CENTRE FOR ECONOMIC POLICY RESEARCH

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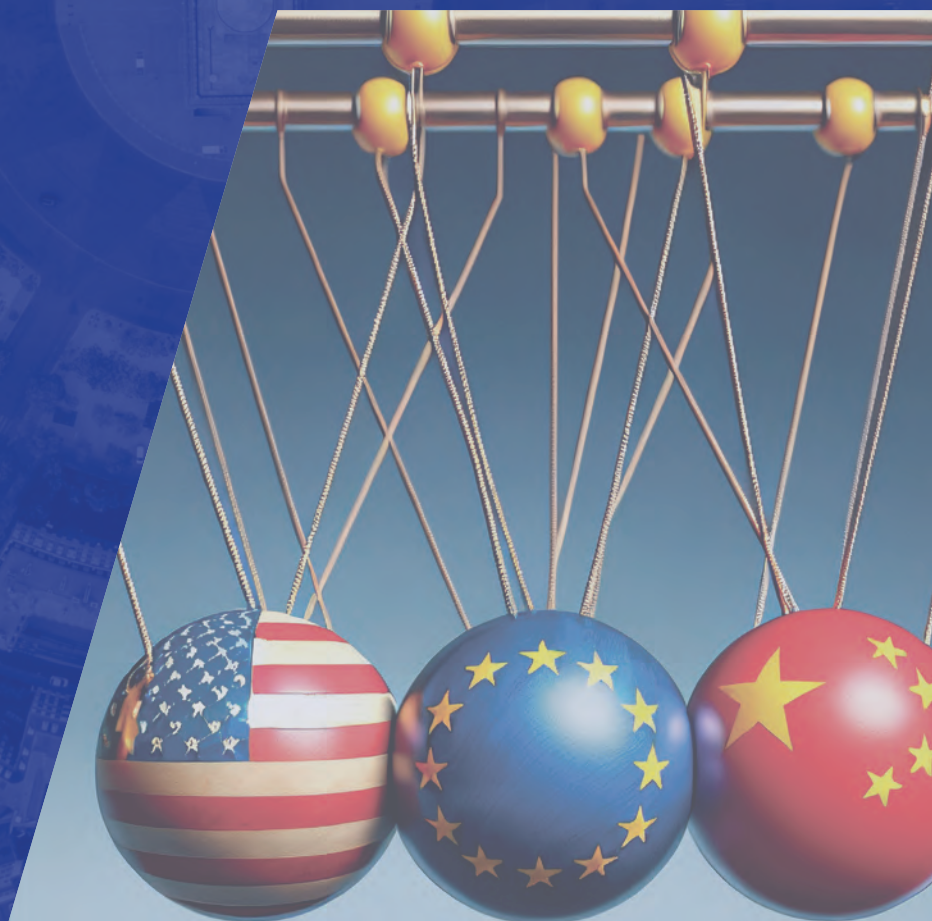
PARIS REPORT 2

Europe's Economic Security

Edited by Jean Pisani-Ferry, Beatrice Weder di Mauro and Jeromin Zettelmeyer



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EUROPE'S ECONOMIC SECURITY

Paris Report 2

In collaboration with Bruegel

CEPR

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Bruegel and CEPR

CENTRE FOR
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Foreword

For more than three decades, CEPR's Geneva Reports have formed the blueprint for reports on seminal topics in economics. As part of the expansion of CEPR's activities in Paris, we decided to launch a new series of Paris Reports, designed to be in-depth studies of very topical policy issues. The first Paris Report, *Rebuilding Ukraine: Principles and Policies*, published in November 2022, offered a perspective on how the reconstruction of Ukraine can be achieved once the war is over, and provided an in-depth, sector-by-sector analysis to inform policymakers and the public about challenges, opportunities and tools for Ukraine's reconstruction.

This second Paris Report focuses on one of the major policy issues currently facing Europe: economic security challenges in the face of supply chain vulnerabilities and geopolitical shocks. This report forms the first output from a new joint initiative between CEPR and Bruegel: *Important Topics of Common European Interest* (ITCEI). The report is made up of five papers, examining where Europe is vulnerable and where and how it should de-risk, taking into account history, trade policy, import dependencies, and the economic impact of a decoupling from China, alongside an introduction from the report's editors that brings together the conclusions of the individual papers and draws implications for policy from them.

In their introduction, the editors argue that though the new global geoeconomics map may necessitate a pivoting of the EU towards economic security, this must not become an excuse for protectionism, and it must preserve international cooperation. Achieving this requires innovative policy instruments, joint preparedness, contingency planning, and stronger governance mechanisms at both the EU and the international level. Furthermore, they argue that ensuring Europe's economic security will need to go beyond diversifying sources of supply for specific goods, to include a strategy to strengthen its single market. Finally, there is an open question whether protecting Europe's economic security requires measures to reduce economic integration with specific countries more broadly, notably with China. Whatever the answer, it should remain within WTO rules, and it should preserve the ability to collaborate in areas such as climate change and WTO reform.

Our thanks go to Anil Shamdasani for his skilled handling of its production, and to Sophie Roughton for managing its dissemination. There were presentations of early versions of the papers at a workshop in October 2023 at Bruegel, which was organised by Katja Knezevic and Matilda Sevon, and at the CEPR Paris Symposium in December 2023, which was organised by Nadine Clarke.

CEPR, which takes no institutional positions on economic policy matters, is delighted to provide a platform for an exchange of views on this crucially important topic.

Tessa Ogden
Chief Executive Officer, CEPR
March 2024

CHAPTER 1

How to de-risk: European economic security in a world of interdependence[1]

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1 INTRODUCTION

Over a period of just 15 years, Europe has been confronted with a financial shock that originated in the United States, a pandemic shock that originated in China but could have come from anywhere else, and an energy shock provoked by Russia's invasion of Ukraine. These events have prompted a re-examination of efficiency/security trade-offs that arise as a result of international integration – and particularly, as a result of specialisation in international trade and vulnerabilities of global supply chains.

Economists and policymakers have long worried about trade-offs of this type. At the most fundamental level, they arise from the standard tension between growth on the one hand and economic crises on the other: higher growth is often accompanied by higher instability. For example, regulation of financial and product markets may prevent or mitigate financial or environmental hazards at the cost of dampening entry and growth of firms. Similarly, in open economies, trade and financial integration may be good for growth but expose economies to imported shocks.

The most recent set of concerns – as exemplified, for example, by a series of European Commission papers (European Commission, 2021, 2022) and an associated legislative agenda (see the contribution by McCaffrey and Poitiers in this volume, and Section 4 below) – differ from these standard preoccupations in two respects.

First, they relate to economic risks due not just to crises or shocks, but to deliberate economic coercion by foreign governments or even sub-governmental entities. This is probably the reason why the term "security" – as opposed to "stability" or "resilience" – has recently become popular to describe the mitigation of economic, rather than just national security, threats (we will discuss the difference in Section 2). One reason to

1 We are very grateful to the authors of the contributions in this volume, particularly Chad Bown, Julian Hinz, Morgan Kelly, Conor McCaffrey, Isabelle Mejean, Kevin O'Rourke, Niclas Poitiers, Pierre Rousseaux and Moritz Schularick, as well as to Shekar Aiyar, Alicia Garcia Herrero, Petros Mavroidis, Francesco Papadia, André Sapir, Fiona Scott Morton, Nicolas Véron, Lennard Welslau and Guntram Wolff for helpful discussions and comments. We are particularly grateful to Niclas Poitiers for his contributions to the survey of EU economic security instruments that appears in Section 4 of this chapter. Any remaining errors are ours only.

be concerned with economic coercion is the fact that China, an increasingly powerful and authoritarian country, has been regularly applying coercion in response to political actions by trade partners (for example, Australia's call for investigations on the origin of the COVID-19 pandemic and Lithuania's decision to let Taiwan open a representative office in Vilnius). But the concern is not just about China; the policies of President Trump between 2017 and 2020 showed that even one's closest ally can be tempted to leverage its market power and its control of the technical and financial infrastructures of globalisation. The possibility of a second Trump term is now prompting a reflection on the need for Europe to prepare for such a risk (Gonzales Laya et al., 2024).

Second, recent concerns have focused mostly on trade-related rather than financial vulnerabilities. This reflects the fact that trade-related vulnerabilities have become more prominent as a result of specialisation and the vulnerability of global supply chains that maximise efficiency, but at the cost of creating hidden fragilities. But it may also reflect a rather myopic reason, namely, that the last two or three external shocks that Europe (and, to a lesser extent, the United States) have suffered have been trade-related: supply chain disruptions related to COVID-19 and energy price shocks following the Russian invasion of Ukraine.

In line with this concern, the papers in this volume focus mostly on trade-related external economic security. This should not be taken to imply that Europe does not need to worry about financial security. But unlike trade-related security, financial risks continue to be mostly of the financial stability variety, linked to shocks and financial vulnerabilities rather than coercion. To the extent that financial coercion is a serious concern, it is linked to one main potential source, namely, the United States after a return of President Trump (see Section 2). In contrast, trade-related external security risks are ubiquitous. This said, the fact that this volume does not address financial security treats is a blind spot, calling for additional work in this area to prepare Europe for the possible consequences of a return of President Trump to the White House.

The chapters in this volume try to answer two critical questions. First, how should trade-related vulnerabilities be identified in practice, and what are the trade relationships that make Europe particularly vulnerable to trade-related shocks and coercion? Second, how can these vulnerabilities be reduced while minimising the costs of 'de-risking' and reducing the chances of unintended consequences? Four such potential costs come to mind:

- **Foregoing some of the gains from trade specialisation and trade openness**. This could weigh on European growth and competitiveness, which depend on export specialisation and on importing raw materials and intermediate inputs more cheaply than they could be produced at home (if at all). It could also make it harder to attain emissions reduction objectives, by raising the cost of the transition to renewable energy sources. In turn, this could exacerbate social and political divisions related to climate action.

- **Becoming more vulnerable to domestic shocks** (such as climate-related shocks, whose consequences may become harder to diversify in a less integrated world).
- **Damaging international cooperation**. This could include cooperation with China on vital matters of common interest, such as climate change mitigation, as well as respect for the rules of the multilateral trading system. Notwithstanding the damage that the WTO has suffered over the last decade, these rules continue to be largely respected (Mavroidis and Sapir, 2024). An aggressive 'de-risking' of European trade relationships through both trade policy tools and subsidies could trigger protectionist reactions from trading partners, particularly if it violates WTO rules. It could also become an excuse for protectionists in the European Union, who may use economic security arguments to further special interests.
- **Damaging cohesion within the European Union**. EU countries differ with respect to the structure of their trade and their dependence on specific export and import markets. As a result, attempts to de-risk trade may have net benefits for some and net costs for others. If de-risking becomes a source of division, it may counterproductive, as internal divisions in the European Union are partly what an adversary – be it in China, Russia, or President Trump – may try to exploit (and indeed, what these three have tried to exploit in the past).

The remainder of this chapter seeks to summarise the answers to these questions as best as we can, drawing on the other chapters in this volume. Section 2 defines what we mean by economic security, and what risks we should be worrying about. Section 3 discusses how these risks should be addressed in principle. What trade relationships require 'de-risking'? Section 4 discusses the instruments. How do we build protection that preserves the benefits of trade? A concluding section summarises the main lessons learned.

2 DEFINING RISKS TO ECONOMIC SECURITY

As Chad Bown notes in his chapter, economic security is still an emerging concept. At its most abstract level, it can be defined as both preventing bad economic outcomes and making sure that, should risks materialise, the damage they cause is kept at a minimum. Societies care both about raising welfare in expectation and about lowering its volatility. Economic security is concerned with the latter.

Defined in this broad way, economic security has been a standard concern of policymakers for centuries – and not just of economic policymakers, since economic harm can be inflicted by 'non-economic' shocks, including political disruptions and wars. The use of state intervention to address these concerns, including industrial policy and trade policy, is similarly nothing new (see the chapter by Morgan Kelly and Kevin O'Rourke). The question, then, is what is special about this round, and why do we need a new term? To the extent that the perceived nature of the risk and risk propagation has changed, it is important to understand how it has changed, both to avoid reinventing the wheel and to prevent us from overreacting to perceived new risks when the old risks and risk propagation channels might still be there.

Economists concerned with crisis prevention and mitigation typically focus on risks and vulnerabilities related to the financial system or the structure of production. For example, credit cycles can expose countries to financial crises, which are propagated internationally. Dependence on commodity exports or imports exposes economies to swings in international prices and to disruptions in domestic production that relies on commodity imports.

The military and security community is, by definition, charged with worrying about a different type of threat: harm that is purposely inflicted by outside actors, normally nation states but also terrorist or criminal organisations. Murphy and Topel (2013) have widened the definition of national security to include all "substantial threats" to the safety and welfare of a nation's citizens (e.g. national catastrophes and public health threats). Defined this broadly, national security would include preparedness and mitigation against any harmful acts conducted by foreign governments or non-governmental organisation with military or non-military means, including economic sanctions, as well as threats related to physical and information infrastructure.

The recent usage of the term 'economic security' is at the intersection of non-financial economic crises and national security in the broad sense defined by Murphy and Topel.[2] Specifically, it focuses on harm inflicted through international economic relationships – and particularly trade relationships – whether these reflect exogenous shocks (such as COVID-related trade disruptions) or deliberate actions by foreign governments or non-governmental organisations (see the chapters by Bown and by McCaffrey and Poitiers; see also European Commission, 2021, 2022). These risks are particularly relevant today because of the combination of trade integration, specialisation, long supply chains, and actors willing to engage in coercion through trade channels.

It is in this sense that the term 'economic security' will be used in the remainder of this chapter, and in which it is used throughout the report. In this definition, achieving economic security involves the prevention and mitigation of:

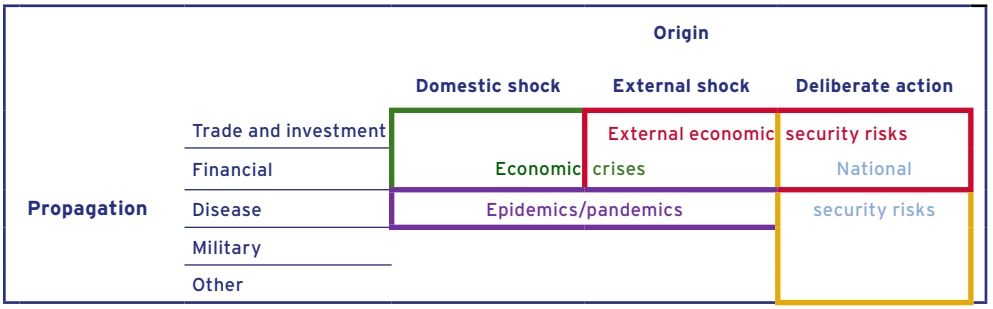
- disruptions of critical imports, whether accidental or deliberate;
- economic coercion through restrictions or boycotts against specific exports, along the lines of actions undertaken by China against Australia;
- broad disruption of global trade at a scale with macroeconomic impact, for example as a result of geopolitical conflict leading to economic sanctions or a protracted tariff war with a major trading partner. Events that could trigger such scenarios include a Chinese attack on Taiwan, or the re-election of President Trump followed by a sharp deterioration of the political relationship between the United States and the European Union.

2 The European Commission (2023) uses a definition which also includes "risks related to physical and cyber security of critical infrastructure" and "risks related to technology security and technology leakage". We would classify this as part of national security (within the "other category" in Table 1) rather than economic security.

It is important to emphasise that this is a narrow – perhaps inappropriately narrow – definition of economic security, for two reasons.

First, it disregards the possibility of economic disruptions as a result of domestic shocks, which historically have been a major source of economic crises, as well as a source of preoccupation among economists (Table 1). Hence, a better term for the type of economic security risks studied in this report would be 'external economic security'. This terminology reminds us that there could be trade-offs not just between economic security and economic growth, but also between external economic security and security from domestic shocks. International integration may increase exposure to the former, but offers protection from the latter.

TABLE 1 **VARIETIES OF WELFARE THREATS AND PROPAGATION MECHANISMS**



Source: Authors' illustration.

Note. The columns in Table 1 define the origin of a bad event – an exogenous shock originating at home or abroad (production disruption, natural catastrophe, transportation or infrastructure disruption, confidence shock); or a deliberate action by a foreign government or a non-governmental entity. The rows define the propagation channel: economic activity related to trade or finance, disease, military action, or other (for example, through IT infrastructure).

Second, it largely ignores external economic security risks through financial channels. However, international finance – including the international payments system and the confiscation of financial assets located in foreign jurisdictions – is an obvious instrument of economic coercion and economic sanctions, as shown by recent G7 sanctions against Russia. The main reason why financial risks do not feature prominently in the recent literature on European economic security is that Europe is much less likely to be at the receiving end of such sanctions, given the control exerted by the United States and its allies over international finance. But this could rapidly change if President Trump is re-elected and decides to use financial coercion against Europe for whatever reason (for example, to force Europe to align its foreign or commercial policies with those of the United States, as was the case when the United States threatened EU firms with 'secondary sanctions' for violating US-imposed sanctions on Iran).

A broader analysis of European economic security should (re)consider such financial economic risks and their mitigation. In the meantime, the remainder of this chapter (and report) focuses on trade and investment-related risks. These are particularly relevant in the relationship with China, but could also become relevant in the event of a return of President Trump and a revival of US tariffs against Europe, whether imposed for mercantilist or political reasons.

3 WHAT TO DE-RISK

Firms have incentives to avoid becoming dependent on one or a small number of suppliers or customers, particularly when these suppliers or customers are vulnerable to high risks outside their control, including politically motivated interference. Yet, as Isabelle Mejean and Pierre Rousseaux point out in their chapter, the private interest in security on the side of firms may not be enough to take care of the collective EU security interest. Firms often fail to realise the extent to which suppliers or customers are themselves subject to risks, simply because they do not know the entire value chain. Firms also do not internalise the potential costs of supplier or customer dependency on the entire value chain, and ultimately the welfare of citizens. If a supplier relationship represents a critical link in that chain, the social costs of having that link fail may far exceed the private costs to the firm. This argument, which is broadly consistent with the evidence presented by Chad Bown, can justify policy-led 'de-risking'. But what areas of trade require de-risking? How can policymakers tell where trade dependencies are 'too high', in the sense that the economic security risks of trade outweigh its benefits, both for efficiency and growth and as protection against domestic disruptions?

The ideal way to answer this question would be through a firm-level model of trade and supply relationships both across borders and within the European Union. The model would 'know' who trades with whom, how specific inputs enter each stage of production, and whom firms sell to. It would also have information about the ease of switching suppliers if a supplier fails or sharply raises prices. Such a model could be used to 'stress test' European economies with respect to specific supply chain or customer risks. Where large effects are found, it would be used to identify trading relationships worth de-risking. Unfortunately, such a model does not exist and may never exist due to data limitations. We are therefore constrained by the available information and should make the best of it.

3.1. Critical goods and the risk from import disruptions

Suppose we were mainly interested in risks related to import disruptions. This would be the case if exports are either well diversified or go mainly to countries that one would not consider to be a major source of shocks. In that case, the following approach might be a close substitute for the perfect model. Using the most disaggregated data possible, one should identify products where:

1. a large share of EU consumption relies on imported inputs;

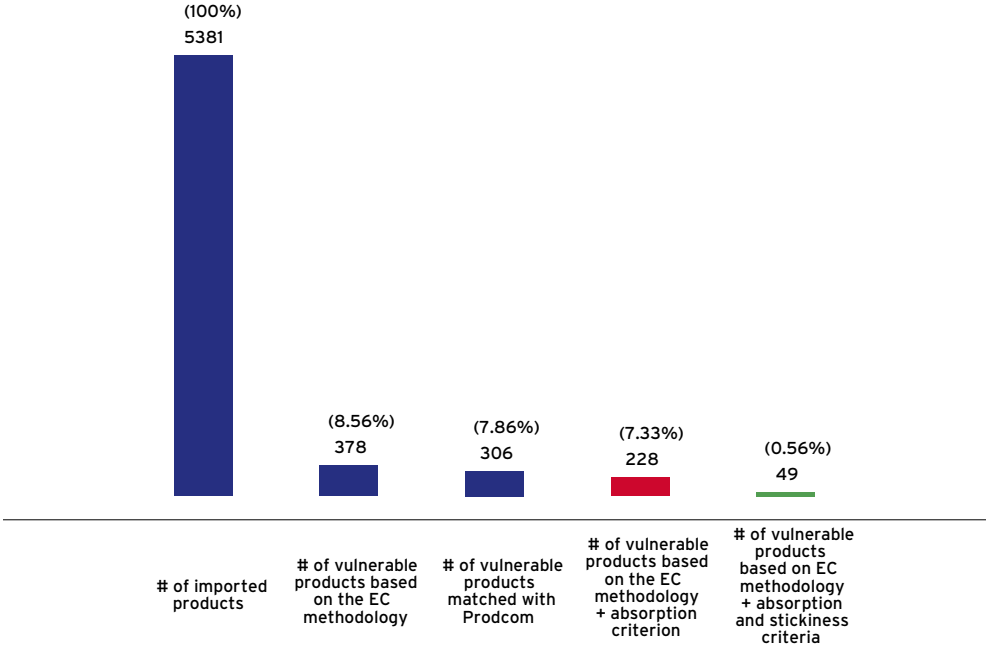
2. foreign supply of these goods is highly concentrated;
3. finding alternative suppliers in the event of a disruption is difficult; and
4. a disruption to supply has high economic costs. Unlike the previous criterion, this criterion reflects the substitutability of products in either consumption or production, as opposed to the substitutability of supplier relationships.

Products that meet all four criteria would be prime candidates for de-risking.

This approach, which builds on work undertaken by the European Commission (2021), approximately describes the approach taken in the chapter by Mejean and Rousseaux. Their main innovation relative to the work of the Commission and other authors is step 3 above, which they implement by eliminating products for which 'relationship stickiness' – the typical duration of firm-supplier relationships – drops below a specific threshold. For example, if the stickiness threshold is set at the sample median, the number of imports on which the European Union should consider itself import-dependent drops from 378 to just 105, and to just 49 if the 75% least relationship-sticky products are eliminated (Figure 1). Focusing only on 'upstream' intermediate products – for which an export ban would affect many supply chains and hence have high economic costs – would reduce the list further, to just 21 products. For 12 of these, the main supplier is China.

To these, Mejean and Rousseaux suggest adding a small number of "critical goods" that "can result in human losses and other severe non-economic consequences", including between 2 and 19 pharmaceutical products, depending on where the substitutability cut-off is set, as well as inputs to the green transition. Interestingly, most of these inputs – including most critical raw materials, which have been one of the main motivating forces in the drive to 'de-risk' imports, particularly from China – currently fail one or several of Mejean and Rousseaux's dependency tests. While highly relationship-sticky, batteries and their components, hydrogen technologies, rare earth metals and solar panels fail the concentration test, and most components of solar panels fail both the concentration test and the relationship stickiness test. Yet, Mejean and Rousseaux urge caution with respect to these products, on the grounds that demand for these products is developing so fast that the structure of EU imports during 2015-19, on which concentration indices and import needs are based, may be a poor proxy for trade dependencies in the future.

FIGURE 1 **NUMBER OF PRODUCTS FOR WHICH THE EU IS IMPORT DEPENDENT ACCORDING TO MEJEAN AND ROUSSEAUX**



Notes: The figure shows the number of strategic dependencies (and their contribution to the value of EU imports) using various methodologies, starting with the strategy proposed by European Commission (2021) (second blue bar) and adding criteria based on the ratio of imports over domestic absorption (red bar) and the degree of product stickiness (green bar). See details in the main text.

Source: CEPII-BACI and Prodcom for 2015 to 2019.

Mejean and Rousseaux's work represents the most exhaustive analysis so far to identify dependencies on the basis of ranking 'critical' imports with respect to concentration and relationship substitutability and deciding on thresholds above or below which concentration is deemed too high or substitutability too low. Precisely because it is more thorough and comprehensive than previous attempts in this literature, it illustrates the intrinsic limitations of this approach.

- We so far have no systematic way of telling which imports are genuinely critical. Focusing on upstream products and pharmaceuticals may miss other products (such as computer chips) whose accidental scarcity would cause large economic or non-economic losses. At the same time, some upstream products and pharmaceuticals might not be critical if they can be substituted by other products. The European Commission's (2021) approach of designating whole 'ecosystems' (sectors such as health, energy, digital, electronics and aerospace) as critical seems even more problematic, both because many products in these sectors are not in fact critical and because it misses products outside these sectors that may well be (for example, most of Mejean and Rousseaux's upstream products).

- As both Mejean and Rousseaux and Bown emphasise, import dependence measures do not reflect indirect exposure due to data limitations. If the European Union has an import exposure to a country which is itself import dependent on China for this product (or an important intermediate input), then direct import dependence on China might significantly understate total import dependence.
- The final lists can be very sensitive to how the cut-offs are set, which is somewhat arbitrary. For example, whether relationship substitutability thresholds are set at the 25th, 50th, or 75th percentile adds or subtracts a large share of products from the sample.
- Supplier relationships in normal times tend to be relatively long (25 and 19 months, respectively, for the 75th and 50th percentiles in Mejean and Rousseaux's sample). This implies that unless replacement duration is significantly lower in a crisis, an import interruption could be very damaging even among products that are relatively non-sticky in normal times. But the impact of a forced interruption on the replacement period could go both ways. On the one hand, firms seeking to replace suppliers under duress would have incentives to do so much faster than in normal times. On the other hand, finding new suppliers at a time when many other firms are trying to do so could take longer and/or result in a price jump of scarce supplies that itself could be very damaging.

3.2 Risk from export disruptions and from decoupling

Another problem is that an approach focused on reducing dependence on critical imports does not consider disruptions to exports, which could equally have a macroeconomic impact if they were highly concentrated in any one destination country. For example, 20% of EU exports go to the United States, 13% to the United Kingdom and 9% to China; while 41% of UK exports go to the European Union, 21% to the United States, and 5% to China. Furthermore, just as import dependency numbers ignore indirect exposures, so too do export shares. For example, direct UK export dependency on China is only 5%, but its indirect exposure via the European Union alone could be larger if UK products are part of the value chains of goods ultimately destined for the Chinese market.

While demand shocks via exports are a standard risk of trade integration, geopolitical conflict can take this risk to an entirely new level. First, hitting exports of specific industries through import bans, high tariffs, or social media campaign can be a form of geopolitical coercion. As reported in the chapters by Bown and by McCaffrey and Poitiers, there are numerous examples of Chinese coercion of this type. This type of coercion is typically not macroeconomically critical, but may seek to exploit the lobbying power of groups that are hurt, as well as internal divisions (in the case of the European Union, this may include divisions across member states). Second, deliberate economic sanctions can of course have a much greater impact than swings in export demand triggered by normal economic fluctuations, or even an economic crisis in a trading partner.

In their chapter, Baqaee et al. simulate the impact of a decoupling from China in a trade model with 43 countries and 56 sectors, in the form of a complete stop in trade between a 'Friends' bloc comprising the G7 countries, Spain, the Netherlands and an artificial country comprising the rest of the European Union, and a 'Rivals' bloc including China and Russia, on the assumption that trade continues both between these blocs and with the rest of the world. As might be expected, the short-term effects are large, with the output of Germany expected to decline by 3–5% of GDP. At the same time, the simulations suggest that the cost of a complete decoupling from China would be relatively low if conducted slowly over time: around 1.25% of GDP for Germany and Japan, while the United States and the remaining other European countries would suffer in the range of 0.47% to 0.69% of GDP. The intuition behind this result is that the welfare costs of an end of the trade integration between China and the 'Friends' group are mitigated by the fact that the Friends continue to trade with each other and with 'Neutrals', and that these groups are sufficiently large and diverse to preserve most of the gains from trade.

3.3 Putting it all together

Combining the insights of the chapters by Baqaee et al. and Mejean and Rousseaux with the assumption that external economic risks do not just include exogenous shocks to trade but also coercion and possibly a wider trade disruption involving China leads to the following conclusions.

First, there is a strong case for 'de-risking' concentrated exposures to critical imports, by either diversifying supply or making preparations to mitigate a disruption. However, identifying such products turns out to be very difficult, mainly because it is hard to assess the criticality of products, i.e., the welfare losses inflicted by a shortage or price spike. While we know that some products are critical – chips, energy, some pharmaceuticals, some minerals, and some upstream inputs – we do not know what other products are critical. A good way to start is by de-risking the products that we know to be critical. Because we don't know how long it would take to find new suppliers in a crisis or how price sensitive these imports might be to a loss of the main supply source, products known to be critical should be de-risked even if their 'relationship stickiness' in normal times is fairly low.

The identification of such products obviously needs to take into account the costs as well as the benefits of de-risking. Take the example of solar panels and their components, which are often cited as a prime de-risking candidate because of their importance in the green transition and China's overwhelming global market share (63%, according to Mejean and Rousseaux). In fact, the short-term economic costs to the European Union of a complete stop in solar panel imports from China would be tiny (hitting mostly installation services, while leaving the solar capacity unchanged). Unlike imported gas from Russia, a disruption of solar panel imports from China would have no direct impact on the energy supply, although it would affect the increase in installed energy capacity and raise the cost of replacing panels that become obsolete. Hence, the main benefit of 'de-

risking' Chinese solar panel imports consists in insuring against a (possible) disruption of the energy transition towards renewables, which could sharply raise solar panel prices. This needs to be weighed against the (certain) price impact of a decision to diversify away from Chinese solar imports by purchasing panels from more expensive sources, which will slow the green transition.

Second, the de-risking of trade dependencies cannot be the only layer of protection against import disruptions, because we know that we will never be in a position to identify and de-risk all critical products. Beyond trade de-risking, it is hence essential to strengthen the resilience of the European economies against import shocks, whatever their source. This is an argument for a better functioning and more flexible Single Market, as well as for the broadening of international trade relationships, in the form of free trade agreements with friendly countries.

Third, it is important to de-risk export dependencies rather than just import dependencies. For specific products, this could be done in three ways: by deterring coercion (as the European Union's new anti-coercion instrument, discussed in the next section, attempts to do); by offering EU producers incentives to diversify export destinations, particularly to reduce concentrated exposures to China; and through insurance mechanisms that reduce the impact of export disruptions to specific products ex post. The latter must of be designed in a way that avoids moral hazard, i.e., it does not encourage concentrated exposures ex ante. We return to possible instruments for export diversification and ex-post protection in the next section.

Fourth, there is a role for deterring coercion, rather than just making ourselves less vulnerable to it. This is because de-risking of export and import dependencies will never be complete – and should not be complete, given that de-risking needs to be weighed against the benefits of trade specialisation and continuing trade with China and other countries that may use coercion.

Fifth, there is the question of whether the European Union should reduce its overall trade integration with China to soften the blow of a sudden trade disruption triggered by a geopolitical confrontation. According to Baqaee et al., the costs of a gradual reduction in trade integration with China would be small for most EU countries, even if trade integration is reduced all the way to zero. Even for Germany, where the cost of complete decoupling from China would not be small, the costs of a partial reduction of trade integration – for example, reducing export and import shares by one third – would be small if pursued gradually. On this basis, policy actions to encourage a pre-emptive reduction in trade integration would be justified if all three of the following conditions hold:

- The probability of a very costly sudden trade disruption is considered to be sufficiently high.

- Firm-level diversifications of trade are not, by themselves, sufficient to engineer this pre-emptive de-risking.
- Targeted (i.e. firm- or sector-level) export diversification efforts do not have a substantial impact in reducing aggregate import dependency.

There is high uncertainty on all of these points. With regard to the second and third, Bown finds that trade diversion triggered by US tariffs on China and Chinese retaliation has further increased EU trade integration with China. With fresh US legislation directed against Chinese imports, such as the Inflation Reduction Act, this effect might continue. At the same time, the combination of a heightened sense of the risks created by a concentrated exposure to China and the structural slowing of the Chinese economy might push in the other direction. Furthermore, targeted de-risking efforts may have an aggregate impact, particularly if they reduce concentrated exposures to China in sectors that have a large weight in the EU economy, such as the car industry.

Finally, it is important to highlight two trade-related economic security concerns that are the intellectual cousins of the risks identified and quantified by Baqaee et al. and Mejean and Rousseaux, but are not directly discussed in those chapters.

The first is the obvious risk, already mentioned in the previous section, of a broad disruption of European trade with the United States in the event of a return of Donald Trump to the US presidency. Given the much larger share of US imports and exports in European trade, this could hit Europe even harder than a disruption of trade with China. While Baqaee et al. do not directly simulate such a shock, this is suggested by their "EU autarky" scenario, which has large costs even in the long run, i.e. even when phased in slowly (a permanent consumption loss of 9% of GDP).

It follows that 'de-risking' the trade relationship with the United States by reducing trade integration might makes sense only if an even more catastrophic sudden decoupling from the United States is viewed as likely. However, a disruption of trade with the United States would likely take the form of a (limited) tariff war rather than a trade embargo. This argues against a pre-emptive reduction of trade. Instead, the European Union must be politically prepared to fight a trade war with the United States if and when a future President Trump decides to start such as war.

A second related concern is that exposures to China and other countries that might engage in coercion against EU firms could come in the form of asset expropriation – in particular, expropriation of production sites. By removing an important source of foreign revenue and profits, this could impact EU firms in much the same way as an import prohibition. However, the risk would show up ex ante in the form of a concentration of profit sources, rather than concentrated exports, and the remedy could involve diversification of production sites and profit centres rather than diversification of exports, as well as increasing capital buffers.

Summing up, our analysis results in five main 'calls for policy action':

1. Reduce import dependency for critical products.
2. Diversify foreign revenue sources and/or strengthen firm resilience to disruptions of foreign demand, asset expropriations, or payments controls impeding profit repatriation.
3. Deepen the Single Market and make it more flexible.
4. Deter economic coercion of any kind, whether through imports or exports or through other means.
5. Possibly, limit overall trade dependency (and particularly export dependency) on China, at the aggregate level.

Achieving these objectives requires policies that are effective, balance costs and benefits, and minimise the risks of unintended consequences. We next examine what such policy might look like concretely, starting with those the European Commission has already been implementing.

4 HOW TO DE-RISK

As the outbreak of COVID-19 revealed dangerous vulnerabilities and called for a reassessment of the international economic relations of the European Union, rising US pressures under the Trump presidency and the increasingly aggressive behaviour of the Chinese government drew European policymakers' attention to the threat of economic coercion and called for a redefinition of the toolkit with which they could react to it. In response to this new context, the European Union took a series of major initiatives to strengthen its economic resilience and to equip itself to better counter malicious behaviour by economic partners (Box 1).

Limitations notwithstanding, this is an impressive package that expresses a change of attitude. Considerable efforts have gone into addressing critical import dependencies, giving the European Commission powers to deter coercion (the Anti-Coercion Instrument, or ACI, subject to support by a majority in the Council) and preventing a breakdown of the Single Market in an emergency (the Internal Market Emergency and Resilience Act, or IMERA). At the same time, these efforts fall well short of meeting the policy objectives listed at the end of the previous section.

First, and mostly obviously, **export dependencies** have been largely neglected. Aside from the intention to negotiate additional trade agreements with friendly nations, there is no instrument to encourage export diversification and/or reduce concentrated export dependence on China.

BOX 1 **RECENT ADDITIONS TO THE EUROPEAN EXTERNAL ECONOMIC SECURITY POLICY TOOLKIT**

The European Union has adopted or is discussing a series of new initiatives, which complement standard trade defence instruments (anti-dumping or anti-subsidy duties consistent with the WTO Agreement on Subsidies and Countervailing Measures, for which the Union has developed procedures that are in the process of being strengthened):

- The **Foreign Subsidies Regulation**[3] (FSR), in force since July 2023, introduced new tools to tackle foreign subsidies that cause distortions and undermine the level playing field in the areas of mergers and acquisitions and procurement (Anderson, 2020).
- The **European Chips Act**,[4] in force since September 2023, is intended to bolster Europe's competitiveness and resilience in the semiconductor sector by supporting large-scale manufacturing projects via somewhat more permissible subsidy rules compared to conventional "important projects of common European interest" (IPCEIs) – investment projects involving cross-border collaboration and state aid from several EU countries. It also entails measures aimed at mapping and monitoring the semiconductor supply chain to assess ex-ante risks of potential import disruption but also and envisions broader powers for the Commission to act in a crisis, including as common purchasing body (Poitiers and Weil, 2022).
- The **Net Zero Industry Act** (NZIA)[5] and related parts of the Temporary Crisis and Transition Framework[6] (TCTF) are intended to strengthen the European ecosystem of clean-tech manufacturing. The NZIA includes measures intended to accelerate permitting, while the TCTF allows member states to provide subsidies to clean tech manufacturing projects which can match subsidies of third countries under certain conditions (Tagliapietra et al. 2023).
- The **Critical Raw Materials Act**[7] (CRMA) aims to tackle the issue of highly concentrated imports of certain raw materials that are of strategic importance. It seeks to boost domestic mining, refining and recycling of such raw materials through accelerated permitting procedures as well as measures related supply chain monitoring, stockpiling and improving the recyclability of CRMs (Le Mouel and Poitiers, 2023).
- The **Health Emergency Preparedness and Response Authority** (HERA),[8] which was launched in September 2021, has as part of its mission to improve the resilience and availability of medical supplies. It aims to achieve this by identifying key supply chain bottlenecks and addressing them through measures such as coordinated stockpiling and joint procurement.
- The **Anti-Coercion Instrument** (ACI), in force since December 2023, is intended to provide the European Union with a wide range of possible countermeasures when a third country exercises coercion. It gives the Union extensive powers to deploy countermeasures in response to an act of foreign coercion, including the imposition of tariffs, restrictions on trade, services and intellectual property rights, and restrictions on access to foreign direct investment and public procurement.

3 https://competition-policy.ec.europa.eu/foreign-subsidies-regulation/about_en
4 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_en
5 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/net-zero-industry-act_en
6 https://competition-policy.ec.europa.eu/state-aid/temporary-crisis-and-transition-framework_en
7 https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en
8 https://health.ec.europa.eu/health-emergency-preparedness-and-response-hera_en

BOX 1 **(CONTD.)**

- The **Internal Market Emergency and Resilience Act**[9] (IMERA), formerly the Single Market Emergency Instrument, on which agreement was reached between the Parliament and the Council in February 2024, aims at ensuring continued access to critical goods and services. Although primarily intended to respond to COVID-type emergencies, it also covers disruptions to the single market triggered by conflicts, such as the war in Ukraine.
- **Commission initiatives on inward and outward investment screening and the coordination of export controls** were proposed in January 2024. The coordination mechanism for inbound investment screening has been in place since 2020, but it mainly commits member states to put an investment screening into place. The 2024 economic security package includes an update of this scheme, but remains vague on the prospect of outbound investment screening.

Second, instruments to address **import dependencies** remain imperfect and incomplete:

- While the Chips Act, the Critical Raw Materials Act (CRMA) and the Health Emergency Preparedness and Response Authority (HERA) have plausible economic security justifications, the Net Zero Industry Act (NZIA) covers a broad swath of goods that mostly fail to meet the definition of critical good proposed in the previous section.[10] At the same time, many other goods that might be critical, such as the upstream products with high import concentration identified by Mejean and Rousseaux, remain outside the scope of any of these acts. There is no framework for identifying goods which may be genuinely critical but are not part of any of the four identified product categories.
- EU-level instruments to reduce dependency on these goods are for the most part weak. EU-level funding for industrial policy directed at expanding EU capacity is small (Chips Act) or nonexistent (CRMA). Trade policy instruments rely mainly on increasing market or investment access for EU companies via new or expanded trade agreements.
- The main channel through which these acts operate is by giving member states greater leeway to subsidise investment in the areas covered by these acts. While this may lead to the occasional success (an investment in a critical area that would otherwise not have happened), there is no governance structure to ensure that critical dependencies are reduced in a timely way. Furthermore, the approach mostly benefits EU countries that have the fiscal resources to provide large subsidies, and large incumbents, which have the clout and scale to lobby for subsidies and participate in IPCEI consortia.

9 https://data.consilium.europa.eu/doc/document/ST-6336-2024-INIT/en/pdf
10 Namely, photovoltaic and solar thermal, onshore wind and offshore renewables, batteries and storage, heat pumps and geothermal energy, electrolysers and fuel cells, sustainable biogas and biomethane, carbon capture and storage (CCS) and grid technologies.

Third, the Commission has missed the opportunity to rally members states behind increasing resilience by **deepening the Single Market**, particularly through the banking and capital markets unions. This could raise economic security both through better risk sharing and by increasing private capital that could fund of new productive capacity.

A more systematic attempt to strengthen economic security could involve the following elements.

1. A process for identifying and regularly reviewing critical import dependencies, based on the criteria developed in Section 2 and better data (Mejean and Rousseaux, Bown). The latter may require more systematic due diligence of European firms on their supply chains from an economic security perspective.

2. Stronger governance and better funding for a competition-friendly EU-level industrial policy. This could involve:

    i. an institution similar to the US Advanced Research Projects Agencies (ARPA) to develop technology in areas that are identified as critical (Tagliapietra et al., 2023, Pinkus et al., 2024); and

    ii. where the technology already exists, allocation of production or investment subsidies through auctions (along the lines of auction mechanisms that are currently used to tender renewable energy capacity).

    These mechanisms would not necessarily require large funding. US ARPA budgets are relatively modest (in the single-digit billions range), while the auction process could be co-funded by member states, along the lines proposed in DG Clima's "Auctions as a Service" concept.[11]

3. The use of WTO-consistent trade instruments to incentivise import and export diversification. These could include:

    i. on the **import** side, countervailing duties, justified by the presence of a foreign subsidy, which are focused on an area in which there is a critical import dependency on the country that is responsible for the subsidy;

    ii. on the **export** side, a duty levied on EU exports to countries for which export exposure is considered excessive. The latter could be politically difficult, but would be fully consistent with WTO rules.[12]

11 https://climate.ec.europa.eu/system/files/2023-11/policy_funding_innovation_conceptpaper_auctionsasaservice.pdf

12 Article XI of the 1994 General Agreement on Tariffs and Trade prohibits quantitative export restrictions (with certain exceptions) but permits "duties, taxes or other charges". See https://www.wto.org/english/res_e/publications_e/ai17_e/gatt1994_art11_oth.pdf.

4. As an alternative to export taxes, exporters that are highly dependent on a specific export destination could be required to buy a publicly provided political risk insurance that would defray the costs of ex-post public support in the event of coercion (and discourage exports to the destination in question).

5. Similarly, European firms that are highly dependent on production and profits in foreign jurisdictions could be incentivised to diversify production, structure their operations, or hold capital to enable them to survive an expropriation (or controls that impede profit repatriation).

6. Finally, to further increase the deterrence value of the ACI, an act of coercion – once declared by a member state and confirmed by the coefficient – could automatically trigger the retaliation powers that the ACI bestows on the Commission, without requiring confirmation by a majority of member states.

TABLE 2 **ECONOMIC SECURITY OBJECTIVES AND AVAILABLE INSTRUMENTS**

Objective	Available instruments	Problems
Reduce import dependency for critical products	Important Projects of European Interest (IPCEIs)	Imperfect match between critical products and targeted products.
	European Chips Act	Lack of cost-benefit analysis
	Critical Raw Materials Act	Weak EU level instruments
	Net Zero Industry Act and related sections of the Temporary Crisis and Transition Framework for State Aid	Weak governance – actions and funding rely mostly on member states and lobbying by large firms.
	Health Emergency Preparedness and Response Authority (HERA)	
Diversify concentrated export exposures at the firm level	None, except for intention to negotiate additional free trade agreements with "friends".	Lack of instruments leaves the European Union vulnerable to coercion
Deepen the single market and make it more flexible	Internal Market Emergency and Resilience Act (IMERA)	No economic security-motivated deepening agenda
Deter economic coercion	Anti-Coercion Instrument	Council majority required to allow the Commission to deploy ACI powers
Limit overall trade dependency on China's market	None, except for intention to negotiate additional free trade agreements with 'friends'.	Economic cost of sudden decoupling may deter appropriate action by the European Union

5 CONCLUSION

The world has changed. The age of unfettered globalisation, systemic convergence and increasing cultural understanding is over and is probably not coming back in the foreseeable future. Instead, fault lines are opening across multiple dimensions.

Europe and the European Union find themselves in the middle of the divide and thus at a critical juncture. The role Europeans played over the last decades – building bridges, promoting increasing interdependence, supporting multilateral rules and institutions – seems to be out of step in world of large-scale shocks, polarisation and power play. First, the outbreak of the COVID-19 pandemic and the following supply chain congestion highlighted the vulnerabilities of Europe's supply chains. Then the Russian aggression against Ukraine served as a wake-up call on the dependency Europe on energy from a country that was willing to wage war in Europe. Finally, geopolitical shifts, the increasingly adversarial tone of the US-China relationship, underscored the need for a comprehensive reassessment of the European Union's economic security strategy. For a while, Europe nurtured the hope that it could avoid being engulfed in the US-China confrontation and maintain good relations with the countries of the Global South. It gradually discovered the extent of the mistrust it elicited in many developing countries.

How should Europe respond? In the bigger picture, the right response must be more integration within, to project the still considerable economic weight of this continent. It also must mean more common defence against aggressions and acts of economic coercion. But those are longer-term goals. In the immediate future, the response cannot eschew the need to define and safeguard economic security.

This volume focuses on economic security with respect to trade risks, both related to shocks – disruptions to supply chains triggered by events such as COVID or natural disasters – and to deliberate economic coercion as well as geopolitical conflict. While firms have incentives to reduce these risks by diversifying their suppliers and broadening their customer base, they may overlook aggregate vulnerabilities across the supply chain. Moreover, they fail to consider the broader societal costs of dependency and coercion, which can outweigh individual firm's private costs.

This implies that there is scope for policy intervention that identifies the most important trade-related vulnerabilities and seeks to reduce them at the lowest possible cost to the gains from trade, multilateral cooperation, and cohesion within the European Union. Economic security should not become the entry point for wholesale protectionism, and it should not serve as an instrument to protect inefficient producers with powerful backing. Vulnerabilities also exist in a closed economy, and openness is often the best insurance against them. The challenge lies in balancing the benefits of international trade with the need for de-risking.

The analysis in this volume leads to four main conclusions.

First, the identification of critical import dependencies is important, but also extremely difficult. We have made progress, with the chapter by Mejean and Rousseaux in this volume going further than all previous attempts. While there is consensus on a small list of products that should be 'de-risked' – semiconductors, critical raw materials, and some pharmaceuticals – this list is clearly incomplete (for example, by missing upstream products that enter many value chains). At the same time, we lack the basis for going much further without worrying about going too far. Improving our analysis would require (1) more work on determining which imports are 'critical' in the sense that an import disruption would have large costs; and (2) better data on indirect rather than just direct trade dependencies.

Second, while the European Commission has done commendable work in beginning to address import dependencies in some areas and establishing the legal basis for responding effectively to economic coercion, its economic security strategy has some important blind spots. While import vulnerabilities have received a lot of attention, vulnerabilities via concentrated exports, which can make firms and entire sectors vulnerable to coercion, have received much less attention. Addressing these vulnerabilities may require instruments that incentivise firms to diversify exports, such as compulsory insurance against concentrated risks, or export taxes. This will need to be complemented by a strategy to address exposures through local production rather than trade, making firms vulnerable to expropriation risk. Finally, another major blind spot is the lack of instruments to address coercion through financial channels, such as interfering with payments. While European firms are not currently on the receiving end of such coercion, this may change if Donald Trump returns to the White House.

Third, EU economic security requires a major push of the Single Market agenda, as part of a general resilience strategy which complements the attempt to de-risk individual import and export dependencies. Unlike the latter, this does not involve trade-offs between security and growth, and it is not sensitive to assumptions about where the next shock will come from and which dependencies are particularly critical. It would help the Union resist external shocks and coercion – whatever the source and the channel – both by allowing a faster redirection of trade and supply and by improving automatic risk-sharing. Better risk sharing, in turn, would make the European Union more cohesive, and would make it harder to exploit internal divisions. The speed of the EU response and its ability to deter coercion could also be improved by activating the retaliatory powers of the Commission under the Anti-Coercion Instrument without requiring confirmation from a majority of member states.

Fourth, there is an open question of whether, in a world of heightened geopolitical risks, the European Union is too trade-integrated with China on the one hand and with the United States on the other, exposing itself to major economic disruption in case it is drawn into a trade conflict between or with these countries. With respect to the United States, the probability of an all-out embargo seems sufficiently low to answer the question in the negative. Instead, the European Union may need to prepare itself (mainly

politically) to fight a trade war with the United States if President Trump returns and reinstates tariffs on the Union. With respect to China, the answer is less obvious. In their chapter, Baqaee et al. show that the costs of reducing trade integration slowly are much lower than those of a sudden decoupling. Whether the European Union should purse a broader de-risking therefore depends on the probability of a sudden, embargo-like collapse in trade compared to the benefits of maintaining integration. Whatever action the European Union takes should remain within WTO rules, and it should preserve the ability to collaborate with China in areas such as climate change and WTO reform.

The new global geoeconomics map may necessitate an EU pivot towards economic security, even beyond the pivot that has already happened. But economic security must not become an excuse for protectionism, and it must preserve international cooperation. This requires innovative policy instruments, joint preparedness, contingency planning, and stronger governance mechanisms at both the EU and the international level.

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CHAPTER 2

Industrial policy in the shadow of conflict: Lessons from the past

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1 INTRODUCTION

The Biden administration's Inflation Reduction Act symbolises the return of industrial policy to the world's economic policy agenda, and poses a challenge to which European leaders are now having to respond. It comes at a time when the world is seeking to transition away from the fossil fuels that have powered our economies since the first Industrial Revolution, and reflects the belief that government policy can and should intervene to accelerate technological change and channel it into desirable pathways. It also demonstrates a political determination on the part of the US government that American tax dollars should promote technical progress and industrial production in the United States, and comes at a time of heightened political tension between the West and China which is bringing strategic considerations back into international trade policy.

Does the past have any lessons for today? The history of industrial policy remains understudied, although it is making a return to the academic agenda (Lane, 2020; Juhász et al., 2023; Juhász and Steinwender, 2024). Much of the existing literature has looked at strategies adopted by 'backward' countries seeking to converge on the economic leaders of the time, with East Asia being a notable case in point (e.g., Amsden, 1992; Rodrik, 1995; Lane, 2022). But the current European debate is not about how best to catch up on a technological leader, but about whether and how the European Union and its member states, already rich, should intervene to ensure that technologies that have not yet been invented are developed and used in Europe. In other words, it is about the role of industrial policy in countries already on, or very close to, the technological frontier, at a time of accelerating innovation: it is less about catching up, and more about trying to forge ahead, as opposed to falling behind (Abramovitz, 1986).

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In this chapter, we revisit the histories of the first and second Industrial Revolutions, focusing on the experiences of countries that were already rich by the standards of the time, on or close to the technological frontier, and which could reasonably have aspired to industrial and economic leadership. Did governments intervene to promote economic growth, technological change, industrial leadership, or national security, and if so what form did these interventions take? Were some strategies more successful than others, and if so why? The chapter is structured thematically rather than chronologically, since we lack the space required to provide a proper narrative history. In the remainder of this introduction, we make some general points about the history of industrial policy, beginning with a discussion of the variety of forms that it has taken over time.

1.1 What is industrial policy?

Juhász et al. (2023, p. 4) define industrial policy as "government policies that explicitly target the transformation of the structure of economic activity in pursuit of some public goal. The goal is typically to stimulate innovation, productivity, and economic growth. But it could also be to promote climate transition, good jobs, lagging regions, exports, or import substitution." The breadth of this definition is useful, since as we will see, governments have often been motivated by strategic considerations when intervening in the economy.

Industrial policy can take many forms. Consider support for technological change. Governments can promote general or sector-specific technical change by intervening directly in the markets for invention or innovation. For example:

- During the 18th and early 19th centuries, the British Board of Longitude awarded £53,000 worth of prizes to innovators, most famously John Harrison in recognition of his chronometer. A condition of the awards was that details of inventions be made public, and the Board spent £45,000 on publications facilitating this (Kelly and Ó Gráda, 2022).

- Alternatively, governments could reward innovators by granting them monopolies. The first patent law is generally held to have been passed in Venice in 1474 (Comino et al., 2020). Patents were subsequently introduced in many European countries, and in England were given a legislative basis with the Statute of Monopolies of 1624. France and the United States passed patent laws in the aftermath of their respective revolutions (Frumkin, 1945; Moser, 2013).

- A third possibility was for governments to finance public research institutions. Publicly funded agricultural research was very important in developing suitable grain varieties in late 19th century frontier economies such as Canada (Olmstead and Rhode, 2007), but governments also financed industrial research. For example, the Japanese government founded an Industrial Experiment Laboratory

in 1900 to do research on behalf of domestic firms, and 15 years later supported the establishment of a research centre focussed specifically on the iron and steel industry – the Iron and Steel Institute of Japan (Mazzoleni and Nelson, 2007, p. 1519).

- In recent decades, governments have promoted inward transfers of technology by encouraging foreign direct investment. In the past, governments pursued the same goal by encouraging the immigration of skilled artisans embodying technical knowledge. Examples of such policies can be found in a wide variety of historical contexts, from Edward III's issuing letters of protection in the 14th century to foreign textile workers coming to England, to the government of Meiji Japan hiring foreign engineers and teachers who could assist in its programme of economic modernisation and industrial development (Lambert and Pajic, 2016; Sukehiro and Wakabayashi, 1989, pp. 466-70).

Governments can also try to stimulate innovation at one remove by intervening in input markets, specifically markets for those inputs most important for invention and innovation. Most obviously, they can finance higher education and technical training, but they can also intervene in capital markets to ensure that would-be innovators have access to an adequate supply of credit.

Third, governments can intervene in product markets via taxes, subsidies, and protectionist policies. Governments can also support industries directly via their procurement policies. For example, the Russian government embarked on a major programme of railway construction in the late 19th century, and through its subsidies and procurement decisions promoted the establishment of a domestic metallurgical and machine-building industry that could supply the railroads with locally produced inputs (Kahan, 1978, pp. 268-9). And governments can take measures to stimulate the private consumption of favoured products, as in the case of the English laws of 1666 and 1678 requiring that people be buried in woollen shrouds (O'Brien et al., 1991, p. 397).

Finally, Juhász et al.'s (2023) definition of industrial policy can be expanded to include targeting not only the structure of the domestic economy, but that of one's rivals. As a French demographer wrote in 1788, "[t]he people that last will be able to keep its forges going will perforce be the master; for it alone will have arms" (cited in Landes, 2003, p. 326). In such a context, industrial policy may seek not only to promote domestic technological progress and economic growth at home, but to slow them abroad. Today's American attempts to weaken China's chip industry are not a dramatic break with the past, in that peacetime export controls justified on grounds of national security have been legal in that country since 1949 (see below).

1.2 Laisser-faire: A historical exception, not the rule

While the current turn towards industrial policy may strike observers as dramatic, in a historical context it is unexceptional. Western policymaking may largely have eschewed such interventions since the 1980s, but this was an atypical interlude.

Prior to the first Industrial Revolution, the major European states pursued mercantilist policies, inspired by the belief that plenty begat power and vice versa (Viner, 1948; Findlay and O'Rourke, 2007). An initial focus in Britain on securing and monopolising profitable trade routes was gradually replaced by what Barth (2016) calls industrial-capital mercantilism, emphasising domestic manufacturing rather than the re-export of imported goods. The turn of the 18th century saw a switch in London from traditional revenue-raising tariffs on imports and exports of 5% to much higher tariffs targeting the growth of silk, paper, and other domestic industries. During the 17th and 18th centuries, continental statesmen such as Colbert also used tariffs to protect domestic industry, especially textiles, and to damage the trade of France's Dutch and English rivals (Coleman, 1961, p. 38). Nor were tariffs the only industrial policy instruments used by early modern states, as we will see.

Industrial protection was common in the 19th century, although Britain adopted free trade in mid-century (Bairoch, 1989). In the United States, tariffs had long shielded northern industries, and the country would remain protectionist into the 1930s. Education and railroad construction were other policies of the time that transformed "the structure of economic activity". Allen (2011, p. 114) goes so far as to speak of a "standard model" successfully pursued by countries throughout Western Europe and North America during this period, and into the 20th century, involving four elements: "railways, tariffs, banks, and schools".

The interwar period saw widespread government intervention, which remained important even in the West after 1945. Industries were nationalised, governments invested heavily in secondary and higher education, and economic planning was adopted in several countries. In France, the *Commissariat Général au Plan* devised plans whose goals included not only economic growth, but "ensuring our defence" and aiding former African colonies "which decided to keep special ties with our nation". The French Atomic Energy Commission was established in 1945 to "pursue scientific and technical research in the view of using atomic energy in the various domains of science, industry, and national defence" (Hecht, 2009, pp. 48, 58); nuclear power has been central to French energy and industrial policy ever since. Across Continental Europe, dividends were taxed and domestic investment subsidised; tripartite agreements between labour, capital and governments sought to boost investment by increasing profits (Eichengreen, 2007). While trade was liberalised between Western economies, especially from the 1960s, this was not a global phenomenon, and capital mobility remained largely restricted until the 1980s (Obstfeld and Taylor 2004). In 1949, shortly after the start of the Cold War, the United States passed the Export Control Act giving the administration widespread powers to control exports. In conjunction with its NATO allies, a Coordinating Committee for Multilateral Export Controls (CoCom) was established to jointly restrict exports to the Soviet bloc; this was only disbanded in 1994.

The Reagan-Thatcher revolution of the 1980s pushed back the boundary of the state in many countries, and the 1980s and 1990s saw the emergence of a global market with much less government intervention than previously. But industrial policy did not disappear in the West: Airbus is an obvious example, as are the energy policies pursued by various governments. And industrial policy has been common in other parts of the world, notably China. In a broader historical perspective, therefore, there is nothing unusual about the re-emergence of industrial policy in the OECD; it is its relative absence in the preceding decades that seems anomalous.

1.3 Industrial policy and geopolitical tension

Industrial policy has been motivated by a variety of concerns. Sectoral lobbying has undoubtedly mattered, but policy has also been driven by a desire to promote national economic development. And the extent to which industrial policies have historically been driven by strategic considerations is striking.

Economics and geopolitics were intertwined throughout the early modern period. As Wilson (1978, p. 1) points out, 1610 was the only year between the start of the 17th century and 1667 not to see war between the major European states. In consequence, war was taken as the normal state of affairs by politicians: "Omit this and much of what came to be the national policy – in economic terms, the mercantile system – becomes unintelligible" (*ibid.*). Long distance trade absorbed the attentions of statesmen not only because of the revenue it could bring to state coffers in an era of mounting military expenditures, and the profits which it offered politically well-connected merchants, but because the shipping sector was a "nursery for seamen" and a source of ships that could be used in the event of war. This was a particularly important consideration for an island nation such as Britain: no fewer than 83% of the ships that warded off the Spanish Armada in 1588 supposedly originated in the merchant marine (Özveren, 2000, p. 25). Governments were unwilling to leave the fate of the shipping sector to the market, intervening with a range of prohibitions and other restrictions on trade, most famously the English Navigation Acts, and being willing to go to war to further their countries' commercial interests. Domestic lobbying by merchants lay behind the legislation of this period, but so did strategic considerations: Adam Smith, no protectionist, concluded a century later that "[a]s defence…is of much more importance than opulence, the act of navigation is, perhaps, the wisest of all the commercial regulations of England".

As we will see, the metallurgical industry was strategically important in the 18th century, and with the Industrial Revolution heavy industry became even more important: iron and steel were essential in producing not only cannons and guns, but ships, rails, trains, and other strategically vital goods. Not to have a domestic heavy industry capable of supplying such products risked catastrophe in the event of war, and governments intervened to ensure that they would not be thus exposed. Their military forces sent delegations to observe best technological practice in leading companies such as Krupps in Germany; governments tried to import technological expertise in the form of engineers and skilled

workers; government procurement policies were used to ensure stable domestic markets for local companies; state-owned companies were subsidised; and tariffs were used to protect domestic firms from their foreign rivals. In 1878, for example, the Japanese navy sent officers to study how weapons-grade steel was produced by Krupp and Armstrong in the United Kingdom. As in other countries, the navy would become a major advocate for the establishment of a domestic steel industry. Military tensions between China and Japan in the 1890s eventually provided the impetus behind the formation of Asia's first integrated iron and steel works, the state-owned Yawata Works, which began production in 1901. The plant was loss-making for the first decade of its existence, but became a central component of Japan's flourishing iron and steel industry, facilitating technological diffusion via the mobility of engineers and direct technical assistance (Yonekura, 1994).

2 PATENTS AND INNOVATION

An influential school of thought holds that Britain's early modern success was largely due to its progressive patent laws, reflecting a more general tendency to protect private property. In contrast, early modern France discouraged innovation by enmeshing the private sector in a web of bureaucracy and privileges. This New Whig view was articulated by North and Thomas (1973, pp. 155-156), who argued that "by 1700…England had begun to protect private property in knowledge with its patent law. The stage was now set for the industrial revolution." Useful industrial policy, in this account, consists of government providing the private sector with the institutional framework it needs to innovate.

In fact, English patents were costly to obtain, and the ability to enforce a patent was uncertain at best. Registering a patent for a successful product was an invariable prelude to litigation from those who wanted to use it for free: "Indeed, by the late eighteenth century, it was becoming a dictum that a patent was of little commercial value until it had been successfully defended in the courts" (MacLeod, 1988, p. 73). During the first parliamentary investigation into patent law in 1829, the engineer Marc Brunel said that "I might as well toss for the fate of a patent" (MacLeod, 2009, p. 43)

The odds were even worse than that. Between 1750 and 1829, only one third of judgements went in favour of the patent holder. Almost none of the epochal inventions of the Industrial Revolution, with the exception of Watt's separate condenser (although even he was reluctant to sue violators for fear that the patent specification would be found wanting), was successfully patented or stayed so for long. Hargreaves was denied a patent on his spinning jenny on the grounds that he had already sold some; Arkwright had his patents for the water frame and carding machine revoked; Crompton lacked the money to patent his mule; Tennant lost his patent for bleaching liquor after being sued by his licensees; Cort lost his patents for puddling and rolling in opaque circumstances following the revelation that his partner had misappropriated government funds;

and Argand had his lamp patent revoked. In contrast with the view that the English patent system turbo-charged the Industrial Revolution, it would appear to have instead resembled an elaborate bait-and-switch scheme in which inventors laboured in the hope of a patent that would prove worthless if others found their invention valuable.

The German chemical industry during the second Industrial Revolution provides another fascinating example of the role of patents. The roots of German success can be found in local states competing to attract the best scientists to publicly financed research institutes. Lehrer et al. (2009) note how the research funding model resembled that of US universities since the 1940s. German success was epitomised by the dye industry: on the eve of World War I, German firms and their foreign subsidiaries accounted for 90% of world production and dyestuffs were Germany's largest export. However, the early breakthroughs in synthetic dyes occurred in Britain and France, partly as a result of a domestic over-supply of German chemists leading them to seek employment elsewhere. Early German firms established in the early 1860s largely operated by pirating these products, aided by the *absence* of a coherent national patent system before 1877. A good deal of their success in this period, Murmann (2003, pp. 89-90) suggests, was the consequence of Darwinian selection in a highly competitive environment where, without patents to hide behind, only the most efficient and resourceful firms survived.

In 1877, a national patent law was introduced under pressure from the engineering industry. The sections dealing with chemicals were drafted by August Wilhelm von Hofmann, the first director of the British Royal College of Chemistry and co-founder of the *Deutsche Chemische Gesellschaft*. They ensured that chemical products, such as a particular dye molecule, could not be patented, only the process used to produce them. This allowed rivals to devise their own processes. It is from this date that German dye firms established their own research laboratories, staffed with graduates from institutes. The typical pattern was for particularly talented hires to be sent to work in a prestigious academic laboratory for several months on problems of interest to the firm (Meyer-Thurow, 1982).

For Haber (1958, pp. 198–203), a major reason for the rise of German producers was their exploitation of the weaknesses of the British and French patent systems, which allowed dye *molecules* to be patented even if not produced in the country. This allowed German firms to patent their new dyes without issuing licences to local producers, effectively blocking innovation. Foreigners were granted 600 patents for coal tar dyes during 1891-5, none of which were produced in Britain (Foreman-Peck, 1999, p. 123).

English patent law didn't have much to do with the first Industrial Revolution and was harmful during the second. The argument that the breakthrough to modern growth was sparked by the protection of private intellectual property rights in the first industrial nation is not supported by the facts. This is not to deny that private sector innovation was crucial in 18th century England, for it was. Nor does it mean that patents were not important in other contexts, since as the German dye example suggests, they were. It

does mean that not all patent systems were alike, and that the details of the legislation mattered. It also suggests that we should be sceptical of the argument that the role of government in promoting British success was a passive one. In fact, the British state was highly interventionist before and during the first Industrial Revolution, as we will see.

3 ZERO-SUM INDUSTRIAL POLICY

The proposition that governments should intervene to address market failures is relatively uncontroversial, and there are arguments for industrial policy that would apply in a closed economy or at the level of the world as a whole. But there are other interventions whose logic relies more on the fact that the world is divided into states with competing economic or strategic interests, suggesting that individual states should grab technologies, markets, or resources for themselves rather than leave them to their competitors. Unsurprisingly, the historical record provides many examples of the latter.

3.1 The Navigation Acts

The 17th and 18th centuries were characterised by a lengthy struggle between the main European powers – notably England (from 1707 Britain), France, and the Netherlands – for control over the trade and resources of the New World, maritime trade within Europe itself, and the long-distance trade between Europe and Asia. The rise of the English shipping industry to a position of global dominance was not a natural market outcome, but the result of conscious government policy involving strict controls on international trade, backed up with military force. The mid-17th century was the turning point. Materially, the Cromwellian regime invested massively in the navy, which was ten times larger at the Restoration than it had been under Charles I (Wilson, 1978, p. 79). Legislatively, the Navigation Laws established the framework under which British trade would be conducted up until the American Revolution on the one hand, and Britain's gradual conversion to free trade in the 19th century on the other. These Navigation Laws, of which the 1660 Navigation Act formed the basis, were aimed primarily against the Dutch, who dominated international commerce in mid-century (Davis, 2012, pp. 295-6). The 1660 Act specified that all commodities imported from outside Europe, and a list of specified commodities imported from Europe itself, be imported in ships that were either English or belonging to the exporting nation. The European goods concerned included the major Baltic and Mediterranean exports, including such strategically important commodities as timber, masts, pitch, and potash. A list of "enumerated commodities", including tobacco, sugar, corn, indigo, and other dye-stuffs, produced in English colonies, could only be shipped to England or its possessions. English ships importing foreign goods could only do so from their original sources (as opposed to, notably, a Dutch entrepôt). The 1663 Staples Act further specified that English overseas colonies buy most of the European imports they required in England, thus reserving an important export trade for English shipping in addition to the import trades listed above.

The net impact of these restrictions was to cut the Dutch middleman out of English trade. Domestic shipbuilding was promoted, while the capture of over 1,000 Dutch ships during the First Anglo-Dutch War of 1652-54 transformed the English fleet into a balanced one combining large, speedy, and manoeuvrable ships capable of defending themselves on the one hand, with cheaper but slower Dutch flyboats on the other (Davis, 2012, p. 12). Dutch ships entering the Baltic had outnumbered their English counterparts by thirteen to one in the first half of the 17th century; the margin was only four to one between 1661 and 1700 (Ormrod, 2003, p. 338). In 1670, the Netherlands accounted for 40% of the European merchant fleet, and Britain only 12%; by 1780 these figures were 12% and 26%, respectively (van Zanden, 2001, p. 80).

England's gain was the Netherlands' loss. While there is debate about the timing and causes of Dutch decline, and whether it was relative or absolute, in the long run there is no doubt that the Dutch lost their pre-eminent role in international trade. Ormrod (2003, p. 337) dates the beginning of the decline to the last third of the 17th century, and concludes that "it is now clear that the Navigation Acts and English protectionist policies helped to secure English commercial hegemony within the North Sea and beyond". Neither is there any doubt that the intention of English policymakers was to benefit at the expense of the Dutch. As a courtier described by Pepys as "a blockhead but stout and honest to his country" put it in the early 1660s, when discussing arguments about whether or not England should embark on a second war against the United Provinces, "[w]hat matters this or that reason? What we want is more of the trade the Dutch now have" (Wilson 1978, pp. 92, 107).

3.2 British machinery exports and skilled emigration

Not all zero-sum policies were successful. In 1719, as a result of French attempts to lure away British artisans, and the suspicious appearance of Russian apprentices in England, an act was passed banning the emigration of skilled workers (Harris, 2017, pp. 8-9). The legislation was subsequently strengthened in 1750. The earliest restriction on machinery exports dates from 1696 and involved stocking frames – extremely complex knitting machines with more than 2,000 parts that had been invented in 1589 and were the basis of a large and successful hosiery industry (Lewis, 1986). This was followed by an act of 1750 banning the exportation of tools used in cotton and linen production. A stricter act in 1781 banned exports of all textile machinery, including models and plans, and this was extended in the following year to machines and copper plates used for textile printing. Metal technologies were added in 1785.

These efforts were unsuccessful. It was easy to conceal machinery parts, claim they were components of permitted exports, or bribe customs officials, while plans and models were impossible to control. Similarly, unless a man was carrying the tools of his trade, it was difficult to distinguish a skilled artisan from an ordinary workman. In 1824, artisan

emigration was no longer controlled and, in 1843, after years of extensive lobbying by both textile manufacturers and increasingly influential machine builders, restrictions on machinery exports were finally removed.

4 INDUSTRIAL POLICY AND UNINTENDED CONSEQUENCES

It is no surprise that industrial policy in the past often had unintended consequences. What may be less well appreciated is that sometimes these unintended consequences had broadly beneficial effects. We illustrate this proposition in the context of 17th and 18th century Britain.

4.1 The Navigation Acts

We have seen that the Navigation Acts increased England's share of international trade at the expense of the Netherlands. That was their aim. More important in the long run was the effect of mercantilist policy on the structure of the British economy. Fuelled by international trade, London grew rapidly to become the largest city in Europe, with a population of almost 900,000 in 1800 (Malanima, 2010). The shipping industry and related activities may have employed a quarter of London's population in the early 18th century (Boulton, 2000, p. 320). By 1700, re-exports of imported commodities accounted for 38% of total exports (op. cit., p. 321). A variety of industries grew up processing imported raw materials. With trade came banking and insurance industries, financial development that in turn fuelled growth in other sectors of the economy, government revenues, a demand for educated workers, and other growth-promoting effects (Allen, 2009; Wright, 2020). With London's growth came high-productivity agriculture in its vicinity, an expansion of coal-mining in northeast England and the coastal trade transporting fuel from Tyneside to the capital, a consequent increase in shipbuilding, and knock-on effects on technologies relating to mining, including steam-driven pumps and horse-drawn railways (Wrigley, 1987, Chapter 6). Trade directly stimulated technical progress: for example, reverberatory furnaces smelting copper with coal rather than charcoal were developed in the late 17th century to satisfy the high overseas demand for copper (Zahedieh, 2013). Taxes on overseas trade became increasingly important: by the early 19th century, they accounted for over 50% of British indirect taxation. By 1818, taxes on "imperial" goods such as tea, tobacco, coffee, sugar, and spices accounted for more than half of this figure (Dal Bo et al., 2023). In the words of Wilson (1978, p. 102), "[i]t is no exaggeration to see these years as a turning-point in England's economic destiny".

4.2 Protection for the woollen industry

At the end of the 17th century, woollen cloth exports accounted for more than two-thirds of total English exports (Davis, 1962, p. 292). The woollen textile industry owed its prominence to 14th century government policy. In 1336, Edward III raised export taxes on raw wool, and merchants were compensated via a monopoly of the export trade.

The net effect was to make raw wool cheaper in England than elsewhere, benefiting the domestic woollen cloth industry, although this was "unpremeditated and certainly neither foreseen nor desired" by the Company of the Staple of Calais that, by the century's end, controlled raw wool exports (Power, 1941, p. 101). Government procurement of clothing for the armed forces provided further stimulus to the industry (Carus-Wilson, 1950, p. 165). The 1330s and 1340s saw English producers capture the domestic market, and by the 17th century they were outcompeting their Hanseatic rivals on northern European markets as well.

Holland retained a comparative advantage in bleaching, dyeing, and printing cloth. In 1614, a group of merchants, led by an Alderman named Cockayne, persuaded James I to ban the export of unfinished cloth in the hopes that it would then be finished at home. The experiment was a disaster. On the one hand, England lacked the skilled workers needed to finish the cloth; on the other, the Dutch responded by banning imports of finished English cloth. Even though the English also banned raw wool exports, in an attempt to further damage their rivals, the scheme was abandoned after a few years (Bowden, 1962, pp. 187-9; Wilson, 1978, pp. 29-30). There followed a series of attempts to ban exports not only of wool but of other raw materials used by the textile industry, including materials used in bleaching such as fuller's earth.

Despite the failure of the Cockayne project, by 1660 around two-thirds of British woollen textile exports consisted of fully finished cloth (O'Brien et al., 1991, p. 401). But a new threat now emerged: highly fashionable and colourful cotton calicoes imported from India. The East India Company exported not only finished Indian cotton textiles to the British market, but unfinished textiles that were printed by a small but rapidly growing calico printing industry based in London. Further competitive challenges facing the industry came from the Irish woollen industry and the linen industry based in Ireland and Scotland. In 1699, Parliament prohibited the export of woollen cloth from Ireland, which eliminated one source of competition at the expense of encouraging the Irish to expand their linen industry (Kearney, 1959).

Indian imports posed a greater challenge, and governments across Europe protected their textile industries. In France, the sale of printed cotton textiles was effectively banned, and similar prohibitions came into effect elsewhere. But in England and Holland, the East India Companies were an important political counterweight to the textile industries, lobbying to keep markets open to Indian calicoes (O'Brien et al., 1991, pp. 400-1). The Dutch VOC won its battle, while the English East India Company eventually lost it. The way this happened had important long-run effects.

In 1701, the English government banned the importation of printed calicoes, except for re-export. Crucially, nothing prevented London printers from finishing white Indian calicoes, and nothing prevented domestic cotton producers from manufacturing cotton textiles. The London dyeing and printing industry consequently flourished, much to the displeasure of the woollen lobby. In 1721, therefore, England followed France and

other countries in banning the wearing of cotton cloth, which ended the importation of Indian cotton textiles for domestic consumption. Again there was a loophole: fustians (a mixture of cotton and linen) were not included in the ban, and fustian production therefore thrived. By the mid-18th century, the Irish linen industry, subsidised by the Linen Board which had been established in 1711, was growing rapidly, partly as a result of the ban on Indian cotton textiles. Rising linen cloth production raised the price of linen yarn, giving fustian producers an incentive to replace fustian's linen warp with cotton. The technological breakthroughs associated with the Industrial Revolution made this possible, and in 1774 it became legal to wear 100% cotton cloth "wholly made of cotton spun in Great Britain" (O'Brien et al., 1991, p. 412). The British cotton textile industry would go on to experience explosive growth and dominate global markets for a century or more.

O'Brien et al. (1991, p. 416) comment that English policymakers "never pretended to formulate anything recognizable as an industrial policy". And yet, as they say, "[b]etween 1696 and 1774 laws emerged which were critical for the subsequent development of the cotton industry" (p. 396). Holland stuck with free trade and never developed a cotton textile industry of consequence, even losing its comparative advantage in finishing cloth (p. 418). France banned not only Asian calicoes but all printed cotton textiles from its domestic market, greatly hindering the development of a cotton textile industry there. In Britain, a set of policies designed to balance special interests, the fiscal needs of the crown, and a desire to promote stability in Ireland, ended up establishing the "legislative foundations" for the first fully mechanised factory industry to emerge during the first Industrial Revolution' (p. 415).

5 RESILIENCE, GEOPOLITICS, AND INNOVATION

Concerns about excessive import dependence are not new, and have tended to grow at times of rising international tension. Countries have adopted various strategies in trying to reduce such (actual or perceived) vulnerabilities. One is to seek alternative sources of supply; another is to use military force to ensure that supplies are secured during wartime.

Take Britain's dependence on the Baltic trade during the early modern period. The Royal Navy's ships, like other British ships of the time, were built almost entirely from material imported from the Baltic: masts, timber for smaller spars and decks, oak for hulls, flax and linen for sails, pitch and tar for waterproofing, high-quality Swedish wrought iron for anchors and other naval hardware, and Russian hemp needed for rigging and other cordage. The Baltic was also an important source of grain. The British were painfully aware of their reliance on a landlocked sea with a single narrow entrance and went to considerable lengths to find substitutes for Baltic timber and hemp. A high-level committee on the topic set up in 1800 included the eminent botanist Sir Joseph Banks. There was particular interest in Canadian masts and oak, along with East Indian jute,

but all were dangerously weak compared with their Baltic counterparts. Other potential sources of hemp were tried and found wanting, while mast timber was sought literally all over the world with a considerable number of trees brought from New Zealand from 1804 despite the danger posed by its hostile Maori inhabitants.

In 1807, Russia joined Napoleon's Continental System, threatening Britain's ability to feed and protect itself and its supply lines. For five years starting in 1808, Britain maintained a fleet of 17,000 men in the Baltic and sent heavily escorted convoys to protect merchantmen from French privateers and small Danish and Norwegian gunboats; in the summer of 1809, 2,210 ships were escorted through the Sound. In 1811, Britain lost three ships of the line, its worst loss during the Napoleonic period, but it won this Baltic battle, maintaining its own naval supplies and depriving its French enemies of theirs (Ryan, 1959).

Food is the ultimate strategic commodity. On the eve of World War I, 58% of the calories consumed by humans in England and Wales were imported (Floud et al., 2012, p. 160); such dependence on imported food was regarded as dangerous by military planners. In 1815 the UK had protected agriculture, partly on security grounds. After Britain's turn to free trade in the 1840s, the strategy adopted was to ensure that the Royal Navy controlled the seas (Offer, 1989, p. 218).

Britain managed to increase domestic food production during World War I, as had been the case during the Napoleonic Wars and would be again during World War II (Olson, 1963). To some extent this happened naturally, as a result of higher domestic prices, but it also reflected active government intervention promoting the production of grain and potatoes at the expense of animal products. There was, however, an additional complication. The new warfare that evolved rapidly on the Western Front was based around massive artillery barrages, which meant that governments needed to maximise production of artillery shells. At the same time, they needed to feed their populations. Both requirements ultimately came down to nitrogen, the main ingredient of high explosives and the most important agricultural fertilizer. Besides nitrogen, other militarily vital chemicals included toluene, acetone, and highly concentrated sulphuric acid. As contemporaries noted, World War I was a chemists' war.

If the outcome of the war had depended on chemical technology the British would have lost. However, what they lacked in technology they could acquire by trade thanks to their naval dominance. Both Britain and Germany were highly dependent on supplies of Chilean nitrates. Once these were cut off by the Royal Navy, the Germans immediately faced a stark choice between producing munitions and growing food, one that was only partially solved by synthetic nitrogen. The British by contrast had access to nitrogen directly in the form of nitrates, and indirectly, in huge quantities, in the form of North

American wheat (Offer, 1989). Besides raw materials, the British were also able to purchase American explosives. The U-boat campaign of 1917 caused a marked fall in nitrate imports, but by that stage synthetic nitrogen was able to meet the deficiency (Haber, 1971, p. 204).

In other words, the key British industrial policy was arguably its ability to maintain overseas supply chains in wartime while disrupting, or destroying, those of its opponents. Britain's control of the seas, combined with the food production of its overseas colonies and allies, meant that hunger was not a serious issue during the war (Offer, 1989). In Germany and the rest of Central Europe, facing an Allied naval blockade, it was a different story. Hunger was widespread in Germany, particularly during the winter of 1916-17, and across the continent several hundreds of thousands of people died of starvation. While Offer (1989) denies that the Allied blockade led to Germany starving, he still maintains that "[f]ood played a critical role in Germany's collapse" (p. 2), being highly damaging to both civilian and army morale. Moreover, the blockade was maintained after the war, until the peace treaties at Versailles had been signed to the satisfaction of the Allies.

Across Central Europe, the lesson was drawn that "countries should never again be dependent on foreign imports for food" (Zahra, 2023, p. xxiii). The policy prescription in most cases was agricultural protection, but elsewhere it was more aggressive. In Japan, naval officers drew the conclusion that "nations had to be able to supply themselves during wartime with adequate quantities of raw materials and manufactured goods. Reliance on other countries for the materiel of war was a sure path to defeat . . . The need for security became, slowly, an impulse for empire, and it led directly to the Pacific War" (Barnhart, 1987, p. 9). Similarly, Tooze (2007) shows how Nazi aggression in the East was partly motivated by a desire to become 'blockade-proof'. As Hitler told a Swiss diplomat, he needed "the Ukraine, so that no one will starve us out as they did in the last war" (Hildebrand, 1973, p. 88). The aftershocks of this period continued to reverberate into the post-war world, not least in Europe, where food security was a key aim of the Common Agricultural Policy. And energy supplies have been a key driver of Western geopolitical strategy since 1945.

Another way for states to maintain food supplies in the face of wartime scarcities was to promote innovation. Finding substitutes for imported goods in anticipation of, or during, wartime blockades has been an important dimension of 'resilience' historically, and has typically involved government intervention. A famous example is the sugar beet industry, effectively established by an 1811 Napoleonic decree. This established sugar beet schools, financed students wishing to study there, decreed that land be set aside for beets and subsidised their cultivation, and ordered that factories be established. Within a year, 40 French factories were producing 3.3 million pounds of sugar. By the end of the century, beet was a more important source of sugar globally than sugar cane (Arrington, 1967, pp. 1-2).

Another example is the development of synthetic fuel and rubber, critical raw materials in an age of motorized warfare and potentially subject to blockade given their geographically concentrated sources of supply. Germany tried to produce synthetic rubber during World War I but with little success. In 1933, however, I.G. Farben was granted a patent on a superior product, Buna S, and under Hitler's Four-Year Plan, designed to promote self-sufficiency, large-scale production commenced in 1937. The Germans also invested heavily in synthetic fuel, which had been developed by Standard Oil due to concerns about American petroleum reserves, and whose technology had been transferred to IG Farben. As part of the same deal Buna technology was transferred to the United States. With the outbreak of war, and the seizure by Japan of Southeast Asia's rubber plantations, the US government sponsored research to resolve various practical issues arising when substituting Buna S for natural rubber; the result was explosive growth in synthetic rubber production, which eventually outstripped its natural counterpart in global importance (Morton, 1981; Tooze, 2007).

6 WAR AND INNOVATION

6.1 Metallurgy and the British Industrial Revolution

War has been a frequent driver of government-led innovation. Consider metallurgy, which along with textiles was one of the key innovating sectors during the first industrial revolution. Driving improvements in the quality of British cast iron was naval demand for cannons, by far the most massive cast iron artefacts of their time. Having a cannon explode on gun decks crowded with men and gunpowder was a catastrophic event, and the Royal Navy, unlike its French counterparts, went to considerable lengths to prevent such failures. Each gun was tested intensively, and the navy maintained intense pressure on suppliers to improve quality.

The traditional source of naval guns was small producers in the Weald of Kent, but quality was low. From 1764, the navy began to take coke-smelted guns from the Carron ironworks in Scotland, and then from south Wales and the West Midlands. In 1769, John Smeaton replaced the clumsy bellows in Carron with a water-powered blowing engine, and shortly after John Wilkinson devised blowing cylinders powered by steam. These enabled longer blasts at higher temperatures in large furnaces, increasing the quantity and quality of iron. French observers were astonished to see a gun made in a single continuous pour from two furnaces. Instead of making the barrel during casting, in 1774 John Wilkinson patented the use of a solid casting drilled out with a rigid lathe that gave precisely circular bores, improving accuracy and reducing windage (the loss of propellant gases from around the cannonball). This technique he then used to make the cylinder of Watt's engine.[2]

2 Predictably, as with most major innovations, his patent was revoked by the government, in this case to permit all its suppliers to use the method.

Moving on to the smelting of wrought iron with coal, the most famous figure was the naval agent Henry Cort, who devised the process of puddling (stirring molten iron in a furnace to burn off carbon by bringing it into contact with air) and passing it through grooved rollers to remove slag and consolidate its grain. Puddling was already known and the rolling process, which he patented first, was his real contribution. Its stated purpose in the patent was to recycle naval scrap, like anchors and chains, by heating it to a welding temperature and then rolling it into new bars; the possibility of using rollers in smelting iron was only mentioned in passing.

Naval demand was also important in the copper industry. The largest single source of demand for copper in the late 18th century was for sheathing the hulls of ships, with the Royal Navy leading the way. Teredo worms could rapidly eat through ship hulls in tropical waters and had been carried into colder waters. It was discovered that copper sheets would not only protect timber from the boring molluscs, but would also prevent weeds and barnacles from encrusting the hull by poisoning them as it dissolved, reducing time in dry dock and leading to a noticeable rise in sailing speed: the passage time to India, for instance, was said to have fallen by a quarter. When war broke out between England and France in 1778, naval demand for coppered ships soared, and the exportation of copper was prohibited (Harris, 1966).

Unfortunately, galvanic action between the sheets and the iron bolts used to secure the frame of ships caused such rapid corrosion that the Navy came close to removing all coppering in the early 1780s. This problem was solved by "two ingenious artists of Birmingham", Westwood and Collins, who, rapidly imitating Cort's application to iron, patented a way of cold rolling copper bolts with grooved rollers to make them as hard as iron ones. By 1784, Williams was producing 40,000 bolts a week for the navy. At this time, Matthew Boulton estimated that private shipyards were using around 1,000 tonnes of copper per year for sheathing, with another 1,500 going to naval yards, which together was around one quarter of British production (Evans and Miskell, 2020, pp. 64–65).

6.2 War and innovation in France during the first Industrial Revolution

Eighteenth century France made extensive and expensive efforts to acquire three strategic British technologies: steelmaking, iron casting, and copper plating. The first two projects were expensive failures while the third succeeded.

The breakthrough technology allowing coal to be used in smelting iron was the reverberatory furnace. Each new material raised fresh challenges in the design of furnaces, grates, flues, refractory bricks, and crucibles to hold the material, which meant that the skills needed to transfer coal technology to new uses often took a long time to acquire (Harris, 1976). The result was that British metallurgy involved a tightly intermeshed web of artisan skills in coke making, furnace design, crucible making, and stoking. As French ironmasters quickly learned, converting an ironworks from charcoal to coal

meant that every single part of the plant and production process had to be redesigned. While a spinning machine could be easily understood, successful adoption of coal-based metallurgy required an entire team of artisans to be transplanted. In the words of one French visitor to Sheffield, "[i]t is the workers who are the true metallurgists".

Steel was needed to produce files which could shape metal parts so that they fit together properly, notably in gunlocks. Files were, in other words, the machine tools of their time. Serious efforts to imitate British steel began in the 1760s, but output was low and quality unreliable as a consequence of using French iron in a charcoal furnace and the lack of suitable refractory clay for the cementation chests (Harris, 2017, pp. 208–10). In 1764, the outstanding young metallurgist Gabriel Jars was sent to Britain to observe, and if necessary spy on, all aspects of British coal and metal manufacture. He gave detailed and well-informed accounts of both blister and crucible steelmaking as well as file manufacturing, and attempted to manufacture steel on his return, but the experiment again appears to have been an expensive failure (Harris, 2017, pp. 224–37). It was only in the late 1820s that successful crucible steelmaking was transplanted into France (Henderson, 1954, pp. 61–62).

French interest in cast iron stemmed from a desire to improve the low quality of its naval cannons that frequently burst when fired. In 1781, the French decided to establish a coke-fired ironworks, and by 1786 they had built a huge plant at Le Creusot, with four large furnaces supplied with air by steam blowing engines, large steam-powered hammers, and six leagues of iron railway for horse pulled trucks. However, the iron ore was unsuitable and the coke of poor quality, so the cast iron produced was unusable (Harris, 1998, pp. 238–58). Again, it was a large-scale transplantation of British skill in the 1820s that turned the Le Creusot works into a highly successful venture (Henderson, 1954, pp. 61–62).

By contrast, the French attempt to copper ships was successful. French adoption was due to an audacious private act of espionage by the industrialist Le Camus de Limare who, in 1781 at the height of the Anglo-French War of 1778, slipped into England and managed to persuade a number of workers capable of melting and rolling copper to come to France. He built a rolling mill at Romilly, and after hostilities ended he obtained a proper iron roller for plates in London and the grooved rollers needed for bolts. Throughout, Le Camus seems to have had a large British workforce that trained French workers. Although the supply of British copper ended with the renewal of war in 1791, the French navy had been coppered and extra metal would be obtained by melting down church bells (Harris, 2017, pp. 268–83). It is easy to see how coppering succeeded where iron making had failed. Iron needed suitable coal, iron ore, fireclay, and, above all, large teams of workers with different skills. Coppering by contrast required only a simple furnace to reheat copper, and machinery to roll plates and bolts.

Whereas the *Ancien Regime* had mixed fortunes in developing metallurgical industries, after the Revolution France made several important advances, notably in artificial alkalis, gunpowder, leather, and canned food. The difference is that while metals relied on artisan skills that the French lacked, these latter advances rested on France's unique abundance of skilled chemists, many of world renown. While this skill base was important in promoting innovation on the supply side, on the demand side military demand was crucial.

The most important innovation was the Leblanc process of making artificial soda for soap, glassmaking, and scouring textiles. Whereas Britain's naval supremacy meant that it could rely on supplies of vegetable alkali in the form of Spanish barilla (the ash of a seashore plant), North American potash, and Scottish kelp, France only had access to the first, which could easily be disrupted in wartime. In response, the *Académie* offered a large prize for a process to generate an artificial substitute. The solution, derived by Leblanc in 1797, was adopted on a large scale in 1808 when war with Spain ended the supply of barilla. A large alkali industry developed, with output rising from 1,000 tonnes in 1810 to 9,000 by 1820, concentrated around the soap-producing centre of Marseille. The Leblanc process, which generated chlorine bleach as a by-product, became the basis of British alkali making until the late 19th century, long after it had been abandoned elsewhere (Haber, 1958, pp. 5–8).

The main component of gunpowder is saltpetre, which provides oxygen to burn the charcoal and sulphur present. Britain could draw on large supplies from India, whereas France had to rely on traditional methods of scraping crystals from cellar walls, or leaving a mix of dung, urine, straw, and woodchips to ferment. Refining the saltpetre was done by boiling the raw material and adding potash, and then collecting the crystals that appeared as the liquor evaporated, an expensive and chemically inefficient process. Lavoisier came up with the idea of running a saturated solution of saltpetre through the raw crystals, a process that was perfected by the leading chemical manufacture Chaptal after Lavoisier's execution. The following 20 years of warfare, learning by doing, and advancing scientific knowledge saw French saltpetre production advance to a fully industrial scale.

While the chemistry of tanning began to be explored from the 1770s onward the real impetus for improvements in the production process came from Revolutionary France's desperate need for military boots. In 1793, Armand Seguin was approached by Berthollet on behalf of the Committee of Public Safety to continue his earlier research on tannin. Seguin introduced two chemical innovations allowing boot soles to be produced in days rather than years. By 1795, a factory with 400 workers was in full production, with artisans from across France being trained to spread the new methods. Seguin became legendarily rich in the process, but the extent to which the technique, which yielded lower quality leather, was used after the wartime emergency is unclear (Gillispie, 2004, pp. 393–95).

A final French advance involved preserving food (Graham, 1981). Heavy losses of troops due to starvation motivated the *Académie* in 1795 to offer a large prize for a technique that would successfully conserve the freshness of food. After 15 years of systematic research, a Paris confectioner, Nicolas Appert, came up with a process in which food in glass jars that had been carefully sealed with a cork were placed in a bath of boiling water, which he subsequently replaced with autoclaves for cooking under pressure. Besides meat and vegetables, Appert also succeeded in preserving milk, beer, and wine, anticipating the work of Pasteur.

6.3 War and the British chemical industry

In 1914, the British chemical industry was small and technologically backward relative to Germany. The government thus took a central role in munitions production, building plants that were operated by private firms and running some factories directly. The effort was successful on its own terms: output of TNT tripled during 1916. Whereas in 1916 Britain imported roughly two thirds of its high explosives, by 1918 it was self-sufficient and supplying large amounts to its allies (Van der Kloot, 2014). Dyes were also vital to the war effort. In early 1915, the government funded the establishment of British Dyes Ltd, which in November 1918 was forcibly merged with its main rival into the British Dyestuffs Corporation. The government held 17% of the firm and had special voting powers to veto unreasonable prices, contracts with foreign manufactures, or diversification into other products. British Dyestuffs thus marks a watershed in British industrial policy where, for the first time, government took a direct role in financing and managing a commercial company. Other dyers were eligible for grants and loans to expand plants and develop new dyes, again in return for close government oversight of their operations (Haber, 1971, pp. 234–36). Despite its clumsy implementation, Haber concludes that without government support the British industry would have been wiped out by German competition in the early post-war years.

Britain produced 25,000 tonnes of dye in 1929 compared with 4,000 in 1913, equal to 90% of consumption (Morgan, 1939), so it is possible to conclude that the government policy of fostering a national dye industry succeeded to a considerable degree. On the other hand, despite the fact that the post-war industry benefitted from protection, imports of German dyes (although only a fraction of their pre-war level) in 1930 were over five times what they had been in 1921, indicating the poor performance of British firms in producing specialty dyes (Haber, 1971, p. 244). This reflects the fact that the number of chemists employed by British Dyestuffs fell from 80 in 1920 to 30 in 1925, and subsequently to 15 (Reed, 2017). Ultimately British Dyestuffs was merged with three other firms (including Nobel Industries, formed from the merger of explosive firms in 1918) into Imperial Chemical Industries (ICI).

In contrast to the wide range of highly profitable new products generated by the over 1,000 researchers of the German IG Farben combine, ICI largely functioned by producing a small range of products at prices usually fixed by international agreement, and contributed little to progress in dyestuffs or organic chemicals. When it joined the international dye cartel in 1931, it had a quota of 7% compared with 66% for the Germans (Haber, 1971, pp. 291–303). Ultimately, hopes that Britain, with its limited educational resources, could develop a chemical industry in a decade that would match what Germany had evolved over two generations were destined to be frustrated.

7 CONCLUSION

As we have seen, a variety of industrial policies were attempted before and during the first and second Industrial Revolutions. Some were successful, others less so. We doubt that the past contains any 'general lessons from history', since context matters so much. But there is one theme that runs through the literature that we think is worth highlighting, namely, the importance of an appropriate skill base.

That skills were seen as a constraint on industrial growth can be seen by the efforts made by governments, from 14th century England to 19th century Japan, to attract skilled workers, or to prevent them from emigrating to rival countries. And we have also seen cases when industrial policy either failed completely, or did not lead to the establishment of internationally competitive industries, due to the lack of skilled workers domestically: this was true of the English Cockayne scheme, which ran into a shortage of workers skilled in the finishing of cloth; of French attempts during the first industrial revolution to import British metallurgical techniques; and of the British chemical industry established during World War I, which played a notable role in the war effort but remained internationally uncompetitive thereafter. In contrast, solid skill bases meant that military demand helped to transform the British metallurgical industry, and the French chemical industry, at the turn of the 19th century. Similarly, the United States' Office of Scientific Research and Development (OSRD), established during World War II, offers a striking example of successful industrial policy that had a long-run impact on the geographical location and direction of US innovation (Gross and Sampat, 2023). Again, this success did not arise in a vacuum, but depended on previous investments in education, scientific research, technical societies, and mass production (Kettering, 1946). As the German example shows, investing in such capabilities can pay handsome dividends.

Another theme running through this chapter is the link between international rivalry and industrial policy, with the first industrial revolution occurring during the 'Second Hundred Years War'. Government policy, motivated by strategic considerations and the exigencies of military conflict, was central to the development of key sectors such as the shipping and metallurgical industries in Britain, and the chemical industry in France. The search for diversified and resilient supply chains was an important consideration

for national governments, but was more likely to be successful in the country with the dominant navy. Government attempts to promote wartime innovation frequently paid off. Closer to our own day, the success of industrial policies associated with the COVID-19 vaccine had a lot to do with the war-like nature of that crisis. Perhaps the relative absence of industrial policy in the 1990s and 2000s is related to the fact that this was a brief interlude between two cold wars, and perhaps we should not be surprised by its resurgence today?

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CHAPTER 3

Identifying European trade dependencies

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1 INTRODUCTION

The risks associated with global trade dependencies have been discussed extensively over the last three years. A primary catalyst for this heightened scrutiny were the disruptions brought about by the COVID-19 pandemic, which underscored the European Union's reliance on foreign nations for crucial commodities, notably medical supplies and pharmaceuticals. Between March 2020 and December 2021, the New York Fed's Global Supply Chain Pressure Index exhibited a consistent upward trend, reflecting the accumulation of disruptions along global value chains. Subsequently, the Russian invasion of Ukraine starkly demonstrated the potential weaponisation of trade dependencies during periods of escalating international tensions.

Global value chains (GVCs) consist of intricate networks of interconnected processes organising the sequence of tasks involved in producing a good, spanning from its inception to the final purchase by end consumers. Over the past three decades, the geographical span of GVCs has significantly expanded, enabling firms and countries to maximise gains from trade (Antràs and Chor, 2021). At the same time, the heightened concentration of activities within specific nodes of these value chains has potentially reduced the resilience of these production processes. First, shocks affecting a single node propagate along the chain, engendering 'granular' risks and comovements (di Giovanni et al., 2020; Bonadio et al., 2021). Second, GVC structures are riddled with diverse externalities. These range from network externalities, which induce suboptimal investments in resilience (Grossman et al., 2021), to information frictions that limit firms' capacity to comprehend their overall exposure to foreign risks, beyond their immediate suppliers (Bui et al., 2022). Consequently, the hyper-globalisation within GVCs exposes economies to a difficult trade-off between the benefits derived from specialisation and the imperative to diversify risks.

Unexpected shocks to the global economy have certainly tilted the balance towards a reduced tolerance for trade-induced risks. Following the onset of the pandemic, policymakers in both Europe and the United States voiced concerns regarding the lack of diversification in supply chains.[1] Calls emerged for public interventions to alleviate the concentration within GVCs, promote diversification, and establish more robust and sustainable supply chains. However, the design of these policies encounters complexities, primarily due to the above-mentioned trade-off. Given the underlying insurance motives, the optimal design of these policies should integrate factors such as the nature of risks the policies seek to mitigate, societal tolerance levels for risk, and the allocation of insurance costs between broader society and the private actors involved in these value chains. Moreover, as global trade dynamics continue to evolve, any resilience policy should adopt a forward-looking approach, not only accounting for existing dependencies but also anticipating future dependencies in key value chains.

To make progress into this direction, in this chapter we combine academic perspectives on the resilience of global value chains with a data-driven examination of Europe's present and future dependencies. The aim is to formulate an appraisal of Europe's trade dependencies, which we argue serves as an indispensable first step for devising effective resilience strategies. Recognising the trade-off between the economic efficiency inherent in specialised GVCs and the strategic advantages derived from enhanced resilience against shocks, it becomes imperative that public interventions aimed at fostering greater resilience in GVCs are well-targeted and thoughtfully designed.

Our diagnosis approach draws inspiration from existing tools proposed to aid in formulating resilience strategies. The European Commission proposed a 'bottom-up' methodology to compile a list of products which resilience policies should prioritise. This method relies on detailed trade data to pinpoint vulnerabilities, defined as product categories predominantly sourced from a limited set of foreign countries. While trade data offer crucial insights into trade dependencies, we argue that refining the list of potential 'vulnerabilities' is imperative. First, our diagnostic process integrates existing production capacities within Europe. Second, it is essential to consider the potential for post-disruption diversification. While the current trade structure informs us about the degree of ex-ante diversification in foreign sourcing, disruptions in the supply chain can prompt diversification ex-post through supplier switching. Our diagnosis thus characterises trade vulnerabilities according to the potential for ex-post diversification.

1 This sentiment was encapsulated in various policy initiatives, such as the 2021 Executive Order on America's Supply Chains, which emphasised that "[t]he United States needs resilient, diverse, and secure supply chains to ensure our economic prosperity and national security. Pandemics and other biological threats, cyber-attacks, climate shocks and extreme weather events, terrorist attacks, geopolitical and economic competition, and other conditions can reduce critical manufacturing capacity and the availability and integrity of critical goods, products, and services." France echoed these concerns in its *Plan France Relance* in 2020: "The France of 2030 will have to be more independent, more competitive, more attractive. It is about no longer depending on others for essential goods, no longer risking critical supply disruptions."

We also propose to complement the data-driven diagnosis with a more explicit analysis of the specific risks targeted by resilience policies. The term 'strategic autonomy' encapsulates various risks, spanning geopolitical risks amidst escalating international tensions, economic risks to industry competitiveness within GVCs, potential societal costs incurred in the case of disruptions to essential goods, and a lack of competitiveness regarding future dependencies (e.g., in green technologies). While each dimension may expose society to sizeable economic costs, different risks do not call for identical public interventions. Thus, a clear delineation of the targeted objectives is crucial for efficiently designing public policies. Finally, we delve into the policy toolbox that governments could employ to craft resilience policies. It is imperative to establish measurable objectives that permit systematic evaluation, ensuring the efficacy of public interventions. Subsequently, the resilience gains obtained through these measures should be evaluated in comparison to traditional trade benefits, such as efficiency and risk diversification.

Related literature

This chapter contributes to various strands within the literature. Central to the field of international economics is the broad discussion on first- and second-moment gains from trade. While conventional (static) trade models primarily emphasise first-moment gains, the influence of trade on the *volatility* of economic activity is a central ingredient of open macroeconomic models. In the seminal model in Backus et al. (1992), trade is a source of risk sharing across countries, effectively smoothing economic fluctuations. While trade provides a natural hedge against country-specific shocks, specialisation simultaneously increases countries' exposure to sector-specific, or even firm-specific, supply shocks (Caselli et al., 2020; di Giovanni and Levchenko, 2010, 2012). The impact of trade on overall volatility thus hinges on the balance between these contrasting forces. In a calibrated multi-country, multi-sector model, Caselli et al. (2020) contend that the risk-sharing property dominates. Conversely, di Giovanni and Levchenko (2012) account for the granular structure of production and trade, underscoring the heightened exposure to idiosyncratic supply shocks, which they argue outweigh the risk-sharing advantages of international trade.

Another branch of literature approaches this question from the perspective of international comovements. Early works like Frankel and Rose (1998) highlighted that countries with more extensive bilateral trade tend to exhibit more correlated business cycles. di Giovanni et al. (2018) offer empirical evidence supporting a causal link from trade to business cycle comovements. Kleinert et al. (2015) and Cravino and Levchenko (2017) emphasise the role of multinational connections as a conduit for the transmission of shocks across borders. A number of papers leverage quantitative multi-country, multi-sector models to quantify the impact of trade and global value chains on aggregate comovements (di Giovanni and Levchenko, 2010; Bonadio et al., 2021; di

Giovanni et al., 2020).[2] Recent literature further incorporates evidence obtained from natural experiments. For example, Boehm et al. (2019) use the 2011 Tohoku earthquake to estimate the diffusion of supply disruptions from Japan to US affiliates of Japanese firms. Their findings underscore substantial complementarities in production functions, intensifying the spread of supply chain disruptions. Similarly, Lafrogne-Joussier et al. (2023) leverage the early exposure of French firms to the COVID pandemic, through Chinese input sourcing, to estimate the propagation of supply chain disruptions. They reveal that firms with higher inventories experienced a mitigated sales drop. Intriguingly, pre-disruption diversification of firms' supply chains does not shield them from shocks, when compared with non-diversified firms. This is due to non-diversified firms actively seeking new suppliers in the aftermath of the shock. This evidence points to a possible substitutability between ex-ante and ex-post diversification strategies.

The literature examining the normative aspects surrounding these debates remains limited in comparison. Grossman et al. (2021, 2023) delve into equilibrium and first-best allocations within models wherein investments in resilience impart externalities on other firms within the production network. They derive policies that implement the first-best allocation, through a combination of subsidies to input purchases, network formation, and investments in resilience.[3] Aside from network externalities, other market failures surround discussions on strategic autonomy. Baldwin and Freeman (2021) formalise a potential divergence between private assessments of the risk–efficiency trade-off associated with trade and the social evaluation, which might place greater emphasis on risks. This divergence gains particular relevance in discussions concerning disruptions to 'essential' products that furnish public goods and services. Escalating geopolitical tensions have prompted examination of the link between trade dependencies and the likelihood of conflicts. Thoenig (2023) introduces a quantitative toolkit to dig into this interaction. In this framework, trade influences the so-called 'geoeconomic welfare gains', which can be positive or negative depending on the direction and extent to which conflict risk reacts endogenously to policy-induced shifts in trade flows.

Alongside academic contributions, a policy-oriented literature delves into the resilience motive for public policies (White House, 2021; US Council of Economic Advisors, 2022.; OECD, 2021). Most relevant to what we do are publications that propose assessments of trade vulnerabilities (Bonneau and Nakaa, 2020; Jaravel and Mejean, 2021; European Commission, 2021; Baur and Flach, 2022; Vicard and Wibaux, 2023). As detailed in Section 2, a common feature of these papers is the use of fine-grained

2 For instance, Bonadio et al. (2021) examine the role of global supply chains during the COVID-19 pandemic using a multi-sector quantitative framework across 64 countries. Their findings suggest that around one quarter of the overall real GDP decline during the pandemic could be attributed to labour supply shocks transmitted through global supply chains. Importantly, they simulate a 'reshoring' scenario, relocating foreign parts of value chains domestically, and demonstrate that domestic production does not inherently render countries more resilient to pandemic-induced contractions in labour supply.

3 Elliott et al. (2022) also construct a model featuring endogenous production networks in which firms weigh the expense of diversifying input sourcing against the advantage of heightened robustness. They show that supply networks of intermediate productivity are fragile in equilibrium, even though this is always inefficient.

data to pinpoint segments within trade networks that concentrate vulnerabilities. While vulnerabilities within production networks can also emerge domestically, policy discussions predominantly revolve around the international segments of value chains, which have faced specific shocks in recent years. Consequently, vulnerabilities are delineated at product nodes heavily reliant on foreign sourcing (particularly from non-EU countries in the case of the European Union) and where the sourcing heavily hinges on a single country. In comparison to existing literature, our approach refines empirical methodologies by incorporating additional data on domestic production capacities, and potential substitution opportunities. Moreover, we discuss the list of identified products in light of the diverse array of risks influencing trade relationships.

The rest of the chapter is organised as follows. In Section 2, we explain our strategy for identifying a list of potential vulnerabilities to EU trade and present the data and results. In Section 3, we study the list of vulnerabilities in light of the various risks associated with international trade dependencies. Based on the analysis, in Section 4 we discuss the set of policies available to reduce the European Union's exposure to such vulnerabilities and discuss the design and governance of these policies.

2 A DIAGNOSIS OF TRADE VULNERABILITIES

Given the efficiency–resilience trade-off, resilience policies must target specific products, crucial to the overall fragility of economic systems to foreign shocks. To achieve this, a comprehensive approach begins with a diagnosis of trade vulnerabilities. We build upon the methodology developed by the European Commission (European Commission, 2021), which we extend to take into account domestic production capacities as well as substitution opportunities within products, across source countries.

2.1 The bottom-up approach of the European Commission

Table 1, borrowed from Vicard and Wibaux (2023), outlines the methodology in European Commission (2021), encompassing three criteria for evaluating the European Union's trade dependencies. The Commission methodology is also compared with alternative strategies used in Bonneau and Nakaa (2020), Jaravel and Mejean (2021) and Baur and Flach (2022). The Commission's criteria measure distinct facets of the European Union's trade dependencies using product-level trade data: (1) the concentration of extra-EU imports; (2) the significance of extra-EU imports in EU imports; and (3) the ability to substitute with EU production. The concentration of European extra-EU imports is assessed via the product-level Herfindahl-Hirschman Index (HHI). A product surpasses the concentration threshold (HHI > .4) if imports are heavily skewed from particular sources, exposing EU importers to country-specific supply shocks. The second criterion is based on the proportion of extra-EU imports out of total European imports. The third criterion is the ratio of extra-European imports to total European exports. A product is considered vulnerable if more than half of the import demand from EU member states

is sourced from outside of the Union, while the value of these imports is larger than the total value of EU exports in that product category. The second and third criteria are thus meant to proxy for the existence of production capacities within the European Union, as measured by intra-EU trade flows (criterion 2) as well as exports from the European Union to the rest of the world (criterion 3). These criteria intend to identify vulnerabilities arising from heavy reliance on non-EU imports, highlighting the significance of EU production capacities as an insurance against shocks affecting imported inputs.

TABLE 1 **VICARD AND WIBAUX'S (2023) REVIEW OF METHODOLOGIES USED TO IDENTIFY VULNERABLE PRODUCTS**

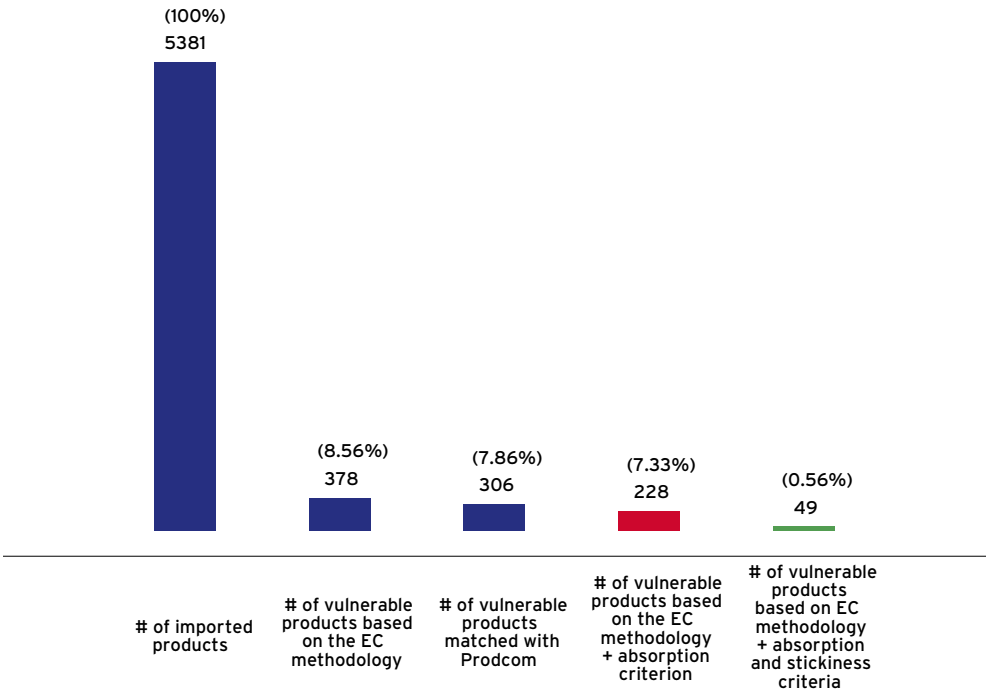
	European Commission (2021)	Bonneau and Nakaa (2020)	Jaravel and Mejean (2021)	Baur and Flach (2022)
Criteria 1	Concentration of imports: HHI > 0.4	Source of imports: Extra-EU imports > 50%	Source of imports: a majority of extra-EU imports	Relevance of the goods for domestic production: 3 most used intermediate goods in the 5 most important sectors of the economy
Criteria 2	Importance in demand: ratio extra-EU imports/ total EU imports > 0.5	Concentration of imports: HHI > 0.5	Concentration of imports: HHI > 0.5	Concentration of imports: HHI > 0.33
Criteria 3	Substitutability by EU production: ratio extra-EU imports/total EU exports > 1	Diversification potential: centrality risk > 2.5 (Y. Korniyeko, M. Pinat and B. Dew, 2017)	Granularity of demand: one French firm represents at least 90% of imports	Substitutability by domestic production: ratio imports/ exports > 1

Various studies, including by the French Treasury, the French Council of Economic Advisors, and CESifo in Germany, have employed methodologies similar to the previously discussed approach. Import concentration remains a key aspect across these analyses. Bonneau and Nakaa (2020) and Jaravel and Mejean (2021) supplement these criteria by assessing the significance of extra-EU imports. Bonneau and Nakaa (2020) add a measure of risk centrality as a proxy for the absence of substitution opportunities. Jaravel and Mejean (2021) instead rely on firm-level import data to measure the granularity of extra-EU imports.[4] Finally, Baur and Flach (2022) add a measure of the product's importance for domestic production, emphasising vulnerabilities affecting domestic industries through value chains. We will come back on this dimension of vulnerabilities in Section 3.2.

4 Their argument is that more concentration in imports across firms is likely to induce more exposure to idiosyncratic shocks as firms tend to concentrate sourcing on a limited number of suppliers.

We implement the bottom-up strategy outlined by the European Commission using the CEPII-BACI database, which comprehensively covers worldwide bilateral trade flows at a detailed 6-digit product level. As detailed in Vicard and Wibaux (2023), the trade vulnerabilities identified by the European Commission methodology vary greatly from one year to the next. We smooth out this volatility by pooling trade data over five consecutive years, from 2015 to 2019, thus focusing on persistent trade vulnerabilities. Our approach consolidates bilateral imports across the 27 members of the European Union, disregarding intra-EU trade flows. Subsequently, we apply the three criteria proposed by the European Commission. In total, we start with a list of 5,381 different products, 378 of which being considered 'strategic dependencies' based on the Commission's approach (see the first two bars of Figure 1). These identified strategic dependencies collectively account for 8.6% of the total value of aggregate imports. Further insights into the nature of these products will be presented in Section 3. Before delving into that discussion, we propose a refinement of the analysis by incorporating two additional criteria that capture substitution opportunities following shocks to foreign inputs.

FIGURE 1 **NUMBER OF 'STRATEGIC DEPENDENCIES' AND THEIR CONTRIBUTION TO AGGREGATE IMPORTS, BASED ON VARIOUS CRITERIA**



Notes: The figure shows the number of strategic dependencies (and their contribution to the value of EU imports) using various methodologies, starting with the strategy proposed by European Commission (2021) (second blue bar) and adding criteria based on the ratio of imports over domestic absorption (red bar) and the degree of product stickiness (green bar). See details in the main text.

Source: CEPII-BACI and Prodcom for 2015 to 2019.

2.2 Controlling for intra-EU production capacities

The European Commission approach primarily relies on the structure of trade, offering insights into ex-ante exposure to foreign shocks. However, recent experience, including in the context of the Russian gas crisis, have underscored the significance of substitution opportunities post-shock as a crucial aspect of resilience (Moll et al., 2023). Dependencies on trade become more detrimental when reliance lacks a balance with domestic production capacities, which could act as a fallback in the event of disruptions in foreign sourcing. The European Commission's third criterion implicitly aims to capture this potential substitution between imports and domestic production. However, the trade data used by the Commission acts as an imperfect proxy for domestic production capacities. For instance, exporting the same product back and forth can lead to significant trade volumes that do not reflect the actual level of production. It is therefore crucial to integrate production data into the analysis of import substitution. Unfortunately, measuring domestic production capacities presents complexities due to the lack of statistics on output at a sufficiently detailed level of disaggregation. Commonly used datasets for measuring domestic output include the OECD-STAN database, covering 27 countries and a maximum of 153 ISIC sectors, the GGDC's World Input Output Database (43 countries and 56 sectors) or the UNIDO-INSTAT dataset (117 countries and 161 manufacturing sectors). However, the European Union possesses relatively robust resources. The Council of the European Union sanctioned the creation of a European survey on manufacturing production in 1991, resulting in the Prodcom dataset. This dataset provides annual statistics on output for 4,000 manufacturing products, using a nomenclature compatible with the Combined nomenclature, the European 8-digit version of the HS nomenclature used in trade statistics. In essence, the Prodcom dataset thus enables a systematic comparison between trade and production data for EU member states, at a granular level of disaggregation.

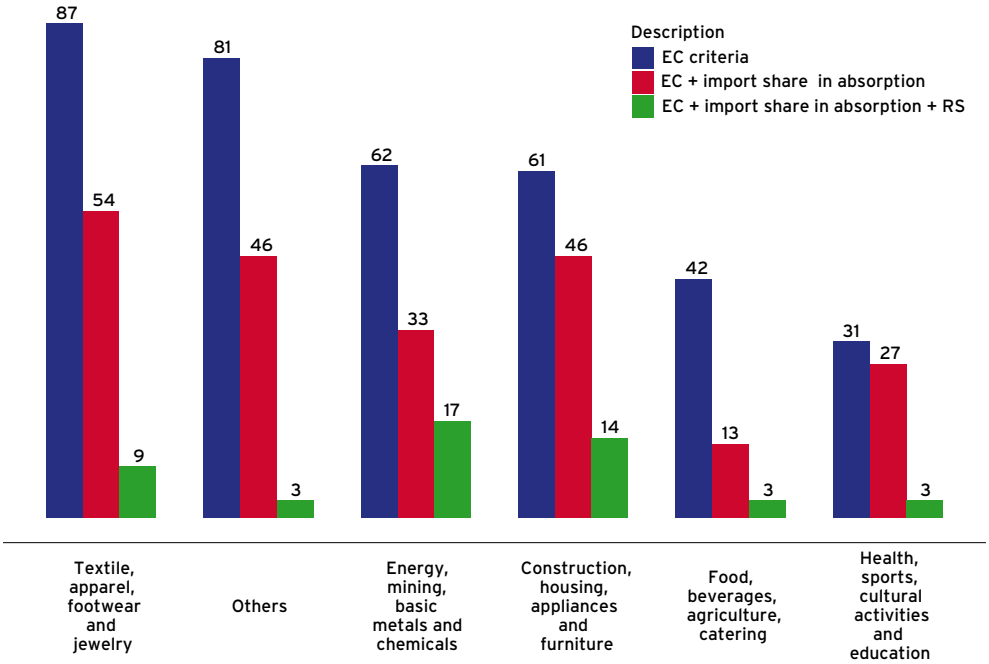
We leverage the availability of these datasets to enhance the European Commission strategy by introducing a fourth 'absorption' criterion. According to this criterion, a product is deemed vulnerable if over 50% of domestic absorption (i.e., output plus imports less exports) originates from foreign sources.[5] Unfortunately, the quality of the data is not perfect and we lose a number of products in the process. Out of the initial 378 products identified as strategic dependencies using the Commission's methodology, 306 products can be merged with production data. After applying the absorption criterion, we identified 228 products as vulnerable (Figure 1, third and fourth bars). Controlling for domestic production capacities thus reduces the list of identified vulnerabilities, now

5 Here as well, both production and trade data are initially aggregated across EU member states and over time. We obtained European output statistics for over 3,700 Prodcom products, which can be linked to 4,800 HS6 categories. However, it is important to exercise caution when interpreting these statistics due to a substantial amount of missing data in the Prodcom dataset. Further details on this are available in Appendix A.1.

accounting for approximately 7.3% of European imports. Remarkably, this reduction persists despite criteria 2 and 3 of the European Commission approach intending to capture the existence of domestic production capacities. This underscores the crucial role of incorporating domestic production measures within the overall diagnosis framework.

The domestic absorption criterion not only fine-tunes the list of strategic dependencies but also alters the sectoral distribution of these dependencies (see Figure 2). Notably, 70% of strategic dependencies are concentrated within the textile, construction, energy and mining, and health sectors. A striking observation is that the absorption criterion significantly reduces the number of vulnerable products in the agricultural sector, from 42 to 13 products. This decline is not unexpected considering the European Union's historical support for agricultural production through its Common Agricultural Policy. Within this sector, the advantages of risk sharing through trade with suppliers outside of the European Union are likely substantial. In times of fluctuating domestic agricultural production, imports from non-EU sources can serve to supplement and stabilise supply. From that point of view, products exhibiting diversified domestic absorption, involving a mix of domestic and foreign products, even if primarily sourced from one country, may not be considered vulnerable.

FIGURE 2 **COMPARISON OF THE SECTORAL DISTRIBUTION OF THREE LISTS OF STRATEGIC DEPENDENCIES**



Notes: The figure illustrates the sectoral distribution of identified strategic dependencies, using the EC methodology (blue bars), the strategy augmented with an absorption criterion (red bars) and the list that further incorporates the stickiness indicator (green bars). The broad sectors are taken from the UN-BEC classification.

Source: CEPII-BACI and Prodcom for 2015 to 2019.

2.3 Controlling for ex-post substitution opportunities

The selection of potentially vulnerable products, based on observed trade and production patterns, inherently assumes that foreign shocks cannot be diversified ex-post, through substitution away from countries and firms facing supply constraints. This conservative assumption serves as a natural starting point, given existing evidence of strong complementarities between inputs in production functions. Boehm et al. (2019) find that firms affected by the 2011 Tohoku earthquake adjusted their output almost proportionally to the reduction in their imports from Japan, suggesting a production function closely resembling Leontief.[6] However, findings by Lafrogne-Joussier et al. (2023) suggest that ex-post substitution patterns may exist in some cases. Among French firms exposed through their supply chains to the early lockdown in China in January 2020, they find no discernible difference between firms that were diversified ex-ante and firms that were not.[7] The reason, they show, is that firms that were not diversified ex-ante are systematically more likely to find new foreign partners immediately after the shock.

We propose integrating the potential for ex-post substitution into our diagnostic framework by introducing a metric called *stickiness* that we borrow from Martin et al. (2020). Their study employs firm-to-firm panel data to establish a product-level measure of stickiness, derived from the average duration of relationships between firms. Longer durations, given a consistent match quality, suggest various frictions that hinder firms from switching between input suppliers.[8] In the presence of sizeable frictions, firms are more likely to be stuck in their existing relationships at the time the shock hits, thereby increasing associated costs. Strategic vulnerabilities concentrated in sticky products become more concerning from this perspective.

The final bar in Figure 1 narrows down the selection of products to 'sticky' products, as defined by a degree of product stickiness within the last quartile of the entire distribution.[9] We set this threshold to focus on the stickiest products in the entire distribution, i.e., those with a stickiness relationship exceeding 3.2 (out of 4). Arguably, the choice of this threshold is somewhat arbitrary and varying the threshold up would mechanically increase the strength of the selection associated with the stickiness criterion, and vice versa. This refined criterion results in a set of 49 products, accounting for 0.5% of European imports. As shown in Figure 2, these products are notably concentrated within

6 For a detailed discussion on substitution patterns, particularly in the context of the European energy crisis, refer to Moll et al. (2023).

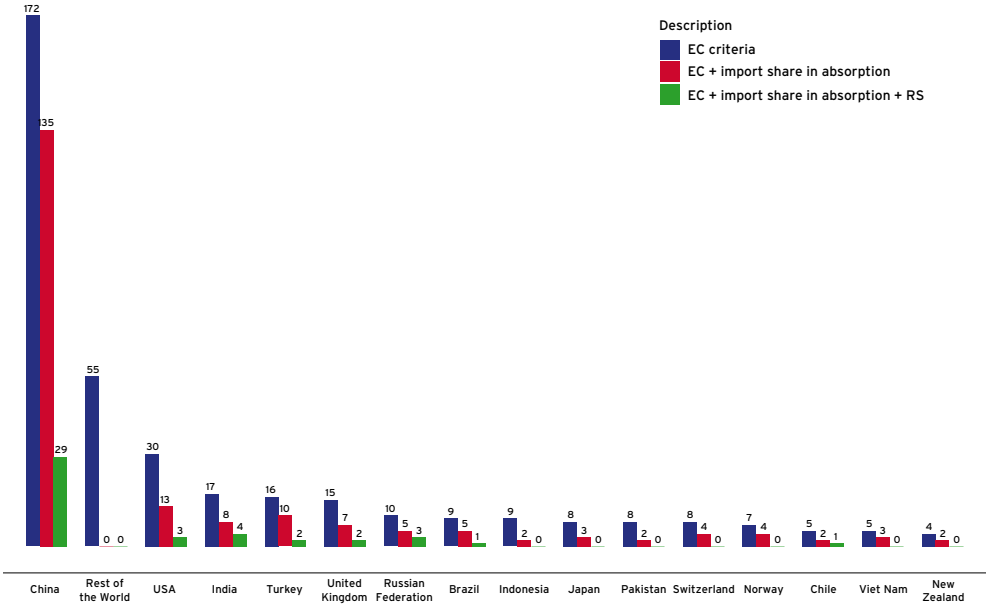
7 Ex-ante diversification here refers to firms importing the same 8-digit product from both China and another foreign country, six months before encountering disruptions in the supply chain related to Chinese inputs.

8 These frictions encompass search frictions constraining importers' knowledge of alternative suppliers, as well as costs – both fixed and variable – associated with a switch from one supplier to another. The empirical approach by Martin et al. (2020) effectively captures both sources of frictions.

9 Figure B1 in Appendix reproduces the cumulative distribution function of the stickiness measure, in the entire distribution and within the list of strategic dependencies identified in Sections 2.1 and 2.2.

the energy, mining, basic metals and chemicals sector. Additionally, the majority of these strategic dependencies are associated with products primarily sourced from China, as highlighted in Figure 3. Table C1 in the Appendix provides a list of these strategic dependencies, detailing the main sourcing country and the HHI concentration index.[10]

FIGURE 3 **COMPARISON OF THE GEOGRAPHICAL DISTRIBUTION OF THREE LISTS OF STRATEGIC DEPENDENCIES**



Notes: The figure illustrates the geographical distribution of identified strategic dependencies, using the EC methodology (blue bars), the strategy augmented with an absorption criterion (red bars) and the list that further incorporates the stickiness indicator (green bars). "Rest of the World" aggregates all remaining countries associated with no more than three vulnerable products.

Source: CEPII-BACI and Prodcom for 2015 to 2019.

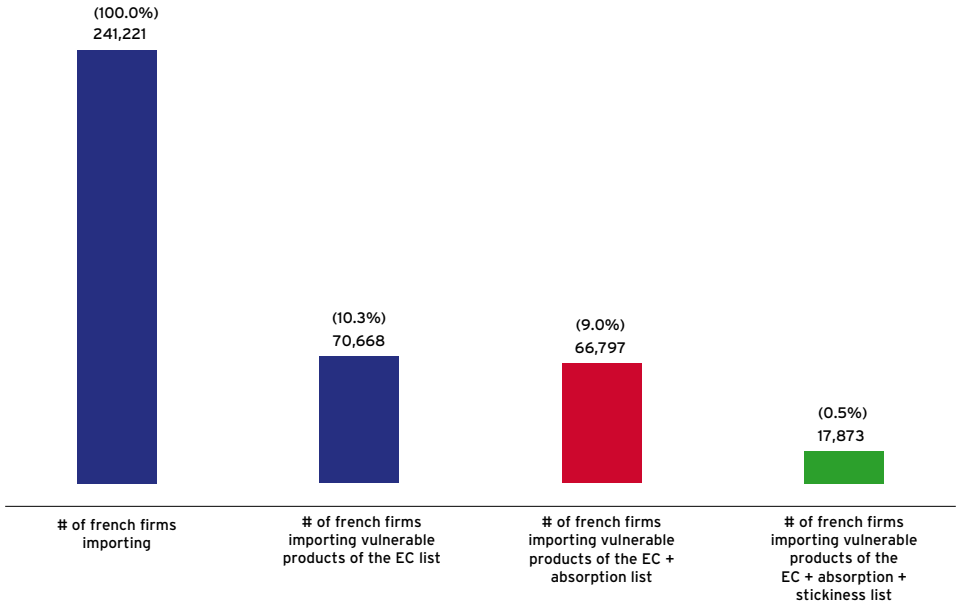
2.4 Improving the diagnosis with better data

While trade data are readily accessible, understanding production capacities within the European Union is constrained by limitations in available statistics. The Prodcom dataset, employed to establish our fourth criterion, suffers from a considerable number of missing values, as explained in Appendix A1. It remains uncertain whether these missing values indicate the absence of product-level production capacities in the respective country or are due to data quality issues such as insufficient coverage, misreporting, or other discrepancies. Given the existing statistical infrastructure at the European level, enhancing the quality of these data might not incur significant costs. On the other hand, the benefit of acquiring more accurate information on product-level production capacities would be substantial.

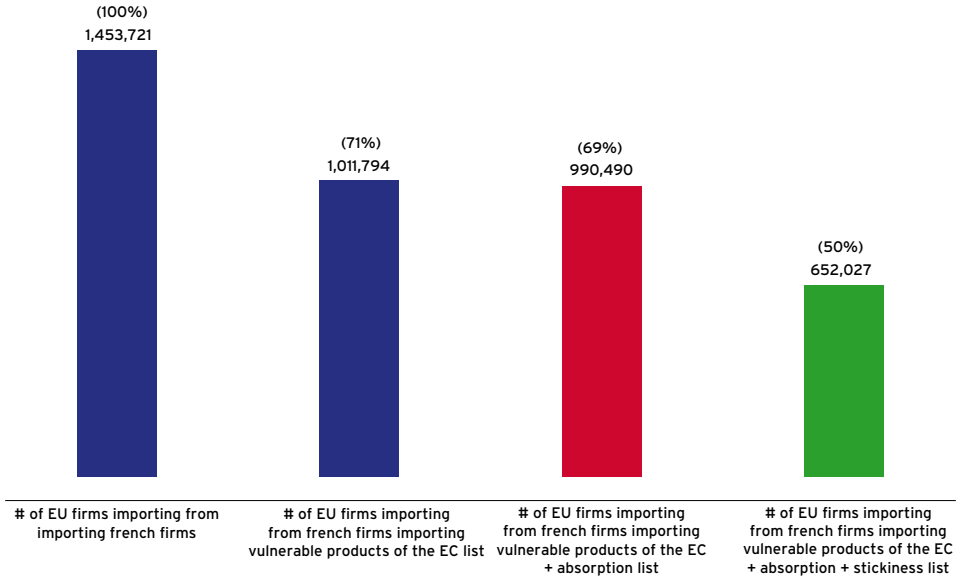
10 In Appendix Table C2, we list an additional 56 products that enter the list of trade vulnerabilities when we set a less stringent criterion for stickiness, at the 50th percentile of the distribution in Martin et al. (2020).

FIGURE 4 **INDIRECT EXPOSURE TO STRATEGIC DEPENDENCIES, THROUGH FIRM-TO-FIRM TRADE**

(a) French firms' direct exposure



(b) Non-French firms' indirect exposure



Notes: The top panel presents statistics on the number of firms and their contribution to French imports from non-EU countries, that are exposed to EU trade dependencies, through their imports. The bottom panel shows statistics on firms that are indirectly exposed, through their interactions with French exposed importers. The top panel uses customs data on firm-level extra-EU imports. The bottom panel uses customs data on firm-to-firm intra-EU exports. A firm is considered directly exposed if it imports at least one product which is classified as a strategic dependency. A firm is considered indirectly exposed if it imports from a French firm that is directly exposed. Figure B2 details the geographical distribution of the number of indirect exposures. Figures B3 and B4 in Appendix B.1 reproduce the analysis excluding French wholesalers.

Source: French Customs data for 2015 to 2019.

Another dimension that is missing from existing diagnoses of trade vulnerabilities is indirect exposure to strategic dependencies. Indirect exposure arises when a firm, although not directly importing from non-European countries, faces exposure to foreign shocks because its suppliers are themselves directly exposed. Evaluating these indirect exposures poses challenges due to the necessity for data on firm-to-firm linkages coupled with firm-level trade exposures.[11] Here as well, the European Union could make significant progress in this realm by leveraging existing data resources. Intra-EU trade data are already collected comprehensively at the firm-to-firm level, and are used to calculate VAT compensations across Member States. These datasets capture all transactions involving a producer in one Member State and its partner in another, providing detailed insights into indirect trade exposures when matched with firm-level import data – also comprehensive for imports from outside the European Union.[12] EU Regulation No. 2019/2152 on European business statistics marks an essential initial step in this direction. It acknowledges the necessity of harmonising and exchanging micro-data within the European Union to modernise statistical information on firms' activity. Unfortunately, the exchange of micro-data, critical for consolidating these sources, remains confined to statistical purposes and does not anticipate use for research purposes. Unlocking the potential of these datasets for research could significantly enhance our understanding of indirect trade exposures within value chains.

We summarise the potential insights that such data would deliver using the French context as an example. In Figure 4, the top panel illustrates the number of French firms (and their contribution to French imports) that are directly exposed to 'strategic dependencies', as defined earlier. By merging these data with French intra-EU export data at the firm-to-firm level, we can pinpoint all non-French European firms indirectly exposed to these dependencies through their interactions with French counterparts (Figure 4, bottom panel). Between 2015 and 2019, 70,668 French firms were exposed to strategic dependencies as defined using the European Commission's bottom-up approach, and 17,873 firms using the augmented Commission bottom-up approach. These firms respectively represent 29% and 7% of the whole population of French firms, and their imports of these products constitute 10.3% and 0.5%, respectively, of the value of France's non-European imports. Merged with intra-EU exports, these data reveal important spillovers to non-French European firms. More specifically, there are 1,011,794 European firms (resp. 652,027 firms) that are indirectly exposed to strategic dependencies through their interactions with the above-mentioned French firms. The combined value of their imports from France is equal to €991 billion, or 70% of France's intra-EU exports (resp. €695 billion, or 50% of intra-EU exports). While these firms may not be directly exposed to European strategic dependencies, they are exposed indirectly. Such indirect exposure

11 Dhyne et al. (2020) address this challenge by combining firm-to-firm sales data for Belgium with firm-level foreign trade data. Their study reveals that while most Belgian firms extensively use foreign inputs, only a small subset directly import them. The discrepancy between the granularity in direct trade and the widespread exposure of firms to foreign inputs suggests potential information frictions regarding firms' knowledge about their own exposure.

12 In some Member States such as Belgium or Portugal, such data can further be matched with domestic firm-to-firm transactions, collected for VAT purposes.

is concerning because shocks propagate along value chains, beyond the node of direct exposure. Additionally, firms with indirect exposure often have limited awareness of their risk exposure. Consolidating trade data across Member States could offer policymakers and companies vital insights into the extent and origins of trade dependencies.

3 A HIERARCHY OF RISKS

Existing datasets constitute a valuable resource for identifying potential trade vulnerabilities. However, it should be recognised that not all trade vulnerabilities pose the same level of risk to the economy. As discussed earlier, different normative arguments justify interventions for enhancing resilience. In this section, we aim to intersect the list of identified trade vulnerabilities with the specific risks they expose the economy to. It is important to note that this analysis is not exhaustive, as many risks are complex and challenging to evaluate based solely on economic criteria. This emphasises the need for a multidisciplinary approach involving experts from various domains such as industry practitioners, international relations experts and climate risk analysts, among others. Leveraging diverse expertise can enable the European Union to make more informed decisions regarding its vulnerabilities.

3.1 Geopolitical risk

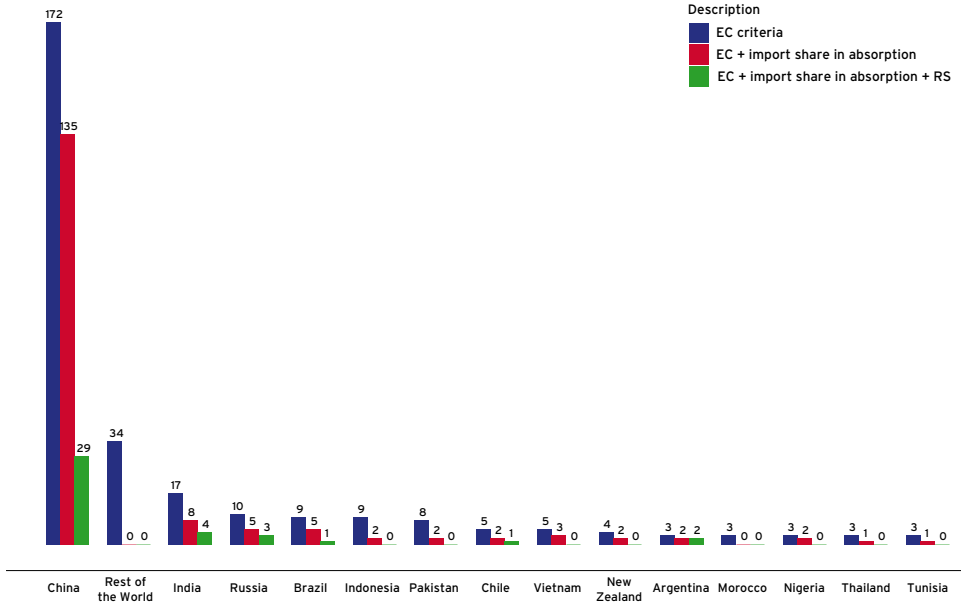
The escalation of geopolitical tensions, notably following the Russian invasion of Ukraine, has underscored the significance of geopolitical risks, presenting multifaceted concerns. These risks unfold in two principal ways. First, political instability can be a source of disruption in value chains, imposing economic costs on countries reliant upon these networks. A pertinent example is the 2018 US–China trade war, which exposed firms and consumers to substantial price escalations. Second, trade interdependencies can be wielded as tools of coercion, limiting countries' capacity to assert independent voices in global discussions. Geopolitical risks are notably prevalent in Africa, where political instability is widespread. The continent plays a pivotal role in numerous value chains by being a major source of valuable minerals. However, in several African nations, political volatility and weak governance pose threats to the security of supply chains, leading to potential disruptions.[13] Conversely, mining extraction activities, particularly those of foreign-owned companies, have been linked to heightened conflicts at local levels, exacerbating violence across territories and persisting over time (Berman et al., 2017).[14]

13 See for instance the example of the Democratic Republic of Congo discussed in Section 3.4. Weak institutional structures also raise ethical concerns regarding labor practices and the environmental impact of economic activities.

14 Caselli et al. (2015) have also established the role of resource endowments, such as oilfields, in interstate conflict

The depiction of the origin of vulnerable products, as identified in Section 2, is illustrated in Figure 3. Further insight into countries outside of NATO is detailed in Figure 5. Out of the 378 (resp. 49) products categorised as strategic dependencies using the European Commission methodology (resp. the extended Commission methodology), 246 (resp. 41) are sourced primarily from countries not affiliated with NATO. China emerges at the forefront of this list, which is unsurprising given its prominent role in global trade.[15] Beyond China, three emerging nations concentrate a notable number of vulnerabilities: India, Russia, and Brazil. Figures B5 and B6 in Appendix B.2 replicates the analysis of direct and indirect firm-level exposures (as displayed in Figure 4), focusing on French importers engaged in trade with these nations. This analysis confirms that exposure to non-NATO countries significantly impacts trade, with 75% of French extra-EU importers engaging in trade with one of these countries between 2015 and 2019. Moreover, 24% of French importers (resp. 6%) are involved in importing products classified as 'vulnerable' based on the baseline (resp. extended) classifications. Here as well, these direct exposures have ripple effects, impacting downstream partners beyond French firms.

FIGURE 5 **GEOGRAPHICAL DISTRIBUTION OF TRADE VULNERABILITIES AMONG NON-NATO COUNTRIES**



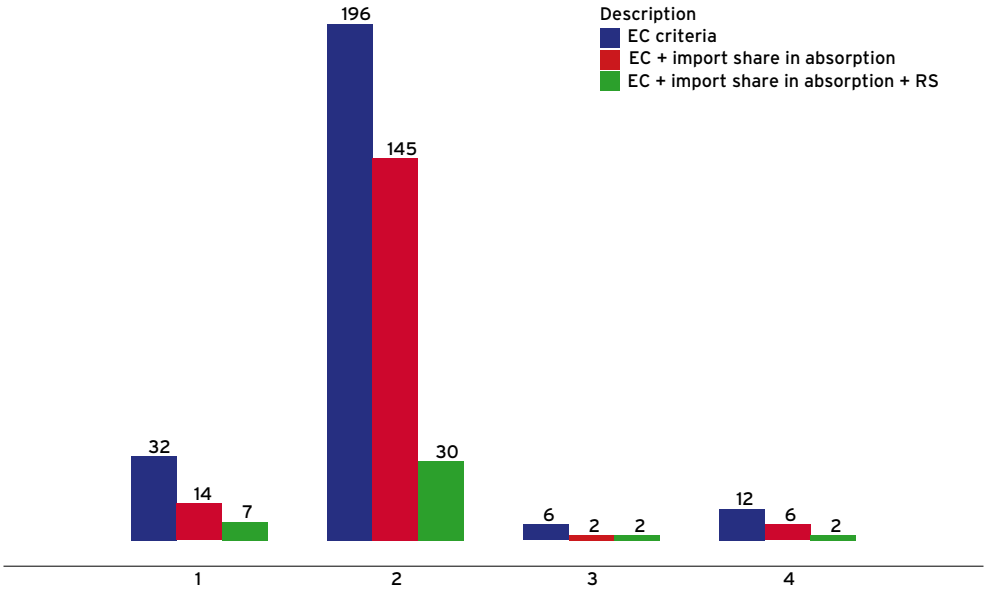
Notes: This figure represents the distribution of non-NATO countries from which the EU imports vulnerable products according to the three methodologies. "Rest of the World" aggregates all remaining countries associated with at least three vulnerable products in the EC methodology.

Source: CEPII-BACI and Prodcom for 2015 to 2019.

15 When we cross Figure 3 with the list of our 49 identified strategic dependencies in Table C1, however, we show that more than half of the 'vulnerable products' that the European Union imports from China are final consumption goods. It is unclear whether geopolitical tensions with China that would affect the supply of these final consumption goods is an important threat to European strategic autonomy. We discuss the heterogeneity of risks along the supply chain in Section 3.2. But this example illustrates that the arguments in this section may need to be crossed.

To enhance the analysis of geopolitical risk, we exploit the country-specific Geopolitical Risk Index (GPR) developed by Caldara and Iacoviello (2022). This index is constructed through a systematic search of country-specific geopolitical events in ten prominent English-language newspapers.[16] The index captures significant global events, such as the Gulf War, 9/11, terrorist attacks in Europe, or Russia's annexion of Crimea in 2014. An important caveat, however, is that the US-centric search may involve level differences between countries. To ensure comparability, we normalise the GPR indices by a country-specific 'norm', represented as the mean level of the index derived from the 200 lowest periods, between January 1985 and June 2023. Averaging these series over 2015-2019 allows us to rank countries based on their level of geopolitical risk.[17] In Figure 6, we dissect the list of trade vulnerabilities based on the position of the primary sourcing country in the GPR distribution.

FIGURE 6 **DISTRIBUTION OF TRADE VULNERABILITIES BY THE POSITION OF THE MAIN SOURCING COUNTRY IN THE DISTRIBUTION OF GEOPOLITICAL RISK**



Notes: The list of trade vulnerabilities is restricted to products mostly sourced from non-NATO countries present in the GPR index data. Countries are then ranked according to their position in the distribution of GPR index over 2015-2019. A value of 3 thus indicates that the product is sourced from a country which is in the third quartile of the entire distribution of GPR indices (including all countries for which a GPR index is computed).

Source: CEPII-BACI and Prodcom for 2015 to 2019, Caldara and Iacoviello (2022) for the GPR indices.

16 The ten newspapers are the *Chicago Tribune*, *The Daily Telegraph*, the *Financial Times*, *The Globe and Mail*, *The Guardian*, the *Los Angeles Times*, *The New York Times, USA Today*, *The Wall Street Journal,* and *The Washington Post*. Examples of the raw time-series are provided in Figure B12 in Appendix B2.

17 The database covers only 44 countries. After excluding the 21 NATO countries, the remaining countries are Argentina, Brazil, Chile, China, Colombia, Egypt, Hong Kong SAR China, Indonesia, India, South Korea, Mexico, Malaysia, Peru, Philippines, Russia, Saudi Arabia, Thailand, Tunisia, Taiwan, Ukraine, Venezuela, Vietnam, and South Africa.

The majority of trade vulnerabilities concerning non-NATO countries are associated with nations positioned within the lower half of the GPR indices distribution, indicating lower geopolitical risks.[18] Nonetheless, there are 18 vulnerable products according to the European Commission methodology, and four vulnerable products according to the extended Commission methodology, imported by the EU from non-NATO countries positioned above the median in terms of geopolitical risk. Table C3 in Appendix C.2 details these 18 vulnerable products, among which are the four identified after applying our two criteria on top of the Commission methodology.

3.2 Supply chain risk

Supply chain risks refer to the various uncertainties, shocks, and disruptions that can occur at any stage of the supply chain process, from sourcing raw materials to delivering finished goods to customers. These risks can arise from various sources, including natural disasters, geopolitical events, economic downturns, technological failures, and changes in regulations or trade policies. The interdependent nature of economic activities within supply chains implies that shocks at one point of the chain spill over to the rest of the chain, thus amplifying the economic cost of the shock. For example, S&P Global Mobility estimates that in 2021, more than 9.5 million units of global light-vehicle production were lost as a direct result of a lack of necessary semiconductors.[19]

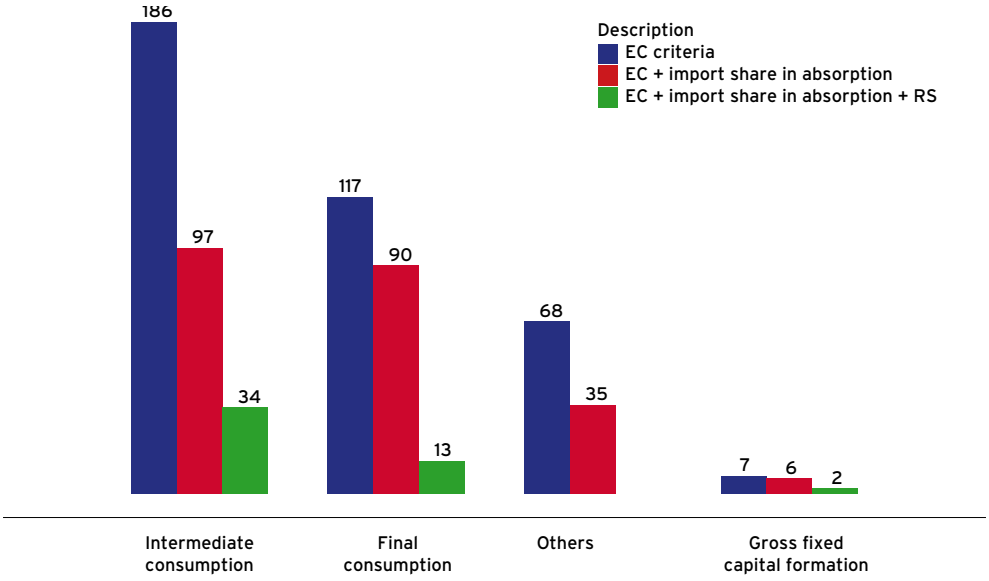
In light of potential cascades within value chains, the resilience of these chains has emerged as a political concern in several developed nations in the aftermath of the COVID-19 pandemic. In their analysis of German vulnerabilities, Baur and Flach (2022) introduce an additional criterion: measuring a product's relevance as an input for domestic production. They argue that trade vulnerabilities become more problematic when they jeopardise the competitiveness of domestic firms. To delve deeper into this argument, we initially cross-reference our list of strategic dependencies with their end use within the global value chain, using the Broad Economic Classification (BEC) developed by the United Nations.[20] While disruptions in final consumption goods predominantly affect product availability and prices, shocks to intermediate inputs can cause a ripple effect throughout the production chain. Subsequently, we refine this analysis using the 'upstreamness' metric developed by Antras et al. (2012). Using input-output tables, Antras et al. (2012) calculate the average number of stages between the production of a good and its absorption by final consumers, labelling a product as more 'upstream' if it enters value chains earlier in the production process. The outcomes are presented in Figures 7 and 8.

18 This result is a consequence of neither Russia nor China being identified as high geopolitical risk countries based on data for 2015-2019.

19 www.spglobal.com/mobility/en/research-analysis/the-semiconductor-shortage-is-mostly-over-for-the-auto-industry.html

20 This classification categorises HS6 products into eight broad economic categories and further divides them into three end-use categories within the GVCs: intermediate consumption, gross fixed capital formation, and final consumption.

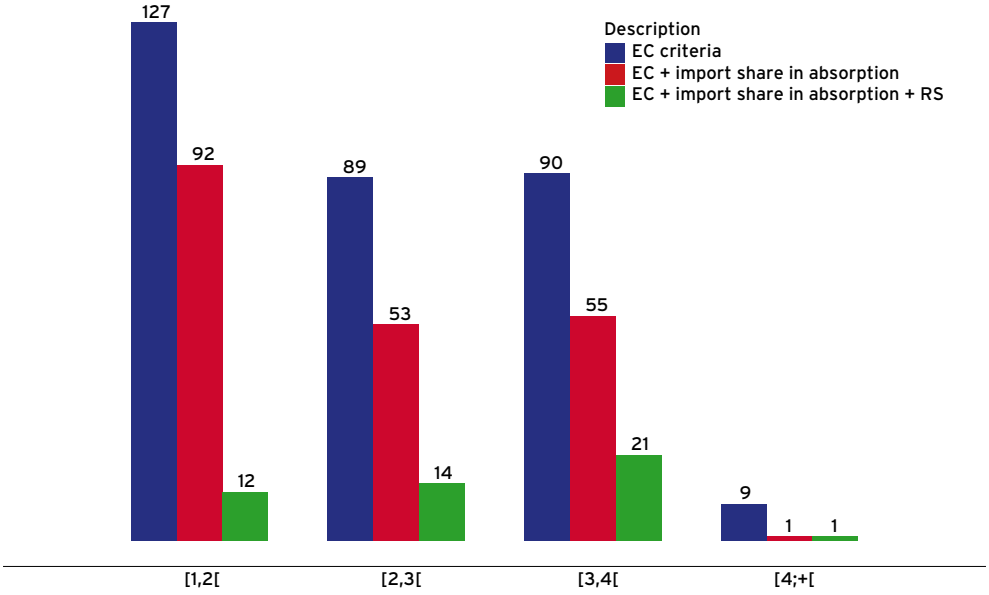
FIGURE 7 **STRATEGIC DEPENDENCIES, BY END USE**



Notes: The figure illustrates the distribution of identified strategic dependencies, by end use (UN-BEC classification). The blue, red and green bars respectively refer to the European Commission classification, the classification augmented with the absorption criterion and the classification augmented with the absorption and stickiness criteria.

Source: CEPII-BACI and Prodcom for 2015 to 2019.

FIGURE 8 **STRATEGIC DEPENDENCIES, BY DEGREE OF UPSTREAMNESS**



Notes: The figure illustrates the distribution of identified strategic dependencies, by degree of upstreamness. The value of the upstreamness indicator approximates the number of stages between the production and the absorption by final consumers. An upstreamness of one thus corresponds to a final consumption good while an upstreamness of four indicates that there are four remaining stages before the product enters aggregate demand. See details in Antras et al. (2012). The blue, red and green bars respectively refer to the European Commission classification, the classification augmented with the absorption criterion and the classification augmented with the absorption and stickiness criteria.

Source: CEPII-BACI and Prodcom for 2015 to 2019.

Additionally, Figures B7 and B8 in Appendix B2 depict the geographical and sectoral distributions of vulnerable products with an upstreamness measure exceeding three. The most upstream vulnerable products are predominantly imported from China and are concentrated in the energy, mining, basic metals, and chemicals sector.

Roughly half of the identified trade vulnerabilities are associated with intermediary products within supply chains (Figure 7). Among these intermediaries, a minority enter value chains at the most upstream level (with an upstreamness value above four), while the rest are positioned two to four stages away from final consumers. Table 2 presents a list of the most upstream vulnerable products identified using our five-criteria method, along with examples of their industrial use. The majority of the most upstream vulnerabilities are related to chemical products. These products often originate from a limited number of countries due to their high degree of customisation and significant economies of scale in their production. They serve as inputs across various sectors, including the pharmaceutical industry, plastic product manufacturing, and metallurgy. Consequently, disruptions in these products could potentially impact several sectors aligned with Europe's core comparative advantages.

TABLE 2 **LIST OF THE MOST UPSTREAM STRATEGIC DEPENDENCIES**

Product	Industrial use	Upstreamness	Exporter (market share)
Acyclic hydrocarbons	Production of polyethylene	4.20	Russian Federation (70%)
Azelaic acid, sebacic acid, and esters	Skin care, production of nylon and polyester, plasticizers and lubricants in the production of plastics and rubber	3.85	China (81%)
Heterocyclic compounds containing pyrimidine ring	Synthesis of pharmaceuticals, agrochemicals, dyes, and nucleotide analogs (antiviral and anticancer agents)	3.85	China (90%) and India (97%)
Heterocyclic compounds containing piperazine ring	Intermediates in antipsychotic, anti-anxiety drugs, and to treat parasitic worm infections	3.85	China (90%) and India (97%)
Heterocyclic compounds containing malonylurea and its salts	Hypnotic and sedative drugs	3.85	China (90%)
Aromatic monocarboxylic acids and phenylacetic acid	Starting material for the production of pharmaceuticals, perfumes, and flavoring agents	3.85	China (73%)
Trichloroethylene	Industrial solvent and degreasing agent, refrigerants and other hydrofluorocarbons	3.85	USA (90%)
Aldehydes	Resins, organic acides, detergents and soaps	3.85	China (58%)

Product	Industrial use	Upstreamness	Exporter (market share)
Oxalic acid, its salts and esters	Mineral processing mechanisms	3.85	China (72%)
Quebracho extract	Natural tannin for processing leather	3.85	Argentina (96%)
Nickel mattes	Extraction and refining of nickel through various metallurgical processes	3.42	Russian Federation (87%)
Unwrought beryllium (powders)	Production of satellite structures and space telescopes, used in nuclear reactors and used military application, medical equipments and nuclear weapons	3.42	USA (62%)
Magnesium (raspings, turnings and granules)	Pyrotechnic compositions and fireworks, reducing agent in the extraction of titanium and zirconium, and used for agriculture, therapeutic applications	3.40	China (91%)
Ferrous products (by direct reduction of iron ore)	Alternative to traditional ironmaking processes such as blast furnace smelting, production of sponge iron	3.36	Russian Federation (60%)
Complex cyanides	Electroplating, metal finishing, gold and silver extraction, pharmaceutical products	3.24	China (75%)
Iodine	Disinfectant and antiseptic, nutrient (thyroid hormones), water purification	3.24	Chile (73%)
Diphosphorus pentoxide	Desiccant and dehydrating agent for pharmaceutical production, glasses	3.24	China (98%)
Phosphinates and phosphonates	Phosphorus for plants, water treatment, metal finishing, detergents, catalysts	3.24	China (83%)
Borates	Disodium tetraborate (refined borax)	3.24	Turkey (77%)
	Disodium tetraborate (refined borax), anhydrous	3.24	USA (62%)
Tungstates (wolframates)	Catalyst, production of thin film materials, pigments, phosphors, ceramics and Glasses	3.24	China (63%)
Silver nitrates	Antiseptic and atibacterial, photographic processing, laboratory reagent, mirror production, antimicrobial properties	3.24	USA (73%)
Castor oil	Laxative, skin care, hair care, anti-Inflammatory, antimicrobial properties, moisturizing lips	3.19	India (98%)

Notes: The table lists the most upstream strategic dependencies, together with examples of industrial uses and their exporter (and respective market shares). The chosen products are those identified as vulnerable based on the augmented EC methodology, with an upstreamness above three.

Source: CEPII-BACI and Prodcom for 2015 to 2019.

3.3 Shortage of critical goods

Beyond their economic cost, shortages of critical goods can result in human losses and other severe non-economic consequences. This was vividly illustrated during the early phases of the pandemic, when shortages of masks and personal protective equipment compelled policymakers to take drastic measures.[21] An important facet of this problem is the trade-off between the risk linked to often low-probability events and the efficiency of productive systems. As highlighted by Baldwin and Freeman (2021), assessments of this trade-off might significantly differ between private and social perspectives. This discrepancy underscores the need for public interventions aimed at ensuring a consistent supply of critical goods.

We illustrate this problem using pharmaceutical products as an example. The shortage of pharmaceutical products has emerged as a critical concern in the past two decades. Research conducted by Galdin (2023), drawing on US data, reveals a tenfold increase in drug shortages during the 2000s. This scarcity prompted the American Medical Association to designate the shortfall of generic drugs a national security issue in 2018. The shortages predominantly stem from disruptions in the manufacturing process and are primarily confined to generic drugs.[22] Moreover, Galdin (2023) establishes a causal connection between the outsourcing of manufacturing facilities to emerging countries and the occurrence of these shortages.

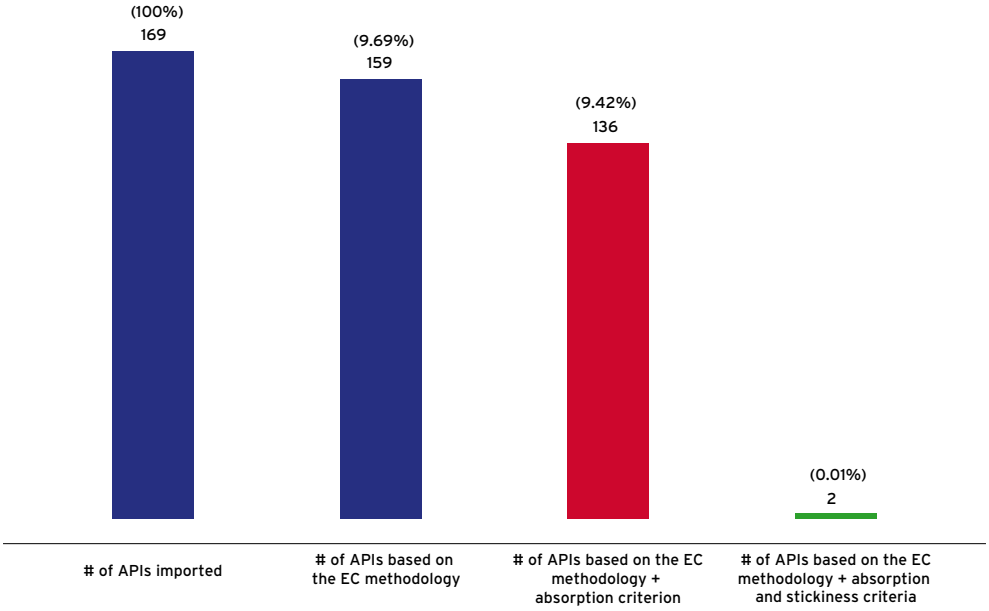
A notable characteristic of pharmaceutical products is the precise identification of numerous drugs in trade data through their active pharmaceutical ingredients (APIs), which constitute the essential components imparting therapeutic effects. In Figure 9, we replicate Figure 1 and focus specifically on these API products. The HS nomenclature enables the identification of 170 products by their APIs, linked to 4,497 therapeutic molecules. Among these API products, the European Commission methodology flags 159 as potential vulnerabilities, which is reduced to 136 when further imposing that the majority of domestic absorption is sourced from abroad. This number diminishes further to just two when concentrating on products presenting difficulties in substitution. When relaxing the stickiness criterion as in Table C2, the number of API products identified as vulnerable increases to 19. The list is provided in Table C5.

21 It is important to note the ambiguous role played by international trade in this precise context. While challenges in shipping these products from dominant global production centres contributed to shortages, the rapid expansion of production within these countries also played a pivotal role in meeting the surge in demand. See Figure B11 in Appendix, illustrating the comparison between EU import growth from 2019 to 2020-2021 for all products versus for the HS products identified by the WTO as vital for fighting COVID-19. Trade significantly facilitated the sourcing of COVID-related products, especially in 2020 and 2021. A prime example is the international trade of vaccines, which surged by 700% in 2021 compared to 2019.

22 See Pauwels et al. (2014) for evidence based on European data. In the European case, generic drugs do not exhibit a notably higher susceptibility to shortages.

While our fifth criterion indicates that API products are not inherently the most challenging to substitute, the absorption criterion underscores a scarcity of EU domestic production for several of these products. This is notable despite the European Union maintaining a status as a net exporter of pharmaceutical products.[23] Table C4 in Appendix C.2 provides a comprehensive list of these products, along with information regarding the diseases they treat and statistics on EU import structures. This list encompasses a broad range of drugs, such as Metharbital, a molecule used in epilepsy treatment, and Daprodustat, utilised in addressing anaemias associated with chronic kidney disease. Regarding the geographical distribution of these vulnerabilities, Figure B10 in Appendix B.2 highlights that vulnerable products predominantly originate from Switzerland, Singapore and the United States – countries with strong comparative advantages in pharmaceuticals. India and China have also developed large production capacities, particularly in generic products.

FIGURE 9 **NUMBER OF 'STRATEGIC DEPENDENCIES' AND THEIR CONTRIBUTION TO AGGREGATE IMPORTS, FOR ACTIVE PHARMACEUTICAL INGREDIENTS**



Notes: The Figure shows the number of 'strategic dependencies' and their contribution to aggregate imports, for active pharmaceutical ingredients when applying the criteria in European Commission (2021) and adding our absorption and stickiness criteria.

Source: CEPII-BACI for 2015 to 2019.

23 It is important to note the sensitivity of these results to the estimation period. When analysed using data limited to 2019, the absorption criterion appears substantially more restrictive, revealing only three API products from the European Commission list exhibiting more than 50% of domestic absorption sourced from outside of the European Union (Figure B9 in Appendix B.2).

3.4 Green strategic technologies

Until now, our assessment of strategic dependencies has been solely based on existing trade data, lacking the forward-looking perspective necessary to anticipate future dependencies. The imperative of decarbonisation mandates a profound structural transformation in our economies, with implications for Europe's comparative advantages. None of the trade vulnerabilities identified in Section 2 and listed in Table C1 is a direct input for green technologies. This remains true even when applying the less restrictive European Commission methodology. While this may seem reassuring in light of the European autonomy on these technologies, we still conduct a dedicated analysis in this section. The rationale for this is that the structure of European imports over 2015-2019 may be a poor proxy for future dependencies in these sectors, given fast-expanding production capacities at the worldwide level. In doing this, we thus adjust our statistical approach, focusing on the latest year of (pre-COVID) available trade data in 2019 and digging into the structure of world exports instead of restricting our attention to European imports.

Several studies have delved into the strategic significance of various technologies, both within the European Union and the United States. These analyses include technology-specific reports such as those by the US-ITC on cobalt and lithium for lithium-ion batteries used in electric vehicles (EVs) (Matthews, 2020; LaRocca, 2020; Horowitz et al., 2021) and a comprehensive report by the European Commission on critical raw materials for strategic technologies (European Commission, 2020). Building upon insights from these studies, our focus in this section is on delineating the market landscape, assessing concentration, and identifying key inputs necessary for producing a set of strategic green technologies.

Lithium-ion batteries stand as a pivotal technology in the electrification of the transportation sector, offering substantial energy storage capacity crucial for powering electric vehicles and reducing reliance on fossil fuels. The European Union's attainment of its climate objectives hinges significantly on securing access to such batteries. This involves ensuring a consistent supply of vital raw materials such as lithium and cobalt, alongside investments in R&D to enhance the performance and cost-effectiveness of European battery production. Table 3 highlights a relatively modest HHI for lithium-ion batteries used in EVs, indicating an emerging market with reasonable competition. This represents a strategic opportunity for the European Union to become a key player in this sector. However, the high concentration of the cobalt market, primarily dominated by the Democratic Republic of Congo (80% market share, with no exporter other than Austria holding a market share above 5%) raises significant concerns. While less pronounced, future market concentration might become an issue for lithium as well. Lithium carbonates are already identified as vulnerable by the European Commission

methodology in our pooled analysis. Moreover, these resources exhibit low levels of ex-post substitutability, with stickiness indicators above 3 (on a scale of 1 to 4). Given the natural resource constraints on these inputs, proactive diversification of sourcing becomes imperative for the European Union.

TABLE 3 **CONCENTRATION OF WORLDWIDE TRADE FOR LITHIUM-ION BATTERIES FOR ELECTRIC VEHICLES AND THEIR COMPONENTS**

Product ✓ (✓ ✓)	HHI	Top X	2nd largest X	Nb X MSh > 5%	Stickiness
Lithium-ion batteries for EV	0.209	China (41%)	Korea (15%)	3	3.02
Cobalt					
Ores and concentrates	0.778	DRC (88%)	Austria (5%)	0	3.49
Oxides and hydroxides (commercial)	0.213	China (32%)	Finland (28%)	4	3.56
Mattes and intermediate products	0.224	DRC (45%)	Canada (8%)	2	3.49
Lithium					
Lithium oxide and hydroxide	0.380	China (59%)	Chile (11%)	3	3.84
Carbonates: lithium carbonate ✓	0.367	Chile (57%)	Argentina (16%)	2	3.16
Alkali or alkali-earth metals	0.192	China (35%)	Russia (15%)	5	3.22
Chlorides	0.0947	China (22%)	Germany (13%)	4	3.37
Fluorides	0.190	China (36%)	Japan (16%)	5	3.88
Mineral substances	0.226	Australia (46%)	China (6%)	2	3.39

Notes: The table details the market structure of lithium-ion batteries and their main components. The HHI is calculated on world exports, as is the market share of the top and second largest world exporters. The fourth column is the number of exporting countries which world market share is above 5%, beyond the top two countries already listed in the previous two columns. The last column is the relationship stickiness measure borrowed from Martin et al. (2020) associated with each product. The blue, red and green ticks represent the products identified as vulnerable after applying the Commission's three criteria (blue), the absorption criteria (red) and the stickiness (green) criteria for this same set of countries.

Source: CEPII-BACI for 2019.

Solar panels represent another crucial element in the European Union's ambitious goals of reducing greenhouse gas emissions. Their scalability and low operational costs position them as a cost-effective and dependable source of green electricity. The increasing demand and decreasing costs of solar panels have spurred notable technological advancements, resulting in more efficient, durable panels and innovations in energy storage and grid integration. However, the concentration of global production limits the European Union's capacity for sourcing diversification (Table 4). China is the largest exporter in this sector, with a 43% market share of world exports, followed by Malaysia at 10%. Although less pronounced, the components of solar panels also display high concentration, with China again the main world exporter, although the HHI is low

across these markets. This concentration among a small number of countries poses a substantial risk to the solar panel supply chain, potentially leading to shortages and price escalations in case of disruptions in these countries. The risk is all the stronger since these markets display relatively high levels of relationship stickiness.

TABLE 4 **CONCENTRATION OF WORLDWIDE TRADE FOR SOLAR PANELS AND THEIR COMPONENTS**

Product ✓ (✓ ✓)	HHI	Top X	2nd largest X	Nb X MSh > 5%	Stickiness
Solar panels	0.216	China (43%)	Malaysia (10%)	4	3.24
Components					
Crystals: mounted piezo-electric	0.145	Japan (28%)	China (19%)	6	2.97
Diodes	0.142	China (32%)	Other Asia (11%)	5	2.73
Parts for diodes, transistors and photosensitive semiconductor devices	0.126	China (24%)	Malaysia (17%)	5	3.26
Photosensitive semiconductor devices	0.0718	USA (15%)	China (13%)	7	2.66
Thyristors, diacs and triacs	0.116	China (27%)	Germany (15%)	3	2.87
Transistors (< 1W dissipation rate)	0.137	China (28%)	Singapore (13%)	7	2.55
Transistors (≥ 1W dissipation rate)	0.110	China (25%)	Germany (11%)	6	2.70

Notes: The table details the market structure of solar panels and their main components. The HHI is calculated on world exports, as is the market share of the top and second largest world exporters. The fourth column is the number of exporting countries which world market share is above 5%, beyond the top two countries already listed in the previous two columns. The last column is the relationship stickiness measure borrowed from Martin et al. (2020) associated with each product. The blue, red and green ticks represent the products identified as vulnerable after applying the Commission's three criteria (blue), the absorption criteria (red) and the stickiness (green) criteria for this same set of countries.

Source: CEPII-BACI for 2019.

Finally, Table 5 provides an overview of the global trade structure for hydrogen, rare earth metals, and graphite. Hydrogen, a versatile and clean energy carrier, holds promise across various applications, from fuelling cell vehicles to providing electricity and heat for buildings. Its production from diverse sources like water, natural gas, and biomass renders it a flexible, scalable solution for decarbonising different sectors of the economy. As of now, the hydrogen market is still relatively competitive, with an HHI of 0.264, and dominated by 'friend' countries (the Netherlands, followed by Canada). However, hydrogen exhibits a high degree of stickiness, which may induce concentration of the market in the coming years (Table 5).

The second panel of Table 5 presents the world trade structure for rare earth metals. These metals play pivotal roles in catalysts, glassmaking, metallurgy, and emerging markets such as battery alloys, ceramics, and permanent magnets (Charalampides et al., 2015). China currently dominates mining activities, enrichment technologies, and

metallurgical processes. It is also estimated that China accounts for almost half of the total global mining reserves in rare earth elements. Due to the challenge of diversifying sourcing and limited global resources, the European Parliament adopted a resolution in 2008 on critical raw materials. Among the proposed strategies are investments in R&D to enhance recycling and efficient use of critical raw materials, as well as efforts to diversify sourcing, including exploration within European countries such as Greece.

TABLE 5 **CONCENTRATION OF WORLDWIDE TRADE FOR HYDROGEN TECHNOLOGIES, RARE-EARTH METALS, AND GRAPHITE**

Product ✓ (✓ ✓)	HHI	Top X	2nd largest X	Nb X MSh > 5%	Stickiness
Hydrogen	0.264	Netherlands (38%)	Canada (33%)	1	3.39
Earth-metals, rare ✓✓	0.234	Viet Nam (33%)	China (29%)	3	3.13
Cerium compounds	0.214	Japan (38%)	France (20%)	2	3.20
Compounds, inorganic or organic of rare-earth metals	0.145	China (27%)	Malaysia (18%)	5	3.30
Graphite					
Natural graphite (powder or in flakes)	0.268	China (49%)	Mozambique (12%)	1	3.09
Natural graphite (other forms than powder or in flakes)	0.234	China (46%)	Mozambique (8%)	2	3.51
Artificial graphite	0.160	China (33%)	Japan (15%)	5	2.88
Colloidal or semi-colloidal graphite	0.113	USA (20%)	Netherlands (18%)	6	3.37
Carbonaceous pastes	0.168	China (32%)	Norway (20%)	3	3.08
Graphite or other carbon based preparations	0.215	China (44%)	Mexico (7%)	4	3.15

Notes: The table details the market structure of hydrogen technologies and rare-earth metals. The HHI is calculated on world exports, as is the market share of the top and second largest world exporters. The fourth column is the number of exporting countries which world market share is above 5%, beyond the top two countries already listed in the previous two columns. The last column is the relationship stickiness measure borrowed from Martin et al. (2020) associated with each product. The blue, red and green ticks represent the products identified as vulnerable after applying the Commission's three criteria (blue), the absorption criteria (red) and the stickiness (green) criteria for this same set of countries.

Source: CEPII-BACI for 2019.

The third panel of Table 5 provides an overview of the global trade structure for graphite, encompassing both natural and synthetic forms. Natural graphite is traditionally used in pencils, as a dry lubricant, and in refractories, but it is now also used as an input for batteries and brake linings. Synthetic graphite, prized for its high thermal and electrical conductivity, plays a vital role in steel production as electrodes, in lithium-ion batteries for EVs and electronics, and in aerospace components. Its applications extend to fuel cells, heat exchangers, nuclear reactors, and foundries, highlighting graphite's versatility in meeting the demands of modern technology and industry. There is a dominance of

China in the export of five out of six graphite products. However, despite this dominance, all these markets still exhibit a high degree of competitiveness, with several alternative export options for artificial graphite. While the structure of supply is still relatively diversified, all these markets display fairly high degree of stickiness. Diversifying sourcing ex-ante is particularly important as a consequence.

4 POLICIES IN THE TOOLBOX

After having developed a methodology to identify potential trade vulnerabilities from existing data in Section 2, we have identified four types of risks associated with trade dependencies in Section 3. The next step involves formulating a policy toolbox to address these vulnerabilities and enhance resilience. This toolbox could encompass various strategies and actions aimed at mitigating risks and building resilience in the face of trade dependencies.

The policy toolbox involves various instruments, many of which intersect with regulatory frame- works, such as Article 107 of the Treaty on the Functioning of the European Union on aids granted by Member States. Such subsidies can directly target domestic production capacities or R&D expenses, in which case they are akin to standard industrial policy. They can also take the form of subsidies for firms to invest in resilience. As discussed in US Council of Economic Advisors (2022), firm-level resilience investments include "understanding the structure of [...] supply chains (visibility), investing in backup capacity (redundancy), improving their ability to solve problems and substitute between inputs (agility), as well as vertically integrating components of the production process". All of these strategies are costly and potentially subject to sub-optimally low investment as a consequence of network or information externalities.

Information externalities are a salient feature of complex production networks as firms often lack comprehensive insights beyond their immediate suppliers. As argued in Section 2.4, the European Union possesses robust capabilities to aid firms in advancing visibility across supply chains, leveraging extensive datasets encompassing both direct and indirect trade exposures. Enhancing firms' understanding of supply chain risks could be achieved by furnishing statistics that offer detailed insights at a granular level. In selected cases, governmental initiatives could orchestrate sophisticated, real-time data collection initiatives to monitor stock levels across multiple manufacturing entities.[24]

Information regarding potential demand at upstream stages is equally crucial to forecast production capacities, which may be particularly useful in nascent industries. In the 1990s, a US public–private partnership named Sematech successfully orchestrated the development of the semi-conductor industry. This initiative facilitated equipment manufacturers to design products that aligned with the requirements of chip designers,

24 A notable example of such an information system is observed in France for certain drugs classified as critical medicine, as detailed at https://ansm.sante.fr/page/informations-relatives-au-decret-ndeg-2021-349-du-30-03-2021.

fostering collaboration and mutual understanding (US Council of Economic Advisors, 2022). Coordination efforts can extend to promoting greater harmonisation in product design, a strategy that mitigates structural weaknesses within strategic value chains and enhances substitutability among suppliers during disruptions. In the semiconductor industry, Berger et al. (2023) advocate for the adoption of standardised chip architectures, promoting uniformity and transparency across multiple manufacturers. Embracing common design platforms not only reduces heterogeneity but also ensures compatibility with various fabrication facilities, reducing reliance on specific foundries and enhancing supply chain flexibility. Such coordination tools hold significant promise, especially for new products involved in the environmental transition.

Designing policies aimed at addressing network externalities within value chains is complex. Such policies can entail a combination of taxes and subsidies applied to transactions among firms operating in adjacent tiers of the supply chain, as well as incentives to encourage investments in agility and foster supplier relationships (Grossman et al., 2023). However, crafting the optimal structure for these tax and subsidy frameworks hinges on assessing firms' bargaining power across the chain and the substitutability among different inputs – factors that are challenging to quantify effectively. Under reasonable assumptions regarding the degree of substitutability between inputs along the value chain, Grossman et al. (2023) show that optimal subsidies for resilience tend to diminish as goods progress downstream. This implies that government intervention might be more critical in industries supplying inputs across numerous individual supply chains, as detailed in Section 3.2.

In critical sectors, the public may be willing to bear a higher cost for achieving a socially optimal level of resilience. This involves government focus on industries that play a pivotal role in national security (Section 3.3). Such interventions often manifest as investments in domestic production capabilities or the creation of stockpiles. Many countries thus maintain substantial 'strategic reserves' of essentials like food, pharmaceuticals or defence resources due to the steep consequences of insufficient supply (Baldwin and Freeman, 2021). Defining the boundaries of national security presents a primary challenge. While today's national security remains a significant concern, particularly amid the current global landscape marked by geopolitical risks, it is crucial to also consider future national security needs. This necessitates substantial investments in green technologies to ensure resilience in times ahead.

While subsidies to bolster domestic production capacities are not the sole tool in the resilience toolkit, public discussions surrounding resilience have predominantly advocated for their implementation. Increasing domestic production has the potential to enhance the agility of production processes, by minimising transportation times and fostering improved communication. Additionally, targeting domestic production in sectors where local absorption heavily relies on foreign products is a mechanical way of improving

overall risk diversification (Section 2.2).[25] The rationale for a renewal of industrial policy becomes particularly evident for green technologies. Protecting nascent industries can justify subsidizing domestic production, even though continued diversification of foreign sourcing remains imperative for certain natural resources (Section 3.4). This diversification can be supported through standard trade policy tools, especially in cases where there are alternative suppliers in the market. The Canadian government has implemented a strategy to strengthen Canada's position across the entire value chain of critical raw materials, including mining, manufacturing, and recycling (Government of Canada, 2022). This initiative positions Canada as a credible and geopolitically low-risk alternative supplier for raw materials, that European producers could exploit in the future. Beyond diversifying suppliers, strategies can target the technologies used in green strategic technologies. For instance, specific types of EV batteries are evolving independently from materials like lithium or cobalt, thereby reducing reliance on these increasingly concentrated markets. The new NMC 811 batteries thus have a very low manganese and cobalt content, while sodium-ion batteries are currently being developed by Northvolt.[26]

While targeted industrial policy supported by public investment holds clear economic justification, the institutional context involves an additional difficulty. Industrial policy is a competence of Member States, yet investments in resilience serve as a public good that benefit the entire European Union. Therefore, coordinating resilience investments at the European level becomes imperative to avoid a potential subsidy war that could exacerbate prevailing imbalances between Member States. The spatial distribution of public investments should also achieve a balance between strengthening existing industrial clusters to maximise vertical spillovers, thereby reinforcing manufacturing comparative advantages in countries that currently exhibit substantial current account surpluses, and reinvigorating regions that have experienced declines in manufacturing employment and could benefit from the structural transformation driven by the environmental transition. At the European level, a more comprehensive understanding of this equilibrium is attainable compared to policies enacted at the individual Member State level, which address similar balances locally without fully considering the implications of these decisions on other Member States.

5 CONCLUSION

In this chapter, we contribute to the recent literature focusing on data-driven methodologies for identifying strategic dependencies using product-level trade data. The European Commission has proposed a 'bottom-up' approach to identify strategic products primarily imported from dominant countries and concentrated markets. While

25 However, overreliance on domestic production might also pose vulnerabilities as international trade plays a vital role in risk sharing.

26 See details at https://northvolt.com/articles/northvolt-sodium-ion/

acknowledging the significance of concentrated foreign input sourcing as a vulnerability, a comprehensive vulnerability assessment should also consider the potential for substituting disrupted input sources, both domestically and abroad. We therefore enhance the Commission's strategy by introducing two new criteria that account for these substitution sources and by explicitly incorporating product-level domestic production data in the vulnerability methodology. In addition to the Commission's three criteria, we identify a product as vulnerable if over 50% of domestic absorption originates from foreign sources and if the ex-post substitutability of a product is in the 25% lowest of the product distribution.

We use the CEPII-BACI and EUROSTAT-PRODCOM databases, which respectively cover worldwide bilateral trade flows and European production at a detailed 6-digit product level. The focus of the analysis is on the European Union, and we therefore consolidate all data across the 27 EU Member States. Our analysis accounts for the inherent volatility in trade flows by pooling data over five consecutive years (2015 to 2019). Following the European Commission's three-criteria methodology, we identify 378 products (out of 5,381) as 'strategic dependencies'. An additional 'absorption' criterion reduces the set of vulnerabilities to 228 products, by disregarding product markets for which at least 50% of European absorption is sourced from domestic firms. Finally, we further restrict attention to 49 products displaying a high level of stickiness, in which ex-post substitution away from disrupted inputs is likely to be difficult. These 49 products account for 0.5% of the total value of the European Union's aggregate imports. Considering the potential for both domestic and foreign substitution not only substantially refines the Commission's list but also modifies the sectoral distribution of these dependencies. We discuss how the European Union could leverage already collected data to improve our understanding of European production capabilities and indirect exposure to trade.

Existing data serve as a valuable resource for identifying potential trade vulnerabilities. However, not all trade vulnerabilities expose the economy to the same level of risk. Several normative arguments justify interventions for enhancing resilience. We analyse our list of vulnerable products through the lens of four (non-mutually exclusive) risks. We first discuss geopolitical risk by focusing on vulnerable products sourced from non-NATO countries (41 products). The potential risk for the economy in the event of geopolitical tensions, and the designed resilience policies, should also take into account the estimated cost of such a disruption, as well as the end use and relevance of the product in the value chain. To this aim, we link the list of vulnerable products to a measure of upstreamness in the value chain. We identify 22 upstream inputs that expose the European Union to supply chain risks. Beyond the economic cost of supply chain disruptions, shortages of critical goods can result in human losses and other severe non-economic consequences. We illustrate this using pharmaceutical products as an example. In this sector, however, trade dependencies are limited due to large European production capabilities and a low degree of stickiness for active principal ingredients. Finally, we conclude the analysis with a focus on a selected sample of green products (cobalt, lithium, rare earth metals,

and graphite) and renewable strategic technologies (lithium-ion batteries for electric vehicles, solar panels, and hydrogen). These are not yet identified as vulnerable but, due to their market characteristics, are expected to be so if the European Union is not able to secure the necessary inputs. This is especially critical given that several of these technologies depend on rare resources, often concentrated among a handful of suppliers outside the Union, with very low potential for ex-post substitutability.

Finally, we discuss resilience policies that governments could employ. A main argument of this chapter is the relevance of supplier diversification (especially towards geopolitically stable countries) and domestic production to offset imported risks from non-EU sources. Subsidies to bolster domestic production, particularly in sectors heavily reliant on foreign products, can improve overall risk diversification and the European Union's position in value chains. The case for such industrial policy is particularly strong in green industries. However, the coordination of these subsidies, which is a competence of Member States, is essential to avoid potential subsidy wars and address imbalances among Member States. The spatial distribution of public investments aims to strike a balance between reinforcing existing industrial clusters and revitalising regions experiencing declines in manufacturing employment. Additionally, there are alternative strategies such as investment in alternative technologies, standardisation of production processes to facilitate substitutability, and the establishment of real-time monitoring of stocks.

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A DATA APPENDIX

A1 Data on domestic production

Eurostat's Prodcom database facilitates the connection between trade and production data, albeit with some caveats. First, the matching of Prodcom codes with the HS nomenclature is not perfect. Second, the Prodcom database contains a significant number of missing values or zeros. The nature of these missing values remains unclear, whether indicating the absence of product-level production capacities in the respective country or poor data quality due to insufficient coverage, misreporting, or other issues.

Focusing on production data reported for the years 2015 to 2019 by the 27 EU countries, we identify 4,248 Prodcom products in the database and 510,836 potential data points. Among these observations, 21% have missing output, 48% are zeros, and 31% correspond to strictly positive output values. On average, for each Prodcom product, 31% of the filled observations are neither zeros nor missing, 49% are zeros, and 20% are missing. These characteristics remain constant over time (as analysed individually for 2015, 2016, 2017, 2018, and 2020). Despite the crucial role of this dataset in identifying European strategic vulnerabilities, the quality of the data is a source of concern and results should thus be interpreted with caution.

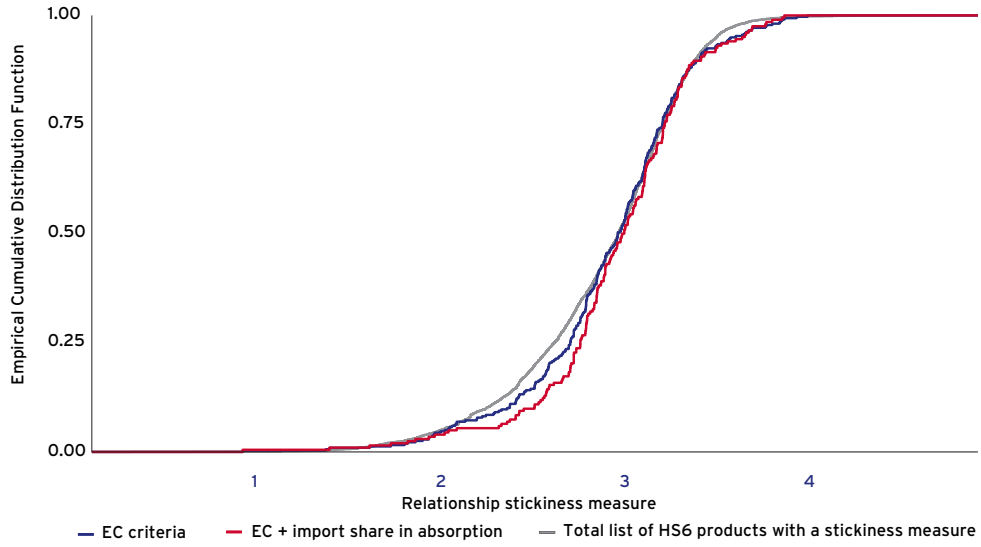
Out of the 378 HS6 products identified as vulnerable using the European Commission methodology, only 336 have an equivalence with Prodcom codes, and 326 are effectively matched with Prodcom from 2015 to 2019. All of these products display some zero production observations, and 325 have missing ones. Among the 326 HS6 products matched with Prodcom, 161 correspond to a one-to-one matching between HS6 and Prodcom codes. Sixteen HS6 codes are matched with multiple Prodcom products, while 129 HS6 codes display many-to-one matching. Finally, 27 HS6 codes correspond to many-to-many matches. For the absorption criteria analysis, we need to consolidate production data across EU countries. To do this, we exclude the many-to-many matches (27 HS6 products), leaving us with 306 HS6 products for which we can calculate absorption. Finally, only four HS6 codes among these 306 HS6 products have a negative absorption due to production data quality issues. Therefore, we exclude these four HS6 products from our list of 306 HS6 products, leaving us with 302 products for which we compute absorption.

This absorption calculation is carried out as follows. For the 161 HS6 products linked to 161 Prodcom products, we compute the consolidated extra-EU import and export flows, for each product and year, using the CEPII's BACI database, and average over time. Simultaneously, we calculate the consolidated EU production, by product and year, excluding missing values and zeros, and average over time. Finally, we merge both datasets to calculate absorption and the contribution of foreign products to domestic absorption. In instances in which the relationship involves an HS6 product merged with multiple Prodcom products, production is consolidated across Prodcom codes, within each HS6 product. When the relationship involves many-to-one matching from HS6 to Prodcom, the trade data are consolidated across HS6 codes within each Prodcom product.

B ADDITIONAL FIGURES

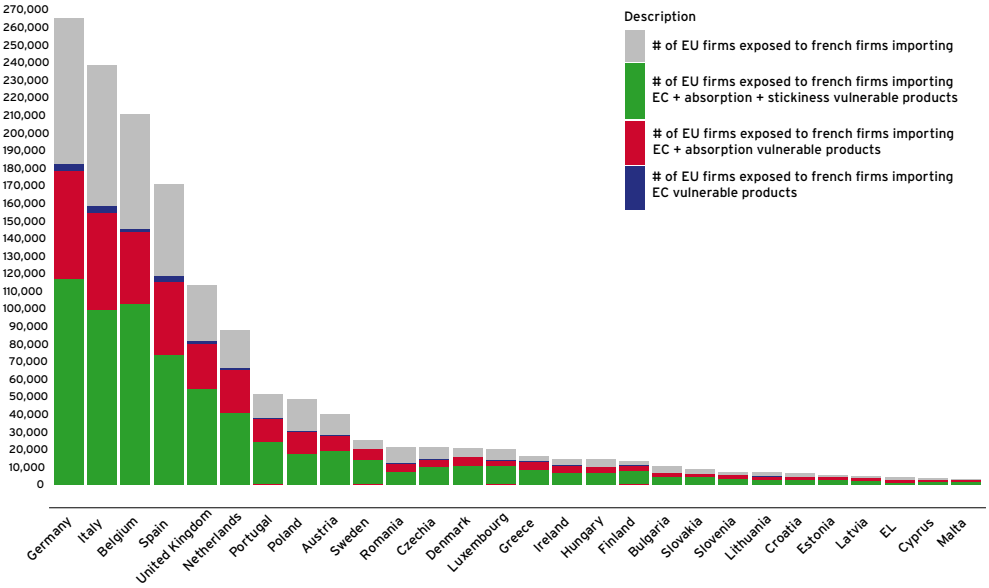
B1 A diagnosis of trade vulnerabilities

FIGURE B1 **CUMULATIVE DISTRIBUTION FUNCTION OF THE MEASURE OF STICKINESS, IN THE ENTIRE DISTRIBUTION AND IN THE LIST OF STRATEGIC DEPENDENCIES IDENTIFIED BY THE EUROPEAN COMMISSION AND AFTER ADDING THE ABSORPTION CRITERION**



Notes: The figure shows the cumulated distribution of relationship stickiness indicators. The grey line is in the overall list of HS6 products, the blue line is restricted to vulnerable products identified using the European Commission baseline methodology, the red line is in the list further restricted with the absorption criterion.
Source: Martin et al. (2020) for the relationship stickiness measure.

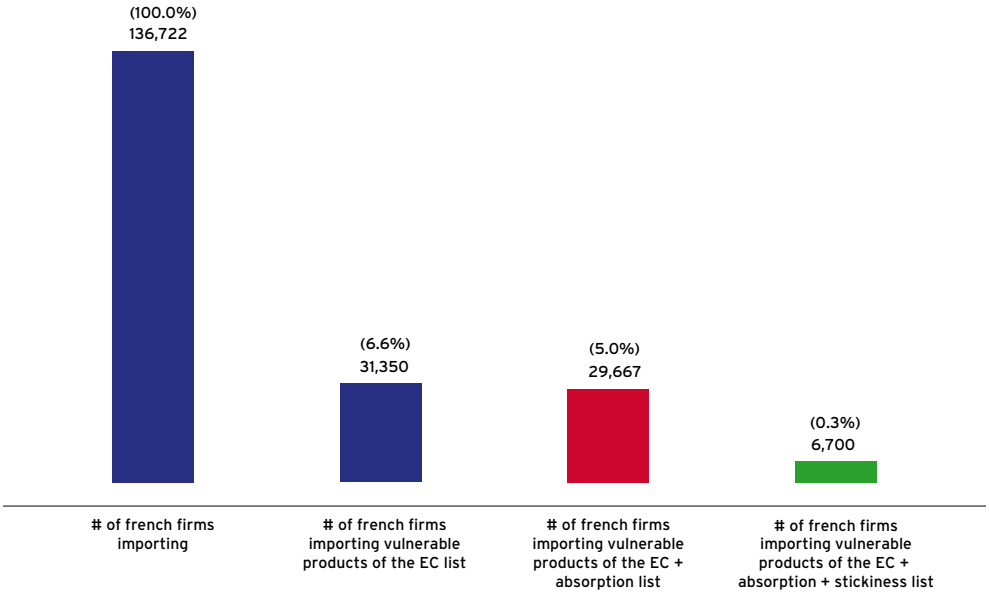
FIGURE B2 **GEOGRAPHICAL DISTRIBUTION OF THE NUMBER OF FIRMS INDIRECTLY EXPOSED TO VULNERABLE PRODUCTS THROUGH THEIR INTERACTION WITH FRENCH FIRMS**



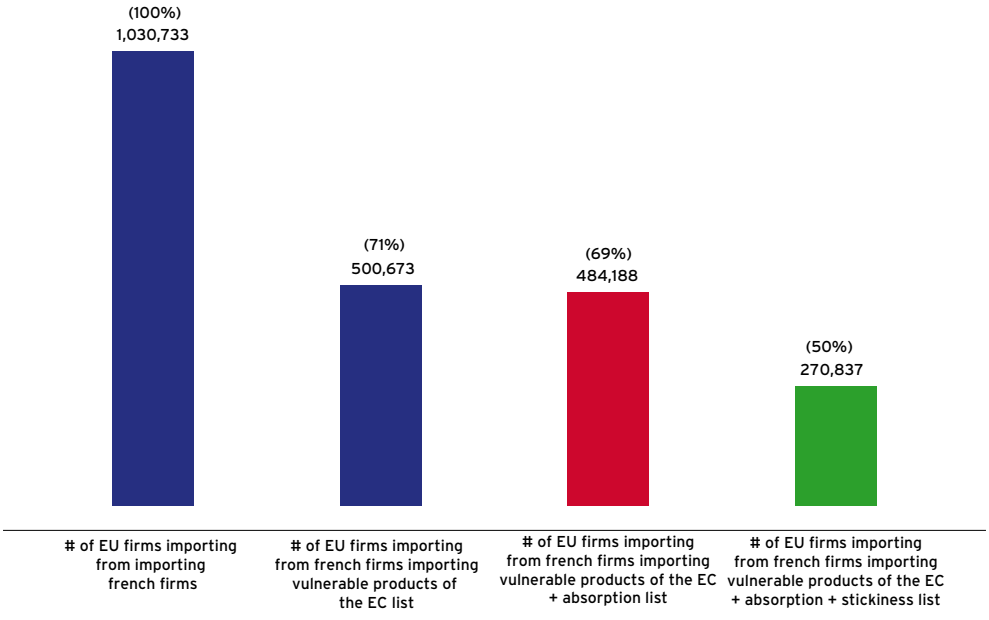
Notes: The figure shows, for each EU country, the number of firms connected with French importers through their own imports (grey bars), and the number of firms indirectly exposed to vulnerable products through these interactions (blue, red and green bars using increasingly restrictive definitions of vulnerable products). The number of firms according to each legend should be read at the highest border of the respective colour. Indeed, a colour bar encompasses all the colours below it.
Source: French Customs data for 2015 to 2019.

FIGURE B3 **INDIRECT EXPOSURE TO STRATEGIC DEPENDENCIES, THROUGH FIRM-TO-FIRM TRADE WHEN EXCLUDING FRENCH WHOLESALERS**

a) French firms' direct exposure



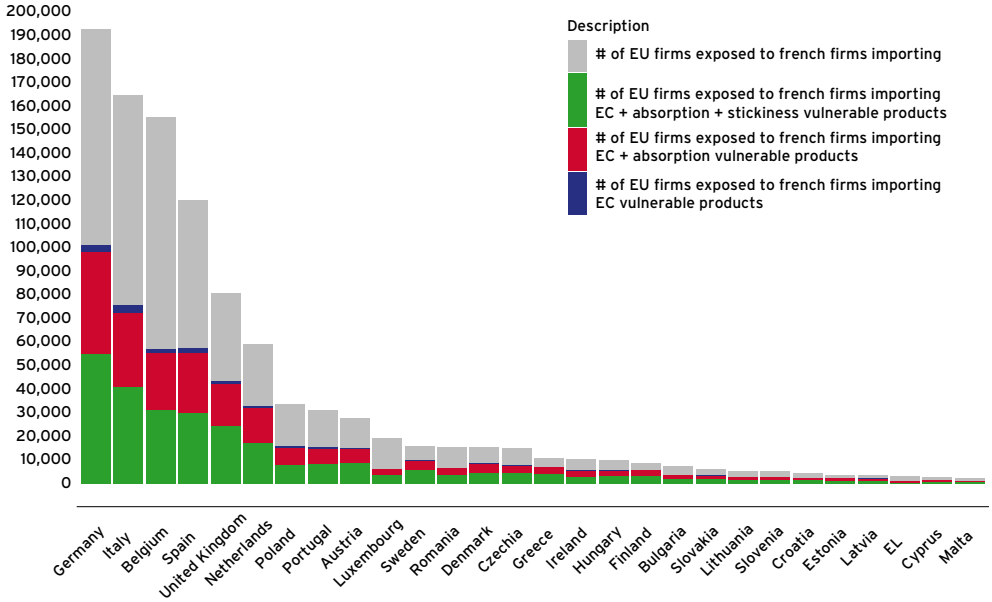
b) Non-French firms' indirect exposure



Notes: The top panel presents statistics on the number of non-wholesaler, French firms and their contribution to French imports from non-EU countries, that are exposed to EU trade dependencies, through their imports. The bottom panel shows statistics on European firms that are indirectly exposed, through their interactions with French exposed importers. The top panel uses customs data on firm-level extra-EU imports. The bottom panel uses customs data on firm-to-firm intra-EU exports. A firm is considered directly exposed if it imports at least one product which is classified as a strategic dependency. A firm is considered indirectly exposed if it imports from a French firm that is directly exposed.

Source: French Customs data for 2015 to 2019.

FIGURE B4 **GEOGRAPHICAL DISTRIBUTION OF THE NUMBER OF FIRMS INDIRECTLY EXPOSED TO EXPOSED TO VULNERABLE PRODUCTS THROUGH THEIR INTERACTION WITH FRENCH NON-WHOLESALER IMPORTERS**



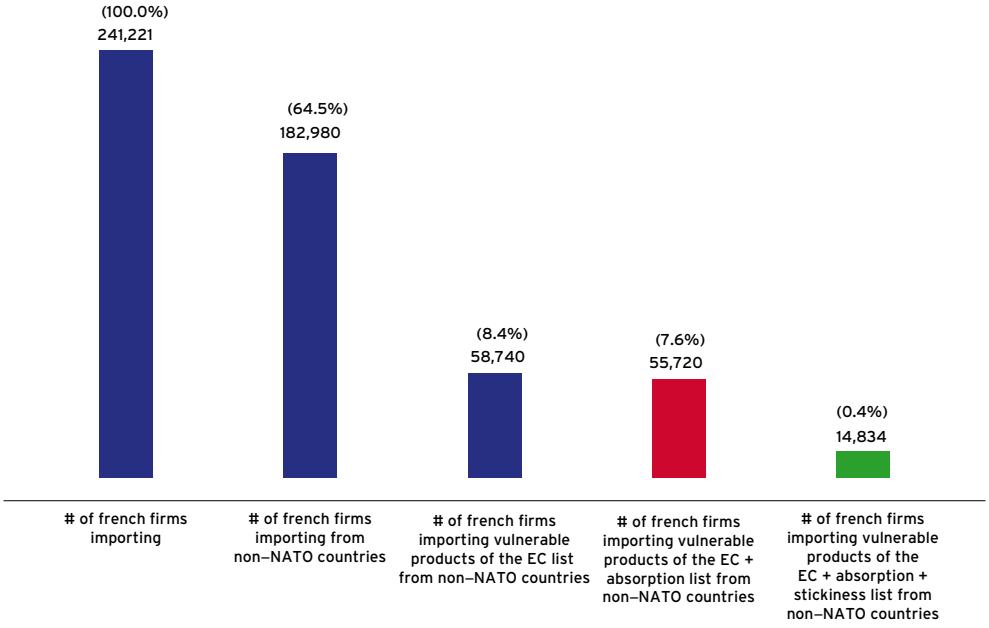
Notes: The figure shows, for each EU country, the number of firms connected with French importers through their own imports (grey bars), and the number of firms indirectly exposed to vulnerable products through these interactions (blue, red and green bars using increasingly restrictive definitions of vulnerable products). French importers in the wholesale sector are excluded. The number of firms according to each legend should be read at the highest border of the respective colour. Indeed, a colour bar encompasses all the colours below it.

Source: French Customs data for 2015 to 2019.

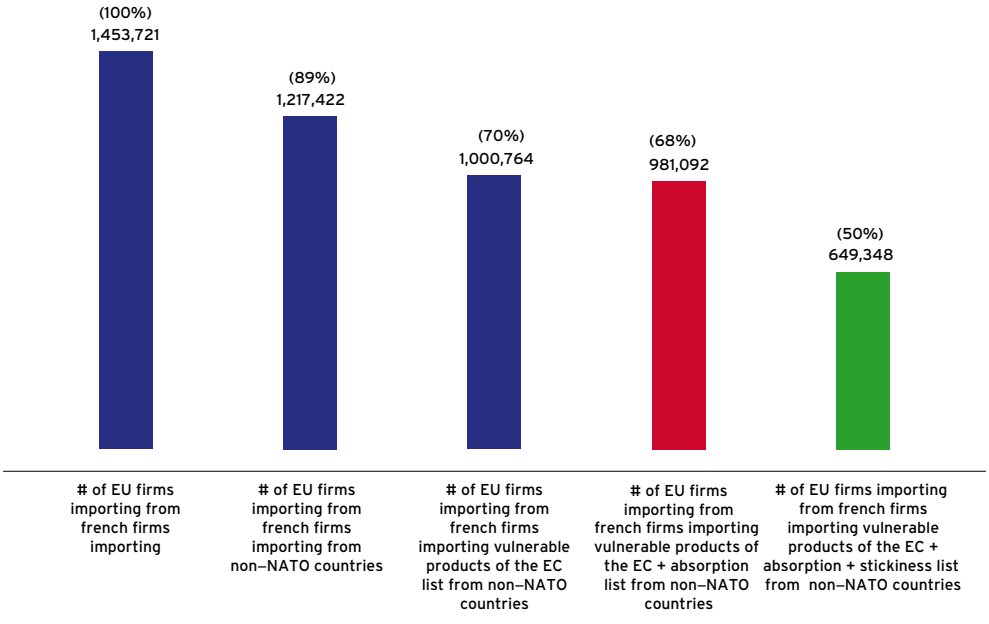
B2 A hierarchy of risks

FIGURE B5 **INDIRECT EXPOSURE TO STRATEGIC DEPENDENCIES VIS-À-VIS NON-NATO COUNTRIES, THROUGH FIRM-TO-FIRM TRADE**

a) French firms' direct exposure



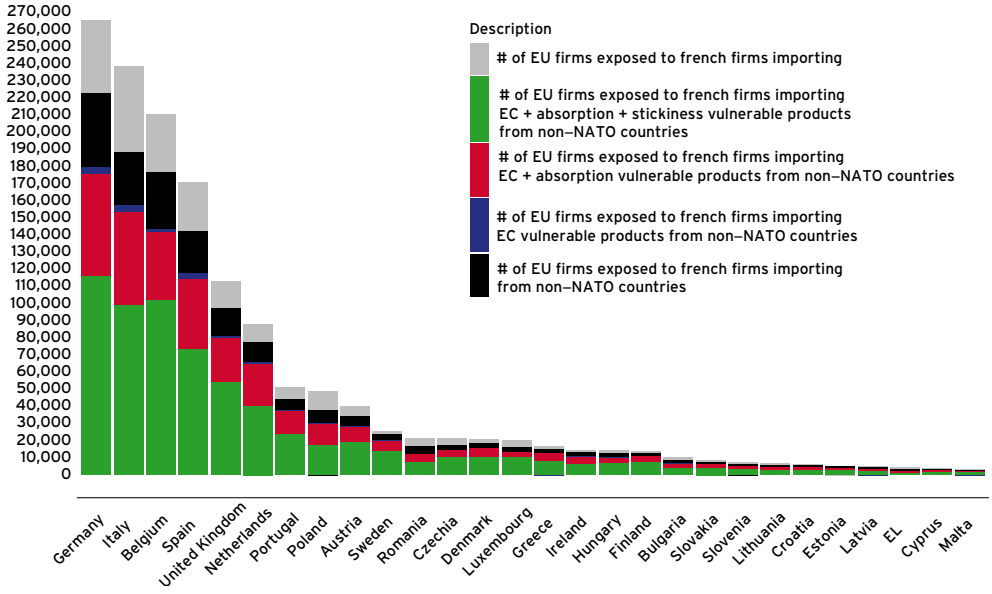
b) Non-French firms' indirect exposure



Notes: The top panel presents statistics on the number of firms (and their contribution to French extra-EU imports) that are exposed to EU trade dependencies vis-à-vis non-NATO countries, through their imports. The bottom panel shows statistics on firms that are indirectly exposed, through their interactions with French exposed importers. The top panel uses customs data on firm-level extra-EU imports. The bottom panel uses customs data on firm-to-firm intra-EU exports. A firm is considered directly exposed if it imports at least one product which is classified as a strategic dependency. A firm is considered indirectly exposed if it imports from a French firm that is directly exposed.

Source: French Customs for 2015 to 2019.

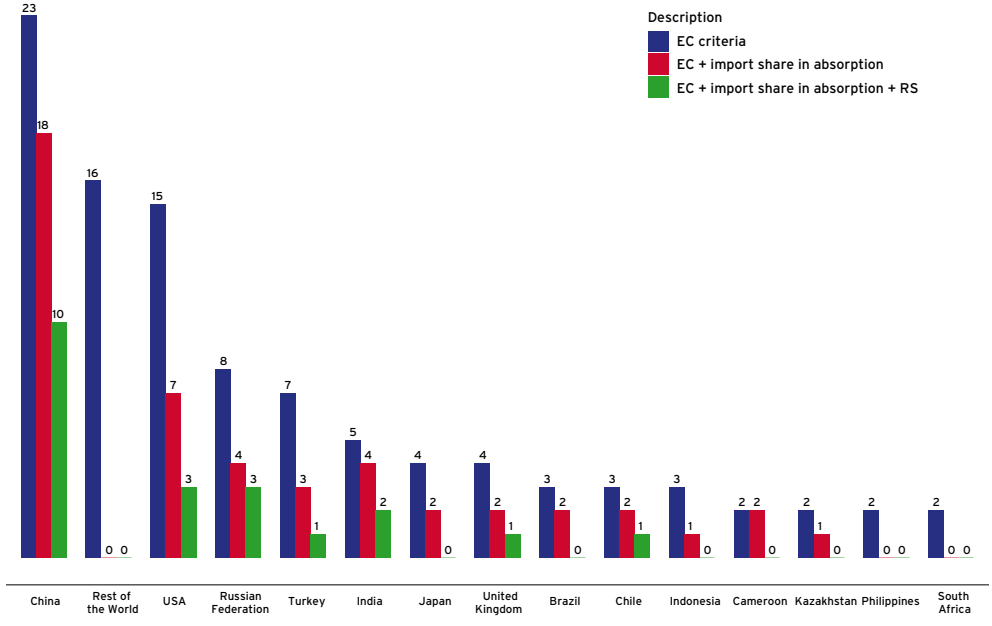
FIGURE B6 **GEOGRAPHICAL DISTRIBUTION OF THE NUMBER OF FIRMS INDIRECTLY EXPOSED TO VULNERABLE PRODUCTS SOURCED FROM NON-NATO COUNTRIES THROUGH THEIR INTERACTION WITH FRENCH IMPORTERS**



Notes: The figure shows the geographical distribution of indirect trade exposures among European firms importing from French importers of vulnerable products from non-NATO countries. The number of firms according to each legend should be read at the highest border of the respective colour. Indeed, a colour bar encompasses all the colours below it.

Source: French Customs for 2015 to 2019.

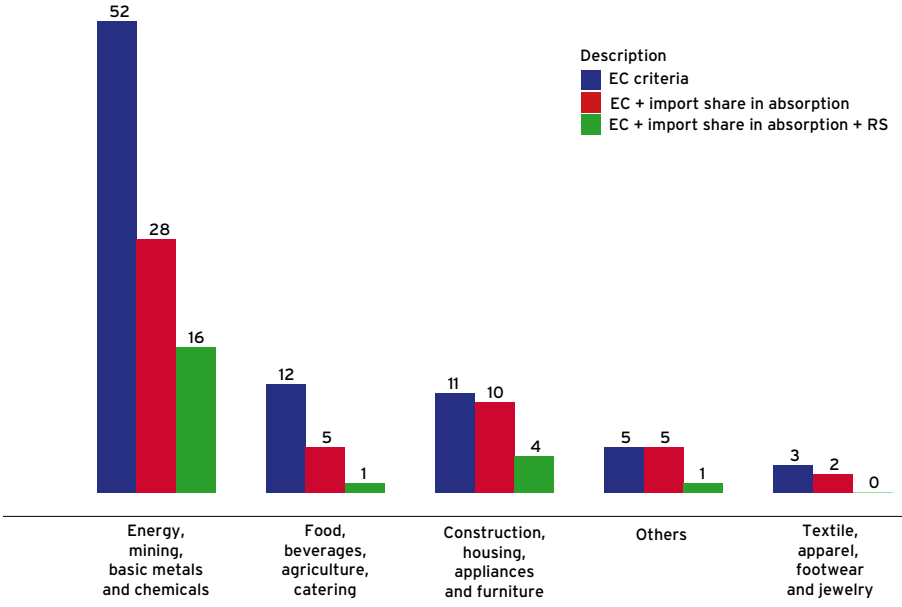
FIGURE B7 **GEOGRAPHICAL DISTRIBUTION OF THE MOST UPSTREAM VULNERABLE PRODUCTS**



Note: The figure shows the number of vulnerable products with an upstreamness measure above three, by country of origin.

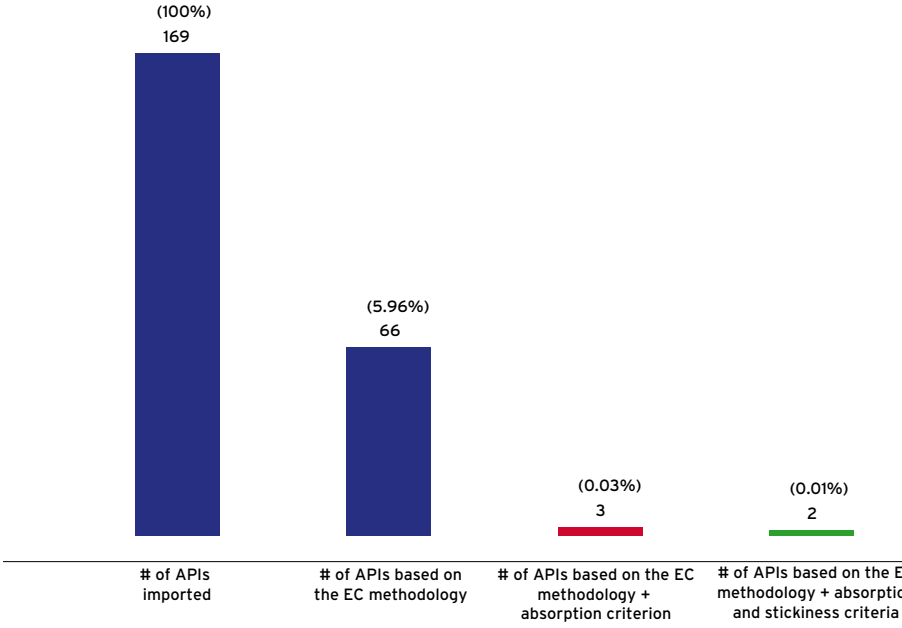
Source: CEPII-BACI and Prodcom for 2015 to 2019.

FIGURE B8 **SECTORAL DISTRIBUTION OF THE MOST UPSTREAM VULNERABLE PRODUCTS**



Note: The figure shows the number of vulnerable products with an upstreamness measure above three, by UN-BEC sector.
Source: CEPII-BACI and Prodcom for 2015 to 2019.

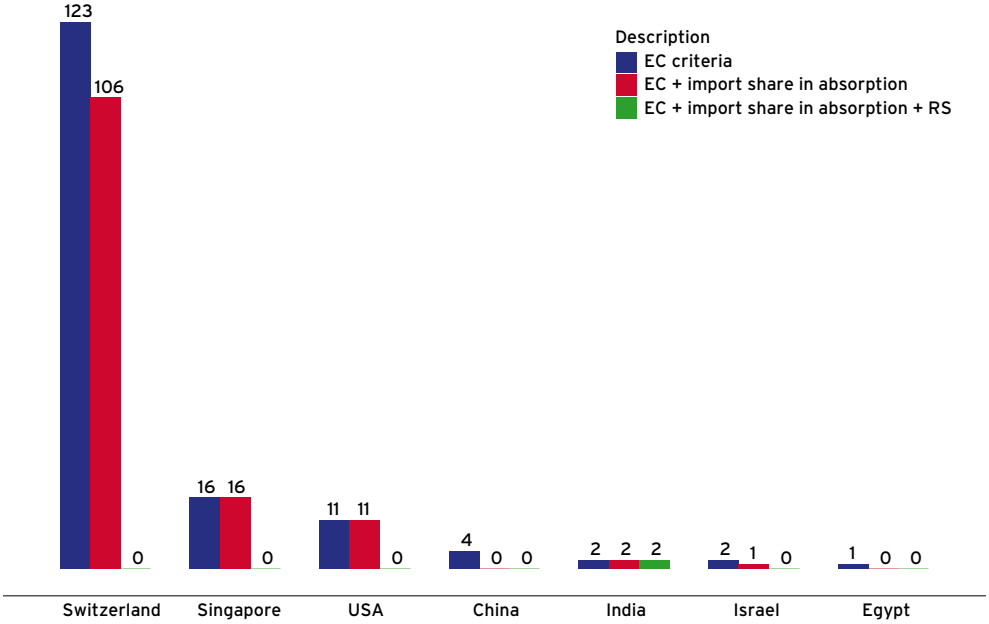
FIGURE B9 **NUMBER OF 'STRATEGIC DEPENDENCIES' AND THEIR CONTRIBUTION TO AGGREGATE IMPORTS, FOR ACTIVE PHARMACEUTICAL INGREDIENTS**



Notes: The Figure shows the evolution number of "strategic dependencies" and their contribution to aggregate imports, for active pharmaceutical when applying the criteria of European Commission (2021) and adding our absorption and stickiness criteria.

Source: CEPII-BACI and Prodcom for 2019.

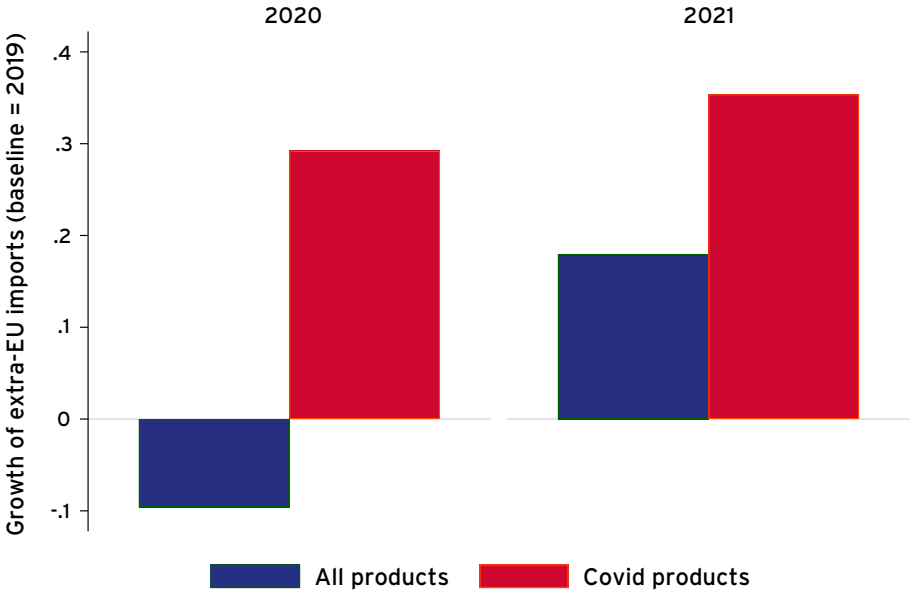
FIGURE B10 **GEOGRAPHICAL DISTRIBUTION OF VULNERABILITIES ON ACTIVE PHARMACEUTICAL INGREDIENTS (APIS)**



Notes: The figure shows the geographical distribution of trade vulnerabilities identified on APIs using the EC methodology (blue bars), the methodology augmented with the absorption criterion (red bars) and the methodology augmented with an absorption and a stickiness criteria (green bars).

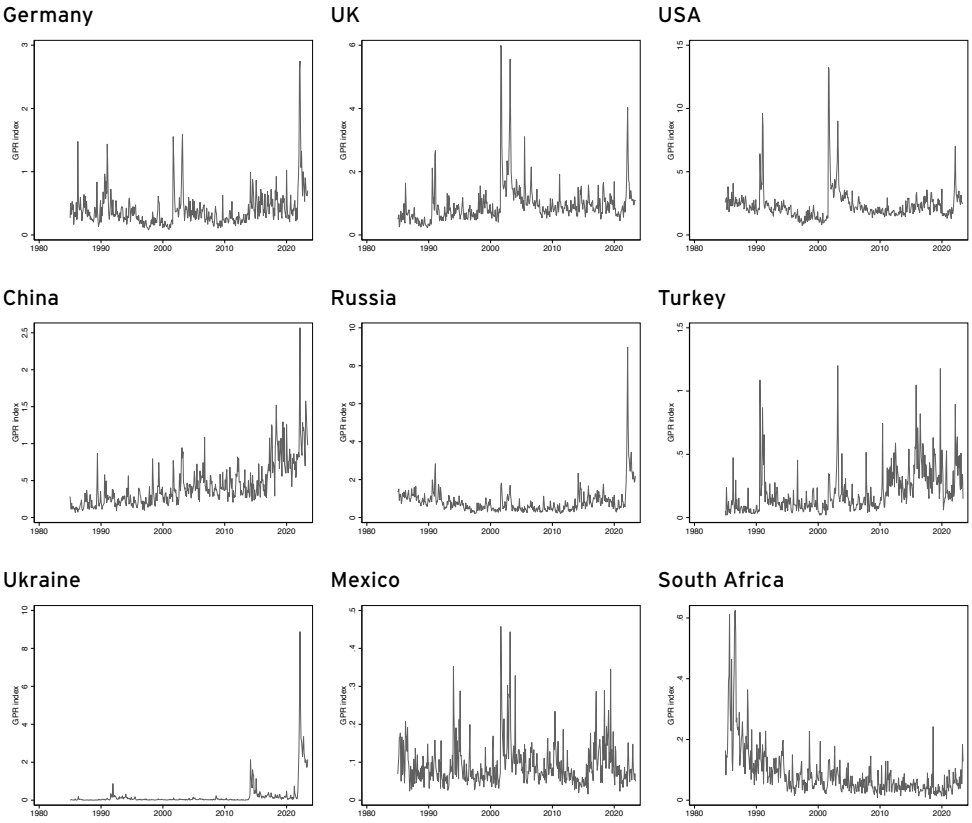
Source: CEPII-BACI and Prodcom for 2015 to 2019.

FIGURE B11 **GROWTH OF EXTRA-EU IMPORTS BETWEEN 2019 AND 2020-2021: ALL PRODUCTS VERSUS COVID- RELATED PRODUCTS**



Notes: The figure shows the growth of EU imports from non-EU countries in 2020 and 2021, using 2019 as reference. The figure compares aggregate imports and imports of products that were critical in fighting Covid-19, using the list of such products from the WTO.

FIGURE B12 **GPR INDICES, RAW DATA**



Notes: The figure shows time-series of the GPR index constructed in Caldara and Iacoviello (2022).

C ADDITIONAL TABLES

C1 A diagnosis of trade vulnerabilities

TABLE C1 **LIST OF STRATEGIC DEPENDENCIES OBTAINED USING OUR FIVE CRITERIA METHODOLOGY**

Product	Exporter (market share)	HHI
Castor oil	India (98%)	0.96
Diphosphorus pentoxide	China (98%)	0.96
Heterocyclic compounds containing pyrimidine or piperazine ring, other derivatives of malonylurea	India (97%)	0.94
Alkaloids	United Kingdom (96%)	0.92
Quebracho extract	Argentina (96%)	0.92
Artificial flowers, foliage and fruit (of plastics)	China (95%)	0.90
Electro-thermic appliances (domestic purpose)	China (95%)	0.90
Bran, sharps and other residues	Argentina (93%)	0.87
Magnesium (raspings, turnings and granules)	China (91%)	0.83
Heterocyclic compounds containing pyrimidine or piperazine ring, malonylurea and its salts	China (90%)	0.82
Trichloroethylene	USA (90%)	0.82
Electric blankets	China (90%)	0.81
Vacuum flasks and other vacuum vessels	China (90%)	0.81
Nickel mattes	Russian Federation (87%)	0.76
Camping goods (of textile materials)	China (84%)	0.71
Phosphinates and phosphonates	China (83%)	0.70
Yarn of coir	India (82%)	0.70
Hair-dressing apparatus	China (81%)	0.67
Azelaic acid, sebacic acid and esters	China (81%)	0.67
Padlocks	China (81%)	0.66
Tents of synthetic fibres	China (80%)	0.65
Cases and containers (trunks, suit-cases, vanity-cases, etc.)	China (80%)	0.65
Borates: disodium tetraborate	Turkey (77%)	0.64
Magnets of metal	China (79%)	0.63
Fabrics, woven of jute	India (75%)	0.61
Silver nitrates	United Kingdom (73%)	0.60
Complex cyanides	China (75%)	0.58
Aromatic monocarboxylic acids and phenylacetic acid	China (73%)	0.56
Lighting or visual signalling equipment (bicycles use)	China (74%)	0.56
Cooking appliances and plate warmers	China (73%)	0.56
Iodine	Chile (73%)	0.56
Oxalic acid and esters	China (72%)	0.54
Yarn (not sewing thread) of synthetic staple fibres	Turkey (71%)	0.54
Saturated acyclic hydrocarbons	Russian Federation (70%)	0.53

Product	Exporter (market share)	HHI
Unwrought beryllium (powders)	USA (62%)	0.52
Disodium tetraborate (refined borax), anhydrous	USA (62%)	0.51
Hand or foot-operated air pumps	China (67%)	0.51
Wigs, false beards, eyebrows and eyelashes(of human hair)	China (70%)	0.50
Vulcanised erasers of non-cellular rubber	China (69%)	0.50
Tungstates (wolframates)	China (63%)	0.48
Interchangeable spanner sockets, with or without handles	Other Asia, nes (64%)	0.46
Vegetable waxes	Brazil (66%)	0.46
Rutoside (rutin)	China (63%)	0.45
Sleeping bags	China (65%)	0.45
Magnets other than of metal	China (64%)	0.43
Vulcanised gloves, mittens and mitts (other than surgical gloves)	Malaysia (63%)	0.42
Halogenated, sulphonated, nitrated or nitrosated derivatives	China (58%)	0.42
Bismuth	China (62%)	0.41
Ferrous products (by direct reduction of iron ore)	Russian Federation (60%)	0.40

Notes: The table lists the vulnerable products identified after applying our five criteria methodology.
Source: CEPII-BACI for 2015 to 2019.

TABLE C2 **LIST OF STRATEGIC DEPENDENCIES OBTAINED USING OUR FIVE CRITERIA METHODOLOGY WITH A LESS RESTRICTIVE STICKINESS CRITERION**

Product	Exporter (market share)	HHI
Dichlorotrifluoroethane	China (100%)	1
Insulin and its salts	USA (99%)	0.98
Theophylline and aminophylline	Israel (98%)	0.96
Anti-knock preparations	United Kingdom (96%)	0.92
Artificial flowers, foliage and fruit other than plastics	China (95%)	0.90
Synthetic Yarn	Turkey (95%)	0.90
Umbrellas and sun umbrellas (excluding garden or similar umbrellas)	China (92%)	0.85
Unwrought thallium (powders)	Japan (91%)	0.83
Umbrellas and sun umbrellas (garden or similar umbrellas)	China (91%)	0.83
Weighing machines (personal and household scales)	China (90%)	0.81
Umbrellas and sun umbrellas (including walking stick umbrellas)	China (90%)	0.81
Maize (corn) oil and its fractions (crude)	USA (89%)	0.80
Christmas festivity articles	China (88%)	0.78
Alarm clocks, electrically operated	China (87%)	0.76
Wall clocks, electrically operated	China (86%)	0.74
Ferro-niobium	Brazil (85%)	0.74
Tennis, badminton and similar racquets	China (85%)	0.73
Beryllium	USA (84%)	0.71
Lamp : portable, electric, designed to function by their own source of energy	China (83%)	0.70
Earth-metals rare: scandium and yttrium	China (83%)	0.70
Amino-acids (other than those containing more than one kind of oxygen function)	Singapore (82%)	0.68
Musical boxes	China (082%)	0.68
Table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output not exceeding 125W	China (0.82%)	0.68
Lighters: pocket, cigarette, gas fuelled, refillable	China (81%)	0.67
Seats with metal frames (excluding medical)	China (80%)	0.65
Ties, bow ties and cravats of man-made fibres (not knitted or crocheted)	China (80%)	0.65
Travel sets for personal toilet, sewing, shoe or clothes cleaning	China (80%)	0.65
Synthetic Yarn	Turkey (80%)	0.65
Festive, carnival or other entertainment articles (other than Christmas articles)	China (77%)	0.61
Vegetable oils: palm kernel or babassu oil	Indonesia (74%)	0.61
Calcium	China (73%)	0.59
Hairpins, curling pins, curling grips, and hair curlers	China (75%)	0.58
Headgear of rubber or plastics	China (75%)	0.57
Toilet and kitchen linen of man-made fibres	China74%)	0.57
Cutlery (not plated with precious metal)	China (73%)	0.57

Product	Exporter (market share)	HHI
Yarn of jute	Bangladesh (72%)	0.56
Loudspeakers: multiple, mounted in the same enclosure	China (73%)	0.55
Shaving, hair, nail, eyelash and other toilet brushes for use on the person	China (72%)	0.5
Plastics: articles of apparel and clothing accessories (including gloves, mittens and mitts)	China (72%)	0.53
Cutlery: hair clippers and mincing knives	China (71%)	0.52
Optical devices, appliances and instrument (including liquid crystal devices)	China (69%)	0.50
Amino-naphthols and other amino-phenols (other than those containing more than one kind of oxygen function)	India (59%)	0.50
Arsenic	Japan (64%)	0.50
Saccharin and its salts	China (67%)	0.48
Handkerchiefs of cotton (not knitted or crocheted)	China (67%)	0.47
Cutlery (other than plated with precious metal)	China (65%)	0.47
Cases and containers with outer surface of sheeting of plastics or of textile materials	China (65%)	0.46
Bromine	Jordan (56%)	0.45
Anthranilic acid and its esters	China (59%)	0.45
Cases and containers of vulcanised fibre or of paperboard	China (66%)	0.45
Outboard motors for marine propulsion, spark-ignition reciprocating or rotary internal combustion piston engines	Japan (62%)	0.44
Aromatic monoamines and their derivatives	India (60%)	0.44
Synthetic Yarn: filament, monofilament of high tenacity yarn of polyesters	China (62%)	0.42
Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens	USA (62%)	0.42
Radio broadcast receivers capable of operating without an external power source	China (61%)	0.40
Wattle extract	Brazil (46%)	0.40

Notes: The table lists the vulnerable products identified after applying our five criteria methodology by retaining only the products after the first four criteria that have a stickiness higher than the median of the distribution in Martin et al. (2020).

Source: CEPII-BACI for 2015 to 2019.

C2 A hierarchy of risks

TABLE C3 **LIST OF GEOPOLITICALLY RISKY STRATEGIC DEPENDENCIES**

Product	Top X (market share)	HHI
Mussels, prepared or preserved	Chile (99%)	0.98
Quebracho extract ✓ ✓	Argentina (96%)	0.92
Bran, sharps and other residues ✓ ✓	Argentina (93%)	0.87
Dark red, light red meranti and meranti bakau thicker than 6mm ✓	Malaysia (93%)	0.87
Pulp of fibrous cellulosic material	Philippines (85%)	0.74
Lithium carbonate	Chile (85%)	0.73
Molybdenum oxides and hydroxides ✓	Chile (80%)	0.65
Live, southern bluefin tunas (Thunnus maccoyii)	Tunisia (72%)	0.59
Iodine ✓ ✓	Chile (73%)	0.56
Coconut oil	Philippines (69%)	0.53
Fresh or chilled, southern bluefin tunas, excluding fillets	Tunisia (65%)	0.53
Copra	Argentina (70%)	0.52
Meat and edible meat offal of camels and other camelids	Chile (57%)	0.47
Chenopodium quinoa	Peru (54%)	0.44
Oil-cake and other solid residues ✓	Ukraine (61%)	0.43
Negligees, bathrobes, dressing gowns (women or girl) ✓	Tunisia (63%)	0.43
Vulcanised rubber, gloves, mittens and mitts other than surgical gloves ✓ ✓	Malaysia (63%)	0.42
Fireclay, whether or not calcined	Ukraine (55%)	0.41

Notes: The table lists the vulnerable products (identified with the EC methodology) imported from non-NATO countries with a GPR index above the median. The red and green ticks represent the products identified as vulnerable after applying the absorption (red) and stickiness (green) criteria for this same set of countries.

Source: CEPII-BACI for 2015 to 2019, Caldara and Iacoviello (2022) for the GPR index.

TABLE C4 **LIST OF HIGHLY CONCENTRATED STRATEGIC DEPENDENCIES FOR API PRODUCTS**

API	Use	Top X (market share)	HHI
Florfenicol	Pathology of farm and aquatic animals	China (99%)	0.98
Ethchlorvynol	Insomnia	Indonesia (99%)	0.98
Daprodustat ✓ ✓	Anemia in people with chronic kidney failure	India (97%)	0.94
Metharbital ✓ ✓	Epilepsy	India (97%)	0.94
Fenproporex	Obesity treatment	Israel (95%)	0.90
Alfentanil	Analgesia or as primary anesthetic agent during cardiac surgery	Switzerland (90%)	0.81
Anileridine	Moderate to severe pain	Switzerland (90%)	0.81
Bezitramide	Relieve pain	Switzerland (90%)	0.81
Bromazepam	Short-term treatment of anxiety	Switzerland (90%)	0.81
Difenoxin	Diarrhea	Switzerland (90%)	0.81
Diphenoxylate	Diarrhea	Switzerland (90%)	0.81
Dipipanone	Acute pain by mouth for adults	Switzerland (90%)	0.81
Fentanyl	Severe pain (advanced cancer pain)	Switzerland (90%)	0.81
Ketobemidone	Powerful opioid analgesic	Switzerland (90%)	0.81
Methylphenidate	Children with attention deficit hyperactivity disorder	Switzerland (90%)	0.81
Pentazocine	Moderate to severe pain	Switzerland (90%)	0.81
Pethidine	Anesthesia in invasive surgery, postoperative analgesia, and general pain relief	Switzerland (90%)	0.81
Phencyclidine	Intravenous anesthetic	Switzerland (90%)	0.81
Phenoperidine	Opiod analgesic	Switzerland (90%)	0.81
Piritramide	Postoperative pain	Switzerland (90%)	0.81
Propiram	Analgesic	Switzerland (90%)	0.81
Trimeperidine	Pain	Switzerland (90%)	0.81
Arbaclofen ✓	Spasticity related to sclerosis and improve social function and behavior in patients with fragile X syndrome	Singapore (81%)	0.67
Atagabalin ✓	Epilepsy and anxiety	Singapore (81%)	0.67
Atrimustine ✓	Lower cholesterol and triglyceride levels in the blood	Singapore (81%)	0.67
Dapabutan ✓	Antiseptic (gram-positive) bacteriostatic drug	Singapore (81%)	0.67
Dicobalt edetate ✓	Antidote to cyanide poisoning	Singapore (81%)	0.67
Eglumetad ✓	Anxiety and drug addiction	Singapore (81%)	0.67
Etofenamate ✓	Muscle and joint paint	Singapore (81%)	0.67
Imagabalin ✓	Generalized anxiety disorder	Singapore (81%)	0.67
Lisadimate ✓	Sunscreens, to absorb UV radiation	Singapore (81%)	0.67
Lumiracoxib ✓	Pain in osteoarthritis, rheumatoid arthritis, acute pain and primary dysmenorrhea	Singapore (81%)	0.67
Meradimate ✓	Sunscreens, to absorb UV radiation	Singapore (81%)	0.67
Mirogabalin ✓	Postherpetic neuralgia and painful diabetic peripheral neuropathy	Singapore (81%)	0.67
Pregabalin ✓	Epilepsy and anxiety	Singapore (81%)	0.67

API	Use	Top X (market share)	HHI
Robenacoxib ✓	Postoperative inflammation and pain in dogs and cats	Singapore (81%)	0.67
Sodium feredetate ✓	Iron deficiency anemia	Singapore (81%)	0.67
Terofenamate ✓	Muscle and joint paint	Singapore (81%)	0.67
Amfepramone ✓	Reduce feeling of hunger	Switzerland (78%)	0.66
Methadone ✓	Detoxification and maintenance of patients who are dependent on opiates and treatment of patients with chronic, severe pain	Switzerland (78%)	0.66
Normethadone ✓	Cough associated with inflamed mucosa	Switzerland (78%)	0.66
Bimatoprost ✓	Glaucoma and ocular hypertension	USA (70%)	0.52
Cobiprostone ✓	Lack of fluid secretion of the bowels	USA (70%)	0.52
Ecraprost ✓	Reperfusion injury, peripheral arterial disease, diabetic neuropathies, lipid emulsion of ecraprost	USA (70%)	0.52
Eganoprost ✓	Prostaglandines used in urology, obstetrics, and ophthalmology	USA (70%)	0.52
Latanoprostene bunod ✓	Reduction of intraocular pressure in patients with open-angle glaucoma or ocular hypertension	USA (70%)	0.52
Lubiprostone ✓	Stomach pain, bloating, and straining	USA (70%)	0.52
Nobiprostolan ✓	Male pattern baldness and hypotrichosis	USA (70%)	0.52
Posaraprost ✓	Prostaglandines used in urology, obstetrics, and ophthalmology	USA (70%)	0.52
Rivenprost ✓	Lack of bone formation	USA (70%)	0.52
Tafluprost ✓	Glaucoma and ocular hypertension	USA (70%)	0.52
Treprostinil ✓	Certain kinds of pulmonary arterial hypertension	USA (70%)	0.52

Notes: The table lists the vulnerable APIs identified after applying the EC methodology and restricting to the one with an HHI above 0.5. The red and green checks represents the APIs identified as vulnerable after applying the absorption (red) and stickiness (green) criteria.

Source: CEPII-BACI for 2015 to 2019.

TABLE C5 **LIST OF HIGHLY CONCENTRATED STRATEGIC DEPENDENCIES FOR API PRODUCTS AFTER APPLYING OUR FIVE CRITERIA METHODOLOGY, WITH A LESS RESTRICTIVE STICKINESS CRETERION**

API	Use	Top X (market share)	HHI
Daprodustat	Anemia in people with chronic kidney failure	India (97%)	0.94
Metharbital	Epilepsy	India (97%)	0.94
Arbaclofen	Spasticity related to sclerosis and improve social function and behavior in patients with fragile X syndrome	Singapore (81%)	0.67
Atagabalin	Epilepsy and anxiety	Singapore (81%)	0.67
Atrimustine	Lower cholesterol and triglyceride levels in the blood	Singapore (81%	0.67
Dapabutan	Antiseptic (gram-positive) bacteriostatic drug	Singapore (81%)	0.67
Dicobalt edetate	Antidote to cyanide poisoning	Singapore (81%)	0.67
Eglumetad	Anxiety and drug addiction	Singapore (81%)	0.67
Etofenamate	Muscle and joint paint	Singapore (81%)	0.67
Imagabalin	Generalized anxiety disorder	Singapore (81%)	0.67
Lisadimate	Sunscreens, to absorb UV radiation	Singapore (81%)	0.67
Lumiracoxib	Pain in osteoarthritis, rheumatoid arthritis, acute pain and primary dysmenorrhea	Singapore (81%)	0.67
Meradimate	Sunscreens, to absorb UV radiation	Singapore (81%)	0.67
Mirogabalin	Postherpetic neuralgia and painful diabetic peripheral neuropathy	Singapore (81%)	0.67
Pregabalin	Epilepsy and anxiety	Singapore (81%)	0.67
Robenacoxib	Postoperative inflammation and pain in dogs and cats	Singapore (81%)	0.67
Sodium feredetate	Iron deficiency anemia	Singapore (81%)	0.67
Terofenamate	Muscle and joint paint	Singapore (81%)	0.67
Fenetylline	Attention deficit hyperactivity disorder and narcolepsy	United Kingdom (39%)	0.29

Notes: The table lists the vulnerable products identified after applying our five criteria methodologyby retaining only the products after the first four criteria that have a stickiness higher than the median of the distribution in Martin et al. (2020).

Source: CEPII-BACI for 2015 to 2019.

CHAPTER 4

What if? The effects of a hard decoupling from China on the German economy[1]

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1 INTRODUCTION

Growing trade and financial integration have been a hallmark of the post-Cold War globalisation era. In the past 20 years, China's meteoric economic rise has pushed global trade interdependencies to hitherto unknown levels. Since its WTO accession in 2001, China has become the world's top manufacturer not only of final goods, but also of intermediate manufactured goods (e.g., Baldwin et al., 2023), giving the country a prominent place in global supply chains. China is the most important trading partner for about 120 countries, among them Germany, Europe's biggest economy. Germany, with its large industrial sector, in particular its large automotive and chemical manufacturing industry, has found in China an important export market that has propelled the growth of German industry. At the same time, German households and firms now import consumer goods and intermediate inputs worth close to 5% of German GDP from China.

This chapter seeks to explore the economic effects of a forced reversal of this trend in the form of a very hard decoupling between China and Germany. We study a hypothetical scenario akin to a 'Cold War 2.0', i.e., a disintegration or fragmentation of the world economy into three distinct blocs: the G7 or 'Western' economics, China and its allies, as well as neutral countries. Moreover, within this framework, we examine an extreme case:

1 This chapter was prepared for the CEPR Paris Symposium in December 2023 and is an abbreviated version of a longer paper that will be published as Baqaee et al. (2023). We thank Dave Donaldson, Beatrice Weder di Mauro, and Jeromin Zettelmeyer for useful comments. Benjamin Moll acknowledges support from the Leverhulme Trust and the European Union's Horizon 2020 research and innovation programme (grant agreement No. 865227). Feodora Teti gratefully acknowledges support received from the German Research Foundation through CRC TRR 190 (project number 280092119). Moritz Schularick gratefully acknowledges support from the German Research Foundation through his Leibniz-Prize (project number 466488674). The views expressed in this chapter are those of the authors and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

a complete cessation of trade between Germany (as well as the rest of the G7 economies and their allies) and China (and Russia). Following a hard decoupling, international trade will be entirely reoriented towards trade within the two rival blocs and between the two blocs and the neutral countries.

We are aware of the hypothetical and extreme nature of a scenario where trade between the two 'cold war' blocs falls to zero, but the insights gained from this analysis offer valuable perspectives on the economic forces at play. Moreover, by examining such an extreme scenario, we aim to delineate the boundaries of possible outcomes and provide a worst-case perspective on the issue. We do not speculate on what events might trigger such a hard decoupling, nor do we take a stance that this is a likely or desirable outcome.

The insights derived in this chapter will come from a recent model of the global economy with many countries, sectors, and complex international production networks. This model is the Baqaee and Farhi (2021) model, which demonstrated its usefulness last year when it was used to gauge the impact of an end of Russian gas supplies to Germany (Bachmann et al., 2022; Moll et al., 2023). In our setup, the model features 43 countries in the three blocs: a bloc of G7 countries and their allies and a Chinese bloc, as well as a 'rest of the world' bloc that belongs to neither. There are 56 sectors with production interlinkages across sectors and countries. These production interdependencies are disciplined with empirical input-output matrices from the World Input-Output Database (Timmer et al., 2015).

Our main focus is on the economic costs to Germany measured by the fall in gross national expenditure (GNE), which is the welfare-relevant quantity in many macroeconomic and trade models including the Baqaee-Farhi model. GNE, also known as 'domestic absorption', is the economy's total expenditure defined as the sum of household expenditure, government expenditure and investment, that is, $GNE = C + I + G$ in the GDP accounting identity $GDP = C + I + G + X - M$. One reason for focusing on GNE rather than GDP is that GDP may not pick up terms-of-trade effects that arise following a trade shock like the decoupling scenario we consider. While GNE differs conceptually from GDP, for an economy like Germany's, its total value is similar to the more familiar GDP quantity.[2]

Our first key result is that in the event of an abrupt 'cold turkey' decoupling scenario, Germany is likely to experience a GNE loss of approximately 5% on impact in the first few months and 4% over the horizon of one year. The Baqaee and Farhi (2021) model does not incorporate standard short-run business cycle amplification effects, such as Keynesian aggregate demand amplification in the presence of nominal rigidities, so

2 For example, in 2022, German GNE was around C3.79 trillion (see https://data.worldbank.org/ indicator/NE.DAB.TOTL.CN?locations=DE), which was around 98% of GDP.

the corresponding economic costs need to be added on top.[3] With more time to adjust, for instance over a time horizon of three years during which trade and production are reorganised, the decoupling cost would drop to around 2%. In the long run, the German welfare loss from no longer being able to trade with China would be about 1.5% of GNE. From a macroeconomic standpoint, these are severe costs, reflecting China's importance in German and global trade. In the short run, they compare to the GDP falls witnessed in the global financial crisis and during the COVID-19 pandemic. Moreover, part of the costs would be permanent, i.e., German welfare would be lower in every single year going forward. At the same time, while severe, these costs are not devastating and could be managed with appropriate policy (and crises of similar magnitudes have been successfully managed in the past).

It is also clear that for such large changes in the economy's input mix of the type that we are concerned with, natural experiments are rare and uncertainty about the right parameter choices is substantial. It seems plausible to assume, however, that the relevant elasticities of substitution, in particular so-called trade elasticities, are larger in the medium and long run and smaller in the very short run (the 'le Chatelier principle'; see for example Samuelson, 1947, 1983; Milgrom and Roberts, 1996).[4] This time dependence of the elasticities implies that the size of economic losses stemming from a sharp reduction in trade with China depends crucially on the time frame over which adjustments take place and is the key to why our model predicts smaller economic costs in the long run than in the short run.

The same time dependence also has a second key implication: a more gradual decoupling in which the trade cut-off occurs over a time horizon of several years leads to considerably smaller overall costs than a 'cold turkey' decoupling scenario because it avoids the most extreme short-run losses. We illustrate this point with a simple illustrative example in which a full decoupling occurs gradually over a time horizon of three years. The logic is that, in this gradual decoupling scenario, the lowest elasticities that are relevant in the very short run (over the first few months) only apply to a partial trade cut-off (say, a cut in trade flows by 5%) rather than to the full cut-off as they do in the abrupt 'cold turkey' scenario. A related implication is that if, along this gradual decoupling trajectory, an abrupt and full decoupling becomes suddenly dictated by geopolitical events, the economic costs are lower than if firms and households had not started to adjust beforehand.

3 See the discussion in Section 4.2. While quantifying these additional short-run amplification effects is beyond the scope of this chapter, the 2022 Russian gas cut-off again provides some guidance: analyses using HANK models to quantify these effects increased the cost estimates relative to the analysis from flexible-price models like ours by around 30% (Bayer et al., 2022, 2023; Pieroni, 2023; see also the discussion in Section 4.2) and we are not aware of empirical evidence suggesting higher amplifications effects during this episode. While one cannot simply 'transport' such an amplification factor from one model/model simulation to another, a 30% higher short run cost would be 6.5% over the first few months and 5.2% over the first year.

4 Past experience has shown that the concept of an 'elasticity' is frequently misunderstood by non-economists in the popular debate. For clarity, 'elasticity' is the technical term for a particular model parameter that is distinct from the colloquial use of the term (i.e., meaning ability to stretch). For example, the 'elasticity of substitution' of a production function is a model parameter that governs how substitutable different factors of production are with each other. It is thus incorrect to make statements like "economists assume that markets are elastic" or "the question is whether there is elasticity".

Note that irrespective of whether decoupling is gradual or abrupt and of the elasticities in the model, the scenarios under investigation remain extreme ones: a total decoupling between the 'West' and China bringing trade between the two blocs to zero. We are not modelling a 'small yard, high fence' de-risking (Sullivan, 2023), but a radical 'big yard, high fence' decoupling. By implication, the economic costs of sectoral de-risking policies are likely to be considerably smaller, particularly when introduced gradually. Nevertheless, gradual de-risking policies in critical sectors could likely reduce the costs of a possible subsequent hard decoupling.[5] The logic is the same as before: in these sectors, a gradual reduction in trade flows would reduce interdependence with China but with the lowest elasticities only applying to a partial trade cut-off, thereby avoiding the largest losses. At the same time, the losses from a subsequent hard decoupling would be lower than if no adjustment had occurred because of reduced interdependence in the most critical sectors.

Taken together, our findings provide a rationale for Western countries to embark on a gradual de-risking trajectory rather than waiting for a much more costly 'cold turkey' decoupling dictated by geopolitical events. As noted by Spillner and Wolff (2023), there is often a wide gap between political rhetoric and observed policies and actions by firms.

The logic of our model suggests that the economic costs may ultimately be lower if policymakers start taking systematic actions towards lowering dependence on China now and do so in a targeted way. One can view the relatively low economic costs of gradual de-risking as an insurance premium paid to insure against the possibility of large losses and potential political backlash associated with a hard 'cold turkey' decoupling.

In this chapter, we provide a rigorous academic foundation for the debate on the potential economic repercussions of geopolitical and security policy choices if they arise, for instance, in the context of a conflict over Taiwan. In 2022, the debate on Germany's dependence on Russian gas and the economic costs of the end of Russian gas supplies showed that interest groups become powerful players in real-time decision-making processes when uncertainty is high (Moll et al., 2023). That is why this chapter aims to explore the key issues ex ante, without political decisions being imminent at this point in time. Taking a proactive approach can help to prepare policymakers in Germany and Europe to weigh policy options ahead of time. As in the case of the Russian gas study last year, we will discipline our model simulations with the best available empirical estimates of key parameters and openly discuss the key assumptions and influential modelling choices.

5 To be clear, and as discussed in Section 3.6, we have not conducted any simulations to capture such sectoral de-risking scenarios; in this part of the chapter, we are just thinking through the logic of the model and taking it to its logical conclusion. But we want to be clear that we are unable to make any quantitative statements about the relative costs and benefits of de-risking scenarios at this point.

The model features various elasticities of substitution that determine the costs of a decoupling such as cross-sectoral elasticities for final and intermediate goods, and between capital and labour. Importantly, the model features a trade elasticity that determines substitution within each sector across goods from different origins. In line with the importance of this elasticity in the trade literature (e.g., Arkolakis et al., 2012), assumptions about the trade elasticity have the largest impact on our cost estimates. The question here is to what extent trade with other countries can serve as an insurance against a disruption of trade with China – and how quickly trade can be reoriented to other countries. If this elasticity is low, it is hard to find alternatives for Chinese goods and the welfare loss of cutting the trade link with China is high. If the elasticity is higher, substitution is easier and welfare costs are much lower.

As in the case of the 2022 cut-off from Russian gas, we would expect the economic costs of a China decoupling scenario to be highly heterogeneous across industries, regions within Germany, and individual companies. So-called 'cascading effects' along the supply chain did not materialise in the case of the Russian gas cut-off (Moll et al., 2023). In the Chinese case, too, we would expect individual sectors to be heavily affected, but this would not drag down the rest of the economy. We would expect individual companies to pay a higher cost from decoupling but without widespread losses across the rest of the economy.

A more systematic analysis of many of the ideas discussed in this chapter will ultimately be published in a longer companion paper (Baqaee et al., 2023). While this more systematic analysis is still work in progress, we present here those results from this other analysis that we view as robust, such as the dependence of the economic cost on the time horizon.

This chapter is organised as follows. Section 2 takes a first look at the data, describing China's importance in German imports and exports. Section 3 introduces the model and its calibration with an emphasis on trade elasticity estimates. It then presents the results from a simulation in which the effects of a decoupling are quantified and contrasts the economic costs of an abrupt 'cold turkey' decoupling with those of a more gradual decoupling scenario. We discuss caveats in Section 4, before concluding in Section 5.

2 TRADE BETWEEN CHINA AND GERMANY

In 2022 – roughly four decades after the beginning of economic opening – China's GDP accounted for 18.5% of the world's total, making it the largest economy in purchasing power parities and the second largest at market exchange rates (IMF, 2023). China's share of global trade has increased dramatically since its WTO accession in 2001, and by 2019 it had become the world's largest exporter and second-largest importer (WTO, 2023). The country's large consumer market and its manufacturing industries have increasingly become the workbench of the global economy, deeply integrated into global production

networks. At the same time, the build-up of China's industries and the construction boom have fuelled economic growth for its trading partners, not least capital goods-exporting economies such as Germany. The rise of China as a global economic superpower has been an important driver of Germany's exports in the past two decades.

Germany and the People's Republic of China established diplomatic relations in 1972. Since the economic reforms initiated by Deng Xiaoping, German trade and investment flows have grown substantially. Germany's exports to China have grown from €1.5 billion in 1990 to around €100 billion in 2022, while its imports from China have grown from little more than €1 billion in 1990 to close to €200 billion in 2022 (Destatis, 2022). In 2022, China was Germany's largest trading partner overall, and its largest import partner and one of the top-five export markets (Destatis, 2022).

2.1 Imports

In 2019, the last year before the pandemic, China's share in German imports was 7.15%.[6] Taking into account that the share of imports in GNE is 32.02% – roughly one third of German income is spent on imported goods – the overall share of imports from China in GNE is about 2.3%.[7] While this is clearly still a macroeconomically relevant number, it is important to see it in the broader context of the size of the German economy.[8]

Table 1 shows that China's share in imports varies significantly across different groups of products (second column) and that the overall importance of products for the German economy in turn also varies greatly (third column). The groups of products in Table 1 are sections drawn from the so Harmonized System, the international standard of names and numbers for the classification of traded goods. The highest Chinese import share can be found in the category "Raw Hides, Skins, Leather, & Furs", yet overall imports in this category only make up 0.15% of Germany's total expenditure.

The sector with the highest share of trade in total expenditure, as well as imports from China in terms of GNE, is "Machinery and Electrical goods" at 8.2% of German GNE and an import share from China of about 14%, resulting in total German expenditures in this category of 1.14% of GNE. Note that this perspective does not allow us to say how easy it would be to substitute these products. Moreover, we will look in greater detail at imports of individual categories of imported metals in Section 4.1, as some imported goods, while having a small share in GNE, may be particularly hard to substitute and an important input for German production.

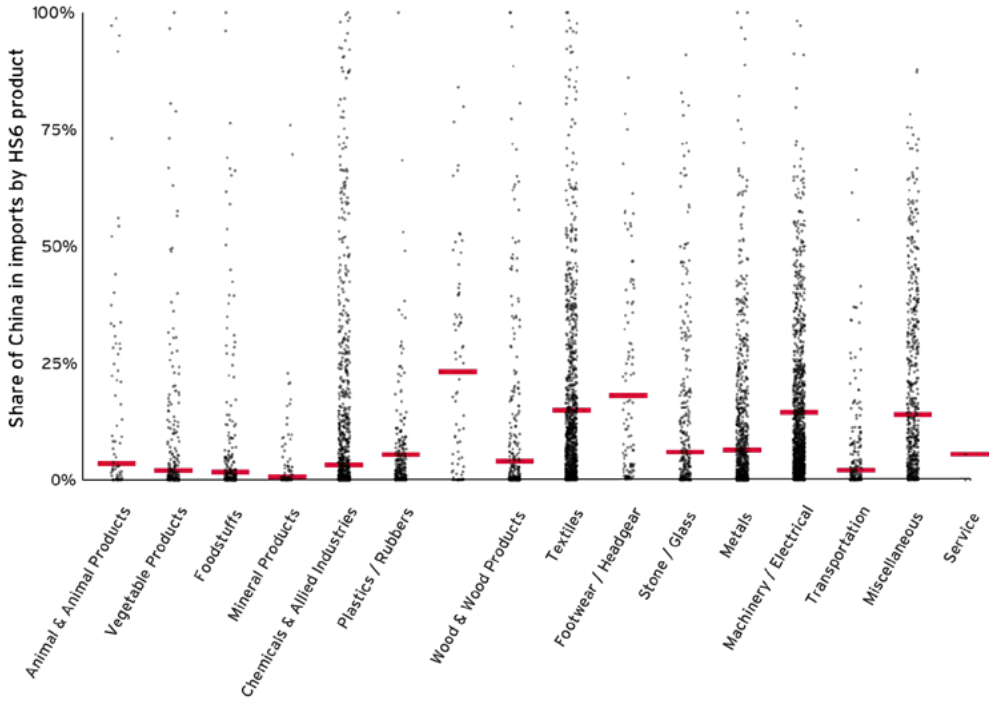
6 Data from the Eurostat Comext database.
7 Data on GNE are taken from the World Bank national accounts data, indicator NE.DAB.TOTL.CN.
8 See also Figure 9 in the appendix, which shows that the share of imports from China in German GNE has been remarkably stable since about 2010.

TABLE 1 **SHARE OF CHINA IN GERMAN IMPORTS IN GROSS NATIONAL EXPENDITURE**

Sector	Share of China in total sector trade (%)	Share of total sector trade in GNE (%)	Share in GNE (%)
Animal & Animal Products	3.01	0.67	0.02
Vegetable Products	1.46	1.08	0.02
Foodstuffs	1.11	1.09	0.01
Mineral Products	0.11	2.46	0.00
Chemicals & Allied Industries	2.73	3.98	0.11
Plastics / Rubbers	4.90	1.62	0.08
Raw Hides, Skins, Leather, & Furs	22.65	0.15	0.03
Wood & Wood Products	3.48	0.82	0.03
Textiles	14.34	1.41	0.20
Footwear / Headgear	17.52	0.40	0.07
Stone / Glass	5.45	0.81	0.04
Metals	5.92	2.59	0.15
Machinery / Electrical	13.94	8.20	1.14
Transportation	1.56	4.30	0.07
Miscellaneous	13.46	2.18	0.29
Service	4.98	0.26	0.01
Total	**7.15**	**32.02**	**2.29**

Figure 1 disaggregates the sectors further, with each dot representing a single product group and the red bars denoting weighted averages and thus corresponding to the numbers in the second column in Table 1. For some products, China's share in imports reaches close to 100%, while for most imported goods the share is much more modest.

FIGURE 1 **SHARE OF CHINA IN GERMAN IMPORTS BY HS SECTION AND HS8 CODE IN 2019**



2.2 Exports

The picture on the export side broadly mirrors that of the import side. Table 2 reports the equivalent breakdown of the share of China in a sector's trade flows, the sector's importance in the overall economy, and the combination of both – China's economic importance in a given sector for the German economy as a whole. Note that we use the same denominator GNE to scale exports for direct comparability to the numbers above.[9]

The overall share of exports to China in total exports stood at roughly 6.7% in 2019, which translates to 2.56% of Germany's GNE. The sectoral composition is somewhat different than on the import side. The most important sectors are "Machinery and Electrical goods", followed by "Transportation" – notably driven by the German car industry – as well as "Chemicals and Allied Industries." China is an important export market for products in these sectors, with up to almost 10% of each total sector exports. But here, too, it is important to note that the smaller shares of these sectors in the overall German economy lead to a smaller macroeconomic footprint. Even for the large automotive and chemical industries, exports to China account for less than 1% of GNE (or GDP), and slightly above 1% for the machinery and electrical goods producing sector.[10]

9 As noted above, in the case of Germany using the actually more applicable indicator of production, GDP, would yield very similar numbers.

10 See Figure 10 in the appendix for the breakdown by product. Again, there is large heterogeneity within individual sectors, but for a very few products the Chinese market accounts for 100% of exports.

TABLE 2 **SHARE OF CHINA IN GERMAN EXPORTS IN GROSS NATIONAL EXPENDITURE**

Sector	Share of China in total sector trade (%)	Share of total sector trade in GNE (%)	Share in GNE (%)
Animal & Animal Products	7.56	0.64	0.05
Vegetable Products	0.54	0.45	0.00
Foodstuffs	1.63	1.17	0.02
Mineral Products	1.03	0.64	0.01
Chemicals & Allied Industries	4.51	5.27	0.24
Plastics / Rubbers	4.31	2.24	0.10
Raw Hides, Skins, Leather, & Furs	3.02	0.10	0.00
Wood & Wood Products	2.93	0.96	0.03
Textiles	1.46	1.06	0.02
Footwear / Headgear	0.44	0.27	0.00
Stone / Glass	3.64	0.91	0.03
Metals	4.53	2.88	0.13
Machinery / Electrical	9.60	11.33	1.09
Transportation	8.39	6.98	0.59
Miscellaneous	8.62	2.99	0.26
Service	2.68	0.20	0.01
Total	**6.72**	**38.08**	**2.56**

As this first look at German-Chinese trade relations shows, there is no doubt that China is a key trading partner for Germany. However, the magnitude of both exports to and imports from China is surprisingly small relative to the size of the German economy. German companies and households bought final and intermediate goods from China equal to 2.3% of total expenditures. Even in the automotive and chemical industries, German exports to China constitute less than 1% of GNE, and about 2.6% in total. The question we address in the following with the help of a quantitative model is what economic effects a hard decoupling, i.e., bringing both imports and exports from China to zero, would entail.

3 MODEL SIMULATION

In this section, we provide a high-level overview of our quantitative model, a description of how we calibrate the model, and the simulation results showing the economic consequences of a hard decoupling of the German economy from China within the context of a fragmentation of the world economy into three blocs.

3.1 Description of the model

Our quantitative results use the model of the world economy in Baqaee and Farhi (2021). We use this multi-sector model to conduct counterfactual simulations of the macroeconomic effects of cutting trade ties with China.

The Baqaee-Farhi model is a multi-sector model with rich input-output linkages. Each producer in each country combines local labour and capital with materials to produce. Materials are purchased from other sectors in the economy, and each sector in each country can source its materials from different countries. Households in each country earn income from local labour and capital, which they use to purchase final consumption goods. In response to the trade disruption, we assume that prices in each market adjust to equate supply and demand.

The model is designed to address questions in which supply chains or production networks play a key role, specifically how a shock to an upstream product propagates downstream along the supply chain. In our set-up the model features 43 countries in three blocs: a block of G7 countries and their allies, a Chinese bloc, as well as a neutral bloc with countries that belong to neither. Each country has 56 sectors with production interlinkages across sectors and countries. These production interdependencies are disciplined with empirical input-output matrices from the World Input-Output Database (Timmer et al., 2015). Each entry of the World Input-Output matrix represents a country-sector pair, for example, how much each sector in Germany spends on inputs from each sector in China.

To calculate the consequences of decoupling, we must make a key assumption about the substitutability between different intermediate inputs in the production process, in particular between imports from China and other inputs. This degree of substitutability is disciplined by various elasticities of substitution. The model features a nested constant elasticity of substitution (CES) structure. Besides the input-output matrices, the key parameters of the model are the elasticities of substitution: σ is the elasticity of substitution across sectors for final goods (56 sectors); θ is the elasticity of substitution across value-added (labour and capital) and intermediate inputs; γ is the elasticity of substitution between labour and capital; and η is the elasticity of substitution across intermediate input sectors. Finally, there is a trade elasticity ε that determines substitutability, within each sector, across goods from differing origins. [11]

The degree to which these elasticities matter depends also on the ease of reallocation of resources in the economy. A low elasticity of substitution is less of a problem if resources can be reallocated to reinforce weak links and maintain production in other sectors.

11 The elasticity of substitution between goods from a given industry across different origin countries is $\varepsilon + 1$. We refer to ε as the trade elasticity, as in the literature (e.g., Costinot and Rodriguez-Clare, 2014). Whereas Baqaee and Farhi (2021) allow the trade elasticity to vary across sectors, we assume that it is identical across sectors and experiment with different values. That is, using the notation of Baqaee and Farhi's Appendix M, we impose that the sectoral elasticities of substitution $\theta_i = \varepsilon + 1$ for all sectors i.

For large changes in the economy's input mix of the type that we are concerned with, there is a considerable degree of uncertainty. It seems plausible to assume, however, that the elasticity of substitution is larger in the medium and long run, and smaller in the very short run (the 'le Chatelier principle'; see for example Samuelson, 1947; Milgrom and Roberts, 1996). The size of economic losses stemming from a sharp reduction in trade with China therefore depends crucially on the time frame over which adjustments take place.

Most of our results focus on economic costs of China decoupling scenarios as measured by the fall in gross national expenditure. GNE, also known as 'domestic absorption', is the economy's total expenditure defined as the sum of household expenditure, government expenditure and investment, and is the welfare-relevant quantity in many macroeconomic and trade models including the Baqaee-Farhi model. One reason for focusing on GNE rather than GDP is that GDP may not pick up the terms-of-trade effect through which German consumers become poorer when the price of imported goods rises (e.g., Obstfeld and Rogoff, 1995; Mendoza, 1995).[12]

3.2 Trade elasticity

One key parameter for the magnitude of the welfare shocks of decoupling is the trade elasticity ε. This describes how strongly trade flows react to trade cost changes and is linked to the substitutability of goods from different origins. If this elasticity is low in absolute magnitude, it is hard to find alternatives for Chinese goods that are no longer available and the welfare loss of cutting the trade link with China is high. If the elasticity is higher, substitution is easier and welfare costs are lower (for an in-depth description of how the trade elasticity is key to the quantification of gains from trade, see Arkolakis et al., 2012).

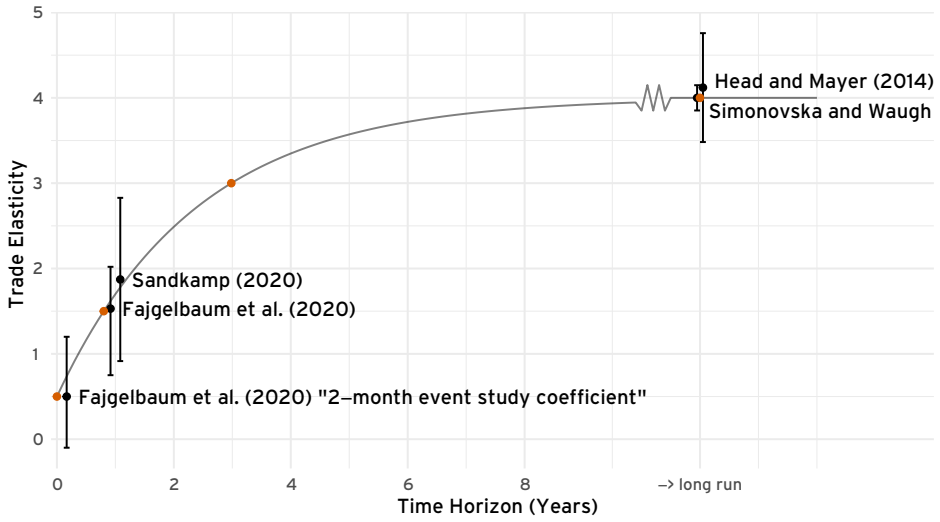
To simulate the impact of de-risking from China on the German economy, ideally we would like to have estimates of an increase in trade costs between China and Germany on trade flows using plausibly exogenous variation for different time horizons, which unfortunately are not available. For the short run, we can draw from recent developments in the literature: Fajgelbaum et al. (2020) find a trade elasticity of 1.5 using the Trump tariffs on China as well as on other trade partners.[13] This number captures the effects over a time horizon of six months to one year. The event-study results of Fajgelbaum

12 Theoretically, the effect is easiest to see in a small open endowment economy with an exogenously given relative price of exports to imports p (which is the country's terms of trade). Real GDP is given by the endowment and therefore not affected by fluctuations in the terms of trade p. However, consumption and welfare decline when the terms of trade p declines, an effect not picked up by real GDP.

13 Fajgelbaum et al. (2020) report –2.5 for $-\sigma$ for the variety-level import response to import tariffs across different countries. Hence, the trade elasticity is $\varepsilon = \sigma - 1 = 1.5$. Sandkamp (2020) finds estimates in a similar ballpark using plausibly exogenous variation as the analysis focuses on the effect on trade between China and the new member states that inherited the European Union's anti-dumping regime when acceding the Union in 2004.

et al. (2020) suggest coefficients that are half as large in the very short run. To be extra conservative, we assume the trade elasticity in the first few months after the shock to be equal 0.5, rising to 1.5 over the horizon of one year and to 3 over three years, as shown in Figure 2.

FIGURE 2 **TRADE ELASTICITY ESTIMATES FROM LITERATURE FOR DIFFERENT TIME HORIZONS**



Notes: The figure summarises estimates of the trade elasticity ε. Some papers in the literature do not directly report estimates of ε in which case we convert these estimates to ε. See the text for detail. As expected from the le Chatelier principle, the trade elasticity increases with the time horizon.

For the long run, we choose a trade elasticity of 4, as suggested by Simonovska and Waugh (2014), as the benchmark value, which is also in line with the results of the meta-analysis performed by Head and Mayer (2014) where they report mean and median estimates in the range of 3 to 5. An earlier survey by Anderson and van Wincoop (2004) reports estimates in the literature ranging from 5 to 10. This is also the range that Arkolakis et al. (2012) use in their quantifications. Hence, our choice of the long-run trade elasticity is at the conservative end in the sense that it will generate higher estimates of welfare losses.

Figure 2 summarises the trade elasticity estimates from the literature and how these vary with the time horizon. The figure includes 95% confidence intervals reported in the corresponding papers to illustrate the statistical uncertainty inherent in these estimates. The black solid line fits an illustrative curve through these estimates to construct a mapping from time horizon to trade elasticity. The red dots on the line are the trade elasticities we will use in our main simulation results with values ranging from 0.5 to 4.[14]

14 As can be seen in the figure, there is scant empirical evidence on trade elasticities for intermediate time horizons above two years, which means that alternative mappings from time horizon to elasticities are possible as well. In particular, the trade elasticity may converge to its long-run value more slowly, perhaps reaching $\varepsilon = 3$ after five years rather than three years. As is evident from Figures 3 and 6, this would not affect our main results much.

In addition to the lowest realistic value used here, we also report results for extremely low trade elasticities of 0.1 and 0.25. We are unaware of any empirical foundation for such low values, but they might still serve a useful purpose as a defence against possible 'this time is different' arguments. We will see that such extremely low hypothetical trade elasticities aggravate the costs by another 1 percentage point, but they do not lead to extreme losses.

3.3 Data sources and key parameters

As mentioned above, the model is disciplined by the most recent version of the World Input-Output Database (the 2016 release). It includes information on final goods expenditure, intermediate goods expenditure, value-added, and factor income for 43 countries and 56 sectors from the year 2000 to 2014. We designate the year 2014 as the steady state of the model and calibrate the shares of final expenditure, intermediate input, value-added, and factors for each country. These calibrated shares serve as inputs to calculate the standard form input-output matrix, following the methodology outlined in Baqaee and Farhi (2021). Subsequently, this matrix is reordered and aggregated based on the country blocs described below.

It is worth noting that an empirically disciplined multi-sector model like the Baqaee-Farhi model reflects an important feature of modern advanced economies: manufacturing typically accounts for a moderate share of aggregate economic activity. This is true even for Germany, which is often viewed as an industrial powerhouse: German manufacturing accounts for 'only' about 23% of total employment and 25% of value added. This is a natural consequence of the structural transformation process during which manufacturing activity is replaced by the service sector. Put differently, some observers seem to be under the mistaken impression that the structure of the German economy is still that of earlier time periods like the 1970s.

All 43 countries are categorised into three blocs: Friends, Rivals, and Neutrals. The Friends bloc includes the G7 countries (Canada, Germany, France, the United Kingdom, Italy, Japan, and the United States), two large economies in the European Union (Spain and the Netherlands), and one composite country that aggregates the remaining 22 EU countries in the sample. This totals ten countries, representing 54% of world GDP in 2014. The Rivals bloc comprises China and Russia, accounting for 15% of world GDP.[15] Finally, the Neutrals bloc comprises the remaining 11 countries in the sample, including the 'rest of the world' as one composite country. We set the elasticities of substitution to $(\sigma, \theta, \gamma, \eta) = (0.9, 0.5, 1, 0.2)$, following the literature in Baqaee and Farhi (2021) and Atalay (2017), but test the robustness of our key results to more extreme parameters, specifically $(\sigma, \theta, \gamma, \eta) = (0.01, 0.01, 0.01, 0.01)$.

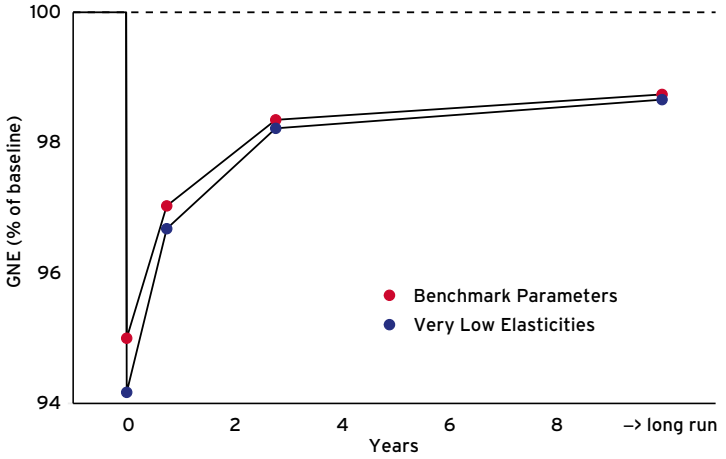
15 Note that in 2022 the Rivals bloc's share in world GDP stood at about 22%. With roughly similar import shares in GNE between 2014 and 2022 for Western countries, this has likely a limited impact on the simulation results.

TABLE 3 **'COLD TURKEY' DECOUPLING: GROSS NATIONAL EXPENDITURE CHANGE FOR DIFFERENT TRADE ELASTICITIES**

Trade elasticity	Benchmark parameters	Very low elasticities
$\varepsilon = 0.5$	–5.00%	–5.83%
$\varepsilon = 1.5$	–2.97%	–3.32%
$\varepsilon = 3$	–1.65%	–1.78%
$\varepsilon = 4$	–1.26%	–1.34%
$\varepsilon = 0.1$	–5.92%	–6.15%
$\varepsilon = 0.25$	–5.62%	–6.38%

Note: The table reports simulation results from the Baqaee and Farhi (2021) model for the economic costs to Germany of a cold turkey decoupling scenario (as described in the text) for different values of the trade elasticity ε. The first column, labelled "Benchmark parameters", uses the benchmark values for the model's other elasticities from Baqaee and Farhi (2021), whereas the column labelled "Very Low Elasticities" uses the extreme paramterisation described in Section 3.3 to probe robustness.

FIGURE 3 **COLD TURKEY DECOUPLING OVER TIME**



Notes: Figure uses the mapping from time horizon to trade elasticities in Figure 2 to provide an illustration of the likely time path of such a decoupling scenario. Because the trade elasticity increases with the time horizon (the le Chatelier principle), the economic costs decrease with time.

3.4 Key results

In all simulations, we assume prohibitively high trade costs between members of the Friends bloc and members of the Rivals bloc, so that trade flows between the two blocs drop to zero. Other trade costs are left unaltered and trade flows within the blocs, as well as with the Neutral bloc, will endogenously adjust.[16]

16 Note that since the Russian invasion of Ukraine, Western countries have already significantly decreased their imports from Russia. The results below are thus conservative, assuming a decoupling – even partial – has not yet occurred.

Table 3 summarises the German welfare losses in response to the full decoupling for a range of long-run to extremely short-run trade elasticities, which we will now discuss in turn in detail.

As discussed in Section 3.3, plausible magnitudes of the trade elasticity crucially depend on the time horizon considered. By running our simulation with different short-run and long-run elasticities, we obtain estimates for the welfare effects over different horizons.

We begin with an extremely low trade elasticity of 0.5 for the very short run, which is even lower than the elasticity that empirical studies found over two-month horizons in the case of the Trump tariffs (Fajgelbaum et al., 2020). We consider this a conservative value even in the very short run over the period of one quarter. In this case, the German welfare loss amounts to 5.0%, rising to 5.8% if we also set the other elasticities in the model to very low levels. Lowering the trade elasticity even further to 0.25 (and hence the time frame of our consideration to the extreme short run) only adds comparatively minor additional welfare losses and puts the total loss at 5.6%. Finally, we consider an extreme case in which we put the trade elasticity close to zero, specifically to 0.1. We do not consider this value to be a realistic one even in the very short run, but see it as a useful worst-case scenario to put an upper bound on the welfare losses. Even such an extreme value does not substantially change the welfare loss estimate: it rises by an additional 0.3 percentage points to -5.9%.

Over the important horizon of one year, we consider an elasticity of 1.5 as conservative. In this case, the German welfare loss of decoupling amounts to 3–4% depending on the other parameters. Compared to other countries, this is at the high end of damages in the Friends bloc, but below the losses experienced by China (4.8%) and Russia (12.3%). It is important to stress that in any scenario we study, the losses are larger for China and its allies.

Figure 3 summarises these model simulations for different trade elasticities and shows the economic costs of a decoupling scenario over time. As already mentioned, a key idea in economics is that elasticities increase with the time horizon (the le Chatelier principle). As illustrated in Figure 2, this also applies to trade elasticities which increase substantially over time. We can use this idea to convert the results in Table 3 into the time dimension and trace out the economic costs for Germany of a 'cold turkey' decoupling from China over time. In the very short run, when the trade elasticity is low, German GNE drops by around 5% in the first few months and by 3–4% in the first year, with business cycle amplification effects coming on top.

For the new long-run steady-state results, which characterises a world with three blocs, we assume a trade elasticity of four. As the trade elasticity increases, the economic costs become more muted before settling at a permanent GNE loss. We estimate a permanent welfare loss of 1.26% in response to both losing access to an export market and the opportunity to source any products from the Rivals bloc. This is at the high end of the losses incurred by Friends countries, as Germany is particularly strongly integrated with

the Rivals bloc. In Europe, only the Netherlands experiences a loss of larger magnitude, while the losses of all the other European countries range between 0.47% and 0.69%. The North American Friends countries lose 0.51% (United States) and 0.86% (Canada). The only other country in the Friends bloc with losses of the same magnitude as Germany in this scenario is Japan (1.24% loss) due to its proximity to and resulting strong pre-shock integration with China. While our focus is on the effects in Germany specifically and the Friends countries more generally, it is worth noting that China and Russia are affected much more severely and face welfare losses of 2.05% and 4.94% in the long run, and up to 7.8% and 21.5% in the short run, respectively. The higher welfare losses for the Rivals bloc are intuitive, as a much larger share of their international trade relations is affected due to the large economic size of the Friends bloc.

Figures 4 and 5 illustrate the global trade adjustments in the long run. Initially, the largest share of international trade takes place within the Friends bloc (see Figure 4), followed by trade between the Friends and the Neutrals blocs. As the Rivals bloc is the smallest of the three, trade flows between Friends and Rivals are also of a smaller magnitude: Friends export seven to eight times more to other Friends than to Rivals, and import almost five times more from other Friends than from Rivals. Nevertheless, at about 2.5% of global GDP, total trade between the Friends and Rivals blocs is non-negligible. As expected, in response to the decoupling (see Figure 5), the largest change happens to trade between Trade and Rivals, which drops to zero. Both Friends and Rivals react by increasing trade within their blocs. They also both trade more with the Neutrals bloc, though in an asymmetric fashion, with Friends increasing imports and lowering exports and Rivals lowering imports and increasing exports. This asymmetry reflects the initial trade imbalance between the Friends and Rivals blocs. Prior to decoupling, Friends import more from Rivals than they export to Rivals. Hence, in response to the shock, Friends primarily look for new partners to source from, while Rivals primarily look for new markets to serve.

FIGURE 4 **TRADE FLOWS AMONG FRIENDS, RIVALS, AND NEUTRALS (% OF GLOBAL GDP)**

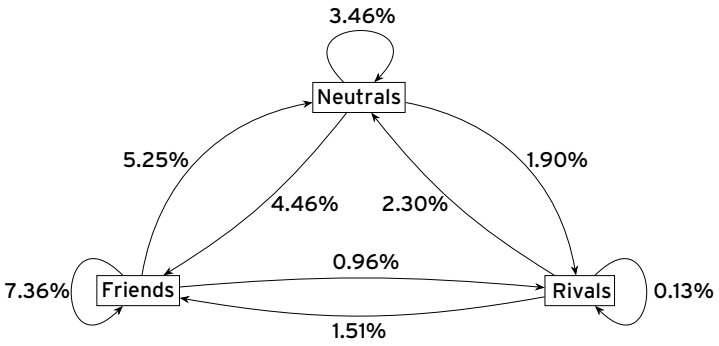
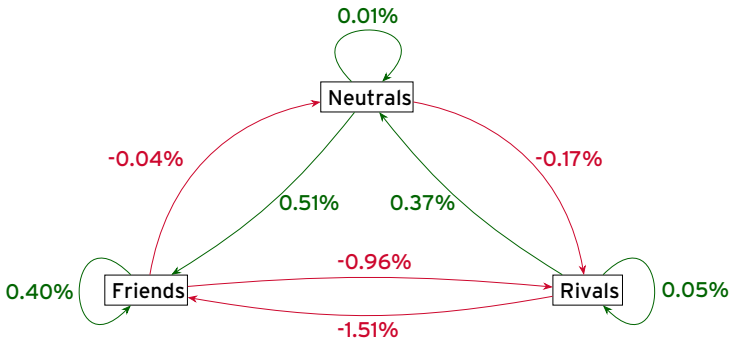


FIGURE 5 **CHANGE IN TRADE FLOWS AMONG FRIENDS, RIVALS, AND NEUTRALS (% OF GLOBAL GDP)**



To gain further insight into the welfare effects, we make use of a decomposition proposed by Baqaee and Farhi (2021), who decompose the total welfare change into a 'technology effect' and a 'reallocation effect'. The former isolates the welfare effects due to the changes in imported materials while otherwise keeping the allocation in the economy constant, while the latter quantifies the effects of reallocating productive resources across producers for given technology and imported materials. The reallocation effect hence captures whether the factoral terms-of-trade change in or against the country's favour. We find that the technology effect (-0.96%) explains about three quarters of the overall welfare loss and the reallocation effect (-0.30%) contributes the remaining quarter.

3.5 Discussion of magnitude

Our simulation results suggest that German welfare costs of decoupling fall in the range of 1.3% in the long run and potentially up to more than 5% in the very short run. The numbers beg the question: are these large welfare costs?

Since World Warr II, the German economy has shrunk in only eight years (1967, 1975, 1982, 1993, 2002, 2003, 2009, 2020) (German Council of Economic Experts 2023).[17] In all these cases except the two most recent ones, GDP dropped by 1% (1993) or less (all other cases). Hence, even our lower, long-run estimate implies losses that are greater than in the third-strongest recession the Federal Republic of Germany has ever gone through. These are severe costs. Also, unlike typical business cycle movements, a decoupling from China implies a permanent downward shift of welfare.

17 It is also projected to shrink slightly in 2023 (European Commission, 2023).

Our estimated welfare loss over the horizon of one year of 3–4% is of a similar magnitude to the COVID recession of 2020 (-3.7%). For comparison, Dhingra and Sampson (2022), in their survey article on Brexit, conclude that in the three years from the referendum up to 2019, Brexit reduced British GDP by 2-3%. As this is also a medium-run assessment, our results suggest that the economic effects of a China decoupling in Germany may be of comparable magnitude to the economic effects of Brexit in the UK.

Finally, in the very short run, the low trade elasticity consideration leads to a welfare loss (-5% to -5.9%) in the first few months that is roughly as strong as in the deepest recession Germany has experienced on an annual basis, namely, the Great Recession induced by the Global Financial Crisis in 2008/09 (-5.7%). A hard decoupling of China would likely lead to a deep recession comparable to the experience in 2008/09.

The scenario under investigation is a specific case of deglobalisation. To gauge how the magnitude of the China decoupling scenario compares to even more extreme cases of deglobalisation for Germany, we additionally simulate scenarios in which the EU member states cut trade ties with all non-EU partners. The long-run German welfare effect of a full European decoupling from the world economy is a much more severe loss of 9.0%. We also consider the most extreme deglobalisation scenario possible for Germany, namely, full autarky of the country. This would lead to a welfare loss of 31.8% for Germany even in the long-run case with a high trade elasticity. These numbers indicate that deglobalisation and cutting European and German trade links to other partners could indeed lead to catastrophic outcomes for Germany according to our quantitative model. Cutting 'only' those links to China and its allies, however, is not sufficient for such truly catastrophic costs to materialise.

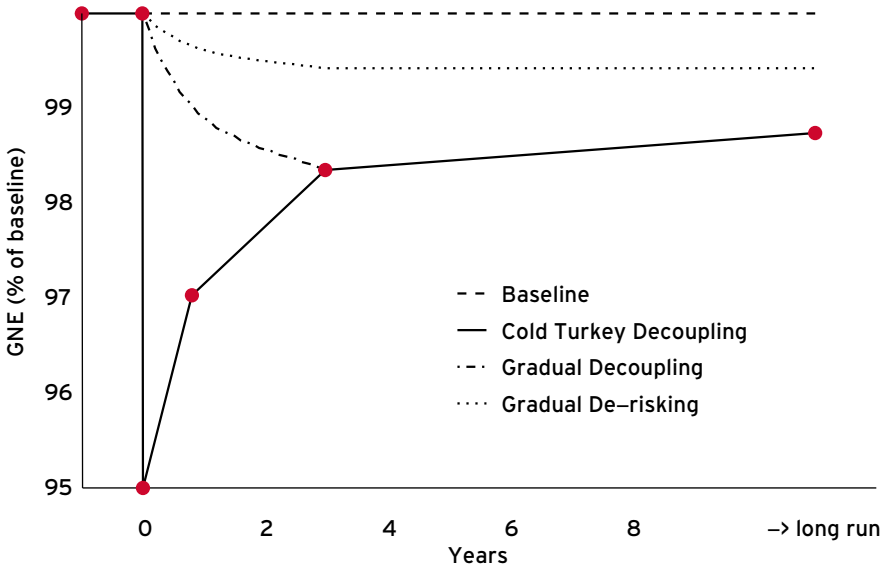
3.6 'Cold turkey' decoupling versus gradual decoupling

How important is the time horizon over which decoupling takes place? To answer this question, we can simulate a number of such alternative scenarios. These will ultimately be presented and analysed more systematically in the scientific version of this chapter (Baqaee et al., 2023). In the meantime, preliminary results using this approach suggest that the time horizon is very important and that a gradual decoupling scenario is likely to be considerably less costly than an immediate 'cold turkey' decoupling. This result is closely linked to the important idea of the le Chatelier principle that elasticities increase with the time horizon which applies, in particular, to the trade elasticity (see the empirical evidence in Section 3.2).

To illustrate the importance of the time horizon, Figure 6 shows the economic costs of a sudden decoupling (again linking the different levels of the trade elasticity considered to the different time horizons, as in Figure 2) and contrasts this cost path to an alternative decoupling scenario in which the decoupling takes place more gradually over a time

horizon of three years. The abrupt decoupling is illustrated by the solid line in the figure, with the red dots referring to the specific selected choices of trade elasticities discussed above. The gradual decoupling alternative is illustrated by the dotted line in Figure 6.

FIGURE 6 **'COLD TURKEY' DECOUPLING VERSUS GRADUAL DECOUPLING VERSUS GRADUAL DE-RISKING**



Matching the previous discussion, the costs of abrupt decoupling are potentially severe in the very short run, but fade considerably once the economy has had a few years to adjust to the new situation. Importantly, however, the losses never fade completely but stabilise at a long run value of 1.3%, which we identified using the long-run elasticity of 4. The sharp short-term reaction to decoupling is driven by the assumption that, in the short run, substitution between inputs from different source countries is very difficult. It is therefore the suddenness of the shock that drives the worst effects.

In line with this intuition, we see a very different time path of the economic costs if we consider a gradual decoupling that reduces trade with the Rivals bloc to zero in small steps over a span of three years, rather than trade immediately stopping. In such a gradual decoupling scenario, the deep initial GNE drop can be avoided, while the losses then converge to those obtained for the sudden policy scenario. Hence, while gradual decoupling ends up at the same new long-run equilibrium and thus the same permanent GNE losses, it reaches this new equilibrium at a much lower cumulative cost by allowing some trade to still take place in a transition period.

Our model can also be used to simulate the effects of alternative intermediate scenarios. One instructive scenario is that the Western and Chinese blocs are on a gradual decoupling trajectory of the type just discussed but then experience a 'cold turkey' decoupling starting from a position of partially severed trade flows. For example, suppose that halfway through a gradual decoupling, a full decoupling suddenly becomes dictated by geopolitical events (so after 1.5 years in the three-year decoupling example just discussed). While we do not show such a scenario in Figure 6, it is clear from the logic of the figure that the corresponding costs will be between that of the two scenarios shown there. This means, in particular, that the welfare losses from a 'cold turkey' decoupling that follows a period of adjustment during which trade routes and supply chains are reorganised are lower than the losses from a 'cold turkey' decoupling that follows a period in which no adjustment took place ('business as usual').

Throughout this chapter, we have considered hard decoupling scenario in which trade between the Western and Chinese blocs drops to zero (either immediately or over several years as in this subsection). Of course, most options on the table for policymakers are considerably less extreme. For example, US policy makers often describe their approach as 'small yard, high fence' (Sullivan, 2023) to emphasise that trade restrictions are 'carefully tailored' toward specific sectors or products, such as advanced semiconductor technology exports to China. Our model can in principle also be used to analyse more targeted 'de-risking' scenarios such as these. Naturally, such less extreme scenarios would have smaller economic costs for the German economy than the hard decoupling scenarios analysed here. In other words, our scenario should be interpreted as a worst-case scenario that allows us to bound the costs of alternative and less extreme de-risking scenarios.

The same logic regarding the dependence of decoupling costs on the time horizon also applies to less extreme de-risking scenarios. To illustrate both these points, Figure 6 also shows the stylised path in a hypothetical gradual de-risking scenario. While we have not conducted model simulations to quantify such de-risking policies, the key takeaways are that the costs would be (a) smaller than those of a hard decoupling scenario, and (b) smaller if the de-risking is gradual rather than 'cold turkey'. However, it is also clear that gradual de-risking also has a price.

Taking the model's logic one step further, gradual de-risking policies in critical sectors may have the potential to substantially reduce the costs of a possible subsequent hard decoupling. In these sectors, a gradual reduction in trade flows would reduce interdependence with China, but with the lowest elasticities only applying to a partial trade cut-off, thereby avoiding the largest losses. At the same time, the losses from a subsequent hard decoupling would be lower than if no adjustment had occurred because of reduced interdependence in the most critical sectors.

Note that while these qualitative statements follow relatively directly from the logic of our model, in particular the time-dependence of elasticities, their quantitative counterparts are an open question because we have not simulated the corresponding scenarios. An important question for future work is how much various gradual de-risking scenarios would reduce the costs of a possible subsequent 'cold turkey' decoupling and at what economic costs.

4 CAVEATS

In the following section, we examine a number of potential caveats to the simulation results. While these results suggest severe but not devastating impacts of a hard decoupling on the German economy, certain subtleties and dimensions remain outside the scope of the model due to aggregation and abstraction.

Specifically, we focus on four key caveats that could magnify the impact: strategic raw material imports from China, which are integral to numerous German industries; short-run business cycle amplification; long-run effects on investment and capital accumulation; and finally, the implications for German foreign direct investment (FDI) in China, a cornerstone of economic interdependence between the two nations.

4.1 Strategic raw materials

While most goods and services can be substituted in the long run, raw materials pose a unique challenge due to their inherent scarcity as natural resources. Germany relies heavily on specific raw materials crucial to key industries, and shortages of these materials could significantly disrupt the economy. For instance, when China restricted magnesium exports – an essential component for aluminium production – in 2021, it raised concerns within the German automotive and aviation industries.[18] Given China's significant role in the market for raw materials, when evaluating the costs of decoupling from China it is important to consider this mechanism as well as the fact that the sector aggregation of our model is high to capture it.

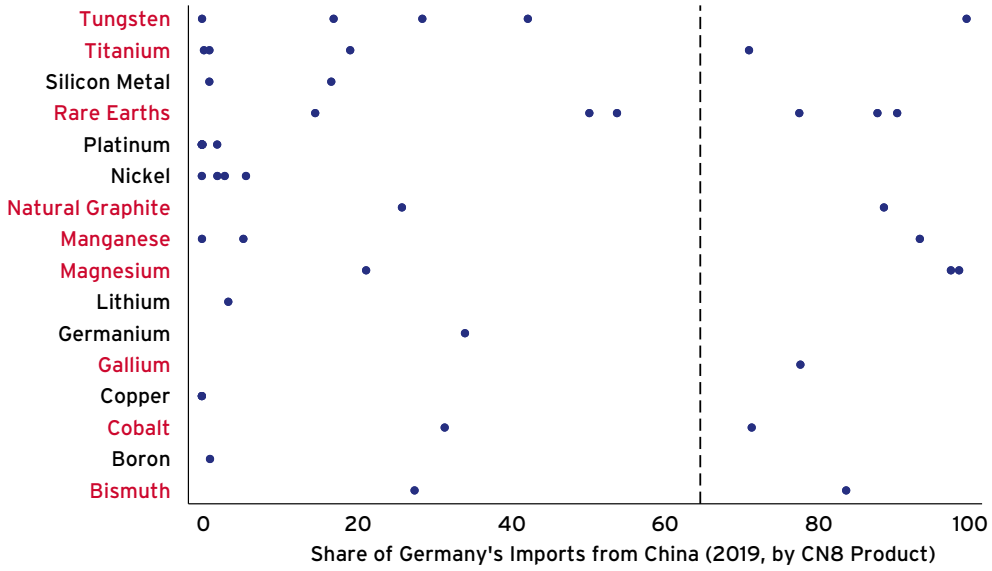
We will next analyse how dependent Germany is on China with respect to the supply of raw materials. To identify the relevant raw materials, we adopt the European Commission's definition, focusing on the 16 critical raw materials outlined in the EU Raw Materials Act (52018PC0368, Annex 1). These raw materials are deemed critical due to their pivotal role in key technologies and strategic industries such as defence while facing a high supply risk, often due to a highly concentrated supplier market. The listed critical raw materials include bismuth, boron, cobalt, copper, gallium, germanium, lithium, magnesium, manganese, natural graphite, nickel, platinum, rare earths, silicon metal, titanium, and tungsten.

18 https://www.politico.eu/article/eu-leaders-alarm-china-magnesium-crunch/

To understand Germany's exposure to China, we look at the share of Germany's imports from China of total imports for the respective raw materials. To do so, we use data on imports from Eurostat's Comext database and map the CN8 product codes to the raw materials using the concordance proposed by the factsheets provided by SCRREEN.[19] In Figure 7, each dot corresponds to one CN8 product. We define dependency on China as high whenever the import share is higher than 65%.

Several notable facts emerge. First, Germany exhibits high dependency on nine out of six- teen critical raw materials. Second, among these nine materials, five – titanium, natural graphite, manganese, cobalt, and bismuth – offer relatively manageable substitution options due to the availability of alternative suppliers. Third, the automotive and high-tech sectors, which are particularly reliant on the four critical raw materials (gallium, magnesium, rare earths, and tungsten) with high dependency on China and little potential for short-run substitutability from other source countries due to China's dominant role in worldwide production, face considerable risk when decoupling from China.[20] However, it is once again important to see even these large sectors in relation to the total German economy – for example, the automotive industry accounts for around 5% of German GDP. Even if we were to significantly underestimate the burden put on this sector by decoupling, it is unlikely to alter the general magnitude of German welfare losses we quantified in Section 3.

FIGURE 7 **GERMANY'S IMPORTS OF RAW MATERIALS FROM CHINA (%)**



19 https://scrreen.eu/crms-2023/

20 Information on the production as well as use of raw materials comes from SCREEN, available at https://scrreen.eu/crms-2023/

As in the Russian gas cut-off of 2022, in the scenario of a sudden lack of these important and rare raw materials, alternatives would likely materialise – albeit with some time lag. Recently discovered deposits of rare earths in Sweden have been heralded as a potential solution for a more diversified sourcing portfolio for Western economies.[21] Even in a pre-crisis setting, the mine operator and independent researchers suggested a time frame between 10 and 15 years to develop a fully operational facility. However, the 2022 Russian gas cut-off has shown that in crisis times, mitigation strategies often accelerate these processes: new terminals for liquefied natural gas (LNG), which had been planned for years and were forecast to take years to go online, were built in just a few months.[22] It appears likely that in a crisis scenario where certain raw materials are suddenly in short supply, alternative sourcing options would also become available sooner than current planning suggests.

We conclude this section by discussing a case study that sheds light on how an economy is able to adjust to a shortage of a strategic raw material of the type discussed in this section, namely, the Chinese rare earth embargo against Japan in 2010.[23]

In 2010, China effectively implemented an export embargo on rare earths to Japan. Superficially, this resembled a textbook example of effective sanctions: China was virtually the sole supplier of rare earths, while these were an important input for Japanese industry.[24] As noted by Gholz and Hughes (2021), in the short run, Japanese firms reduced demand both at the intensive and extensive margin. Firms for which rare earths were crucial to their inputs came up with ways to use raw materials more effectively, thus pushing the technology frontier outwards. For example, glass manufacturing companies started recycling cerium polish, which requires the rare earth mineral cerium. Other firms such as headphone manufacturers that previously bought rare earths due to their low cost – rather than because they were critical to the production process – substituted away completely. In the medium to long term, Japanese firms were working on technological innovations to either reduce usage of rare earths or enable substitution with different materials. Reductions on the consumer side, such as post-consumption recycling, appear to play a lesser role due to practical difficulties. On the supply side, it took two years for alternative producers to enter the market, even though investments in these projects had started long before the embargo. The Japanese government subsequently supported

21 See, for example, https://www.dw.com/en/explainer-what-the-rare-earths-find-in-sweden-might-mean-for-the-eu/a-64375644.

22 See, for example, https://www.berliner-zeitung.de/wirtschaft-verantwortung/statt-in-acht-jahren-leitung-fuer-erstes-lng-terminal-in-rekordzeit-fertiggebaut-li.296981, which cites industry sources which claim that under usual circumstances, the construction of the first LNG terminal in Wilhelmshaven that was opened in December 2023, only four months after the final cut-off from Russian gas, "would have taken six to eight years from planning to operations."

23 This example is taken from an online appendix to Bachmann et al. (2022) available at https:// benjaminmoll.com/RussianGas_Substitution/, which also includes other case studies regarding economies' ability to substitute in the face of adversity. See also the 36 cases studies in the appendix of Moll et al. (2023) describing how German firms and households substituted natural gas and gas-intensive products in the aftermath of the 2022 cut-off from Russian gas.

24 Some authors have argued that the embargo was not fully effective (e.g. Johnston, 2013). However, the embargo seems to have triggered some substitution by Japanese firms, so it arguably must have been effective to some extent.

one of the firms via a long-term supply contract, which ensured its survival amidst price fluctuations in the years after the embargo subsided. Overall, the economic costs of the Chinese rare earths embargo for the Japanese economy were relatively muted.

4.2 Short-run business cycle amplification

The Baqaee and Farhi (2021) model is a real model with no further business cycle amplification and therefore omits some of the channels through which a large trade shock may affect the economy. In particular, the model omits standard Keynesian demand-side effects in the presence of nominal rigidities as well as amplification effects due to financial frictions. As we now explain, these may be particularly relevant in the short run and therefore for the 'cold turkey' decoupling scenario, but relatively less so for the gradual decoupling scenario, therefore further strengthening our argument that a gradual decoupling has much lower economic costs.

To be clear, our flexible-price model does include what many lay people would call 'demand-side effects', namely, that increasing consumer prices of goods previously imported from China erode purchasing power and consumer welfare. But it omits the feedback from the drop in aggregate consumption to production and employment: rising prices of goods previously imported from China drag down consumer spending, and this feeds back into production and employment which further drags down consumption, and so on.

This important mechanism is operational in standard macroeconomic models with nominal rigidities that are consistent with empirical evidence on household consumption behaviour, in particular heterogeneous agent New Keynesian (HANK) models consistent with the large observed marginal propensities to consume. See, for example, Bayer et al. (2022), Bayer et al. (2023), Pieroni (2023), and Auclert et al. (2023) for analyses emphasising this mechanism in the context of rising energy prices (e.g., following the 2022 cut-off of Germany from Russian gas).

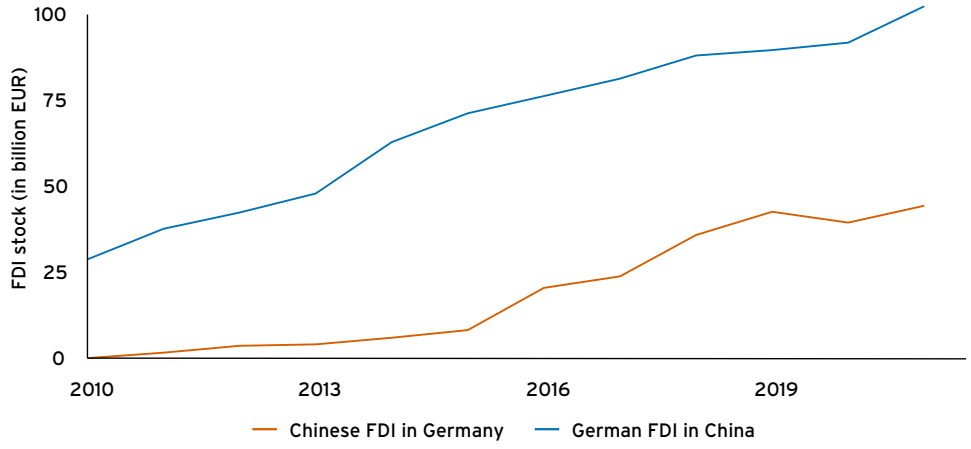
Particularly in the case of a full and immediate 'cold turkey' decoupling, we would expect such amplification effects to be potent. Given that the model omits such effects, the model-implied short-run GNE losses in this scenario of around 5% are likely an underestimate of the true effect. Analyses of such effects for the case of the energy crisis have shown that they can amplify the overall effects substantially, for example increasing GNE losses from around 2.3% to around 3% (i.e. by around 30%) (Bayer et al., 2022; Pieroni, 2023). Applying a similar 30% amplification factor to the short-run GNE losses in the short-run decoupling scenario would increase these from 5% to 6.5% – a very substantial economic cost, but still not catastrophic.

In the case of the gradual decoupling scenario discussed in Section 3.6, such effects are likely more muted. This further strengthens the argument that the economic losses from a gradual decoupling strategy are considerably smaller than those from an immediate 'cold turkey' event.

4.3 Long-run effects on investment and capital accumulation

Given that the Baqaee and Farhi (2021) model is a static model, another omission from our analysis are the standard long-run effects on investment and capital accumulation (as in a neoclassical growth model). Alvarez (2017) and Kleinman et al. (2023) show how to incorporate capital accumulation into quantitative trade models of the type used here in a tractable fashion, and the latter also analyse a US-China decoupling scenario. While they find that modelling capital accumulation changes various model predictions in interesting ways, they do not find that it drastically amplifies the long-run effects of policy counterfactuals relative to static models. In line with this result is the standard result from the neoclassical growth model that capital accumulation amplifies productivity changes by a factor of $1/(1-\alpha)$, where α is the capital share which typically takes values of around 1/3 so that $1/(1-\alpha) = 1.5$.[25] Applying this factor to the long-run GNE losses of 1.26% yields 1.89%. We are thus relatively confident that, even taking into account the effects on investment and capital accumulation, the long-run welfare losses from decoupling would remain below 2% of GNE. We plan to explore these issues in more detail in the scientific version of this chapter (Baqaee et al., 2023).

FIGURE 8 **BILATERAL FDI STOCK BETWEEN GERMANY AND CHINA OVER TIME**



25 Consider a neoclassical growth model with production function $Y = AK^{\alpha}L^{1-\alpha}$ where A is productivity, K is capital, L is labour, and α is the capital share. Then the steady state value of the capital stock is:

$$K^{*} = \left(\frac{\alpha A}{\rho+\delta}\right)^{\frac{1}{1-\alpha}}$$

where ρ is the discount rate and δ is the depreciation rate. It follows that steady-state production $Y^{*} = A(K^{*})^{\alpha}L^{1-\alpha}$ and consumption $C^{*} = Y^{*} - \delta K^{*}$ are both proportional to $A^{\frac{1}{1-\alpha}}$ meaning that any percentage change in productivity A is amplified by a factor of $\frac{1}{1-\alpha}$. The final step in the argument is that gains and losses from trade effectively show up in economy-wide productivity (e.g., Alvarez, 2017).

4.4 Foreign direct investment

China and Germany are not only linked through trade; in the past years, companies from both countries have increasingly invested in the other economy. In 2019, German firms held FDI stock worth about €90 billion, while Chinese-owned FDI stock in Germany stood at about €43 billion.[26] Figure 8 shows that since 2010, both economies have seen a persistent increase in bilateral FDI, with German FDI in China being about twice as high as Chinese FDI in Germany.

Table 4 breaks down these stocks by broad sectors. As in Tables 1 and 2, once viewed within the bigger perspective of its share in the total economy, these seemingly large figures become quite small in terms of shares in GNE. For example, the German car industry's share of China in its total sector FDI stock is almost a quarter. Taking into account the share of this sector's global FDI stock in total GNE (3.37%), German FDI from the automobile sector in China suddenly loses its overall economic significance, making up just 0.79% of GNE. Total FDI profits reaped by German companies in China stands at 0.44% (Bundesbank, 2023).

In an extreme scenario, as simulated above, where a complete decoupling takes place, one could argue that not only would trade be affected by sudden restrictions, but also FDI profits could not be repatriated and FDI stock may even have to be written off. In this unlikely scenario, it would also be likely that this action takes place on both sides, i.e., Chinese FDI in Germany would also be confiscated. As the numbers above show, while not insignificant, disrupting investment would also not be catastrophic.

Another way to look at the possible impact of the investment channel is to gauge the significance of the affected German-owned companies in China in a global perspective. Table 5 shows a steady increase in the number of companies, the number of employees of those companies, as well as their annual turnover. In comparison with global figures from 2020, with German investors owning more than 40,000 firms outside of Germany, employing more than 8 million workers, and generating an annual turnover of more than €3.1 trillion, these numbers are – again – rather small.

26 Data from Jungbluth et al. (2023) and Heritage Foundation & American Enterprise Institute (2022).

TABLE 4 **SHARE OF CHINA IN GERMAN FDI STOCKS AND PROFITS IN GROSS NATIONAL EXPENDITURE IN 2019**

Sector	Share of China in total sector FDI (%)	Share of total sector FDI in GNE (%)	Share in GNE (%)
Chemical Products	9.44	2.88	0.27
Pharmaceutical Products	4.98	1.14	0.06
Electromedical Devices	7.94	0.99	0.08
Electrical Equipment	22.32	0.88	0.20
Mechanical Engineering	14.27	1.41	0.20
Automobile and Parts	23.50	3.37	0.79
Energy Supply	-	1.24	-
Motor Vehicles Maintenance	-	6.79	-
Information and Communication	0.60	2.62	0.02
Banking	2.12	2.21	0.05
Investment Companies	-	3.06	-
Insurance, Reinsurance, etc.	1.75	2.33	0.04
Other Financial Activities	2.83	0.43	0.01
Real Estate	1.14	1.69	0.02
Company Management	0.01	2.28	0.00
Other Services	1.52	0.92	0.01
Total	**6.47**	**42.43**	**2.74**

TABLE 5 **SIZE MEASURES FOR GERMAN FIRMS IN CHINA**

	2010	2015	2020
Number of companies	1,451	2,096	2,394
Employees (in thousands)	463	706	750
Annual turnover (in million Euros)	122,615	264,752	330,868

Source: Data from Deutsche Bundesbank & Bertelsmann Foundation (Jungbluth et al., 2023).

4.5 Other channels

Another potential mechanism that is abstracted from in the model is international migration. A decoupling between Germany and China would likely lead to a decrease in the number of Chinese migrants in Germany, and vice versa. This in turn could have implications for the labour market and human capital flows.

Chinese residents in Germany, numbering 149,550, constitute approximately 1.1% of the foreign population and a mere 0.18% of the total German population (Destatis, 2023). Meanwhile, Germans in China represent a small fraction of the population. Foreigners make up only about 0.06% of the total Chinese populace (Bickenbach and Liu, 2022). Among these, Germans are the second largest group of Europeans. Net migration flows between Germany and China saw a decrease of 4,159 from 2015 to 2020. These figures highlight the relatively minor scale of human capital movement between the two countries. Consequently, while migration is an integral aspect of global economic interactions, in the specific case of Germany and China, its broader effects from decoupling appear to be minimal. This suggests that migration-related factors are unlikely to significantly magnify the impacts of economic decoupling between Germany and China.

5 CONCLUSION

This chapter has examined the economic implications of a hypothetical 'hard decoupling' of the German economy from China, in a scenario that entails a broader decoupling of a G7/Western bloc from China and its allies. Our findings show that the costs of such a decoupling scenario would be serious, but not devastating. Particularly in a 'cold turkey' situation in which an immediate and total separation between Germany and other Western countries and China occurs, the potential economic contraction could be as severe as a reduction equivalent to 5% of gross national expenditure in the first year alone. It is vital, however, to recognise that these assumptions and scenarios represent the extreme end of the spectrum, likely constituting an upper bound on the potential economic fallout in less extreme scenarios.

On the analytical side, it is important to stress the dependence of our results on estimates of a key parameter, namely, trade elasticity. The capacity to reorient trade towards alternative countries is a key factor in mitigating the adverse effects of decoupling from China. A lower trade elasticity means it is harder to replace Chinese goods, thereby escalating the welfare losses associated with severing trade links. The time horizon is of central importance here. Long-run trade elasticities of 4 or above result in a welfare cost of between 1% and 2%. Yet in the short run, the cost are likely to be higher by up to a factor of three.

While other European countries would also face significant economic repercussions, Germany's situation is particularly acute due to its deep trade ties with China. It is crucial to

underscore that this chapter does not argue that such a hard decoupling scenario is likely or desirable. Our aim is to provide the best possible estimate of the economic costs of such an outcome, however likely or unlikely it may seem. Understanding the costs of choices driven by geopolitical and security policies is vital for policymakers, businesses, and the public.

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APPENDIX: ADDITIONAL FIGURES

FIGURE 9 **SHARE OF IMPORTS FROM CHINA AND OTHER COUNTRIES IN GERMAN GROSS NATIONAL EXPENDITURE OVER TIME**

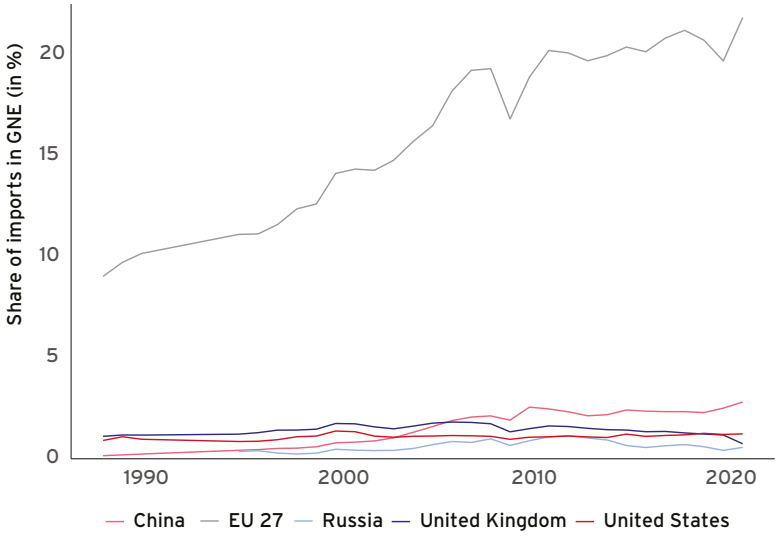
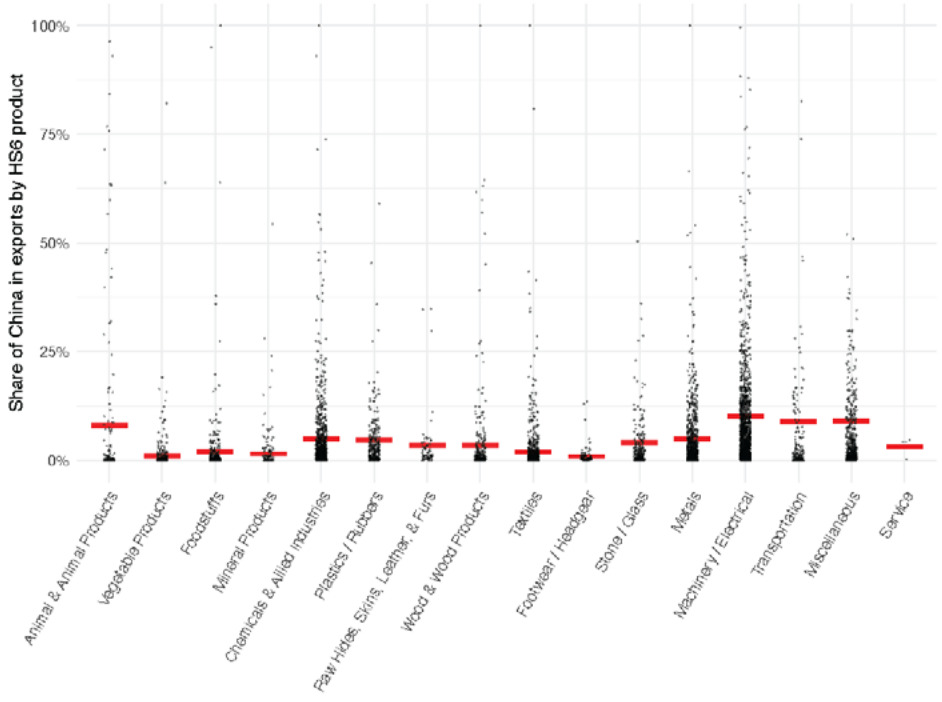


FIGURE 10 **SHARE OF CHINA IN GERMAN EXPORTS BY HS SECTION AND HS8 CODE IN 2019**



CHAPTER 5

Trade policy, industrial policy, and the economic security of the European Union

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> *"This is why – after de-risking through diplomacy – the second strand of our future China strategy must be economic de-risking. The starting point for this is having a clear-eyed picture on what the risks are."*
>
> Ursula von der Leyen, President of the European Commission, 30 March 2023

1 INTRODUCTION

Out of fear about its economic security, the European Union is transitioning to a new form of international economic and policy engagement. The Trump administration in the United States, Russia's invasion of and war on Ukraine, and concerns over China's increasingly aggressive foreign and economic policies have combined to put a new EU policy into motion. Without the assurance that other countries will continue to follow the rules of a multilateral trading system, the European Union is working through what comes next.[2]

The European Union is taking steps to rebalance its position in the global economy. While seeking to preserve the benefits of interdependence with the rest of the world, the European Union is contemplating policies that would induce change. One change seeks to alter the footprint of global production for certain goods, affecting whom it sources imports from and whom it sells exports to. It wants to decrease certain trade dependencies (which could be weaponised) and increase others (to encourage diversification). A second change is the enactment of new contingent policy instruments intended to allow the European Union to respond more quickly when policymakers in other countries act badly (or to establish a credible threat sufficient to deter them from doing so in the first place).

1 For helpful conversations and feedback, I thank Panle Jia Barwick, Olivier Blanchard, Heather Grabbe, Gene Grossman, Wonhyk Lim, Niclas Poitiers, Michele Ruta, Reinhilde Veugelers, Beatrice Weber, Jeromin Zettelmeyer, and participants at the CEPR Paris Symposium 2023. Thanks to Jing Yan, for outstanding research assistance; Nia Kitchin and Alex Martin, for assistance with graphics; and Barbara Karni and Madona Devasahayam, for editorial assistance. All remaining errors are my own.

2 See European Commission (2023a).

This chapter describes how the European Union is seeking to use trade and industrial policy to achieve its economic security objectives. It identifies some of the economic costs and trade-offs of using such policies. Because the issues it examines – many of which are noneconomic, for which reasonable estimates of costs and benefits are lacking – are evolving, the chapter shies away from normative recommendations. Instead, it explores the political economy of what is emerging and why. The paper focuses on EU efforts to 'de-risk' vis-à-vis China especially, given the emphasis EU policymakers now place on doing so.

The chapter is organised as follows. Section 2 defines the concept of economic security and the events that led it to play such a sudden and prominent role in modern policy.[3] It provides some early evidence to motivate the new policy interventions but emphasises that much remains unknown, especially concerning their design.

Section 3 explores a case study that highlights the difficult choices the European Union faces in responding to threats to its economic security. The case study involves the electric vehicle (EV) industry, the European Union's potential use of trade defence instruments (TDIs) to address unfairly subsidised imports from China, and China's potential retaliatory response of placing export restrictions on graphite, a critical material needed to manufacture EV batteries. It also identifies unknowns facing policymakers seeking "a clear-eyed picture on what the risks are", in the words of European Commission President Ursula von der Leyen. The section also explores empirically whether the European Union's trade interdependence with China may be deepening – despite stated goals to de-risk – in part because of the third-country effects arising from the US–China trade war.

Section 4 introduces the policy instruments the European Union, its member states, and other governments are pursuing to address concerns about their economic security. They include stockpiling and inventory management, investment or production subsidies, various forms of tariffs, export controls, and regulations on foreign investment. This section also highlights proposals for new policy instruments, analyses the associated trade-offs, and briefly describes basic World Trade Organization (WTO) rules that might discipline such instruments.

Section 5 turns to the potential for selective international cooperation over the use of such policy instruments. It explores how countries facing common concerns over economic security have been acting in coordinated fashion – implicitly or explicitly – and the difficulties of doing so.

Section 6 concludes with some caveats and lessons from history.

3 Other treatments touching on some of the aspects of economic security introduced here include Hoekman et al. (2023) and Pinchis-Paulsen et al. (forthcoming). Paulsen (2023) presents a legal treatment from the perspective of historical trade negotiations.

2 THE MODERN POLICYMAKER CONCERN OVER ECONOMIC SECURITY

2.1 What is economic security?

Economic security at the national level is still an emerging concept.[4] At a minimum, it involves a country getting the goods and services it needs when it needs them, at a reasonable price, with an acknowledgment that its economy is open and has some interdependence with the outside world. The nascent field of economic security shares similarities with national security, which Murphy and Topel (2013, p. 508) define as "the set of public policies that protect the safety or welfare of a nation's citizens from substantial threats."[5] Modern concerns over economic security, however, involve recognition that others – typically policymakers abroad – may be working against a country's effort to achieve its objectives.

Policymakers might work at cross-purposes to another country's interests for a variety of reasons, economic and noneconomic. For example, a large (price-shifting) exporting country might impose export restrictions or a nationally optimal export tax in order to shift the terms of trade in their country's favour if the national benefits of the price change are larger than the efficiency costs associated with the economic distortions it causes.[6] Domestic policymakers might give in to political pressure to impose a policy that benefits one local group (consumers) at the expense of another (firms/exporters); if the country is large, the policy could have unintended effects abroad.[7] Foreign policymakers could also be concerned about the relative sizes of two economies – which affect the ability to wage war – and therefore want to slow the other country's economic growth. They might be seeking to achieve a more targeted, albeit noneconomic objective (i.e., curtailing another country's access to a good or service that improves its military capabilities and threatens the other country's national security). Or they could be seeking to influence political outcomes abroad toward a leader more sympathetic to their country's interests.

This concept of economic security expands the scope of the nascent literature on supply chain resilience, which examines other important shocks – climate change, public health emergencies, natural disasters – that could be transmitted from one country to another through interdependent supply chains. By including resilience to actions by malicious policymakers abroad, economic security also recognises that foreign governments may adopt noncooperative policies and that a strategic setting is in play.[8]

4 In the poverty literature, economic insecurity at the individual level is relatively well defined, with a variety of measures and data informing policymakers on economic well-being.

5 On national security (NS), Murphy and Topel (2013, p. 508) write, "[w]hile NS policies are typically thought of in terms of military assets, our definition includes the development and deployment of any public good that would mitigate catastrophic outcomes for a large segment of the population".

6 This dimension is not the only one along which interdependence could be exploited. A large importing country could impose tariffs. A country with large state-owned enterprises could allocate its foreign direct investment flows in ways that benefit them. On the role of international trade agreements such as the WTO in handling the international externalities associated with policy changes, see Bagwell and Staiger (1999, 2002).

7 India, for example, periodically imposes export restrictions on onions, in order to limit domestic price increases for a staple food. It also responded to the sudden surge in domestic COVID-19 infections in 2021 by banning exports of COVID-19 vaccines from the Serum Institute for six months (Bown and Bollyky, 2022).

8 Even if markets are competitive for firms, countries may still be 'large', in that governments can use border policies (import or export restrictions) to exert market power by influencing the terms of trade and thus act strategically vis-à-vis actors in other countries.

The European Commission, some EU member states, the US government, and academics have begun to develop criteria to help policymakers. The initial approach involved efforts to define an ex ante basket of goods and services that are necessary for economic security and for which countries have import dependencies that might be vulnerable.[9]

Mejean and Rousseaux, for example, use detailed trade data to build on the European Commission's 'bottom-up' approach to assess EU vulnerabilities in their chapter in this volume.[10] To the extent possible, they also include information on the European Union's domestic supply capabilities, in order to assess the ability of EU consumers to substitute away from imports if necessary toward domestic production. They propose refinements to earlier lists of potentially vulnerable products by also considering the type of risk government policy is supposed to address. For example, policymakers might be more worried about the vulnerabilities of products that are essential for human health and have public good qualities, such as personal protective equipment (PPE) and vaccines, than they are about products for which the main concern is economic competitiveness.

Such trade dependency approaches have their limitations, however, because of deficiencies in the data available to policymakers. For example, information on the foreign source of imports may be available at a detailed (product) level, but the same level of aggregation is not typically available for foreign production or for input–output relationships involving foreign supply chains. (The graphite example presented below is one illustration of this potential limitation.) The European Union can be exposed indirectly: a disruption in country B can hurt EU imports from country A because A is dependent on imported inputs from B. Policymakers may not be able to observe this dependency, because it arises through input choices made by firms in country A in order to sell a good or service to the European Union.[11]

Policymakers also need more information about the responsiveness time horizon. Beyond whether and how costly it is for EU consumers to find an alternative production source, policymakers want to know how quickly such a switch can materialise. This issue has taken on increased salience since product shortages developed during the pandemic and Russia's war on Ukraine.[12] A final open question involves whether dependencies have the potential to shift more quickly and with less warning (to outsiders) when a major trading partner is a state-centric nonmarket economy. Is trade dependency on China, for example, riskier than dependency on some other country because China is more likely to use industrial policy and to do so through opaque means that make such shifts difficult for outsiders to observe and respond to?

9 See European Commission (2020, 2021); White House (2021); Bonneau and Nakaa (2020); and Jaravel and Mejean (2021).
10 See also Baur and Flach (2022) and Vicard and Wibaux (2023).
11 For an application to US supply chain exposure to China, see Baldwin et al. (forthcoming).
12 For an examination of the average duration of firm-to-firm purchasing relationships as a proxy for responsiveness to shocks, see Martin et al. (forthcoming).

2.2 How did we get here?

Three main factors explain why economic security suddenly became such a concern for policymakers: the success of the international trading system at achieving some outcomes, its failure at achieving others, and the suddenly changing world.

For decades, major industrial economies like the European Union and United States largely got what they wanted out of the global system. Following the end of World War II, they repeatedly gathered to negotiate reciprocal reductions to tariff barriers. Low trade barriers combined with major technological advancements (containerised shipping, the information and communications technology (ICT) revolution, and managerial improvements) and peace after the end of the Cold War (and China's 1978 opening up) resulted in efficient and often global supply chains. However, this efficiency also sometimes resulted in the geographic concentration of production for certain goods and services that these economies would come to regret once the world changed.

The global trading system failed elsewhere. China's integration into the global economy was phenomenally successful at lifting hundreds of millions of its people out of poverty in less than four decades. But its integration was also disruptive to people elsewhere, for reasons beyond the mere entrance of a new trading partner forcing incumbent economies to adjust. China's failure to transition to a market economy, its use of industrial policy, its deployment of export restrictions and targeted acts of economic coercion, and the inability of trading partners to turn to the WTO to do much about it led US political leaders in particular to perceive that the WTO system had failed. There would be no quick fixes, as a design flaw meant that the WTO lacked a legislative function to change its rules in ways that would allow the system to keep going. A result was the US–China trade war, in which both countries violated WTO rules and norms, and the withdrawal of US support of binding WTO dispute settlement.[13]

The third factor explaining the new emphasis on economic security is the suddenly changed world. The distribution of political-economic shocks has changed in ways that challenge the optimality of the existing location of global production. For certain goods, manufacturing has been deemed excessively concentrated geographically. Climate change has increased the frequency and severity of storms and droughts, leading to extreme events ranging from floods to wildfires. The COVID-19 pandemic woke the world up to the frightening possibility of sudden public health emergencies that could lead to lockdowns affecting production, snarled transportation and logistics, and wild swings in demand. These shocks raised concerns about supply chain resilience, which are arguably more economic (than geopolitical) in nature.

13 On the US–China trade war, see Bown (2021). On the United States and WTO dispute settlement, see Bown and Keynes (2020).

Geopolitics is the last important change to the distribution of shocks; it is also the factor that differentiates economic security from simple supply chain resilience.[14] Geopolitics means that a foreign policymaker may actively work to reduce the economic security of another economy. From the European Union's perspective, three major changes to geopolitics are worth highlighting.

The first was the shock over the presidency of Donald J. Trump. Trump bullied the European Union, supported Brexit, and sought to undermine European institutions.[15] By threatening to withdraw the United States from NATO, he put decades of European military security at risk.[16] On trade policy, he ended up imposing tariffs only on European steel and aluminium, an action not that different in terms of its economic magnitudes from what the George W. Bush administration did in 2002. However, the US relationship with Europe soured when Trump claimed that those metal imports from the European Union threatened America's national security and when he further threatened additional tariffs on imports of European cars. The Trump administration ended US support for the WTO, a problematic step given that the multilateral system forms the institutional foundation for the European Union's trade relationship with the world. Then, under Trump's 2020 Phase One agreement, China was supposed to purchase additional US exports, even if they came at the expense of exports from Europe and other countries. [17] (These purchases never happened, as described below.) The election of Joseph R. Biden restored many – though not all – of the pre-Trumpian features of the transatlantic alliance, but the fear of a return by President Trump in 2024 never receded from European view.[18]

The second and most important geopolitical event for Europe was Russia's invasion of Ukraine. The move exacerbated Russia's deteriorating relationship with Europe and other Western economies, which began to sour following Russia's 2014 annexation of Crimea. In 2022, Russia weaponised its exports by withholding sales of natural gas to Europe through the Nord Stream 1 pipeline. Prices spiked, contributing to inflation, stoking political problems across Europe, and causing immediate-term economic concerns for the competitiveness of energy-intensive industries, especially in Germany.

Europe's third geopolitical concern involves China. Under President Xi Jinping, China has become much more aggressive toward its neighbours, threatening the security of major shipping lanes through the East and South China Seas. It has widened its use of economic coercion by cutting off trade to punish countries whose foreign policy it disagrees with, including Lithuania for its diplomatic ties with Taiwan and its opening

14 For one formal modeling approach, see Clayton et al. (2023).
15 See Matthew Rosenberg, Jeremy W. Peters, and Stephen Castle, "In Brexit, Trump Finds a British Reflection of His Own Political Rise," *New York Times*, 13 July 2018.
16 Julian E. Barnes and Helene Cooper, "Trump Discussed Pulling US From NATO, Aides Say amid New Concerns over Russia," *New York Times*, 14 January 2019.
17 See Chad P. Bown, "Unappreciated Hazards of the US–China Phase One Deal", *PIIE Trade and Investment Policy Watch*, 21 January 2020.
18 See Andrew Gray and Charlotte Van Campenhout, "Trump Told EU That Us Would Never Help Europe under Attack: EU Official," Reuters, 10 January 2024.

a 'Taiwan Representative Office' in Vilnius.[19] (There is also increasing worry that China may seek to retake Taiwan by force.) Finally, in response to EU sanctions over human rights violations related to the mass detention and persecution of Uyghurs in Xinjiang, China imposed counter sanctions, including on members of the European Parliament.

2.3 Is a policy needed, or are firms adjusting on their own?

An important motivating question is whether policy is needed. Perhaps these shocks are not systematically affecting economic activity or firms are already internalising the fact that the world is changing and adjusting their decisions even in the absence of new government policy.

There is evidence that some of these shocks have adversely affected firms and supply chains. While many of the shocks are new and have therefore not yet been fully examined, the evidence to date is that shocks have had the expected impacts. Consider, for example, the earthquake that led to the tsunami and nuclear incident at Fukushima, Japan in 2011. Boehm et al. (2019) find that the decline in US manufacturing output resulting from Japanese affiliates that were unable to import because of the shock was sizable. Lafrogne-Joussier et al. (2023) study the behaviour of French firms in response to the early days of the COVID-19 lockdowns in China. They find that French firms sourcing inputs from China saw imports fall by more than firms sourcing from elsewhere and that those firms subsequently experienced a larger drop in domestic sales and exports. In terms of mitigation strategies, geographic diversification did not appear to help, but firms with larger inventories did seem to weather the shocks better than other firms did.

Early evidence about firms' response to incentives about resilience is mixed. Castro-Vincenzi (2022), for example, examines how the global automobile industry adjusted to climate-related shocks. He finds that firms responded to the increased incidence of extreme weather events (floods) by having more plants, operating smaller plants, and holding some unused capacity at those plants, in order to be able to smooth their global production over bad states of the world. Khanna et al. (2022) examine firms exposed to the sudden shock of COVID-19 pandemic lockdowns in India. They find that firms and their supply chains were adversely affected in the expected ways, but they fail to find evidence that firms with more complex supply chains underperformed those with simpler supply chains. One interpretation of this evidence is that firms that know that they have complicated production chains invest in resilience ex ante to mitigate shocks. However, in examining firms' long-run response to the Fukushima incident, Freund et al. (2022) find no evidence that they re-shored or nearshored production or increased import diversification to mitigate risk. This finding suggests that active policies may be needed to induce firms to diversify.

19 The Chinese government views Taiwan as part of China and that the island should not have independent diplomatic relations with other countries. On the Lithuania incident, see Norihiko Shirouzu and Andrius Sytas, "China downgrades diplomatic ties with Lithuania over Taiwan," Reuters, 21 November 2021.

Even for the firms that may be responding to the heightened likelihood of shocks by increasing their supply chain resilience, are they investing optimally in resilience and, by extension, in security? Are they doing enough? Might some be investing too much? New theoretical work has begun to explore the market failures and externalities that might exist as well as the appropriate policy intervention to create the right incentives. So far, this work suggests that the answer is complex, nuanced, and highly dependent on the details of the underlying supply chain and network.[20] Nevertheless, the European Union and other countries are already changing policies, even if they are not being guided by this research. The following sections explain how.

3 EUROPE'S TOUGH CHOICES INVOLVING ECONOMIC SECURITY

The European Union faces important choices and difficult trade-offs. Its 'open strategic autonomy' approach suggests a wish to remain internationally integrated with the outside world.[21] Although interdependence failed to prevent Russia's invasion of Ukraine, most of the evidence from the post–World War II process of European integration is that it can be an important force for policy moderation and peace. Although its perspective on China has become more jaded, Europe does not see eye to eye with Washington. The differing views partly reflect the fact that, unlike the United States, Europe is not bound by treaty to uphold the military security of countries in Asia and the Pacific.[22] But European positioning toward China also represents a hedge, as the bloc's own future relationship with the United States remains uncertain over fear of the re-election of Trump, who has already proposed imposing a 10% tariff on all imports, including imports from Europe.[23]

At the same time, the European Union is facing increasing threats to its economic security from China. This section illustrates them by examining ongoing EU–China disputes over EVs, critical minerals, and materials needed to manufacture batteries. It then explores the data, which, paradoxically, suggest that not only is this case study not unique but that some of Europe's trade may be becoming more rather than less dependent on China, for reasons outside of the control of European policymakers.

20 See Grossman et al. (forthcoming) and Grossman et al. (2023).

21 European Commission Director General for Trade, Sabine Weyand, defined open strategic autonomy as meaning "we act together with others, multilaterally, or bilaterally, wherever we can. And we act autonomously wherever we must. And the whole of it adds up to the EU standing up for its values and interests" (Bown and Keynes 2021a).

22 See Lindsey W. Ford and James Goldgeier, "Who Are America's Allies and Are They Paying Their Fair Share of Defense?" Brookings Commentary, 17 December 2019; US State Department, "US Collective Defense Arrangements," Archived Content, 2009–17.

23 See Jeff Stein, "Trump Vows Massive New Tariffs If Elected, Risking Global Economic War," *Washington Post*, 22 August 2023; Charlie Savage, Jonathan Swan, and Maggie Haberman, "A New Tax on Imports and a Split from China: Trump's 2025 Trade Agenda," *New York Times*, 26 December 2023.

3.1 Is China weaponising supplies and exports of electric vehicles, graphite and critical minerals?

China has actively used industrial policy in a number of sectors, including its EV supply chain.[24] One key element was a local content requirement for EV batteries, introduced in 2016 and kept in place until 2019.[25] During this period, China's EV consumer subsidies were limited to automakers that used batteries on the government's 'whitelist', which included only local Chinese firms like BYD and CATL, hurting Japanese and Korean battery manufacturers in particular.

Barwick et al. (in progress) provide evidence that as expected, China's discriminatory policy for EV batteries led to an increase in battery sales by BYD and CATL. They also find, however, that because of learning-by-doing in the downstream EV industry, China's whitelist policy combined with EV consumer subsidies (applied around the world) resulted in sharper EV price reductions for vehicles using BYD and CATL batteries. The implication is that China's discriminatory local content policy for EV batteries indirectly provided downstream Chinese EV manufacturers a further unfair advantage that worked like a subsidy.[26]

China's subsidies and industrial policy are likely contributors to the surge in China's EV exports into the European Union (Figure 1). China's industrial policy in other sectors has proven concerning: in addition to the injury it caused to firms in other markets, the subsidies can result in excessive firm entry, with inefficient companies operating at insufficient scale. The current worry is that China's industrial policy for EVs will similarly result in excess capacity and the dumping of its exports, including into the nascent European EV market.[27]

In October 2023, the European Commission launched an anti-subsidy investigation into Chinese EVs that could result in countervailing measures (tariffs).[28] The case faced a mixed response across Europe. The French government welcomed the investigation,[29] in part because automakers like Renault and Peugeot are direct competitors of lower-priced Chinese EV brands like BYD and Polestar. Germany, whose automakers export some EVs from their Chinese factories back to Europe, has been more circumspect,[30]

24 China's industrial policy for the EV supply chain follows a pattern that is similar to that in industries such as shipbuilding, steel, aluminum, and solar panels. For new techniques to identify, measure, and assess the impact of China's industrial policy on shipbuilding, see Kalouptsidis (2018) and Barwick et al. (forthcoming).

25 Qichao Hu, "In Honor of John B. Goodenough's 100th birthday: What America Can Learn from China's Success in EV Batteries," SES, 22 July 2022.

26 Barwick et al. (in progress) find that China's industrial policy reduced EV sales globally relative to a counterfactual without the whitelist policy. The intuition is that the Chinese policy shifted sales from previously low-cost to high-cost suppliers, allowing inefficient firms to expand, resulting in business-stealing from more efficient firms.

27 Joe Leahy, "EU Companies Warn China on EV Overcapacity," *Financial Times*, 19 September 2023.

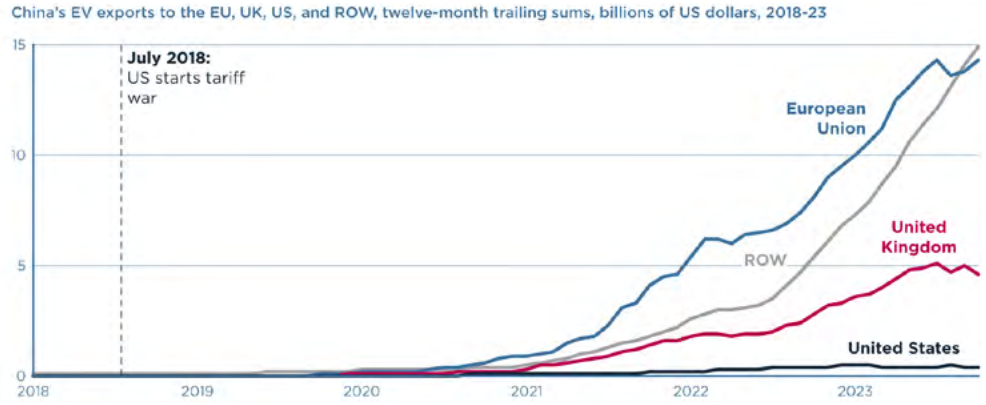
28 European Commission, "Commission Launches Investigation on Subsidised Electric Cars from China," Press release, 4 October 2023.

29 Reuters, "France's Le Maire Welcomes EU Action against Chinese-Made Electric Cars," 13 September 2023.

30 Patricia Nilsson, Gloria Li, and Sarah White, "German Carmakers in the Line of Fire of Possible EU-China Trade War," *Financial Times*, 19 September 2023.

concerned about being caught up in the EU tariffs.[31] It is also worried about the potential of Chinese retaliation through tariffs that could hit exports into China from Germany's European plants (more on this below) or actions that might go after the German industry's sizable investment in facilities in China.

FIGURE 1 **CHINESE EXPORTS OF ELECTRIC VEHICLES TO THE EUROPEAN UNION HAVE SKYROCKETED, LEADING TO AN EU ANTI-SUBSIDY INVESTIGATION**



Note: ROW = rest of world; EV = electric vehicle.

Source: Compiled by author with data from UN ITC Trade Map and Chinese customs.

China immediately responded to the European Commission's investigation by announcing new export restrictions on graphite (on "national security" grounds).[32] It was not the first time China retaliated against an EU TDI, although in the past it retaliated by imposing its own TDIs, as it did in response to EU measures on steel fasteners (Bown and Mavroidis, 2013) and X-ray equipment (Moore and Wu, 2015); in response to EU measures on solar panels, China retaliated with a TDI on upstream polysilicon.[33] (In January 2024, China did also respond to France's support for the Commission's EV investigation with a new TDI action potentially affecting French cognac.)[34]

Graphite is used to produce EV batteries. The European Union is the largest importer of Chinese graphite subject to the new export restrictions (Figure 2). The three largest EU member state buyers of Chinese graphite exports are Poland, Hungary, and Germany, home to some of the European Union's largest EV battery plants (Figure 3).

31 Siyi Mi, "EU Needs More Than Just Tariffs to Counter China's Electric Cars," Bloomberg, 28 September 2023.

32 China's Ministry of Commerce, "Announcement of the Ministry of Commerce and the General Administration of Customs on Optimizing and Adjusting Temporary Export Control Measures for Graphite Items," 20 October 2023. China's export curbs also likely target the United States, Japan, South Korea, and other countries. They follow on new Chinese export restrictions on germanium and gallium, announced immediately after the Netherlands imposed export controls on semiconductor manufacturing equipment, following the US lead (Qianer Liu and Tim Bradshaw, "China Imposes Export Curbs on Chipmaking Metals," *Financial Times*, 3 July 2023).

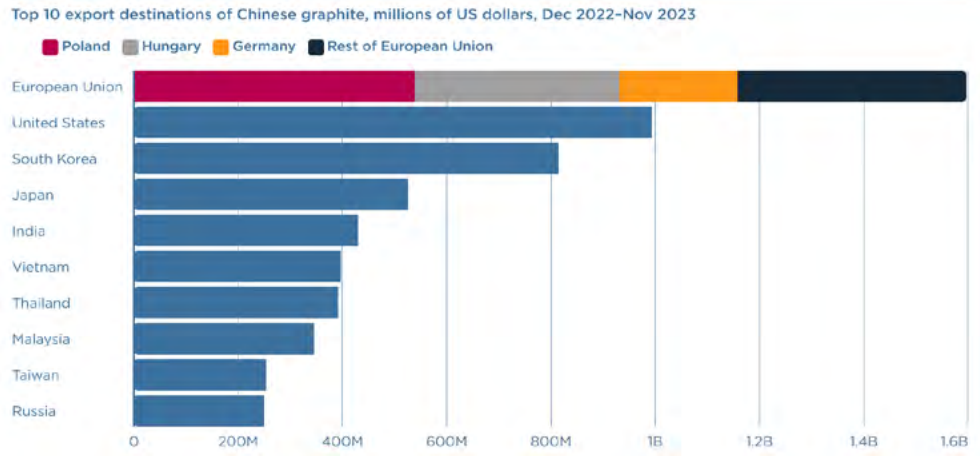
33 Michael Martina, "China Hits EU with Final Duties on Polysilicon," Reuters, 10 April 2014.

34 Edward White, Adrienne Klasa, and Madeleine Speed, "China Targets French Brandy Imports in Escalating Trade Dispute," *Financial Times*, 5 January 2024.

Chinese battery plants are coming online in Hungary and Germany; other EV battery plants across the European Union are operated by firms from Korea (Samsung SDI, SK Innovation, and LG Energy Solutions), Japan (AESC), the United States (Tesla), and a host of European countries.[35]

What worries EU policymakers is how China chooses to implement these graphite export restrictions. It could cut off all buyers located in Europe, harming the EU battery industry and, by extension, EV manufacturing plants in Europe, beyond the injury already inflicted by China's subsidies and industrial policy for batteries and EVs. Alternatively, China could allocate graphite export licenses in a manner that differentiates between buyers within Europe. One approach would be to allocate licenses in a way that drives a political wedge between EU member states, in order to influence the outcome of Brussels' anti-subsidy investigation. Another would be to allocate licenses to benefit battery plants of Chinese-headquartered firms in Europe, such as CATL, at the expense of non-Chinese battery manufacturers in Europe. This strategy could have similar effects as the 2016–19 whitelist policy, raising the question of whether China's application of differential export restrictions – which can work like a subsidy economically – satisfies the legal definition of a subsidy and therefore justifies EU use of its new Foreign Subsidies Regulation, discussed below.

FIGURE 2 **EU MEMBER STATES ARE LARGE BUYERS OF THE CHINESE GRAPHITE THAT CHINA SUDDENLY ANNOUNCED WOULD BE SUBJECTED TO EXPORT CONTROLS**



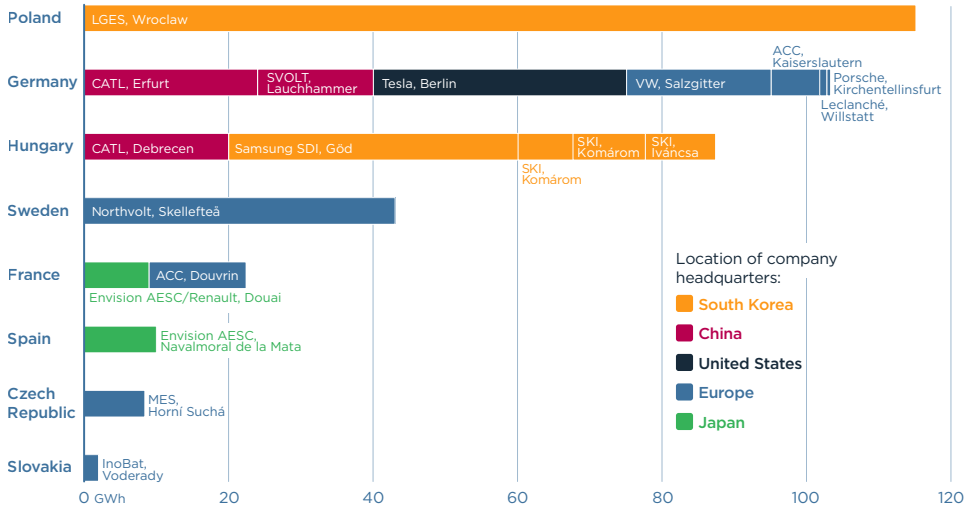
Note: HS codes 38011000; 38019090; 68151900; 25041040; 25041091; 38019010; 38249999. China's exports to rest of world were $1.4 billion (not shown).

Source: Compiled by the author with data from Chinese customs.

35 Edward White, William Langley, and Harry Dempsey, "China Imposes Export Curbs on Graphite," *Financial Times*, 20 October 2023; Tom Philips, "Top Five: EV Battery Factories in Europe," Automotive IQ, 21 April 2020; Marton Dunai, Yuan Yang, and Patricia Nilsson, "The Electric Vehicle Boom in a Quiet Hungarian Town," *Financial Times*, 29 November 2022.

FIGURE 3 **CHINESE BATTERY MANUFACTURERS IN EUROPE ARE CLUSTERED IN GERMANY AND HUNGARY**

Expected giga-watt hour (GWh) capacity of EU gigafactories by 2025



Note: LGES = LG Energy Solutions; CATL = Contemporary Amperex Technology Co., Limited; SKI = SK Innovation; VW = Volkswagen; AESC = Automotive Energy Supply Corporation; ACC = Automotive Cells Company; MES = Magna Energy Storage. Announcements as of January 2024.

Source: Compiled by the author with data from Benchmark Mineral Intelligence.

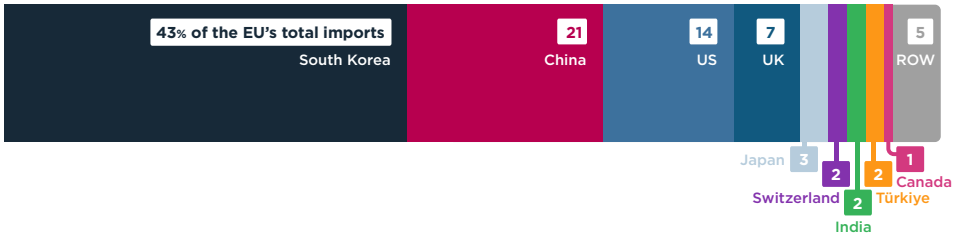
The graphite example also helps illustrate the separate informational challenge facing 'clear-eyed' policymakers seeking to de-risk from China. Suppose forward-looking EU policymakers examined the data to assess whether they should be concerned about excessive dependence on graphite imports from China. Panel a of Figure 4 displays the most disaggregated trade data comparable across countries (the six-digit Harmonised System level) for the graphite products over which China ultimately imposed export restrictions. Viewing it alone, they might have concluded that the European Union had little to worry about, as China is the source of less than 25% of EU graphite imports; South Korea is a larger foreign source than China, and other trustworthy trading partners, including the United States, the United Kingdom, and Japan, also export graphite.

However, panel b, based on production data, provides cause for concern. Japan, South Korea, the United Kingdom, and the United States do not mine (produce) graphite in significant quantities (the European Union also has only limited graphite mining). In contrast, China produced nearly two-thirds of all graphite mined globally in 2022. Countries other than China are thus likely sourcing their raw graphite from foreign sources – likely China. Thus, what appears to be a diverse set of foreign sources for EU graphite imports (panel a) is merely a statistical artifact of the 6-digit Harmonised System code capturing products beyond those found in the Chinese export restrictions.

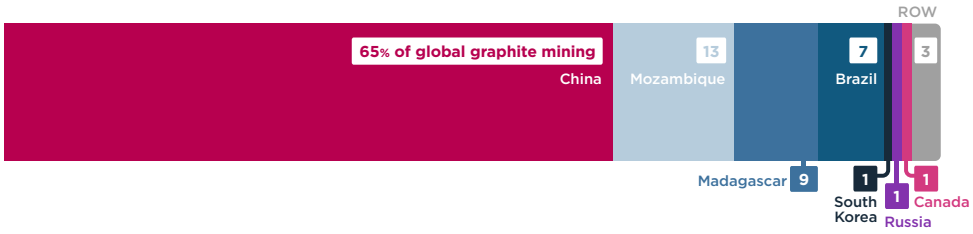
The implication is that, if China applied its export restriction on raw graphite universally, then Japan, South Korea, the United Kingdom, and the United States would be cut off as well, and the European Union would no longer be able to import graphite products from them or China.

FIGURE 4 **THE EU'S APPARENT LOW IMPORT DEPENDENCE ON CHINESE GRAPHITE MAY BE MISLEADING GIVEN CHINA'S DOMINATION OF UPSTREAM MINING**

a. EU graphite imports by source, percent of total, Dec 2022-Nov 2023



b. Global graphite mining by source, percent of total, 2022



Note: ROW = Rest of world. Total may not sum to 100 due to rounding.

Source: Panel a: Compiled by the author with data from Eurostat for the 12 months of December 2022 to November 2023, 6-digit HS codes 380110; 38019; 681519; 250410; 380190; 382499. Panel b: Compiled by the author with 2022 data from USGS, Graphite Statistics and Information, Mineral Commodity Summaries, 2023.

The European Union's dependence on China for graphite both illustrates the problem policymakers seek to address and shows why examining trade dependencies alone is not enough, as Mejeun and Rousseaux note in their chapter in this volume.[36] Furthermore, graphite is different from other minerals needed for EV batteries like lithium and cobalt, for which China's supply chain choke point is not the mining but the mineral-processing stage.[37] The difference reveals the complexity of understanding how a country might weaponise a supply chain.

For most other products, the informational challenge facing policymakers is often worse. Critical minerals are among the few goods for which global production data are available. Product-level production data are not available for most manufactured goods of concern for economic security.

36 Put differently, graphite would presumably be identified as a strategically dependent product under a separate criterion examined by Mejean and Rousseaux that takes into consideration EU production capacities (which, in the case of graphite, are minimal).

37 Much of the mining of these and other critical minerals outside China is also done by Chinese firms or joint ventures with Chinese firms, which raises separate issues (Leruth et al., 2022).

3.2 Is China trading more with the European Union because of the US–China trade war?

Before turning to EU policy instruments, consider a separate question motivated by the Chinese EV example. Are other economic forces pushing the European Union to trade more with China – including by importing products like EVs – and are these forces working against the European desire to de-risk unilaterally?

One such force may arise from the remnants of the (ongoing) US–China trade war. In July 2018, the United States began to impose additional tariffs on a range of imported goods from China. China retaliated in kind. By the time the two countries paused their tariff escalation, in early 2020, new US and Chinese tariffs covered more than half of their bilateral trade (Figure 5). The average US tariff on imports from China, for example, increased from 3% to 19%.[38] In part because the European Union and the United States are similar, high-income consuming economies, if the US tariffs stopped potential Chinese exports from entering the United States, then Chinese exports may be surging into the European Union and other third-country markets (trade deflection).[39] Increasing the chances of this happening is the fact that China also reduced its tariffs toward the European Union and other third countries throughout the trade war.[40]

As part of the initial wave of tariffs, in July 2018, the United States imposed 25 percent duties on automobiles from China, including EVs, even though China was not yet exporting EVs in great numbers to anyone (see Figure 1). China's immediate tariff retaliation included hitting US EV exports and likely accelerated what was already going to turn into a profound shift in EV trade patterns. China's tariffs first contributed to the United States suddenly losing its considerable EV exports to China, as Tesla accelerated construction of its gigafactory in Shanghai. The United States then lost its EV exports to the European Union, as Tesla switched to exporting to the European Union from its new Chinese plant.[41]

As of late 2023, China was not exporting many EVs to the United States, in part because of the additional US trade war tariffs of 25%. (US lawmakers have called for increasing US tariffs on Chinese EVs still further.)[42] In contrast, China's exports to the European Union had soared to over $14 billion – more than three times the 2021 level and roughly 17 times the levels in 2020 (see again Figure 1).

38 For an analysis of the US–China trade war, see Bown (2021).
39 For early evidence of trade deflection, see Bown and Crowley (2007). For early evidence from the US–China trade war, see Fajgelbaum et al. (forthcoming).
40 See Chad P. Bown, Euijin Jung, and Eva Zhang, "Trump Has Gotten China to Lower Its Tariffs. Just Toward Everyone Else," *PIIE Trade and Investment Policy Watch*, 12 June 2019.
41 See Figures 3 and 4 of Bown (2023a), and the discussion therein.
42 David Shepardson, "US Lawmakers Want Biden to Hike Tariffs On Chinese-Made Vehicles," Reuters, 8 November 2023.

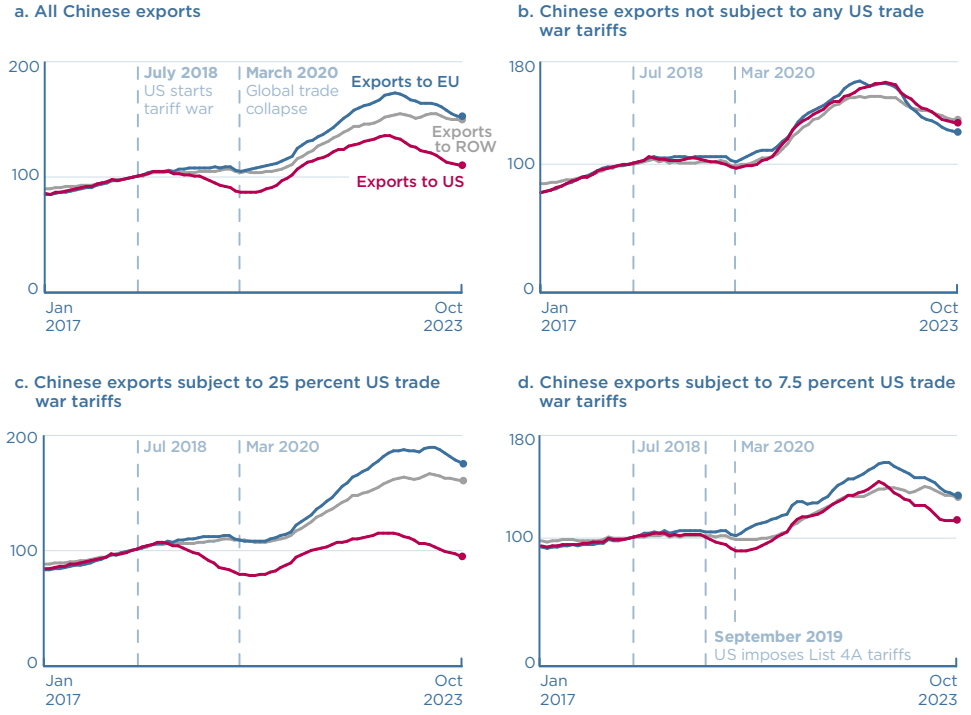
FIGURE 5 **US AND CHINESE IMPORT TARIFFS TOWARD EACH OTHER INCREASED CONSIDERABLY DURING THE TRADE WAR OF 2018-19 AND HAVE REMAINED ELEVATED SINCE**

Source: Bown (2023b).

More generally, there is some evidence beyond EVs that China is exporting more to the European Union because it cannot export to the United States (Figure 6). As a starting point, consider China's exports in June 2018, the month before the trade war started. By October 2023, China's total exports to the European Union had grown by 52%, whereas its total exports to the United States had grown by only 10%.[43] These results mask considerable heterogeneity, given that not all Chinese products were hit with US tariffs. For products not hit with any US tariffs, Chinese export growth to the United States since June 2018 was higher than export growth to the European Union (panel b of Figure 6).

FIGURE 6 IS CHINA DEFLECTING EXPORTS TO THE EUROPEAN UNION OF PRODUCTS HIT BY US TRADE WAR TARIFFS?

China's exports to the EU, US, and rest of world (2017-2023), by US trade war tariff list, twelve-month trailing sums (June 2018 = 100)



Note: ROW = Rest of world; US = United States; EU = European Union.

Source: Constructed by the author with data from UN ITC Trade Map.

43 A separate issue involves the extent to which even the US tariffs are affecting supply chains beyond the movement of final assembly before shipment to the United States (Chad P. Bown, "Four Years Into the Trade War, Are the US and China Decoupling?," *PIIE Realtime Economics*, 20 October 2022). Freund et al. (2023) suggest perhaps not and provide evidence that foreign sources replacing China are deeply integrated into China's supply chains and themselves have experienced faster import growth from China.

These results contrast with those for Chinese exports of products subject to the 25% US tariffs. Chinese exports to the European Union of those products rose 77% between June 2018 and October 2023, whereas exports to the United States declined 5% (Figure 6, panel c).[44] These tariffs affected $271 billion of annual Chinese exports to the European Union in the 12 months ending in October 2023.

The intermediate case involves products subject to US tariffs of only 7.5% (Figure 6, panel d). For these products, the difference between the growth of Chinese exports to the European Union and its exports to the United States was only 21 percentage points.

A similar trade-diverting phenomenon has likely arisen in the context of EU exports to China.[45] As part of the trade war, China retaliated with its own tariffs, which hurt US exports to China. Despite the US–China Phase One agreement of January 2020 – in which China promised to purchase an additional $200 billion of US goods and services exports over 2020–21 – US exports to China have mostly not resumed.[46] For manufactured goods especially – the most comparable part of US and EU exports to China – US exports to China remain below pre-trade war levels (Figure 7, panel a). Unsurprisingly, China increased its imports from the European Union, a pattern that was not reversed when the Phase One agreement went into effect.

China cut automobile sector imports from the United States during the trade war. In contrast, its imports from the European Union remained high, though they have slowed recently (panel b of Figure 7). These factors highlight some of the German policymaker concerns over its automakers being excessively dependent on the Chinese market.[47]

Overall, these data raise important questions about any EU de-risking strategy. Economic forces external to the EU–China relationship are pushing the European Union to trade relatively more with China, not less. If the European Union seeks to de-risk and European firms do not face all of the societal incentives to do so, the European Union may need to undertake explicit policy actions to adjust their incentives.

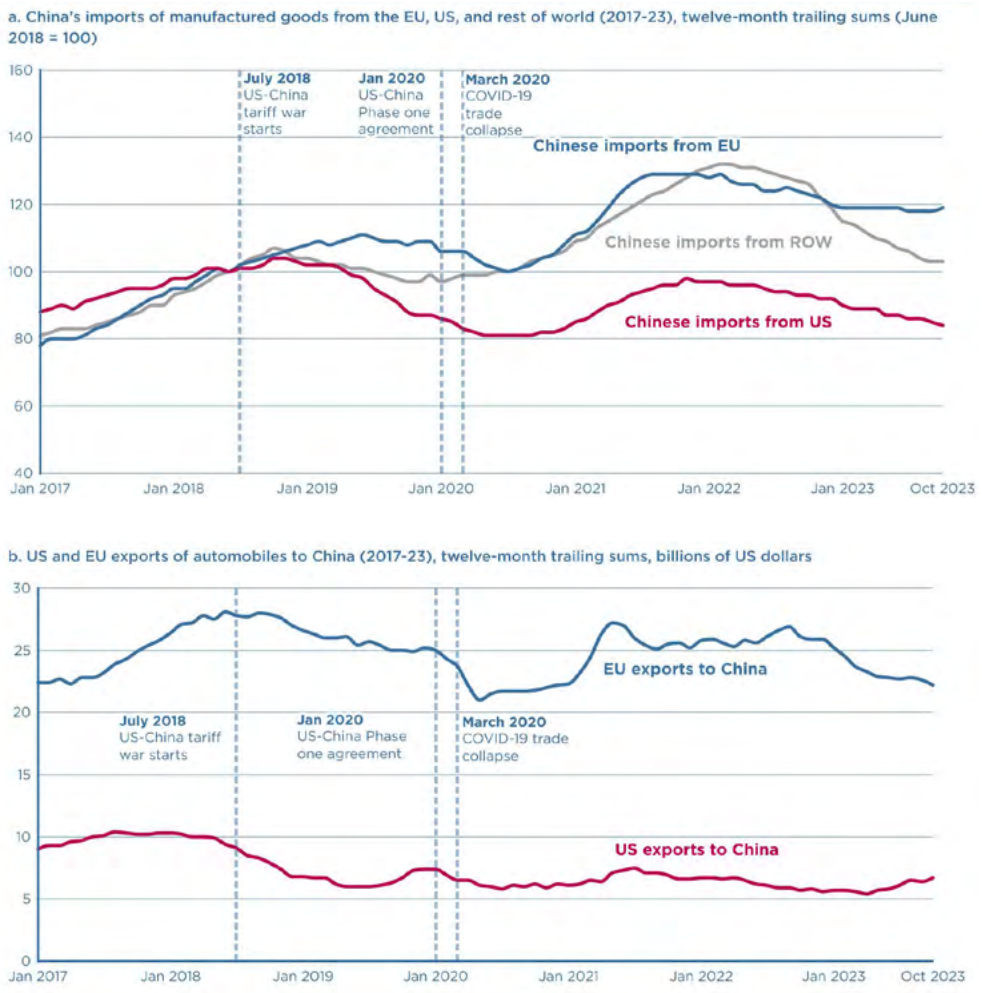
44 These results are not driven exclusively by EVs. Dropping EVs from panel c implies that by October 2023, there was still a 73 percentage point difference between the growth of Chinese exports to the EU versus the US for products hit with 25% US tariffs since June 2018.

45 Assessing Chinese imports in a way like that shown in Figure 6 is complicated by uncertainty over which products have continued to apply binding tariffs on US exports; it is difficult to assess, given the purchase commitments in the Phase One agreement of January 2020 (Bown, 2021).

46 See Chad P. Bown, "China Bought None of the Extra $200 Billion of US Exports in Trump's Trade Deal," *PIIE Realtime Economics*, 8 February 2022; Chad P. Bown and Yilin Wang, "Five Years into the Trade War, China Continues Its Slow Decoupling from US Exports," *PIIE Realtime Economics*, 16 March 2023.

47 Germany and the Slovak Republic accounted for 90% of EU exports of autos to China in 2023; one of the Slovak Republic's largest auto production complexes belongs to Volkswagen.

FIGURE 7 **CHINA IS BUYING MORE EU EXPORTS AND LESS US EXPORTS OF MANUFACTURED GOODS SINCE THE TRADE WAR**



Note: ROW = rest of world; US = United States; EU = European Union. EU exports converted to US dollars from euros using end of month dollar/euro spot exchange rate from Federal Reserve Economic Data (DEXUSEU).

Source: Constructed by the author with data from US Census (via Dataweb), Eurostat, and UN ITC Trade Map.

4 POLICIES TO REDUCE ECONOMIC INSECURITY

The European Union and other governments can deploy multiple policy instruments to alter firm incentives. This section focuses on five of them: inventory management, supply-side subsidies, tariffs, export controls, and foreign investment regulations. It explores examples of how governments are using these policies for reasons that are consistent with an effort to improve their economic security. Although the emphasis

remains on EU interests, some of the novel policies worth discussing arise from other countries. This section also reviews existing WTO system rules (where applicable) as well as potential tweaks to those rules that might be incorporated to facilitate the use of those instruments to help achieve domestic policymakers' objectives.

The working assumption is that policymakers want to balance multiple objectives. One is to maintain access to critical goods across more states of the world – even when there is the realisation of bad shocks – but recognising that bad shocks can also occur at home. However, there is also acknowledgment that the current geographic concentration of production of certain goods increases the probability of certain bad shocks; given policymaker uncertainty that firms are internalising those risks, government officials may want to create additional incentives to shift the location of production (or shift it more quickly). Finally, there is recognition that in the worst states of the world (war, pandemic), a local supply chain is preferable, because policymakers can compel it to do things they cannot if production is conducted abroad.

4.1 Inventory management

Holding inventories is one way to help smooth consumption across good and bad states of the world. Stockpiling can make it more difficult for a malicious foreign policymaker to impose effective export restrictions. Establishing a credible threat to release previously produced supplies onto the market to dampen any adverse price effects could dissuade malevolent policy.

Perhaps the most famous example of stockpiling as such a tool of economic policy is the Strategic Petroleum Reserve (SPR), an emergency stockpile of petroleum that the US government established in 1975 after suffering through the economic shocks of shortages and inflation induced by the 1973 OPEC-led oil embargo. In 2022, following Russia's invasion of Ukraine, the United States sold off over 40% of the SPR to help limit rising fuel prices globally.[48] In the European Union, there have been discussions about whether to create a strategic natural gas reserve. One debate is whether such an arrangement may have eased the pain or even deterred Russia's withholding of natural gas exports in 2022 or in the 2021 lead-up to its February 2022 invasion of Ukraine.[49]

Other stockpiling examples are not necessarily motivated by concerns over cartel-like behaviour. In the United States, the Strategic National Stockpile (SNS) is tasked with maintaining an adequate US inventory of PPE in case of a public health emergency. The SNS was quickly exhausted in the COVID-19 pandemic, however, leading to PPE

48 Ben Lefebvre, "Biden Sold Off Nearly Half the US Oil Reserve. Is It Ready for a Crisis?," *Politico*, 16 October 2023.

49 S&P Global, "Time for Europe and the IEA to Create a Strategic Gas Reserve," Commodity Insights, 27 September 2021. Beginning in mid-2021, months before invading Ukraine, Russia limited natural gas exports to Europe to long-term contracts and ended spot market sales (US Energy information Administration, "Russia's Natural Gas Pipeline Exports to Europe Decline to Almost 40-Year Lows," 9 August 2022).

shortages with tragic public health effects (Bown, 2022a; Joskow, 2022), illustrating how the existence of a stockpiling program does not imply that it will work in the face of an adverse shock. (Although it was not weaponised, PPE also did turn out to have had geographically concentrated production in China.)

Some countries, including India, hold stockpiles of food.[50] With respect to WTO rules, these stockpiles have become very contentious, as they can conflict with explicit national commitments to limit subsidies for food products under the WTO's Agreement on Agriculture.[51]

In the 1970s, stockpiling took on a prominent role in public policy debates out of fear over cartels for oil and other commodities (Nichols and Zeckhauser, 1977). But inventory management for economic security has its own policy challenges and trade-offs. Holding inventories is costly. Governments in power may also be unable to resist releasing stockpiles for political reasons – to lower prices to benefit consumers right before an election, for example – making inventory management for economic security reasons difficult to sustain.

Nevertheless, given that the private sector can hold inventories, it is also important to understand the nature of any market failures that would create a role for government. One potential explanation is scale: the size of the optimal stockpile may be sufficiently large that no private sector actors may emerge. A second is the potential time-inconsistency problem. Although policymakers may encourage stockpiling, the private sector may fear that the emergence of a crisis that causes them to draw down (and profit from) their inventories will make policymakers reverse course by imposing price controls or taxing 'excess profits', thereby eliminating the value of the private sector's investments. (The inability of policymakers to tie their own hands discourages the private sector from creating stockpiles in the first place.)

Finally, inventories are feasible only for certain types of goods. Stockpiling cannot work for goods that need to be invented to address an emergency, such as new diagnostics, treatments, or vaccines in response to a pandemic. Holding inventories will also be less effective at addressing shortages of goods with quick product cycles – such as advanced node semiconductors – whose value starts high but then may diminish quickly as they are replaced by newer products.

50 See Pratik Parija, Anup Roy, and Bibhudatta Pradhan, "India's Grain Stockpiles Key to Modi's Pre-Election Strategy," Bloomberg, 8 August 2023.

51 For a discussion, see Glauber and Sinha (2021).

4.2 Production subsidies and the management of capacity utilisation

One way to incentivise the movement of a supply chain away from its current location is through a subsidy. In theory, there are at least two ways to condition the subsidy. One is to grant it provided the supplier leaves its current location. Another is to allocate it if the firm arrives (and starts investing or producing) in a particular location. This distinction has become important, as explored below.[52]

One potential benefit to a subsidy may be increased diversification and thus continued provision of output in certain states of the world, such as when a foreign shock might otherwise have cut off supplies. There may also be spillovers if the subsidy moves production to a local supplier, giving local policymakers greater control (or responsiveness) in case of an emergency. In the case of COVID-19 vaccine production, for example, US government use of the Defense Production Act and priority-rated contracting was likely effective at triggering an earlier and larger production response than it would have had the United States not had local manufacturing capacity.[53]

Subsidies are also costly, however, for several reasons. First, subsidies involve fiscal costs. Second, efficiency costs may emerge if forced diversification results in firms producing at a smaller scale or otherwise losing access to local agglomeration externalities. Ongoing subsidisation may be required if the objective is to maintain domestic production in the new environment even if the new industry is not competitive with foreign firms. (An alternative would be less efficient protection via tariffs.)

Even subsidies to maintain some domestic production do not guarantee greater responsiveness to an emergency, however. For example, the US government funded a programme to keep production capacity for vaccines set aside (in reserve) in case of a pandemic. But the contractor, Emergent BioSolutions, mismanaged the manufacturing process of the Johnson & Johnson and AstraZeneca vaccines when COVID-19 hit, forcing it to destroy hundreds of millions of doses of the vaccines (Bown and Bollyky, 2022). (This transgression has been largely forgiven by history, because of the success of mRNA vaccines by Pfizer/BioNTech and Moderna, which made those tainted vaccines superfluous for the US market.)

Existing WTO rules have two main concerns with subsidies.[54] The first is that the WTO prohibits subsidies contingent on local content (as opposed to the use of imported inputs) or exports. The second involves the potential international economic externalities of the subsidy and whether it erodes the partner's expected access to the EU or third-country markets. Such harmful effects – which are likely to emerge for large producing economies like the European Union – make these subsidies 'actionable' and subject to a

52 For a new database on contemporary use of industrial policy, see Evenett et al. (2024).
53 For a discussion of DPA and priority-rated contracting as it was applied to COVID-19 vaccine supply chains, see Bown (2022a). For recent EU proposals, see Aurélie Pugnet, "European Commission Mulls New European Defence Act before End of Year," *Euractiv*, 4 September 2023.
54 For a discussion, see Bown (forthcoming).

policy response by the adversely affected trading partner. The cost–benefit calculation influencing the European Union's decision on whether to impose a subsidy may thus also need to consider additional costs, such as the lost export market access for a different EU industry if its subsidy induces (WTO–consistent) retaliation by the trading partner.

The next sections highlight examples of governments using subsidy policies in an attempt to de-risk. It also describes some government efforts to subsidise a supply chain to leave one country and go into a third country.

4.2.1 The Inflation Reduction Act and US subsidies for critical minerals

Under the Inflation Reduction Act (IRA) of 2022, the United States has developed a creative approach for subsidising the creation of supply chains outside of China. In trade circles, the IRA is best known for the local content requirement of its EV consumer tax credits under Section 30D, which led to trade disputes with Europe and South Korea that the Biden administration resolved through a regulatory decision in which subsidies for leased EVs were exempt from the local content requirement (Bown 2023a, 2024).

For critical minerals and materials, however, more important are Section 30D's provisions requiring that, over time, even vehicles assembled in North America cannot receive the consumer tax credit if these key battery inputs continue to be sourced from China. The law also implicitly recognises that many critical minerals are unlikely to be mined or processed in the United States. It therefore allows for tax credit eligibility if the critical minerals are sourced from a US free trade agreement (FTA) partner. In a March 2023 decision, the US Treasury expanded the definition of free trade agreement partner to extend beyond the 20 countries with which the United States has a Congressionally approved FTA to include other countries with which the US government might negotiate critical minerals agreements.

To date, the United States has negotiated such a critical minerals agreement with only one country (Japan) to completion; it is in talks with the European Union and the United Kingdom. There have also been public reports of requests from other countries, such as Indonesia and the Philippines. South Korean battery companies (which have significant manufacturing plants in the United States) have lobbied the United States to negotiate such agreements with Indonesia and Argentina, presumably because they source critical minerals from those countries.[55] The United States has been unresponsive to date, in part because much of the nickel industry in Indonesia involves Chinese ownership or joint ventures of local firms with Chinese firms.[56] These arrangements may therefore not address the concerns over supply chain control driving US worries over its economic security.

55 Kyongae Choi, "Finance Minister Calls for US Cooperation in IRA Guidance on Critical Minerals," Yonhap News Agency, 26 February 2023.

56 Mercedes Ruehl, Christian Davies, and Harry Dempsey, "Indonesia Business Presses US over Green Subsidies for EV Minerals," *Financial Times*, 29 March 2023.

As neither the European Union nor the United States is likely to mine or process significant amounts of critical minerals domestically, a bilateral critical minerals agreement may not be particularly valuable to either. Nevertheless, European automakers and battery manufacturers would likely benefit from creation of a separate critical minerals supply chain outside of China that could result from US policy incentives. Even if European automakers continue to source from China, the existence of alternative suppliers would reduce China's supply-side market power, to the benefit of all potential buyers.

Of course, creating additional supply chains to limit China's ability to weaponise its exports is a costly approach to tackling the climate crisis. It would be more efficient globally to negotiate new rules with China to discipline its use of export restrictions as part of a bigger package of cooperation on trade and climate (Bown and Clausing, forthcoming).

4.2.2 Japan's 'China exit' subsidies

Japan's recent efforts illustrate a second example of creative subsidies to de-risk from China. In the face of early COVID-19 supply chain disruptions facing Japanese firms in China, the Japanese government earmarked $2.2 billion in April 2020 for 'China exit' subsidies – subsidies for the affiliates of Japanese-headquartered firms to leave China. Nearly 10% of the funding – and 30 of the 87 projects announced in July 2020 – involved the Japanese government subsidising firms to move production from China to third countries in Southeast Asia, such as Laos, Vietnam, and Malaysia,[57] in part to take advantage of comparative advantage and the existence of local, pre-existing supply chains. Although some production lines involved PPE and other COVID-19-related products – and thus were in response to immediate concerns of supply shortages coming out of China – subsidies were also granted to Japanese firms making products completely unrelated to the pandemic, including aviation parts, auto parts, and fertilizer.

4.2.3 Subsidies and coordination of the movement of semiconductor supply chains

There are multiple issues of concern about the future location of production of semiconductors. One is the subsidies China has provided to the industry (OECD, 2019) and its stated goal (in the Made in China 2025 industrial policy) to dominate the sector globally, which could result in it having supply-side market power that it could weaponise. Another potential concern involves the existing geographic concentration of semiconductor production in East Asian hotspots (Taiwan, South Korea), especially the most advanced nodes in Taiwan, by TSMC.

The semiconductor shortages that arose in 2021 hurt Europe. German automakers in particular were forced to cut back production, with considerable impact on the German economy.[58]

57 See Isabel Reynolds and Emi Urabe, "Japan to Fund Firms to Shift Production out of China," Bloomberg, 8 April 2020; *Nikkei Asia*, "Japan Reveals 87 Projects Eligible for 'China Exit' Subsidies," 17 July 2020.

58 Joe Miller and Martin Arnold, "Car Chip Shortage Weighs on German Economy," *Financial Times*, 17 July 2021.

Two main factors drove the auto industry shortage. The first was global automakers' decision to pull semiconductor orders in response to the mobility restrictions imposed in early 2020 because of the pandemic. The second was that, seeing heightened demand because of those restrictions, semiconductor manufacturers quickly replaced those orders with higher-value chips from consumer electronics firms.[59] As a result, when mobility restrictions were lifted and automakers tried to place new orders later in the year, there was a major backlog, as semiconductor manufacturers were operating at capacity and producing more profitable varieties of chips. The experience heightened European policymaker awareness that Europe had a dwindling share of global chip manufacturing and thus little control over the supply chain in the event of an emergency.[60] Since then, policymakers have sought both to diversify more production out of East Asia and to bring some of it to Europe, in part to retain some control over suppliers in the event of future shocks.

Germany has reportedly offered as much as €5 billion of subsidies for TSMC to construct a manufacturing facility in Dresden. The complex arrangement involves equity stakes by NXP, Infineon, and Bosch and thus required sign-off over any anti-trust concerns by the German cartel office.[61]

Other countries are also working to diversify TSMC's production outside of Taiwan. Japan granted over $3 billion in subsidies to the company to build a facility on the island of Kyushu.[62] The United States is expected to subsidise TSMC's construction of a plant in Arizona once it begins to disburse funding made eligible under the CHIPS and Science Act of 2022.[63]

Germany has also promised Intel nearly €10 billion of subsidies for two plants in Magdeburg.[64] Intel has also received subsidies for a new assembly, packaging, and test facility in Poland, which is likely to service the German plants.[65] France will provide €2.9 billion of subsidies to GlobalFoundries for a new facility with STMicroelectronics in southeastern France.[66]

59 See Semiconductor Industry Association, "Semiconductor Shortage Highlights Need to Strengthen U.S. Chip Manufacturing, Research," Blog, 4 February 2021.

60 In May 2021, the US government reportedly contemplated using the Defense Production Act to forcibly allocate some production of chips toward similarly harmed auto plants in the United States. It decided against it, because doing so would have simply reallocated semiconductors away from goods like consumer electronics that were still in high demand because of pandemic-era mobility restrictions requiring work from home and school from home. (See Trevor Hunnicutt, Andrea Shalal, and David Shepardson, "Exclusive: Facing Chips Shortage, Biden May Shelve Blunt Tool Used in COVID Fight, Reuters, 5 May 2021.)

61 See Debby Wu and Aggi Cantrill, "TSMC to Build $11 Billion German Plant with Other Chipmakers," Bloomberg, 8 August 2023; Linda Pasquini, "Germany Approves Stakes by Bosch, Infineon and NXP in TSMC Chip Plant," Reuters, 7 November 2023.

62 Kana Inagaki, "How TSMC's Chip Plant Is Shaking Up Japan," *Financial Times*, 25 September 2023.

63 Cecilia Kang, "How Arizona Is Positioning Itself for $52 Billion to the Chips Industry," *New York Times*, 22 February 2023.

64 Friederike Heine, Supantha Mukherjee, and Andreas Rinke, "Intel Spends $33 Billion In Germany In Landmark Expansion," Reuters, 19 June 2023.

65 Karol Badohal and Supantha Mukherjee, "Focus: How Poland Snagged Intel's Multi-Billion Dollar Investment," Reuters, 22 June 2023; Intel, "Intel Plans Assembly and Test Facility in Poland," Press release, 16 June 2023.

66 Dominique Vidalon and Sudip Kar-Gupta, "France to Provide 2.9 Billion Euros in Aid for New STMicro/ Globalfoundries Factory," Reuters, 5 June 2023.

It is noteworthy that Europe and other key US allies have provided government support to US–headquartered companies like Intel, GlobalFoundries, Micron, and IBM, given that most of these companies are expected to apply for and receive CHIPS Act funding that also expands US–based production. (Micron will also receive $1.3 billion from the Japanese government for a factory in Hiroshima,[67] and IBM has partnered with Rapidus, a newly formed Japanese semiconductor manufacturer, to produce advanced-node chips in Japan.)[68] Although the CHIPS Act included guardrails to prevent companies that accept US funding from expanding their manufacturing facilities in China, the US administration has not complained about allied countries subsidising US-headquartered firms.

Under the CHIPS Act, the United States also has created incentives similar to Japan's China exit/third- country subsidies. Up to $500 million may be used to subsidise assembly, packaging and test facilities in labour-abundant countries outside the United States. In 2023, for example, the United States announced that it was exploring such partnerships with Panama, Costa Rica, and Vietnam.[69] (Intel, for example, already has facilities in Costa Rica and Vietnam.)

Many, including prominent European policymakers,[70] have described the proliferation of state funding for semiconductors as simply a 'subsidy war'. While this is a risk, a more nuanced view is that Europe and the United States have common objectives and would benefit from coordinating their uses of industrial policy. Even before the inauguration of the Biden administration, in January 2021, the European Commission released a blueprint seeking to reboot transatlantic ties after the Trump administration.[71] The Biden administration has made similar efforts: the United States and the European Union established the Trade and Technology Council early in 2021, using it, in part, to discuss coordination of their industrial policies for semiconductors. This information-sharing has also extended to Japan, a country with common concerns. [72]

67 Yoshiaki Nohara, "In Boost for Chip Ambitions, Japan Inks $1.3 Billion in Subsidies for Micron Plant," Bloomberg, 2 October 2023.

68 Tim Kelly and Jane Lee, "IBM Partners with Japan's Rapidus in Bid to Manufacture Advanced Chips," Reuters, 12 December 2022.

69 See US State Department, "Department of State Announces Plans to Implement the CHIPS Act International Technology Security and Innovation Fund," Press release, 14 March 2023; US Department of State, "New Partnership with Costa Rica to Explore Semiconductor Supply Chain Opportunities," Press Release, 14 July 2023; US Department of State, "New Partnership with Panama to Explore Semiconductor Supply Chain Opportunities," Press Release, 20 July 2023; US Department of State, "New Partnership with Vietnam to Explore Semiconductor Supply Chain Opportunities," Press release, 11 September 2023; Francesco Guarascio, "Vietnam Eyes First Semiconductor Plant, US Officials Warn of High Costs," Reuters, 30 October 2023; Reuters, "Intel to Invest $1.2 Bln In Costa Rica over Next Two Years," 30 August 2023.

70 "'It's like a declaration of war,' Robert Habeck, Germany's vice-chancellor and economics minister, said last month… . 'The [Americans] want to have the semiconductors, they want the solar industry, they want the hydrogen industry, they want the electrolysers,' Harbeck told a business conference." See Guy Chazan, Sam Fleming, and Kana Inagaki, "A Global Subsidy War? Keeping Up with the Americans," *Financial Times,* 13 July 2023.

71 European Commission, "A New EU-US Agenda for Global Change," Joint Communication to the European Parliament, European Council and the Council, 2 December 2020.

72 See Yuka Hayashi, "US, EU Agree to Coordinate Semiconductor Subsidy Programs," *Wall Street Journal*, 5 December 2022. Rihao Nagao, "Japan and EU to Share Chip Subsidy Info to Disperse Production. Three-Way Exchange with US Aims for Better Supply Chain Distribution," *Nikkei Asia*, 29 June 2023.

Nevertheless, not all subsidies that these governments are disbursing are in this vein. In Japan, for example, 90% of the 2020 China exit subsidies were earmarked for production to leave China by returning to Japan. For PPE, the US government spent over $1 billion in 2020–21 to subsidise the creation of entire domestic supply chains in response to the shortages arising during the early days of COVID-19 (Bown, 2022a). In the IRA, a plethora of local content provisions attempts to incentivise clean energy projects to disproportionately rely on US-made inputs like steel.

4.3 Tariffs

Tariffs are another instrument potentially affecting supply chains. They can be used to address two different margins.

First, a government can raise its tariffs on all trading partners – by, for example, raising its most favoured nation (MFN) tariff. Doing so creates incentives for increased local production because it discriminates equally against all foreign firms. An MFN tariff creates incentives similar to the production subsidy described in Section 4.2, but it does so less efficiently, as it also increases the price to domestic consumers. (The effect of a 10% tariff is equivalent to the combined effect of two domestic policy instruments, a 10% production subsidy and a 10% consumption tax).

The potential WTO concern with simply raising the MFN tariff is that tariffs are legal commitments under Article II of the General Agreement on Tariffs and Trade (GATT). However, specific rules are written into the WTO allowing governments to increase those binding tariff commitments. Under GATT Article XXVIII, a WTO member can raise its MFN tariff without even having to resort to arguments that its domestic industry is injured or that it faces an import surge or that imports are unfair because they are being subsidised or dumped into the market. The cost of using Article XXVIII is that trading partners are permitted to retaliate by reciprocally raising their tariffs.

Second, a government can change the tariffs it imposes on some countries but not others, in order to encourage imports from country B in lieu of country A, by either lowering the tariff facing exporters in B selectively or raising the tariff facing exporters in A selectively. The relative efficacy of the two options also depends on the starting point. In the extreme example in which the country's starting point MFN tariff is zero, the only policy option is the second, as governments rarely subsidise imports.

The WTO concern with discriminating between two foreign sources of imports is violation of the MFN principle in GATT Article I. Even this constraint is not legally insurmountable, however, as the WTO provides for numerous exceptions to MFN. The biggest loophole is GATT Article XXIV, which allows countries to lower tariffs toward one another preferentially under an FTA, provided doing so covers substantially all trade. (Multiple such agreements are already in place with the European Union, including with major economies such as Japan, Korea, Canada, and most recently the United

Kingdom. It also has a customs union with Türkiye.)[73] Otherwise, applying tariffs in a discriminatory manner across WTO members requires resort to specific TDIs. For example, if imports from country A have been dumped (anti-dumping duty) or subsidised (countervailing duty), causing injury to the domestic industry, the WTO member can impose a TDI on imports from country A (but not B), thereby creating the differential tariff treatment that generates incentives to source from country B instead of country A.

If the European Union is committed to following WTO rules, it could legally adopt explicit approaches to shift its relative tariffs to create private sector incentives to encourage more diversification beyond that already implied by its existing web of FTAs and customs unions. Each of the three approaches described next has trade-offs.

4.3.1 The proactive approach to tariffs

A first, proactive approach to de-risking would involve two steps. The first would be for the European Union to increase its MFN tariffs under GATT Article XXVIII, as described above. The cost would be that trading partners would be allowed to retaliate by reciprocally raising their tariffs. Which trading partners would do so is an important issue, examined below.

The second step would be for the European Union to negotiate additional FTAs with preferred trading partners under GATT Article XXIV. Unlike an action under Article XXVIII, these preferred trading partners have to be willing to find such an agreement mutually advantageous. But as long as the agreement covers "substantially all trade", it would be WTO-consistent.

Going back to the first step, trading partners receiving better-than-MFN tariff treatment from the European Union would not seek retaliation (or rebalancing). The only countries likely to retaliate would be those that the European Union is seeking to de-risk from in the first place.

The effect of this policy would be similar to where the United States and China ended up with each other as a result of their trade war (see Figure 5), with each country applying higher tariffs toward the other than it does toward other WTO members. The difference is that in the US–China case, the MFN tariffs are the low tariffs and the discriminatory tariffs are the high tariffs. In the hypothetical case proposed here for the European Union, the MFN tariffs would be the high tariffs and the discriminatory tariffs the low tariffs.

73 The European Union has negotiated such agreements with other economies, including Mexico and MERCOSUR (awaiting ratification); it is conducting negotiations with others, including India and Indonesia. See European Commission, "Negotiations and Agreements," last accessed 31 December 2023.

4.3.2 The reactive approach to tariffs

The second approach – establishing contingent tariff instruments to deploy if certain conditions arise – is the current EU approach. One such policy is the European Union's new anti-coercion instrument (ACI), which could be used to retaliate if, say, China repeated something similar to what it recently did to Lithuania.[74]

Other policies include TDIs. The European Union could, for example, impose countervailing duties after an investigation into whether imported goods that caused injury to European producers were subsidised (see the EV example described in section 3.1). At the time of writing, the European Commission was reportedly considering self-initiating similar anti-subsidy investigations into Chinese wind turbines and steel.[75] Alternatively, the European Union could impose a substitutable TDI, such as antidumping. Such TDIs are not new to the European Union; through 2019, over 6% of EU imports from China were already subject to a TDI (Bown, 2022c).

One limitation of these instruments is that they are reactive. If they need to be triggered, their deterrence value has failed. In addition, showing evidence of injury to the domestic industry (let alone subsidised or dumped imports) often implies that the foreign industry has already been established (and is a successful exporter) and the TDI is going to have limited effectiveness at addressing the larger concerns of trading partner subsidies distorting global economic activity.

Another limitation is that existing TDIs are not directly linked to concerns over economic security or that the European Union is becoming overly dependent on a particular foreign supplier. Put differently, the European Union could become overly reliant on one country as an import source, but without that country having subsidised production or dumped its exports into the EU market, that country would not meet the legal criterion to trigger traditional TDIs.

Finally, one historical argument in favour of TDIs may also now need to be abandoned. Under the rules-based trading system, many observers viewed a country's use of TDIs as a signal of adherence to WTO rules (as countries could have imposed protection in some other, less transparent form but did not). Under WTO rules, policymakers are supposed to be able to impose TDIs 'for free'. Yet numerous examples of China retaliating against EU TDIs illustrate the limited value of seeking to avoid trading partner retaliation by shifting import protection into TDIs instead of another instrument.[76]

74 European Parliament, "Anti-Coercion Instrument: The EU's New Weapon to Protect Trade," Press release, 3 October 2023. An important initial motivation for the ACI was the Trump administration's tariffs, threats, and other actions beginning in 2018 (Hackenbroich and Zerka 2021; Wu 2023).

75 See Andy Bounds, "EU Plans Anti-Subsidy Probe into Chinese steelmakers," *Financial Times*, 10 October 2023; Alice Hancock and Andy Bounds, "EU Considers Anti-Subsidy Probe Into Chinese Wind Turbines," *Financial Times*, 6 October 2023.

76 China's retaliation to EU TDIs is reminiscent to how China retaliated beginning in 2009 to US use of TDIs (Bown, 2019).

4.3.3 A middle-ground approach to tariffs

If renegotiating a country's relative tariff profiles is politically infeasible and the existing TDIs imperfectly address concerns over economic security, policymakers could consider a new TDI proposal. Suppose governments could trigger a bilateral trade restriction for goods with geographically concentrated production when bilateral dependence exceeds a certain critical threshold. For example, when Russian gas or Chinese graphite hits, say, 30–40% of EU market penetration, the European Union could be permitted to impose an import quota to prevent the volume from increasing further.

There is value to a well-designed new TDI if it helps prevent excessive dependencies, weakens a trading partner's ability to weaponise its exports, and thus helps keep markets open in a world threatened by policy responses to economic security. Furthermore, such a remedy might not be much worse than the existing TDIs (antidumping, countervailing duties, safeguards), given that they also target something other than short-run economic efficiency. Economists have suggested that the costs to such TDIs could be offset if they serve other beneficial functions, including acting as an escape value (increasing trade barriers only selectively) and allowing governments to maintain greater trade policy cooperation overall in the face of shocks.[77] Bagwell and Staiger (1990), for example, develop a theory from a repeated game setting in which terms-of-trade shocks generate pressure to increase tariffs. They show how TDIs can help governments avoid defection. Bown and Crowley (2013) provide evidence consistent with this motive affecting US use of TDIs in 1997–2006.

The downside of using such TDIs includes the static inefficiency costs associated with any additional act of import protection (unless the policy-imposing country is large and can extract terms-of-trade gains, as through an optimal tariff). Making a new TDI available could also promote rent-seeking and firms wasting valuable resources in an effort to obtain protection. A cooperative and enforceable agreement in which all countries committed not to impose export restrictions or tariffs would yield better joint outcomes. (The assumption is that fully cooperative policy is currently impossible.)

In addition to short-term inefficiencies, any application of this new TDI policy would also be costly for buying firms. A government policy that forced some firms to source from a higher-cost third-country supplier would hurt their competitiveness. There may thus be a complementary role for subsidising such firms to offset those losses.

Two other concerns with such a proposal are the difficulty of setting criteria for such a new TDI and the nonavailability of sufficiently precise supply chain data to administer it effectively. For example, what is the right threshold level past which the TDI would be triggered? Even the 30% import dependency threshold would not have identified graphite

77 For an economic model whereby such TDIs can act as insurance for import-competing sectors affected by negative price shocks, see Fischer and Prusa (2003).

from China as a product from which the European Union should seek to diversify import sources based on the six-digit import data (see Figure 4). Furthermore, the source country's share of global production is also critical but often much more difficult for a policymaker to obtain.

4.4 Export controls

The change in geopolitics has increased the use of export controls, including by the European Union and its member states. Historically, such export restrictions have often been imposed on dual-use goods for national security reasons.[78] Some of the modern applications have come alongside the United States' use of export restrictions targeting China. Others were imposed in response to Russia's invasion of Ukraine.

To see why export controls have increased, assume there is a negative externality associated with the European Union exporting some good or service to another country. One example is the equipment created by ASML in the Netherlands to manufacture advanced-node semiconductors, a dual-use good. When that negative externality arises because of the export of the good, a first-best policy can be an export ban.

Export controls are mostly undisciplined under WTO rules. Article XI of the GATT provides the basic guidelines for export restrictions. Export quotas are forbidden, but the potentially economically equivalent policy instrument of an export tax is not. Even the ban on export quotas is subject to exceptions, as the prohibition does not extend to instances in which it is "temporarily applied to prevent or relieve critical shortages of foodstuffs or other products essential to the exporting contracting party", where neither *temporarily* nor *essential* is defined.

4.5 Regulation of foreign investment

Governments are also worried about foreign policymakers acquiring access to goods or services that threaten their national security or otherwise taking actions that reduce their economic security, through state-directed foreign investment decisions. One way this could happen is through inbound investment (foreign firms acquiring local firms for their sensitive technologies).

Since 1975, the Committee on Foreign Investment in the United States (CFIUS) has reviewed, mitigated, and even blocked such transactions from taking place in the United States.[79] In 2020, the European Union's related Foreign Direct Investment Regulation took effect. It encourages member states to create inbound foreign direct investment (FDI) screening systems, set minimum standards for such systems, and establish a mechanism for coordinating such reviews across members. By 2022, two-thirds of EU

78 A dual-use good is one, such as high-end chips, that can be used for both innocuous purposes (video games, smartphones, or socially beneficial artificial intelligence applications) and advanced weapons systems or other military purposes that might endanger national security.

79 See Congressional Research Service (2018) for the history of CFIUS and an overview of how it has been used.

member states had inbound FDI screening legislation in place (European Commission, 2023b). In 2023, however, Germany's foreign investment screening process was caught up in controversy when the German government allowed COSCO, the Chinese state-owned shipping company, to take a sizable ownership stake in a Hamburg port terminal.[80]

An additional regulatory policy tool affecting European inbound FDI is the European Union's new Foreign Subsidies Regulation (FSR).[81] It was established out of concern that foreign-headquartered firms could imperil the level playing field of the European Union's internal market by providing subsidies to their affiliates operating in EU member states. Even if the European Union wants the main benefit of the policy tool to be to deter foreign subsidisation, the FSR seems likely to be triggered, especially given the increasing levels of Chinese investments into the EU market (see the concerns raised by the EV battery example described in Section 3.1).

An additional potential tool is the regulation of outbound FDI out of concerns over policy substitution. For example, the Netherlands, the United States, and Japan have coordinated their export controls to prevent physical goods – such as equipment to manufacture high-end semiconductors that might prove beneficial for advanced weapons systems – from getting to China. However, the US government is also worried that American investors may provide China with the financial resources to develop the product or industry locally. One way it has attempted to limit this possibility is through the constraints in the CHIPS Act funding – that companies applying for and accepting US federal subsidies for their investments in the United States face limits on investments in their Chinese operations for ten years.[82] In addition, in an August 2023 Executive Order, the Biden administration announced a limited screening process to deter American investments in China and other countries that could help them develop military technologies.[83] The European Commission is similarly examining security risks associated with outbound investments (European Commission, 2023a).

80 Hans von der Burchard, "Germany Doubles Down on China Port Deal Despite New Security Concerns," *Politico*, 10 May 2023. For data on how Germany has used foreign investment screening, see Federal Ministry for Economic Affairs and Climate Action of Germany, "Investment Screening in Germany: Facts & Figures," 9 January 2023.

81 For a discussion of the regulation, see Andhov et al. (2023, pp. 80–85).

82 Commerce Department, "Preventing the Improper Use of CHIPS Act Funding. A Rule by the National Institute of Standards and Technology," 88 Federal Register 65600, 25 September 2023.

83 See White House, "Executive Order on Addressing United States Investments in Certain National Security Technologies and Products in Countries of Concern," 9 August 2023; Department of Treasury, "Provisions Pertaining to US Investments in Certain National Security Technologies and Products in Countries of Concern," A Proposed Rule by the Investment Security Office, Federal Register, 14 August 2023; Martin Chorzempa, "Biden's New Outbound Investment Restrictions with China Are A Sensible Compromise, But Further Tightening Is Likely," *PIIE Realtime Economics Watch*, 10 August 2023.

5 NEW FORMS OF (SELECTIVE) INTERNATIONAL COOPERATION

Geopolitics and the fear that certain foreign policymakers are actively working against the European Union's economic security goals leave little immediate-term hope for additional *multilateral* cooperation on trade.[84] However, there is still considerable scope for selective cooperation, especially among countries that have common de-risking objectives and similar concerns over malicious policymakers abroad. In fact, the failure to coordinate such policies may often undermine each individual countries' economic security objectives. This section introduces a number of new scenarios likely to arise, and the trade-offs associated with different approaches to selective international cooperation to tackle them.

5.1 Joint application of export controls toward third parties

First consider the issue of export controls. Export controls are difficult for policymakers to impose even on their own firms because they eliminate market access opportunities. Furthermore, unilateral export controls may result mainly in self-harm if there are other innovative countries capable of producing the goods being controlled. Not only are such unilateral controls unlikely to prevent the dual use goods from getting to the adversary, but the unilateral restriction will end up hurting only the competitiveness of the national industry.

The Trump and Biden administrations used slightly different approaches to ensure that US-led export controls ended up being so comprehensive. The Trump administration mainly coerced firms in trading partners through an extra-territorial application of what is referred to as the foreign direct product rule (FDPR). It states that if a foreign firm does not voluntarily follow US export controls, it can lose access to the US inputs and technology it needs (at least in the short run) to produce the good being controlled. The Biden administration has mostly taken a different approach. Alongside its export controls on equipment to manufacture advanced node semiconductors, for example, it has exerted considerable diplomatic effort to convince key governments in the Netherlands and Japan of the underlying national security concern and to voluntarily impose similar controls on their firms rather than using the FDPR.

Coordinating export controls across all major producers is essential if the policy is to work. Uncontrolled foreign firms have an incentive to backfill and provide the technology, goods, or inputs needed. Coordinating export controls across countries is also extraordinarily difficult, however, especially without an institutional arrangement

84 A counterargument is the existential and global threat of climate change, for which the only solution is multilateral cooperation; see Bown and Clausing (forthcoming).

and ex ante agreement on when and how to do so. Without access to the intelligence and an understanding as to how they would jointly suffer if the technology were to fall into the wrong hands, policymakers in other countries will not understand the costs of failing to act and thus have an incentive to hold out, in order to benefit their firms.[85]

The difficult task of coordinating export controls is not new; it has simply been deprioritised since the end of the Cold War. There are thus lessons to be learned from that era's Coordinating Committee for Multilateral Export Controls (CoCom) arrangement (the forum through which Western countries coordinated export controls in an effort to prevent dual-use goods from flowing to the Soviet Union). The system was imperfect for a number of reasons. Addressing those imperfections today is likely to require building new institutional arrangements – beyond the export control regimes currently in place – to handle the new geopolitical environment.[86]

5.2 Joint resistance against imposing export restrictions on each other

A weakness of current international agreements, including the WTO, is the limited disciplines constraining the use of export restrictions, either to exploit market power (terms-of-trade gains) or to implicitly subsidise downstream processing in certain supply chains. Although EU member states and the United States certainly use export controls for national security purposes, neither has traditionally used export restrictions to achieve such economic objectives.[87]

During the pandemic, the unwillingness of governments to commit not to impose export restrictions on COVID-19 vaccines was particularly damaging politically. However, because of the time-consistency problem inherent in any such announcement – even if governments announce ex ante that they plan to share vaccines, if and when vaccines are successfully invented and produced in their jurisdiction they will face tremendous domestic political pressure to renege and not export ex post – other actions on deepening interdependence would likely have been required to make such an agreement enforceable.[88]

Looking ahead, the United States seems eager to commit – alongside trading partners – not to impose export restrictions in the critical minerals agreements being negotiated.[89]

85 The Toshiba-Kongsberg incident in the 1980s involved Japanese and Norwegian firms conspiring to provide milling technology to the Soviet Union to make quiet submarines. See Chad P. Bown, "The Return of Export Controls: A Risky Tactic That Requires Cooperation from Allies," *Foreign Affairs*, 24 January 2023.

86 For a discussion of existing multilateral arrangements on export controls, see Bown (2020a).

87 Article I, Section 9 of the US Constitution bans the use of export taxes.

88 Bown (2023c) provides one such proposal for how to do so. See also Bollyky and Bown (2020).

89 The criteria for critical minerals agreement partners require that a country "(A) reduces or eliminates trade barriers on a preferential basis, (B) commits the parties to refrain from imposing new trade barriers, (C) establishes high-standard disciplines in key areas affecting trade (such as core labor and environmental protections), and/or (D) *reduces or eliminates restrictions on exports or commits the parties to refrain from imposing such restrictions on exports*" (88 Federal Register 23370, 17 April 2023, emphasis added).

5.3 Joint regulation of foreign investment

There are also positive spillovers from international coordination of both inbound and outbound foreign investment screening. Failure to share information and intelligence on actors of joint concern will work against achieving even common objectives.

For inbound investment, if one country's screening prevents a malevolent actor from acquiring a sensitive technology only by pushing the actor to another country to access the same technology instead, the objective is not met. A similar concern arises for screening of outbound investment. If the goal of the screening is to discourage actors in one financial market from investing in technologies or productive capabilities in the market of an adversary – that would subsequently get funded by an investor in an ally – the first country's screening mechanism does little to protect national security and may affect only the country's economic competitiveness.

5.4 Agreement not to impose tariffs during a market downturn

The discussion of subsidies – and industrial policy for semiconductors in particular – suggests that, at least on their face, the European Union, the United States, and Japan are seeking to coordinate (or at least communicate regarding) the subsidies they are offering to firms in order to diversify the global manufacturing footprint. However, governments may want to have a jointly agreed upon plan in place to execute if market conditions change, an industry downturn occurs, and there is significant excess capacity in the sector.[90] In the 1980s through early 2000s, for example, the semiconductor industry (especially the memory part of the industry) was characterised by booms and busts and the use of TDIs (in the form of antidumping and countervailing duties).[91]

Given that governments in almost all major semiconductor supplying economies are now subsidising, the evidentiary criterion under WTO rules will be trivial to meet if trading partner governments seek to impose TDIs. The worry is that someday the United States, the European Union, and Japan impose TDIs on each other, even though they may have implicitly agreed today to coordinate (or greenlight) the others' subsidies. (An additional challenge is that in many countries, TDIs can be a largely bureaucratic process driven by firm-level demands for protection that may be difficult for policymakers to stop once firms start it.)

90 This desire may be prompted by fear that the export controls limiting China's ability to produce advanced-node semiconductors will push its firms into building excess capacity to supply legacy chips, which could contribute to an oversupply in that segment of the market.

91 For the evolution of the political economy of the semiconductor industry, see Bown (2020b).

As an alternative, governments may want to commit ex ante to a plan whereby they agree to share the future pain and jointly (and uniformly) scale down parts of the industry in the event of a downturn. The challenge is that policymakers have little experience in the joint coordination of the scaling up or the scaling down of activity (through bankruptcies or mergers and acquisitions, for example).

If the goal of collective effort is to ensure a more geographically diversified supply chain that is also less reliant on manufacturing in China – which has the stated goal of dominating the industry, and a history of weaponising supplies when it has that dominance – policymakers should be forward looking and commit to cooperation in the (seemingly inevitable) difficult times to come.

5.5 Coordination of subsidies for industries with cross-border supply chains

Coordinating international subsidies can also help tackle potential impediments associated with cross-border supply chains during emergencies. The shortage of inputs needed to produce COVID-19 vaccines provides one example. The failure to provide sufficient capacity-building subsidies for input providers in a foreign country likely contributed to the input shortages that slowed the speed and reduced the scale of production of finished vaccines in manufacturing facilities in other countries.[92] Another such shock could be war.

Lessons can be drawn from the Canada–US Defense Production Sharing Agreement (DPSA).[93] Early on in the Cold War, the two countries' military defences were integrated, out of fear that the Soviet Union might attack North America through its border with Canada. The DPSA was established in 1956 to support a more integrated US–Canada industrial base and cross-border supply chains, to overcome the fact that the large asymmetry between the two markets for military procurement (and scale economies of production) meant that Canadian firms selling only to Canada would never be competitive with their American peers.[94] The DPSA was a trade agreement that sought to coordinate the amount of military cross-border spending by the two countries in order to avoid bilateral trade imbalances. As part of the agreement, the United States waived the Buy American Act to give Canadian firms the ability to competitively bid for US Department of Defense contracts; for production planning purposes, under US law Canada is part of the defence industrial base.[95]

92 Bown (2022a, 2023c) describes the COVID-19 vaccine input shortage problem, how it was affected by US use of the Defense Production Act and priority-rated contracting, and the role that international policy cooperation could play in tackling the problem in a future emergency.

93 For a historical perspective and political-economic context for the DPSA, see US State Department (1959). The common defense traces back to 1940; it was formalised in 1958 (NORAD, 2023).

94 Even when it comes to a defense contractor benefiting from spillovers impacting commercial sales of related products – e.g., subsidies to military jets leading to lower production costs for civilian aircraft – recall that potential commercial sales were impeded by tariffs and other trade barriers at the time, as the Canada-US Free Trade Agreement did not arise until 1989.

95 There have been efforts to expand elements of the Defense Production Act to benefit not only Canada, but also the United Kingdom and Australia under the AUKUS agreement that those two countries have with the United States. See Bryant Harris, "Biden seeks legislation to invest in Australia, UK defense industries," *Federal Times*, 25 May 2023.

New institutional arrangements may be needed to commit the European Union to engage with other countries to act collectively in response to certain negative shocks. Joint public investments in nonemergency states of the world may also be necessary, to ensure both preparedness and mutual interdependence when such shocks materialise.

5.6 The multi-country response to acts of targeted economic coercion

The European Union's ACI is an attempt to aggregate a response across EU member states to ensure that third countries can no longer use coercive actions to target individual members (e.g., China and Lithuania) without fear of collective retribution. A separate issue involves whether countries outside the European Union – with, say, joint concerns over China's acts of economic coercion – would want to join together ex ante and promise to assist one another should any of them be targeted in the future.

Economies can respond to an act of economic coercion in two ways. The first is to offer to help partners who may be injured. For example, other countries could preferentially open up their market further to countries whose exports (or investment) were adversely affected, in order to help them deal with the blow of being shut out of the foreign market.

In response to the Lithuania incident, for example, the European Commission approved €130 million to support companies affected by the Chinese trade restrictions.[96] Taiwan also set up a $1 billion fund for joint projects between Taiwanese and Lithuanian companies and attempted to reroute the Lithuanian exports that had been blocked from China and were sitting in Chinese ports.[97] In another example, in late 2023, China unilaterally blocked Japanese seafood exports. The United States attempted to assist the Japanese industry in part through its procurement policy, with US military bases in Japan purchasing hundreds of tons of scallops.[98] Finally, Australia, the European Union, the United Kingdom, and the United States all reduced tariffs or opened up in other ways to increase imports from Ukraine in response to Russia's invasion in 2022.[99]

A second possibility, however, is to coordinate a joint retaliatory action after one in the group is targeted by a third country's act of economic coercion. Such action has been taken after acts of war (numerous countries responded to Russia's invasion of Ukraine by cutting off their import markets from Russian or Belarusian goods); it has not yet been activated after acts of economic coercion. Theoretically, there is some merit to establishing such a policy mechanism. Maggi (1999) shows that, in a repeated game in

96 European Commission, "State Aid: Commission Approves €130 Million Lithuanian Scheme to Support Companies Affected by Discriminatory Trade Restrictions," Press release, 26 April 2022.
97 Milda Seputyte, "Taiwan Plans $1 Billion Fund for Lithuania Projects as China Anger Mounts," Bloomberg, 11 January 2022.
98 Leo Lewis and Kana Inagaki, "Japan's Scallop Industry Seeks Safe Harbour from China Ban," *Financial Times*, 4 November 2023.
99 Chad P. Bown, "Russia's War on Ukraine: A Sanctions Timeline," *PIIE Realtime Economic Issues Watch*, 31 December 2023.

which trading relationships are asymmetric, the credible threat of multicountry tariff retaliation can support greater tariff cooperation than a web of bilateral agreements. Put differently, a commitment to pool enforcement power across trading partners could better deter large countries from bullying smaller ones.

In the current environment, a carrot-based approach may be better than a stick-based one because the latter could result in further tariff escalation – a problem in an already tense geopolitical climate in which governments often face domestic political pressure to overreact. However, even in a carrot-based approach, an ex ante agreement would be needed (with some sort of automaticity if triggered), because there are clear, short-term disincentives for even allies to respond on behalf of another economy that has been targeted, given that economic coercion often provides firms in allies preferential access into the bully's market.

For example, the lack of an ex ante agreement was likely a contributing factor behind South Korea's lack of sympathy for Micron (a US-based competitor to Samsung and SK Hynix) when the Chinese targeted it in 2023.[100] The United States reportedly asked South Korean companies not to backfill Micron's orders in the Chinese market, to no avail.[101] The Korean government would surely have appreciated trading partners to have made such an offering in 2017, when China targeted Korean firms with acts of economic coercion after Korea deployed the THAAD missile system.[102]

5.7 Traditional efforts at deeper, preferential liberalisation with third countries

A more traditional approach to increasing economic security is to diversify sourcing through new preferential trade agreements. The European Union has many such agreements and is negotiating new ones. There are no current prospects for such a deal with the United States, however. Exporters in the United States and the European Union thus face tariff discrimination in each other's markets relative to exporters located in countries that have such arrangements.

100 See Thomas Hale, "China Escalates Tech Battle with Review of US Chipmaker Micron," *Financial Times*, 1 April 2023; Eleanor Olcott and Demetri Sevastopulo, "China Bans Micron's Products from Key Infrastructure over Security Risk," *Financial Times*, 21 May 2023.

101 Demetri Sevastopulo, "US Urges South Korea Not to Fill China Shortfalls If Beijing Bans Micron Chips," *Financial Times*, 24 April 2023; Ryan McMorrow, Song Jung-a, Tim Bradshaw, and Qianer Liu, "South Korea Signals Its Chipmakers Can Fill Gap after China's Ban on Micron," *Financial Times*, 22 May 2023; and David Shepardson, "House Lawmakers Urge US To Rally Allies over China Micron Ban," Reuters, 2 June 2023.

102 See Darren J. Lim and Victor Ferguson, "Chinese Economic Coercion During the THAAD Dispute," ASAN Forum, 28 December 2019.

6 CONCLUSION AND LESSONS FROM HISTORY

The European Union is suddenly concerned about its economic security, for the reasons described in this chapter. It may be able to improve its security – by deterring foreign policymakers from taking malicious actions and ensuring better EU outcomes when malicious policies cannot be deterred – but doing so will be costly. One way to limit those costs is to continue to push for reengagement, especially by China, on cooperative efforts to negotiate new rules that discourage use of such policies.[103]

In the absence of that cooperation, what policy actions the European Union will take to improve economic security remains unclear. Data-driven efforts to diagnose EU trade vulnerabilities[104] identify some products for which the European Union could be susceptible to malicious acts by foreign officials, motivating policy action. The length of this product list should not be exaggerated, however.

In a noncooperative policy environment, much of what comes next for the European Union also rests outside its control, determined by the policy decisions by other major economies. Will China continue on the trajectory President Xi Jinping has set? What will happen in Ukraine? How will the results of the presidential election in the United States affect economic security elsewhere? Adoption of new contingent policy instruments, such as the ACI, may help the European Union deter trading partners from acting maliciously. But right now, it is too early to tell.

To conclude, history offers two lessons about interdependence and activist trade and industrial policy. One lesson involves the loss of benefits from interdependence; the other is the unknown and unintended consequences that could result from activist policy.

6.1 The need for caution

Even in a rapidly changing geopolitical environment, caution is warranted before policymakers abandon trade interdependence. There is historical evidence at both the macro and micro levels that economic interdependence can affect policy decisions in a positive direction. At the macro level, interdependence can affect decisions to forgo war.[105] Martin et al. (2008) find that the larger are bilateral imports (as a share of GDP) from another country, the less likely the two countries are to engage in military conflict. However, the more a country imports from third countries, the more likely it is to go to war with the first country, because it is less reliant on it.

103 For proposals to address some of the greatest concerns with China's economic system in a cooperative setting, see Bown and Hillman (2019) and Mavroidis and Sapir (2021).
104 See the chapter by Mejean and Rousseaux in this volume.
105 Thoenig (2023) provides a framework and recent survey.

At the micro level, there is considerable historical evidence from the GATT and early WTO period that interdependence can also affect trade policy choices. For example, define interdependence as country B having the capacity to retaliate against country A's exports if country A imposes a trade policy that B does not like. Such retaliation capacity has been shown to shape policymaking behaviour by avoiding instances that would provoke such a retaliatory response.[106] It can affect whether industries in country A file for antidumping tariffs as well as the willingness of country A to grant those tariffs. Country B's retaliation capacity can also affect the willingness of country A to follow trade rules when implementing acts of protection as well as country A's willingness to comply with GATT/WTO dispute settlement rulings that find that country A did not follow the rules. If, for some reason, these relationships were unique to the period of the 1970s through the mid-2000s and systematically broken down afterward, it is important that researchers help policymakers better understand why.

During the COVID-19 pandemic, there were also numerous examples showing how trade interdependence can maintain openness even when policymakers have a strong domestic political-economic imperative to close off markets. For example, on 15 March 2020, the European Union's initial export controls for PPE were so tight that they would have cut off sales to Norway and Switzerland. Five days later, after pushback – including revelations that Swiss-made ventilators required imported parts from other EU member states – the European Union revised the policy.[107]

On 29 January 2021, under pressure for failing to have quickly accessed and distributed COVID-19 vaccines to its eager citizens, the European Commission invoked Article 16 of the Northern Ireland protocol in its trade agreement with the United Kingdom. This invocation could have limited exports of the vaccine to the United Kingdom. However, within hours of learning that the United Kingdom was a primary source of the lipid nanoparticle input needed to manufacture the BioNTech/Pfizer and Moderna vaccines on the continent, the European Union rescinded the export restriction. Interdependence thus helped avoid what could have been a damaging escalation affecting both trade and public health.[108]

Similar stories emerged in the United States. In response to a shortage in the early days of COVID-19, on 3 April 2020, the United States imposed export controls on PPE. The initial controls would have limited US exports to Canada and Mexico, whose hospitals relied on sales from a 3M plant in the United States. Given that Canada was a major

106 For a survey of this literature, see Bown (2009, pp. 92-97).

107 See Bown (2022b); Peter Siegenthaler, "Swiss Ventilator Company Inundated by Demand Due to Covid-19," Swissinfo.ch, 17 March 2020.

108 See Bown and Bollyky (2022); Michael Peel, Sam Fleming, George Parker, and Arthur Beesley, "EU Reverses Course after Irish Border Curbs for Vaccines Trigger Uproar," *Financial Times*, 29 January 2021; Financial Times, "EU Threat to Vaccine Exports Exposes Mutual Risks to Global Supply Chain," *Financial Times*, 18 March 2021; Bill Gardner and Ben Riley-Smith, "Exclusive: Pfizer Warns EU to Back Down on Covid Vaccine Threat to UK," *Telegraph*, 19 March 2021.

source of the key input (pulp) needed to manufacture PPE, it was able to convince the United States to adjust the policy, and the export restrictions were revised on 17 April.[109] (However, out of fear that it would be cut off again in the future, the Canadian government subsequently subsidised the establishment of PPE manufacturing facilities in Canada.)[110]

6.2 The risk of unintended and unanticipated consequences

Major shifts in policy often have unintended and unanticipated consequences – as activist US policy in the 1980s illustrates. Faced with new import competition from Japanese semiconductors, for example, the United States pressured Japan to negotiate a semiconductor trade agreement in 1986 that was in part a voluntary export restraint (Japanese firms shipping fewer chips to the United States) and partly a voluntary import expansion (Japan committing to buy more chips from US firms) (Irwin, 1996). Combined with other factors, the agreement led to a period of high prices and super-normal profits that made it easier for firms from Taiwan (TSMC) and South Korea (Samsung) to enter the sector. Both firms subsequently helped transform the now global and highly fragmented industry in ways that modern policymakers find concerning.

Japan's agreement in 1981 to voluntarily restrain automobile exports to the US market also had far-reaching political-economic effects on the US industry. It contributed to a wave of Japanese FDI and jobs in the United States. However, Japanese investment and jobs at Japanese firms were in right-to-work states in the South, whose workers were not unionised, putting long-run competitive pressure on US carmakers and their unionised workers, located primarily in the Upper Midwest.

The economic trade-offs associated with trade interdependence are not new; the fear that foreign governments will weaponise them is new, at least in modern times. As the European Union confronts this geopolitical reality, it will need to balance the benefits of openness against the costs of policies needed to adjust and maintain that openness in its newly modified form.

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109 See Bown (2022b); Chris Bush, "Nanaimo's Harmac Mill Works to Fill Doubled Pulp Order for Medical Masks and Gowns," *Vancouver Island Free Daily*, 24 March 2020; and Bown and Keynes (2021b).

110 David Cochrane and Vassy Kapelos, "3M to Make Critical N95 Masks at Brockville, Ont., Plant," *CBC News*, 20 August 2020.

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CHAPTER 6

Instruments of economic security

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Bruegel

1 INTRODUCTION

The last years have seen rising concerns over the 'weaponisation of interdependence', i.e., that economic links are being exploited for geopolitical purposes (Farrell and Newman, 2019). There has been a significant shift in the prevailing narrative on both sides of the Atlantic from seeing economic interdependence as leverage to achieve political liberalisation towards a geopolitical view that sees it as a liability which opens Western economies towards foreign influence (Pisani-Ferry, 2021). The relationship between the United States and China soured, and China's WTO accession is now seen as a mistake by some.[2] Meanwhile, the Russian invasion of Ukraine is portrayed as a glaring example of a failed Western strategy of '*Wandel durch Handel*' ('change through trade'). Rather than reducing tensions, economic interdependence instead left some parts of Europe significantly dependent on Russia at the time of the invasion, arguably strengthening Russia's hand.

However, a strategy of economic decoupling, undoing decades of globalisation and therefore vastly reducing the gains from trade, seems neither feasible nor desirable (Ayar et al., 2023). There has been a new consensus among the G7 countries that the 'de-risking' of economic relationships with revisionist countries is a more feasible strategy.[3] The central idea is to diversify supply chains and build a 'high fence' around a 'small yard'[4] to protect vital economic sectors from foreign interference without jeopardising the economic benefits of globalisation. Put simply, the aim of this strategy is to reduce risks without entering into all-out trade wars and undermining the rules-based economic order.

1 We would like to thank Alicia García-Herror, André Sapir, Beatrice Weder di Mauro, Chad Bown, Heather Grabbe, Guntram Wolff, Jean Pisani-Ferry and Jeromin Zettelmeyer for their comments and discussion and Luca Léry Moffat for excellent research assistance.

2 For a discussion, see Hillman (2022).

3 The G7 wants to "coordinate our approach to economic resilience and economic security that is based on diversifying and deepening partnerships and de-risking, not de-coupling" (G7 Hiroshima Leaders' Communiqué, 20 May 2023, available at https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/g7-hiroshima-leaders-communique/).

4 "Many of you have heard the term 'small yard, high fence' when it comes to protecting critical technologies. The concept has been citied at think tanks and universities and conferences for years. We are now implementing it" (remarks by National Security Advisor Jake Sullivan on the Biden-Harris Administration's National Security Strategy on 13 October 2022, available at https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/10/13/remarks-by-national-security-advisor-jake-sullivan-on-the-biden-harris-administrations-national-security-strategy/).

Many of the solutions put forward as part of this strategy include significant government intervention. While additional state support in certain areas – in particular, around green industries – could have positive outcomes, this approach is not without risks. State support can backfire unless accompanied by strong governance. This risk is exacerbated in the case of the European Union as the cohesion of the Single Market is threatened when discipline on state aid by individual member states is eroded (Kleimann et al., 2023). Therefore, it is important to have a thorough understanding of the problems that 'economic security' measures aim to solve to judge the trade-offs involved in the proposed solutions.

To support the development of such an understanding, we attempt with this chapter to derive a nuanced view of the economic risks that arise from economic interdependence with China in particular.[5] Based on this view, we assess the appropriateness of EU instruments aimed at improving economic security. We conclude that the European Union has made significant steps forward in terms of ex-ante instruments, though many of them need more European coordination to avoid risks for the Single Market. However, there is a lack of credible ex-post instruments. We see the need for a new ex-post instrument that shares the costs from economic coercion and helps countries and firms respond. However, such instruments have to be underwritten by member states, and therefore the credibility of any European economic security instrument depends crucially on a closely coordinated foreign policy.

WHAT IS ECONOMIC SECURITY?

Despite its prominence in recent debates, the term 'economic security' is only vaguely, if at all, defined. The term has been used in varying scopes by the different actors, and at times has been employed as a catch-all term for policies aimed at mitigating all kinds of economic shocks as well as a wide range of 'national/physical security' measures. This conflation of different types of risks can unsurprisingly lead to poorly targeted government interventions.

For the purpose of this chapter, we employ a narrow definition that is centred around the notion of economic 'de-risking' from shocks, and not the use of economic measures to pursue national security objectives. We focus in particular on risks surrounding 'economic coercion' – the politically motivated disruption of supply chains and targeting of economic interdependencies. Examples of such coercions include sanctions and trade embargoes, the weaponisation of energy markets following the Russian invasion of Ukraine, or Chinese economic coercion against Japan, South Korea, Lithuania or Australia. In these cases, a hostile government targeted specifically vulnerable economic sectors with the aim of inflicting economic and political damage. We assess instruments

5 We focus predominantly on China due to the documented potential exposure of EU firms to Chinese shocks; see, for instance, the survey results reported in Attinasi et al. (2023). See Box 1 for a discussion of the United States.

and strategies that are aimed at mitigating and limiting the risks from such deliberate and targeted economic shocks. It is noteworthy that these types of shocks are not only a concern for strategic imports; recent cases of economic coercion have actually targeted exports more than imports.

While threats to economic security can come from a range of sources, such as climate-related shocks or natural disasters, we focus on improving resilience towards economic coercion for two reasons. First, the policy lessons are equally applicable to other supply chains disruptions. Second, economic coercion includes an additional factor (the behaviour of hostile governments) not present in 'accidental' shocks, which therefore necessitates additional policy responses to affect other countries' incentives. As such, policies designed to address threats arising from economic coercion should also address wider risks to economic security. We also focus on foreign trade shocks and not domestic shocks, which can have similar implications and are part of some broader definitions of economic security. This chapter is concerned with the interaction of economic outcomes with foreign policy, which is less of a concern with shocks of domestic origin, and relevant policy instruments differ.

We deliberately abstract from policies that are framed as part of 'economic security' (for example, in the European Commission's Economic Security Strategy)[6] but are not 'economic' in either nature or objective. With the exception of the very rare cases in which technical complexity creates monopolistic power and therefore the potential for future economic coercion,[7] measures aimed at preventing technology transfers are hard to justify on economic security grounds alone. While maintaining European technological leadership in certain cutting-edge sectors is clearly desirable, it fails to meet the definition of economic security as articulated here. Other justifications – like maintaining an edge in dual-use technologies for defence reasons – are thus generally necessary to justify measures restricting technology transfers.

The distinguishing between 'economic' security risks from national security is important for two reasons. The first is that economic efficiency arguments become less important when considering policies with direct national security implications. Economic analysis can help identify the most efficient way to achieve a desired outcome, but it cannot ascertain whether a policy is necessary for defence purposes. The second reason to separate economic security from national security are the legal implications. WTO rules give countries the ability to react to policies that harm their economic interests (e.g., with countervailing duties and rebalancing of tariffs) and to call panels to adjudicate whether rules were broken. The WTO framework also includes exemptions for measures pertaining national security.[8] The principle that states can intervene in markets to

6 See https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023JC0020&qid=1687525961309

7 Given the potential for technological advantages to confer monopolistic powers on semiconductor firms, coupled with the immense capacity for economic coercion in this sector, we believe that the 2023 export controls introduced by the Netherlands on advanced semiconductor manufacturing equipment are one of the very few instances in which technological defence measures can be justified by economic security arguments. For an English translation of the justification given by the Dutch government, see: https://csis-website-prod.s3.amazonaws.com/s3fs-public/2023-07/230721_CSISTranslations_Dutch_Export.pdf?VersionId=PFyXBJnymtuZdVoStanOfEgHdrZBGm1n

8 Article XXI of the GATT.

ensure their national security in ways that would be otherwise prohibited is generally recognised. However, there has been considerable debate about the wide-ranging usage of these exemptions by the United States (Maruyama and Wolff, 2023). In several cases, the United States has justified policies that are arguably primarily targeting protectionist aims with such national security exemptions (for a discussion of the role of transatlantic relations, see Box 1).

BOX 1 ECONOMIC SECURITY AND THE TRANSATLANTIC RELATIONSHIP

While there have been regular trade conflicts between the European Union and the United States (such as a long-running dispute on subsidies for Airbus and Boeing), these were primarily concerned with protectionist measures and support for national champions. However, during the Trump administration new conflicts arose that were explicitly framed around security. While not directly comparable to the current economic security debate concerning Russia and China, certain facets of the European discourse can be traced back to these origins.

The retreat of the United States from the Iran nuclear deal (the Joint Comprehensive Plan of Action, or JCPOA) was a leading cause for the European desire to have a more autonomous foreign policy. Even though the European Union believed it to be in its interest to keep trading with Iran, the United States threatened European companies with secondary sanctions if they did so (Leonard et al., 2019). This did not affect European 'economic security' per se, but it did advance a discourse on how to harden European trade flows against foreign interference. In 2018, the Trump administration put tariffs on EU steel and aluminium exports justified by national security concerns,[9] launching a transatlantic trade conflict with a vague notion of national security at its centre.

Since President Biden took office, the European Union and the United States have managed to resolve major trade conflicts. The Airbus-Boeing trade dispute was suspended,[10] an agreement on the transfers of personal data found[11] and the trade and technology council established,[12] which aims to prevent future conflicts through intergovernmental consultations. The US tariffs on European steel and aluminium justified by 'national security' have been put under a moratorium, though a permanent solution has not yet been reached (Dadush, 2021). There are ongoing efforts enhance economic security in the G7[13] and to cooperate on common concerns such as those surrounding critical raw materials.[14] However, should political dynamics change after the 2024 US election, transatlantic relations could be tested once again and new EU–US trade disputes could arise.

9 https://www.commerce.gov/sites/default/files/the_effect_of_imports_of_steel_on_the_national_security_-_with_redactions_-_20180111.pdf
10 J. Brunsden, S. Fleming, A. Williams and J. Politi (2021), "EU and US end Airbus-Boeing trade dispute after 17 years", *Financial Times*, 15 June (https://www.ft.com/content/985ae1d6-89eb-46d6-b06c-8299ba70c588).
11 https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_3752
12 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/stronger-europe-world/eu-us-trade-and-technology-council_en
13 https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/g7-leaders-statement-on-economic-resilience-and-economic-security/
14 https://www.whitehouse.gov/briefing-room/statements-releases/2023/03/10/joint-statement-by-president-biden-and-president-von-der-leyen-2/

The European Union and the United States have recently converged on a shared a paradigm of 'de-risking', a notion that was first embraced by Commission President von der Leyen in March 2023.[15] It is noteworthy that the European Union and the United States have come from opposite directions to similar strategies. In the United States, the emphasis in 'economic security' has primarily been on security, representing a 'securitisation' of economic policy. Important economic policies have been announced by National Security Advisor Jake Sullivan rather than by economic policymakers. Many actions considered to fall under the umbrella of economic security, like the US CHIPS and Science Act[16] or outbound investment screening,[17] have been explicitly justified on national security grounds. This stands in contrast to the European context, where the European Commission has been hitherto primarily concerned with economic policies and without a strong national security mandate. The Geopolitical Commission of President von der Leyen[18] is trying to use its economic powers to assert itself as a player in foreign policy. Yet its economic security strategy includes many measures that are not directly related to economic considerations and mirror US policies[19].

A BRAVE NEW WORLD OF ECONOMIC INTERDEPENDENCE

The idea of using economic linkages to achieve political goals is by no means new (Mulder, 2022). Since the end of the Second World War, outright economic sanctions have mostly been used by the United States and its allies against emerging market developing countries (Hufbauer et al., 2007). Even before the Russian invasion of Ukraine, there had been a surge in the number of sanctions imposed by Western countries (Felbermayr et al., 2020). However, while sanctions have historically been mostly used by Western countries, economic coercion is by no means exclusive to the West. The examples of such measures targeting Western countries range from the oil embargo during the Yom Kippur War in 1973 (Hansen, 2023) to import restrictions on Norwegian salmon by China after the 2014 Nobel Peace Prize for Liu Xiaobo (Harrell et al., 2018).

15 Speech by President von der Leyen on EU-China relations to the Mercator Institute for China Studies and the European Policy Centre on 30 March 2023 (https://ec.europa.eu/commission/presscorner/detail/en/speech_23_2063).

16 "CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China", White House Fact Sheet, 9 August 2022 (https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/).

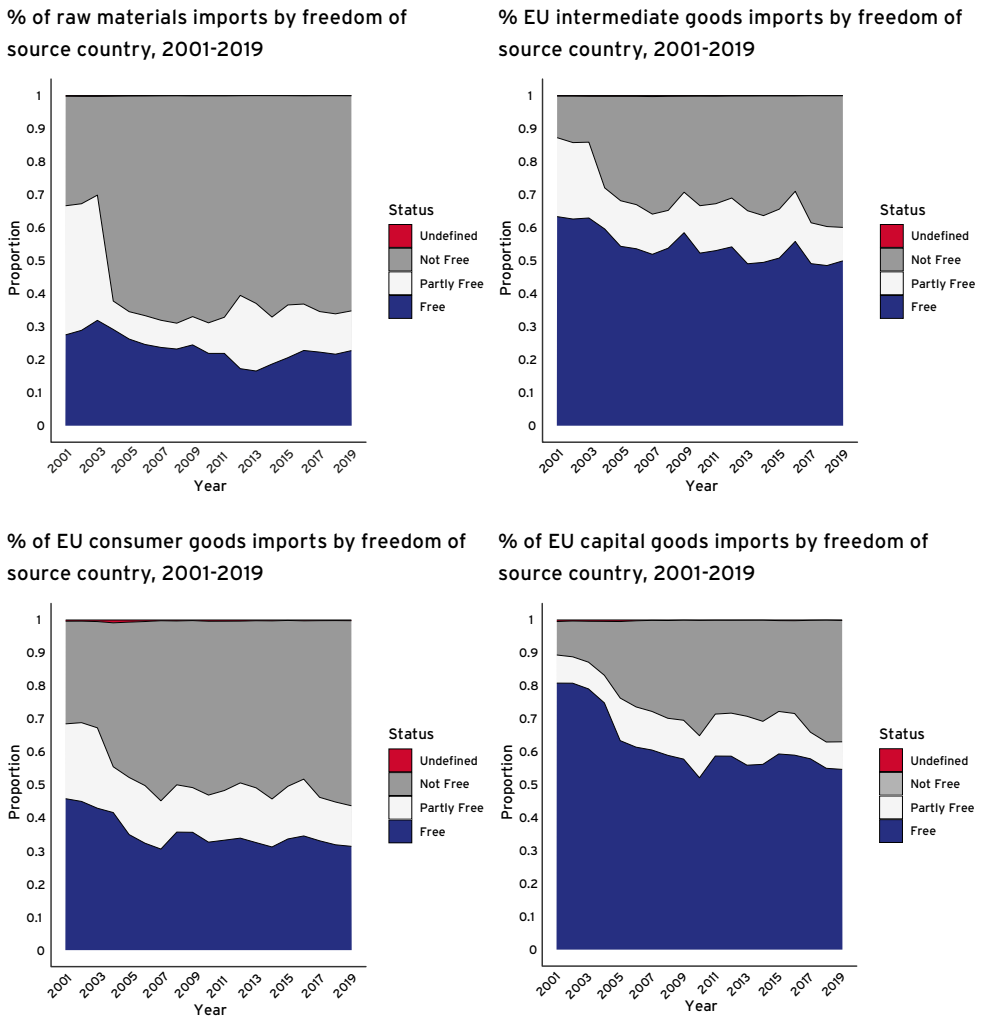
17 "It's important to recognize this is a national security action, not an economic one… This order protects our national security interests […] Again, I want to be clear: This is a national security action, not an economic one" (Background Press Call by Senior Administration Officials Previewing Executive Order on Addressing U.S. Investments in Certain National Security Technologies and Products in Countries of Concern, 10 August 2023; https://www.whitehouse.gov/briefing-room/press-briefings/2023/08/10/background-press-call-by-senior-administration-officials-previewing-executive-order-on-addressing-u-s-investments-in-certain-national-security-technologies-and-products-in-countries-of-concern/)

18 https://ec.europa.eu/commission/presscorner/detail/en/IP_19_5542.

19 Joint Communication to the European Parliament, the European Council and the Council on "European Economic Security Strategy", JOIN(2023) 20 final (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023JC0020).

Given the dominance of Western economies in the financial and technology sphere, the type of economic linkages targeted by non-Western economies have historically often been access to raw materials. However, recent decades brought a remarkable shift in the goods that are available for use in economic coercion against the West. Figure 1 shows the breakdown of EU imports in main categories by the political system of the source countries (as defined by Freedom House). While raw materials where long primarily imported from non-free countries, as recently as 2001 only 10% of imports of intermediate inputs came from such countries; by 2019 this share had increased to almost 40%.

FIGURE 1 **EU IMPORT SOURCES BY POLITICAL SYSTEM**



Source: Bruegel basted on Eurostat, UNCTAD and Freedom House.

As a result, EU industry imports many more intermediate goods from countries with authoritarian political systems. Intermediate imports are often more specialised and differentiated, limiting their substitutability compared to commodities. This thus represents a new type of risk. Meanwhile, advanced technologies are increasingly dependent on specialised materials as critical inputs, such that raw materials have also become more susceptible to economic coercion (Le Mouel and Poitiers, 2023).

One additional and often overlooked source of European vulnerability is export dependency. China in particular has become an increasingly important market for Western exports (see Figure 6), with approximately 10% of German passenger car exports in 2022 going there for example.[20] As will be illustrated, this means that import bans are also available as a means for China to put political pressure on Western governments. As Baqaee et al. show in their chapter in this volume, potential economic costs of sudden trade disruptions with China for a country like Germany are significant (they assess that the effect of a total cessation of trade with China for Germany would be "severe but not devastating").

THE THREAT OF ECONOMIC COERCION

Economic coercion comes in many shapes and forms. Adachi et al. (2022) have accumulated a tally of Chinese coercive methods since 2012 (see Figure 2). Many measures targeted individual firms, while trade restrictions have been the most common form used to target countries. Within these trade restrictions, import restrictions (China blocking the imports of goods from foreign markets) have been used more often than export restriction.[21]

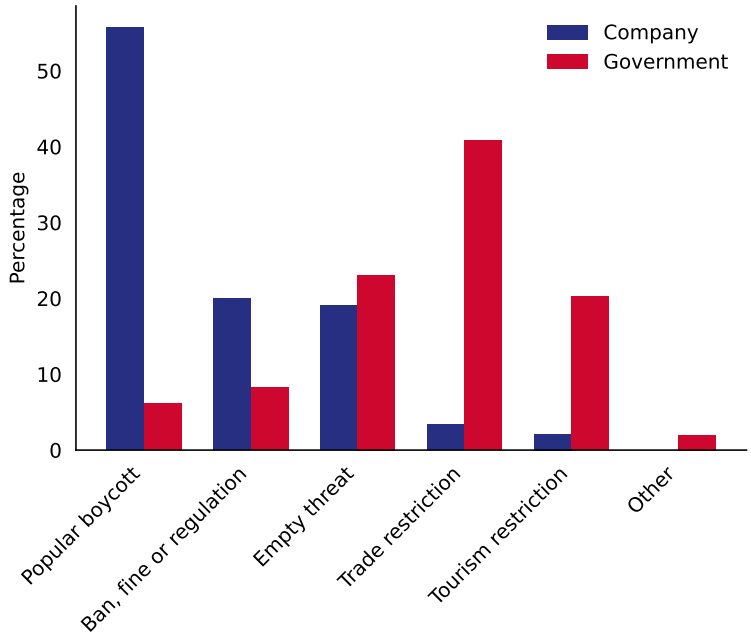
Unlike Western sanctions, which follow formal legal procedures and can be challenged in courts, measures taken by China are often informal. Documentation detailing measures can be difficult to find, and targeted entities might thus find it difficult to challenge them even where avenues to do so might exist (Hackenbroich et al., 2022). A particular problematic example are popular boycotts against certain foreign brands, individuals or firms. While sometimes genuine, these movements to encourage firms and consumers to punish certain firms are often stoked by state-controlled media and on social media.[22] They represent the most common form of economic coercion used by China against firms and are particularly difficult to attribute to undue state intervention.

20 Source: https://www.vda.de/en/news/facts-and-figures/annual-figures/exports

21 "Beijing frequently restricts trade by targeting imports of agricultural goods or commodities. Only on rare occasions has it employed or threatened to employ export restrictions, as was the case with rare earths to Japan in 2010" (Adachi et al., 2022, p. 6).

22 See Lim and Ferguson (2019) for a discussion of the use of boycotts by China during the dispute with South Korea regarding the THADD missile defence programme.

FIGURE 2 **FORMS OF CHINESE ECONOMIC COERCION**



Source: Adachi et al. (2022).

The experience of trade wars and Western sanctions against Russia provide us with some insights into what types of goods are vulnerable to economic coercion. We have seen in instances like the Sino-US trade war that began in 2018 that trade diversion is a major feature limiting the effects of trade-restrictive measures (Fajgelbaum et al., 2023). Similarly, sanction circumvention and alternative sourcing pose major challenges for the effectiveness of Western sanctions against Russia (Babina et al., 2023).

The effectiveness of any type of coercive economic measure depends on the market power of a country or coalition. If alternatives are widely available, a targeted economy can easily switch the import sources for a product. Similarly, if alternative export markets exist, a bilateral trade relationship cannot easily be weaponised. This rules out most commodities from being used or targeted effectively for economic coercion, as they have many sources and markets. Even where a high degree of market concentration is measured, this does not necessarily imply high monopolistic power. The contestability of a market also depends on barriers to entry for newcomers. Many of the products for which there is a high degree of market concentration are low-tech products such as artificial flowers or electric blankets (see the contribution by Mejean and Rousseaux in this volume). If the dominant producers were to limit exports of these products, it would be rather easy for new companies to enter the market. This was the case for many rare gases, the supply of which was disrupted by the Russian invasion of Ukraine. Their prices spiked after the outbreak of the war, but came down rather quickly as new producers

entered the market.[23] Furthermore, there may exist close substitutes that might not be employed at the moment but could become commercially viable if the supply chain of the incumbent technology were disrupted. Examples of this dynamic were documented during trade embargoes (Mulder, 2022). However, it can be difficult to assess the feasibility of such substitution before an actual disruption occurs.

An economy can have monopolistic power for several reasons. First, a natural resource might only exist in a few countries, giving them effective control over where its supply goes. Second, infrastructure bottlenecks might create monopolistic power in segregated markets. This was the case for Russian pipeline gas: a lack of liquefied natural gas (LNG) capacity in central Europe allowed Russia to hike prices in European gas markets. Third, economies of scale or industrial policy can lead to dominance on certain markets, as is the case of the Chinese in the solar panel industry (García-Herrero et al., 2023). Fourth, advanced technological capacities might give monopoly power. An example of this would be ASML in the chip industry (Poitiers and Weil, 2021; Kleinhans and Baisakova, 2020). The 'contestability' of a market is also important. Only if a monopoly market can be maintained over time can it be exploited over extended periods without the risk of losing future markets. In 2022, there was considerable concern over the supply of certain gases that were primarily produced in a Russian-Ukrainian supply chain. However, alternative sources were brought online relatively quickly, which prevented lasting shortages (Darvas et al, 2023).

To induce harm that is macroeconomically significant, the impact of a bilateral flow needs to have a material impact on the overall export or import performance of the targeted economy. For certain goods – in the fields of health, defence or clean energy, for instance – disruptions to imports may be highly damaging to some non-economic outcome, with a prominent example being personal protective equipment or vaccines during the COVID-19 pandemic. In highly diversified advanced economies like the European Union, the capacity to induce truly significant shocks, macroeconomic or otherwise, is limited to a very small number of strategic goods. However, in many cases of economic coercion, the harm is market- and industry-specific rather than macroeconomic. Though few individual products are of such importance that they can affect the economy as a whole, targeted measures can easily harm politically important constituencies and thus exert political pressure on policymakers.

In the following, we consider two recent cases of economic coercion that are illustrative of how economic interdependence can be weaponised: the measures taken by China against Australia and Lithuania since 2020.

23 "How rare-gas supply adapted to Russia's war", The Economist, 30 March 2023 (https://www.economist.com/finance-and-economics/2023/03/30/how-rare-gas-supply-adapted-to-russias-war).

Australia: A tale of two sectors

In mid-2020, following then-Australian Prime Minister Scott Morrison's calls to open an investigation into the origins of the COVID-19 pandemic,[24] China began a campaign of economic coercion against that Australia which only began to be eased in early 2023. It targeted Australian exporters and introduced "discriminatory tariffs on wine and barley" and "informal and WTO-illegal bans on coal, beef, lobster, cotton, wood, nickel and copper concentrates" (Uren, 2023a).[25] As a result, China's share in Australian exports fell from its mid-2021 peak of almost 45% to less than 30% by the end of 2022[26].

The Australian economy as a whole successfully navigated the coercive measures introduced by China. The value of Australian exports rose between 2020 and the end of 2022, largely driven by energy exports to Asian markets other than China. There was, however, important variation in the impacts on the various targeted sectors. In the case of coal, the decline in exports to China was more than offset by higher exports to the rest of the world, in particular to Asian countries who were themselves indirectly affected by China's actions (Figure 3, panel A).[27] Significant export diversification, coupled with high coal prices following the Russian invasion of Ukraine, meant that Australian coal exporters enjoyed surging import revenues over the period of the unofficial embargo.

This makes for a stark contrast with Australian wine exporters. Due to a 2015 free trade agreement,[28] Australian wine exporters had been at an advantage in China compared to many other wine-exporting countries, making it an important export destination. However, following the imposition of countervailing duties as high as 218% in late 2020, wine exports to China collapsed from approximately 38% of total Australian wine exports in 2019 to 0% since 2022. Unlike in the case of coal, the industry failed to expand into other markets. Consequently, monthly Australian wine exports in June 2023 were down over 40% from their October 2020 peak. These duties, coupled with a strong harvest, led to a significant oversupply of Australian wine,[29] depressing prices and adversely impacting the industry.[30]

24 Some analysis has also pointed to Australia deciding to exclude Huawei from 5G infrastructure as a cause for the Chinese response (Hackenbroich et al., 2022).

25 The reasons used to justify these different de facto import embargoes were both imaginative and spurious. For instance, mandatory testing for traces of heavy metal was introduced for the import of crustaceans, with the testing period long enough that live lobster exports could not survive the process (Buckland et al., 2023)

26 The value of Australian exports to China did grow slightly over this period, due to an increase in the price of iron ores, a key input into the Chinese economy and overwhelmingly the largest component of Australian exports to China- averaging over 50% of monthly bilateral exports in 2019.

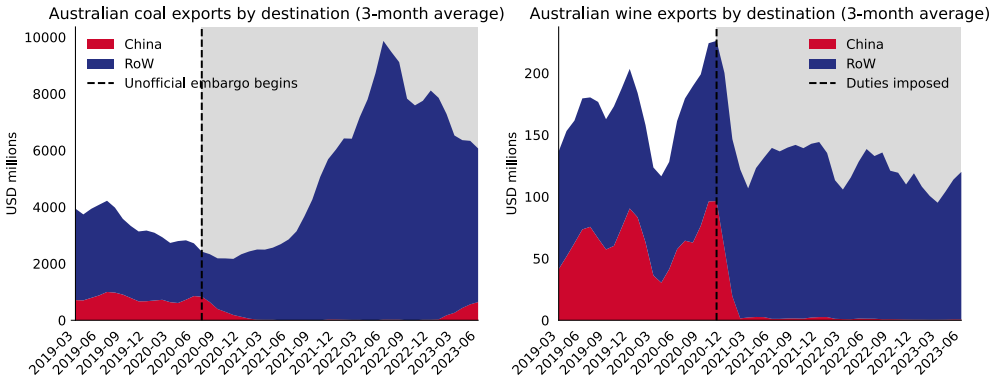
27 As detailed by Uren (2023b), "China started buying coal from Indonesia, which then cut its sales to India and elsewhere. India boosted its purchases of Australian coal that had previously gone to China". Japan and Korean also massively increased their purchases of Australian coal over this period. This also coincided with energy shortages following the Russian invasion of Ukraine, which meant that coal prices increased significantly.

28 See C. Hall and X. Yin (2023), "China's wine market ready to welcome likely return of Aussie wine as ties improve", Reuters, 3 November (https://www.reuters.com/markets/asia/chinas-wine-market-ready-welcome-likely-return-aussie-wine-ties-improve-2023-11-03/)

29 Reports estimate it at two billion litres (e.g., https://www.rabobank.com.au/media-releases/2023/230815-navigating-oversupply-in-australias-wine-industry/).

30 UN Comtrade data show that Australian wine imports actually increased steadily each year between 2019 and 2022, which seems to suggest limits to the wine industries' ability to diversify into the domestic market.

FIGURE 3 **CHINESE ECONOMIC COERCION AGAINST AUSTRALIA**



Source: Bruegel based on Australian Bureau of Statistics (left) and UN COMTRADE (right).

The two industries detailed here are representative of the broader range of targeted industries. Some, such as barley, succeeded in diversifying away from Chinese buyers (to Saudi Arabia) and saw their exports grow over the period in question. Lobster and wood exporters, on the other hand, failed to move into new markets and suffered the same fate as their counterparts in the wine industry (Buckland et al., 2023).

Lithuania: Much ado about nothing?

The trade restrictions introduced by China against Lithuania in 2021 marked the most serious incident of Chinese economic coercion against a member of the European Union. The relationship between the two countries had been particularly fraught since the formation of a new Lithuanian government in 2020,[31] but broke down entirely in mid-2021 when the Lithuanian authorities announced that they would allow a Taiwanese representative office to be opened in Vilnius.[32] After two years of an essential trade ban (detailed below), the Lithuanian government reported in November 2023 that "most" Chinese trade measures had been lifted.[33]

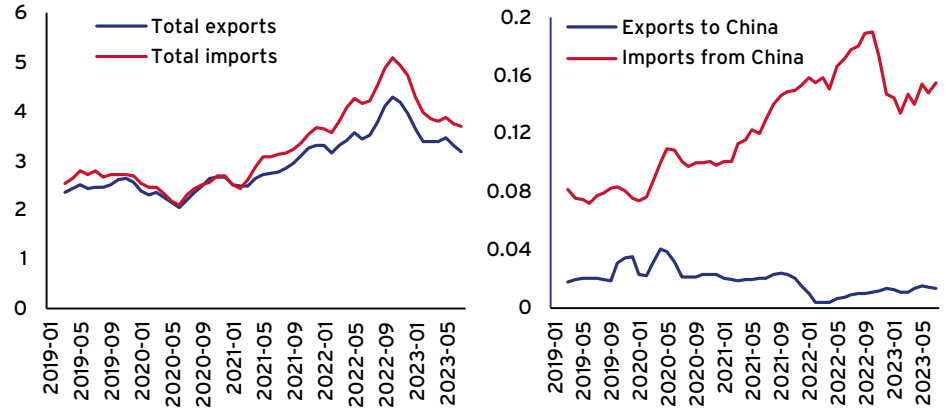
Given the opacity of China's actions, it is difficult to disentangle precisely which measures were implemented and when. However, the European Commission details[34] that the original measures enacted included disruptions of logistic networks (leading to more expensive and delayed freight deliveries), difficulty obtaining trade credit insurance for imports, and general disruption to supply chains containing Chinese components. These measures were escalated following the opening of the Taiwanese office in November

31 For instance, in May 2021 Lithuania became the first country to withdraw from the China-CEEC initiative.
32 The standard practice to avoid Chinese disapproval has been to allow institutions that represent the city of Taipei, not Taiwan. For more details on the actions undertaken by Lithuania, see Andrijuaskas (2022).
33 See comments by Foreign Minister Gabrielius Landsbergis in M. Seputyte and N. Drozdiak (2023), "Lithuania Says Businesses Remain Wary on China Trade", Bloomberg, 28 November (https://www.bloomberg.com/news/articles/2023-11-28/lithuanian-businesses-remain-wary-on-china).
34 https://ec.europa.eu/competition/state_aid/cases1/202221/SA_102002_F035D780-0000-CD6F-966F-FA9205787732_62_1.pdf

2021 to go beyond direct trade between the two nations. They also targeted Lithuanian participation in global supply chains, with products from other European countries containing Lithuanian components being threatened with rejection by Chinese customs authorities. Official import bans on certain products were introduced in 2022, with China relying once again on spurious reasons such as a "lack of documentation" for its actions.[35]

Lithuanian exports to China fell by two-thirds between 2020 and 2022, but imports from China grew by the same amount over the period in question, which reinforces the idea that China most often targets countries' exports. Neither Lithuanian total exports nor total imports were significantly impacted, which is unsurprising given that China made up just 1% and 4% of Lithuania's 2020 exports and imports, respectively.[36] However, as in the case of Australia, certain sectors were negatively affected by the measures, with two of the three firms claiming assistance under a national support scheme (Box 2) operating in the PV industry.[37]

FIGURE 4 **LITHUANIAN EXPORTS AND IMPORTS TO THE WORLD (LEFT) AND TO CHINA (RIGHT), 3-MONTH AVERAGE (€ BILLIONS)**



Source: Bruegel based on Eurostat.

There are some key observations to be made from the joint experiences of Australia and Lithuania of Chinese economic coercion.[38] First, exports to China were targeted more strongly than imports. Second, despite significant trade restrictions from one of the world's largest economies, neither country suffered macroeconomically. Third, targeted industries can emerge unscathed without government intervention, largely

35 See D. Patton and A. Sytas (2022), "China suspends Lithuanian beef, dairy, beer imports as Taiwan row grows', Reuters, 10 February (https://www.reuters.com/world/china/china-suspends-lithuanian-beef-imports-taiwan-row-grows-2022-02-10/).

36 The decrease in Lithuanian imports and exports visible from late 2022 onwards accounts largely to the economic slowdown in trading partners and is unrelated to the Chinese actions (e.g. https://inovacijuagentura.lt/news/2023/08/lithuanias-export-growth-has-slowed-down-slightly-in-the-first-half-of-2023.html?lang=en).

37 This is unsurprising given the well-documented dominance of China in this supply chain.

38 The experiences also match those of South Korea during the THAAD dispute of 2016-17 (Lim and Ferguson, 2019)

through successful diversification. As the cases of Australian coal and barley exports show, commodities are particularly poor targets for economic coercion, as global markets provide alternative buyers. However, they also show that even if the wider economy can withstand coercion, certain sectors can be strongly impacted by the measures. The markets where Chinese coercion had the largest effects (wine, lobsters and wood in Australia) are macroeconomically insignificant, yet their targeting affected some constituencies. In other words, the inflicted damage was political rather than macroeconomic.

BOX 2 LITHUANIAN SUPPORT SCHEME

In April 2022, the European Commission approved under EU state aid rules a Lithuanian loan scheme designed "to support and facilitate access to finance by companies affected by the exceptional circumstances resulting from China's discriminatory trade restrictions on Lithuania".[39] This was approved to last until the end of 2027 or the end of the trade restrictions, whichever came first. However, due to a lack of uptake, the scheme was wound down in 2023.[40]

Administered by INVEGA, the Lithuanian national promotional institution, the scheme was capped at a maximum of €130 million overall, and at €5 million per firm. Access was limited to Lithuanian firms for whom the "proportion of either imports from or exports to China represents at least 25% of the beneficiary's total imports or exports in 2021" that were unable to receive financing on the market (which had to be proven by rejections from three financial institutions). The loans had to be used (i) to source inputs from different sources, (ii) to explore the possibility of entering new markets, or (iii) to use "the time to undertake such efforts".

Estimates at the time of approval were that there were then 130 expected beneficiaries, with this expected to increase to up to 500 as Chinese restrictions persisted and grew. However, only three firms – all small and medium-sized enterprises (SMEs) – availed of the support offered. The total amount of loans granted was €4.22 million, just 3% of the maximum amount permitted.

WHERE IS THE EUROPEAN UNION EXPOSED TO ECONOMIC COERCION?

As monopolistic power is necessary for economic coercion, potential vulnerabilities can be identified by looking at market concentration. The Herfindahl-Hirschman index (HHI) provides us with an index that measures market concentration. It is widely used not only for assessing competition cases, but also in defining economic security risks (European Commission, 2021; Xavier and Mejean, 2021; Welslau and Zachmann,

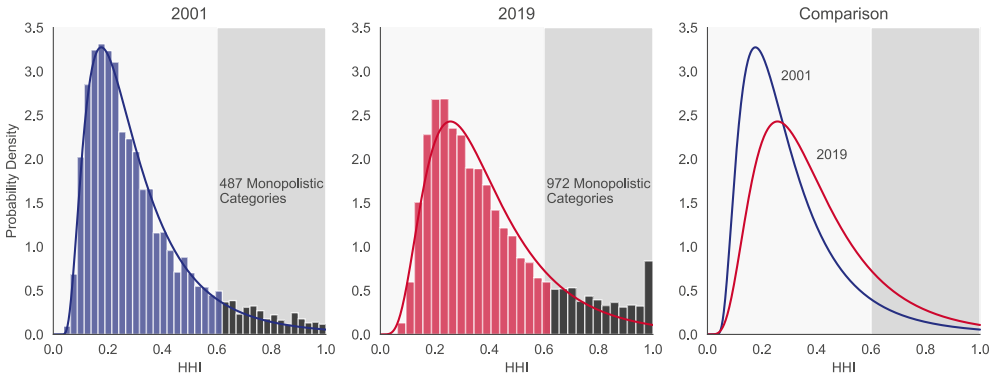
39 https://ec.europa.eu/competition/state_aid/cases1/202221/SA_102002_F035D780-0000-CD6F-966F-FA9205787732_62_1.pdf

40 See https://www.vz.lt/smulkusis-verslas/2023/02/06/invega-stabdo-paskolas-nukentejusiems-nuo-kinijos-veiksmu-is-130-mln-eur-paskolu-suteikta-uz-3-mln-eur

2023). The HHI has a value between 0 and 1; the lower the value, the more competitive a market. In competition policy, an HHI value above 0.25 is considered indicative of a high degree of market concentration, and any market with a concentration above 0.6 is considered 'monopolistic'.[41] While these measures might not apply one-to-one to import vulnerabilities, they provide a yardstick of how concentrated import markets are.

Figure 5 plots the distribution of HHI values from EU imports by product category for the years 2001 and 2019.[42] For easier comparison, estimated distributions for both years are displayed in the right panel. We highlight goods with an HHI above 0.6 as monopolistic and thus problematic. This is a conservative choice compared to the threshold values used in other analysis (an HHI of 0.4 in the case of the European Commission). However, this analysis is meant to illustrate the evolution of EU import markets and we abstract from the second stage of import concentration analysis, justifying a more restrictive approach.[43]

FIGURE 5 EVOLUTION OF CONCENTRATION OF EU IMPORTS



Source: Bruegel based on Eurostat.

Between 2001 and 2019, the distribution of import market concentration shifted considerably to the right. While in 2001, 487 products had concentrations considered 'monopolistic', in 2019, 972 products fell into this category.

Table 1 provides a breakdown for the European Union of the type of products that were in highly concentrated markets in both 2001 and 2019. In both periods, most of the products in highly concentrated markets were manufactured goods. For instance, in 2019, 626 products were such goods, but they accounted for only 11% of the value of manufactured goods imports into the European Union. This was more than double the 5% of the import value of manufactured goods falling into the 'problematic' category in 2001.

41 Horizontal Merger Guidelines (08/19/2010) of the US Department of Justice, available at https://www.justice.gov/atr/horizontal-merger-guidelines-08192010

42 We focus on individual goods categories rather than market values, as harm to an individual industry might come even from a low value but indispensable import is affected.

43 See the contribution by Mejean and Rousseaux in this volume for both a more detailed discussion of how to identify dependencies and a more comprehensive data exercise.

For non-fuel raw materials, 22% of products were in monopolistic markets in 2019. While the share of value of non-fuel raw materials in monopolistic markets did not change significantly over the period in question, many more of the highly concentrated goods categories were classified as 'critical raw materials' in 2019 than in 2001. Similarly, many more of the highly concentrated manufactured goods imports are 'high-tech' goods, with the share increasing from 25% to 43%. A significant part of the increase can be directly attributed to China, which was the main source country for 20% of the highly concentrated import categories in 2001, before this share more than doubled to 49% in 2019. Meanwhile, the share of the United States in concentrated EU imports roughly halved in almost all categories (for an analysis of the trends, see Welslau and Zachmann, 2023).

TABLE 1 **BREAKDOWN OF HIGHLY CONCENTRATED IMPORT MARKETS**

	Year	No. products	Products	Value	Products HT/CRM	Value HT/CRM	Products China	Products US
Raw materials								
Total	2001	71	15%	4%	7%	4%	13%	21%
	2019	110	22%	2%	6%	18%	16%	11%
Non fuels	2001	66	15%	7%	8%	8%	14%	20%
	2019	101	22%	9%	7%	21%	17%	11%
Manufactured goods								
Total	2001	348	9%	5%	11%	25%	20%	37%
	2019	626	15%	11%	10%	43%	49%	19%

Note: HT = high-tech goods according to classification by the United States Census Bureau.; CRM = critical raw materials as defined by the European Commission.

Source: Bruegel based on Eurostat.

Overall, EU imports of both raw material and manufactured goods were much more concentrated in 2019 than in 2001. This shows that a high degree of market concentration is not merely a feature of a few goods categories that might have been supported through strategic Chinese industrial policy, but rather the effect of an increase in market concentration across the entire spectrum of imports. Therefore, a strategy to limit import concentration cannot only be focused on strategic imports, as potential targets for import bans are plentiful and new ones are likely to arise in an overall concentrated market environment. As is discussed in more depth later, an effective diversification strategy should therefore aim to lower the degree of market concentration more generally.

It is also important to note that import dependencies alone are not necessarily concerning. Among the categories of goods for which Mejean and Rousseaux (in this volume) find the European Union to be reliant on highly concentrated import markets are, for instance, artificial flowers and camping flasks. While shocks in the countries of origin would likely lead to EU import disruptions in these sectors, it seems implausible that these shocks would cause social welfare losses significant enough to warrant government intervention.

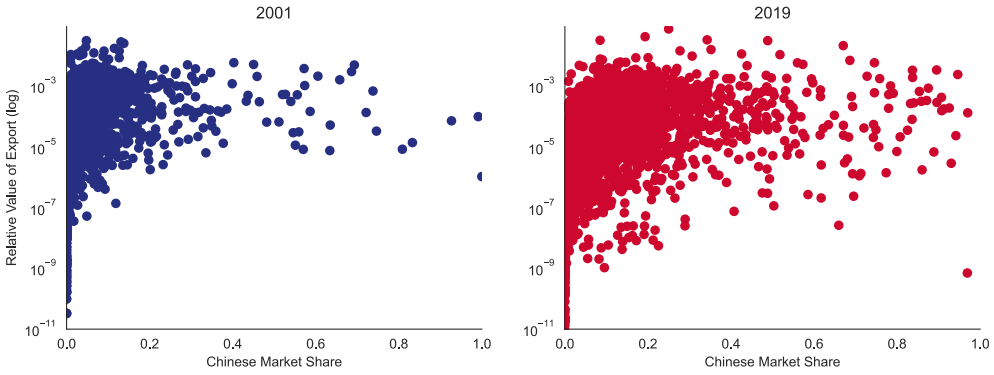
There are important precedents for the weaponisation of import vulnerabilities. This includes the Chinese threat of banning exports of certain critical raw materials in the case of a 2010 trade dispute with Japan[44] and recent export restrictions for critical minerals.[45] However, most cases of economic coercion by China either directly target companies operating in its markets or exports to China. This stands in contrast to the almost exclusive focus of economic security on risks stemming from Western imports from China. As Adachi et al. (2022) show and the cases of Australia and Lithuania illustrate, imports from China are not typically the primary vulnerability for economic coercion. Instead, these past experiences have shown that China tends to weaponise access to its domestic market for foreign exporters.

Given that a market must be sufficiently large to have monopolistic power as an export destination, China is virtually the only country of concern to the European Union for this type of risk.[46] While other countries can also harm EU export interests, they are unlikely to be sufficiently large to inflict significant damage. Therefore, in Figure 6 we use Chinese market shares as a gauge of export vulnerabilities instead of the HHI. The economic importance of an export is measured by its relative value (i.e., its share of total exports to China). A product in the lower-left corner is of relatively low value and is not exported much to China, whereas a product in the upper-right corner is of high value with most of it being exported to China. Overall, a large shift to the right is evident. In other words, there are now a much large number of products where a Chinese embargo on EU exports would inflict significant harm, increasing the number of potential targets for Chinese restrictions.

As in the case of the increasing import concentration, the increase in Chinese market shares in exports represents a structural shift rather than something that is product-specific. A strategy focused on the most exposed exports might limit some potential harm in the short term, but the number of potential targets is so high that broader diversification is necessary and overarching policy instruments are required.

44 For a discussion, see Le Mouel and Poitiers (2023).
45 https://www.reuters.com/markets/commodities/chinas-rare-earths-dominance-focus-after-mineral-export-curbs-2023-07-05/
46 For a discussion of the role of security concerns with regards to the United States, see Box 1.

FIGURE 6 **CONCENTRATION OF EU EXPORT MARKETS**



Note: Bruegel based on Eurostat.

INSTRUMENTS OF ECONOMIC SECURITY

The increased exposure of the European Union to economic security risks has rightly drawn the attention of policymakers. Various initiatives have been proposed with the aim of increasing the resilience of the European economy against such risks. Given the different types of threats, these rightly include a wide range of instruments.[47] Table 2 provides an overview of the policy instruments relevant to the economic security debate, including both those announced under the auspices of economic security but that are in fact more pertinent to national security, as well as policies relevant to addressing economic security risks that have not yet been put forward. We distinguish them along two main dimensions: the nature of the threat (e.g., whether it targets exports or imports)[48] and the intended timing of implementation (pre-emptive, ex-post or both, which we term 'overarching'). It is noteworthy that many of these policies have the potential to improve the resilience of the European economy in areas beyond responding to economic security threats.

47 Due to capacity constraints, we do not consider here general policy measures to improve the Single Market, even if these measures should improve the competitiveness of European firms, thus likely contributing to the economic security of the European Union. For a discussion on these measures, see Kleimann et al. (2023)

48 Some have attempted to argue that potentially losing current comparative advantages in critical technologies constitute a threat to economic security, given that it may result in future import dependencies. In our view, this is currently too many degrees removed to fall under economic security concerns.

TABLE 2 **INSTRUMENTS FOR ECONOMIC SECURITY**

	Vulnerability	Threat	Ex-ante instruments	Ex-post instruments	Overarching instrument
Economic Security	**High export concentration**	**Targeted trade embargoes**	**Diversification** - Free/Preferential Trade Agreements (FTAs/ PTAs) - Secondary instruments, e.g., export credit agencies, development policies, 'clubs', TTCs, Global Gateway	**Bespoke national support** e.g., state aid-sanctioned scheme in Lithuania **Missing:** EU support	**Anti-coercion instrument** - Introduction of proportionate retaliatory measures **Internal Market Emergency and Resilience Act**[49] - Monitoring, stockpiling, joint procurement and potential 'priority rated orders'
	High import concentration	**Disruption of supply of critical components**	**Diversification** - FTAs/PTAs - Secondary instruments (see above)		
			Increase domestic production - Industrial policy - Strengthening the single market		
			Ensure a level playing field - Foreign Subsidy Regulation - Trade defence instruments		
National Security	**'Critical' competitive advantages** **("narrow yard with high fences")***	**Loss of technological advantage in dual use goods and the control over their production**	**Boost industry** - Industrial policy		
			Prevent leakages - Export controls* - Outbound investment screening* - Toolkit on Tackling Foreign R&I Interference*		
			Ensure a level playing field - Foreign Subsidy Regulation - Trade defence instruments		
	Not otherwise classified		**Protecting infrastructure** - Cyber Resilience Act* - NIS2 Directive*		
			FDI Screening*		
			EU Standardisation Strategy*		

Note: Includes current/proposed EU policy measures, as well as those we believe are missing. * denotes policies or ambitions put forward under the umbrella of economic security that generally fall outside of our definition.[50]

Source: Authors' own compilation.

49 Agreement had not yet been reached on the final version of this instrument at the time of writing, so the policy measures included here are based on the Commission proposal.
50 As discussed previously, there are some rare instances involving technology-induced monopoly that legitimise the use of technology security tools to maintain economic security.

As mentioned, Table 2 includes a number of policies mentioned in the Commission's Economic Security Strategy but that are arguably more concerned with non-economic risks. The downsides to many cyber-attacks or research interference are not primarily economic in nature. There are certain technologies which the Commission has declared to be of particular concern due to "the enabling and transformative nature of the technology; the risk of civil and military fusion; and the risk of misuse of the technology for human rights violations".[51] The latter two criteria are not relevant in terms of our narrow definition of economic security. The former, which the Commission defines as assessing the technology's "potential and relevance for driving significant increases of performance and efficiency and/or radical changes for sectors, capabilities, etc.", could fall under the remit of economic security only in sectors where a high degree of technological complexity creates a monopoly, as described earlier.

In the following, we will discuss the role of some of them in more details, as part of four complementary strategies to enhance economic security: mapping of vulnerabilities; diversification of imports and exports; industrial policy and technology security in strategic sectors; and ex-post policies to help solve political damage.

Mapping vulnerabilities

The first step in responding to economic security concerns is to identify risks. Global value chains are enormously complex and not all dependencies are direct (Qiu et al., 2023). Coercive measures can go beyond direct bilateral trade, as was the case in China's actions against Lithuania. As such, a detailed understanding of the European. Union's dependencies on other countries for both exports and imports is necessary. This would allow authorities to identify potential vulnerabilities ahead of shocks and assist affected firms, in particular SMEs, to diversify their supply chains and mitigate the risk in question. Hackenbroich et al. (2022) argue that there may be scope for an EU body to carry out detailed data analysis for this purpose.

Monitoring supply chains by requesting, and in some instances requiring, firms in strategic sectors to disclose information on their suppliers, stocks and productive capacities is a key, and controversial (e.g., Sultan et al., 2023), component of the proposed EU Internal Market Emergency and Resilience Act (IMERA).[52] Similarly, the European Chips Act entails mapping and monitoring the semiconductor supply chain to assess ex-ante risks of potential import disruptions.[53] Depending on the importance of a sector, a balance has to be found between the administrative burden on firms and the benefits from further insights. For instance, informational requirements should be higher for those sectors flagged by Mejean and Rousseaux's method as being at risk (see their contribution in this volume).

51 https://defence-industry-space.ec.europa.eu/system/files/2023-10/C_2023_6689_1_EN_ACT_part1_v8.pdf
52 Formerly called the Single Market Emergency Instrument (SMEI).
53 See https://digital-strategy.ec.europa.eu/en/factpages/european-chips-act-monitoring-and-crisis-response

However, awareness of risks alone does not directly lead to mitigation measures; economic incentives have to align as well. While over 95% of firms surveyed in the European Investment Bank Investment Survey (EIB, 2023) had experienced some form of disruption to international trade, less than half of them had changed or were planning to change their sourcing strategy. Even where potential downsides are large enough to warrant a change in sourcing, there might not be readily available alternatives. This leads us to the next strategy.

Diversification

Since monopolistic power is a necessary condition for effective economic coercion, trade diversification is the most effective strategy to reduce vulnerabilities as it can lead to more competition across a wide range of imports and exports. While precise results change depending on the criteria used to determine dependence, there has been significant churning in the products in which the European Union has been overly dependent on imports (Vicard and Wibaux, 2023). Failing to further comprehensively diversify both imports and exports will likely lead to more goods falling into the concerning range of high export or import concentration. Otherwise, in focusing on individual goods in structurally concentrated markets, policymakers will be constantly racing to address different areas of concern.

To achieve greater diversification, a combination of policy tools provides the most promising avenue. First and foremost, free and preferential trade agreements (FTAs/PTAs) open new markets for both exporters and importers. The European Union has made progress in broadening its level of trade covered under PTAs. As of 2020, 50% of extra-EU exports were covered by reciprocal PTAs, up 8 percentage points from 2010 as trade agreements with Canada, Japan and Korea came into force (Dadush and Dominguez Prost, 2023).[54] The December 2023 agreements[55] between the EU and Chile, an important exporter of some CRMs, to enhance and modernise their existing FTA also shows how these agreements are not necessarily static, and should be updated if needed to reflect the increased focus on economic security.

However, due largely to domestic political pressure, the European Union has struggled to conclude trade agreements with major trading partners such as the Mercosur countries, while even negotiations with close allies like Australia have proven difficult.[56] Besides the difficulty of ratifying FTAs, there are other limits to relying on FTAs for diversification. Many of the products for which the European Union has problematic imports dependencies do not have significant tariffs precisely because there is no

54 If intra-EU trade is also included, the average of EU countries' exports covered by reciprocal PTAs was 81%.

55 For more information on the Advanced Framework Agreement and Interim Trade Agreement, see https://ec.europa.eu/commission/presscorner/detail/en/ip_23_6542.

56 Negotiations between the European Union and the Mercosur states on a deal began in 2000 and only concluded with an agreement in June 2019. More than four years later, we are still awaiting ratification by the European Union. The October 2023 breakdown in EU-Australian trade agreement negotiations also fails to bode well for the prospect of new deals on the horizon.

European industry that would justify protective measures. Where most favoured nation (MFN) tariffs offered to all WTO members are already very low, the European Union cannot offer significantly better market access through an FTA compared to the access that China has, for instance. This is the case for CRMs, many of which have no tariffs at all applied to them (Le Mouel and Poitiers, 2023).

Therefore, a diversification strategy must complement FTAs with external financial instruments.[57] The Commission aims to better harmonise and streamline European development assistance under the umbrella of the Global Gateway. However, beyond its primary objective of promoting economic development globally, this initiative has as a stated goal to support the European Union by "strengthening the resilience of its supply chains, and to opening up more trade opportunities for the EU economy".[58] To an extent, this is indeed already happening. In October 2023, the European Union signed Memoranda of Understanding under the Global Gateway framework with both the Democratic Republic of Congo and Zambia to deepen cooperation around the development of resilient value chains of critical raw materials, which could help to improve import diversification.[59] More should be done in this area, such as potentially investing in infrastructure in northern Africa to further diversify European energy imports (as argued by Rizzi and Varvelli, 2023).

Export credit agencies (ECAs) should play an important role in this strategy, including the potential creation of a European Export Credit Agency. ECAs are state-owned or publicly financed bodies that are used to support exports by providing a range of financing instruments (largely insurance and guarantees, but also loans) below market rates to de-risk trade. Going beyond facilitating direct exports, they can also be used to support investments in third countries which, if targeted appropriately, can ultimately improve diversification of supply. A European ECA could compliment the 24 national ECAs (European Commission, 2023b).[60] The support in question is significant, with EU ECAs in 2021 insuring projects amounting to approximately €90 billion (Schlögl et al., 2023). The ECAs' funding could be boosted and applied strategically towards the objective of economic security. It will not be commercially viable to produce many of the products for which the EU is reliant on imports from China in a high wage economy. Some raw materials do not exist in Europe or local resistance to their mining could be too high. In such cases, ECAs can play a critical role in promoting investments into alternative sourcing in partner countries (Le Mouel and Poitiers, 2023). Export promotion offices could also be useful to help firms identified as being overly reliant on a particular export

57 Article 5 of the Regulation establishing the Neighbourhood, Development and International Cooperation Instrument (NDICI, the EU's primary international development tool) states that the EU should "seek to promote increased synergies and complementarities" between trade policy and sustainable development (https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX%3A32021R0947).

58 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021JC0030 (p. 2).

59 https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5303

60 The Commission has raised concerns that national ECAs "do not follow overarching EU interest and policies… and can be also in competition with one another" (European Commission, 2023a, p.7). It also argued that better coordination between national ECAs and EU and national development finance agencies could lead to better outcomes across a range of policy areas, including the sourcing of CRMs and "the trade aspects of EU geopolitical strategies" (ibid, p. 39).

market to identify and access new markets. The Enterprise Europe Network (EEN), a Single Market Programme-funded umbrella of national SME support organisations (such as chambers of commerce or government agencies) already offers assistance to SMEs in the areas of 'resilience' and 'internationalisation'. This role could be boosted, however, as awareness of the network is just 9% among SMEs.[61]

Targeted industrial policy and interventions

For sectors that combine a high degree of dependency with a high degree of economic importance, diversification may not be enough to safeguard economic security. There are very few sectors in which we might see macroeconomically significant impacts arising from supply chain shocks. As noted, concerns beyond economic outcomes, such as defence and health, may justify such policies in other areas, but this group should also be limited. Three types of strategies are possible: (i) maintaining strategic reserves; (ii) growing domestic production; or (iii) improving productive capacities in third countries.

In some cases, stockpiling a certain buffer level will often be the more cost-effective option, but it is not always feasible. Certain goods (like medicines) might spoil, and in certain fast-moving sectors (for instance, PVs), technology quickly becomes obsolete. As such, this should play only a limited role.

The global trend thus far has been to prioritise boosting domestic supply via industrial policy. Examples include the European Chips Act or Net Zero Industry Act in the European Union, the Inflation Reduction Act and Science and Chips Act in the United States, and the K-Chips Act in Korea. However, competing policies have led to costly subsidy races even among like-minded partners, and heavy-handed reshoring policies can have unintended consequences. Javorcik et al. (2022) estimate that friend-shoring could generate global real GDP losses as high as 4.6%. Reshoring drug production to avoid shortages could lead to prices increasing by up to 30% (Galdin, 2023). Import restrictions have likely contributed to shortages of infant formula in the United States.[62] Meanwhile, producing green technology in Europe would lead to much higher costs of decarbonising, slowing down the green transition and Europe's attempts to diversify from Russian hydrocarbons. In the European Union, the emphasis on national state aid also poses risks to the Single Market (Kleimann et al., 2023; Tagliapietra et al., 2023).[63]

In the instances in which increasing domestic production is justified, a bespoke strategy should be designed for the sector in question that aims to minimise distortions and leverage the comparative advantages of the European Union in that area. For instance, McWilliams et al. (2024) argue that an EU industrial policy for the solar panel industry

61 Source: Flash Eurobarometer 537 (2023); firms would likely be more aware of their local branches of the EEN, such as national export promotion offices.

62 https://www.cato.org/blog/rock-bye-trade-restrictions-baby-formula

63 This already at a time when concerns are growing over single market fragmentation due to the relaxing of state aid rules following the Russian invasion of Ukraine (see https://www.euractiv.com/section/economy-jobs/news/analysis-eu-subsidy-race-is-on-and-germany-is-winning-it/).

should focus on recycling and innovation, not import substitution. Given the different abilities of EU countries to support their domestic industries, a 'Europeanisation' of state-aid tools like the Important Projects of Common European Interests (IPCEIs) will be indispensable if fragmentation of the Single Market is to be avoided. Currently, IPCEIs and similar policies, such as the European Chips Act and funding for clean tech through the Temporary Crisis and Transition Framework, rely on national funding. While they have to be part of a common European framework, individual projects are chosen via opaque processes by EU countries based on (sometimes competing) national interests. Going forward, project selection should be based on more thorough, transparent methodologies instead (Poitiers and Weil, 2022).

Internationalising industrial policy provides a very promising avenue to increase the security of supply while simultaneously minimising protectionism, though international policy coordination will be challenging. Variations of this approach include CRM 'clubs' and the establishment of clean-tech partnerships to leverage different countries' relative comparative advantages, as proposed by García-Herrero et al. (2023).

Beyond growing domestic production, technology security measures (such as export controls or outbound investment screening) to prevent diffusion in the aforementioned key sectors at risk of complexity-driven monopolisation must also be complemented by policies that reinforce and strengthen existing advantages, through support for R&D, skilled immigration and via bespoke industrial policies. In addition, policymakers must be cognisant of the risk of reciprocity in these measures (as was the case with China in 2023)[64] and should therefore be judicious in their application.

In sum, there may be cases in which the risks associated with supply disruption warrant using industrial policy to promote alternative supply chains, either in the European Union or in other countries, or the imposition of technology security measures. However, policymakers should not pretend that this is a cost-free approach, and need to weigh losing the gains from trade against the potential welfare losses from supply chain disruptions. If they opt for industrial policy, how exactly they choose to design this approach, in particular to minimise any protectionist elements, is critically important.

Ex-post instruments

While some goods and industries are of such strategic importance that they warrant state intervention as discussed above, it would be prohibitively expensive to do so for all smaller industries that are exposed to economic security risks (think for instance again of the artificial flower industry identified by Mejean and Rousseaux in their contribution to this volume). Therefore, ex-ante policies alone will not suffice. Ex-post policies can help deter targeted attacks against such industries and soften their impact when they

64 See Reuters (2023), "China export curbs choke off shipments of gallium, germanium for second month", 20 October (https://www.reuters.com/world/china/china-export-curbs-choke-off-shipments-gallium-germanium-second-month-2023-10-20/#:~:text=It%20had%20exported%205.57%20tons,in%20making%20high%2Dtech%20microchips).

do occur. The first instrument in this regard is the IMERA. In cases of severe supply chain disruptions or the risk thereof, it allows the European Union to impose reporting obligations and build strategic stockpiles, and in case of crisis it prepares potential interventions into supply chains (Ragonnaud, 2024). However, the primary existing ex-post EU instrument to this end is the newly introduced Anti-Coercion Instrument (ACI).[65] This provides a wide-ranging trade defence instrument that is intended to be applied in retaliation in case of economic coercion against an EU country. To quote the Commission, "the primary objective of the ACI is deterrence",[66] and it will therefore be considered a success if it is never called upon. If triggered, however, the retaliatory measure could apply in virtually all areas of economic policy.

This instrument should be complemented with another instrument that helps share the burden of economic coercion. This would entail providing affected firms with financial and perhaps logistical support to enable them to find new markets for their exports or imports. The logic for supporting firms is twofold: it removes the ability of adversaries to target groups and inflict political damage on European countries, which they could try to leverage to change policy; and it supports firms that will likely have suffered a serious shock to their business model through no fault of their own.

While in most cases the economic damage of economic coercion will be small enough that national government could finance support to affected workers and firms, there would be several benefits from setting up an EU-wide tool. EU solidarity assistance would reinforce the signal that an attack against one country is an attack against all and disincentivise divide-and-rule strategies by third countries.[67] It would also potentially allow firms in other countries that are indirectly affected by the coercive measures (e.g., German firms that export to China but use Lithuanian components, in the case of sanctions against Lithuania) to be supported without the need for new state aid schemes to be approved in each country. Such a measure to fortify the joint EU response becomes more important as we see other European countries such as Czechia pursue foreign policy akin to that of Lithuania (McVicar, 2023).

The challenge of this proposed instrument is that it introduces the potential for moral hazard. If firms believe that the European Union will bail them out in the event of supply chain disruption, they may choose to deepen their exposure to geopolitical risks as opposed to diversifying, increasing their potential exposure to economic coercion. Similarly, countries themselves could feel emboldened to pursue foreign policy beyond the EU consensus, safe in the knowledge that their firms will be supported by other

65 See https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202302675

66 https://policy.trade.ec.europa.eu/enforcement-and-protection/protecting-against-coercion/qa-political-agreement-anti-coercion-instrument_en

67 This was a feature of Chinese measures against Lithuania, as it sought to pressure German industry to intervene; see for instance A. Sytas and J. O'Donnell (2022), "German big business piles pressure on Lithuania in China row", Reuters, 21 January (https://www.reuters.com/world/europe/german-big-business-piles-pressure-lithuania-china-row-2022-01-21/).

member states.[68] Therefore, any new ex-post instrument should be accompanied by new incentives for companies to diversify their supply chains and customer base to limit potential abuse through moral hazard, as well as further progress on common foreign policy.

Part of this could be accomplished by the nature of the support itself. For instance, limiting support to capped, concessional loans with strict terms of use would reduce any perverse incentives of doubling down on critical imports from China. Eligibility requirements should also be used to minimise these risks: receiving state-aid could be made conditional on previously having fulfilled certain reporting obligations, having conducted risks assessments ('supply chain stress testing') or on companies having insured themselves against certain economic security risks in private markets.[69] There could be some symbiosis with the supply chain monitoring detailed previously, with firms operating in dependent sectors required to demonstrate diversification efforts before being deemed eligible for support, for example.

Overall, there is a need to strike a balance in both the nature of the instrument and the eligibility: too generous and lenient and there is the risk of moral hazard; too frugal and restrictive and it risks becoming a pointless instrument, unable to adequately support those negatively impacted and therefore failing to negate the political pressure points.[70]

For the success of both the deterrence of the ACI as well as any EU-wide support scheme, a common or at least strongly coordinated foreign policy is a prerequisite. All EU countries would have to underwrite the potential backlash against a forceful application of the ACI and be willing to pay for EU assistance for affected companies – even if they did not necessarily agree with the action that provoked the coercion in question. As detailed in Hackenbroich et al. (2022), when considering their responses countries must weigh up both the underlying policy as well as the value of preserving EU solidarity and unity against coercion, which will likely be successful if it succeeds in dividing member states.

In the previously documented instance of Lithuania, this was not the case, as other EU countries appeared unwilling to pay a price for a foreign policy action taken by Lithuania alone. Despite public proclamations of outrage by other EU countries, there was neither material support nor immediate retaliation against China for what even the Commission described as "discriminatory trade measures".[71] In contrast to the United States, which promised a $600 million export credit agreement to Lithuania,[72] and Taiwan, which established both a loan and investment fund focused on Central and Eastern Europe

68 This same moral hazard applies to the ACI, as discussed in Hackenbroich et al. (2022).
69 To reduce the administrative burden, we would propose limiting these additional requirements to larger firms, with SMEs covered regardless.
70 The lack of uptake of the Lithuanian support scheme warrants consideration.
71 See https://ec.europa.eu/commission/presscorner/detail/en/ip_22_2665
72 https://www.reuters.com/business/lithuania-get-us-trade-support-it-faces-china-fury-over-taiwan-2021-11-19/

of approximately €190 million and €1 billion, respectively,[73] the only response from the European Union was to allow Lithuania to provide state aid from its own finances (see Box 2) and to file a complaint to the WTO.[74] This failed to send a message of European unity; nor did it create a precedent that could serve as deterrence against future economic coercion. Therefore, it is unlikely that any additional support scheme could be introduced in the absence of further progress on aligning foreign policy.

CONCLUSION

The recent rise in geopolitical tensions has coincided with deeper economic integration of the European Union with non-democratic countries and an increase in the market concentration of EU imports. While the European Union has benefited from this trade in many ways, it has also led to economic security risks beyond traditional trade wars. To counter these risks, the Union should invest in a deeper understanding of its supply chains and pursue targeted industrial policies in a small number of carefully selected industries of strategic importance. However, the depth of exposure to economic coercion and other shocks stems from a structurally more concentrated imports and exports. Unless the European Union manages to diversify its trade relationships more broadly, many products will remain exposed.

While it is difficult to inflict macroeconomically relevant harm through economic coercion alone, there are many products where pressure could be applied on politically important constituencies. Therefore, the European Union should invest into ex-post policies that mitigate economic harm where it occurs. Such policies, taken together with deterrence through the threat of defensive measures under the ACI, would disincentivise the use of economic coercion against the Union. However, for ex-post policies to be effective, a more common foreign policy is necessary, as otherwise common burden sharing and unified responses are not credible.

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CENTRE FOR ECONOMIC POLICY RESEARCH

This second Paris Report focuses on one of the major policy issues currently facing Europe: economic security challenges in the face of supply chain vulnerabilities and geopolitical shocks. The report forms the first output from a new joint initiative between CEPR and Bruegel: Important Topics of Common European Interest (ITCEI).

Five chapters examine where Europe is vulnerable and where and how it should de-risk, taking into account history, trade dependencies and policy instruments. Morgan Kelly and Kevin O'Rourke examine the history of industrial policy in the shadow of conflict. Isabelle Mejean and Pierre Rousseaux identify trade dependencies that may expose the EU to trade disruptions using a novel methodology that considers the possibility of substitution away from disrupted input sources. David Baqaee, Julian Hinz, Benjamin Moll, Moritz Schularick, Feodora Teti, Joschka Wanner and Sihwan Yang examine the short- and long-run effects of a hard decoupling between China and Russia on the one hand, and the EU the G7 on the other, on the economies involved, focusing on Germany. Chad Bown examines the economic security of the EU from a trade policy perspective, while Conor McCaffrey and Niclas Poitiers discuss instruments of economic security.

In an introductory chapter, Jean Pisani-Ferry, Beatrice Weder di Mauro and Jeromin Zettelmeyer summarise the main policy lessons from the perspective of the editors. They argue that even though new geoeconomics risks may necessitate a pivoting of the EU towards economic security, this should not become an excuse for protectionism, and must preserve international cooperation. Achieving this requires innovative policy instruments, joint preparedness, and stronger governance mechanisms at both the EU and the international level. Furthermore, ensuring Europe's economic security will need to go beyond diversifying sources of supply for specific goods, to include a strategy to strengthen its single market. Finally, there is an open question whether protecting Europe's economic security requires measures to reduce economic integration with specific countries more broadly, notably with China. Whatever the answer, it should remain within WTO rules, and it should preserve the ability to collaborate in areas such as climate change and WTO reform.

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