated in Norway's own direct suppliers, as illustrated by the larger circles in red at the center of Figure 7. We can make better sense of that by looking at Table 5, which shows

the proportion of ties among Norway's direct partners compared to their overall ties including indirect partners. As we can observe, most countries have over 80% of their dependency ties linked to other Norwegian key partners. The exceptions being the bigger global economies of China and the U.S., and to a lesser extent Germany, India, and Turkey. This suggests that Norway is part of somewhat cohesive cluster of suppliers (mostly within the EEA), linked to the broader global supply chain network through a few central actors such as China and the U.S.

Table 5 – Proportion of within group ties for Norway's direct partners

	2012	2015	2018	2021
BEL	89 %	86 %	89 %	89 %
CHE	90 %	87 %	89 %	88 %
CHN	53 %	35 %	46 %	44 %
DEU	79 %	74 %	78 %	79 %
DNK	88 %	85 %	87 %	87 %
ESP	81 %	80 %	81 %	83 %
FIN	81 %		83 %	82 %
FRA	86 %	84 %	87 %	89 %
GBR	83 %	83 %	82 %	82 %
IND	79 %	74 %	76 %	76 %
ITA	83 %	80 %	83 %	84 %
JPN	77 %		78 %	77 %
NLD	84 %	80 %	87 %	87 %
POL			81 %	82 %
SWE	82 %	77 %	83 %	82 %
TUR	79 %	75 %	74 %	76 %
USA	65 %	62 %	67 %	58 %
Overall	81 %	77 %	80 %	80 %

Norway's network of indirect supply chain dependencies includes many more products than its direct one. Table 6 shows that the most sectors included dependencies associated with over 80% of all products studied. This percentage is lower for strategic sectors, except for Critical Materials and Minerals. These percentages are more than twice as big than what we found in direct dependencies (Table 4) for most sectors and years. This suggests that through its indirect dependencies Norway may be exposed to strategic vulnerabilities associated to a much larger set of products.

Table 6 – Products with indirect dependencies (% of total products by sectors)

	Advanced Industrial Products	Basic Industrial Products	Consumer Manufactures	Food, Animal and Vegetables Products
2012	74 %	84 %	92 %	92 %
2015	70 %	80 %	79 %	86 %
2018	74 %	84 %	89 %	91 %
2021	75 %	84 %	90 %	91 %
	Critical Minerals and Materials	Energy	ICT	Public Health
2012	84 %	55 %	60 %	53 %
2015	81 %	50 %	60 %	52 %
2018	85 %	58 %	65 %	52 %
2021	85 %	60 %	67 %	53 %

5.2.2 National or systemic indirect dependencies

Similar to the direct ties, we further analyze products based on the extent to which Norwegian trading partners' dependencies are higher than the global average. As Figure 8 shows, the discrepancy between the global average and Norwegian partners is tilted in the other direction, with Norwegian partners being more diverse than the global average. Considering that Norwegian trading partners are primarily in the EEA, as well as China and the U.S., this should come as no surprise as these collectively make up the backbone of the global economy. However, as shown in Figure 10, indirect dependencies are higher than the global average dependency on Public Health products, indicating that the wider Norwegian supply network might be vulnerable to disruptions in this category. For example, India has become a key supplier of antibiotics, and during Covid-19, India's exports of some products were limited by export restrictions.

Figure 8 – Average Concentration in Norway Supply and Global Supply Network

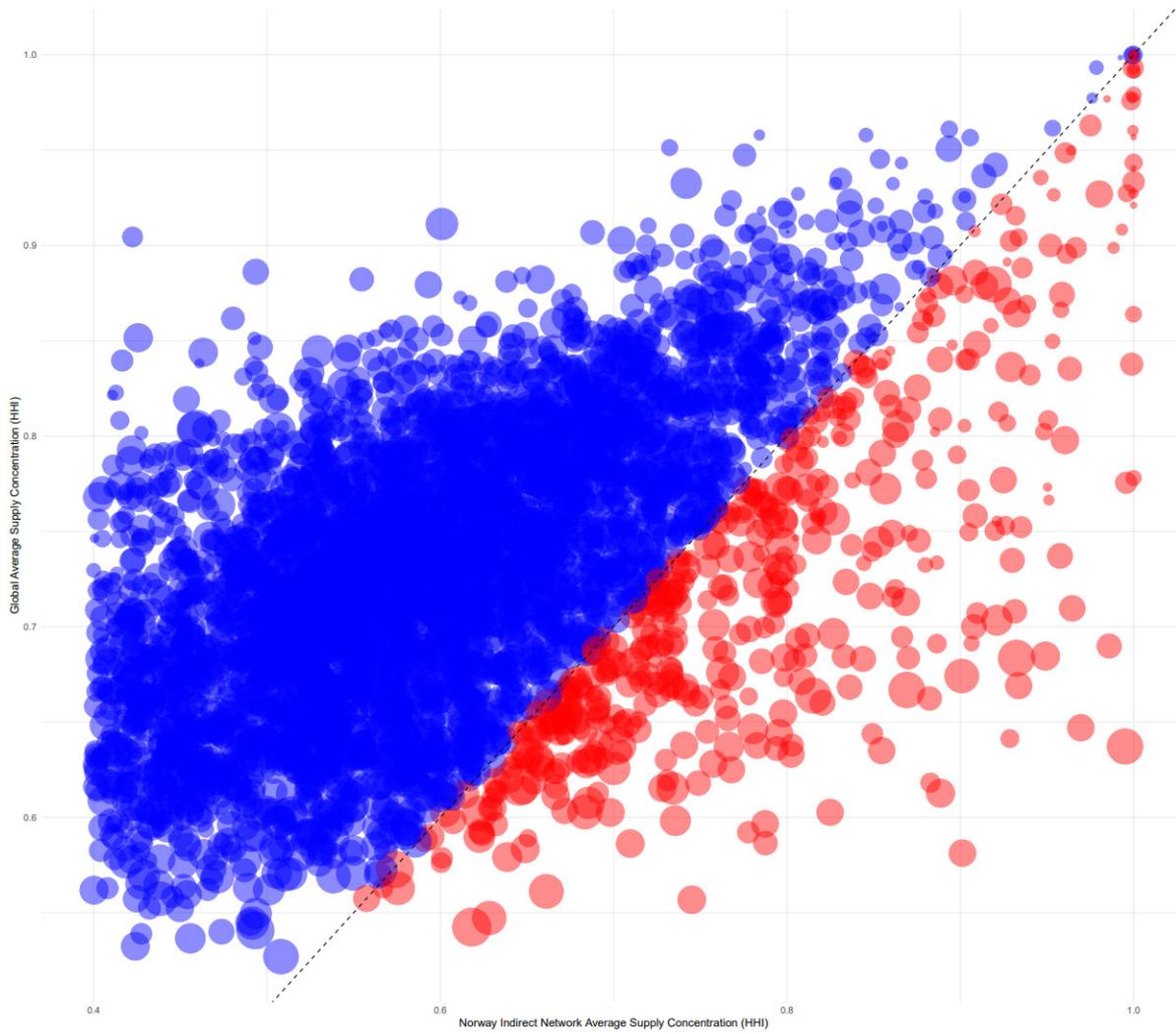


Figure 9 - Number of Dependencies Ties by sector

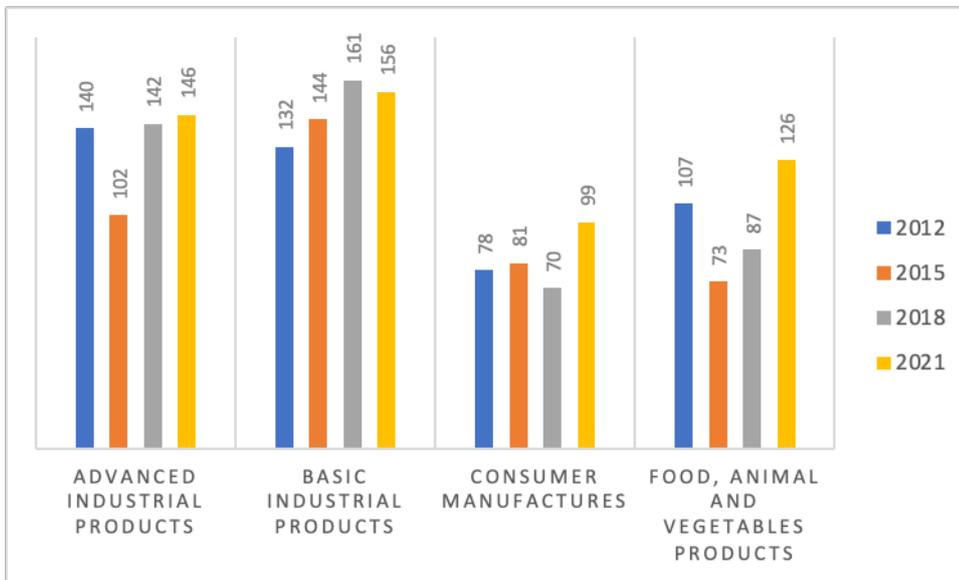
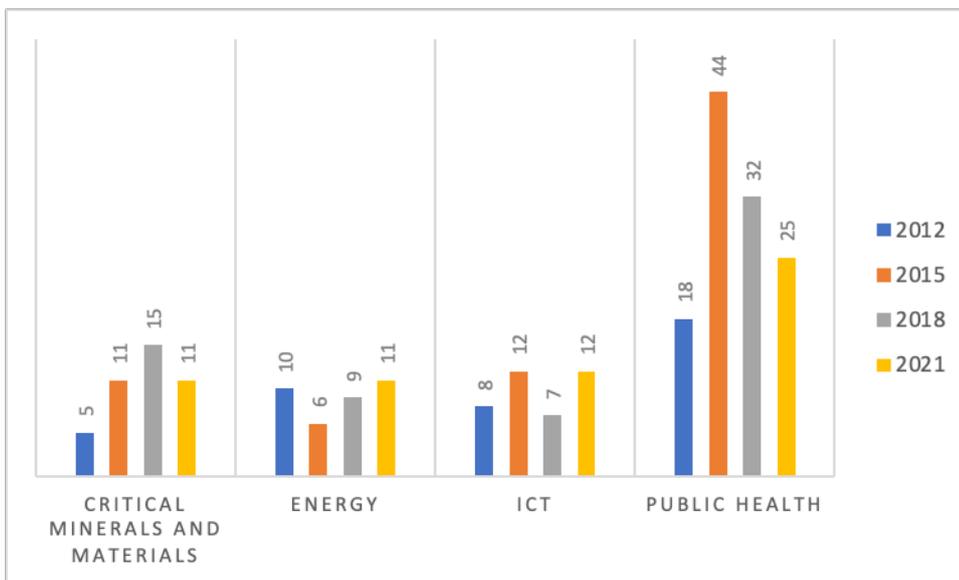


Figure 10 - Number of Dependencies Ties by sector

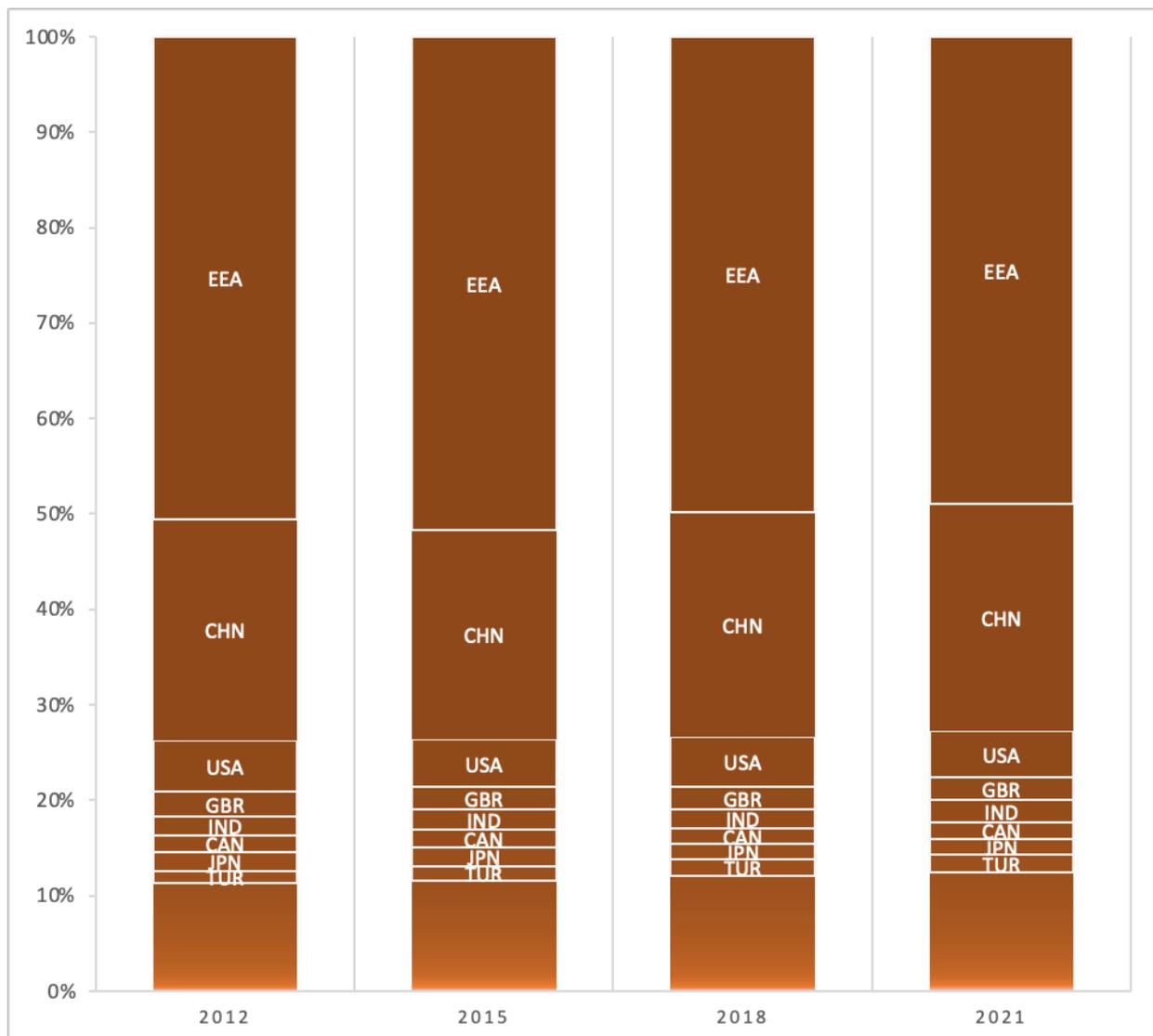


In order to grasp the main chokepoints in Norway’s indirect dependencies network, one can look at the top products associated with most dependencies in each sector. Table A8 and A9 in the annex show these products for overall sectors and selected strategic sectors respectively. While the list contains several products that at face value may not pose strategic risks, it also contains a much wider range of products in strategic sectors. To be sure, this is a function of the much bigger size of this network born out of the dependencies of over a dozen countries, instead of Norway’s only. However, it still points to how Norway’s indirect trade relations may contain a wider range of chokepoints that could transmit risks to its economies.

5.2.2 Norway's Indirect Dependencies by Supplier

Understanding the vulnerabilities in Norway's network of indirect suppliers requires identifying which countries occupy the respective chokepoints. Figure 11 shows the distribution of centrality among suppliers across the respective years. The centrality of EEA economies is summed up as one. As we can observe, the EEA countries occupy a smaller share of the centrality in this network, being the source of around 50% of all dependencies. China comes next accounting for over 20% of all dependencies, followed by the U.S. which accounts for 5% of all dependencies. This is an interesting contrast to the centrality of distribution in Norway's direct network, where EEA countries amount to around 60% of the dependency ties, China around 15%, followed by the UK and the U.S. with over 5% across all years. Hence, through its indirect network, Norway's is not only exposed to dependencies associated with a larger number of products, but there is also a larger dependency outside the EEA, including greater dependency on China.

Figure 11 – Distribution of Centrality Among Suppliers



Looking at the position of individual countries, we observe that China is the source of most dependency ties aggregated by general sectors, except for Basic Industrial Products, where Germany holds the biggest share. Germany is also the most central country in the supply of Critical Materials and Minerals as well as products associated with the Energy and Public Health sectors. In contrast with Norway's direct dependence, this picture does not differ when we zoom into products that have a higher average concentration than the global one. While this could signal some space for finding alternative suppliers, these products represent a very small number of products and may not be where the most significant chokepoints of the network lie. A more direct study of inter-product substitution, rather than supplier substitution, could give more insight on the policy space available for Norwegian partners to reshape the geography of their dependencies. Furthermore, the sample includes the dependencies of countries like China, the U.S. and India, whose options for 'friendshoring' would be substantially different from one another.

In order to further specify the current chokepoints in Norway's indirect network, we can look at the products whose supply is most concentrated on non-EEA partners. Tables A10 and A11 in the annex show the 10 products in which non-EEA country have higher overall centrality, as the number of dependency ties weighed by the market space. We observe that China indeed occupies most chokepoints across sectors. However, the products whose provision it controls do not seem to have strategic importance at face value. When we zoom into products that are associated with strategic supply chains, we have a broader set of suppliers than the previously aggregated analysis would suggest. In sum, while indirect dependencies imply a greater dependence on China, these are largely not in strategic sectors and thus far less concerning.

Conclusion

This report has provided an overview of Norway's position in global supply chain networks and discussed potential geopolitical risks associated with its strategic vulnerabilities and capacities therein. We studied Norway's positions in a network formed by supply dependencies emerging from interstate trade of over five thousand products across four years. We focused on three dimensions: i) Norway's centrality as supplier upon which other countries depend, ii) Norway's direct dependencies on supply from other countries, and iii) Norway's indirect dependencies on the imports of its main suppliers.

In terms of Norway's centrality in supply chains, we found that it has a limited global imprint beyond a few well-known sectors. The countries which depend on Norway for a larger number of products are mostly its Nordic neighbors followed by some other EEA partners. Among the products in which Norway is a central global supplier to numerous countries, the seafood sector stands out by far. To a smaller extent, Norway is also a relevant global supplier of industrial inputs, energy, and critical materials. That said, our focus on the number of products and trading partners overlooks how particular bilateral dependencies can be strategic. One such case is Norway's role in the supply of gas to Europe, which is channeled to the entire continent mostly through pipelines via a few allied states. Norway's potential for expanding its production of critical minerals is also a development that escapes our study. It is likely that an expanded role as a supplier of critical materials would enhance the dependencies, in particular for allies and partners, but also potentially for the broader global economy.

Norway's direct dependencies, in contrast, include a broader range of products. Among strategic sectors, critical materials stand out as the sector with a higher proportion of products

associated with dependencies. Geographically, these dependencies are stably concentrated in the EEA with the main non-EEA partners being China, followed by the UK and the U.S. However, when we differentiate among products where Norway's supply is more or less concentrated compared to the global average, we see that China's participation is considerably smaller in the latter group and EEA countries have bigger participation in the first. This suggests that Norway's dependence on China is not specific to the choices of Norwegian private and governmental actors, but more likely a feature of global supply chokepoints to which all countries are subject to.

A similar pattern exists in Norway's indirect dependencies. The network analysis of those indirect dependencies shows that Norway's main economic partners form a cohesive cluster which are mostly interdependent with each other. Most of all this is a feature of the significant interdependence between European countries since key Norwegian partners in the EEA have over 80% their dependency ties with other key partners of Norway. The main exception to that pattern is China and the U.S., both of which have about half of their dependencies tied to a different pool of countries. However, when we look at the distribution of dependency among suppliers, we see that EEA economies are considerably less central in this network than they are in Norway's direct network. This share of centrality is mostly accounted for by China, which is a larger hub in Norway's indirect supply network than it is in Norway's direct one.

Regarding products, when we compare the average concentration of Norway's indirect network with global averages, we observe that the majority of products are more concentrated globally. This is to a much greater extent than is the case for Norway's direct network and suggests that most of Norway's indirect dependencies may emerge from worldwide supply chokepoints. However, when looking at the products with a higher non-EEA supply centrality, we see that several of those chokepoints do not have strategic relevance. We also find that among the strategic sectors, particularly of critical materials and energy, chokepoints are fairly distributed among non-EEA countries.

In sum, our study found that Norway has a comparatively limited exposure to geopolitical risk through its supply chain networks. It's position as a supplier of strategic goods is mostly limited to European partners, while it's centrality as a global supplier of seafood is unlikely to be weaved into geopolitical disputes. At the same time, Norway's direct and indirect dependencies are mostly to other EEA economies. Most dependencies on non-EEA countries, both direct and indirect, are on products that have higher global average concentration, and are thus likely chokepoints with a limited availability of suppliers worldwide. As previously mentioned, this suggests limited capacity for any policy intervention aimed at immediate substitution of suppliers. Instead, it demonstrates the need for a deeper analysis of each specific product group associated with potential chokepoints to map inter-product substantiality as well as the feasibility of longer-term construction of alternative supply chain when needed.

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