

The Policies of the Green Industrial Transition from Geopolitical Viewpoints and their Potential Implications for Geoeconomic Fragmentation. A Comparative Approach of EU, USA, and China

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Abstract: *The paper tackles the impact of the national economic policies designed to address the challenges related to climate change. The research hypothesis is that divergent policies have significant effects on the economy, leading to potential disruptions, economic fragmentation, and geopolitical tensions. The analysis reveals that, globally, 165 jurisdictions reported having updated the nationally determined contributions (NDCs) to reduce carbon emissions under the Paris Agreement. However, only 39 jurisdictions implemented a form of carbon emissions pricing system. The NDCs and the sectoral policies, rather than the aggregate policies (mainly, carbon taxation) seem to be the cornerstone of the climate objectives. In addition, the analysis highlights the increased endeavours to ensure open strategic autonomy and the security of global value chains and supply sources. The article concludes that, in major jurisdictions (EU, USA, and China), the green transition policies differ in terms of approach and stance. Thus, they become sources for geoeconomic fragmentation and geopolitical tensions provoked by harsh competitiveness and security concerns in the quest for strategic resources and critical minerals necessary to the green transition. Furthermore, the EU resorts to a regulatory approach, while the USA pursues a supportive fiscal stance, and China maintains the political guidance characteristic of a centralised state.*

Keywords: *Green transition policies, geoeconomic fragmentation, industrial policies, carbon taxation, recovery and resilience plans.*

JEL classification: D78, D81, F12, F51, Q58.

1. Introduction

The impact of climate change affects significantly the global and national economies, leading to potential disruptions and material consequences of climate-related hazards. At the same time, the process of greening the carbon-intensive activities and sectors may have important economic and societal repercussions, while policies for mitigation and adaptation are required in order to reverse the impact of climate change-related risks. For instance, a retraining and upskilling of the workforce affected

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by unemployment may be needed, subsequent to the new industrial conditions that no longer require the former job-related skills. Economic damages attributable to climate change have been recorded in climate-exposed sectors, such as agriculture, forestry, fishery, energy, and tourism (IPCC, 2023).

However, from another perspective, this global shift to the greening of the economies may imply intertemporal opportunities and exchanges, resulting eventually in enhanced competitiveness and economic development that might thus foster growth, and new labour market opportunities. With such prospects in view, countries and national authorities are seeking to formulate and implement industrial strategies at sectoral level.

Globally, the majority of states are signatory parties of the Paris Agreement, and pledged to reduce the carbon emissions on a voluntary basis in line with the nationally determined contributions, according to Art. 4(2). Nevertheless, the national authorities seem to focus their engagements in specific economic sectors seen as a priority for the transition process, and as a source of growth and competitive advantage abroad. Countries prepare strategies oriented towards building specific capacities likely to give them an edge on competitiveness abroad (UNFCCC, 2015). Also, the IMF supports the opinion that the states should embrace green industrial policies, which are substantial, durable actions to meet climate commitments under the Paris Agreement, and in line with established guardrails, to preserve the international trade rules that have underpinned global prosperity (Bataille *et al.*, 2023).

2. Research methodology

The research methodology to approach the geopolitical risks and geoeconomic implications – stemming from various strategies for greening the economies and particular policies for the industrial sectors – pertains to the analysis of macroeconomic frameworks and development models over time, and the synthesis of documented and authentic scientific and public resources, giving substance to the main findings.

The paper was developed using the following methods / techniques of investigation and analysis: **(i) the qualitative research** – to explore in retrospect the interplay between geopolitical and economic considerations for sectoral policies potentially generating geoeconomic fragmentation, **(ii) the descriptive method and the observation method** – to investigate how specific policies might affect the economies and determine divergent pathways leading to fragmentation, given the impacts on the global economy, particularly on the energy chain and on international prices, **(iii) the analytical research** – to interpret the developments in the economic relations and the particular cases of EU, US, and China, and **(iv) the applied research** on how potential policy approaches in US, EU, and China may relate to diplomatic tensions, geopolitical risks, and the geoeconomic impact, affecting trade relations and the global value chains of critical resources.

3. Brief literature review

As of September 17, 2021, 165 signatory parties communicated new or updated Nationally Determined Contributions (NDCs). However, the Intergovernmental Panel on Climate Change (IPCC) considers that national pledges are insufficient to limit the increase of the global average temperature as per the objectives of the Paris Agreement. The Synthesis Report of 2021 states that the “*best estimate of peak temperature in the twenty-first century (projected mostly for 2100 when temperature continues to rise) is in the range of 2.1–2.9° C depending on the underlying assumptions*” (UNFCCC, 2021).

According to an analysis of the sectoral policy options related to climate change, these may reduce emissions considerably in the economies where they are applied. For instance, “policies planned in Canada, EU countries, the UK, and the US would reduce combined emissions of the power and EITE sectors by more than 30 percent relative to baseline levels. In China, India and Japan emission reductions would be between 5 and 15 percent from the baseline levels” (Chateau *et al.*, 2022). Another viewpoint is that “technology policy is the most widespread form of climate policy and is often preferred over seemingly efficient carbon pricing” (Rausch and Yonezawa, 2023).

Direct and indirect carbon pricing (including cap-and-trade systems, taxation of direct emissions and border-adjustments) require measurement and reporting systems. As of March 1, 2024, 73 Carbon Pricing initiatives are implemented in 39 sovereign jurisdictions covering 11.66 GtCO₂e [billions of tonnes of carbon dioxide emissions], which represent 23% of the global GHG emissions (World Bank, 2024). Direct and indirect carbon pricing generates fiscal revenues that are expected to support expenditures with sectoral subsidies for greening the economic sectors, and to ensure a just social transition.

However, compared to the UNFCCC 2021 Synthesis Report on the 165 jurisdictions with NDCs that include specific objectives for sectoral policies, the 39 jurisdictions reported by the World Bank to have adopted a carbon pricing scheme represent a small fraction. The NDCs and the sectoral policies, rather than the aggregate policies (mainly carbon taxation), seem to be the cornerstone of the climate objectives.

The impacts of the policy initiatives and industrial actions meant to address the imbalances in the supply chains, and the geopolitical fragmentation of foreign trade relations, have emerged as a key topic for current policy analysis. A group of researchers at S&P Global tackled the state of the supply chains in 2024, and discussed the costs associated with the green resilience, as supply chains are critical to the global economy (Fontecchio *et al.*, 2024). During the pandemic disruptions, many companies tried to avoid empty shelves, or idled manufacturing, by increasing their inventories. This represented a departure from a “just in time” inventory model to a “just in case” model (Rajanayagam, 2021).

Supplier diversity has increased sharply since 2019, and over 40% of the U.S. organisations have adopted supplier diversity programmes by 2024 (Overvest, 2024). However, while supplier diversity creates resilience, concentrating your purchases on a smaller number of suppliers reduces the prices due to the economies of scale. The auto industry, one of the most prominent sectors with public visibility to greening, is a key sector for the industrial policies, but it still makes an interesting exception when it comes to increasing supplier diversity. The auto industry manufactures, at the same

time, electric vehicles and internal combustion engine vehicles (while the latter still prevail largely), in order to meet the global demand (IEA, 2023a).

The *competitive advantage theory* states that the rivalry between supply chains is beneficial to the global economy, as it boosts efficiency and competitiveness (Porter, 1990 and 1998). However, the escalating trade protectionism and geopolitical rivalry (see the Trump administration's approach aimed at decreasing the dependency on Chinese imports starting from 2017, and China's retaliatory responses) sparked discussions on deglobalisation, offshoring, friend-shoring, or nearshoring strategies and policies. The nearshoring and the reshoring of supply chain inputs have tangible advantages: they shorten supply chains and avoid exposure to geopolitical rivals or geopolitically sensitive bottlenecks. Resilience is a desirable quality, especially as regards critical materials, but friendly and nearby nations may have higher labour costs (Rouimi *et al.*, 2024).

The new geopolitical context – marked by trade protectionism, economic inward-looking policies, and supply chains reconfigurations – determined both the private and the public sectors to reassess their trade with geopolitical rivals, given the economic dependencies that directly impact sectors and industries critical for growth and resilience. According to the “Dell theory of conflict prevention” (Friedman, 2005 and 2007), two countries that are both part of the same global supply chain will not take antagonistic positions, nor will they engage in conflicts, pondering the economic self-interest that prevails to the benefit of both. In fact, Dell theory relates with how conflict prevention occurred between India and Pakistan in their 2001–2002 nuclear standoff, wherein India was at risk of losing its global partners. Friedman took the computer company Dell as an illustrative example for global value chains and integrated global trade relations in the IT industry. Extrapolating, he argued that countries likewise seek to preserve peace and prosperity, by deepening trade and economic diplomacy relations, and hence their economies become more and more intertwined. In practice, that theory proves to be more descriptive than predictive: the recent global geopolitical dynamics revealed that countries that anticipate the possibility of engaging in a war are unlikely to remain part of the same global supply chains.

4. Analysis of the causes for the potential geoeconomic fragmentation

This individualised and globally-uncoordinated approach (whereby each of the 193 signatory parties to the Paris Agreement establish willingly, and based on their own choice, the carbon reduction pathways) may become a source of geoeconomic fragmentation in time. In other words, the capital and the technologies will probably be channelled into the advanced economies or in clusters of technological development. This would be detrimental to the emerging markets and to the developing economies, and would produce an asymmetric shock hindering development in some regions, and raising concerns about the “just transition” issue among the advanced economies and the emergent ones. The International Energy Agency estimates that the emerging markets and the developing economies may need annually about USD 2 trillion until 2030 to reach the decarbonisation objectives, with the majority of that funding flowing into the energy industry (IEA, 2023b).

Generally speaking, efforts to decarbonise the economies are pursued in key

economic sectors. The energy sector, the ferrous and non-ferrous metals sector, the buildings and construction (including adjacent materials) sector, the chemical sector (e.g. sulphur oxides, ammonia, etc.), and the transportation sector are the most common and representative sectors for which sectoral strategies and policies are developed. However, in certain circumstances, policies from one sector may affect other sectors and policies. For instance, a higher cost of the megawatt production – triggered by higher costs with the new technologies for generating renewable energy, or by carbon pricing – may affect the energy-intensive chemical sector.

Another example in this sense is the interplay between the industrial policy and the competition policy, which complement one another or clash with each other at times, generating synergies and tensions. The checks and balances are important when the industrial policy supports the market consolidation, the integration in the global value chains, and the security of supply sources. In its turn, the competition policy limits the anti-competitive practices, the mergers, the exclusions and exemptions, the state aid, and the subsidies to industrial sectors in this case (UNCTAD, 2023).

In the context of globally advancing a greener agenda, relevant transition strategies may be implemented and adequate instruments may be used, if we take heed of the macro models that indicate possible outcomes under various scenarios. Once identified, the possible solutions for a transition to a greener economy, should be analysed in terms of feasibility (cost-benefit analysis or cost-efficiency analysis).

Some global initiatives implemented at the sectoral level are based on a shared vision and on mutual values for the industrial sectors. For instance, in the maritime transport sector, new standard requirements have been issued for ships' fuel to ensure compliance with the objective of reducing GHG emissions (IMO, 2023). At the same time, the Getting to Zero Coalition (the World Economic Forum in partnership with the Global Maritime Forum) and the University Maritime Advisory Services (UMAS) support green sea shipping, and they issued recommendations in a policy report, advocating for sectoral support measures (Baresic *et al.*, 2021).

Basically, any sectoral policy approach to decarbonisation should be sectoral-backed and provide a gradual realistic trajectory of emissions reduction with milestones along the net-zero pathway. The public sectoral policies need to have the engagement of the private sector in reaching the decarbonisation objectives. This should be complemented by commitments from stakeholders, which are essential for the successful implementation and transition. Furthermore, these actions should be based on assessments and reporting, in a transparent and accountable manner. Historically, the economies have evolved and developed in close dependency to the fossil fuel energy sources. Therefore, the transformation should be a structural one, at sectoral level. It should not take place only via a market-based pricing system of carbon taxation, as aggregate policy with implications for general prices and risks of higher and longer inflation (generated by higher energy prices, higher costs of financing the green transition, and higher risks of a disorderly transition to the green economy). To address such imbalances at sectoral level in the global economy, the establishment of a World Carbon Bank has been suggested. This would reduce the inequitable carbon issuances and divergent pricing systems for carbon taxes (Rogoff, 2019). However, this comprehensive policy measure has not been discussed yet in the global fora.

Reaching carbon neutrality requires two shifts: one towards scaling-up the green industrial sectors with a focus on research, innovation, and new ecologically efficient technologies, and another one towards reducing the carbon-intensive industrial sector to net-zero within the projected timeframe. From a macroeconomic perspective, two elements may be needed simultaneously to achieve carbon neutrality, i.e., policies fostering inflows of investments and capital for green technologies and innovation, as well as carbon pricing systems to drive down emissions in fossil fuel-dependent sectors.

5. Geopolitical and economic implications of different greening approaches

Critical raw materials are natural resources of high economic importance, bearing risks of supply disruption entailed by the regional concentration of these resources and the lack of similar and affordable substitutes for them.

Given the need to shift the economies towards an ecologically neutral footprint and clean growth, the competition for strategic resources (critical minerals included) is increasing. The industrial challenge for Europe, USA, and China lies in attracting clean-tech capital and in implementing policy measures and actions to support the national environment and accelerate the green transition. For example, the US Inflation Reduction Act and the US CHIPS Act seem to be influencing responses in other key jurisdictions (i.e., EU, China). Europe resorts to subsidies for domestic manufacturing that may be enhanced through a proposed European Sovereignty Fund, which would finance industrial policy initiatives, next to an Innovation Fund meant to finance innovative projects (e.g. clean energy technologies, including wind turbines, solar photovoltaic panels, heat pumps, batteries, and electrolyzers).

In November 2023, European Union leaders reached a provisional agreement on a European Critical Raw Materials Act, as demand for rare earths and other critical minerals –essential for the two pillars of growth (the greening and the digitalisation of the economy) – may increase in the coming years (EU Council, 2023).

Pieces of national legislation, focused on subsidies and financial support at sectoral level, may raise concerns about the security of supply sources in other jurisdictions, in a context of higher commodity prices that seriously impact major industrial firms with international coverage. Internationally, the channelling of financial flows to new clean energy investments, for instance, could determine a re-allocation of resources to jurisdictions that advance faster on the transition path to net-zero carbon emissions. Subsequently, clustered investments may create imbalances and market fragmentation, both at sectoral level and among jurisdictions.

Such schemes rely on the customs policy, and will eventually impose trade tariffs on most of the economies that do not implement a carbon taxation mechanism. The EU's Carbon Border Adjustment Mechanism (CBAM), although designed to comply with the existing international trade rules, has already provoked negative responses among policymakers around the world (Bataille *et al.*, 2023). At the same time, proposals of the US administration to impose tariffs on the carbon embedded in imports, including the Biden administration's Global Arrangement on Sustainable Steel and Aluminium (GASSA), may affect the exports of the developing economies. On the other hand, a proposed joint trade deal between the US and the European Union offers

a historic opportunity to align the global economy with the climate action (European Commission, 2023). However, negotiations targeting the imports of high-carbon steel and aluminium can be challenging, while the imbalances stemming from overcapacities and mismatches in USA's and EU's greening policies may hinder the discussions (Sutton and Williams, 2023).

Developing economies, unable to compete with the developed ones in terms of subsidy packages, may also lack the needed resources to import clean energy technologies. As a result, they may impose export controls on raw materials, especially on critical minerals, to exploit to their benefit the market advantages and their strong position as raw materials suppliers. For example, as regards the export controls that could escalate trade tensions, China recently imposed such controls on graphite, a material used in electric vehicle batteries, in retaliation for the US-led restrictions on the technology sales to Chinese companies (Dempsey *et al.*, 2023). The controversies over green subsidies and carbon tariffs could lead to antagonist positions at the intersection of climate, trade, and industrial policies. The green industrial policies have the potential to steer the economies towards decarbonisation. Nevertheless, they may negatively impact trade and the international financial flows.

The analyses conducted so far convey a wide range of messages and findings. Some researchers point out that the environmental policy actions, and the subsidies to key economic sectors at national level (e.g., the chemical sector or the fossil fuels sector) vary in scope. The Greenness of Stimulus Index (GSI) assessed the environmental impact of USD 17.2 trillion of stimulus efforts across 30 countries, and found that the environmental policy interventions had been rather negative than positive (Vivid Economics, 2021). Other studies recommend the adoption of transparent and coherent sectoral measures on the transition pathways to the green economy. Climate Action 100+ initiated the Global Sector Strategy to map out the key transition levers, and to support investments for the aviation, food and beverage, electric utilities, and steel sectors. (Katowice Committee, 2021). G7 members have allocated more than USD 189 billion of recovery funds to support the fossil fuel industries (Hodgson, 2021), and some policies seem to subsidise or exempt from taxes the sectors that generate the most GHG emissions. Globally, the IMF estimates that in 2022 alone, fossil fuel subsidies surged to USD 7 trillion (Black *et al.*, 2023). In the EU, EUR 60 billion are estimated to have supported the fossil fuels sector (especially, the gas-dependent economic sectors) in 2023 (Maggiore, 2023).

6. Practical comparative considerations on the EU's, USA's, and China's approaches to greening the economy

The European Union aims to become the first region globally with a neutral emissions footprint on the environment. However, the EU is interconnected economically and geopolitically with other regions at the international level and – despite its endeavours to raise awareness on the greening needs of the international economy – its main economic partners approach the greening objectives differently, as analysed below. Nonetheless, their final goal is the same. Yet, the various approaches adopted to achieve this common goal may increase the geoeconomic fragmentation and the geopolitical tensions at international level.

6.1. The EU's approach: Regulatory Framework and EU funds for investments

In the European Union, the Recovery and Resilience Facility (RRF) is the core of the one-off Next Generation EU Instrument, which finances the structural shift of the economies of the EU Member States towards digitisation and green footprint of emissions. Under the RRF, the “investment projects are classified based on the statistical classification of economic sectors from the national accounts data set, NACE” (Corti *et al.*, 2021). Some activities or sectors might not be eligible for financing under state aid rules, (i) “in accordance with the provisions of the General Block Exemption Regulation, e.g. the sectors of: steel, synthetic fibres, coal, shipbuilding production, energy and related infrastructure, transport and related infrastructure”, or (ii) “based on the Business Activity Codes (NACE code), indicatively: commerce, food & beverage services, education, construction, health, banking, insurance, gambling, energy, transport” (KPMG, 2023). However, exceptions are possible for RRF financing as long as the transition processes have ecological ends, i.e. in the sectors of energy production, distribution and infrastructure, and in the sector of transport and related infrastructure.

Seeking to enhance the open strategic autonomy and to make EU's industry more competitive globally, the European industrial strategy covers around 14 key industrial ecosystems, i.e. aerospace and defence, agri-food, construction, cultural and creative industries, digital, electronics, energy intensive industries, energy-renewables, health, mobility (transport) and automotive, proximity, social economy and civil security, retail, textile and tourism (European Commission, 2020a and 2021).

Figure 1. EU's industrial ecosystems

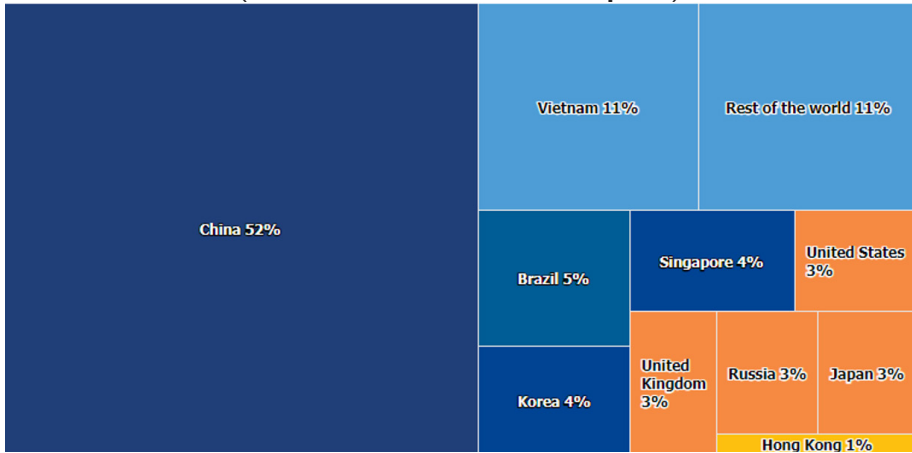


Source: European Commission, May 2021.

(Accessed on Mar. 1, 2024).

Moreover, according to the European Commission’s Communication on Critical Raw Materials Resilience, the EU – as a major trading partner – is looking to diversify its imports and exports, to forge new commercial alliances, and to expand current trade relations, while also monitoring its strategic dependencies (European Commission, 2020b). The Net-Zero Industry Act (NZIA) complements the EU Green Deal, and requires that at least 40% of the new net-zero technologies (needed in the EU) be made in the EU, that energy from renewable sources predominates in the economies of EU Member States, and that a storage capacity for at least 50 million tons be created and used for carbon capture.

**Chart 1. EU dependencies on critical material imports
(% of total critical material imports)**



Source: European Commission, May 2021 (Accessed on Mar. 1, 2024).

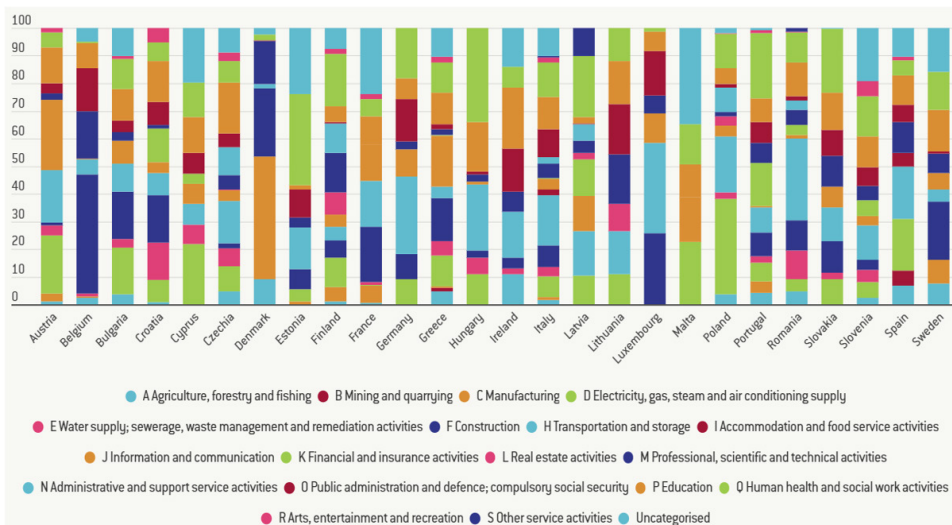
To access the supplementary EU funds, each EU Member State presented its own National Recovery and Resilience Plan (NRRP). Eight of these national plans have been surveyed comparatively, and revealed that the future fragmentation trajectories have already been outlined, as each Member State formulated its own NRRP according to its uppermost views (Corti *et al.*, 2021), emerging *ab initio* as potential sources of geoeconomic fragmentation and future pressures for EU’s Cohesion Policy, designed to reduce imbalances and regional disparities. This tendency was further exacerbated by the time lag between the approval of the first NRRP and of the last one – see Poland’s case (European Commission, 2022).

In Poland and the Czech Republic, the largest expenditures are for clean technologies and renewables, which amount to 37.5% and 31.7%, respectively, of their recovery plans. This is hardly surprising, as both countries still rely heavily on coal-power generation, which is very carbon-intensive and jeopardises the attainment of EU’s climate goals. In Hungary, the share of the proposed spending on clean technologies and renewables is much lower (10.9%); instead, the focus is on sustainable mobility, which accounts for 25.1% of the entire plan (Astrov *et al.*, 2022).

Drawing on the NRRPs, the heterogeneity of the sectoral allocation of resources

in each EU Member State is brought to light, revealing the diversity of choices for the allocation of resources within the EU. To compare the national plans is a challenging task, because they present data in very different structures. Moreover, an accurate comparison is difficult to achieve, as the number and the definition of headline categories for investments, and the availability of summary information about sub-categories vary from country to country (Darvas *et al.*, 2023).

Chart 2. Composition of recovery plans according to economic activities
(% of total)



Source: Darvas *et al.*, 2023.

In addition to the RRF, the Just Transition Mechanism is an important tool to maintain cohesion at regional level, while implementing the EU Green Deal. It builds upon prior results of other initiatives at sectoral level, such as the EU Initiative for Coal Regions in Transition (Alves-Dias *et al.*, 2018).

The European Green Deal Industrial Plan and the Net-Zero Industry Act (NZIA) loosen the state aid rules, and allow subsidies for various types of clean energy. Europe will also provide subsidies for domestic manufacturing through a proposed European Sovereignty Fund that will finance industrial policy initiatives, and an Innovation Fund, which will finance innovative demonstration projects.

The EU's Green Deal Industrial Plan sets forth ambitious targets for domestic manufacturing for a broad swath of clean energy technologies, including wind turbines, solar photovoltaic panels, heat pumps, batteries, and electrolyzers.

The Critical Raw Materials Act addresses the issue of the dependencies on imports for about 30 materials of high economic importance. It encourages the open strategic autonomy and self-sufficiency across the entire value chain. It expects that, by 2030, the EU will be able to extract 10%, process 40%, and recycle 15% of the quantity of critical raw materials it needs annually to satisfy the demands of the single market.

However, Europe's geology, cost of labour, and environmental standards might be less economically viable than those of other regions.

In addition, via the Technical Support Instrument (TSI), the European Commission provides technical expertise to the EU Member States in a wide range of policy areas, including in their process of designing and implementing reforms that support the green transition (climate action, circular economy, and energy transition) and contribute to the achievement of the goals of the European Green Deal. The TSI has a budget of €864 million for the period 2021-2027, and supports green transition-related projects, e.g. a reform project called *Establishment of the National Decarbonisation Fund* approved for Bulgaria in 2021, a reform project titled *Update of Cyprus Energy and Climate policies* approved for Cyprus in 2021, a reform project called *Strengthening the green transition in Slovakia through climate and macroeconomic modelling* approved for Slovakia in 2022, as well as a reform project titled *Implementing Romania's renewable energy support scheme* approved for Romania in 2023.

6.2. The USA's approach: Legislative action and US budget support for the private sector

In USA, the main sectoral strategy for a cleaner and greener economy is encompassed in the provisions of the Inflation Reduction Act (IRA). The IRA aims to achieve a significant reduction of the greenhouse gas (GHG) emissions of 50-52% below 2005 levels, by 2030, to provide only carbon pollution-free electricity by 2035, to achieve a net-zero emissions economy by 2050, and to use at least 40% of the federal investments' benefits to support a socially just transition (US Congress, 2022). However, US IRA may create trade imbalances through the domestic rules that run counter to the rules of the World Trade Organization regarding the equal treatment of foreign and domestic suppliers.

In the United States, the Infrastructure Investment and Jobs Act (IIJA), most commonly known as the Bipartisan Infrastructure Law, provides resources for upgrading the power grid, improving public transportation, and investing in zero-emission transport and school buses, installing a nationwide EV charging network, cleaning up legacy pollution, replacing lead pipes and delivering clean water (US Congress, 2021a). IRA complements the prior Build Back Better Act (US Congress, 2021b). It aims at rebuilding the middle class, it seeks to create jobs, spur long-term growth, reduce price pressures, and provide agencies with the necessary funding to achieve, *inter alia*, the greening of the US economy, and particularly of its most important energy-intensive sectors.

- In the energy sector, the objective is to more than double the deployment of wind, solar, and battery storage. The targeted support for clean electricity is supposed to steer investments to new research and innovations in this domain (wind energy, solar energy, etc.). The support is directed towards domestic manufacturing of clean energy technologies with the goal of developing new capacities for clean hydrogen, enhanced geothermal systems, and floating offshore wind energy.
- In the transportation sector, the US auto industry – in its shift to electric vehicle production – will be supported by investments in associated sectors

of batteries and chargers. In addition to the public transportation, the rail network, the charging stations network, and the battery supply chains will enable the acceleration of sectoral investments. In line with these developments, the American Battery Materials Initiative will leverage federal resources for growing the end-to-end battery supply chain, in order to develop more sustainable, secure, and resilient supply chains (White House, 2022a). Furthermore, gearing the current fleets of vehicles to cleaner fuels and less emissions should contribute to reducing GHG and carbon emissions.

- In the buildings sector, the Bipartisan Infrastructure Law seeks to expand the usage of clean electric appliances, and the application of measures for efficiency upgrades, cutting down the GHG emissions. The funding provided under this law is aimed at modernising the power grid, weatherizing and upgrading homes, schools, businesses and communities, and funding new programmes to support cutting-edge clean energy technologies (White House, 2022b). A new Building Performance Standards Coalition of over 30 states and local governments is expected to pass regulation to reduce building emissions, increase the energy efficiency and the electrification, and lower the energy costs.
- The industrial sector will be supported to expand the clean hydrogen hubs. It will receive additional funding for clean hydrogen innovation, as well as cleaner industrial facilities for steel, iron, cement, and other energy-intensive materials. In October 2023, “seven regional clean hydrogen hubs [...] were selected in order to receive USD 7 billion in Bipartisan Infrastructure Law funding to accelerate the domestic market for low-cost and clean hydrogen”. Altogether, these hubs aim at generating “more than three million metric tons of clean hydrogen per year”. Thus, they will spare the environment of “25 million metric tons of carbon dioxide emissions from end uses each year”. Overall, the use of clean hydrogen can diminish emissions in many sectors of the economy, being essential “for hard-to-decarbonize sectors and industrial processes, such as heavy-duty transportation and chemical, steel, and cement manufacturing” (White House, 2023). In the US, just like in other countries, new Carbon Capture, Utilisation, and Sequestration (CCUS) technologies are meant to facilitate the cumulative pollution reduction.
- The agricultural sector is paired with rural development and climate-smart forestry to support initiatives in the areas of ecosystem restoration and biodiversity preservation.

Via the Mineral Security Partnership, the United States addresses the sectoral challenges arising from the dependency on critical raw materials (US Department of State, 2023). Hence, it develops global supply chains with allies and mineral-rich countries. Critical mineral free trade agreements allow the US to secure essential material resources, while offering access to tax credits (Williams, 2023). However, this approach risks creating a fragmented mineral ecosystem with two markets – one in

China, and the other one in the advanced economies of the Organization for Economic Cooperation and Development (OECD).

6.3. The Chinese approach: Centralised strategic planning and state budgetary support for the public sector

China's efforts to highlight the issue of environmental sustainability within its development strategies can be traced back to the 1980s and the 1990s. Since 2015, considering its participation in the Paris Agreement and its later commitment to the 30-60 targets, China adjusted its economic policy strategies to achieve the goals of (i) sustained economic growth, and (ii) a green and low-carbon transition (UNCTAD, 2023b). Moreover, from 2020-2021 onwards, China stepped up its greening efforts to align its long-term growth strategy with the global endeavours. In this regard, its flagship strategy at sectoral level is the 14th Five-Year Plan for 2021-2025 (UNDP, 2021), designed to steer China towards the green development. China has pledged to peak emissions before 2030, and become carbon neutral before 2060.

Five key documents guide China's greening strategy at the sectoral level:

(i) The Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy - Document "1" (China State Council, 2021a).

(ii) The Action Plan for Carbon Dioxide Peaking before 2030 ('1+N'), where "N" stands for the specific sectoral five-year plans that are developed (China State Council, 2021b).

These two policy documents form the core of China's new 1+N policy system that guides the fight against climate change.

(iii) The State Council's white paper "Responding to Climate Change: China's Policies and Actions" (China State Council, 2021c).

(iv) "China's Mid-century Long-term Low Greenhouse Gases Emissions Development Strategy" (China State Council, 2021d).

(v) "China's Achievements, New Goals and New Measures for Nationally Determined Contributions" assumed by China under the Paris Agreement (China State Council, 2021e).

- The 14th Five-Year Plan (FYP) defines the key environmental targets for the next five years. These revolve around emissions and the intensity of energy consumption. The aforementioned FYP also identifies the need for these targets to be supplemented with controls on total emissions, and the construction of coal power plants. Petroleum consumption will also "reach its peak plateau" during the 15th FYP (2026-2030). This, coupled with the target to reduce domestic coal consumption during the same period, provides a possible pathway to peaking CO₂ before 2030.
- 1+N offers an important set of detailed and concrete targets for energy and other key industrial sectors. It also provides plans on climate action

for various key policy areas, i.e. the circular economy, carbon trading, and carbon sink.

- Other 30 documents – detailed background documents – (Watts, 2021) are to be presented. These focus on elaborate climate actions in key sectors (energy, buildings, and transport), and major industries (manufacturing industry, ferrous and non-ferrous metals, petrochemicals and chemicals). They also place emphasis on the scientific and technological support, the carbon sink capacity, statistical accounting, inspection and assessment, and fiscal, financial, and price policies. In this comprehensive framework, China extends the dialogue with its international counterparts for climate action within the climate agenda, which includes the development of standards, and knowledge exchange on a coherent set of policies and regulations.

7. Conclusions

The United Nations (Department of Economic and Social Affairs) published a guidance note, in 2021, to steer the transition process to green economic sectors in a feasible and orderly manner (UN, 2021). Its main message is suggesting that, in the process of the smooth transition strategy (STS), *“the national STS should include a comprehensive and coherent set of specific and predictable measures that are in accordance with the priorities of the graduating country while taking into account its own strengths, specific structural challenges and vulnerabilities and be implemented as part of the country’s overall development strategy”*. Depending on the structure of each national economy, authorities may resort to specific sectoral policies to support the ultimate goal of reaching net-zero carbon emissions. Thus, tailored measures for each strategic sector at national level may seem the adequate way to nationally guide the transition process to a greener economy. However, the individual and uncoordinated approaches might increase the geoeconomic fragmentation and forge diverging pathways of development. These risks could be minimised through international cooperation and robust coalitions in support of the transition towards green economies.

In the same vein, the Katowice Committee has issued a guide containing recommendations for policymakers, and best-case practices (at sectoral level) in terms of greening measures to stimulate the lowering of GHG emissions (in the main sectors: agriculture, energy, construction and energy efficiency of buildings, transportation, mining, waste management, etc.). The conclusions highlight the importance of implementing just transition policies, which are comprehensive, inclusive, and based on social dialogue and on stakeholder engagement. They also stress the importance of tailoring the different paths of just transition and economic diversification (paths already taken by various countries) to the needs of the national and/or local context (UNFCCC, 2023). Climate Action 100+ launched the Global Sector Strategies, acknowledging that companies ought to take more action to decarbonise. For corporates to thrive in a transitioning economy, the policies and the real economy conditions should be aligned with this goal. Otherwise, companies face barriers to completing their transition to net-zero emissions. Consequently, the investors’ engagement with isolated companies is often insufficient to ensure their full transition. For each sector, a

connection with the wider ecosystem is needed. The CA100+ Global Sector Strategies project has already produced a number of reports for aviation, steel, food and beverage, electric utilities (Katowice Committee, 2021). In the same study previously mentioned, Vivid Economics presents a stark opinion on the National Recovery and Resilience Plans (NRRPs) and the sectoral impacts (of the actions to be undertaken) on nature and climate: *“The approach must enable government decision-makers to connect policy levers with nature impacts, and make transparent the effects upon nature of finance decisions. Climate resilience and nature resilience go hand-in-hand, and the NRRPs’ strong focus on climate change shows that without the right tools to measure the nature impacts of spending even so-called ‘green’ public finance risks missing the bigger, holistic environmental picture.”*

Given the emergent policy orientations towards the security of supply chains and critical mineral resources (necessary to the new economic paradigm of greening economies), the renewed emphasis on global value chains and foreign trade relations is likely to consolidate on short and medium terms. This indicates the scope and importance of the economic diplomacy efforts in reconfiguring geopolitical relations. During the years 2020–2022, S&P Global Ratings took negative rating actions on over 200 corporate issuers due to supply chain events and bottlenecks (Teshler, 2023). Companies that manufacture consumer products were particularly prone to negative rating actions during those years. Many companies reacted to these pressures by diversifying their suppliers or bringing manufacturing closer to home, but there was a price associated with these actions. The gross operating profit margins for manufacturing firms, at the global level, are expected to fall from 10.7% of sales (in 2022) to 10.4% of sales in 2024. In 2022, capital expenditures were equal to gross operating profits. This year, capital expenditures are anticipated to exceed gross operating profits by 5%. The squeeze is on for many companies (Rogers, 2023a). Among companies, there are growing concerns that supply chains affect all aspects of their business, from market share to creditworthiness, increased price competition, and profit margin compressions. To sum up, in the global geoeconomic landscape, economies need anchored supply chain policies that facilitate the increase in supplier diversity, the nearshoring of the production of critical components, the holding of higher inventories, and investments in technological improvements (Rogers, 2023b).

From the above overview of the strategic sectors and transition policies, we can infer that the specific sectoral policies – developed and implemented at national level to support strategic economic sectors – emerge as a potential risk factor triggering economic fragmentation and separate transition pathways to net-zero carbon emissions. The EU Member States have included significant aspects of the ecological transition into their NRRPs, and the EU funds allocated to it vary among Member States. In addition, the funds provided through Next Generation EU and REPowerEU are conditioned on specific objectives, and the time lags for the attainment of those objectives differ from country to country. Furthermore, some of the EU funds support plans of investment in capacities for energy security that include fossil fuels (e.g. natural gas) or nuclear fuels (as transitory fuels until the complete greening of the economy).

In major jurisdictions (EU, USA, and China), the green transition policies differ in terms of approach and stance. Hence, they become sources of geoeconomic fragmentation and geopolitical tensions, provoked by harsh competitiveness and

security concerns in the quest for strategic resources and critical minerals necessary to the green transition. The EU resorts to a regulatory approach, while the USA pursues a supportive fiscal stance, and China maintains the political guidance characteristic of a centralised state.

The investments in technology can also improve the supply chain resilience. However, increasing the resilience requires trade-offs, e.g. diversity of suppliers, higher prices versus lower prices and economies of scale, proximity of resources versus skilled labour availability, infrastructure versus greening policies (including industrial policies). The largest trade-off is that supply chain tensions are addressed in the short term, while geoeconomic resilience is built in the long term. Quintessentially, taking into account all the arguments presented in this paper, we consider that the interplay between the economic implications of the new industrial policies and the geopolitical fragmentation constitutes an emergent topic for future in-depth research.

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