Projektbericht
Research Report

May 2021

Globalisation – Quo Vadis?

Economic, supply and technological sovereignty

- Final Report -

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Study commissioned by
Austrian Federal Chancellery (Bundeskanzleramt Österreich)

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Title

Globalisation – Quo Vadis? How globalisation and resilience can be rethought

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Executive Summary

Europe finds itself in a systemic competition in which the social market economy meets state capitalism. This competition is about economic as much as military supremacy, but also about whether the fundamental Western values related to individual freedom, the rule of law and freedom of speech have a future. A new balance must be found between global free trade and autonomous governing; new forms of international and European cooperation must be designed; and the scope for action of a sovereign state must be re-explored on the basis of realistic economic foundations.

Across Europe, this has led to renewed and intensifying discussions regarding more independence and autonomy. How does Austria want to contribute to this ambitious aspiration, and where does it see its own interests best represented? While not a foresight exercise in the strict definition, this report is an analytic contribution based on information and data available towards that end. Specifically, it focuses on proactive preparedness for sovereignty challenges. To do so analytically, this report employs the concept of sovereignties to analyse three different domains of interest to Austria, namely economic, supply and technological sovereignty.

A comprehensive analysis of future challenges Austria and the EU are facing shows that in all three sovereignty domains, there exist considerable weaknesses, but also strengths. To start with, this report investigates the domain of economic sovereignty and argues, based on current empirical evidence, that open markets are, in general terms, beneficial for economic welfare. For the EU, which is dependent both on imports of certain raw materials simply not available in Europe and on exports, autonomy in the sense of autarky is not a realistic policy option. A policy of isolation would clearly reduce the welfare of the European people. For the small and very open economy of Austria, this applies to an even greater degree, even though it is necessary to recalibrate interests so that societal as well as environmental issues are taken into account.

Supply vulnerabilities include both, temporary disruptions of supply chains and more general vulnerabilities resulting from import dependencies regarding strategic or critical goods. Here, the COVID-19 pandemic demonstrated not only the EU's dependence on critical imports, but also challenged the strong international fragmentation of supply chains and just-in-time production. The globalisation process is characterised by, inter alia, a relocation of parts of the production process to countries with low production costs and the transferral of expensive warehousing to the street or the seas through just-in-time delivery systems. Such systems are vulnerable not just to large scale disruptions as in the case of the pandemic, but also to more local or regional disruptions due to man-made or natural disasters as well as political developments or strategies in the supplying

countries, to name but a few. Resilience and robustness therefore need to be addressed beyond conclusions based on the immediate experience with the pandemic.

When it comes to technologies, one key aspect concerns threats that result from the actions of adversarial forces but also from the negative effects that agglomeration of market power by large (tech) companies have – not only economically, but even more importantly socially and politically. Another aspect concerns the capacity, and the capability, to seize emerging opportunities, among others through increasing competitiveness and smart innovation policies. Empirical evidence indicates that innovation is requiring an increasing amount of input, which means that Austria, and Europe in large, need both to focus on continuing its investments and seek ways to make sure these investments are made in the most efficient way. For this, horizontal as well as vertical policy options are already established but also need further calibration.

The report discusses different proactive strategies to mitigate vulnerabilities and seize opportunities in the three domains.

Regarding economic sovereignty, there are clear benefits from free trade; numerous studies show positive macroeconomic effects where regional trade agreements were enacted. With tariff barriers increasing between China, USA, and also Europe, state aid and subsidies are often referred to as a potential remedy, but the empirical evidence strongly indicates that these policies weaken trade and may lead to fratricidal subsidy competition.

With regard to supply sovereignty, strategies include stockpiling, reshoring as well as supply diversification. Stockpiling and reshoring can be identified as potential strategies to achieve *robustness* for very specific critical goods. By contrast, the empirical evidence does not point towards reshoring as an efficient strategy to achieve resilience, given that disruptions can occur within the EU and that reshoring will increase manufacturing costs substantially, does not per se protect against a potential explosion in demand during a crisis (e.g., for face masks during the COVID-19 pandemic), may limit the opportunities for companies to adjust their supply chains in case of disruptions and may affect EU exports negatively.

Concerning technology, Europe is following a distinct model of ascertaining value-based technological sovereignty, with the European Commission pushing for a comprehensive reform of the digital space to rebalance rights and responsibilities of users, intermediary platforms, and public authorities, and to establish a common European data space. In addition to those efforts to step up regulatory measures and standard setting, the European Union now also follows a more active policy with respect to important projects of common European interests, based on value chains identified as critical to

technological sovereignty. While this is still an emerging topic, preliminary findings indicate areas of proactive engagement for Austria.

Instead of pursuing some form of (illusionary) autarky, experts largely agree on strategies aimed at establishing redundancies and greater diversification within supply chains, identification of key technologies through foresight exercises combining technological and industrial strengths with a high-quality digital infrastructure and a regulatory framework based on fundamental values, emphasising increased risk awareness and management, greater transparency and sharing of data. There are some far-reaching conclusions to be drawn from this analysis, with respect to both content and procedure.

In terms of economic sovereignty, Austria and the EU in general should work towards agreements on global rules regarding minimum social and environmental standards and apply market-conform instruments such as emission trading systems or a border-adjustment mechanism to obtain a level playing field regarding EU and global production costs. Recommendations include

- Less dependence on imports from a small number of countries might be achieved by a diversification of suppliers while securing free access to markets
- Observance of social and environmental standards in global trade agreements
- Establishment of a border adjustment mechanism accounting for international cost differences that are due to lower environmental and social standards in other parts of the world
- Caution when it comes to the identification or definition of specific strategic industries and focus on providing a regulatory framework and funding
- Regarding EU state aid rules, which protect Austrian companies from unfair competition, but also Austria as a member state from a fratricidal spending competition, it is in Austria's crucial interest to contribute to ensuring that state aid control regarding foreign companies is made more effective, both within and outside of the EU.
- Reform of the WTO Agreement on Subsidies and Countervailing Measures with the aim of reducing market distortions, increasing transparency and adapting the framework for trade in services.

Regarding supply sovereignty, the report emphasises the need to develop further strategies to mitigate supply chain vulnerabilities. This includes both the development of methods to gain adequate data on supply chains and potential vulnerabilities as well as strategies to achieve supply chain robustness and resilience. Recommendations include

- The establishment of a common European list of critical goods for which *robustness* is considered essential, complemented by a joint European stockpile of such goods that can sensibly be warehoused and where the need in a crisis can be reasonably anticipated
- Alternatively, or additionally, the development of national or, ideally, European public-private robustness-oriented procurement strategies with the aim of developing a network of selected, and where necessary redundant, producers of critical goods both within the EU and abroad
- Limited and targeted reshoring or development of production capacities for specific critical goods
- The implementation of European legislation that rules out any form of "Harm-Thy-Neighbour" policies, i.e., seizures of, or export restrictions on, goods considered critical and in short supply during a crisis
- National or European programs aimed at supporting efforts of, especially smaller, companies to build more diversified and thus resilient global value chains
- The development of mechanisms for collecting and sharing data regarding supply chains and vulnerabilities, for example through voluntary public-private partnerships or data sharing across the EU at the level of customs authorities.

Regarding technological sovereignty, the report emphasises that Europe's ambitions in designing, governing, and developing future technologies are grounded in core European values of democracy, equity, social justice and privacy. Technological sovereignty is as much about Europe's quest to (re)enter the global geopolitical domain determining the future of the planet by innovating and deploying new technologies, as it is the ambition to gain the necessary autonomy in governing the democratic and equitable wellbeing of (all) European peoples. Specifically, recommendations include

- Establishing technological sovereignty as a policy-guiding principle for Europe to enhance its position as a standard setter in the global economic and technology arena, enable democratic governance, advance Europe's access to key technologies and their resources, and navigate societal development in line with the values and welfare of its citizens
- Prioritising regulatory mechanisms that counter the expanding role of private interests in technological governance, with special attention on social impacts of datafied environments
- Development of regular foresight exercises regarding technological advancements and potential impacts

- Continuation of investments in research and innovation and, specifically, more competitive funding for basic research, mission-oriented research instruments, and efforts to establish a venture capital market
- Support of EU wide initiatives of developing new value chains critical to technological sovereignty
- Encouragement of application and inclusion of responsible innovation principles and methods to address the social impacts and unwanted consequences of innovation in disruptive technologies.

Zusammenfassung

Europa befindet sich in einem politischen und ökonomischen Systemwettbewerb, in dem die soziale Marktwirtschaft westlicher Prägung auf den Staatskapitalismus trifft. Bei diesem Wettbewerb geht es um die wirtschaftliche als auch um die militärische Vormachtstellung, aber auch um die Zukunft westlicher Grundwerte wie individuelle Freiheit, Rechtsstaatlichkeit und Redefreiheit. Vor diesem Hintergrund gilt es unter anderem, ein neues Gleichgewicht zwischen globalem Freihandel und autonomem Regieren zu finden. Neue Formen der internationalen und europäischen Zusammenarbeit müssen entworfen werden, und der Handlungsspielraum souveräner Staaten muss auf der Grundlage einer realistischen Einschätzung der ökonomischen Rahmenbedingungen neu abgesteckt werden.

In ganz Europa hat dies, vor allem unter dem Eindruck der COVID-19-Pandemie, erneute intensive Diskussionen über mehr Unabhängigkeit und Autonomie ausgelöst. Wie will Österreich zu diesem ehrgeizigen Unterfangen beitragen, und wo sieht es seine eigenen Interessen am besten vertreten? Der vorliegende Bericht will zu dieser Diskussion beitragen. Dabei handelt es sich um keine Foresight-Analyse im engeren Sinne, sondern um eine auf empirischer Evidenz beruhende Untersuchung zukünftiger Herausforderungen und proaktiver Strategieoptionen für Europa und Österreich. Als analytische Grundlage verwendet dieser Bericht das Konzept der Souveränität, wobei drei Bereiche analysiert werden, die für Österreich von besonderem Interesse sind: wirtschaftliche Souveränität, Versorgungssouveränität und technologische Souveränität.

Eine umfassende Analyse der künftigen Herausforderungen für Österreich und die EU zeigt, dass hinsichtlich aller drei Souveränitätsbereiche erhebliche Schwächen, aber auch deutliche Stärken bestehen. In einem ersten Schritt analysiert der Bericht den Bereich der wirtschaftlichen Souveränität und zeigt auf der Basis aktueller empirischer Evidenz, dass offene Märkte für den wirtschaftlichen Wohlstand grundsätzlich von Vorteil sind. Für die EU, die sowohl auf Importe bestimmter, in Europa nicht verfügbarer Rohstoffe, als auch auf Exporte angewiesen ist, stellt Autonomie im Sinne von Autarkie keine realistische Option dar. Eine Politik der Isolation würde den Wohlstand in Europa erheblich beeinträchtigen. Für die kleine und sehr offene Wirtschaft Österreichs gilt dies in noch größerem Maße. Dessen ungeachtet ist es notwendig, ökonomische, soziale und ökologische Interessen in Einklang zu bringen.

Schwachstellen im Hinblick auf die Versorgungssouveränität betreffen sowohl temporäre Unterbrechungen in globalen Lieferketten als auch Importabhängigkeiten bei strategischen oder kritischen Gütern. Hier hat die COVID-19-Pandemie nicht nur die Abhängigkeit der EU von kritischen Importen verdeutlicht, sondern auch eine Diskussion

über die Fragmentierung globaler Lieferketten und die Just-in-Time-Produktion ausgelöst. Wesentliche Elemente des Globalisierungsprozesses sind die Auslagerung von Teilen der Produktion in Länder mit niedrigen Produktionskosten sowie die Verlagerung teurer Lagerhaltung auf die Straße oder den Seeweg durch Just-in-Time-Liefersysteme. Solche Produktionssysteme sind anfällig für eine Vielzahl von Störungen, die nicht nur durch globale Krisen wie die Pandemie ausgelöst werden können. Selbst lokale oder regionale Produktionsausfälle oder -verzögerungen, ausgelöst durch menschliches Versagen, Naturereignisse und -katastrophen, aber auch politische Entwicklungen und Strategien in Lieferländern können zumindest temporär zu massiven Lieferengpässen führen. Vor diesem Hintergrund gilt es, nicht allein Lehren aus den Erfahrungen während der Pandemie zu ziehen, sondern Strategien zur grundsätzlichen Stärkung der Resilienz und Robustheit von Lieferketten zu entwickeln.

Im Falle von Technologien stehen zunächst ökonomische sowie auch soziale und politische Bedrohungen im Mittelpunkt, die sich aus den Handlungen gegnerischer Kräfte ergeben, aber auch aus den negativen Auswirkungen, die die Agglomeration von Marktmacht durch große (Technologie-)Unternehmen hat. Ein weiterer Aspekt betrifft die Fähigkeit und das Potenzial, sich aus dem technologischen Wandel neu ergebende Chancen zu ergreifen, unter anderem durch eine Steigerung der Wettbewerbsfähigkeit und eine Innovationspolitik, die bewusst auf vorhandene Stärken zu setzen vermag und zugleich bestehende Schwächen kompensiert. Empirische Erkenntnisse zeigen, dass für ein gleichbleibendes Maß an Innovationsfähigkeit zunehmend mehr finanzieller Einsatz erforderlich wird. Dies impliziert, dass Österreich im Speziellen und Europa im Allgemeinen nicht nur weiterhin in Innovationen investieren müssen, sondern dabei auch auf eine effiziente Mittelverwendung achten sollten. Sowohl horizontale als auch vertikale Politikoptionen sind dafür bereits etabliert, bedürfen aber weiterer Optimierung.

Der Bericht diskutiert verschiedene Strategien, um in den drei Bereichen Schwachstellen abzumildern, aber auch um Chancen, die sich neu eröffnen, zu identifizieren.

Hinsichtlich der wirtschaftlichen Souveränität gibt es eindeutige Vorteile durch den Freihandel; zahlreiche Studien zeigen positive makroökonomische Effekte dort, wo regionale Handelsabkommen in Kraft gesetzt wurden. Oft werden angesichts zunehmender Zollschranken zwischen China, den USA und auch Europa staatliche Beihilfen und Subventionen als möglicher Lösungsweg genannt; die empirische Evidenz deutet jedoch darauf hin, dass solche Maßnahmen den Handel schwächen und zu einem gegenseitigen Subventionswettbewerb führen können.

Im Hinblick auf die Stärkung der Versorgungssouveränität analysiert der Bericht (staatliche) Bevorratung, die Verlagerung von Produktionsstätten zurück nach

Österreich und Europa (Re- und Nearshoring) sowie die Diversifizierung von Bezugsquellen als mögliche proaktive Strategien zur Stärkung von Resilienz und Robustheit. Dabei werden Bevorratung und Rückverlagerung als potentiell geeignete Strategien identifiziert, um in erster Linie Robustheit, d.h. eine trotz Störung ununterbrochene Versorgung, für spezifische kritische Güter zu gewährleisten. Auf der Basis der empirischen Evidenz kann eine Rückverlagerung von großen Teilen der Produktion hingegen nicht als grundlegende Resilienz-Strategie empfohlen werden. Nicht nur können Störungen in Lieferketten auch innerhalb Europas auftreten, eine Rückverlagerung wäre außerdem mit einer erheblichen Steigerung der Produktionskosten verbunden. Über eine Rückverlagerung ließe sich auch eine krisenbedingte Nachfrageexplosion (wie etwa für Gesichtsmasken während der COVID-19-Pandemie) kaum auffangen. Im Gegenteil, eine Rückverlagerungsstrategie würde die Möglichkeiten für Unternehmen einschränken, ihre Lieferketten im Falle von Störungen flexibel anzupassen, und könnte EU-Exporte grundsätzlich negativ beeinflussen.

Im Technologiebereich verfolgt Europa schon jetzt einen eigenen Weg, der als wertebasierte technologische Souveränität bezeichnet werden kann. Insbesondere die Europäische Kommission setzt auf eine umfassende Reform des digitalen Raums, um die Rechte und Verantwortlichkeiten von Nutzer/innen, intermediären Plattformen und Behörden neu zu bestimmen; auch soll ein gemeinsamer europäischer Datenraum geschaffen werden. Neben diese Bemühungen um verstärkte Regulierungsmaßnahmen und Standardisierung verfolgt die Europäische Union neuerdings auch eine aktivere Politik in Bezug auf prioritäre Projekte von gemeinsamem europäischem Interesse („important projects of common European interests"); dabei spielt die Identifikation von strategischen Wertschöpfungsketten für die technologische Souveränität eine entscheidende Rolle. Während hier einiges gerade im Entstehen begriffen ist, lassen erste Untersuchungen bereits Rückschlüsse auf jene Bereiche zu, in denen Österreich sich proaktiv engagieren sollte.

Anstatt eine Form von (illusionärer) Autarkie anzustreben, empfehlen Experten daher in erster Linie Strategien, die darauf abzielen, Lieferketten stärker zu diversifizieren und Redundanzen zu erreichen, ein erhöhtes Risikobewusstsein und -management sicherzustellen und mehr Transparenz durch Datenaustausch zu schaffen. Außerdem wären Schlüsseltechnologien durch Foresight-Analysen zu identifizieren, bei welchen technologische sowie sektorale Stärken mit einer qualitativ hochwertigen digitalen Infrastruktur und einem auf Grundwerten basierenden regulatorischen Rahmen kombiniert werden. Aus dieser Analyse lassen sich einige weitreichende Schlussfolgerungen ziehen, sowohl inhaltlich als auch prozedural.

In Bezug auf die ökonomische Souveränität sollten Österreich und die EU auf Vereinbarungen über globale Regeln für soziale und ökologische Mindeststandards

hinarbeiten und marktkonforme Instrumente wie Emissionshandelssysteme oder ein Grenzanpassungsverfahren anwenden, um gleiche Wettbewerbsbedingungen für die EU hinsichtlich der globalen Produktionskosten zu erreichen. Die Empfehlungen umfassen:

- Eine geringere Abhängigkeit von Importen aus wenigen Ländern könnte durch eine Diversifizierung der Lieferanten erreicht werden, während gleichzeitig der freie Marktzugang sichergestellt wird.
- Die Einhaltung von sozialen und ökologischen Standards in internationalen Handelsabkommen.
- Einführung eines Grenzausgleichsmechanismus zum Ausgleich unterschiedlicher Produktionskosten in anderen Teilen der Welt infolge geringerer Umwelt- und Sozialstandards.
- Vorsicht bei der Identifizierung oder Definition spezifischer strategischer Branchen und Konzentration auf die Bereitstellung eines rechtlichen Rahmens und finanzieller Förderungen.
- Im Bereich des EU Beihilferechts, welches sowohl österreichische Unternehmen vor unlauterem Wettbewerb als auch Österreich als Mitgliedstaat vor einem unproduktiven Subventionswettlauf schützt, ist es vor allem in Österreichs Interesse, auf eine Anwendung des EU Beihilferechts auf ausländische Unternehmen hinzuwirken.
- Reform der WTO-Regeln über Subventionen und Gegenmaßnahmen mit dem Ziel, Marktverzerrungen zu verringern, die Transparenz zu erhöhen und den Rahmen für den Handel mit Dienstleistungen anzupassen.

Im Bereich Versorgungssouveränität werden Strategien empfohlen, die auf eine Sicherstellung der Grundversorgung im Krisenfall, aber auch eine grundlegendere Stärkung der Störungsresistenz von Lieferketten abzielen Dies umfasst sowohl die Entwicklung von Methoden zur Gewinnung von Daten zu Lieferketten und potenziellen Schwachstellen als auch Strategien zur Stärkung der Robustheit und Resilienz von Lieferketten. Die Empfehlungen umfassen:

- Erstellung einer gemeinsamen europäischen Liste kritischer Güter, für die Robustheit als wesentlich angesehen wird, ergänzt durch eine gemeinsame europäische Bevorratung von Gütern, die sich für eine Einlagerung eignen und bei denen der Bedarf in einer Krise sinnvoll abgeschätzt werden kann.
- Alternativ oder zusätzlich die Entwicklung nationaler oder, im Idealfall, europäischer öffentlich-privater, auf Robustheit ausgerichteter Beschaffungsstrategien mit dem Ziel, ein Netzwerk ausgewählter und erforderlichenfalls redundanter Hersteller kritischer Güter innerhalb der EU und im Ausland aufzubauen.

- Begrenzte und gezielte Rückverlagerung oder Entwicklung von Produktionskapazitäten für bestimmte kritische Güter.
- Die Umsetzung europäischer Rechtsvorschriften, die jegliche Form von „Schade-dem-Nachbarn“-Politik ausschließen, etwa die Beschlagnahmung von oder Exportbeschränkungen für Güter, die in einer Krisensituation als essenziell eingestuft werden.
- Nationale oder europäische Programme zur Unterstützung insbesondere kleinerer Unternehmen beim Aufbau diversifizierterer und damit resilienterer globaler Wertschöpfungsketten.
- Entwicklung von Methoden für die Erhebung und den Austausch von Daten zu Lieferketten und potenziellen Schwachstellen, beispielsweise durch freiwillige öffentlich-private Partnerschaften oder EU-weiten Datenaustausch auf der Ebene der Zollbehörden.

In Bezug auf die Gestaltung, Steuerung und Entwicklung künftiger Technologien beruhen die Ambitionen Europas auf den europäischen Grundwerten Demokratie, Gleichheit, soziale Gerechtigkeit und Privatsphäre. Bei der technologischen Souveränität geht es gleichermaßen um das Bestreben Europas, durch Innovationen und Einsatz neuer Technologien (wieder) eine globale geopolitische Gestaltungsmacht zu erlangen, wie um das Bestreben, die erforderliche Autonomie bei der Steuerung des demokratischen und gerechten Wohlergehens der europäischen Bevölkerung weiter zu gewährleisten. Die Empfehlungen umfassen insbesondere:

- Etablierung technologischer Souveränität als politisches Leitprinzip für Europa, um seine Position als Standardsetzer auf dem Gebiet der globalen Wirtschaft und Technologie zu stärken, eine demokratische Regierungsführung zu ermöglichen, den Zugang Europas zu Schlüsseltechnologien und ihren Ressourcen zu verbessern und die gesellschaftliche Entwicklung im Einklang mit den Werten der EU und dem Wohlergehen seiner Bürger zu gewährleisten.
- Priorisierung von Regulierungsmechanismen, die der Rolle privater Interessen in der technologischen Governance entgegenwirken, unter besonderer Berücksichtigung der sozialen Auswirkungen datenbasierter Umgebungen.
- Entwicklung einer Foresight-Kapazität hinsichtlich des technologischen Fortschritts und möglicher Auswirkungen.
- Investitionen in Forschung und Innovation und insbesondere einer wettbewerbsfähigeren Finanzierung der Grundlagenforschung, missionsorientierter Forschungsinstrumente und Bemühungen zur Schaffung eines Risikokapitalmarktes.

- Unterstützung EU-weiter Initiativen zur Entwicklung neuer Wertschöpfungsketten, die für die technologische Souveränität von strategischer Bedeutung sind.
- Förderung der Anwendung und Einbeziehung verantwortungsbewusster Innovationsprinzipien und -methoden zur Bewältigung der sozialen Auswirkungen und unerwünschten Folgen von Innovationen in disruptiven Technologien.

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1 Trends in globalisation from the perspective of Austria

The past few decades have been characterised by a strong globalisation of trade as well as the allocation of capital and the division of labour. Until the Great Financial Crisis (GFC) of 2007/2008 (sometimes also called the Great Recession), world trade in goods and services grew faster than global economic output. The economic opening of China and the fall of the Iron Curtain played a decisive role in this. With the liberalisation of cross-border trade in services, for example within the framework of the General Agreement on Trade in Services (GATS), which came into force in 1995, more and more services are being traded globally. This includes tourism as well as transport and financial services. Digitalisation has intensified these trends even further. Globalisation is therefore a phenomenon that, in addition to the movement of goods, also includes transport, communication, capital movements and the mobility of people.

For a long time, there was little doubt, politically and economically, about the advantages of this globalisation. In principle, all countries benefit from an international division of labour. The prerequisite for this is an exchange of goods and services that is as free as possible without customs duties and other trade restrictions. Still, Western countries have also seen an increasing scepticism and criticism of globalisation, as social scientists were quick to point out (e.g., Beck 2000). This has to do with the unequal distribution of advantages and disadvantages from globalisation among different population groups, but also with the unequal safeguarding of social and environmental standards. In Austria, for example, this scepticism manifests itself in the critical attitude of the population towards multilateral trade agreements (e.g., Eurobarometer 2016: 21ff.). A second, more recent point of criticism concerns the rise of China specifically, which has become one of the main suppliers of goods in supply chains as well as producer of important technologies. China also uses its growing economic power to pursue its geostrategic goals.

The COVID-19 crisis has only highlighted the (mostly unintended) dependencies of Austria, and Europe by and large, on global market forces, and China specifically. Above all, the pandemic has demonstrated the susceptibility of the globally interconnected economic system to an interruption in supply chains. In Europe, for example, industrial production already fell in the first months of 2020, although most national lockdowns, Italy being an important exception, did not come into force until March 2020. The main reason for this was the production interruptions in China at the turn of the year (see Czypionka et al. 2020). The production of goods, especially in the automotive or the electronics industries, is highly fragmented internationally. Hence, parts are produced in

many countries, delivered just in time and then assembled on site. Even local interruptions in the value chains can therefore cause major delays or even a longer disruption of production along the supply chain. This can happen, not least, when a company depends on a single wholesale supplier, but also if there are several suppliers, but all of them are based in the same country. Due to the economic slump triggered by the COVID-19 pandemic, for example, the volume of world trade in goods declined by 5.3% in 2020. As a result of the fast recovery of world-wide industrial production and the recovery of the Chinese economy, however, by the end of 2020 the world trade volume had already reached its pre-crisis level. Yet this pertains only to trade in goods, while trade in services is still negatively affected. According to current estimates and projections by the IMF, world trade in goods and services declined by 9.6% in 2020 and should grow by 8.1% in 2021 and by 6.3% in 2022 (IMF 2021). According to current estimates of national accounts, Austria's real exports of goods and services declined by 10.4% in 2020, where exports of goods decreased by about 7%, and tourism exports plummeted by 39.5%. A strong rebound can be expected for 2021, but only for goods exports, while tourism might fall again and recover only in 2022 (Bittschi et al. 2021).

While the COVID-19 crisis has demonstrated that the Austrian economy as well the economy of the entire European Union (EU) must be made more resilient to crises, the main problems were already evident for observers before the pandemic. Calls for a stronger industrial policy and for the promotion of national champions have been growing louder (see e.g., Fuest et al. 2019). In its Spring 2019 World Economic Outlook, the International Monetary Fund (IMF) had warned of growing political and economic uncertainty and its effects on the global economy (IMF 2019). In addition to the international division of labour, this also applies to Europe's dependence on important goods, services, and technologies that are produced abroad. In the COVID-19 crisis, this applies above all to medical products, but also to raw materials or even agricultural raw materials such as yeast.

Today, Europe finds itself in a systemic, global competition in which the social market economy meets state capitalism. It is about economic and military supremacy, but also about whether the fundamental Western values related to individual freedom, the rule of law and freedom of speech have a future. All of this means that politicians, observers and scholars alike have increasingly concluded that a new balance has to be found that walks the tightrope between unfettered global free trade and autonomous governing, that new forms of international and European cooperation must be designed, and that the scope for action of a sovereign state must be re-explored on the basis of realistic economic foundations. If the weighing of interests has so far been tailored to the economic benefits of globalisation, it now appears to be necessary to redraw it in the sense that environmental issues or the observance of social standards along the supply

chain have to be observed. This explains why "strategic autonomy" has become a rallying cry at EU level.[1] Still (or maybe because of that), the meaning of this terms remains highly elusive (as is the case with "resilience" or "strategic sovereignty").[2] Under its headline, many issues and challenges, but also a number of different instruments and regulatory measures have been suggested in different policy areas. Those contributions are far from coherent, and, as one observer has recently stated, the overall meaning of strategic autonomy remains largely unclear (Tamma 2020).

This report is not the space for a thorough discussion of the term of "strategic autonomy", but in a nutshell, it can be defined as a broader political aspiration to set sovereign priorities and to make independent decisions in matters of foreign policy and security, economy and international cooperation, together with the institutional, political and material means to carry these through – in cooperation with third parties – while also being able to set, modify and enforce international rules as opposed to reluctantly obeying rules set by others.

To paraphrase from one of the speeches that Charles Michel (2020) gave on the topic, more independence of the European Union from other global powers is needed to achieve three objectives: stability, disseminating European standards, and promoting European values.

The most thorough discussion of "strategic autonomy" to date (Lippert et al. 2019) encapsulates a number of fields of action, that can be largely divided in the areas of security and diplomacy, on the one hand, and economy, trade, and competitiveness, on the other hand. The same study also points at some crucial aspects for achieving (more) strategic autonomy at the European level, four of which are relevant here: strategic autonomy is a necessary prerequisite for the Union to be able to co-create the global order based on European values; it is urgent due to the emerging multi-polar constellation; it would be possible, in principle, to achieve more strategic autonomy within the EU legal framework; however, this would also pose a challenge because of many goal conflicts within the European bloc.

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[1] By our count, there have been ten major speeches by high-level representatives of the EU between 2018 and 2020 such as President of the European Council Charles Michel, European Commission President Ursula von der Leyen, and two of her Commissioners, revolving around "strategic autonomy", or at least mentioning it as vital aspect.

[2] In the academic as well as in the policy literature, the terms "strategic autonomy", "strategic sovereignty", "technological sovereignty", "digital sovereignty", etc., are often used interchangeably and lack clear demarcation from one another. Among these terms, "strategic autonomy" is the most frequently used and most general term that covers the (political) aspiration of the EU to become more independent from, but also more proactive in shaping, global trends. To operationalise this broad political term, we introduce the term "sovereignties" in Section 3 as an operational approach for the analysis of three distinct policy domains: economic, supply, and technological sovereignty. While this is not the common demarcation, it is used consistently in this report in order to distinguish between the political aspiration (strategic autonomy as the overarching policy goal) and the analytical concept (sovereignty as a policy challenge in a given domain).

Despite this only brief (and necessarily incomplete) summary, we nevertheless want to mention two important aspects about "strategic autonomy". As for the first aspect, the term "strategic autonomy" implies that the EU needs to gain more independence from its global competitors and sometimes even adversaries as well as from multinational (tech) companies. However, to do so, EU institutions may also need more autonomy from the EU's member states, i.e., greater (exclusive) competencies. Such a viewpoint is perfectly understandable for any representative of the EU institutions. Things may look different, however, from the perspective of the member states in general, and for Austria as one of the smaller, yet economically powerful and competitive member states of the European Union, in particular.[3] And yet this report starts with the assumption that it is reasonable for Austria to endorse, and participate in, the aspiration of gaining more autonomy for the EU. Why?

One reason is simply based in economics. "Economic nationalism" may have its merits in politically polarising debates, but for Austria, free trade is – and remains – of fundamental importance. Not least because of its deep economic and political entanglements within the Union and its proximity to the countries of Central and Eastern Europe, Austria benefited particularly strongly from the expansion of the EU and the fall of the Iron Curtain (e.g., Breuss 2020). Another reason is to be found in the power equation of international political economy. As noted, Europe is not alone in its striving for more autonomy. The same is true for the United States of America (US) and for China, respectively, albeit from very different points of departure. Given the fact that a multi-polar global order is emerging, a larger bloc, like the European Union, has more weight than a people of 9 Mio. In contrast to large member states, Austria can therefore hardly claim strategic autonomy in major parts of its economy, it can only seek strategic autonomy jointly with its European partners.

The second aspect of strategic autonomy relevant here concerns the fact that, because of the broad aspiration encapsulated in the term, it applies to numerous policy fields. Precisely because of this nature, it is open for any member state to set priorities which policy fields to engage in, and to identify which are the appropriate instruments to achieve them. Unlike the study mentioned above (Lippert et al. 2019), which was written by a German think tank and directed at the German government, this report focuses on Austria's motivation to participate in shaping strategic autonomy while keeping in mind

[3] In this context, considerations regarding a strengthening of the subsidiarity principle within the EU would also be relevant. This is a concern that the Austrian government has frequently addressed and also emphasised during its 2018 Council Presidency. Given the focus on policy issues where questions of subsidiarity are not applicable (e.g., trade or competition policy) or where we suggest rather greater than less cooperation at the EU level (e.g., policies geared towards achieving supply chain robustness or resilience), the subsidiarity principle will not be dealt with in the report.

its interests with regard to developments in globalisation in general, and global trade and technology in particular.

Achieving strategic autonomy is an ongoing process and requires the participation of all member states. Austria should endorse and actively engage in pursuing this ambition – but with a clear view of Austria's interests. This, then, is the question that this report sets out to answer: If independence, autonomy and sovereignty are now topics so strong and important for Europe, the European Union, and its member states – what does that imply for Austria? More specifically, how does Austria want to contribute to this ambitious aspiration, and where does it see its own interests best represented?

States have long been engaged with foresight exercises, with foresight defined as "a systematic, participatory, future intelligence gathering and medium-to-long-term vision-building process aimed at present-day decisions and mobilizing joint actions" (Gavigan et al. 2001; see also Miles et al. 2008: 11). This involves the evidence-based analysis of potential future developments based on existing data, facts, trends as well as emerging signals and the systematic and strategic preparation for such potential developments. While this report cannot be regarded as a foresight exercise in the strict definition, it is an analytic contribution based on information and data available towards that end. Specifically, it focuses on proactive preparedness for future challenges; importantly, this includes a clear vision of what to prepare for and why. To do so analytically, this report employs the concept of sovereignties to analyse three different domains of interest to Austria, namely economic, supply and technological sovereignty (see Section 3).

The aim of this report is not to provide a broader vision of sovereignty in each of these domains. This is a political decision translated to policy action, ideally resulting from a debate including stakeholders and citizens. Our report focuses, first, on an analysis of future challenges Austria and the EU face and what spheres for engagement exist (Section 4). It then discusses different options how these challenges could be met proactively and outlines future opportunities that could be seized (Section 5). Finally, based on the empirical evidence presented in these two Sections, it develops policy recommendations for each of the three sovereignty domains (Sections 6 and 7). The aim is to provide both the necessary empirical evidence as well as a thorough analysis and recommendations to enable Austrian policy makers to make important choices. At the same time, the analysis is also guided by a "political eye" – i.e., by analysing how issues of economic globalisation and technology innovation are transformed (and in the current political arena dominated) by the main actors US, China, Russia and Europe, and what Austria's stakes, opportunities and challenges are therein.

2 Methods and limitations of the study

This study is primarily based on existing analyses and data from publicly available sources (e.g., Eurostat, OECD, International Monetary Fund), the existing literature as well as on expert knowledge gained through interviews. Two methodological approaches were used.

First, a systematic literature review was carried out to map the meaning of "strategic autonomy" and develop the central concept of "sovereignties". The literature was also extensively reviewed to gain an overview of the current state of empirical evidence for the analysis in terms of the challenges and the strategic options regarding economic, supply and technological sovereignty in the form of "evidence summaries" (cf. Khangura et al. 2012; Thomas et al. 2013). These "evidence summaries" in turn formed the basis for the written synthesis of the study in the form of a foresight paper. In addition, we also built on own previous work (e.g., Braun 2019; Czypionka et al. 2020; Bittschi et al. 2021; Langer and König 2020; Novitzky et al. 2020; Weyerstraß 2019, 2020).

Second, in addition to the evidence gathered from the literature analysis, a number of expert interviews were carried out (for methodological considerations, see e.g., Bogner et al. 2009; 2014). Among other things, these interviews helped clarifying and identifying current developments with relevant experts from Austrian crisis management boards and platforms. It should be noted that all interviewees agreed to be interviewed based on the assurance that their contributions would be treated with complete anonymity. While their expert opinions and views inform our report, we have not indicated specific contributions unless contributors are unidentifiable.

Despite the broad array of empirical and conceptual considerations that form the basis of this report, a number of limitations need to be mentioned. One concerns data: this report does not conduct an empirical data analysis. One reason is simply that the scope of this report itself was limited to a literature review and expert interviews. In addition, it should be stated that access for research on economic and societal issues to relevant data sets, specifically on firm level as well as administrative data, is often lacking in Austria. This not only (and at least indirectly) affected this report (in the sense that robust analyses of empirical data for Austria is often missing), but it should also be of concern when seriously thinking about establishing a smart foresight exercise.

Another important limitation that needs to be emphasised concerns the scope of this report. As mentioned in the previous section, "strategic autonomy" encapsulates also the wide fields of (collective) security, defence and arms control, and diplomacy in their own right. While those are certainly important issues also for a state like Austria, they are not considered here. In accordance with the terms of reference for this study, the

report at hand is investigating only a selected number of policy fields concerning economic prosperity, and trade, and technological development.

As the definition of foresight referred to in the previous section implies, evidence matters in determining what works to best achieve strategic goals and to identify potential harm that can be avoided. Evidence-based policy making is therefore offered as the best way to follow rigorous and accurate use of scientific and research evidence. Yet policymaking involves trade-offs between competing social and ethical values and implementation options. This is especially the case when a "wicked problem" is to be addressed – such as governing technologies and globalised economies (Head 2019). No single optimal solution exists to address the challenges posed by globalisation, globalised supply networks, and technological leadership. As Rittel and Webber (1973: 155) have argued in their seminal paper, "policies that respond to social problems cannot be meaningfully be correct or false […] there are no [policy] solutions in the sense of definitive and objective answers." Obviously, thus, this report cannot claim to conduct a foresight study in its own right; rather, it is to be regarded as one contribution towards this end.

One of the focus areas of this report is technological sovereignty. Important to note here is also that our definition is a limited one compared to other, broader conceptualisations of the term (cf. Edler et al. 2020; Bauer and Erixon 2020). We also contend that many of the sovereignty challenges that are deemed to be technological in nature are to be treated under questions related to global trade issues, supply chain vulnerabilities or strategic import dependencies. In this study, we consider questions related to technological sovereignty mainly as falling within the general framework of a critical globalised economy analysis. A different approach is warranted, however, with regard to digital and datafied technologies (traditionally under the heading of ICT) because de-territorialised data and information flows utilise non-finite, not scarce, non-rivalrous assets that are mostly created, operated and owned by multinational corporations as well as state and other public entities (Section 4.3 and Section 5.3).

Finally, as for the results of this report, it is important to note that we are not able to develop any kinds of lists that are ready to be used by policy makers. We do not provide a list of critical goods so essential to warrant measures of ensuring robustness such as stockpiling. On the one hand, an identification of critical goods requires a careful analysis of the essential need regarding certain goods as well as a thorough risk assessment regarding the supply of such goods. On the other hand, and as we argue in section 5.2.1, stockpiling also requires a careful assessment of the management, quality assurance and logistical costs involved. Decisions on critical goods and stockpiling are therefore the result of a cost benefit assessment, which is not mainly an economic, but a political question.

Similarly, a development of in-depth future risk scenarios regarding supply chains disruptions is beyond the scope of this study.[4] And while there is a list of technological fields of strategic relevance, based on careful review of recent analyses and several interviews (Section 6.3), this list should only be taken as a starting point for a more in-depth discussion among stakeholders and experts. We also cannot provide a thorough analysis of strategic import dependencies of Austria or the EU, especially with regard to goods related to the domain of technological sovereignty broadly understood past ICT and including all domains of technology from mobility to energy and beyond. We argue that much of this discussion, while warranted, should happen under the heading of technological leadership or technology foresight, not sovereignty (see Section 3), and is therefore beyond the scope of this report. It is important to stress, however, that any such an analysis would necessitate a large-scale and in-depth analysis of the specific inputs (raw materials or semi-finished goods) and the corresponding supply chains for a broad variety of goods in various industrial sectors, as well as a systemic evaluation and analysis of data and information related to specific technology domains, drawing up scenarios, running modelling exercises based on appropriate inputs and analysis and inviting different publics to the foresight discussions. This was not feasible within the scope of this study due to data and time limitations.

[4] The European Commission regularly publishes a cross-sectoral overview of natural and man-made disaster risks the EU may face. In addition, EU civil protection legislation obliges Member States to assess their disaster risks and their risk management capabilities every three years. Decision (EU) 2019/420 of the European Parliament and of the Council of 13 March 2019 amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism.

3 Conceptual considerations

Foresight, as defined in section 1, implies developing the right mix of policy measures to help shape a desirable future pathway and to hedge against uncertainties, while being realistic about Austria's and the EU's interdependencies, the realities of the global economic system and Austria's position in it and the realities but also the advantages of global trade. The challenge here, then, is to distinguish between different domains of interest to Austria, in order to be able to assess current and future challenges and to discuss potential remedies. To do so, the report suggests using the concept of sovereignties for distinguishing between three domains: economy, supply, and technological sovereignty. As these three domains inform and structure the analysis as well as the recommendation part of this report, the concept of sovereignties needs to be explained briefly.

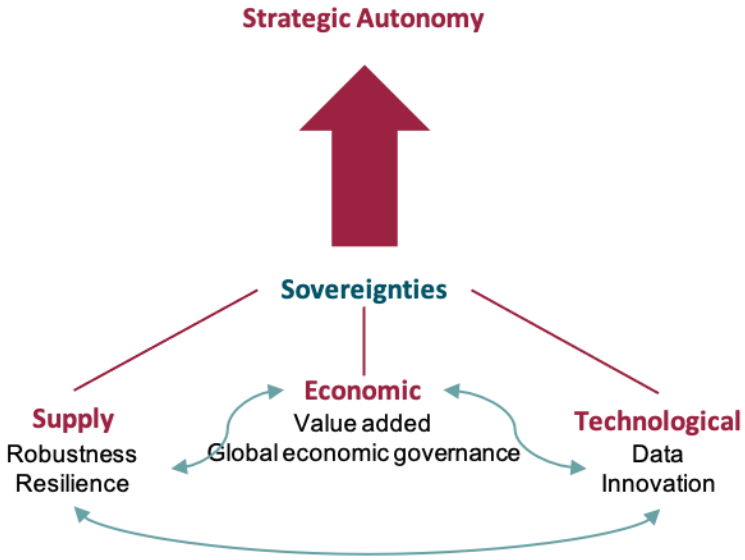
The notion of sovereignty (singular), at least in its more modern conceptualisation, developed with the rise of the nation-state. The classic theory of sovereignty emerged out of a set of particular circumstances in a bid to solve the European wars of religion in the 17th and 18th century, and to create a political instrument to justify and consolidate seizing control of and by the state. While the idea of sovereignty has been discussed and challenged throughout the 20th century both practically and theoretically (for a useful discussion, see Aalberts 2012), it has had real-world ramifications as it informed international law as much as economic and security policy at the global level. It also has been used in critical debates in philosophy (e.g., Derrida 2005; Agamben 2018), psychology (e.g., Lakan 2006) and general legal theory discussions in which different, often competing and conflicting interpretations of sovereignty emerged (for a recent overview, see Herzog 2020). Three core aspects about the classic concept of sovereignty need to be emphasised: first, sovereignty is the expressed and institutionally recognised right to exercise control over a territory and thus also concerns the territorial integrity of the (therefore: sovereign) state, second, sovereignty is seen as a level of entry for each sovereign state at international stage, and third, sovereignty in this conceptualisation is therefore a prerequisite, and does not require action on behalf of the sovereign.

In the past few years, a somewhat different understanding of sovereignt*ies* (plural) has emerged in the political and the policy domain. This understanding is closely related to the topic of globalisation and the more encompassing (and loose) term of "strategic autonomy". Its key difference to sovereignty in the modern conceptualisation is that it is somewhat de-territorialised, that it refers to a status to be achieved (and maintained), and that it is used for specific fields, or domains, of policy making (which is why we use it in plural here). Specifically, this newly emerging concept has been used, variably, to

describe various forms of independence, control and autonomy over technology infrastructures, data processes and digital contents (Couture and Toupin 2019). Within the digital domain, it has been applied to discuss the potential for control of data and software, of standards and protocols, processes, hardware, services, and digital infrastructures (Floridi 2020). For these reasons, it has also gained importance and recognition in policy discourses, and in technology and digitalisation discourses in particular. However, there is a tendency to speak also of different sovereignties beyond the digital and the technological sphere.[5]

One commonality of each domain of sovereignty in the European context is that they have to take into account specific functions (following Edler et al. 2020: 11), namely safeguarding governmental tasks including public services, achieving societal goals and defending European values, and ensuring economic competitiveness. At the same time, the differentiation in separate domains is justified by the fact that each is defined by a specific set of features that are mandatory to maintain sovereignty, or to achieve it in the first place. Accordingly, this report distinguishes between three domains of sovereignty, as mentioned before. Despite keeping them separate, there are of course interlinkages and hierarchies between these domains, as depicted in Figure 1, which lays out the conceptual elements of the proposed approach of smart foresight for active engagement.

Figure 1: Schematic depiction of different sovereignty domains



Source: Figure by the authors.

[5] As two of our interview partners pointed out, there are already discussions about several other "sovereignties", such as "knowledge", "production" or "data sovereignty". This implies that the concept is prone to being overstretched at one point.

It should be noted that, as this concept of sovereignties relates to a political system more generally, it stands in contrast to the notion of "functional sovereignty" (Pasquale 2018) used in the literature. The latter refers to the power of private firms acquiring de facto regulatory and market power to rise above all other market players, regulatory bodies, or even states. Thus, such companies become the force shaping and organising the market as a whole and being able to police disputes and interactions among the other market participants. Among other things, sovereignties, as used in this report, is about avoiding this kind of functional sovereignty.

Economic sovereignty: generating value added through global trade

Economic sovereignty can be defined as the ability to participate in the market, i.e., to produce or consume goods and services, without interference. For macroeconomic theorists following neoclassical economic theory, the concept of sovereignty as a policy guiding principle is therefore meaningless if related to interventions in the optimisation process of households and companies. Neoclassical macroeconomists believe that the macroeconomic outcome is optimal if each household is free to maximise his utility and each company can maximise its profits without any interventions. Hence, economic sovereignty in the sense that the government intervenes to direct companies' supply decisions towards specific countries or continents, for example, is seen to be at odds with such an optimal market outcome. Yet even neoclassical economists defend governmental interventions in the case of market failures such as external effects, e.g., pollution of which the polluter does not have to bear the costs (see also the discussion in section 5.1.2). But according to the neoclassical theory, there are no market imperfections that justify the concept of governmental economic sovereignty.

Institutionalists, by contrast, defend the importance of the concept of economic sovereignty and emphasise the importance of institutions such as the rule of law or the institutional framework under which an economy operates. Within the classic literature, Williamson (1985: 20) distinguishes between private decisions (households and companies) and "legal centralism". Commons (1968: 62-64) extends the concept to third parties involved and considers, in addition to sovereignty by the private sector and the state, the sovereignty of religious and moral institutions, based on the power of public opinion.

Leonard et al. (2019) take a more modern European angle. They define the EU's economic sovereignty as the ability of the EU countries to participate in the definition of the rules of the game of the global economy. Hence, this definition does not contradict the neoclassical paradigm of the freedom of markets. This idea may be illustrated by an example. If transportation costs were higher, for example because all costs caused by environmental damages by the large container ships or costs caused by paying higher

wages to container vessel crews, then companies could be expected to buy from less distant suppliers. The same is true if potential costs caused by disruptions in the supply chains were considered. In this sense, the EU or its member states can, and some initiatives are already underway, enact due diligence legislation to oblige companies to ensure that minimum standards are met along their supply chains, and that transportation costs cover all the external costs. In the end, if intermediate products produced in countries located far away caused in sum similar costs as goods produced at closer distances, then supply chains would be more local.

In this report, we adopt a definition of economic sovereignty that integrates the definition above with the general tenets of neoclassical theory. In our view, economic sovereignty can be understood as the ability to generate value added and to act within the global market without undue interference by, or imbalanced dependencies on, external actors, but in mutually beneficial cooperation with economic partners under clear and mutually agreed rules. Importantly, economic sovereignty should not be equated to autarky, nationalism or protectionism. Instead (European) economic sovereignty means that the EU has to power and the ability to co-shape the global economic governance.

Supply sovereignty: Resilience and robustness

Within the EU discourse, the term resilience emerged first within the area of development policy and, according to Pospisil (2016), as a result of EU policy failures. In addition, a "development-security nexus" developed with regard to the concept (Pospisil 2016: 238, transl. by the authors), in part due to the merging of EU working groups on the issues of peace and conflict and fragile statehood. As a result, the definition of resilience offered by the European Commission as "the ability of an individual, a community or a country to cope, adapt and recover quickly from stress and shocks caused by a disaster, violence or conflict" (European Commission 2019: 1) illustrates the origin of the EU use of the term within development or security-strategic policy areas. In the context of the EU Global Strategy (EUGS), where the term was first dominantly used (Pacher 2019), resilience mutated into a new paradigm, used to provide a universal answer to various different questions and to forge cohesion between foreign policy, security policy and home affairs (Pospisil 2016: 249f.).[6] Accordingly, scholars have criticised the use of the concept resilience as too ambiguous and, ultimately, empty (Pospisil 2018: 34, see also Juncos 2017, Wagner and Anholt 2016).

[6] Moreover, using the term resilience allowed the European Commission to avoid the term stability: 'There was a conscious effort by the authors of the EUGS not to use the term "stability", preferring instead that of resilience. In the minds of EU policymakers, stability was associated with a policy of tacit support for authoritarian powers' (Juncos 2017: 12, see also Wagner und Anholt 2016: 415ff.).

For this reason, it is necessary to briefly glance into the relevant academic debate, where the notion of resilience was first popularised in the field of ecology and ecological systems in the early 1970s by Holling (1973). At the most basic level, resilience refers to the ability to recover after stress, to endure a greater amount of stress or to endure a given amount of stress with less disturbance. Depending on the definition of stress as well as of recovery and endurance, resilience can therefore relate to stability but also adaptability or transformability in the face on any given, short or long term, change or shock. Academic disciplines using the concept, such as psychology, ecology, economics, engineering, political science or business management have all developed their own concepts of resilience (see Bhamra et al. 2011 or Martin-Breen and Anderies 2011 for broad overviews).

Given both the ambiguity and various uses of the term resilience, on the one hand, and the focus of this report, on the other, we draw on definitions developed for supply chains more specifically. Here, Ponomarov and Holcomb (2009: 131) provide a fairly encompassing definition of resilience as "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function." Here, resilience focuses on both anticipatory and reactive adaptability, i.e., on preparedness, responsiveness and recovery. As Brandon-Jones et al. (2014: 58), point out, however, there is a difference regarding reactive adaptability between *re-establishing* operations within a short timeframe *after* a disruption, and *maintaining* operations *despite* a disruption. Accordingly, they define *resilience* (of a supply chain) "as the ability of the supply chain to return to normal operating performance, within an acceptable period of time, after being disturbed" and *robustness* "as the ability of the supply chain to maintain its function despite internal or external disruptions." These definitions draw on earlier work by Christopher and Peck (2004), who introduced the distinction between resilience and robustness, but also on insights from systems biology, where "robustness is a property that allows a system to maintain its functions despite external and internal perturbations" (Kitano 2004: 826). As Kitano argues, a "system must be robust to function in unpredictable environments using unreliable components. Understanding the origin and principles of robustness in biological systems will help us to put various biological phenomena into perspective; it will also catalyse the formation of principles at the systems level" (Ibid.). In this report, we draw on the distinction between resilience and robustness by Brandon et al. as two ways to operationalise the concept of supply sovereignty.

Technological sovereignty: navigating futures

The concept of sovereignties is probably most often used in the realm of digital and datafied technology[7] as the infosphere and networks have become de-territorialised (Castells 2009); data, the new oil as it is often referred to (Bhageshpur 2019), not being finite, scarce, rivalrous and natural; digital assets being mostly private; digital twins or data doubles (identities in cyberspace) being created, operated and owned by multinational corporations as well as state and other public entities. It is therefore unsurprising that debates focus on digital or technological sovereignty to provide effective, future-proof, democratic forms of control, both de facto and de jure, of the technological (Floridi 2020). In this report, technology and "the technological" are meant not merely as the innovation, manufacturing and deployment of technological artefacts, but as an economic and social complex that involve knowledge, innovation, manufacturing and supply-chain architectures, embedded in complex social, political and global market flows (Sheng et al. 2019). Seen in this holistic way, technology has not only been crucial for the emergence and maintenance of capitalist production but has also been increasingly seen as a means to exert power and prowess.

To understand better the significance, and meaning, of technological sovereignty in the European context, it is worthwhile to distinguish the concept from the somewhat similar notion of leadership. While overlapping, they are not the same. *Technological leadership* is a strategic ambition to initiate and steer commercialisation of technological advances, strategically linking business and technology as well as creating appropriate systems of managing technology research and development.

Technological sovereignty, here, refers to a policy-guiding principle targeted at guaranteeing Europe's ability in determining its unhindered access to certain key technologies and their resources to uphold its democratic governance and to steer the societal development and welfare of European citizens in line with Europe's values, strategic goals and ambitions. Policies foster clear understanding of major technological transformations. The utilisation of classic indicators of innovative capacity (mainly in terms of excellence, time-to-market, knowledge transfer etc.) remain crucial and require steering public and private investment towards developing such capacities utilising geographical and other cultural characteristics that inform and aid public and private ambitions. Against this backdrop our approach to technological sovereignty is

[7] In the past two years, several reports have been concerned with outlining what "technological sovereignty" might mean, such as Bauer and Erixon (2020); Business Europe (2020); Darnis (2020); Gabriel et al. (2020); Schieferdecker and March (2020). Very recently, the topic has also made headway into Austrian policy discussions, see Austrian Council for Research and Technology Development (2021). For this report, the conceptual study by Edler et al. (2020) has been the most informative one even if we apply a more limited definition of technological sovereignty.

procedural as opposed to normative. We use the concept to guide policy action as a process asking questions in different technology domains and addressing different levels of technology readiness (TRL).[8] Framed differently, we suggest based on the discussion and evidence presented in this report to ask questions such as (a) Does this policy decision help guarantee access to this technology in full and at the desired TRL? (b) Does this decision assist in securing full access to all resources required for this technology at the desired TRL? (c) Would investment in or advancement of this technology foster democratic governance and steer welfare? (d) Does investment in or advancement of this technology help better ground our society in European values?

To sum up, to describe the three domains is to identify unique features that are relevant for achieving (and maintaining) sovereignty. In the economic domain, these features are the ability to generate value added and to co-shape the global economic governance. In the domain of supply, these features are robustness and resilience. In the domain of technology, the features are related to values, to data, to innovation and also to norms and standards. Hence, while there are clearly interlinkages between these three domains, the specificities of each domain warrant a separate analysis of each domain. In the next Section (Section 4), the empirical evidence for threats and vulnerabilities in each of the three domains is investigated more thoroughly, while Section 5 will then discuss the ways of how these challenges can be addressed in the Austrian and in the European political system. As mentioned in Section 2, due to limitations in data, of process and of method we mainly focus on threats and vulnerabilities as these can be substantiated in a more conceptual approach and certain conclusions may be derived from the evidence at hand. Such conclusions are less possible regarding a more proactive role in the technological sovereignty discussions; therefore, we refrain from taking strong positions regarding strengths and opportunities for Austrian policy in this regard.

[8] See https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf.

4 Sovereignty challenges

This chapter discusses empirical evidence regarding developments in globalisation and the challenges these present with regard to economic, supply and technological sovereignties. It starts with a discussion of macroeconomic trends regarding trade in service and goods, the role that China played in this development as well as China's increasing importance for foreign trade (4.1). It then discusses in more detail vulnerabilities related to supply chain disruptions but also Austria's and the EU's strategic dependence on the import of critical goods (including raw materials, pharmaceuticals and food) (4.2). Section 4.3 analyses challenges related to and stemming from networked and platformised societies, use and travel of data beyond supply chain logistics.

4.1 Economic trends in globalisation

In the following we discuss general trends regarding global trade, and the role that China played in this development. We focus mainly on trade in goods and only briefly sketch some issues related to services. This has several reasons. First, services are very divers and influenced by very different factors. For example, some services such as transport are closely related to trade in goods. Hence, more local value chains in the production of goods would immediately affect patterns of the connected international transport services. Second, international trade in services also contains cross-border tourism which is unrelated to industrial production. Third, the COVID-19 pandemic influenced trade in goods and trade in service very differently. While both trade in goods and trade in services collapsed in the first months of 2020 when the pandemic started to impact industrial production first in China and then via international value chains worldwide and trade in services was inhibited by travel restrictions, trade in goods recovered quickly.

At the end of 2020, world trade in goods was already higher than before the pandemic, trade in services was sill considerably lower, in particular due to ongoing travel restrictions. Fourth, during the negotiation rounds on the General Agreement on Tariffs and Trade (GATT) and World Trade Organisation (WTO) rules, trade in goods was liberalised to a much greater extent than trade in services. Since 1995, the General Agreement on Trade in Services (GATS) stipulates that WTO member states extend the liberalisation commitments also to services. The last round of negotiations, which is still ongoing, began in 2000. In contrast to agreements on trade in goods, the GATS is less far-reaching. Each WTO member is free to choose the depth of liberalisation (mode of supply) and the sectors to be liberalised. In addition, it can negotiate national treatment restrictions on an individual basis. GATS is not a deregulation agreement, since both public and private monopolies can be maintained if national legislation so provides. The

GATS does not force governments to privatise publicly owned service providers (e.g., water supply). The GATS also does not impose regulations on nation-states on how to formulate safety standards, quality standards, prices, etc. Nevertheless, global trade in services is becoming increasingly important with the rising digitisation, shopping around the globe, and the global transfer of data.

Regarding both trade and industrial policies, China deserves attention for several reasons. First, simply due to its size with the world's largest population, the opening up of the economy and its integration into the world economy was one of the main drivers of globalisation. Second, the other major players in the world economy and in world trade, the US and Japan, share Europe's political and social values. On the other hand, economic and political issues and goals in China are highly intertwined. In contrast to the US, the EU or Japan, China has a socialist economic system with only a small share of private businesses. All large companies are state-owned, allowing the government to pursue political goals with industrial policy measures. A good example in this regard is the "New Silk Road" or "Belt and Road Initiative" (BRI). It was officially launched in 2013 and is now a cornerstone of the economic development and trade strategy of the Chinese government.

Concerning the goals of the BRI, official and unofficial targets may be distinguished. According to the Chinese government, the BRI aims at providing a response to the infrastructure needs of originally more than 60 developing countries, located mainly in Eurasia. Over the course of time, the BRI was more and more extended, now also involving developed countries. Currently, 140 countries are participating in the BRI, of which 40 are located in Sub-Saharan Africa, 34 are in Europe and Central Asia (including 18 countries of the European Union), 25 are in East Asia & the Pacific, 17 are in the Middle East & North Africa, 18 countries are in Latin America & the Caribbean, and 6 are in South East Asia.[9] From a strategic point of view, for the EU of particular relevance is that the list of participating countries comprises candidate and potential candidate countries for EU membership, e.g. Albania, Bosnia and Herzegovina, and Serbia.

The initial aim is to use China's financial and industrial power to build and operate infrastructures such as ports, roads, railways, energy systems, industry and telecommunications networks across the entire Eurasian continent. Beyond Asia and Europe, it even extends to Africa and South America (French Ministry of Economics and Finance: 2018: 1). According to the French Ministry of Economics and Finance (2018: 5-6), the BRI is much more comprehensive than these economic goals. The BRI could help China to secure its supply of raw materials. This involves diversifying supply sources and routes. Furthermore, the initiative should help to reduce the large disparities in per-

[9] https://green-bri.org/countries-of-the-belt-and-road-initiative-bri/.

capita income between the Chinese provinces. A third goal is to diversify China's export markets and help upgrade China's manufacturing industry by reducing transport costs and by increasing China's price and non-price competitiveness. This should also help China to achieve its ambitious market share objectives under the "Made in China 2025" plan. "Made in China 2025" was presented to the public in 2015. It aims at making China a major industrial power, focusing on ten industries: ICT, robotics, aerospace, maritime equipment and shipping, rail infrastructure, new energy vehicles, power equipment, agricultural equipment, new materials and medicine. “Made in China 2025" aims to use government subsidies and state-owned enterprises and acquire intellectual property to catch up with and then surpass Western technological competencies in the above-mentioned high-tech industries (French Ministry of Economics and Finance 2018).

In addition to global trade in goods and services, the international division of profits by multinational companies with the aim of saving taxes has become a major issue in discussions on globalisation. In this regard, Sébastien et al. (2018) mention the OECD’s action plan to combat the erosion of the tax base. Here, the issue is that certain countries offer companies very low business tax rates. Typically, such “tax oases” are small countries with limited needs for physical infrastructure or the provision of public goods. The fight against such tax havens would increase welfare in all countries which now face the threat that companies relocate their business to low-tax countries. Fighting the options of tax evasion and tax avoidance would ensure the tax base and tax income of industrialised countries that otherwise would either have to cut spending on infrastructure, public goods, or social welfare, or shift the tax base more and more towards the factor labour.

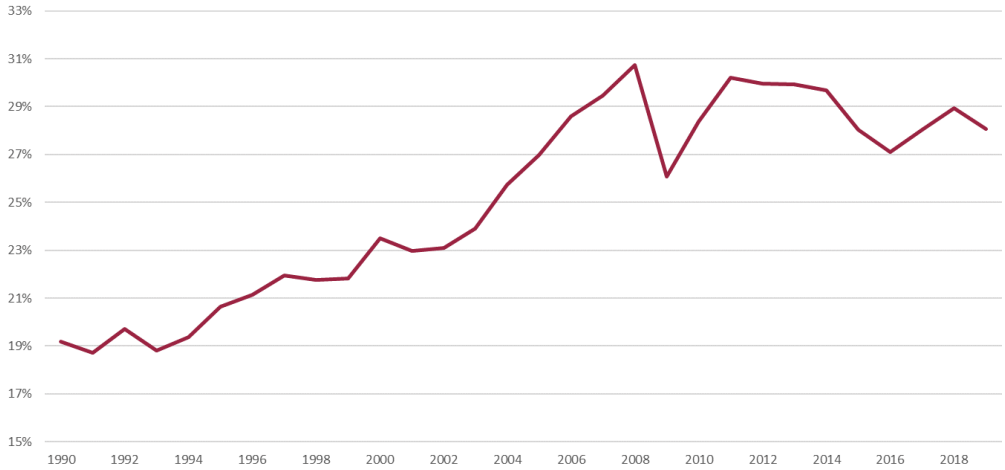
4.1.1 Trends in global trade and the world economy: the end of globalisation?

Past decades were characterised by an increasing globalisation of the world economy. World trade rose much faster than world GDP, implying an increasing openness of the countries. Since 1990 world GDP (in US dollar at current prices) rose by around 400%, while world GDP (defined as the average of world exports and imports) rose by almost 600% (Figure 2). The increasing openness of the world economy is also visible in Figure 3 which shows that the average of exports and imports accounted for around 19% in 1990. By 2008, this openness had risen to 31%. However, both figures show that the Great Recession of 2009 slowed down the trend of ever-increasing economic globalisation.

Figure 2: World GDP and world exports and imports, index, 1990 = 100

Source: World Bank, World Development Indicators; own calculations and illustration

Figure 3: Openness of the world economy

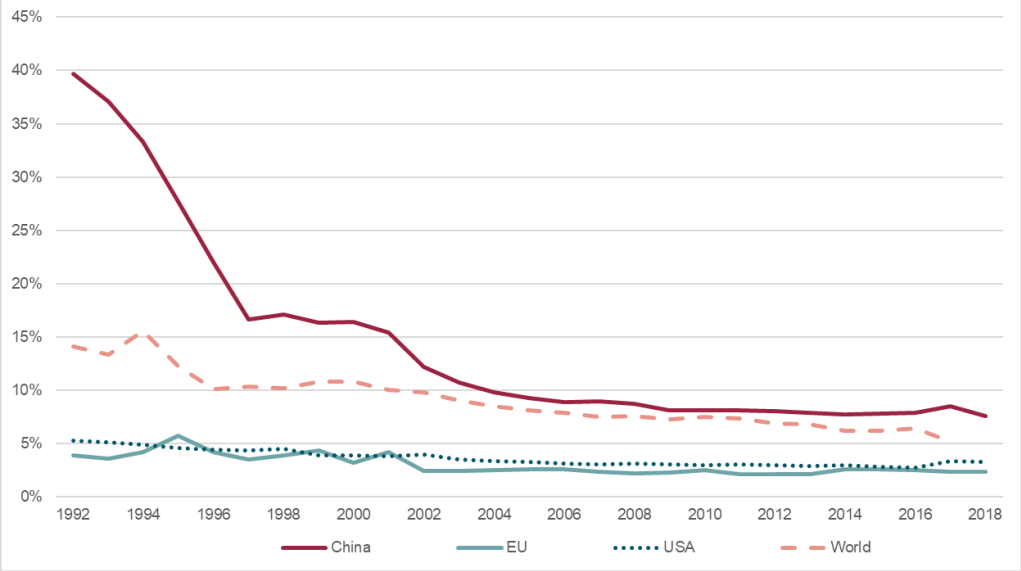


Note: Sum of world exports and imports, divided by twice world GDP; Source: World Bank, World Development Indicators; own calculations and illustration

Two driving forces of the growing globalisation trend, at least until the Great Recession, were the fall of the Iron Curtain in 1989/1990 and the increasing integration of China into the world economy and into global value chains. The integration of China was associated with a substantial reduction of its tariff rates, as shown in Figure 4. These developments enabled companies to reap the benefits of lower production costs outside (Western) Europe. In accordance with the theory of comparative advantages formulated by David Ricardo (1817), countries specialise in the production and export of goods and services in which they have comparative advantages. After the integration of many Asian countries into the world economy, companies located the production of labour-intensive

goods or parts to these countries with a high population. Later on, European companies also imported more medium- and high-tech products from Asia, as these countries were able to produce these products also at lower costs than companies in Europe or North America. This led to the high import dependence of Europe on these products.

Figure 4: Average tariff rates



Source: World Bank, World Development Indicators; own illustration

Although compared to the Great Depression of the 1930s considerably fewer protectionist measures were introduced during and after the GFC, worldwide trade barriers nonetheless increased (Evenett 2019). This becomes especially obvious when not only conventional tariff and non-tariff trade restrictions are considered, but also more subtle, hidden protectionist measures such as rescuing firms to safeguard national interests or manipulating currencies. Despite all their public commitments to open markets, the G20 countries were at the forefront when it came to the introduction of protectionism. The EU countries, as well as Russia, Argentina, India and Brazil, imposed the bulk of the protectionist measures. In the US, the early years of this era saw the use of industrial policy tools such as the Buy American Act provisions in President Barack Obama's 2009 stimulus plan, as well as trade protection tools such as the EU's antidumping tariffs. Although less than one percent of the international movement of goods was actually affected by crisis protectionism in the course of the Great Financial Crisis, this low total figure should not obscure the consequences of these trade restrictions for individual goods that seriously affect some countries (Berensmann and Brandi 2011). After Donald Trump took office as President of the US, global average tariffs rose further. Fuelling this dynamic was both growing mistrust between China and the US and the increased use of foreign economic instruments in pursuit of power policy

goals (see also section 5.1.2). In addition, the WTO has repeatedly failed to modernise the global system of trade rules since its inception in 1995.

Furthermore, scepticism vis-à-vis globalisation through bi- or multilateral trade agreements has increased. This is not only evident in the policies of former US president Donald Trump, but also in the EU, where doubts regarding such trade and investment agreements have grown. Here, the failure of the Transatlantic Trade and Investment Partnership (TTIP) between the US and the EU, is one example[10]. Another example is the trade agreement between the EU and the South American trade bloc Mercosur, currently comprising Argentina, Brazil, Paraguay and Uruguay[11]. In June 2020, the EU and Mercosur concluded negotiations over the Political Dialogue and Cooperation part of their Association Agreement, after the free trade section had been completed in June 2019. With a number of EU member states and civil society organisations voicing concerns about the environmental impact of the deal, its ratification is uncertain in the short-term. At the same time, we see efforts in other world regions to establish large free trade areas: On 15 November 2020, countries in the Asia-Pacific region concluded the Regional Comprehensive Economic Partnership (RCEP), creating the largest free trade area in the world. The negotiations were initiated by the ASEAN states (the Association of Southeast Asian Nations, which is made up of Brunei, Indonesia, Cambodia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam). After more than eight years of negotiations, the ASEAN countries were able to agree on the agreement with China, Japan, South Korea, Australia and New Zealand. The planned trade agreement thus includes 15 countries which account for slightly less than 30% of world GDP, world trade and world population.

The weaker dynamics of global trade in the past few years have been accompanied by a shortening of value chains in the past decade. This means that the share of domestic value added of exports has increased since 2011 for the largest economies and implies that foreign inputs have become less important for the production of domestic goods. This has been particularly pronounced in China, which since at least 2005 has pursued a very active policy of increasing the domestic share in its value added. At the same time as world trade in goods slowed down, global trade in services increased. The same is true for other areas of globalisation such as international flows of data and cross-border tourism (Felbermayr and Görg 2020).

According to a study by the Bavarian Industry Association (vbw 2021), the political and economic changes in the global economy are likely to result in a decrease of the

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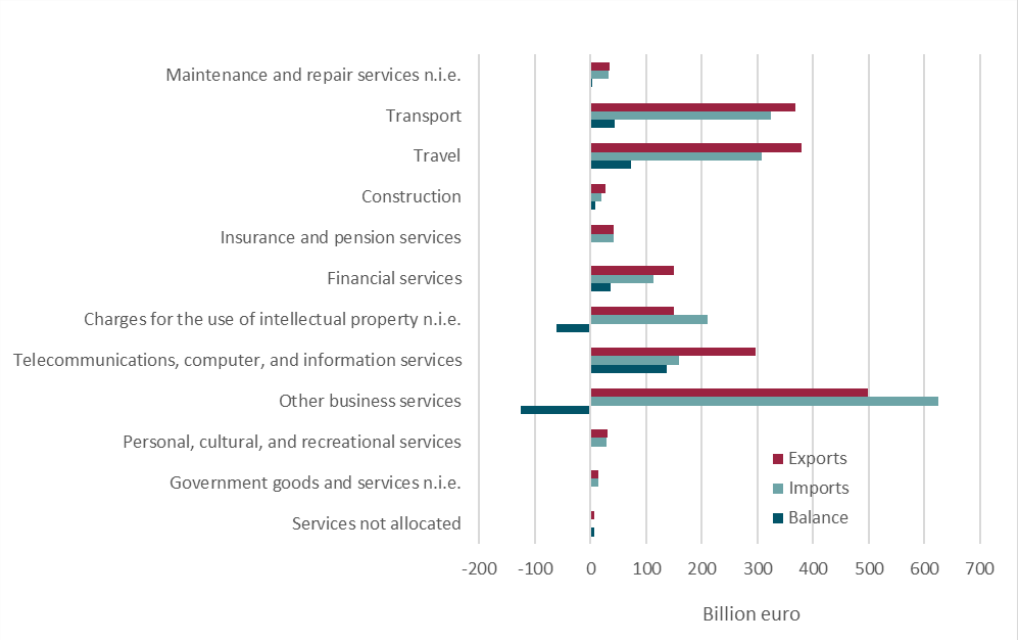
[10] The TTIP negotiations were launched in 2013 and ended without conclusion at the end of 2016. A decision by the European Council of 15 April 2019 states that the negotiating directives for the TTIP were obsolete and no longer relevant.

[11] Venezuela is a full member but has been suspended since December 2016.

economic importance of the "West" (North America plus Western and Central Europe) in the medium term. It remains an important output market, however, not least because of the high starting level. This means that the Chinese economy is growing much faster than the economies of North America or Europe. But since the income level is still much higher in North America and in Europe, even smaller growth rates still represent substantial income, and hence import, growth in absolute value terms. There is particularly large growth potential in the East Asia and Pacific region and, to a somewhat limited extent, in South Asia. The shift in the balance of economic power will also change the (economic) political balance of power. The current world trade order was essentially shaped by the "West", i.e., those regions that will lose economic importance. Together with the long-standing globalisation scepticism and increasing protectionism, there is a realistic danger of de-globalisation. The study hypothesises the formation of a block: China and the Asia-Pacific region as well as Africa on the one side, America, UK, Australia and New Zealand on the other. Since the EU is intertwined with all world regions, joining one of the blocs would have major negative economic consequences.

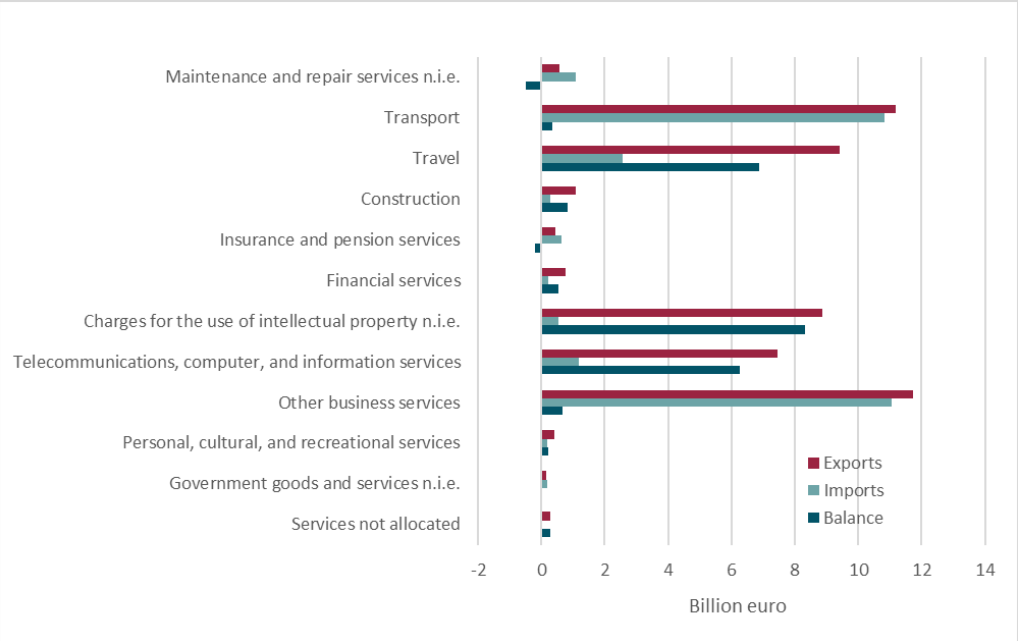
For the EU, trade in services is becoming increasingly important. Both, vis-à-vis the rest of the world in total as well as vis-à-vis China, the EU has a surplus in cross-border trade in services (Figure 5 and Figure 6). Here China might become increasingly a petitory on the world markets, however, since an exporter of machinery and equipment will also export maintenance services. Furthermore, telecommunication services and financial services will also gain in importance in the future. Hence, trade in (high-tech) goods and trade in services are highly interconnected. In contrast to goods trade, some services are more difficult to regulate, e.g., the transfer of data.

Figure 5: EU trade in services with the rest of the world



Source: Eurostat; own illustration.

Figure 6: EU trade in services with China

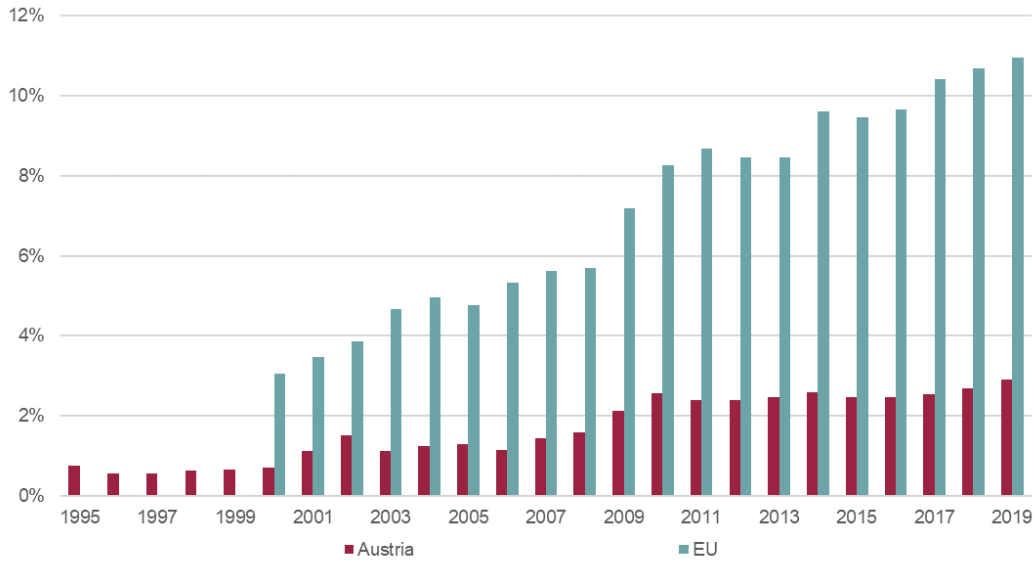


Source: Eurostat; own illustration.

4.1.2 The rising importance of China for foreign trade

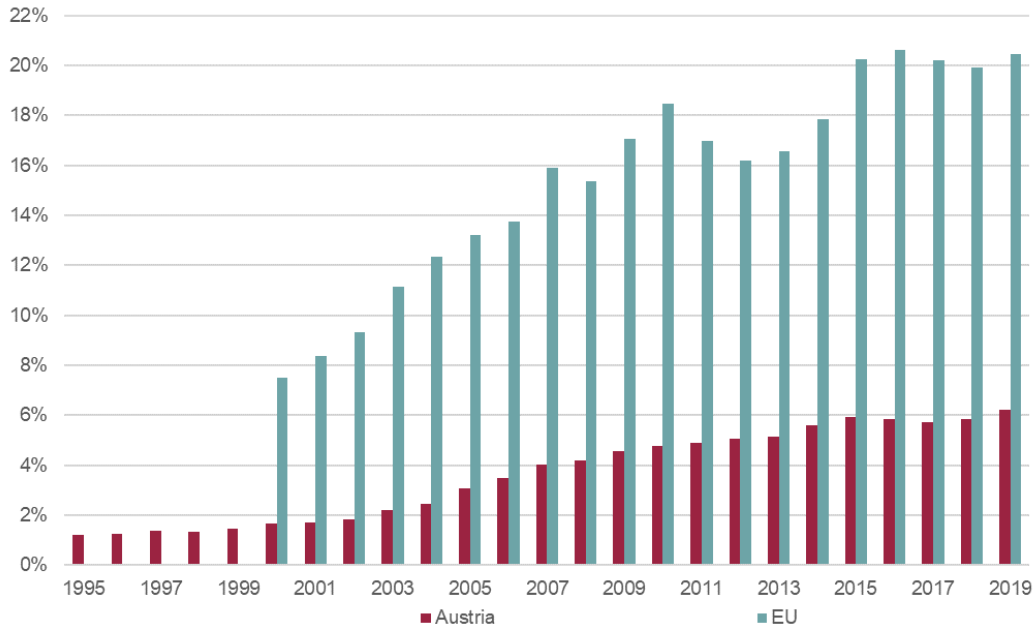
The rising importance of China is visible in its growing share in Austria's and the EU's foreign trade, as depicted in Figure 7 (exports) and Figure 8 (imports).

Figure 7: Share of China in Austria's and the EU's exports



Note: EU: EU28, data only available from 2001 onwards. Source: UN Comtrade; own calculations and illustration

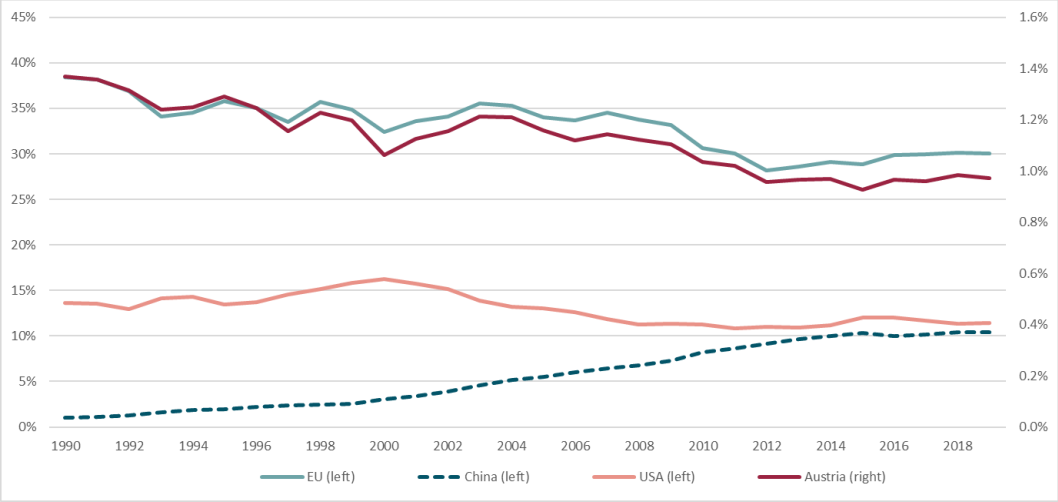
Figure 8: Share of China in Austria's and the EU's imports



Note: EU: EU28, data only available from 2001 on. Source: UN Comtrade; own calculations and illustration

As can be seen, from the early 2000s onwards China became increasingly important as an export market for Europe, but also, and even more so, as supplier of European imports. The rising share of China in world trade at the expense of the US and of Europe is visible in Figure 9. Between 1990 and 2019, the share of China in the world's exports and imports grew from just 1% to more than 10%. During the same time, the shares of the US and of the EU fell from 13.6 to 11.5% and from just below 40% to 30%, respectively. EU exports and imports comprise intra-EU trade. Since the GFC, the shares of the large economies in world trade seem to have stabilised. The share of Austria in world trade moved more or less in parallel to that of the entire EU (Figure 9).

Figure 9: Share of selected countries and regions in world trade



Note: Shown are the shares of the selected economies in world trade as defined as the average of exports and imports.
Source: World Bank, World Development Indicators; own calculations and illustration

According to preliminary data published by Eurostat on 15 February 2021, in 2020 China overtook the US as the EU's most important trading partner regarding the sum of the value of exports and imports (Eurostat 2021). This development was to a large extent driven by the COVID-19 pandemic. China was hit first and recovered quickly, and furthermore China was one of the main suppliers of protective masks and medical equipment. Hence, trade between the EU and China continued to rise in 2020, while trade between the EU and the US as well as the other major trading partners dropped sharply.

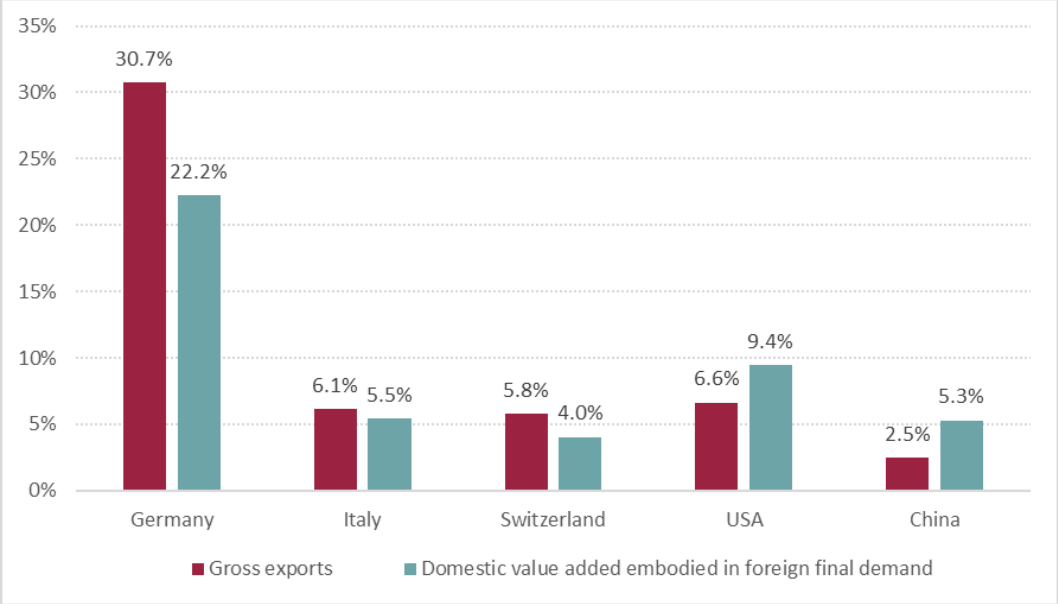
In 2019, China was the EU's third largest export market, behind the US and the UK (Figure 16 in the Appendix), and even the largest supplier of its imports (Figure 17 in the Appendix). For Austria, the direct importance of China is much smaller. Germany is by far Austria's largest export market (Figure 18 in the Appendix), and also the largest trading partner on the import side (Figure 19 in the Appendix). While Germany accounts for 29% of Austria's exports and for 35% of Austria's imports, also the tight export links

with its Eastern neighbours are visible from the figures. Nonetheless, China is already Austria's third largest import partner, placed even before the US and the neighbour countries except for Germany.

The rise of China as a player in the world economy together with its growing importance as an investor in industrialised and developing countries raised concerns of policy makers in some countries. The large deficit in the trade with China has caused the US government to impose additional tariffs on imports from China. Trade between the euro area aggregate and China is almost balanced, with a small deficit in trade with goods and an also small surplus in the services balance of the euro area. On the individual country level, Germany, Ireland and Finland record trade surpluses with China, while the other countries have deficits (Weyerstraß 2019).

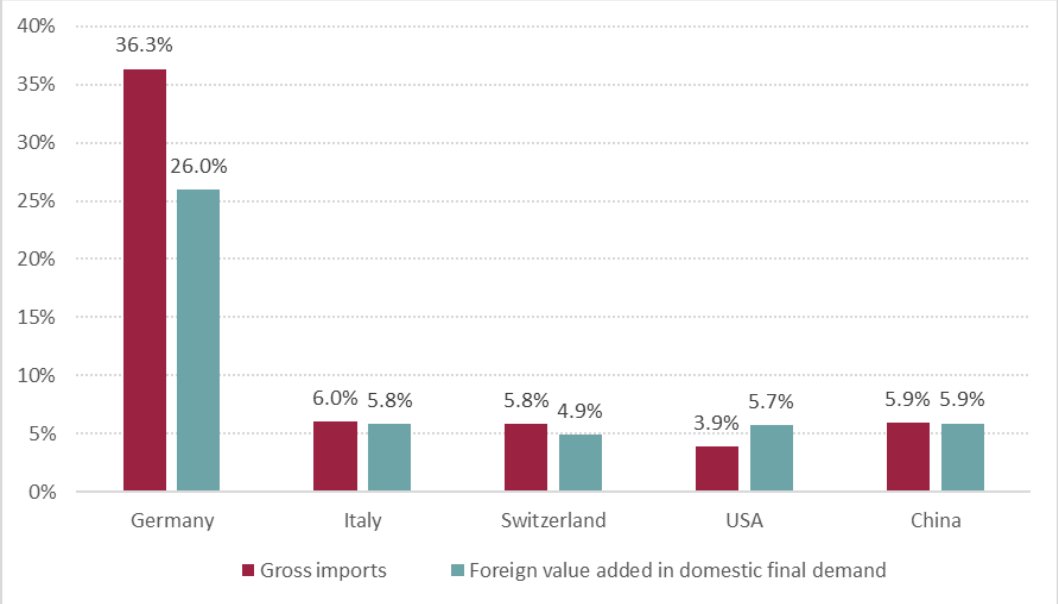
In addition to direct trade links, it is also important to consider indirect links via the value chain. The Organisation for Economic Cooperation and Development (OECD) provides a database with trade in value added that takes the global fragmentation of value chains into account (OECD 2018). The latest version currently contains data until 2015. Based on this dataset, Figure 10 and Figure 11 compare the country structure of Austria's exports and imports, respectively, regarding the gross export and import data with the trade in value added. The importance of Germany declines considerably, while the share of China rises. The trade in value added considers, e.g., that Austria exports parts to German car manufacturers, and a certain share of the German cars are exported to China. Hence, higher demand for Austrian suppliers to the German car industry that is due to increasing demand from China should be attributed to Austria's trade with China rather than the direct links between Austria and Germany. As can be seen, these indirect effects via the value chain are much for exports than for imports.

Figure 10: Austria's export structure in trade in value added (2015)



Source: UN Comtrade; OECD trade in value added; own calculations and illustration

Figure 11: Austria's import structure in trade in value added (2015)



Source: UN Comtrade; OECD trade in value added; own calculations and illustration

4.2 Supply chain vulnerabilities and strategic import dependencies

As Christopher and Peck (2004) point out, the term supply chain is fairly ambiguous. It is, for example used to describe "integrated manufacturing and/or logistics activities within a single firm's manufacturing, transport, distribution or retail network" but can also refer to "an organisation's supplier base". The authors therefore suggest basing the definition on an end-to-end perspective on the flows of product from the source of raw materials to the end consumer. Accordingly, they define a supply chains as: "the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer" (Ibid 4). In this definition, the network character of supply chains is crucial. Rather than linear chains or processes, modern supply chains are characterised by "product and information flows that travel within and between nodes in a variety of networks that link organisations, industries and economies" (Ibid).

4.2.1 Supply disruptions

In the age of the globalised economy, the supply chains of companies are long, complex and spread globally. As a result, they are vulnerable to various types of disruptions in different geographical areas.

"Recent experiences from the last decade such as earthquakes, tsunami, economic crises, political instability, supplier bankruptcy, SARS, strikes, terrorist attacks show that the severity and complexity of supply chain disruptions are increasing at an alarming rate and thus imposing threat on market share and enterprise existence" (Ali and Nakade 2014: 81).

"Despite increased attention from academia and industry, the frequency and impact of disruptions remains stubbornly high" (Brandon-Jones et al. 2014: 55).

As a recent report from the McKinsey Global Institute (Lund et al. 2020) based on interviews with experts in four industries (automotive, pharmaceuticals, aerospace, and computers and electronics) shows these industries have experienced supply disruptions lasting a month or longer every 3.7 years on average. Shorter disruptions have occurred even more frequently.

Note that disruptions and delays are only two of the risks potentially affecting global supply chains. Christopher and Peck (2004), for example, distinguish between risks internal to the firm (affecting process and/or control), external to the firm but internal to the supply chain network (affecting supply and/or demand) and risks external to the network. Chopra and Sodhi (2004), by contrast, distinguish between six different types

of risk companies may face regarding their supply chains. Since we focus in this report on policy options rather than managerial decisions, we distinguish in the following between three fundamental causes of supply chain disruptions.

Disruption of goods supply due to production interruption on supplier side

The first is a disruption to the production of goods on the supplier side, which can result in a contagion along the supply chain. Such a disruption can be local, as for example in the case of supplier bankruptcy, a fire in a production site, or a terrorist attack, or affect a wider but limited geographic area as in the case of the severe floods in the Chao Phraya river basin north of Bangkok, Thailand, or the earthquake in eastern Japan, both in 2011, and still have a devastating effect on specific supply chains. For example, in March 2000, lightening hit a power line in Albuquerque, New Mexico, resulting in a fire at a Royal Philips electronics plant, destroying or damaging the stock of millions of microchips. As a result of the local fire, a mobile phone customer of the plant, Telefon AM L.M. Ericsson lost access to its main supply of microchips, resulting in a loss of $400 million in sales (Chopra and Sodhi 2004). Yet as the COVID-19 pandemic has demonstrated, such disruptions can also be widespread and even global affecting production within the EU as well. In early March 2020, China, Korea, Italy, Japan, US, and Germany were among the countries with the highest number of reported cases. These six countries account for, about 55% of world supply and demand (GDP), about 60% of world manufacturing, and 50% of world manufacturing exports (Baldwin and Tomiura 2020).

Disruptions due to limitations of movement of people and goods

A second cause of disruptions are limitations to the movement of people, impacting trade in both services and goods. This is especially the case regarding the COVID-19 crisis, where restrictions to the movement of people have an impact on supply chains especially in labour-intensive industries as, for example, in the food industry. Lockdowns as well as border closures reduce the availability of seasonal workers for planting and harvesting in the fruit and vegetable sector. Distancing rules and other health and safety measures add to the disruptions in the food processing industries. Here, meat processing, for example, seems more sensitive to disruptions mainly due to the labour-intensive nature of the operations, while the grain processing industry, characterised by greater automation, has been less affected (OECD 2020a). Global Chinese food exports, for instance, decreased by 17% between January-February 2019 to January-February 2020. This decline is mainly due to a decline in food production in highly labour-intensive sectors such as fish meat (26%) and crustaceans (25%), rice (18%) groundnuts (31%) or oil seeds and oleaginous fruits (22%) (Espitia et al. 2020: 8f.).

In addition, delays at the border, resulting for example from increased monitoring and inspections, as well as transport and logistics bottlenecks have affected food supply

chains, most importantly for perishable high-value products, such as fruits and vegetables. Cereals, by contrast, have been less affected by disruptions because they can be loaded, shipped and handled with minimal labour input (OECD 2020a). This points to another major disruption to supply chains caused by restrictions to the movement of people, namely in the transport and logistics sector.

Maritime transport

80% of the global merchandise trade is transported by sea. Moreover, container trade is highly concentrated on a limited set of maritime routes, with a small number of central ports both within and outside of the EU acting as the main hubs (Heiland and Ulltveit-Moe 2020, see Table 1).

Table 1: Top 10 ports in terms of direct connections and their importance for global trade

Port	Country	Connected ports	No of country pairs shipping through	% of global trade passing through
Port of Singapore	Singapore	158	3,517	32%
Port Klang	Malaysia	109	1,172	13%
Port of Algeciras	Spain	98	3,351	18%
Busan New Port	Korea	95	1,526	32%
Port of Hong Kong	China	88	989	20%
Port of Shanghai	China	87	420	18%
Port of Antwerp	Belgium	86	1,831	19%
Port of Shekou	China	83	558	19%
Port of Tanjung Pelepas	Malaysia	82	1,719	17%
Rotterdam Maasvlakte	The Netherlands	78	2,268	21%

Source: Heiland and Ulltveit-Moe (2020).

Given the high interconnectivity of shipping routes, disruptions to operations of individual ports reverberate throughout the system, affecting not only direct trading partners of countries implementing restrictions. During the first Covid-19 pandemic lockdown in China, the number of inactive container ships increased dramatically in East Asia and the Pacific, while exporters elsewhere were limited by a lack of containers (Skerritt 2020). As a result, container prices have increased, and in some cases considerably so, which creates flow-on effects for the price of cargo, including food products (OECD 2020b: 4).

By mid-April 2020, not only all of the central ports listed above had implemented some form of restriction, mainly in the form of limiting crew change, mandatory screening or quarantines, but so had 120 out of 126 countries: 92 countries had prohibited crew changes completely, while in the other 28 countries, crew changes were subject to tests and approval from the authorities (Heiland and Ulltveit-Moe 2020). In addition, lockdowns or port closures as well as other health and safety measures caused further shipping congestions and delays, for example with regard to loading and unloading of cargo or the introduction of additional documentation requirements and examination. These delays were only partially offset by some countries setting up "green lanes" at ports of entry. As of mid-March 2021, the situation is somewhat more relaxed, but crew changes are still impossible in 30 countries, while 78 make crew changes dependent on screening (Inchcape Shipping Services 2021). Given that crew changes amount to around 100.000 per month globally (Daniel 2020) and are necessary to comply with work contracts and labour regulations, the disruption to global sea transport is considerable.

The discussion above draws mainly on experiences in the context of the COVID-19 pandemic and disruptions to supply chains related to restrictions to movement due to governmental health and safety measures. The recent complete blockage of the Suez Canal due to a grounded container ship (the Ever Given), however, powerfully demonstrated the general vulnerability of just-in-time delivery to disruptions in the important maritime transport sector. While such complete blockades of maritime routes are rare events, their implications can be substantial. Experts differ in their assessment of the economic costs of the blockade. The German insurance company Allianz estimated the costs for global trade at 6 to 10 billion Euro per week and a reduction of annual trade growth by 0.2 to 0.4 percentage points. According to Lloyd's List, the blockage held up an estimated $9.6 billion of trade along the waterway each day, equating to 400 million US dollar and 3.3 million tonnes of cargo an hour, or 6.7 million US dollar per minute. [12] Calculations by other experts, by contrast, are much lower, but still at overall 1.5 to 2 billion euro. [13]

Air cargo

Unavailability and delays affecting maritime transport, in turn, increased the demand for air cargo, while supply plummeted as a result of the drop in passenger air travel (around 70% of air cargo is normally transported via passenger planes). In Mai 2020, global air cargo capacity was overall 26% lower than during the same period in 2019, with capacity mainly affected on routes between Europe and Latin America (declines of more than

[12] Mary-Ann Russon, The cost of the Suez Canal blockage, BBC News 30.03.2021, at: https://www.bbc.com/news/business-56559073.

[13] Der Standard, Containerschiff Ever Given nach Blockade freigelegt, Suezkanal wieder befahrbar, 29.03.2021, at: https://www.derstandard.at/story/2000125429579/suezkanal-blockade-containerschiff-ever-given-freigelegt.

80%; OEDC 2020a). The simultaneous increase in demand and drop in supply resulted in a steep rise of the price for air cargo. Air freight costs on routes between China, North America and Europe increased between 30 and over 60% in March 2020 compared to 2019 prices (OECD 2020b, citing Curran 2020).

Crossroad truck transport

Crossroad truck transport in Europe, by contrast, was affected in the first instance by a severe drop in demand, as non-essential industries were effectively shut down. This resulted in over 50% less truck traffic in Spain in early April 2020, 46% in France and 37% in Italy compared to the pre-crisis period. Overall, truck traffic fell by 24% across Europe (OECD 2020a: 4f.). At the same time, border closures (effectively suspending Schengen rules) as well as measures such as inspections, screening, social distancing etc. have resulted in long border waiting times and delays. The EU responded with a number of emergency measures such as the March 2020 guidelines issued by the European Commission (2020a) regarding "green lanes" to let trucks transporting goods pass through fast-track border crossings or allowing workers in critical occupations (including seasonal farm workers) to travel to their workplaces, complemented by additional guidelines regarding migrant workers in July 2020 (European Commission 2020b).

Shortages due to national regulation, e.g., requisitioning of goods or export limits

A final reason for disruptions to supply chains has less to do with disruptions to production or transport problems, but is the result of governmental policies regarding both the requisitioning of goods intended for export or general export limits, as the following examples illustrate (see Fiorini et al. 2020 for details):

On 2 April 2020 the Trump administration invoked the 1950 Defense Production Act. The Act provides the federal government with unfettered authority to direct the output of US companies in the national interest in case of a national emergency. It was followed by a presidential memorandum on 3 April that instructed federal authorities to assign health and medical products that were, or threatened to be, in scarce supply, to domestic use. This concerned, for example, the export of respirators intended for customers in Canada and Latin America. The conflict was, partially, resolved with a temporary final rule issued by US Federal Emergency Management Agency (FEMA) that prohibited the export of scarce medical products without FEMA authorisation, but included an exception for exports of personal protective equipment conditional on existing export agreements and at least 80% of the US output being allocated to the US market.

A number of EU countries implemented similar measures affecting both other EU members as well as third countries. On 5 March 2020, for example, French authorities

requisitioned the entire stock surgical masks of a Swedish multinational firm (Mölnlycke) warehoused in a distribution centre in Lyon and intended for customers in various other European countries, among them 1 million masks purchased each by Italian and Spanish customers. The seizure was based on a presidential decree by president Macron published two days earlier, which provided the legal basis for a requisitioning of all surgical masks and respirators stocked or produced on French soil and their redistribution among medical staff and French citizens affected by COVID-19. Similarly, in late March Italian custom authorities requisitioned large shipments of surgical gloves and intubation devices intended for further transport to, inter alia, France. The legal basis for the seizure was governmental decree issued on 17 March 2020 which authorised the head of the Civil Defence to order the requisition of almost any good needed to address the COVID-19 emergency.

Exports limits or bans, for example on surgical masks were also (temporarily) applied by Bulgaria, the Czech Republic, France and Germany (OECD 2020c: 8) Germany and France enacted barriers to the export of respiratory masks and other medical items in early March 2020, disregarding the rules of the European single market. Following protests by other countries including Austria, the European Commission solved the situation by allowing export controls on third countries in exchange for removing these restrictions on intra-European trade. This measure could well be covered by current WTO law (see also section 5.1.2), but it puts European trading partners under pressure. Evenett (2020a) shows that more than 50 countries introduced such measures, criticising the strategy of using export restrictions to improve the availability of critical medical supplies domestically in the short term as a "Sicken-Thy-Neighbour-Policy."

In fact, the introduction of such restrictions does not change the fundamental problem of a lack of international production capacity for certain medical devices that are currently in high demand. On the contrary, such measures prevent output-maximising production based on the division of labour (Felbermayr and Görg 2020). Export restrictions treat critical goods as a zero-sum game. Clearly, export limits or restrictions can maximise the domestic availability of a product or good, but domestic availability may not be enough to meet domestic demand. In turn, they prevent other countries from gaining access to the required amounts of such goods, and thus provide a reason for such countries to respond by placing export restriction on the same or other urgently needed goods or on production inputs. Overall, export restrictions are therefore likely to reduce the global supply leading to higher prices due to government actions triggering a “multiplier effect” of trade policy (Espitia et al. 2020): As different exporters face the same shock and have similar incentives to insulate the domestic market, their simultaneous behaviour has aggregate consequences. Rising prices on the global market induce further export restrictions as governments strive to maintain stable domestic

supply and prices. Studies analysing the impact of export restrictions implemented as a reaction to the shocks to the food market in 2006/7 and 2008/11 found, for example, that, on average, uncooperative trade policies resulted in an average increase in global food prices by 13% (Giordani et al. 2016) and were responsible for 45% of the increase in the world price of rice and 30% of the world price of wheat (Martin and Anderson 2012).

4.2.2 Strategic dependencies on critical goods

While the previous sections addressed challenges related to a temporary disruption of existing supply chains, this section addresses strategic import dependencies of Austria and the EU with regard to critical goods. According to Zenglein (2020), the EU is strategically dependent on a specific source of import if the EU is a net importer of a good, the EU imports more than 50% of that good from the specific source, and this source controls more than 30% of the global market for that good. This definition is also used by others, e.g., by Rogers et al. (2020). This definition differs from the use of "strategic" in similar contexts. The Strategic Forum on Important Projects of Common European Interest (IPCEI) established by the European Commission, for example, identified a list of 31 "strategic value chains" for "Europe's industrial competitiveness, climate ambitions, strategic autonomy and security" (Strategic Forum 2019a: 104-5, see also Strategic Forum 2019b). Here, criteria for a value chain being "strategic", are "technological innovativeness", "economic and market potential" and "societal and political importance for Europe" (see also Section 4.3.1).

Note also that although often used interchangeably, critical and strategic dependence should not be equated. Zenglein refers to "critical strategic dependence […] when limited access to a product category can disrupt a country's economy or leave it otherwise vulnerable. This needs to account for the required technology, know-how, costs, and time required to build up alternative sources for vital industrial production" (Zenglein 2020: 6). The term critical (also often termed essential) goods is more ambiguous and variously defined. The European Commission, for example, similarly uses economic importance and supply risk as the two main parameters to decide which materials are critical for the EU (see below). Others refer to critical or essential goods in relation to supplies needed in the context of disaster management and response (World Customs Organization n.y.). In our analysis of options to achieve robustness (see section 5.2), we define critical goods as those goods where even a short supply disruption is not acceptable.

Strategic and critical dependence on imports from China

Based on the definition above, the EU was, in 2019, *strategically dependent* on imports from China in 659 out of around 5,600 product categories defined in the UN Comtrade

database. These imports accounted for 43% of the value of the EU's total imports from China. The ten most important product categories, i.e., the products with the largest EU dependence on imports from China, are (1) mobile phones, (2) data processing machines, (3) communication devices (excl. phones), (4) digital processing units or optical readers, (5), electrical static converters, (6), photosensitive electronics incl. LED and photovoltaic cells, (7), video game consoles, (8), footwear (other than sportswear), and (10) printed circuit boards (Zenglein 2020: 6). Six out of these ten product categories are, at least in part, consumer goods or consumer electronics. Although they are important from the viewpoint of consumer welfare and choice of consumption goods, these products are hardly relevant when it come to the assessment of *critical* strategic dependence from China (Ibid.) as defined above.

Overall, the EU's critical strategic dependence on China is generally limited. There are 103 product categories in electronics, chemical, minerals/metals, and pharmaceutical/medical products in which the EU has a critical strategic dependence on imports from China. Most of these products are concentrated in technologically less sophisticated parts of the value chain (Zenglein 2020: 7). In these areas, the high dependence on imports in China is simply the result of the companies' cost-minimising globalisation decision, just as the theory of comparative advantages of David Ricardo (1817) would predict. This is especially the case for the electronics sectors, where the EU's critical strategic dependence is the highest (see Table 5 in the appendix). It should be noted, however, that in these product categories the strategic dependence on China is not due to the fact that these products are technologically highly complex, but just due to the high costs that would arise for the establishment of alternative, and especially domestic, supply chains. Capable Chinese manufacturing has a competitive advantage regarding critical inputs that can be found in the early stages of supply chains for many products, including essential parts of many high-tech electronic products. "As an example, even the most advanced micro chip is useless without a proper printed-circuit board (PCB) and accompanying diodes, optoelectronics, or resistors, and these components are mainly imported from China" (Zenglein 2020: 7).

Raw materials

In addition to the specific dependence on China discussed above, the EU is also strategically dependent on many raw materials. This dependency is not the result of production cost-related business decisions by companies, but of the global distribution of raw material deposits. Since 2011, the EU regularly publishes a list with critical raw materials and their main exporting countries. The most recent update was published in 2020 (European Commission 2020c). The assessment is based on data for the most recent complete 5-year period for the EU without the United Kingdom (EU-27). It analysed 83 materials and assessed critical vulnerabilities within the supply chain,

distinguishing between extraction and processing. The decision if a material is critical for the EU was made on the basis of the two parameters: economic importance and supply risk. Hence, a material which is produced only in one country, but only used for very few products in the EU or that can easily be substituted by another good might be regarded critical in the parameter supply risk but is hardly of economic importance. Hence, only those intermediate goods or raw materials that are highly used in the EU or which cannot easily be substituted and for which also the risk of disruptions in supply is high are of critical importance for the EU. On this basis, supply risk considers the following aspects: concentration of supply to a very small number of countries, governance risks in the supply countries (including political risk and the observance of human rights), the respect for environmental standards in the supply countries, the possibility of substituting raw materials by recycling products that are already in use in the EU, the reliance of the EU on imports, and export restrictions imposed by the supplying countries. The 2020 EU list contains 30 materials, shown in Table 2.

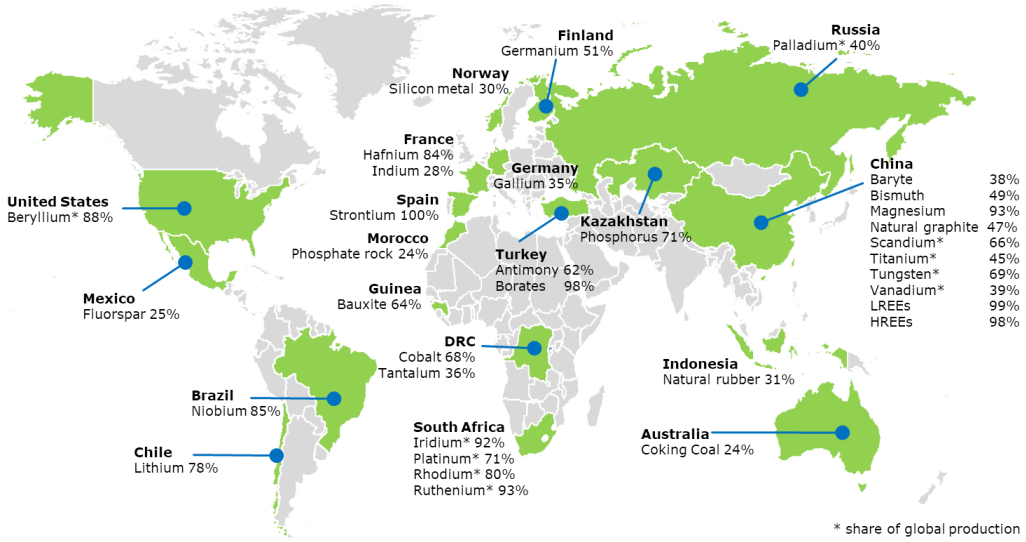
Table 2: 2020 Critical raw materials (new as compared to 2017 in bold)

Antimony	Hafnium	Phosphorus
Baryte	Heavy Rare Earth Elements	Scandium
Beryllium	Light Rare Earth Elements	Silicon metal
Bismuth	Indium	Tantalum
Borate	Magnesium	Tungsten
Cobalt	Natural Graphite	Vanadium
Coking Coal	Natural Rubber	**Bauxite**
Fluorspar	Niobium	**Lithium**
Gallium	Platinum Group Metals	**Titanium**
Germanium	Phosphate rock	**Strontium**

Source: European Commission (2020c: 3)

For most of these products, the EU relies heavily on a very small number of exporters. This is visualised in Figure 12 which has been extracted from the list published by the European Commission (2020c: 4, see also Table 6 in the appendix). It is evident that the supply of many critical raw materials is highly concentrated. This is, for example, the case for rare earth elements (REE) (98% of EU imports from China), borate (98% from Turkey) iridium or platinum (93% and 71% from South Africa). The EU also relies on single EU companies for some of its supplies, for example for its supply of hafnium and strontium.

Figure 12: Largest suppliers of EU critical raw materials

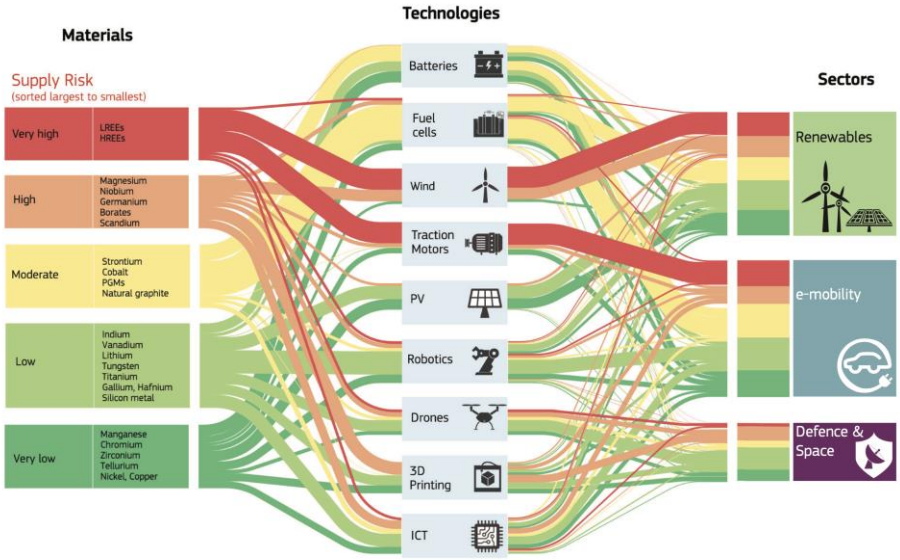


Source: European Commission (2020c).

The EU's dependence on critical raw materials, being already high, will rise further in the coming decades. This is due to the intensification of electrical mobility as well as the aim of reducing greenhouse gas emissions. The European battery, motor and wind generator production, for example, currently depends on imports of graphite (48% of imports from China), cobalt (68% of imports from the Democratic Republic of Congo), lithium (78% of imports from Chile) in addition to rare earths (almost 100% of imports from China). According to EU projections, for electric vehicle batteries and energy storage, the EU would need up to 18 times more lithium and 5 times more cobalt in 2030, and almost 60 times more lithium and 15 times more cobalt in 2050, compared to the current level. Demand for rare earths used in permanent magnets, e.g., for electric vehicles, digital technologies or wind generators, could increase tenfold by 2050 (European Commission 2020d: 18). At the same time, worldwide demand for these materials will also rise due to population growth, industrialisation, decarbonisation of transport, energy systems and other industrial sectors, increasing demand from developing countries and new technological applications. Yet the supply of raw materials depends on a variety of factors (European Commission 2020e). As a result, increasing demand does not necessarily translate into a future supply bottleneck. Increased demand may indeed lead to higher prices, making, in turn, investments in the extraction of raw materials, but also in substitution and recycling, commercially more attractive and viable. "On the flip side, currently low prices for some materials may make investment in future capacity less attractive, considering that those investments require a high capital investment over a long period" (Ibid.: 9). The study (ibid.) provides a good overview over the supply risks

regarding different raw materials, as well as their use in important current and future technologies and sectors (summarised in Figure 13)

Figure 13: Semi-quantitative representation of flows of raw materials and their current supply risks to nine selected technologies and three sectors



Source: European Commission 2020e: 9, for details see the study's Annex 1 - Methodological notes

This projection is in line with those of other international institutions. Arrobas et al. (2017) project that demand for metals and minerals increases rapidly with climate ambition. The most significant example of this is electric storage batteries, where the rise in demand for relevant metals, aluminium, cobalt, iron, lead, lithium, manganese and nickel would grow by more than 1,000% by 2050. The OECD (2019) forecasts that, despite improvements in materials intensity and resource efficiency and the growth in the share of services in the economy, global material use will more than double from 79 billion tons in 2011 to 167 billion tons in 2060. While this figure includes uncritical materials such as construction materials and wood, for metals the OECD projects an increase from 8 to 20 billion tons in 2060. The EU is between 75 and 100% reliant on imports for most metals.

Pharmaceuticals and medical equipment

As the COVID-19 pandemic has shown, the EU also relies on imports of pharmaceuticals. medical devices such as personal protective equipment, including masks and artificial respirators, as well as related products. In response to shortages, member states have taken initiatives to manufacture and distribute medical devices, and the EU has taken a number of coordinated actions, including creating a stockpile of rescue equipment for

emergency responders and restricting exports of personal protective devices outside the European Union. A mapping of EU trade in four product categories (pharmaceuticals, medical devices, personal protection, and medical supplies) shows that in all four categories, only five trading partners supply about 75% of EU imports (Hallak 2020). The EU's top import partners are Switzerland, the United Kingdom, the US, China and Singapore.

For Sweden, a recent report on "resilience through trade" by the Swedish Board of Trade comes to a similar result. A calculation of Swedish diversification indices for pharmaceuticals and medical equipment/personal protective equipment based on the Hirshman-Herfindahl index pointed out potential risks due to a low, below average level of diversification in the former (Kommerskollegium 2020: 24f.).

Regarding the supply of pharmaceuticals, a distinction can be made between direct and indirect imports. Regarding the former, it needs to be noted that the EU already imports most of its *pharmaceuticals* from within the EU (62.5% measured in Euro value from within the EU27, 13.3% from Switzerland, and 3.9% from the United Kingdom). It relies less on the US (8,8%), China (2.4%), Singapore (2.4%) or India (1.3%) (based on Eurostat data for 2019 [Eurostat 2021]; calculations in Erixon and Guinea 2020: 5). The numbers change slightly when based on volume rather than value. The vast majority of EU27 imports of all pharmaceuticals (in volumes) are still from Europe (71.3%) with 64.2% from the EU27, 5.2% from the United Kingdom, and 1.9% from Switzerland. Reliance on the US is smaller when measured on volume (4.0%), but greater for China (14.4%).

Similarly, human medicinal products (68.9% from EU27 vs. 0.3% from China, in value, 85.5% from EU27 vs. 0.3% from China, in volume), finished pharmaceutical products (68.1% from EU 27 vs. 0.3% from China, in value; 85.7% from EU27 vs. 0.3% from China, in volume) as well as vaccines (80.9% from EU27 vs. 0.05% from China, in value, 95.0% from within EU27 vs. 0.05% from China, in volume) are mainly imported from within the EU27.

The EU is, however, more dependent on direct imports from China when it comes to Active Pharmaceutical Ingredients (8% in value, 22.5% in volume) as well as antibiotics (7% in value, 10.3% in volume).

In short, the data suggests that EU supply regarding most types of pharmaceuticals or medicines is already somewhat resilient to economic shocks *outside* of the EU and Europe (including Switzerland and the UK), at least with regard to *direct* imports. Two aspects are important, however.

First, direct imports from outside of the EU27 concern specific pharmaceuticals, medicines or, especially, active ingredients that may need to be labelled as either critical

or strategic or both. This is, for example, the case for Heterocyclic compounds containing pyrimidine ring or for vitamin B, both active pharmaceutical ingredients, and for Chloramphenicol, an antibiotic, where the EU is strategically dependent on imports from China (Zenglein 2020: 7).

Second, additional insight into the manufacturing value chains in the chemical and pharmaceutical sectors in the EU's top five import partners (Switzerland, the United Kingdom, the US, China and Singapore) also suggests that China and other countries account for a much larger share of raw materials and intermediate goods than *direct* imports would suggest. Based on 2015 data from the OECD for the chemical and pharmaceutical sector, around 29% of primary, and around 38% of intermediate goods that are *used by the EU's largest import partners* originate from China; 56% and 34% from other countries, respectively (Hallak 2020: 7). In other words, the main countries the EU imports from, import their own supplies to a large extent from China and other countries, thus potentially increasing EU dependency indirectly. As an example, the COVID-19 pandemic has shown how diverse the supply chain for the production of vaccines is. These results suggest not only that chemical and pharmaceutical production is far more dispersed than the direct import figures suggest, but also that the EU is more dependent on the import of critical materials and goods from China in this sector, even if mainly indirectly (Ibid.).

Food

Overall, the Covid Pandemic did not result in any severe food shortages in Austria or the EU. Shortages during the early period of the outbreak and the first lockdowns were mainly due to excessive private stockpiling of specific food types and not due to supply shortages. In addition, some specific food items were in low supply at the retail level beyond the initial panic purchases, such as fresh yeast. While the raw materials were in ample supply, producers were not able to meet the much-increased demand for yeast due to bottlenecks during packaging process caused by a shortage of packaging foil (Laufer 2020). Finally, food availability was also negatively affected by restrictions to the movement of people (see also section 4.2.1), for example through lockdowns, distancing rules as well as other health and safety measures. As a result, farm and food processing labour shortages caused delays, further exacerbated by disruptions to domestic (as well as European and global) transport and distribution channels.

Indeed, as Juegen Voegele, Vice President for Sustainable Development at the World Bank, pointed out in early April 2020, "[p]roduction levels and global stocks for staple foods are at an all-time high and world prices for most food commodities have been remarkably stable since 2015" (Voegele 2020). Importantly, the situation during the COVID-19 pandemic differs substantially from the two most recent world food prices in

2007/8 and 2010/11 (others put them at 2006/7 and 2008/11) hikes insofar as production levels for all major staples (wheat, rice, maize) are above average compared to the last five years. In addition, oil prices are low and global food stocks at historic heights. By contrast, recent food price spikes were in part caused by low global food stocks, high oil prices and significant weather-related declines in production.

Numerous countries are, however, experiencing high food price inflation at the retail level, which reflects both, ongoing supply disruptions due to social distancing measures and currency devaluations and other factors. While global food prices rose by close to 20% between January 2020 and January 2021 (De Préneuf 2021), data supplied by the UN Food and Agriculture Organization (2021) indicates that food prices in Austria increased comparatively moderately, by 3.5% between mid-February 2020 and mid-March 2021.

A detailed analysis, conducted jointly by AgrarMarkt Austria and Johanneum Research (Kleb et al. 2015) in 2015 analyses the Austrian value chains within the food sector, also pointing out critical import dependencies. Starting at the beginning of the food value chains, the report notes that Austria is highly dependent in imports for potassium and phosphorus (see also the section on raw materials) for the production of mineral fertilisers. While potassium is mainly imported from Germany, Austria depends on imports of phosphorus mainly from Morocco (90% of imports, see also above), and to a smaller extent from Jordan, South Africa and China. In addition, the report identified the import of natural gas as essential for the production of nitrogen fertilisers. Thus, despite overall sufficient production of fertilisers in Austria and large export volumes, "domestic self-sufficiency in the true sense of the word is not conceivable for industrial fertilizers" (Kleb et al. 2015: 20). This is even more the case for pesticides, which are mainly imported from Germany and the Netherlands, but where production relies on raw materials and active ingredients mainly supplied by China.

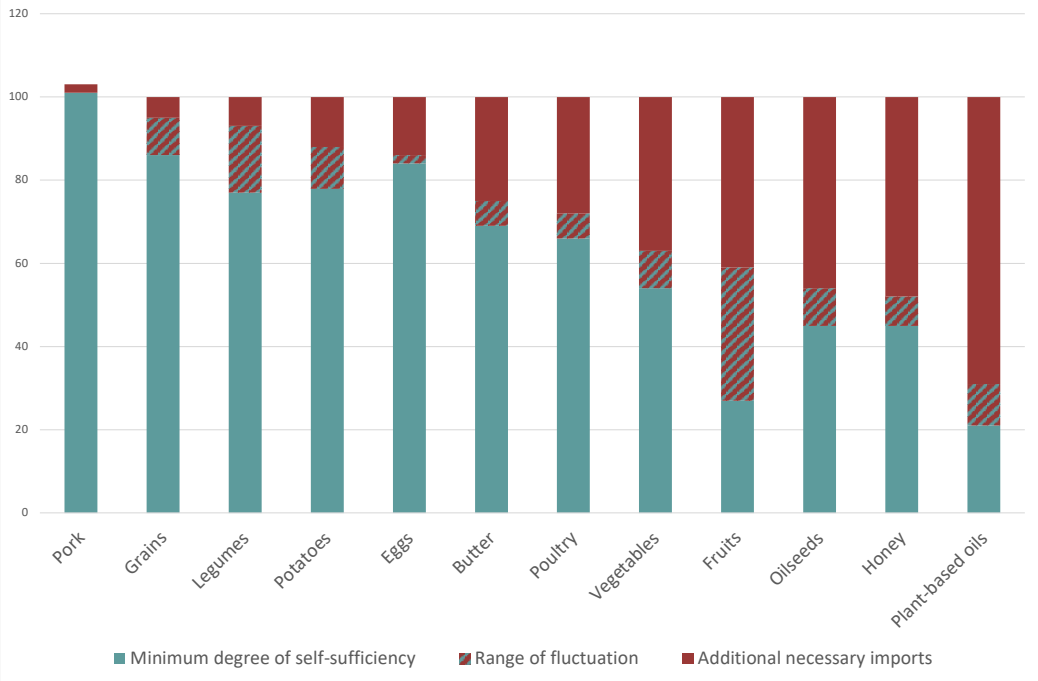
With regard to the seed supply, there is a dependency on imports for the important crops maize and sugar beet as well as, to a lower extent, for rapeseed. Especially for maize and sugar beets reproduction in not possible since they are hybrid seeds. A similar dependency can be identified with regard to soybeans. Although Austria is among the largest soybean producers within the European Union, they are mostly used for food processing or export. Soy used for animal feed, by contrast, has to be mainly imported, with the main trading partners being Brazil, Argentina and the US.

Given its geographic location, Austria is also dependent on imports of fish, the degree of self-sufficiency is only at around 5%. Around 50% of fish consumed in Austria is imported from Norway, Denmark and the Netherlands, and 50% from African or Asian countries with China and Thailand being the most important import partners.

Finally, especially due to climate conditions, Austria depends on imports for certain types of fruit and vegetables. Austria is particularly dependent on imports for certain types of fruit and vegetables, as either too little is produced to meet domestic demand or because the goods cannot be grown competitively due to the climatic conditions (seasonal restrictions on outdoor cultivation). The degree of self-sufficiency is, for example, below 50% for tomatoes, zucchini, mushrooms, peppers and melons. With the exception of fruit from Turkey, Austria's most important import partners are within the EU (Italy, Spain, Germany, the Netherlands), but for imports of bananas and citrus fruit as well as other types of "exotic fruit" Austria depends on imports from abroad. Finally, Austria is completely dependent in imports of rice. While around 50% of imports come from Italy, Austria also imports rice from Asia and here mainly from Thailand.

Overall, according to the agricultural report 2018/19 (Statistik Austria 2020: 78f.) Austrian self-sufficiency regarding plant-based produce reached 108% for wine, 87% for grains, 83% for potatoes, 59% for fruits, 54% for vegetables, 48% for oilseeds and 28% for plant-based oils. Due to the extensive animal husbandry, Austrian self-sufficiency is overall greater for meat (109%, but note variation regarding different types of meat), cheese (113%), eggs (86%) and butter (69%) (see also Figure 14, indicating ranges of fluctuation 2015-2019).

Figure 14: Degree of self-sufficiency for selected agricultural raw materials



Note: 2015-2019, grains: only 20% of domestic production used for food. Source: Österreich isst informiert (2020), own illustration.

This is also reflected in the results of the survey conducted by Kleb et al. (2015: 96). Based on their definition of suppliers or sub-suppliers as critical if a) they cannot be replaced at short notice and b) a disruption of their supply would disrupt domestic production, 45% of the Austrian companies in the food sector, that had participated in the survey, stated that they had critical suppliers. Goods and services affected included grain, flour, grain mixes; soy meal; oilseeds; fruit; raw milk; live cattle, boneless meat; auxiliary materials (baking agents, yeast, fruit preparations, fats, sugar); natural gas, electricity, liquid nitrogen; transport services especially for fresh produce; packaging material and special packaging. The survey did not distinguish between Austrian suppliers and suppliers within the EU or in third countries, but in conjunction with the import dependencies discussed above it can be assumed that a number of critical suppliers are located in third countries.

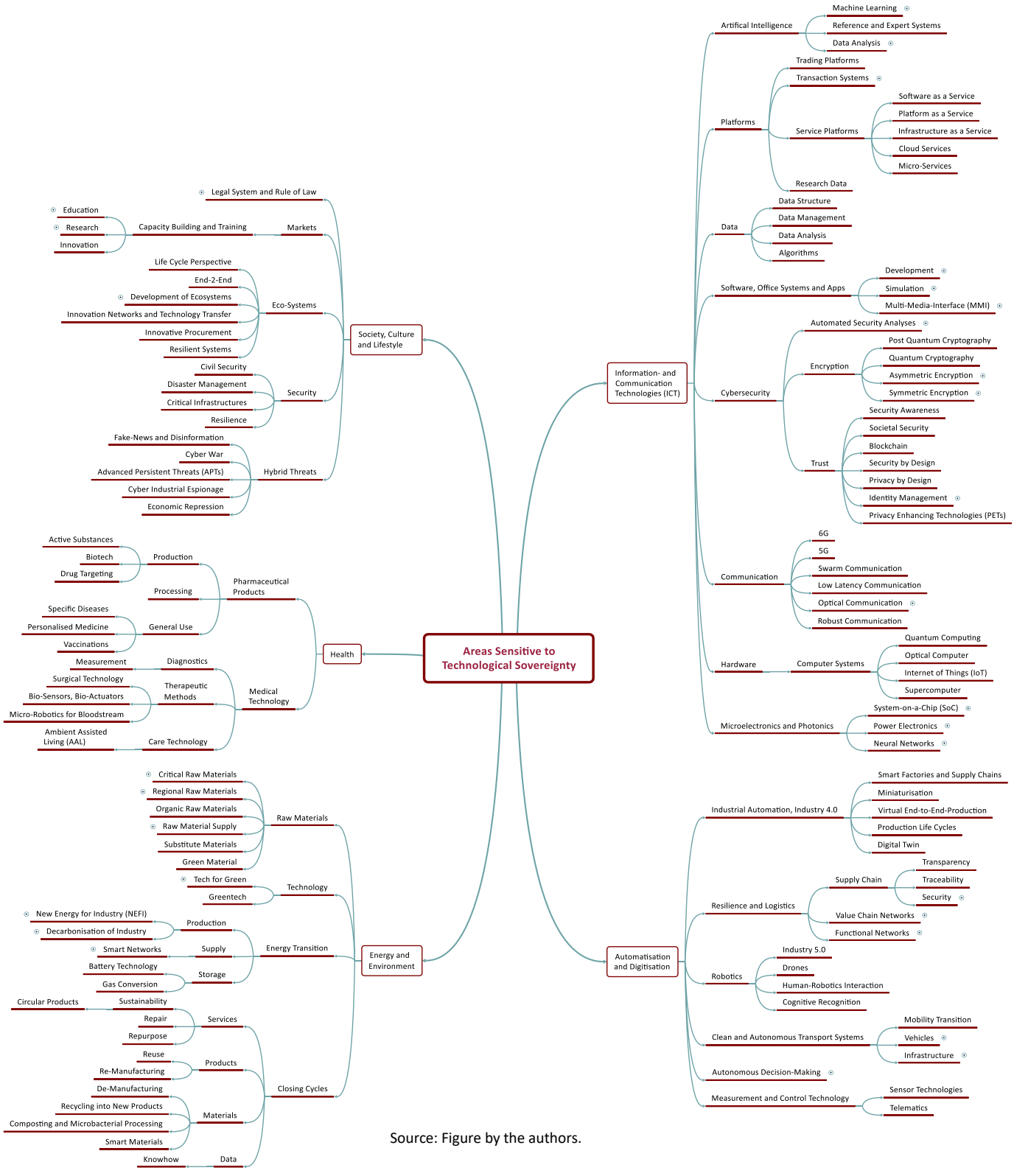
4.3 Technologies

As emphasised already before, technology and the technological are to be understood holistically as an economic and social complex. This does not only involve highly advanced technologies, but also aspects or items we have grown accustomed to in our daily lives: smartphones and computers, transport infrastructure and motorised vehicles, household appliances and power supply, agricultural fertilisers and pharmaceuticals, to name but a few. To indicate the many dimensions of how technologies are relevant to sovereignty, Figure 15 provides a rough and heuristic attempt to depict sensitive areas in form of a mind map. While the exact delineation of and consequences drawn from the main areas is a matter for continued discussion with different expert and lay publics, what should become clear from this figure are the many layers of entanglement of the technological with economic, social and political spheres. This entanglement needs to be emphasised even more strongly as the following paragraphs on challenges regarding technological sovereignty are necessarily narrower.

To assess current and future challenges that the European Union, and Austria specifically, are facing, two features of technologies need to be highlighted. First, given that they are deeply interwoven in all aspects of our daily lives, as well as their peculiar nature, a first set of challenges concerns security issues: technologies are highly vulnerable to global risks, and there are specific trends that demand careful assessment (see 4.3.1). Second, technological change is a key driver of economic growth, as has long been discussed in economic literature (Arrow 1962). Technologies are essential to improving public health and welfare, to inform sustainability and address issues related to climate change. More so than ever before, technologies, understood in the broad sense, are embedded in complex political, social and material flows; global value chains are efficient, specialised, and interconnected. Science and technological innovation have

become key in informing and assisting structural change (and economic recovery); the term often referred to here is “knowledge society”. A second set of challenges, then, concerns the requirement to keep Europe pro-actively innovating (see 4.3.2).

Figure 15: Areas sensitive to technological sovereignty



Source: Figure by the authors.

4.3.1 Data, information and interferences

The COVID-19 pandemic has prompted policymakers to address the need for strategies that better deal with global risks of technological interconnectedness, even at the expense of the efficiency, productivity improvements, and collaboration potential brought about by globalisation (Michel 2020; Evenett 2020b). Technologies embedded in global flows involve more than traditionally understood technological artefacts. They refer to a complex of data and information networks that impact societal and political processes, create risks and opportunities alike.[14] There is an elevated risk of bias, manipulation, surveillance and authoritarian control over social networks, the internet and any uncensored citizen expression platform, by private or state actors. Biased censorship and propaganda attacks shape opinions as confidence in traditional trustworthy institutions and figures of social authority essential to improvement of societies crumbles. Some state and private actors advance illiberal and hierarchical control over agendas and see technology as a way to dominate citizens with positions influencing democratic viewpoints that they consider hostile.

Illiberal states have exerted influence operations targeting vulnerable states on their periphery, as well as countries in Western institutions like the European Union (EU) and the North Atlantic Treaty Organization (NATO). Russia, for instance has substantially increased its investments in propaganda outlets beyond its borders and funded nongovernmental organisations and political parties that advanced its anti-EU agenda via local and transnational networks, platforms and other digital assets. In semi-consolidated democracies and transitional governments on Russia's periphery, the Kremlin targets states that seek to integrate with, or in the case of political leaders that are willing, distance themselves from, the EU to present an opportunity to weaken from within. Georgia and Ukraine had been attacked with cyberwarfare and disinformation campaigns (Perlroth 2021). Countries like Hungary and Bulgaria face acute challenges from the Russian government, which exerts significant influence in politics, business, and the energy sector (US Senate 2018). These influences utilise technology platforms to spread misinformation, supply chain pressure, but also involve influence that may be called technoscientific sovereignty challenges. A case in point is Hungary's authorisation and deployment of Sputnik, the Russian COVID-19 vaccine, which has not yet been approved by the European Medicines Agency (EMA). This has led to a debate between the EMA and certain EU countries, such as the Czech Republic, Slovakia and Poland, that may follow suit (Holt 2021). Illiberal states use critical technologies and interconnected economic, social and material flows to exert political pressure or create hybrid

[14] Note that this section does not elaborate further on the potential disruptions in the material supply of goods relevant for technological parts, as this has already been described above (for this, see Section 4.2).

interference. The pandemic has increased global and regional risks of political and technological confluence.

Cyber-attacks, information operations, malign financial influence, the subversion of political and social organisations, and strategic economic coercion are among the most common threats and risks emerging from connected datafied transnational social networks. All these forms of influence are seen as malign (Berzina and Soula 2020). Hybrid interference means non-military practices for covert manipulation of other states' strategic interests. This is achieved by weakening its resolve through subtle means of interference calibrated to undermine its internal cohesion. It is deliberately designed to utilise cornerstones of liberal democracy as strategic vulnerabilities: state restraint, pluralism, free media, and open economy. The openness provides loopholes for interference through the tactical combination of covert action that involves cultivating local subversive groups and assisting counter-elites; geo-economics to interfere strategically in target countries; and disinformation (Wigell 2019).

An important, though unintended, effect of technological and business innovation in recent years was that traditional political intermediaries of democracy – political parties as well as traditional news media – have been weakened, or at least bypassed, as technological platforms and social media have taken over influencing and even creating the democratic public sphere. Networks' automated advertising systems permit and stimulate the design and use of websites that look like authentic media outlets, but that work as repositories and recyclers of fraudulent information. Third parties use advanced technologies (e.g., bots, microtargeting adverts) to create or intensify conversations and distort the awareness that users may have of what is actually taking place or what is being discussed in a platformised public sphere. Disinformation, misinformation, fake news and interfering in elections by electoral mobilisation to drive content sharing, discussions and platform use make these platforms the new battleground in the geopolitical competition between authoritarian regimes and liberal democracies. Spill over effects of misinformation, as evidenced during the COVID-19 pandemic, also involve activity designed to induce confusion and mistrust in science, scientists and politicians (Leclercq et al. 2020).

In the past few years, public authorities in several European nations have described interferences in elections and referendums. Similarly, disinformation campaigns cover a broad range of topics to attack the EU, amplify localised polarising content to influence public opinion, and attempt to suppress voter turnout. Adversaries are using tools to exploit existing cleavages in democratic societies and vulnerabilities in democratic governments. Authoritarian regimes are trying to weaken Europe and its partners and to diminish confidence in democracy as a viable form of government (Berzina et al. 2019). One stark example that can help to highlight how technology can weaponise

democracy concerns elections. Research indicates that online search results have the potential to shift more than 20% of undecided voters – and maybe up to 80% in some demographic groups – without leaving a paper trail (Epstein and Robertson 2015).

Another aspect concerns data collected by private tech companies. This has the potential to impact not only the partial abdication of state responsibilities by corporate or corporate driven interests, but also to shape research agendas as well as the public conversation and drive the further expansion of corporate players into the production of social knowledge. By amassing and offering large and diverse digital data, major technology companies play a critical role in the organization of scientific evidence, reshaping also the agenda and conversation about how to regulate them (Iazzolino et al. 2021).

4.3.1 Opportunities not to be missed

Some two or three decades ago, an important shift in company strategies took place, aligned with a new economic thinking concerning innovation and knowledge. Instead of focusing on competition in a given market, a number of new, emerging tech companies such as Google (Alphabet), Apple, and Amazon, focused on adding value through innovation, thereby creating new wealth and generating new jobs. Yet the new technologies on which these wildly successful companies built their fortune on were created serendipitously and often relied on long-term public funding. This is in line with economic theory, where the creation of new knowledge is referred to as an example of external effects and thus market failure (Arrow 1962, see also section 5.1.2): it requires public funding of research and development as there is limited incentive for individual companies to invest in research that is often risky and whose results are often years away from (potentially profitable) products or services (Stephan 2012: 205-7). The result of decades of long-term public funding in research and development and of impressive entrepreneurial venture resulted in the fact that, today, the most valuable companies in the world are all closely related to unique technological competences and advantages.

This development only indicates the heightened role of innovation: to generate wealth and to ensure profitable industries, it is important for advanced economies to stay at the helm in technology development; this, in turn, requires keeping (and raising, if possible) the ability to innovate. Economically, while investments in research and development have been increased substantially over the past decades, the productivity of research is declining (Jones 2009; Gordon 2016). These diminishing returns can only be offset by further increasing investments (Bloom et al. 2017; Boing and Hünermund 2020). Europe is lagging in this respect. While companies based in the US increased their investment by 10.8% and Chinese companies by 21.0%, EU based corporations increased their R&D by 5.6% only, just a bit higher than the rest of the world (RoW) (5.1%) (Grassano et al.

2020). Beyond traditional R&D, web-based services and their offering are a next battleground between Europe and the US, and, eventually, China. America dominates the field through a few big tech companies, such as Amazon, Alphabet, Microsoft, and Apple, plus, on a lesser scale, the likes of Netflix and HBO. Although China has its own big tech companies – e.g., Tencent and Alibaba – and is trying to penetrate the European market, US-Chinese competition has so far been limited. In web-based services, as in AI and data, Europe is lagging and dependent on US and Chinese systems. With some exceptions, like Spotify, it has not been able to create new tech-related companies that become as large and therefore as globally recognised as similar companies from (literally) the Silicon Valley (and the US, more generally).

Strategic value chains

The notion of strategic value chains has recently become a topic of heightened attention across Europe. Broadly defined as "networks of independent and interlinked economic actors creating future added value around a product, process or service", three criteria have to be met for a value chain in order to justify being labelled "strategic" (Strategic Forum 2019a: 7). The first one is "technological innovativeness", thereby underscoring again the high relevance of technological development (the other two criteria are the "economic and market potential" of a value chain, and its "societal and political importance for Europe"). In the report, a total of 31 such value chains were identified (see Table 7 in the appendix). The high number is striking, and, as all of these value chains necessarily contain a strong element of technological innovation, the list not only indicates the potential future dependency of Europe in a number of critical fields, but also the difficult task of prioritising those value chains that are of highest importance and imminence, and to develop instruments that can ensure their technological sovereignty.

When assessing the listed value chains, it is possible to discern at least three different types of strategic ambition (with many value chains addressing more than one ambition at the same time): the first ambition is for Europe to remain at the helm of global competitiveness by acknowledging the need to transform the respective industry (such as, "clean, connected, and autonomous vehicles"). Another ambition is to attend to a field that is (or is likely to become) an enabling technology for many other value chains (such as, "micro-electronics"; but this also includes all technological advancements to become more resource independent). The third ambition is to ensure that Europe actively pursues its interests with an emerging technological field (such as, "hydrogen technologies and systems").

Given the heightened attention towards the topic, it is noteworthy that only three have already advanced to implementation (concerning batteries, micro-electronics, and high-

performance computing) at the time the report was published. The Strategic Forum (2019a: 8) recommended another six for action, of which only two have been advanced to serious negotiations thus far. The large majority of 22 value chains was either declared as prioritised for later or simply "identified".

Digitisation and AI

The digital element of Europe's ICT sector today accounts for around 1.7% of GDP, lower than the share in China (2.1%) and only half of the share in the United States (3.3%). The share of fully digitised companies in Europe increased by less than 10 percent a year between 2010 and 2016. While Europe has close to six million professional developers, more than in the United States, only two European companies are in the worldwide digital top 30, and Europe is base to only 10% of the world's digital unicorns. Europe has about 25% of AI start-ups, in line with its size in the world economy, but its early-stage investment in AI lags behind that of the United States and China. Europe is behind the United States in AI diffusion, and less than half of European firms have adopted one AI technology, most of which are still in the pilot phase. AI initiatives remain fragmented in Europe, and investment in AI is non-comparable to the size of that in the United States or China. Only four European companies are in the top 100 global AI start-ups.

European companies also lag behind their US counterparts in their adoption of big data architecture and of the advanced machine learning techniques that are the foundations of AI. European companies show 12% less AI utilisation than in the United States. Only 5 percent of European AI adopters (compared with about 8 percent in the United States) are using these tools in about 90 percent of their entire organizations. In the most advanced industry—high-tech—93% of adopters are capturing AI for 10% of its potential use, but still only 17% of European companies (compared with about 22% in the United States) are using AI technologies at 75% of potential. At the other extreme, only 2% of European firms in healthcare systems and services are using those technologies at 80% of potential (Bughin et al. 2019).

5 Addressing the challenges

Section 4 analysed a number of challenges that Austria, but also the EU are facing. In this Section, we discuss different options for Austria and the EU of developing proactive strategies to address these challenges based on empirical evidence for the impact of different strategies. The underlying guiding question is: what are realistic goals for Austria, within the European polity, to focus on?

5.1 Economic sovereignty

5.1.1 Macroeconomic effects of economic integration

Several theoretical and empirical studies show positive impacts of economic integration. In 1988, a study was carried out on behalf of the European Commission with the aim of quantifying the expected macroeconomic effects of the common market in advance. The "Cecchini Report" (Cecchini et al. 1988) estimated that the completion of the internal market could increase the real GDP of the then 12 Member States of the European Community, the predecessor of the European Union, by around 5%, creating 200 million additional jobs. In addition, it expected the price level to be reduced by up to 6% and the budget balance to be improved by 2.2% in relation to the gross domestic product. Ex post, the European Commission (2012) concluded that in 2008, real GDP in the then 27 EU Member States was 2.1% higher and employment 1.3% higher than it would have been without the internal market. Intra-EU trade increased from 12% of GDP in 1992 to 21% of GDP in 2011.

Based on a meta-study, Badinger and Breuss (2011) conclude that the various stages of European integration exerted positive macroeconomic effects. The customs union that came into force in the 1960s produced more trade creation than trade diversion. Studies on the internal market find positive effects on economic growth and prosperity. Most studies on the economic and monetary union (EMU) identify positive effects on intra-trade between member states, and most studies also confirm that EMU promoted economic growth, employment and price level stability. With regard to the various rounds of enlargement, positive macroeconomic effects can be identified for the acceding countries. The "old" member states also benefit in aggregate. However, the positive effects for the "new" member states, for example with regard to the relative increase in wealth, are around ten times larger than for the "old" member states, which is mainly due to the significantly smaller size of the acceding economies. In addition, the effects are very unevenly distributed across the "old" member states. The geographically closest member states of Austria and, to a lesser extent, Germany benefited most from

the EU's eastward expansion, while member states further away even lost marginally, as there were certain trade diversion effects to the new member states.

As a small, open economy, Austria is more dependent than large countries on access to a larger market. The Austrian economy has therefore benefited above average from the fall of the Iron Curtain in 1989, its own entry into the EU in 1995, participation in the Economic and Monetary Union from 1999 onwards and finally the EU's eastward expansion from 2004. According to an estimate by Breuss (2013), Austria's real GDP has grown by 0.5 to 1 percentage point per year since 1989 above the EU average. Compared to the non-EU member Switzerland, the growth lead was 0.6 percentage points.

Model simulations (Breuss 2013) show that economic growth in Austria increased by 0.6 percentage points per year due to its EU integration and the associated participation in the Common Market. Membership in the European Economic and Monetary Union since 1999 brought about another growth effect of 0.4 percentage points. And finally, due to its tight historically grown political and economic relations as well as its geographical proximity to the Eastern neighbouring countries, the EU Eastern enlargement brought another GDP growth effect for Austria of 0.2 percentage points per year.

Since some of these integration levels overlap in time, the isolated effects cannot simply be added together. If this is taken into account, the model simulations come to the conclusion that the integration steps in Austria resulted in an additional increase in real gross domestic product of 0.9 percentage points per year and the creation of around 17,000 jobs. The unemployment rate fell annually by 0.7 percentage points and the inflation rate by 0.2 percentage points. Keuschnigg and Kohler (1996) estimate that the level of real GDP in Austria was permanently increased by around 2% as a result of joining the EU. According to Keuschnigg and Kohler (2002), the EU's eastward expansion brought Austria a further increase in real GDP of 0.64%. The prosperity of the population is not only positively influenced by a higher per capita income, but also by the greater choice of places to live and work. In addition, increased competitive pressures put pressure on consumer prices, which in turn increases real income.

The economic effects of globalisation and EU membership are visible in other macroeconomic indicators beyond GDP, employment, and inflation. According to Breuss (2013), since joining the EU in 1995, Austria’s total factor productivity (TFP) grew by 0.9% per year in the period until 2012, above the EU average (0.5%) and Germany (0.4%). However, driven by the higher expenditures on research and development in these countries, Sweden and Finland which joined the EU together with Austria 1995 experienced even higher productivity gains of about 1.5% per year.

Fritz and Streicher (2018) analyse the impacts of the globalisation on the Austrian economy with a view on the value added contained in exports. The reasoning is that

exports or the share of exports in GDP alone is misleading. The reason is that exports contain imported intermediate goods. Hence, only that part of exports that has been produced in Austria is relevant for Austria's GDP and employment. Fritz and Streicher (2018) conclude that the value added of Austrian exports increased from 21.7% in 1995 to 29.3% in 2013. According to Fritz and Streicher (2018), in 2013 around 18% of Austrian added value was induced by exports of goods.

Stöllinger (2010) analyses "export premia", defined as differences in various microeconomic figures between exporting companies and those that operate only on the Austrian market. The study concludes that on average the turnover of exporters is 3.6 times as high as that of non-exporting companies, investment of exporters is 3.8 times as high as investment of non-exporters, and exporters have on average twice as many employees as non-exporting firms. Furthermore, labour productivity of exporters is 66& higher as that of non-exporters (which is partly related to a higher capital intensity), and exporters pay on average 23% higher wages.

While exports are beneficial for the economic, especially for a small open economy such as Austria, also openness for imports exerts positive effects. First of all, imports increase the choice of product varieties, and they reduce the domestic price level due to more intensive competition. However, gains from openness are unequally distributed across consumers. Fajgelbaum and Khandelwal (2016) analyse the gains from trade for different groups of households. They argue that poorer households spent a larger share of their income on goods with a higher import share. Hence, while they estimate the overall welfare gain for consumers to 42% (measured are consumer welfare with imports as compared to a counter-factual situation without imports), this welfare gain amounts to 68% for the lowest income percentile (i.e., the 10% of households with the lowest income), to 56% for median percentile, and to just 38% for the 10% of households with the highest income.

Sachs et al. (2018) measure welfare gains brought about by increasing globalisation. They estimated that worldwide Japan gained most from the rising globalisation. According to these estimates, between 1990 and 2018 real income per capita rose by around 1.800 euro (measured in 1990 prices). In the ranking of globalisation winners, Germany in on the 7th place with an income gain of 1,112 euro between 1990 and 2018. Austria ranks 13th with an increase of real income of 870 euro in this period.

Based on a meta study and on own econometric research, the National Board of Trade Sweden (Kommerskollegium 2018, 2019) estimates the economic impacts of regional trade agreements (RTAs). RTAs are treaties that are signed by two or more countries to encourage free movement of goods and services across the borders of its members. With regard to their scope, various types of RTAs can be distinguished: preferential trade

agreements, free trade areas, customs unions, common markets, and economic unions. The Board concludes that the positive impact of RTAs on trade of its members ranges between 50 and 170% after ten years. The more comprehensive a trade agreement is (e.g., economic union vs. a mere bilateral reduction of tariffs), the larger is trade creation, and the smaller is trade diversion.

Although bilateral trade agreements exert positive effects on the contracting parties, multilateral agreements are preferable. The main reason is that bilateral agreements often lead to trade diversion away from the rest of the world towards the contracting parties. A recent example for this is the "Phase 1 deal" between the US and China that came into force in February 2020. This agreement includes specific targets for increased Chinese imports of US goods and services, amounting to 200 bn US dollar over 2020 and 2021. According to Chowdhry and Felbermayr (2020), both industrialised countries such as Germany and Australia and developing, energy and agricultural products exporting countries will face substantial losses.

5.1.2 State aid/subsidies

Within economic theory[15], there is a widespread consensus that the aim of subsidies is to lower the cost of producing or exporting a good artificially and that subsidies therefore distort the market. A distortion of the market can, of course, be desirable, especially if the market results in a level of production of a good that is not considered preferable, i.e. in the case of market failure. Market failure comes in different forms. High initial fixed production costs of a good, for example, can prevent the production of a good or result in a very high price, especially if producers are not certain whether demand will allow them to achieve economies of scale, i.e., sell enough goods to lower the cost per unit. Here, subsidies can help overcome initial fixed costs and thus jumpstart production. Similarly, subsidies can be used to address externalities, i.e., beneficial or harmful effects of the production of a good that are not reflected in the costs or revenues of producers. A classic example for positive externalities are investments in research and development (Arrow 1962), for negative externalities it is environmental pollution caused by (the production of) a good. Subsidies can be used to incentivise producers to reduce negative effects (for example by investing in environmental measures) or to enable or increase production of a good with positive externalities. Market failures can also prevent innovation, for example if producers cannot obtain funds necessary for investments at the capital markets. Subsidies can provide the

[15] For more detailed discussions of the impacts of subsidies, and trade policies more generally, see for example Brander and Spencer (1985); Erceg et al. (2018); Felbermayr et al. (2013); Rodrik (2018); Sykes (1989); for a comprehensive overview Kommerskollegium (2020c). For critical views see Howse (2020); Sykes (2014).

incentives to invest in innovation, especially in areas where immediate payoff in terms of revenue is uncertain.

These examples for subsidies to address market failures need to be distinguished from subsidies that distort a generally functioning domestic or international market. Here, a distinction can be made between export and production subsidies. Both aim at artificially lowering the marginal cost at which a good can be produced and subsequently be sold, either on the domestic or the international market.

For goods aimed at the domestic market, lower prices due to subsidies can increase domestic consumption of goods or increase domestic welfare because consumers have access to a product at lower prices. It needs to be kept in mind, however, that this increase in welfare is also paid for by domestic taxpayers. In addition, if such subsidised goods were previously imported from the international market, domestic subsidies have an impact here as well, by reducing the market share of producers in other countries.

For goods aimed for export, subsidies allow producers to export their goods at a lower price on the international market. Domestic producers can thus become more competitive on the international or global market, increasing their market share. At the same time, export subsidies raise the welfare in the *importing* countries, because consumers there benefit from lower prices. Again, it has to be kept in mind that this increase in welfare abroad is paid for by domestic taxpayers. This observation has led to the witticism that importing nations ought to respond to subsidies on their imports by "sending a thank-you note to the embassy" (Sykes 2014: 3) At the same time foreign producers of the same or a similar good now face greater competition, potentially losing market share and revenue.

Depending how goods are traded, subsidies can therefore increase the competitiveness of domestic versus international producers, which may be exactly the intention of a subsidy. Yet if that is the intention, i.e., to distort the market by allowing domestic producers to produce at artificially lower costs either for exports or for the domestic market to get ahead of foreign competition, then it must be taken into account that foreign countries may react with countermeasures to reduce the distortion. These can be subsidies as well, but also duties etc. on imported goods. In other words, they can attempt to make imported goods more expensive or increase competitiveness of their own production by artificially lowering prices in return. As Yalcin et al. (2017) estimate, non-tariff barriers such as subsidies and state aid may be responsible for about 16% of the global trade slowdown discussed above (see section 4.1.1). To prevent the escalation of market distorting subsidies and countermeasures into fratricidal subsidy competition or trade wars, subsidies are, albeit not always entirely successfully, regulated at both the international and the EU level, as will be discussed in the following.

The WTO Agreement on Subsidies and Countervailing Measures (SCM)

Under the WTO Agreement on Subsidies and Countervailing Measures (SCM), subsidies are defined as follows (SMC, article 1): "a subsidy shall be deemed to exist if there is a financial contribution by a government or any public body within the territory of a Member […] and a benefit is thereby conferred". It also states that the SCM only applies "if such a subsidy is specific in accordance with the provisions of Article 2". Article 2 clarifies the term specificity related to subsidies. Subsidies are considered specific, if they are limited to either specific firms or sectors and/or to specific geographical areas - in other words, if they are not generally accessible. WTO rules thus refer to subsidies that fulfil three criteria: they entail a financial contribution, are specific and confer a benefit to the recipient.

According to Article 3 of the SCM Agreement, subsidies contingent on export performance as well as subsidies contingent upon the use of domestic over imported goods, are prohibited. In other words, WTO members "shall neither grant nor maintain subsidies" that distort exports or benefit domestic products over imports. All other subsidies are actionable subsidies, i.e., they are not prohibited per se, but can be challenged if they have adverse effects on another Member. In this case, if successfully challenged, the subsidising member can remove the adverse effects or compensate the affected member.

To regulate subsidies, the SCM Agreement contains rules on transparency measures as well as dispute settlements between members for both prohibited and actionable subsidies. Importantly, the Agreement explicitly includes the option for a member to impose countervailing measures, e.g., in the form of duties, on subsidised imports from another member. In other words, the Agreement explicitly includes the option mentioned above, namely for members to offset, i.e., retaliate against, market distorting subsidies that present a threat to its own producers.

For some time now, discussions have focused on a number of problems connected to the SCM rules that result in a suboptimal regulation of subsidies (for the following and a detailed discussion see Bacchus et al. 2018; Bown and Hillman 2019; Howse 2020). Among these problems are the definition of public body, which currently excludes state owned enterprises and thus creates loopholes for indirect state subsidies. In addition, the term financial contribution does not capture all possible market distorting benefits governments may grant. In addition, some members partially or fully ignore the notification requirement for subsidies. Challenges against subsidies are often not brought forward or successful due to the very high burden of proof. Finally, decisions on prohibited or successfully challenged actionable subsidies resulting in the violating member to withdraw a subsidy or to remove the adverse effects cannot be enforced by

the WTO, and countervailing measures can only be used by injured members under specific conditions.

Much of the recent criticism and reform efforts related to the WTO rules on subsidies focus on China[16]. For example, China has been accused by US administrations under presidents GW Bush and Obama of mass subsidisation of steel, aluminium and solar panels, sectors in which China has been able to massively increase its share of global production since 2002. Here, the WTO remedies did little to offset market distorting subsidies. From 2008/9 onwards, the US therefore imposed anti-dumping and countervailing measures according to WTO rules covering around 90% of the imports of steel and aluminium and almost 100% of the imports of solar panels by 2017 (Bown and Hillman 2019: 8). China's expansion into third countries pushed the US to impose similar measures on these countries as well. In 2018, under the Trump administration, the US finally imposed tariffs on virtually all steel and aluminium as well as similar protections for solar panels, which China responded to by retaliating. The trade war between the US and China had begun. These US tariffs, however, also applied to trading partners such as Canada, Mexico or the EU - never accused on subsidising – and all retaliated against US imports. "The result has been a major wave of WTO trade litigation … weakening the rules-based trading system without addressing the subsidies themselves" (Ibid.: 9). Many economists doubted the effectiveness of the US measures (for surveys, see Sarkar 2018; Boak 2018), and data shows that they succeeded, at least so far, neither in reducing the US trade imbalance with China beyond a short dip in 2019, nor in reshoring US manufacturing (i.e., increasing manufacturing jobs or production) (Zumbrum and Davis 2020). While imports from China decreased in 2019 for the first time since 2011, and substantially so, US manufacturing output remained stable (Kearney 2020). US firms mainly shifted imports of manufactured goods from China to other countries such as Mexico. As the 2019 Kearny report (2020: 14) concludes, "the combination of relatively high production costs, lack of significant domestic productivity gains from automation and technology, and ongoing skilled labour shortages make a sudden resurgence of domestic US manufacturing highly improbable".

Addressing current criticism regarding WTO SCM agreement rules, Japan, the EU and the US started a trilateral initiative aimed at formulating a reform proposal. In their joint statement of 14 January 2020[17], first proposals included, inter alia, an expansion of the list of prohibited subsidies according to Article 3; a reversal of the burden of proof for

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[16] On China's subsidy policies, see for example Kalouptsidi 2018; Lim et al. 2018; Qiang et al. 2018; on US-China trade disputes also Beshkar and Chilton (2016); Bown (2017).

[17] Joint Statement of the Trilateral Meeting of the Trade Ministers of Japan, the United States and the European Union. Washington, D.C. January 14 2020. Available at: https://trade.ec.europa.eu/doclib/docs/2020/january/tradoc_158567.pdf

specific types of subsidies considered to "have such a harmful effect […] that the subsidizing Member must demonstrate that there are no serious negative trade or capacity effects and that there is effective transparency about the subsidy in question"[18]; an addition to the instances of "serious prejudice to include subsidies distorting capacity"; an amendment addressing "the determination of the proper benchmark for subsidies consisting of the provision of goods or services or purchase of goods by a government in situations where the domestic market of the subsidizing Member is distorted"; the addition of strong incentives for members to notify subsidies properly; a redefinition of the term "public body" to include state owned enterprises.

In addition, the trilateral group stated that, while technology transfer between firms in different countries was an important part of global trade and investment, forced technology transfer needed to be addressed as an unfair practice "inconsistent with an international trading system based on market principles and [undermining] growth and development". While the group "discussed possible elements of core disciplines that aim to prevent forced technology transfer practices of third countries", no specific proposals were made.

Some observers have pointed point out that such reform proposals may have little chance of success given that China has hardly any incentive to agree to WTO rule changes that target the government's flexibility to manage its economy and political system, both of which are under considerable pressure (Howse 2020: 375). We still believe, however, that reform efforts should be pursued. Despite the focus of much of the criticism on subsidy policy by China, it should be noted that subsidies that may be considered harmful to international trade are also used fairly extensively by other members such as the US or the EU. According to a study by the Swedish Board of Trade, "export subsidies are the most frequent type of subsidy [mainly used by the EU and China, the authors], followed by loans and loan guarantees, direct support measures [mainly used by the US], and taxes and social insurance relief, as defined by the Global Trade Alert database. Subsidies are most frequently used in the machinery and vehicles, aircraft and vessels sectors, as well as for minerals and chemical products. Moreover, we observe that a significant share of the global trade flows is potentially affected by these industrial subsidies" (Kommerskollegium 2020b: 1). Note that the report is very careful in interpreting the data given that Global Trade Alert (GTA) notification data predates the COVID-19 pandemic and does not provide information on political reasons for granting a subsidy or, importantly on unnotified subsidies. Yalcin et al. (2017) or Evenett (2019),

[18] Subsidies discussed in this category include excessively large subsidies; subsidies that prop up uncompetitive firms and prevent their exit from the market; subsidies creating massive manufacturing capacity, without private commercial participation; and subsidies that lower input prices domestically in comparison to prices of the same goods when destined for export.

also drawing on GTA data, albeit with a different focus of analysis, confirm the picture of increasing use of discriminatory measures against foreign commercial interests.

EU rules on state aid

A key difficulty regarding state aid is noted by Sykes (2014: 8): "All governments engage in expenditures that affect production costs for private firms. Public education, highway networks, public works projects and so on can enhance the competitiveness of domestic firms. Likewise, governments engage in numerous activities that raise production costs in the private sector, including a wide range of tax and regulatory measures. From the myriad ways that governments benefit and burden their domestic firms, how can one identify the activities that constitute undesirable 'subsidies'?"

For this question, the European Union has developed a rather extensive set of answers. The network of legal regulations on state aid within the EU is too complex and dense to be discussed in any detail in this report (European Commission 2021a). We do, however, want to draw attention to the very fundamental provisions in the Treaty of Lisbon (TFEU). Here, article 107 TFEU generally rules out any state aid which distorts competition within the internal market.

Art. 107 (1) TFEU: Save as otherwise provided in the Treaties, any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market.

The definition in paragraph 1 already limits the applicability of EU state aid rules to measures which constitute the concept. Similar to the WTO definition, these include aid granted through *state resources*, a *favourable impact* as well as *specificity*, i.e. a selective effect on specific sectors or enterprises. By contrast, measures that are universally available and do not selectively benefit a specific enterprise or sector, are not considered state aid in the sense of Art. 107 TFEU. In the same vein, direct aid to citizens does not count as state aid in need of approval as the beneficiaries are not enterprises (art. 107 (2) TFEU).

Additionally, paragraphs 2 and 3, list a number of exemptions under which state aid is deemed, or may be deemed compatible with the internal market. Here, we want to highlight especially

- "aid to make good the damage caused by natural disasters or exceptional occurrences" (art. 107 (2.2) TFEU);

- "aid to promote the execution of an important project of common European interest or to remedy a serious disturbance in the economy of a Member State" (Art. 107 (3) TFEU); and
- "aid to facilitate the development of certain economic activities or of certain economic areas, where such aid does not adversely affect trading conditions to an extent contrary to the common interest" (Art. 107 (3) TFEU).

Paragraphs 2 and 3 thus provide options that can be used in the case of a crisis, whether this comes in the form of a natural disaster or a different form of exceptional occurrence (such as a pandemic). In principle, EU competition rules open up options to provide subsidies/state aid to advance projects related to technological sovereignty or related to improving the robustness/resilience of supply chains, for example by developing production of specific goods within or reshoring the production to the EU. Note, however, that the exemptions under paragraph 3 include the condition that granted state aid does not negatively affect competition and trade within the internal market. In contrast to the WTO, the EU also has much more powerful enforcement instruments.

In the context of the current Covid crisis, the European Commission adopted, in March 2020, a Temporary Framework under Article 107 3b to enable Member States to use the full flexibility already envisioned under existing state aid rules in the case of emergency situations to support the economy in the context of the coronavirus outbreak (European Commission 2020g). The Framework clearly spells out the types of aids, maximum amounts as well as a clear time frame and other conditions within which such aid can be granted by Member States.

In sum, under EU state aid legislation, subsidies are thus not impossible, and even explicitly permitted in specific circumstances, but there are strict rules under which they can be granted, rules aimed at ensuring free and undistorted trade and competition within the internal market. Importantly, while EU state aid rules may seem a disproportional restriction of governmental discretion regarding industrial or economic development policies, they, in fact, not only protect producers from unfair competition and distortive subsidies within the internal market, but also member states by preventing a fratricidal aid competition between Member States. "[They permit] the Commission to defend the Union's line against actions such as state aid for particular branches and enterprises that contradict the common trade policy and weaken the EU's unified external front" (Lippert et al. 2019: 24).

This is especially crucial for smaller member states, such as Austria, that would find it difficult to compete in a subsidy spending race with much larger Member states such as Germany or France. As Yalcin et al. (2017: 36f.) show based on GTA, larger European economies like Germany, the United Kingdom and France implemented between around

90 and 130 non-tariff barriers between 2009 and 2017, of which subsidies and state aid measures make up the largest number. While we have no further information, we assume that these were admissible measures under EU state aid rules, which provides an idea of the extent of measures possible in the absence or a loosening of such rules. In this context, it is also hardly surprising that countries such as Germany, Poland, France and Italy call for additional "flexibility" in EU anti-trust competition guidelines, while smaller member states including Sweden, the Czech Republic, Estonia, Finland, Ireland, Latvia, Lithuania and the Netherlands put pressure on the European Commission to refrain from doing so (Stolton 2020). Rather than loosening EU state aid rules, Petropoulos and Wolff (2019), for example, advise "applying a form of state-aid control to foreign companies needs to be made more effective, both in our markets as well as extraterritorially. EU competition law should be applied in a non-discriminatory way, regardless of the origin of the firm". Similarly, Leonard et al (2019: 11) argue that the vigilance applied by the European Commission in monitoring state aid provided by EU member states to national companies should also apply to state aid provided by foreign governments: "The main venue for tackling distortions arising from state subsidies remains the WTO, but this should be no excuse for failing to exercise vigilance. In the event WTO-based measures are not enough to ensure a level playing field, the EU should consider reviewing its competition policy instruments and their possible application to state aid emanating from foreign governments".

5.2 Supply sovereignty

As argued in Section 3, in terms of supply sovereignty, it is fruitful to distinguish between the robustness and the resilience of supply chains. To recollect, while resilience can be defined as the ability of a supply chain to return to normal operating performance, within an acceptable period of time, after being disturbed, while robustness is defined as the ability of the supply chain to maintain its function despite internal or external disruptions (Brandon-Jones et al. 2014: 55). Achieving robustness and resilience relies on partly similar, partly different strategies, which will be discussed in the following sections.

Any strategy aimed at proactively achieving resilience or robustness, however, can only be developed on the basis of an identification of supply chain vulnerabilities. Here, one approach consists in developing crisis scenarios based on different types of disruptions (e.g., European Commission 2021; Kleb et al. 2016, Lund et al. 2020). Under this approach, the analysis mainly focuses on the probability of occurrence and potential severity of man-made or natural disasters, as well as their potential impact on the production of goods in different sectors. Lund et al. (2020), for example, categorise disruptions based on their severity (magnitude of estimated costs of shocks), the

expected frequency (based on experiences to date), and lead time (i.e., the ability to anticipate such shocks). The authors then analyse 23 industry value chains to assess their exposure both generally and with regard to specific types of shocks, such as pandemics, large-scale cyberattacks, geophysical events, heat stress, flooding or trade disputes, taking into account factors such as "how much of the industry's current geographic footprint is found in areas prone to each type of event, the factors of production affected by those disruptions and their importance to that value chain, and other measures that increase or reduce susceptibility" (Lund et al. 2020: 5).

A different, but often complementary, approach focuses on the development of critical goods lists. Approaches to the definition of goods as critical vary, however. While some definitions are based on import dependencies and supply risk in terms of country-level concentration of global production (e.g., the list of critical raw materials compiled by the European Commission 2020; see also Zenglein 2020), others, and especially lists of critical medical goods, often rely on a needs-based definition.

The WHO model list of essential medicines, for example, first developed in 1977 and updated every two years by the WHO Expert Committee on the Use of Essential Drugs, focuses on the "minimum medicine needs for a basic health-care system, listing the most efficacious, safe and cost–effective medicines for priority conditions"[19]. While the WHO emphasises that the medicines on the list are those that need to be available "in a functioning health system at all times in adequate amounts, in the appropriate dosage forms, with assured quality and adequate information, and at a price the individual and the community can afford"[20], it is not, strictly speaking, a list of medical emergency supplies. Criteria for the selection of medicines for the list focus on disease prevalence, treatment facilities, safety, efficacy, quality, availability, and cost factors. The WHO also has a public repository of 148 national essential medicines lists.[21]

In the US, the Food & Drug Agency FDA has very recently (2020) put together a list of "essential medicines, medical countermeasures and critical inputs that are medically necessary to have available at all times in an amount adequate to serve patient needs and in the appropriate dosage forms"[22]. The selection criteria for the list include 1) the *need* for both, short-term treatment for severe injuries/illnesses and urgent medical conditions in acute care medical facilities as well as for responses to future pandemics,

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[19] See https://www.who.int/publications/i/item/eml-20.

[20] See https://www.who.int/groups/expert-committee-on-selection-and-use-of-essential-medicines/essential-medicines-lists with a direct link for the 2019 list.

[21] See https://digicollections.net/medicinedocs/static/PublicSubcollections/National-Essential-Medicines-Lists-NEMLs-Repository/index.html.

[22] See https://www.fda.gov/about-fda/reports/executive-order-13944-list-essential-medicines-medical-countermeasures-and-critical-inputs.

epidemics, and chemical, biological, and radiological/nuclear threats; and 2) the *usability* for the widest populations to have the greatest potential impact on public health (for details, see US Food & Drug Agency 2020a). The list includes not only finished products but also active pharmaceutical ingredients of essential medicined as well as ingredients or components that possess unique attributes essential in assessing the safety and effectiveness of such products. Finally, the list includes diagnostic testing kits and supplies for rapid test development and processing, personal protective equipment, active vital sign monitoring devices, devices for vaccine delivery, and devices for management of acute illnesses such as ventilators, among others. The list was published on 30 October 2020 (US Food & Drug Agency 2020b), and the FDA is currently cooperating with other government agency on strategies "for acquiring the products on the list, accelerating domestic manufacturing, and identifying and addressing supply chain vulnerabilities".

The European Medicines Agency (EMA), by contrast, has not, to our knowledge, established a list of critical medical goods. EMA has, however developed guidelines regarding the criteria for the classification of critical medicinal products for human and veterinary use to be used by EU member states. The guidelines focus on two broad criteria, namely a) therapeutic use, i.e., whether the "medicinal product is an integral part of the treatment for or prevention of a disease, which is life-threatening or irreversibly progressive, or without which the public and animal health could be severely harmed", and b) the unavailability of alternatives (European Medicines Agency 2016).

As part of its current objective to increase the EU's resilience, the European Commission also launched a structured dialogue on security of medicines supply in late February 2021[23]. Within the first phase of the dialogue, four workstreams will focus, inter alia, on available methodologies and criteria regarding the identification of medicinal products that are considered to be critical to public health as well as a methodology to trace EU manufacturing capacity for those critical products. Results are expected by the end of 2021.

With regard to achieving supply chain robustness, the two most often discussed strategies are maintaining stocks of certain goods to be used in the case of disruptions in the supply chains (stockpiling), and the relocation of the production and sourcing of goods back (reshoring) or geographically closer (nearshoring) to domestic markets. However, as Stéphane Miroudot, senior trade policy analyst in the Trade in Services Division of the OECD Trade and Agriculture Directorate, points out, the "first mistake is to equate self-sufficiency or domestic production with robustness … [and the] second

[23] https://ec.europa.eu/health/human-use/strategy/dialogue_medicines-supply_en.

mistake is to focus on the location of production; the overriding imperative during a crisis is to maintain and scale up production" (Miroudot 2020: 129).

Strategies aimed at achieving robustness should therefore generally be guided by decisions of both governments and individual businesses/industries regarding the definition of specific goods as so critical that that even a short disruption in supply is not tolerable (see also Kommerskollegium 2020a).

5.2.1 Stockpiling

For goods defined as critical in the above-mentioned sense, stockpiling may be, where feasible, a first option to achieve robustness. In Germany, for example, stockpiling has a long tradition and was more extensive than in most other EU member states, at least prior to the COVID-19 pandemic (Folkers 2019: 501). Stockpiles include strategic oil reserves Germany holds in compliance with International Energy Agency (IEA) regulations as well as large amounts of food for national emergency/catastrophe situations. The federal grain reserve (*Bundesreserve Getreide*) holds stocks of 625.974 tons of wheat, 64.335 tons of oats and 100.382 tons of rye. The civil emergency reserve (*Zivile Notfallreserve*) includes stocks of 81.570 tons of rice, 19.126 tons of lentils, 23.204 tons of peas as well as 4.695 tons of condensed milk (Deutscher Bundestag 2020). Stocks are kept in warehouses located in proximity to areas of dense population, with precise locations kept secret. The most important criterion for the selection of the stockpiled foodstuffs is their storability and long shelf life ensuring necessary replenishments only every ten years. As the data supplied by the Federal Ministry for Food and Agriculture (BMEL) shows, between ca. 11% (lentils) and 56% (oats) of the stocks have been warehoused for over ten years (Ibid.).

Similarly, the US hold large stockpiles. In 2003, for example, the federal government introduced the "strategic national stockpile" (SNS) of critical medical supplies as a response to the terrorist attacks in September 2001. In February 2020, stockpiles regarding medical supplies included almost 300 million N95 respirators, over 260 million gloves, 430 million surgical/face masks, 11 million face shields, almost 70 million surgical gowns and coveralls as well as almost 7 million goggles (US Department of Health & Human Services 2020). In addition, stocks include a broad range of pharmaceuticals. Yet even these stocks were not able to ensure sufficient supply during the surge in demand caused by the COVID-19 pandemic (Vecchi et al. 2020). As a result, stocks have since been further increased in (US Department of Health & Human Services 2020). Stocks are stored in warehouses throughout the country and organised for rapid delivery in pre-packed transport-ready containers containing 50 tons of emergency medical resources each.

Achieving robustness through stockpiling, however, is generally costly, because it binds resources, creates warehousing, management and quality assurance costs and, depending on the good, stockpiles may have to be regularly replenished. Importantly, costs related to stockpiling are continuously incurred, while stocks will only be used in the event of a disruption affecting such goods. This is especially the case where stockpiles are created to cover longer-term supply disruptions as in the case of severe natural disasters or global events such as the COVID-19 pandemic (Tomlin and Wang 2012: 82f).

Stockpiles also need to be very carefully designed. Stockpiling was, for example, widely discussed in the EU in response to a series of pandemic threats during the first decade of the 21st century, which witnessed threats related to SARS, "bird flu" (H5N1) and "swine flu" (H1N1) or H7N9 in China. Especially concerns over a potential H5N1 "bird flu" pandemic in the mid-2000s led to the establishment of large, and extremely costly, stockpiles of antiviral medication such as oseltamivir (brand name Tamiflu) in many EU Member states (Elbe et al. 2014: 441). While exact amounts invested in the acquisition of Tamiflu remained confidential in most countries, the estimated cumulative costs were likely to run into billions of euros across the member-states of the EU.

"Yet the human pandemic of H5N1 did not materialize, and many public health planners were caught off-guard when the next pandemic was eventually caused not by H5N1, but by H1N1. As it became clear that the course of that new H1N1 pandemic would not nearly match the dire predictions that had formed the basis for so many pandemic preparedness plans, an intense public backlash against the costly pharmaceutical stockpiles ensued" (Ibid.).

For companies, stockpiling is therefore generally considered sensible especially for critical goods or commodities with low holding costs and little danger of obsolescence or in the case where disruptions can be predicted with reasonable confidence (Chopra and Sodhi 2004).

Governments thus not only have to assess what and how much to stockpile, but also how much such undertakings cost and whether this is an efficient use of limited funds. A short overview over the US Strategic National Stockpile Management System (US Department of Health & Human Services 2020) provides insights into the measures potentially necessary to sustain medical stockpiles. SNS management includes conducting routine quality assurance on all products as well as overseeing the shelf life of medicines to ensure the stock is rotated and kept within US Food and Drug Administration (FDA) potency shelf-life limits. Here, the Federal Shelf Life Extension Program (for federal stockpiles) managed by the Department of Defense and the FDA, conducts stability testing determining whether products are stable and safe for

continued use allowing their use beyond their original expiration dates (FDA 2021). Participation in the Shelf Life Extension Program requires tracking the expiration date and manufacturer lot numbers of eligible products, the coordination of product shipments to FDA for stability testing, tracking FDA testing results for each lot of product as well as disposing of and replacing product lots that have failed FDA testing. In addition, inventory management involves performing annual inventory of all products as well as regular inspections of environmental conditions, security, and package maintenance. In addition, the SNS has created an Inventory Management and Tracking System (IMATS) to support state and local public health agencies in managing medical countermeasures during a crisis, allowing responders to track MCM inventory down to local levels, monitor reorder thresholds and support warehouse operations (US Department of Health & Human Services 2019).

In addition, Finkenstadt et al. (2020) point to the SNS's need for a modern inventory management system relying on blockchain transaction channels along with QR or bar-coding systems linking all inventory items as well as a virtual control system consisting of several elements: "a bar-code system for tracking inbound and outbound material; warehouse-management systems for aggregating data at each site; a single, trusted repository for all relevant global data; and a real-time visualisation system that shows the status of all of the SNS's and the states' materials" (Ibid.).

As mentioned above, critics have pointed out that the SNS, designed for short-term threats such as bio-terror attacks, had not been adequately able to handle the COVID-19 pandemic. The fact that supplies ran out in early 2020 is partly due to a failure to replenish supplies in time, partly due to "grossly inadequate levels of funding" (Finkenstadt et al. 2020). President Trump's budget for the fiscal year 2021, proposed in February 2020 and not yet taking account of the COVID-19 pandemic, foresaw $705 million (same as in the 2020 budget) for the SNS "to manage and sustain inventory, procure FDA approved products transitioned from Project BioShield, and train state and local responders nationwide for effective distribution and dispensing of stockpiled products. The Budget supports procurements of high-priority medical countermeasures, including *smallpox vaccine, anthrax antibiotics and therapeutics, and pandemic influenza antivirals"* (US Department of Health & Human Services 2020a: 179, emphasis added). The budget estimates costs for the procurement and sustainment of products at around $469 million, of which $145 million are warehousing costs, and around $136 million in additional operational costs (US Department of Health & Human Services 2020b: 112).

In Germany, the federal food reserves have also come under criticism. According to the Federal Audit Office (Bundesrechnungshof 2020: 16f., see also Bundesrechnungshof 2019: 38), annual expenditure for the food stockpiles, including staff costs and interest payments, increased from around 13 million in 2012 to around 21 million euro in 2018,

while the credit-financed value of the stored goods is estimated at around 260 million euro. Yet the stockpile amounts only to a few kilograms of food per person (with a value of 3.25 euro per person), and many of the stockpiled foods, grains in particular, are difficult to use in an emergency (e.g., due to the need for prior milling). Indeed, according to the Federal Audit Office representatives of the BMEL admitted that the stockpile created a "pseudo security" ("Scheinsicherheit") at best able to mitigate "diffuse anxieties" and would, in an emergency, not amount to more than "a drop in the bucket" (cited from Bundesrechnungshof 2019: 23f.; translation by the authors). In 2017, federal legislation concerning the stockpiles was amended, defining food stockpiling as a voluntary rather than obligatory task of the federal government ("Kann-Regelung").[24] The option to phase out the federal food reserves, which have never been used within Germany in their entire history[25], has been discussed, but a decision has so far been postponed, not least due to fears of public as well as parliamentary backlash. Indeed, the Federal Office for Agriculture and Food has recently published new tenders for the warehousing of 75.000 tonnes of wheat and 10.000 tonnes of oats.[26]

In Switzerland, by contrast, stockpiles are not maintained by the government but rather by private companies.[27] According to Article 102 of the Swiss constitution, the "Confederation shall ensure that the country is supplied with essential goods and services in the event of the threat of politico-military strife or war, or of severe shortages that the economy cannot by itself counteract. It shall take precautionary measures to address these matters. In exercising its powers under this Article, it may if necessary depart from the principle of economic freedom"[28]. The government does indeed delegate this responsibility to private companies. According to Article 7 of the National Economic Supply Act (NESA), the Federal Council may require stocks of certain essential goods to be held by private companies ("*Pflichtlager*"). Stocks remain in the ownership of the companies and can therefore be regularly exchanged and sold through the companies' usual sales channels. The costs of maintaining stocks are passed on to the consumers via the companies' sales prices According to estimates by the Federal Office for National Economic Supply, this amounts to about CHF 12 per Swiss resident annually (in 2021).

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[24] Gesetz über die Sicherstellung der Grundversorgung mit Lebensmitteln in einer Versorgungskrise und Maßnahmen zur Vorsorge für eine Versorgungskrise vom 4. April 2017, Artikel 1, BGBl. Teil I 2017 Nr. 19 S. 772, in force since 11 April 2017.

[25] In 1999, a few hundred tons of stockpiled foods from the Civil Emergency Reserve were flown to Kosovo to mitigate a temporary food shortage, see https://www.ernaehrungsvorsorge.de/staatliche-vorsorge/haeufig-gestellte-fragen-faq/.

[26] See https://www.ble.de/DE/Themen/Landwirtschaft/Kritische-Infrastruktur/Notfallreserve/Bundesreserve/bundesreserve.html.

[27] For further information see https://www.bwl.admin.ch/bwl/en/home.html.

[28] See https://www.fedlex.admin.ch/eli/cc/1999/404/en

The cooperation between the private sector and the state is also reflected in the organisation of the National Economic Supply. The overall organisation is headed, as outline in the law, by a representative from the private sector. It consists of around 250 executives from the private sector and other administrative branches and is divided into six divisions (energy, nutrition, therapeutic products, logistics, ICT and industry), each again headed by a representative from the relevant sector of the economy. The Federal Office for National Economic Supply (BWL) is the administrative body.

Stockpiling is based on a list of products defined by the Federal Council. This list is regularly adapted and has changed substantially since the 1990s: while metals, textiles or soap are no longer on the list, the importance of medical products has increased. Currently, obligatory stockpiles exist for three product categories, namely food (sugar, rice, cooking oils and fats, coffee, soft and durum wheat, animal feed and nitrogen fertilisers), energy (petrol, aviation fuel, diesel, extra light heating oil [also as substitute for methane] and uranium fuel bundles) and medical products (anti invectives [both finished products and active ingredients], neuraminidase inhibitors, strong analgesics and opiates, vaccines, insulin, haemostatics, blood bag systems as well as respiratory masks and gloves). For the fourth category, industrial products, polyethylene (plus various additives) and polystyrene form a supplementary stock. The amount of stockpiled goods is not defined by volume but rather by a minimum time period (in months) during which they have to be able to secure the average domestic demand (Bedarfsreserve). For the food category, for example this ranges from two months for stocks related to animal feed to four months for wheat, rice or cooking oil and fats. As of early 2021, around 300 companies are keeping emergency stockpiles with the overall value of the stocked goods, subject to market fluctuations, estimated at CHF 2.5 billion (see also Menzi 2021: 23).

5.2.2 Reshoring

Where stockpiling is not feasible, reshoring can be a preferrable strategy to ensure robustness regarding absolutely critical and essential goods and services. For example, concerning raw materials, the European Commission, drawing on data from minatura2020.eu, points out that “Europe’s own mineral resources are under-exploited, and the EU has vulnerabilities in processing, recycling, refining and separation” (European Commission 2020d: 18). The Commission report also emphasises, however, that reshoring will result in higher production costs compared to global market prices due to, inter alia, higher labour costs and stricter environmental standards. In addition, increased mining may face opposition in public opinion (Ibid.).

Achieving robustness through reshoring is generally risky because crises can affect domestic production. Supply chains may be shorter but still disrupted as the COVID-19

pandemic has shown. For Austria, for example, an analysis of the risk- and crisis management regarding the food industry in 2015 assessed various crisis scenarios according to their probability as well as likely impact (Kleb et al. 2015). While the report considered the outbreak of a pandemic a minor risk due to the low probability of its occurrence, it identified domestic or European crises, such as a widespread blackout within Austria, crop failures in large part of central Europe due to extreme weather conditions or more local natural disasters as much more likely.

Second, reshoring will increase prices for domestically manufactured goods, mainly due to higher labour costs within Austria or the EU compared to the global market. Two examples regarding the production of face masks are instructive: In Austria, the Health ministry decided in early 2020 to import FFP2 face masks from China rather than relying on apparently more expensive masks from the domestic market (Nationalrat 2021). Similarly, several Swedish firms that redirected production in the Spring of 2020 and started manufacturing protective equipment "never got their products sold. [One firm] started to manufacture several 100 000 visors per month, but the orders did not materialize as purchases were instead made from China" ("Dagens Eko", 9 August 2020, cited from Kommerskollegium 2020a: 21). In addition, specific goods rely on highly specialised production means. Here, the production of surgical face mask can also serve as an example: While surgical masks can be produced fairly cheaply, they have a relatively sophisticated manufacturing process (for the following, OECD 2020c: 8). In particular, they require a layer of polypropylene non-woven fabric, which the OECD has identified as the main production bottleneck (ibid). Polypropylene is, as other required inputs for face masks, a common material that can be easily supplied. Similarly, PP non-woven fabric is a common good, used for a number of hygiene products such as baby diapers or disposable wipes, but also in the automotive and construction industries. The specific type of PP non-woven fabric (PP electret melt-blown non-woven) used in surgical face masks, however, requires rather specialised heavy machinery. Given the high initial investment in this machinery, there are a limited number of companies specialising in the production of the needed fabric. A reshoring strategy aimed at achieving robustness would therefore have to include the reshoring of the production of this type of fabric, which comes with high entry fixed costs for the producing companies.

This is related to a third point, namely that reshoring can contribute to securing domestic supply for domestic consumption or use of a good as long as a crisis does not increase demand dramatically. "[I]t is unrealistic to think that a country can maintain and sustain an industry with the production capacity required at the time of the crisis." (Miroudot 2020: 129). Again, the example of face mask production is illustrative: At the beginning of the crisis, China was the main manufacturer of surgical masks, producing about 50% of the world's supply. Yet even China was not able to meet the increase in domestic

demand in January 2020. Quite the opposite, despite an export stop China had to import over 50 million masks in early January 2020. At the highpoint of the pandemic, China's domestic masks demand was estimated at more than 10 times its manufacturing capacity. By the end of February 2020, China had been able to increase the domestic production to around 116 million masks per day and started exporting masks to other countries (OECD 2020c). Similarly, within the EU demand for surgical face masks exploded once the WTO had changed its recommendation on 6 April 2020 and EU countries made the wearing of masks in public buildings, public transport or retail businesses mandatory. Meeting such an explosion in demand would require substantial investments to ensure some form of EU autarky. Outside of an immediate health crisis, however, there is a much more limited market for surgical masks.

In summary, policies "that introduce new barriers to trade and investment to push firms towards domestic production or reshoring would raise costs and lead to sourcing patterns driven by policy risks and not by the optimal organisation of production required for addressing other risks (Miroudot 2020: 128).

The arguments above also apply to reshoring as a strategy to increase resilience, i.e., the ability to resume operations within a short time frame after a disruption. Importantly, reshoring would limit the opportunities for companies to adjust their supply chains in case of disruptions. Resilience implies agility (Christopher and Peck 2004). Reshoring may also affect EU trade negatively in the longer run "as other countries follow our example and adopt their own strategies for greater self-sufficiency. Under such a scenario, EU exports would fall both because EU production factors are increasingly allocated to domestic production and because our trading partners close their markets" (Kommerskollegium 2020b: 10).

The conclusion that the COVID-19 pandemic should not be taken as an argument against global value chains in general is also in line with the findings of the OECD (2020d). There is no evidence that economies would have fared better in the absence of global value chains, as government lockdowns have also affected the supply of domestic inputs. On the contrary, as Bonadio et al. (2020) show, participation in global supply chains alleviated the economic effects of the COVID-19 pandemic in terms of labour supply and GDP in most countries. On average, GDP contraction would have been slightly worse with renationalised (30.2%) instead of global supply chains (29.6%) for the duration of the shock, with variation depending especially on the severity of domestic lockdowns. As their data suggests, benefits from renationalisation will only materialise, if domestic disruptions to production are less severe than those of foreign trading partners. They also show that this effect holds across different sectors.

More generally, Caselli et al. (2020) show that openness to international trade can help to reduce the volatility of domestic income. Hence, openness can be viewed as an *insurance* to economic shocks rather than being an additional *source* of shocks. However, the extent of this insurance function depends on the nature of global shocks. If the global division of labour follows comparative advantages, this leads to sectoral specialisation of the countries. In this case, macroeconomic volatility increases in the degree of trade liberalisation when shocks are sectoral in nature. If, by contrast, the shocks are predominantly country-specific, then international trade has an insurance function and macroeconomic volatility decreases with increasing globalisation. Caselli et al. (2020) show that country-specific shocks are quantitatively much more important than sectoral ones. The COVID-19 pandemic is a systemic shock that affects all countries and sectors of the economy. Therefore, a reduction of globalisation would not help in mitigating the negative impacts of the pandemic. In addition, higher trade barriers would reduce the average efficiency of economies, which could hardly strengthen the functioning and capacity of health systems.

5.2.3 Diversification, information and transparency

Outside of essential goods and services, experts therefore largely agree on strategies aimed at establishing redundancies and greater diversification within supply chains to achieve resilience and even, in some cases, robustness. International production and supply networks can be disrupted and play a role in the propagation of economic shocks across countries and industries. But they also help firms and countries to recover faster. Diversified suppliers and a production network across different countries allows companies to adjust their production in case of a geographically limited disruption.

More resilient production networks can therefore be achieved through better risk management strategies at the firm level, putting the emphasis on risk awareness, greater transparency in the value chain and promoting agility[29]. One of the fundamental preconditions for improved supply chain resilience is an understanding of the complex network that connects the business both to its suppliers and their suppliers as well as to its downstream customers.

Supply chains that are relatively localised and small may be able to rely on personal and informal communication mechanisms to manage risks. However, where supply chains grow, becoming complex and globalised, information and knowledge regarding the supply reduces some of the uncertainty associated with longer chains and allows

[29] For a detailed overview over management issues and solutions related to supply chain security, see Hintsa and Uronen (2012).

companies to react more quickly by rerouting product flows if disruptions occur (Brandon-Jones et al. 2014: 56).

The assessment by Christopher and Peck (2004) more than 15 years ago that upstream and downstream "visibility" in supply chains is "often very poor" still holds true today. While large and especially multinational companies may be able to build up sophisticated supply chain management systems, most of our interviewees estimated visibility for smaller companies not to reach beyond the first or second "link" in the chain.

Remarkable in this context is the recent initiative by US President Biden to launch a fairly extensive investigation into US supply chains. The Executive Order 14017 of 24 February 2021 (The White House 2021) includes a 100-day review of supply chain risks in three categories: semiconductor manufacturing and advanced packaging; high-capacity batteries including electric-vehicle batteries; critical minerals and other identified strategic materials, including rare earth elements; as well as pharmaceuticals and active pharmaceutical ingredients. In addition, the President ordered Sectoral Supply Chain Assessments, to be conducted over a year, in broader industrial sectors such as the defence sector, public health and biological preparedness, critical sectors and subsectors of the information and communications technology (ICT), the energy, transport as well as agricultural commodities and food products. The responsible Agencies and Departments are directed to review risks to supply chains and industrial bases including critical goods and materials within supply chains, the manufacturing or other capabilities needed to produce those materials, as well as vulnerabilities created by failure to develop domestic capabilities. They are also asked to identify locations of key manufacturing and production assets, the availability of substitutes or alternative sources for critical goods, the state of workforce skills and identified gaps for all sectors, and the role of transportation systems in supporting supply chains and industrial bases.

A somewhat similar initiative (the Supply Chain Resilience Initiative) was announced by the Australian government in October 2020 (Australian Government 2020). Here, the assessment will include the identification "of essential goods and services critical to Australians at times of crisis", a mapping of "industry supply chains and Australia's manufacturing capabilities" as well as an evaluation of "supply chain resilience under normal circumstances and in possible crisis situations" (Ibid.). The outcomes of this work will be published in Sovereign Manufacturing Capability Plans and complemented by a large government program worth 107.2 million CAD starting in July 2021. It will provide support for business projects aiming "to address a supply chain vulnerability for a critical product or input identified in a Sovereign Manufacturing Capability Plan".

What the two initiatives have in common is the underlying evaluation and assessment of existing supply chains. We have no information (yet), however, as to the methods that

will be employed in the assessments. As several of our interviewees have noted, the core problem concerns reliable information on supply chains. Firms usually only know about the first tier of their supply chain; attempts by researchers to gain a system-wide overview (both in depth and in breadth) require high methodical skills and are limited in several aspects. From the interviews, three approaches could be discerned. First, a survey among firms provides a good overview of the first tier of supply dependencies; it is, however, only a snapshot and cannot be expanded deeper into the tiers of the supply chain. Second, if a company provides the relevant data, a more thorough overview of supply decency can be gained, but this is usually restricted to one company and, again, does not go beyond the first tier. A third method consists of applying systematic web crawling, which can identify more tiers of a given supply chain in a specific industry but is limited to the extent supplying companies reveal their business network on the internet.

Regarding the latter, a prominent example of a commercial database is the Bloomberg Global Supply Chain Data, which, according to the website, provides "customer and supplier relationships data across more than 23,000 public and 100,000 private companies". These are connected with "over 450,000 unique relationships", both real and estimated, with data sourced from "financial reports, investor presentations, conference calls, news releases, trade journals, product catalogs, and company websites". We have no information on the fees Bloomberg charges for the access to the database.

5.3 Technological sovereignty

Regarding technological sovereignty, we find a range of activities almost all of which have been happening at European level. Most significantly, the European Commission has pushed its technological agenda as well as efforts to strengthen European digital sovereignty into the focus of its political program (in addition, it has also substantially revised its industrial strategy, with a strong focus on identifying "strategic dependencies"[30]). This has prompted one informed observer to call European policy developments the long awaited "Digital Independence Day" in Europe (Renda 2020a). During the past three decades the EU suffered from an "inferiority complex" when it came to digital technology and innovation. With new challenges and inspired by a post-pandemic global setup, Europe aims to play a pivotal role on the global stage, convincing like-minded countries to agree on common rules for responsible AI, an overall framework for enhanced trust in the digital infrastructure, and meaningful aid to

[30] The latest revision of the industrial strategy only comes at a time when this report is about to be finished; see the press report from 5. May 2021: https://ec.europa.eu/commission/presscorner/detail/en/IP_21_1884.

developing countries on how to leverage the outstanding potential of digital transformation (Renda 2020b).

5.3.1 Technology and European values

When it comes to maintaining decision making in matters of European values with respect to technologies (broadly defined), the European Commission set three areas of priorities: the maintenance of a strong and competitive economy, a frictionless single market with confident costumers whose rights are respected; the creation of a trustworthy environment in which citizens are empowered in how they act, interact and trust those managing data they provide both online and offline; and guiding the digital transformation in a way that enhances our democratic values, respects our fundamental rights, and contributes to a sustainable, climate-neutral and resource-efficient economy (European Commission 2020h). Four core values underpin policy action: a single market with appropriate consumer protection (*consumer and privacy principles*); public trust in research and innovation and trustworthiness of technologies deployed (*technological trustworthiness*); upholding of democratic values and fundamental rights (*democracy*); and adherence to creating a climate-neutral and resource-efficient society (*sustainability*).

It is noteworthy that the US and China are driven by different principles. US technological innovation is based on the tradition of technological leadership embedded in "permissionless innovation" (Thierer 2014) – the concept of innovation of digital products and services to the marketplace to be left to tech companies deciding what products were needed, how they were deployed, and who could purchase them. China aims, similarly, at technological leadership fighting US (and potentially EU) technological supremacy and as a self-claimed "decent, but nonliberal" state it applies alternative values and policy goals to avoid hegemonic innovation regimes stemming from the global North (Wong 2016). Against this backdrop, European policy goals to pursue its own way towards a digital transformation and put itself in a position to be a trendsetter in the global debate is as ambitious as it is challenging.

The European Commission in December 2020 proposed a comprehensive reform of the digital space with a strong focus on European values (European Commission 2020i, 2020j). The strategic ambition of the Digital Acts package is to better protect European citizens and their fundamental rights online, and lead to fairer and more open digital markets for every citizen in Europe. The Digital Services Act proposes binding obligations to all digital services that connect consumers to goods, services, or content, including new procedures for faster removal of illegal content as well as comprehensive protection for users' fundamental rights online. The new framework aims to rebalance rights and responsibilities of users, intermediary platforms, and public authorities and

focuses on respect of human rights, freedom, democracy, equality and the rule of law. Most importantly, platforms that reach more than 10% of the EU's population (that is 45 million users) are considered systemic in nature and are subject not only to specific obligations to control their own risks, but also to a new oversight structure. The Digital Markets Act targets the negative impacts of platforms acting as digital gatekeepers. This aims at fighting the power of such platforms to act as private rule-makers and to function as bottlenecks between businesses and consumers.

This package could be an important move towards ascertaining value-based technological sovereignty in and for Europe, also sending a strong signal to both major technology corporations wishing to enter (or stay on) the European market as well as policymakers and politicians the world over (global standards setting) that such an approach is possible. The proposed regulation targets many of the challenges, including but not limited to human rights, democracy, level-playing field and fight against corporate capture encountered in recent years related to the social, economic and democratic impacts of platformised public and economic spheres.

5.3.2 Data, platforms and assets

Europe is home to some of the biggest generators and aggregators of industrial data; competitive advantage can, however, only be exploited if there is a high degree of European control over data infrastructure. Data, data management, interoperability and public trust in data are key issues in creating an effective and trustworthy European Data Space. A new Data Governance Act proposal (European Commission 2020k) was published on 25 November 2020 by the European Commission as a first move along the path towards a common European data space. The main ambition is to establish shared principles for data sharing between private entities and between the public and private sectors. The Data Act's interpretation of data is mainly understood as input for key promising technologies such as artificial intelligence and establishing favourable conditions to be met by data intermediaries, or companies that help "data-holders" (i.e. entities that control and could grant access to data) to make their data available for potential use by other entities. The Digital Services Act, made public in December 2020, proposes that large technology entities "shall not use data collected on the platform […] for [their] own commercial activities […] unless they [make it] accessible to business users active in the same commercial activities" (European Commission 2020j). The proposed regulation aims to address issues of functional sovereignty (corporate entities acting as de facto rule makers) by designating and targeting gatekeepers, that "shall not use data received from business users for advertising services for any other purpose other than advertising services". If approved, this regulation would force platforms acting as gatekeepers to share the customer data they collect with smaller rivals and to

stop giving preference to their services as well as make tech giants liable for the products and services they market or embed in their platforms.

Responding to the call to protect the Union's democratic systems and to combat disinformation, the European Commission presented an action plan against disinformation with specific proposals for a coordinated European response. The action plan focuses on four main areas: (a) improved detection; (b) coordinated response; (c) online platforms and industry; and (d) raising awareness and empowering citizens (Bentzen 2019).

Disinformation is not the only area where platforms need to be better regulated. It has been an emerging practice of platforms managing and collecting huge amounts of data to allow access to and selective use of data for academic and other knowledge production purposes that are favourable for platform owners. The selective use of and access to digital data offer major technology companies to exercise bias in the organisation of scientific evidence and reshaping evidence that may support regulation. To counter this practice the Digital Services Act proposes that "gatekeeper platforms" shall facilitate access by researchers to key platform data. In addition, however, efforts to open national data sets (administrative data) would have to be ramped up.

Concerns related to takeovers of strategic European companies by investors have been a long time worry of the European Commission, growing with the economic troubles caused by the COVID-19 pandemic. In May 2020 the European Commission issued guidelines to ensure a strong EU-wide approach to foreign investment screening related to economic vulnerability (European Commission 2020l). According to the Commission the aim is to preserve EU companies and critical assets, in areas such as health, medical research, biotechnology and infrastructures that are essential for our security and public order, without undermining the EU's general openness to foreign investment. Under existing EU rules, Member States are empowered to screen foreign direct investments (FDI) from non-EU countries on grounds of security or public order. Member States can also impose mitigating measures (such as supply commitments to meet national and EU vital needs) or prevent a foreign investor from acquiring or taking control over a company.

5.3.3 Regulation, strategic value chains, and research

The EU stirred digitisation and technology development into the central focus of its political agenda. Efforts to step up European capacities to answer potentially critical developments with regards to technology revolve around two areas. One concerns regulatory measures and standard setting, the other concerns a more active policy with respect to important projects of common European interests.

To start with, three examples (on quantum computing, blockchain and ledger and Artificial Intelligence technologies) can help to highlight the realm of activities at European level. Quantum-resistant public-key cryptographic algorithms are core features of the cybersecurity landscape, an important field of policymaking and technological sovereignty. The EU Cybersecurity Strategy (European Commission 2020p), presented by the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy in December 2020, explicitly singles out quantum computing and encryption as key technologies (along with AI) for achieving (a) resilience, technological sovereignty and leadership, (b) building operational capacity to prevent, deter and respond, and (c) advancing a global and open cyberspace. Regarding blockchain, in September 2020 the European Commission adopted a comprehensive package of legislative proposals for the regulation of crypto assets, updating relevant financial market rules, and advancing with creating a Pan-European blockchain regulatory sandbox facility (European Commission 2020q). This facility aims to test innovative solutions and identify obstacles that arise in using Distributed Ledger Technologies (DLTs) for trading securities. On Artificial Intelligence (AI), the Commission published a White Paper in February 2020 stating its intention to invest in next generation technologies and infrastructures, including AI, to increase Europe's technological sovereignty in key enabling technologies and infrastructures for the data economy (European Commission 2020r). Europe's ambition is to combine technological and industrial strengths with a high-quality digital infrastructure and a regulatory framework based on fundamental values. With AI the Commission emphasises a need for a common European approach to AI to reach sufficient scale and avoid the fragmentation of the single market and warns that national initiatives risk to endanger legal certainty, to weaken citizens' trust and to prevent the emergence of a dynamic European industry.

Given the regulatory power and also the awareness of Europe's market size and the assumption of global players in need of entry to this market, Europe sees itself as a regulatory superpower. It has had relatively important successes in terms of imposing European standards on a global scale, therefore the policy ambition is to translate recent regulatory success in AI and data to other areas and potentially become a global standard setter. While this ambition is hailed by many, there is also criticism of the determination arguing that "referees don't win" matches and thus dialogue between Europe and the US, or a more cooperative attitude related to Chinese technology corporations on the subject of regulation or ban is suggested. The dialogue, critics argue, should aim not at creating and achieving identical rules, but to attain interoperable, secure and accountable systems that can work together.

One evolving discussion concentrates on the identification of Important Projects of Common European Interest, based on the respective article 107 in the Treaty of the European Union (see discussion 5.1.2), and the necessary process of prioritising and implementing the strategic value chains that are supposed to be aligned with these (see Table 7 in the Appendix). It is claimed that the focus on value chains would pose "a new approach to industrial policy" (Strategic Forum 2019a: 11). If a value chain is approved as being an important project of common interest according to the rules defined by the European Commission (2014), European state aid regulation can be waived and a range of activities is eligible for public funding, from research to feasibility studies and investments and first industrial deployment are (for a summary, see Peneder & Polt 2020: 5).

In addition to the instrument of IPCEI (which is more aligned with an attempt to revamp industrial policy at European level), regulatory as well as distributive instruments towards science and research have a long tradition within the European project of integration. The most significant outcome of this tradition is the Framework Programme for Research and Innovation, which exists since the 1980s and is currently in its ninth edition (also known as "Horizon Europe"). From the outset, the Framework Programme is a massive instrument of funding research across Europe, currently with 95.5 Billion Euro available in appropriations between 2021 and 2027. One key feature of the Framework Programme is its broad scope, both in terms of the type of research to be funded (ranging from basic research to to-the-market innovation) and in terms of the directions (ranging from purely bottom-up research funding to research and development that aims at mission-oriented research, meaning research that is (somewhat) directed towards specific goals. In addition to six thematic fields that the Framework Programme aims to cover, there are also five (more specific) missions: cancer; adaptation to climate change including societal transformation; healthy oceans, seas coastal and inland waters; climate-neutral and smart cities; soil health and food.

And still, there are a range of other initiatives to be noted as well. As 5G communication technology is expected to become the connectivity infrastructure paving the way for a large array of new products and services, such as connected, cooperative and autonomous (CCA) vehicles or connected industrial robotics, it is of especially high strategic importance for the EU. In January 2020, the European Commission published a "Toolbox On 5G Security" (European Commission 2020m) that recommends strategic and technical measures to be implemented to strengthen the security of their 5G networks. The EU regulatory frame presents guidelines designed to help EU member states mitigate potential risks arising from 5G technology while supporting the commission to ensure a diverse and sustainable 5G supply chain to avoid long-term dependency on third countries. In similar vein to other policy measures related to the

digital, the European Commission confirmed that "5G network security is an issue of strategic importance for the entire Single Market and the EU's technological sovereignty" (European Commission 2020n). Following a risk-based approach, Member States can apply restrictions for suppliers considered to be "high risk" and even exclude them from the core parts and sensible functions of their telecom networks. However, the institution did not identify any specific "high risk" company, despite the geopolitical tug of war over Huawei, which the US has completely banned from its 5G networks and has been pushing its allies to do the same. The core principle of operation in the EU is that non-EU providers are welcome to do business in Europe as long as they comply with the rules.

In a Recommendation published in September 2020, the Commission called Member States to boost investment in very high-capacity broadband connectivity infrastructure, including 5G, which is the most fundamental block of the digital transformation. Measures, developed together with Member States by 30 March 2021, will provide a common approach for the timely rollout of fixed and mobile very high-capacity networks, including 5G networks. The measures aim to reduce the cost and increase the speed of deployment of very high-capacity networks, notably by removing unnecessary administrative hurdles; provide timely access to 5G radio spectrum and encourage operators' investments in expanding network infrastructure; and establish more cross-border coordination for radio spectrum assignments, to support innovative 5G services, particularly in the industry and transport fields (European Commission 2020o).

Another key enabling technology of the digital era are cloud services. In an effort to create a new framework for data governance, a majority of Member States have adopted a joint declaration working together towards a European cloud federation initiative, aiming at shaping a secure, efficient and interoperable cloud supply for Europe. An EU Cloud Rulebook, a set of common technical rules and interconnected cloud capacities across Europe are planned. Europe aims at stepping up its funding efforts to bridge the current funding gap relative to other countries, mainly the US and China, in aiding cloud infrastructure innovation and deployment. According to the German EU Council Presidency, "Europe must rely on the strength of its broad research base and foster its growing digital infrastructure and economy, while making sure the continent's core democratic values also apply in the digital age" (EU2020.de 2020). One of the core concerns of cloud users' is their ability to control strategic and sensitive personal and non-personal data. However, specific commercial practices and a lack of interoperability between cloud providers hinder digital transformation and scale-up, as well as create risks of vendor lock-ins undermining user trust and cloud uptake.

The first major European initiative in this regard, led by Germany and France and their most important high-tech firms, is the launch of GAIA-X, a project to facilitate a secure pan-European data collection, data processing and data sharing mechanism. The GAIA-X project does not focus on creating a European competitor in cloud service provision but plans to establish a new pan-European collaborative effort amalgamating and making interoperable different cloud service providers. GAIA-X is not intended to compete against existing offers but focuses on linking different elements through open interfaces and standards in order to create an innovative aggregation platform. The platform will mainly operate in the areas that require the guarantee of identities of sources and recipients, access and usage rights, and an overall harmonisation of existing standards in order to allow for interoperability of infrastructures, applications and data. Furthermore, it will intervene in the provision of data through federal catalogues and in the establishment of compulsory EU-wide certification and standard schemes to support suppliers in offering safe and compatible services. Besides the European firms involved, major US cloud providers have also joined the initiative, as non-European firms can also enter the scheme if they accept the standards in line with EU values. Opening up to non-European players promotes the creation of a level playing field open to all who accept the common principles, without creating regulatory barriers to market entry – another instance of European standards setting and creating level playing field not only in economic but also in value terms.

6 Conclusions

Based on the empirical analyses in Sections 4 and 5, the aim of this concluding Section is to present suggestions for measures Austria and the EU could pursue to achieve greater sovereignty in the three discussed domains, namely economic sovereignty, supply sovereignty and technological sovereignty. Before we present the discussion of options in the three different domains, however, several fundamental considerations that guide the analysis will be mentioned:

First, while the pandemic has, again, demonstrated the vulnerability of global trade to supply disruptions, it also clearly demonstrated the advantages of global supply chains in overcoming crises. As the empirical evidence discussed in Section 5.2.2 clearly indicates, globalised trade *mitigated* rather than exacerbated the economic impact of the crisis.

Second, and crucially, in the midst of a crisis such as the COVID-19 pandemic, there is a danger of losing sight of the general and main challenge Austria and the EU are facing, which relates to the underlying tension between, on the one hand, an economy that is dependent on free trade, as long as it wants to maintain its course of economic growth, and, on the other hand, an increasing understanding that unfettered globalisation comes with risks that at least need to be acknowledged, if not mitigated.

Third, it is key for Austria and the EU to achieve greater robustness and resilience regarding the supply of critical goods. Resilience or robustness should not, however, be equated with achieving large-scale autarky as a general strategy for either Austria or the EU.

Fourth, free trade should remain a key aspect of EU trade policy to be supported by Austria. In recent years, protectionism has increased globally, and markedly so by major global players such as the US or China, but also the EU. Protectionism, however, increases uncertainty in global trade, leads to mutual retaliation measures and reduced economic welfare.

Fifth, digitisation and technology development will remain central to the European political agenda, and it is also likely that it will become the centre of global competition. While the EU is already becoming key standards setter in the global economic and technology arena, the innovation capacity needs to be increased, and this does not only mean increasing investments, but also optimising the way those investments are spent.

Finally, but importantly, Austria's fate as a small open economy lies with a strong and united Europe. Rather than emphasising national strategies, Austria's engagement should be aimed at deepening European integration while being a strong voice

representing the interests of the smaller member states. At the same time, this is a role Austria can approach with self-confidence. Given its competencies in many areas such as hydro power or photovoltaics, Austria can play an important role in bringing the EU to the top worldwide in these technology fields that are becoming increasingly important in combating climate change. More generally, the great financial crisis or the COVID-19 crisis have shown the crucial contribution of member states with a strong industrial base, such as Austria, in weathering such crises. At the beginning of the recent crisis, the manufacturing sector was hit by the temporary interruption of global supply chains. By the end of 2020, however, it was manufacturing that recovered the fastest due to high demand from Asia and the US. Services, by contrast still suffer from policies aimed at containing the pandemic. In addition, Austria can play an important role in containing China's influence in the EU's neighbouring regions. Historically, Austria has been an important link to the East, and the Western Balkans in particular. It therefore has a crucial role as an advocate for these countries to become members of the EU, as soon as they fulfil the relevant criteria, thus mitigating China's attempts to increase its political and economic influence in the region through its "Belt and Road Initiative".

6.1 Economic sovereignty: shaping the future of globalisation

There is little doubt that globalisation and the allocation of resources according to global comparative advantages has increased welfare. Even before the COVID-19 pandemic demonstrated (again) vulnerabilities of the global trade system to disruptions and triggered a discussion on the future of globalisation, the trend towards ever increasing globalisation had slowed down considerably. This is apparent in the return to protectionist policies by major economic players and a growing scepticism vis-à-vis bi- or multilateral trade agreements. While much of the discussion focuses on the politics of former president Donald Trump, we see somewhat similar developments in the EU as well. Initiatives such as CETA, TTIP or an EU Mercosur Free Trade Agreement have been met with much criticism from within the EU, and the future of the latter two is, at this point, unclear.

By contrast, the Asia-Pacific region has a large growth potential and invested successfully in establishing large free trade areas such as the Regional Comprehensive Economic Partnership (RCEP) in late 2020, including 15 countries which account for slightly less than 30% of world GDP, world trade and world population. Unless the EU strengthens its efforts to shape the global trade system, tendencies towards increasing global protectionism as well as both public and governmental scepticism towards free trade agreements create a realistic danger of de-globalisation and a decrease in the economic importance of the EU or the US, and thus of those economic players that that

predominantly shaped the current world trade order. In the future, we are likely to see the formation of different economic, but also political blocks with China and the Asia-Pacific region as well as Africa forming one block, America, UK, Australia and New Zealand the other. Future EU trade policy thus needs to ensure that the EU as a global economic player is not left behind when it comes to global free trade. Since the EU has close economic ties with all world regions, joining one of the blocks would have major negative economic consequences. Yet given its importance as an economic area, Europe can be self-confident enough to play an independent and thus stabilising role in the world economy.

This is also true regarding the position of China in the world market. The rising importance of China as the EU's export market and suppliers of import goods notwithstanding, the overall economic exposure of the EU to China is still relatively limited. Despite its large coverage in media and in the political debate, investments related to the Belt and Road Initiative (BRI) are still small in the EU. There are also a few greenfield investment initiatives of Chinese companies. The economic importance of China also varies between the EU member countries. It is highest for Germany, Ireland and the Scandinavian countries and smallest for most Eastern and Southern countries. Regarding the economic ties between the EU and China it has to be kept in mind that the dependence goes both ways. China has much to lose from deteriorating relations with the EU, which is one of the largest foreign investors and job-creators in the country, as well as an important market and source of know-how. The policy of the EU vis-à-vis China should therefore not be constrained by an exaggerated perception of economic vulnerability, but the EU should be aware of its relative strengths. Preserving a healthy degree of economic interdependence should be in the interest of both the EU and China (see also Zenglein 2020).

In an era characterised by the developments sketched above, Austria's fate as a small open economy lies with a strong and united Europe. This does not mean that Austria is spell-bound to what the larger nations in the EU realm decide; on the contrary. Austria can align itself with the greater powers within the block (Germany, France) *and* at the same time be the voice and unifying power of the smaller countries in Europe. Beyond existing collaborations and its strong political presence in the Wester Balkans, Austria could also align more closely with the interests of Northern European countries and create alliances that help make Europe both more united and stronger. In particular, Austrian EU policy should focus on securing the full operation of the European Single Market, including full freedom of movement of services and people. This would make the European Union more competitive and an even stronger player within global markets. In addition, a well-functioning single market would facilitate the adjustment of both companies and consumers to economic disruptions.

As the empirical evidence on trade agreements has clearly shown, open markets are beneficial for economic welfare. The politics of former US president Donald Trump clearly illustrated the dangers – and futility – of a renationalisation or of nationalist policies. Such an approach provokes reciprocal actions by other governments – the trade war between the US and China with ever new rounds of new and higher import tariffs is a warning sign in this regard. As could also be seen during this trade war, in the end such a policy is also detrimental to those domestic industries and workers meant to be shielded by the protectionist measures. For example, when the US administration had imposed tariffs on certain imports from China, China reacted by importing soybeans from other countries. This hit US farmers. So even for a large economy such as that of the US, autarky is less an option than it might have been a few decades ago. And for the EU, which is dependent both on imports of certain raw materials simply not available in Europe and on exports, autarky is not a realistic policy option. A policy of isolation would clearly reduce the welfare of the European people. And for the small and very open economy of Austria, this applies to an even greater degree.

Having argued against economic nationalism and in favour of open markets and borders, it should be stressed, however, that where open markets lead to the exploitation of workers or the environment by moving parts of the supply chains to countries with less strict rules, such a globalisation cannot be the future. Discussions in the past decades, and not least the protests against free trade agreements, have clearly shown that in the future the focus cannot be on trade liberalisation alone. Here, Austria and the EU in general should work towards agreements on global rules regarding minimum social and environmental standards and apply market-conform instruments such as emission trading systems or border-adjustment taxes to obtain a level playing field regarding EU and global production costs. In the end, global differences in social standards or environmental regulation should no longer be a reason for companies to relocate (parts of) their value chains.

Rather, in a globally connected world, the companies at the end of the supply chains ought to – as far as this is practically feasible – consider environmental and social issues along their supply chains. Here, possible political instruments include due diligence legislation that requires companies to take responsibility for the observation of environmental and social standards in the countries from which they buy their raw materials and intermediate products. Already existing legislation or legislative initiatives could be expanded accordingly (see also section 6.2). Another political instrument is the currently debated carbon dioxide border adjustment mechanism. Such a mechanism would increase the price of imported goods by taking possible emission taxes into account that are imposed in but not outside of the EU. The same principle could be applied to the internalisation of external costs in general, making long-distant transport

more expensive. All this would make it relatively more attractive for companies to develop value chains at smaller distance. Such a policy could increase the economic sovereignty of the EU and protect workers in European industries that are currently at risk of being pushed out of the labour market because the production is moved to countries with lower wage costs. At the same time, differences in wage costs as such can hardly be levelled by EU politics. Such differences in wages, and thus in productions costs, due to global differences in the abundance of the production factor labour should be accepted. Only those cost differentials that are due to the exploitations of workers or the environment should be subject to European attempts to ensure global minimum standards.

Using subsidies and restrictive conditions to establish or expand domestic production capacities, by contrast, may not only be contrary to WTO regulations, but such a policy which counteracts market forces would also be inefficient. Tariffs that are not due to the internalisation of external costs create welfare losses. Compared to a situation without tariffs, such measures lead to a transfer of consumer and producer surpluses to the government, but in addition to this redistribution, they also result in "dead-weight losses": total welfare in a world with tariffs is lower than welfare in a world without such restrictions.

Similarly, the state aid rules of the EU are already flexible and allow subsidies necessary to address acute crises as well as future developments. We therefore do not consider the EU state aid regulatory system to be in need of fundamental reform. Care should be taken, however, to adapt the existing framework to new challenges, as outlined in the "fitness check" the European Commission recently conducted (European Commission 2020s: 107ff.). State aid rules are an important means to avoid distortions of trade both within the internal market and on the global market. Most importantly, however, while EU state aid rules may at times seem a disproportional restriction of governmental discretion regarding industrial or economic development policies, they, in fact, not only protect producers from unfair competition and distortive subsidies within the internal market, but also member states by preventing a fratricidal aid competition between Member States. This is especially crucial for smaller member states, such as Austria, which would find difficult to compete in a subsidy spending race with much larger Member states such as Germany or France. Rather than working towards or supporting a loosening of EU state aid rules, it is in Austria's crucial interest to contribute to ensuring that state-aid control to foreign companies is made more effective, both within and outside of the EU. Austria should therefore be a strong voice within the European Union regarding a reform of the WTO Agreement on Subsidies and Countervailing Measures. A reform of the rules as well as other measures to reduce market distortions, to increase

transparency in terms of subsidy notifications and to adapt the framework for trade in services would be in Austria's interest.

The increase of public debt during the COVID-19 crisis, public finance burdens related to the ageing of the population, and necessary investments to combat climate change will require a stable growth of public revenues in the future. In this context, all global initiatives to combat global tax evasion and to ensure a fair international distribution of taxes paid by globally operating multinational companies are welcome. Hence, the Austrian government should contribute as much as practically possible to engage in these discussions and initiatives at the OECD and the EU level.

Most importantly, the EU should strive for multilateral agreements of free trade, even if the welfare gain for the EU might be modest in terms of addition GDP created (Kommerskollegium 2020a, see also 2002b; Sébastien et al. (2018). Such ambitious agreements are especially important because they provide a kind of insurance against global trade wars. Here, again, the trade war between the US and China can be taken as a negative example. In order to end the trade war, the two governments reached the "Phase 1 deal" in February 2020, setting targets for additional Chinese imports of US goods and services. Such bilateral agreements with specific bilateral trade targets lead to trade diversion to the contracting parties and away from other countries. By contrast, multilateral agreements do not create such detrimental effects for third parties.

Regarding the connection between trade, social and environmental issues, Sébastien et al. (2018), for example, recommend signing such multinational agreements only if the implementation of the Paris Climate Agreement is observed. Yet the EU could push even further regarding the combination of trade issues with the observance of social and environmental standards in global trade agreements. Indeed, the EU has not only considerable influence on global prices and trade volumes due to the sheer economic weight of the single market, but also wide-ranging experience with non-protective trade policy instruments and with setting standards regarding production processes and working conditions. The combination of both allows it to develop the rules for trade, investment and services in bilateral agreements, and to be a strong player in multilateral agreements as well.

Only if multilateral or plurilateral efforts fail, the EU should, as the Swedish Board of Trade (Kommerskollegium 2020a) concludes, liberalise the imports of critical goods, such as raw materials and intermediate goods, unilaterally. Liberalisation of intermediate goods improves firm level productivity, thus strengthening competitiveness. Another option if multilateralism fails is to continue to diversify the EU's network of regional trade agreements and to make them more interregional. The

long-term objective would be to multilateralise mutually agreed commitments in EU regional trade agreements (RTAs).

6.2 Supply sovereignty: ensuring robustness and resilience

The temporary interruption of global value chains during the first phase on the COVID-19 pandemic demonstrated the general vulnerability of Austria's and the EU's supply chains. The first outbreak of the COVID-19 virus in China interrupted production in countries where the virus had not even appeared at that time, as Chinese manufacturing was brought to a standstill in the affected provinces. On the other end of the value chains, suppliers of products which China imports to be used as intermediate products were affected as well. As the pandemic spread across the globe, disruptions increased. The pandemic thus not only demonstrated the EU's dependence on critical imports, but also challenged the strong international fragmentation of supply chains and just-in-time production. During the globalisation process, producer strategies were mainly based on a rationale of cost-effectiveness. As a result, parts of the production were moved to countries with low labour costs; just-in-time delivery systems meant that expensive warehousing was transferred to the street. Such systems are vulnerable to disruptions, whether based on more local or regional supply disruptions, large-scale supply and demand disruptions as in the case of the pandemic or disruptions due to political developments or political strategies in the supplying countries. Resilience and robustness are therefore elements of supply sovereignty that need to be addressed beyond conclusions based on the immediate experience with the pandemic.

As outlined in section 5.2, the development of proactive strategies aimed at achieving resilience or robustness depend on the identification of supply chain vulnerabilities. Two main approaches were identified: One approach consists of developing crisis scenarios based on different types of disruptions (e.g., European Commission 2021; Kleb et al. 2016, Lund et al. 2020). Under this approach, the analysis mainly focuses on the probability of occurrence and potential severity of man-made or natural disasters, as well as their potential impact on the production of goods in different sectors. A different, but often complementary, approach focuses on the development of critical goods lists. Here, some definitions of critical goods are based on import dependencies and supply risk in terms of country-level concentration of global production (e.g., the list of critical raw materials compiled by the European Commission 2020; see also Zenglein 2020), others, and especially lists of critical medical goods, often rely on a needs-based definition.

To achieve robustness, i.e., the uninterrupted supply of specific critical goods, stockpiling is clearly advisable. Given the cost and management intensity of establishing and maintaining stockpiles, however, suggestions point towards a greater coordination and cooperation at the EU level rather than nationalised approaches. Cooperation within the EU could, for example, lead to a joint list of essential goods and a division of labour regarding the stockpiling of these goods, where feasible, including maintenance as well as distributions logistics throughout the EU. This could build upon the recent EU initiative to create a decentralised[31] European stockpile (strategic medical rescEU reserve) for medical and personal protective equipment, vaccines, therapeutics and laboratory supplies as well as a distribution mechanism under the umbrella of the EU Civil Protection Mechanism.[32]

With regard to the goods to be stockpiled, the examples from other countries (see section 5.2.1) have shown that the main items included concern basic and durable foodstuffs, such as grains, rice, powdered or condensed milk, but also cooking oils and fats as well as animal feed. While these goods are characterised by a fairly low obsolescence, it also needs to be taken into account that some of them require further processing before consumption. This is especially the case for grains that need to be milled before further use. A substitution in milled form (flour) is not considered advisable due to the substantial reduction in shelf-life.

A second category usually includes pharmaceutical products (both finished products and active ingredients) as well as personal protective gear such as respiratory masks and surgical gloves. Whether and to what extent medicinal products or pharmaceuticals on critical goods lists can or should be stockpiled depends on risks assessments regarding supply disruptions, assessments regarding the needs for specific medicinal products in medical emergencies (robustness) as well as the suitability for and costs of stockpiling. Known stockpiles, such the SNS in the US or the Swiss stockpiles include personal protective equipment, especially gloves and respiratory masks, which can be stockpiled over a long period of time. With regard to *pharmaceuticals*, stockpiling in Switzerland, for example, follows three fundamental criteria: a good is critical in terms of supply (small number of suppliers and potential substitutes), it is essential in terms of medical need and the number of patients surpasses those of so-called “orphan” diseases or medical conditions (i.e., more than 5 patients per 10,000 inhabitants) (BWL 2014: 10).

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[31] The decentralised stockpiles are currently hosted by 9 EU Member States (Belgium, Denmark, Germany, Greece, Hungary, Romania, Slovenia, Sweden, and The Netherlands).

[32] Commission Implementing Decision (EU) 2020/414 of 19 March 2020 amending Implementing Decision (EU) 2019/570 as regards medical stockpiling rescEU capacities (notified under document C(2020) 1827) (Text with EEA relevance), C/2020/1827, OJ L 82I , 19.3.2020, p. 1–5; see also the European Commission website on Crisis Management and Solidarity: https://ec.europa.eu/info/live-work-travel-eu/coronavirus-response/crisis-management-and-solidarity_en#requestsformedicalandprotectiveequipment.

Note, however, that the Swiss system (which also includes the stockpiling of fuels, heating oils or plastics) is based on mandatory stockpiling by the private sector ("Pflichtlager", see section 5.2.1), with costs transferred to consumers. This system has the distinct advantage that stockpiles do not have to be warehoused, managed and regularly replenished by public authorities. Rather, stocked goods remain in the ownership of the private companies as part of their inventory.

The Swiss system is based on both, the constitutional *responsibility* of the government to ensure a national emergency supply as well as the constitutional *right* to depart, if necessary, from the principle of economic freedom. While the introduction of a similar system of mandatory stockpiling by the private sector could therefore be difficult, if not impossible, to implement in countries without such constitutional provisions (as argued for example by the German Federal Ministry for Food and Agriculture, see Deutscher Bundestag 2020), the fundamental approach of including the private sector in stockpiling strategies could certainly be adopted in Austria and the EU as well.

One approach could consist in designing EU-wide public-private robustness-oriented procurement strategies based on involving selected providers instead of maintaining large stockpiles. This view is supported, for example, by Paolo Mazzoni, head of Government and Public Affairs at 3M in Italy (cited from Vecchi et al. 2020), who argues that the most efficient way for governments to ensure the availability of critical devices is the selection of a group of reliable providers from which to purchase available stocks, to be used when needed. This would entail such experienced providers planning production, warehousing, but also being responsible for supply logistics in the case of a disruption or emergency. In return, providers would be compensated for the incurred continuous costs as well as the costs for the final products delivered.

"This solution could be more value for money than the direct purchase and management of a warehouse […] Different procurement approaches, where public authorities act as sophisticated buyers to stimulate innovation and productivity through more public-private dialogue and collaboration, in coordination with local development policies, could, therefore, provide more affordability, sustainability and overall resilience" (Ibid.).

Here, reshoring can provide additional safeguards to achieve robustness as well as resilience. Yet re-locating entire (or crucial parts of the) supply chains back to the EU or individual member states will come with several problems (see also section 6.1 above). First, production costs will inevitably be higher, thus rendering the production of such good less competitive on the global – and domestic- market. Outside of a supply disruption, producers may therefore find it more difficult to keep their goods on the market. In general, policies aiming at opposing market forces are considered inefficient. Second, the use of state aid and/or restrictive conditions to establish domestic

production capacities or to subsidise the production of such goods, even if admissible under, accordingly adapted, EU state aid rules, would breach WTO rules laid out in the SCM, almost certainly resulting in countervailing measures by the EU's trade partners. Third, the question remains whether domestic production under normal circumstances can be increased substantially enough to meet a greater – and potentially explosive – demand during a large-scale crisis that results in a disruption of other, global, supply chains.

Note that the arguments above refer to reshoring as a strategy to achieve greater robustness and resilience in the supply of critical goods. By contrast, reshoring can certainly present a strategy aimed at the maintenance or development of high-tech skills, innovation, R&D etc. For example, one of the arguments of the European Commission to tap into EU raw materials resources is also related to the fact that "[i]nvestment in the production of primary and secondary raw materials would benefit employment in all manufacturing industries […,] help retain existing geological and metallurgical high-tech skills and develop new ones to boost the EU's global competitiveness in a sector that has solid growth potential in the 21st century" (European Commission 2020d: 18). Reshoring related to *technological sovereignty* has recently also gained currency in the press, academic research and policy discussions (Backer et al. 2016). The post-pandemic risks debate has elevated this option for managing global value-chains for key technology related manufacturing. Smart backshoring (relocation of key or specific elements of, or strategic relocation from offshore production sites) as well as nearshoring (relocation of previously offshored activities to a nearby neighbouring location) options should be considered related to specific technologies, especially those that are deemed strategic for technological sovereignty. Emerging technology options, such as additive manufacturing and manufacturing on-demand, may also inform debates and challenges related to technological sovereignty. Such decisions related to specific technologies should be made involving a wide array of stakeholders in the discussion process.

Generally, however, we do not consider reshoring or a re-nationalisation of early links in the supply chains as a sustainable strategy to achieve either robustness or resilience. To reiterate: "the choice of autarky and self-sufficiency remains illusory given the small size of the European continent, its population, its natural wealth and the importance of international trade for European employment and economic activity. A renationalisation of trade policies would lead each of the Member States into a strategic impasse and a loss of real sovereignty, due to the low weight of their respective economies in world trade" (Hervé 2021).

Therefore, the answer to the challenges posed by strategic dependencies or crisis-related disruptions to supply chains should not predominantly be reshoring or

backshoring, i.e., nationalisation, but rather more diversification. In the international trading system, it is also paramount that importing countries can trust that foreign suppliers and their governments will not act opportunistically in crises, i.e., that they do not impose export restrictions. The greater this risk, the more necessary it is to ensure sufficient diversification of supply sources to compensate for the (often temporary) loss of one or more suppliers. This is economically more advantageous and a more sustainable strategy than foregoing the benefits of the international division of labour.

While a diversification of suppliers is mainly a management decision by individual firms, information and transparency regarding suppliers is key. Here, as also outlined by our interviewees, one of the main problems is that especially smaller companies often lack adequate data regarding their supply chains. For Austria and the EU, greater transparency regarding crucial supply chains, and thus also over potential supply vulnerabilities, especially due to chokepoints (reliance on single or a very small number of suppliers), would not only aid in the identification of goods where full or partial reshoring may be necessary, but also of opportunities for nearshoring in the EU's neighbourhood (for example in the Western Balkans) and for greater supplier diversification.

In similar vein, data availability also remains an issue when it comes to system-wide analysis. Eurostat data, for example, is only available at a highly aggregated level, i.e., at the level of imports by member state or exports by exporting country, but not at firm level. As already indicated in section 5.2, there are also inherent difficulties in tracing supply networks for research on logistics. The example of the commercial database Bloomberg Global Supply Chain Data illustrates (see section 5.2.3) that data would need to be collected from a broad variety of sources (Bloomberg mentions financial reports, investor presentations, conference calls, news releases, trade journals, product catalogues, and company websites), merged and analysed. Importantly, supply chain data, especially if used for encompassing supply chain management, increasingly requires technical and personnel capacities to analyse so-called "big data", i.e., data far exceeding traditional data in terms of size and complexity (Jabbour et al. 2020 for a literature overview).

In addition, there are also restrictions due to legal and cultural circumstances. Legally, firms are not obliged to reveal their supply networks, but they could do so voluntarily, of course. In that respect, however, there are also large differences within European countries. As our interviewees report, access to firm data for researchers concerned with logistics of supply chain is often available in Scandinavian countries, and, in general, also more common outside the German-speaking countries.

Similar problems were reported for an analysis regarding data on specific SME imports and importers (e.g., European Commission 2017). Request for data sent to member states governments via the European Commission did not result in any replies, although it is unknown whether this was due to a lack of data or an unwillingness to share available data. Both may very well be the case. Barriers in gaining access to data from private companies "take the form of concerns on the part of private companies about losing their competitive advantage; legal constraints concerning privacy and confidentiality of client information; and the costs of setting up the necessary infrastructure and training staff for a non-core business related activity" (Klein and Verhulst 2017: 8, see also 15ff.). Based on case studies where corporate data was made accessible, Klein and Verhulst (2017: 11ff.) identify six types of incentives for private companies: reciprocity (e.g., gaining access to data sources in return); research, recruitment and insights (, e.g. ability to benefit from external data analysis skills and methodologies; opportunity to identify and hire new talent); increasing revenue (if data is offered for sale); regulatory compliance; reputation and public relations; and responsibility and corporate philanthropy. Where the main drivers for voluntary data sharing in cross-sector partnerships are based on reciprocity and self-interest (which can be assumed for the sharing of supply chain data), governments or public authorities need to adopt an active role, working closely with businesses to identify and implement win-win scenarios (Susha et al. 2019)

Yet any sharing of data by private companies requires that companies are actually in possession of data on their supply chains, and as mentioned above, this is often not the case. Here, existing EU legislation[33] as well as legislative initiatives regarding due diligence with respect to supply chains may be a first step. In its Communication on Future EU Trade Policy, the European Commission (2021b: 14) announced that it will bring forward a "proposal on mandatory due diligence, including effective action and enforcement mechanisms to ensure that forced labour does not find a place in the value chains of EU companies. Similarly, the German "Sorgfaltspflichtengesetz" (for details see BMWI 2021) ("due diligence act"; often termed "supply chain act" [Lieferkettengesetz]) will, if ratified by the German Parliament, oblige German companies to ensure that their direct suppliers adhere to human rights as well as, albeit less emphasised, environmental and social standards. In addition, violations of these standards by suppliers further along the chain must be analysed and addressed if companies gain substantial knowledge of them. From 2023 onwards, it will apply to companies with 3000 or more employees, to

[33] Regulation (EU) 2017/821 of the European Parliament and of the Council of 17 May 2017 laying down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high-risk areas, *OJ L 130, 19.5.2017, p. 1–20.*

be extended to companies with 1000 or more employees in 2024. In France, similar legislation exists since 2017.[34]

Such due diligence legislation, while certainly important, focuses mainly on large companies or even, in the French case, on multinational enterprises. For smaller companies, however, some degree of transparency over their supply chains is a vital precondition for diversification as well.

Further initiatives and funding programs at the Austrian or EU level could be envisioned. Importantly, governments can support efforts of firms, and especially SME, to build more resilient global value chains by collecting and sharing information on potential concentrations and bottlenecks upstream, by developing stress tests for essential supply chains and by creating a conducive regulatory environment which is not a source of additional uncertainty (see also OECD 2020d). Given the interdependencies within the European internal market, the EU could take the initiative in designing a specific funding and support program. The above-mentioned study (European Commission 2017) already developed a number of suggestions.

Alternatively, such support could be organised at the level of the member states and within EU state aid rules (see section 5.1.2), provided such support is available to all firms (i.e., not *specific* in terms of Art. 107 (2) TFEU) or characterised as a common European interest (Art. 107 (3) TFEU). Examples that could provide important inputs for EU policies in this area are, for example, the recent initiatives in Australia or the US.

In addition, an EU Horizon 2020 project (PROFILE, www.profile-project.eu), which brings together five European customs administrations (Belgium, Norway, Sweden, Switzerland and The Netherlands), leading technology providers (e.g., IBM) and universities as well as research institutes, currently investigates and develops solutions for the collection, organisation, mining and analysis of big data, as well as for customs-to-customs systematic sharing of Entry Summary Declarations and other risk-relevant information through the EU-wide PROFILE Risk Data Sharing Architecture (RDSA). The project also connects national customs risk management systems to logistics Big Data of INTTRA and the Universal Postal Union (UPU) and provides customs an improved access to online data, especially valuation-relevant data of e-commerce sites. The main aim of the project is to facilitate customs responsibilities regarding inspections and customs declarations and to improve customs capacities to cope with transnational crime and terrorism, but future projects could potentially also include the analysis of customs data for the development of an EU-wide database on supply chains at the firm level.

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[34] LOI n° 2017-399 du 27 mars 2017 relative au devoir de vigilance des sociétés mères et des entreprises donneuses d'ordre (1). Available at: https://www.legifrance.gouv.fr/eli/loi/2017/3/27/2017-399/jo/texte

Finally, as also argued above (see section 6.1), the EU should strive to complete the Single Market. From a resilience perspective, a well-functioning single market makes it easier for both companies and consumers to adjust to economic disruptions. Importantly, while the EU should aim at removing unnecessary restrictions on global trade as a general strategy, this is of utmost importance in times of crisis. Here, EU legislation, or at least some form of binding agreement among its members, that prevents member state governments from setting export limits or requisitioning critical goods is woefully needed as the pandemic has shown. "Harm-thy-neighbour" policies are fundamentally opposed to European values and commitments, and they are detrimental from a purely rational and economic point of view.

6.3 Technological sovereignty: navigating futures

Technological sovereignty is an emerging policy-guiding principle to design and apply policies that guarantee the autonomy of governance specifically in the era of digitalisation. This entails, among other technological and digital transformations, the widespread use of artificial intelligence (AI) and a generic shift towards the application of arithmetic decision making in all walks of life from mobility to industrial manufacturing (Braun 2019). Europe's ambitions in designing, governing, and developing future technologies are grounded in core European values of democracy, equity, social justice and privacy. Technological sovereignty is not (only) Europe's quest to (re)enter the global geopolitical domain determining the future of the planet by innovating and deploying new technologies, but also Europe's desire to gain the necessary autonomy in governing the democratic and equitable wellbeing of (all) European peoples.

Navigating global technological futures, whether of specific technologies or of the digital age as a whole, requires an approach that is as much grounded in shared visions of justice, collective and individual needs and rights, awareness of potential exploitative use, attention to diverse knowledges both in Europe and globally, the creation and maintenance of a pluralistic and safe internet, and in appropriate safeguards of a platformed public sphere as in a thorough understanding of the nature of the technologies that will create and determine our futures. It is connected to a digital infrastructure related to technologies such as 5G, artificial intelligence (AI), cloud computing and the internet of things (IoT) protecting and aiding digital markets.

When it comes to strategy, it is common to distinguish between horizontal and vertical policies, the first referring to (regulatory and distributive) measures on various matters which cut across different subject areas, and the latter referring to regulations which apply to a specific sector, or field. Traditionally, the focus of European member states

has been on horizontal actions, due to some implications from the European treaties but also because of efficiency. In the most general term, it is advisable that politics should provide a framework that is conducive to Schumpeterian "creative destruction", i.e., "the process of industrial mutation that continuously revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (Schumpeter 1942 [1994]: 82f.). What this means in less dramatic terms is that, usually, a horizontal approach would be advisable: instead of deciding now what strategic future industries might be and tailoring policy initiatives for to them, Austria as well as the EU should focus on providing the resources and regulatory framework required to boost both industry and academic innovation and research and development.

From this perspective, legislation on the establishment of start-ups, as well as University spin-offs are typically seen as helpful, as well as the establishment of a venture capital market. When it comes to research and development, the key for Austria is to increase the performance of its innovation system; this is also in line with the goals in the Austrian Strategy on Research, Technology and Innovation for 2030 (Austrian Government 2020: 8). Austria already spends a relatively high share of its GDP in research and development. This has brought some important achievements. There is now a relatively high degree of cooperation between science and businesses. Yet when it comes to other key indicators, such as the number of start-ups and spill-overs, Austria is lagging. Also, the quality of basic research remains relatively modest in comparison to increased investments (see Janger and König 2020). There are various potential reasons for these mixed results, among them most likely a relative low share of competitive funding for basic research, and also a relatively low share of investments in mission-oriented research (that is, research on a rather broadly defined topic that spans the entire innovation cycle, from basic research to technological development and market roll out). A shift towards more mission-oriented research would not only align with the broader European trend, but also potentially bring synergies with industrial policy.

The current emphasis on missions and a renewed interest in industrial policy also indicates that there is now a renewed interest across Europe to embark (again) on more vertical-oriented policy measures. In that respect, the ongoing discussions about role of strategic value chains within the European single market deserve specific attention. Austria has now begun actively participating in the process of identifying, and implementing, important projects of common European interest (IPCEI) (Peneder and Polt 2020). Eight strategic value chains have been identified as of key importance (Strategic Forum 2019a: 12-3, see also Table 7 in the appendix); a systematic assessment from an Austrian perspective of those eight value chains provides a useful overview of where industry as well as research and development centres located in Austria would

make an important contribution. Importantly, the assessment also provides a good comparison of each of the value chain's potential for the Austrian economy (Hartmann et al. 2020). As nuanced as the findings of this report are, we conclude from them that Austria would be well-advised to participate in most of the IPCEI to be implemented.

While the discussions on strategic value chains and IPCEI are certainly of utmost importance to Austria, there are also important aspects that should not be lost out of sight. First, and most generally, as a small player within a bigger polity and single market, Austria needs to find its niche areas, that is: it needs to develop capacities to identify where its vested interests lie and to strategically direct its resources towards such areas and fields to be at the forefront of developments.[35] Yet caution is advised when it comes to the identification or definition of specific strategic *industries* that might be important in the future.

Second, and with this caveat in mind, it should also be stressed that the majority of 31 value chains that have been initially listed by the group of European experts (see Table 7 in the appendix) appears to remain largely out of the scope of the discussions. It would be advisable to continue the Austrian discussion on strategic value chains that has already begun (Peneder and Polt 2020) but to decouple it somewhat from the now pre-given European discussion that currently centres primarily around IPCEI as a policy instrument. Important as this European instrument may be, it comes with the danger of losing sight of the other potential fields of technology that are of strategic relevance to Austria. This is because of the way the strategic value chains to be implemented were selected at the European level; hence to focus only on these could in effect produce a certain myopia on the Austrian side.

Therefore, third, to lay the ground for inserting Austria's interests when it comes to implementing instruments for additional value chains, it could be advisable to insist on maintaining a broader perspective, at least in the domestic domain. One example of how an alternative list of fields of technologies could look like is provided in Table 3. Based on a selection of interviews, this list comes up with a limited number of fields with strategic relevance that nonetheless is different than the ones outlined in the report by the Strategic Forum (2019a). And while this list should only be taken as a preliminary and first attempt (as it relies only on very limited input and thus is far from being complete in terms of the norms of foresight as stated in Section 3), it could serve as a starting point for the continuing discussion in Austria. It should also be noted that this separate list still allows linking to the value chains debated in the European context, as

[35] This is in line also with the Austrian Strategy on Research, Technology and Innovation for 2030, as adopted in 2020, where participation in EU Missions, EU Partnerships, and IPCEIs is foreseen as part of the overarching field of action to strengthen the national innovation system. See Austrian Government (2020: 8).

the similar focus on fields such as micro-electronics, health, renewable energy, and energy storage highlights.

Finally, and following from the previous point, to be able to insert Austrian interests into the European debate, it would be advisable to establish a national forum of continued exchange between policymakers, stakeholders, and foresight specialists. This forum could be organised as an inter-service working group, hosted, for example, by the Austrian Council for Research and Technology Development (RFTE). Importantly, this working group should not only facilitate the exchange among experts, but it should also have the capacity to conduct foresight studies to inform the discussions and building consensus on sound evidence. The list in Table 3 could serve as a starting point for such an ongoing, and structured approach for identifying future fields of technology with strategic relevance to Austria.

At the European level, the capacities to strengthen technological development along strategic value chains should probably not be fixated on IPCEI alone. As the example with GAIA-X shows, there are different avenues to achieve that goal. Europe does have a sophisticated and densely populated landscape of innovation policy instruments. It reaches from the various specific programmes within the Framework Programme for Research and Development ("Horizon Europe"), including basic research (European Research Council), topic-related funding for research and development (Societal Challenges), and support to bring novel technologies to the market (European Innovation Council), to cohesion funds, most prominently from within the European Regional Development Fund (ERDF).

Table 3: Future fields of technology with strategic relevance to Austria

Technological field	Specification/Application	Related strategic value chains (EU)
Microelectronics	• Chip design • Power electronics • (New) Sensor Technologies • Processor Technology	Micro-electronics
Health (medical technology and pharmacy)	from mask production to high-tech pharmaceuticals and therapies (biotech)	Smart Health
Energy with focus on renewable energy (conversion, production, storage, transmission, grids)	• Power electronics for energy supply, conversion, and transmission (especially in connection with renewable energies; smart grids) • Digital technologies for the energy transition • Batteries for mobility transition	Micro-electronics; industrial IoT; batteries; hydrogen
Safety and Security	• IT Security • Quantum communication/cryptography	Cybersecurity; high performance computing

Production/ Transport/ Logistics	• Circular Product Design
	• New materials
	• Clean Industry (Emission Reduction)
	• Industrial process technology (engineering)
	• Automotive engineering (e-mobility, autonomous and connected vehicles)
	• Aircraft construction
	• Digitalisation and digital networks in the ecosystem with a focus on
	  • Industry 4.0
	  • Circular economy
		Critical raw materials for innovative applications; advanced materials; low CO2 Emissions Industry; industrial robotics; clean, connected and autonomous vehicles
		
		industrial IoT; net zero energy building construction and renovation; plastics recycling; E-waste recycling

Source: Based on interviews and literature review; Question: In which technology fields would EU sovereignty be desirable and would Austria be able to make important contributions, thereby also securing or building added value? "Related value chains" refers to the eight value chains identified by the Strategic Forum (2019a).

Another important topic concerns standardisation: as the EU moves digitisation and technology development into a central focus of its political agenda, Austria could also support the role of the EU and the European Commission as key standards setter in the global economic and technology arena. Austria may bring its existing regulatory capacity and experience with regulatory sandbox experiments[36] to aid European standards

[36] See, e.g., Austrian Federal Ministry of Transport, Innovation, and Technology (2019); Austrian Federal Ministry of Finance (2020).

setting and regulatory sandboxing agendas. Austria may also offer valuable expertise to assess and further research societal impacts of datafied environments, platforms and address potential adverse effects of restricting the public sphere, limiting diversity and generating systemic biases.

Value based and citizen centred approaches to advance Europe's position as regulatory superpower and global trendsetter should continue to be supported and aided. Vigilance and capacities to tackle amplified local polarising content are required. Austrian politics and administration should also carefully assess practices, policies and political decisions of some EU states, such as neighbouring Hungary, that tend to align their strategies with some of Europe's adversaries. As evidenced by a number of publications by local NGOs, operations that may have hostile effects in this realm are often assisted by regulatory measures and financial aid.[37]

Finally, specific emphasis should be directed towards involving experts and civil society actors alike into policy level decision making related to future technologies to assess societal impacts, public acceptance and to anticipate dual impacts. It is a truism that technologies are not simply artefacts or systems that do things or make lives better, but complex sociotechnical apparatuses that are as much world-making as they are embedded in the societies they are innovated and deployed in (Bijker 1995; Jasanoff and Kim 2015). Many have called attention in the last decades to the dangers of seeing technology as solutions to the social or technical ills we encounter and suggested policy approaches and implementation practices to aid value-based design and better social embeddedness of future technologies (Mejlgaard et al. 2018; Novitzky et al. 2020; Owen et al. 2013). As future technologies will have strong social impacts, and technical approaches do not provide full insights into potential adverse societal effects, especially in quantum computing and artificial intelligence, development and research and innovation should be complemented by responsible innovation principles and methods to address undesirable consequences of innovation in disruptive technologies.

When discussing technological sovereignty, our aim in this report is to avoid using sovereignty, and technological sovereignty specifically, as a "catch-all phrase" to legitimise actions that aim to use technology or R&I to address multiple ills of present European societies. Policy considerations reflecting on challenges of energy transition and mobility transformations are to be carefully assessed, societal and democratic impacts are to be anticipated, political and economic considerations evaluated. These areas, as indicated in Figure 15 (mind map), are interrelated and interdependent. Technological sovereignty at a European and Member State level, including that of Austria, should not offer legitimation for policy orientations towards uncritical

[37] See, for example, Nagy Márton (2021); Szabolcs (2021); Szabolcs and András (2021).

investments in, development and application of new technologies in various domains of social life. The emerging concept of technological sovereignty is but one element of technology foresight and strategy. Policy decisions to invest in, develop and deploy new technologies should be made based on in-depth foresight analysis as well as in discussion with, and with the inclusion of, a broad range of different publics, and taking Responsible Research and Innovation principles to heart (Owen and Pansera 2019). As stated in Section 3 we consider technological sovereignty as policy-guiding principle, not as technological foresight or a strategy development initiative. It is targeted at guaranteeing Europe's and EU Member States' ability to access key technologies and their resources in line with values, strategic goals and ambitions as well as to fend off malign political, economic or organisational interference. Deciding on specific technology foci and R&I investment strategies are questions that require broader societal assessment and engagement than evidence-based discussions on technological sovereignty as policy orientation can offer.

As this section has highlighted, however, there are several important conclusions to be drawn for Austria when it aims at participating in shaping the ambitious aspiration of Europe to become strategically autonomous. However, this also requires additional resources to establish capacities for preparedness on a continuous basis, a better, and coordinated, access to data sets, and permanent forums at governmental level involving policy makers, experts, stakeholders and citizen that allow for discussions to develop broader visions of sovereignty in each of the domains treated in this report – and possibly also others.[38]

6.4 Sovereignty futures

Based on the discussion above, our summary of the policy orientation in the sovereignties dealt with is procedural and not normative. Rethinking globalisation and strategic autonomy (to return to the beginning of this report) is a typical "wicked problem." It poses challenges characterised by a lack of definitive problem formulation because access to, trade of and innovation in goods, services and technologies are equally relevant and form elements of the puzzle of sovereignty as a policy challenge. There are no clear rules as to when the broader political aspiration of strategic autonomy can be declared achieved as was evidenced by the onslaught of the COVID-19 pandemic or the continuous interplay of technological innovation and global political conflicts. Long-term consequences of policy decisions in trade, manufacturing, and innovation

[38] One example here could be a climate citizens council ("Klimarat"), now proposed by the Austrian government; another example, geared more towards the role of scientific policy advise, is the Future Operations Clearing Board, which is already established, but not formally implemented.

point towards limited opportunities of trial-and-error approaches and, most importantly, have no clear-cut right or wrong answers to them.

As this report argues (see Figure 1), it makes sense analytically to distinguish between several sovereignty domains in order to better grasp the respective challenges that come along with them. Sovereignty challenges are future oriented in the continuous present tense: a political community must address questions related to economic, supply chain and technological sovereignty with cautious and continuous care. Such continuous care is best achieved by establishing a foresight exercise (as briefly defined in Section 1) on policy decisions regarding access to, trade and investment in, and advancement of specific technologies, their resources, modes, ways of manufacturing and trade in the present (Stilgoe et al. 2013). It must be guided by and embedded in European and Austrian values of democracy and equity, involve different publics in the discussions of mitigating sovereignty policies and ambitions of specific social groups or societal domains, and should be oriented towards social and environmental justice.

To extend our definition of technological sovereignty (see Section 3) to all sovereignty domains discussed in this report, we suggest the development of policy action by interrogating complex procedural questions in different economic, strategic and technology sovereignty domains and in addressing different TRLs when technology challenges are involved. Answering these questions may serve as guidelines towards developing policy actions. Thus, we suggest a focus on fostering a political acknowledgement of a healthy interdependence among different major players in the globalised economy as well as a focus on European and Austrian standard setting practices in global social and environmental standards and regulations.

Regarding global trade, Austria should be active in European and global initiatives and organisations to ensure free access to global markets. At the same time, in a globally connected world, social and environmental issues as well as a fair taxation of internationally active companies and a fair distribution of such tax revenues have to be taken into account in the negotiations of multinational trade and investment treaties. Addressing the complexities of sovereignty policy actions should be guided by achieving robustness and resilience in supply chains, preferably as a joint European effort. Stockpiling and reshoring may be options to achieve robustness for the supply of critical goods, but also in areas of specific technologies that are of strategic Austrian importance. Importantly, however, challenges related to strategic dependencies or crisis-related disruptions to supply chains need to be met with greater supply chain diversification. In addition, opportunistic behaviour during crises, especially in the form of export restrictions or goods seizures, should not be possible at least within the EU. In the technology domain, Austria should support global standards setting and bring its regulatory capacity and experience to aid European regulatory agendas. Beyond tax

issues on a local, regional and global level, Austria should carefully assess strategies of its neighbours, most prominently those of Hungary, that align themselves with some of Europe's adversaries in forging global partnerships and cooperation.[39]

As our approach is procedural, we suggest discussing the evidence presented in this report regarding strengths and weaknesses as well as opportunities and threats by applying a matrix of questions that focus on key logistical challenges and societal values as opposed to specific goods, services or technologies. Such questions, potentially serving as guide to developing policy actions, entail interrogating policy decisions and policy development processes and assess whether:

a) a specific decision guarantees unhindered access to a specific good, service, technology or a combination thereof that serves Austria's strategic and competitiveness goals,
b) the specific policy assists in securing full access to all resources required for a specific good, service or technology,
c) the specific policy strengthens the acknowledgement of healthy interrelatedness amongst main global players, especially that of Europe in such collaborations,
d) a specific policy that aims at reshoring the manufacturing of a specific good or technology or a combination thereof serves Austria's strategic and competitiveness goals,
e) a specific policy action fosters setting global-, regional- or Pan-European social and environmental standards,
f) Investment in or advancement of a specific technology help better ground Austrian society in European values,
g) a specific policy action addresses adverse societal effects, such as limiting the public sphere, restricting diversity and generating systemic biases,
h) a specific policy action helps develop the knowledge base for understanding and assessing the evolving landscape of technological developments and the innovation trajectories of relevant technology domains.

Such questions guide our policy recommendations and should assist policy makers in developing policies that foster sovereignty principles and policies that are embedded in European values and at the same time enhance the wellbeing of Austrian citizens. We also suggest that taking care of the future should entail applying participatory approaches to technology and policy foresight, as well as inviting members of different publics to assess technologies and use participatory scenario building methods to

[39] See https://www.rferl.org/a/fudan-university-hungary-orban-china-ties/31236149.html.

address sovereignty complexities by incorporating multiple knowledges into the decision-making process.[40]

[40] For example, the application of the Quadruple Helix concept may be useful here (Schütz et al. 2019).

7 Policy recommendations

Overall, and in addition to some specific policy measures that Austria could follow, this report suggests a combination of analysis and anticipation of potential impacts, expert and civic inclusion, reflection as well as dialogue, and policy measures that are sandboxing policy trajectories reflecting on the evolving policy and political landscape on the local, regional, national, European and global level.

7.1 Achieving economic sovereignty

- Economic sovereignty in the sense of less dependence on imports from a small number of countries might be achieved by a diversification of suppliers while securing free access to markets, preferably within multilateral trade agreements.
- Austria could also be a strong and constructive voice within the EU for the observance of social and environmental standards in global trade agreements. This could also aid addressing public discourses focussing on such standards as a rationale for rejecting free trade agreements.
- If such connections are not enforceable, the EU could establish a border adjustment mechanism accounting for international cost differences that are caused by lower environmental and social standards in other parts of the world.
- The perception of strategically important goods is subject to changes in political preferences and to technological progress. Therefore, caution is advised when it comes to the identification or definition of specific strategic *industries.* Despite the importance of IPCEIs, we believe it to be crucial for Austria and the EU to continue providing a regulatory framework and funding to encourage Schumpeterian 'creative destruction'.
- Austria should support the adaptation of EU legislation consistent with future EU common, but also Austrian, interests. Importantly, state aid rules not only protect Austrian companies from unfair competition, but also Austria as a member state from a fratricidal spending competition. It is also in Austria's crucial interest to contribute to ensuring that state aid control regarding foreign companies is made more effective, both within and outside of the EU.
- Austria should be a strong voice within the European Union regarding a reform of the WTO Agreement on Subsidies and Countervailing Measures with the aim of reducing market distortions, increasing transparency and adapting the framework for trade in services.

7.2 Achieving supply sovereignty

- Austria as well as the EU should develop further strategies to mitigate supply chain vulnerabilities. This includes both, the development of methods to gain adequate data on supply chains and potential vulnerabilities as well as strategies to achieve supply chain robustness and resilience.
- Austria should support the establishment of a common European list of critical goods for which *robustness*, i.e., an uninterrupted supply during a crisis, is considered essential.
- Drawing on the new rescEU reserve, this could be complemented by the establishment of a joint European stockpile of such critical goods that can sensibly be warehoused and where the need in a crisis can be reasonably anticipated, as well as, drawing on the EU Civil Protection Service, an extended system of joint management, quality assurance, and distribution logistics in the case of a crisis.
- As an alternative, especially for goods less suitable for stockpiling, the development of national or, ideally, European public-private robustness-oriented procurement strategies should be considered with the aim of developing a network of selected, and where necessary redundant, producers of critical goods both within the EU and abroad.
- Such procurement strategies could be complemented by targeted reshoring or the development of production capacities for specific critical goods.
- Importantly, Austria should be a strong voice within the EU for the implementation of European legislation that rules out any form of "Harm-Thy-Neighbour" policies, i.e., seizures of or export restrictions (at least within the EU) on goods considered critical and in short supply during a crisis.
- These initiatives aimed at achieving robustness could be complemented by the development of national or European programs aimed at achieving greater *resilience.* Here, a main focus could be on supporting efforts of, especially smaller, companies to build more diversified and thus resilient global value chains by collecting and sharing information on potential concentrations and bottlenecks upstream and by developing stress tests for essential supply chains.
- Given the lack of (accessible) official data, mechanisms for sharing information regarding supply chains, and especially supply chain vulnerabilities, could be developed, for example through voluntary public-private partnerships or data sharing across the EU at the level of customs authorities.

7.3 Achieving technological sovereignty

- Technological sovereignty is an important policy-guiding principle for Europe to enhance its position as a standard setter in the global economic and technology arena, enable democratic governance, advance Europe's access to key technologies and their resources, and navigate societal development in line with the values and welfare of its citizens. It is important that concerted European sovereignty and regulatory efforts are supported by national policies and practices.
- Austria, in line with the rest of Europe, should use current European citizen centred approaches to advance Europe's position as a regulatory superpower and global trendsetter. Priority should be given to democratic governance and state or public policy led regulatory mechanisms that counter the expanding role of private interests in technological governance. The social impacts of datafied environments warrant special attention, as does addressing adverse societal effects, such as limiting the public sphere, restricting diversity and generating systemic biases.
- Capacities for analysis and foresight exercises with regard to technological advancements and potential impacts should be further developed and institutionalised. Decision making and public discussion(s) should include experts and civil society actors; sandboxing methods could applied and supported to address and experiment with evolving policy and political measures at the various levels of the multilevel system of governance.
- When it comes to horizontal tasks, Austria should continue to invest in research and innovation; specifically, this implies a more competitive funding for basic research, fostering mission-oriented research instruments, and increasing efforts to establish a venture capital market.
- As for identified future fields of technology with strategic relevance (vertical policies), Austria should embrace and support EU wide initiatives of developing new value chains critical to technological sovereignty, in particular the (much discussed) "Important Projects of Common European Interest" (IPCEI). At the same time, it would be advisable to strategically develop a complementary yet separate list of fields of particular importance to Austria (as discussed with respect to Table 3, which may serve as a basis for that purpose).
- Complementing these technology and engineering innovation and research endeavours, the application and inclusion of responsible innovation principles and methods should be encouraged and facilitated by policymakers and funding organisations both at the national and the European level to address the social impacts and unwanted consequences of innovation in disruptive technologies.

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9 Appendices

9.1 Appendix tables

Table 4: List of interviewees

Name	Institution
Per Altenberg, MA, MsFS	National Board of Trade, Sweden
Dr. Margaretha Gansterer	Professor, University of Klagenfurt
Dr. Ingo Hegny	Federal Ministry for Climate Action
Dr. Stefanie Lindstaedt	Professor, Technical University of Graz & Head of Know Center
Falko Loher, Bakk. MA	Federal Ministry for Climate Action
Dr. Jan Pospisil	Research Director, Austrian Study Centre for Peace and Conflict Resolution (ASPR)
DDr. Erich Prem	CEO of Eutema Technology Management
Mag. Ingolf Schädler	Member of HLG European Strategic Value Chain

Note: In addition, three further interviews were conducted with relevant experts, who, however, asked for anonymity.

Table 5: Selection of products with EU strategic dependence on China (2019)

Product	Use	EU import share from China	China global market share
Heterocyclic compounds containing pyrimidine	Active pharmaceutical ingredient (API)	98.1%	**91.8%**
Vitamin B	Active pharmaceutical ingredient (API)	97.9%	**68.3%**
Chloramphenicol	Antibiotic	97.4%	**93.3%**
Manganese	Metal	83.0%	**75.0%**
Magnesium unwrought 99.9%	Metal	95.2%	**69.0%**
Aromatic monocarboxylic acids	Organic chemical	93.2%	**89.9%**
Hydroxides and peroxides of strontium or barium	Inorganic chemical	87.0%	**83.6%**
Printed circuit bands	Electronics	63.0%	**57.0%**
Electrical transformers exceeding kvA	Electronics	64.4%	**52.6%**
Manganese dioxide battery cells	Electronics	76.3%	**40.7%**

Source: Zenglein (2020).

Table 6: List of EU critical raw materials

Raw materials	Stage	Main global producers	Main EU sourcing countries	Import reliance	EoL-RIR	Selected Uses
Antimony	Extraction	China (74%) Tajikistan (8%) Russia (4%)	Turkey (62%) Bolivia (20%) Guatemala (7%)	100%	28%	• Flame retardants • Defence applications • Lead-acid batteries
Baryte	Extraction	China (38%) India (12%) Morocco (10%)	China (38%) Morocco (28%) Other EU (15%) Germany (10%) Norway (1%)	70%	1%	• Medical applications • Radiation protection • Chemical applications
Bauxite	Extraction	Australia (28%) China (20%) Brazil (13%)	Guinea (64%) Greece (12%) Brazil (10%) France (1%)	87%	0%	• Aluminium production
Beryllium	Extraction	United States (88%) China (8%) Madagascar (2%)	n/a	n/a	0%	• Electronic and Communications Equipment • automotive, aero-space and defence components
Bismuth	Processing	China (85%) Lao Pdr (7%) Mexico (4%)	China (93%)	100%	0%	• Pharmaceutical and animal feed industries • Medical applications • Low-melting point alloys
Borate	Extraction	Turkey (42%) United States (24%) Chile (11%)	Turkey (98%)	100%	1%	• High performance glass • Fertilisers • Permanent magnets
Cobalt	Extraction	Congo DR (59%) China (7%) Canada (5%)	Congo DR (68%) Finland (14%) French Guiana (5%)	86%	22%	• Batteries • Super alloys • Catalysts • Magnets
Coking coal	Extraction	China (55%) Australia (16%) Russia (7%)	Australia (24%) Poland (23%) United States (21%) Czechia (8%) Germany (8%)	62%	0%	• Coke for steel • Carbon fibres • Battery electrodes

Raw materials	Stage	Main global producers	Main EU sourcing countries	Import reliance	EoL-RIR	Selected Uses
Fluorspar	Extraction	China (65%) Mexico (15%) Mongolia (5%)	Mexico (25%) Spain (14%) South Africa (12%) Bulgaria (10%) Germany (6%)	66%	1%	• Steel and iron making • Refrigeration and Air-conditioning • Aluminium making and other metallurgy
Gallium	Processing	China (80%) Germany (8%) Ukraine (5%)	Germany (35%) UK (28%) China (27%) Hungary (2%)	31%	0%	• Semiconductors • Photovoltaic cells
Germanium	Processing	China (80%) Finland (10%) Russia (5%)	Finland (51%) China (17%) UK (11%)	31%	2%	• Optical fibres and Infrared optics • Satellite solar cells • Polymerisation catalysts
Hafnium	Processing	France (49%) United States (44%) Russia (3%)	France (84%) United States (5%) UK (4%)	0%	0%	• Super alloys • Nuclear control rods • Refractory ceramics
Indium	Processing	China (48%) Korea, Rep. (21%) Japan (8%)	France (28%) Belgium (23%) UK (12%) Germany (10%) Italy (5%)	0%	0%	• Flat panel displays • Photovoltaic cells and photonics • Solders
Lithium	Processing	Chile (44%) China (39%) Argentina (13%)	Chile (78%) United States (8%) Russia (4%)	100%	0%	• Batteries • Glass and ceramics • Steel and aluminium metallurgy
Magnesium	Processing	China (89%) United States (4%)	China (93%)	100%	13%	• Lightweight alloys for automotive, electronics, packaging or construction • Desulphurisation agent in steelmaking
Natural Graphite	Extraction	China (69%) India (12%) Brazil (8%)	China (47%) Brazil (12%) Norway (8%) Romania (2%)	98%	3%	• Batteries • Refractories for steelmaking

Raw materials	Stage	Main global producers	Main EU sourcing countries	Import reliance	EoL-RIR	Selected Uses
Natural Rubber	Extraction	Thailand (33%) Indonesia (24%) Vietnam (7%)	Indonesia (31%) Thailand (18%) Malaysia (16%)	100%	1%	• Tires • Rubber components for machinery and household goods
Niobium	Processing	Brazil (92%) Canada (8%)	Brazil (85%) Canada (13%)	100%	0%	• High-strength steel and super alloys for transportation and infrastructure • High-tech applications (capacitors, superconducting magnets, etc.)
Phosphate rock	Extraction	China (48%) Morocco (11%) United States (10%)	Morocco (24%) Russia (20%) Finland (16%)	84%	17%	• Mineral fertilizer • Phosphorous compounds
Phosphorus	Processing	China (74%) Kazakhstan (9%) Vietnam (9%)	Kazakhstan (71%) Vietnam (18%) China (9%)	100%	0%	• Chemical applications • Defence applications
Scandium	Processing	China (66%) Russia (26%) Ukraine (7%)	UK (98%) Russia (1%)	100%	0%	• Solid Oxide Fuel Cells • Lightweight alloys
Silicon metal	Processing	China (66%) United States (8%) Norway (6%) France (4%)	Norway (30%) France (20%) China (11%) Germany (6%) Spain (6%)	63%	0%	• Semiconductors • Photovoltaics • Electronic components • Silicones
Strontium	Extraction	Spain (31%) Iran, Islamic Rep. (30%) China (19%)	Spain (100%)	0%	0%	• Ceramic magnets • Aluminium alloys • Medical applications • Pyrotechnics
Tantalum	Extraction	Congo, DR (33%) Rwanda (28%) Brazil (9%)	Congo, DR (36%) Rwanda (30%) Brazil (13%)	99%	0%	• Capacitors for electronic devices • Super alloys

Raw materials	Stage	Main global producers	Main EU sourcing countries	Import reliance	EoL-RIR	Selected Uses
Titanium	Processing	China (45%) Russia (22%) Japan (22%)	n/a	100%	19%	• Lightweight high-strength alloys for e.g. aeronautics, space and defence • Medical applications
Tungsten	Processing	China (69%) Vietnam (7%) United States (6%) Austria (1%) Germany (1%)	n/a	n/a	42%	• Alloys e.g. for aeronautics, space, defence, electrical technology • Mill, cutting and mining tools
Vanadium	Processing	China (55%) South Africa (22%) Russia (19%)	n/a	n/a	2%	• High-strength-low-alloys for e.g. aeronautics, space, nuclear reactors • Chemical catalysts
Platinum Group Metals	Processing	South Africa (84%) - iridium, platinum, rhodium, ruthenium Russia (40%) - palladium	n/a	100%	21%	• Chemical and automotive catalysts • Fuel Cells • Electronic applications
Heavy Rare Earth Elements	Processing	China (86%) Australia (6%) United States (2%)	China (98%) Other non-EU (1%) UK (1%)	100%	8%	• Permanent Magnets for electric motors and electricity generators • Lighting Phosphors • Catalysts • Batteries • Glass and ceramics
Light Rare Earth Elements	Processing	China (86%) Australia (6%) United States (2%)	China (99%) UK (1%)	100%	3%	

Notes: Import reliance = (Import – Export) / (Domestic production + Import – Export); End of Life Recycling Input Rate (EoL-RIR): percentage of overall demand that can be satisfied through secondary raw materials
Source: European Commission (2020c).

Table 7: Strategic value chains

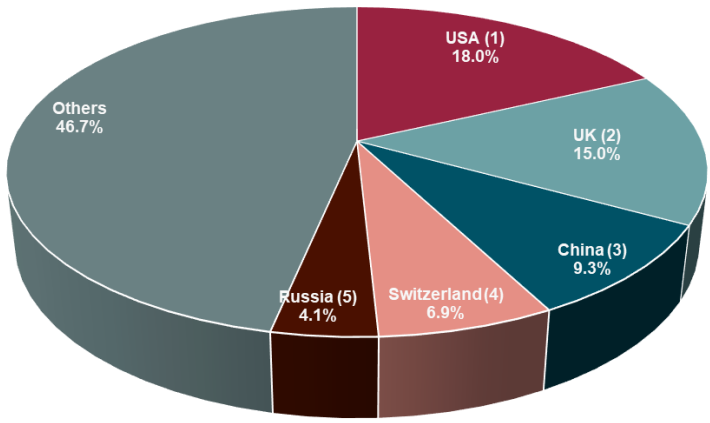
Strategic value chain	Policy instrument	Status
Batteries	IPCEI	Implemented
High performance computing	Joint Undertaking	Implemented
Micro-electronics	IPCEI	Implemented
Clean, Connected and Autonomous Vehicles	IPCEI	Actions recommended
Cybersecurity	n.n.	Actions recommended
Hydrogen technologies and systems	IPCEI	Actions recommended
Industrial Internet of Things	n.n.	Actions recommended
Low CO2 Emissions Industry	n.n.	Actions recommended
Smart Health	n.n.	Actions recommended
Additive manufacturing	n.n.	Prioritised
Bio-based materials	n.n.	Prioritised
Critical raw materials for innovative applications	n.n.	Prioritised
Net zero energy building construction and renovation	n.n.	Prioritised
Smart vessels	n.n.	Prioritised
Space launchers	n.n.	Prioritised
Wired and wireless networks	n.n.	Prioritised
Advanced materials	n.n.	Identified
Augmented reality and virtual reality devices	n.n.	Identified
Energy efficient and smart trains	n.n.	Identified
Energy efficient and smart aeronautics	n.n.	Identified
E-waste recycling	n.n.	Identified
Industrial robotics	n.n.	Identified
Nuclear decommissioning	n.n.	Identified
Photonics, integrated circuits	n.n.	Identified
Photovoltaics	n.n.	Identified
Plastics recycling	n.n.	Identified
Precision farming	n.n.	Identified
Proteins from crops and residues (including aquaculture) and fermentation	n.n.	Identified
Structural electronics products	n.n.	Identified
Wave and tidal energy	n.n.	Identified

Wind energy	n.n.	Identified

Source: Strategic Forum (2019a: 104-5)

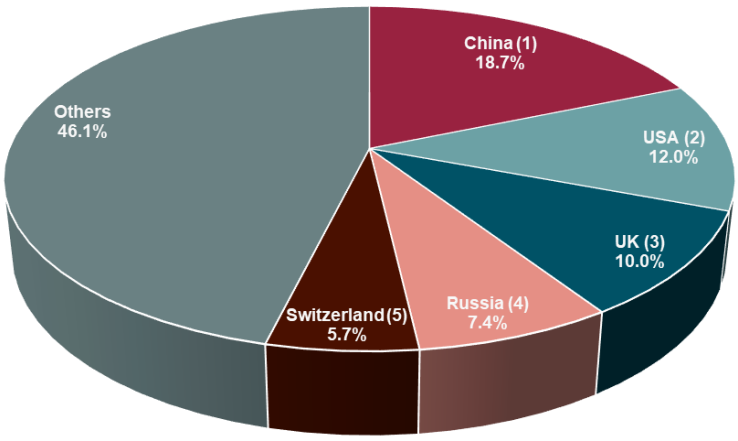
9.2 Appendix figures

Figure 16: EU27 export structure (2019)



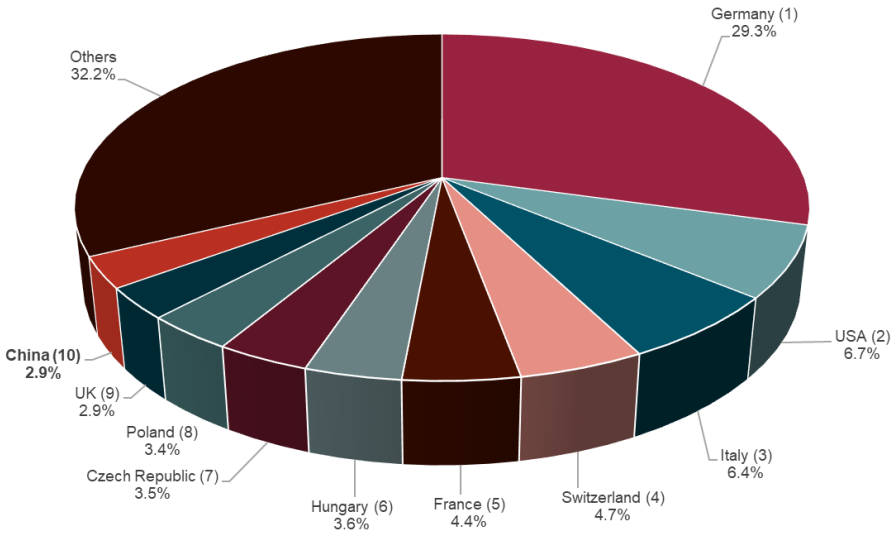
Source: Eurostat; own calculations and illustration

Figure 17: EU27 import structure (2019)



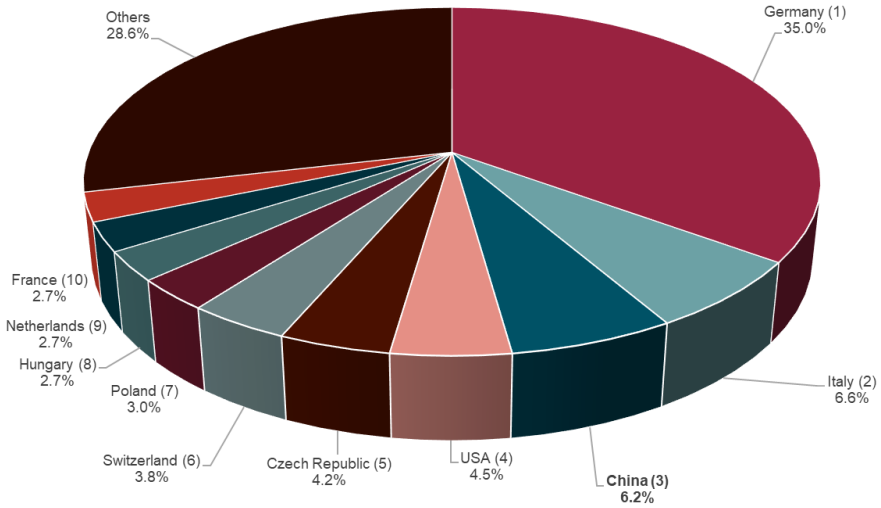
Source: Eurostat; own calculations and illustration

Figure 18: Austria's export structure (2019)



Source: Statistik Austria; own calculations and illustration

Figure 19: Austria's import structure (2019)



Source: Statistik Austria; own calculations and illustration