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The intersection between climate transition policies and geoeconomic fragmentation

A report of the International Relations Committee Network on climate change

No 36x

Contents

Abstract

Two phenomena are increasingly reshaping the world economy. One is the growing and well-documented importance of climate transition policies that differ across countries. The other is the stark rise of geoeconomic fragmentation (GEF) concerns. While differences in climate transition policies are not new, they could amplify GEF, which is a new, growing risk. Conceptually, GEF is a policy-driven reversal of global economic integration, guided by strategic considerations such as national security, sovereignty, autonomy, or economic rivalry. It does not include reversals to global economic integration that are driven by autonomous change, such as shifts in technology, demographics or preferences, or policies motivated primarily by prudential or environmental concerns and labour or human rights. GEF propagates via all the channels through which countries engage with each other economically and politically to provide global public goods such as climate change mitigation. The steep rise in trade and investment restrictions points to coming headwinds which could be compounded by uncoordinated climate transition policies. Conversely, GEF could make transition policies more difficult as, together with their prerequisites – such as shared regulatory approaches, knowledge sharing and financial aid to less well-off countries – they hinge on effective cross-border coordination and collaboration. There is a considerable risk that GEF may hinder climate transition policies.

The report is structured as follows. The first section sheds light on how climate policies may contribute to GEF. The second section analyses the extent to which GEF could hinder the green transition. The last section discusses gaps and avenues for further analytical and model-based work.

JEL codes: F52, F64, H87, Q54.

Keywords: Geoeconomic fragmentation, climate change, international public goods, international cooperation

Executive summary

Two phenomena increasingly contribute to reshaping the world economy. One is the growing urgency of tackling climate change, which tends to be addressed by uncoordinated national transition policies. The other is the stark rise of geoeconomic fragmentation (GEF) concerns, as evidenced by the increase in trade and investment restrictions globally. This report aims to sketch out how geoeconomic fragmentation and climate change policies interplay, discuss key dimensions of the nexus and identify some analytical challenges.

Uncoordinated climate transition policies can increase GEF.

- Current global production and consumption patterns contribute to climate change.
- Climate transition policies aimed at addressing some of those negative externalities are set to increasingly and permanently modify the structure of economies and have international spillovers through their effects on trade and financial flows at the global level.
- Because of these spillovers, the lack of global coordination could lead to frictions and uncooperative policy actions, met in turn with more retaliatory measures, which would compound GEF.
- Uncoordinated transition policies could result in subsidy races, increased protectionism or even trade wars. Uncooperative policies could distort trade flows and lead to a reallocation of the production of green products mainly in response to financial incentives and not necessarily according to a country's comparative advantage.

Increased GEF might hinder the pace and scope of the low-carbon transition.

- Trade restrictions targeting green products would diminish cross-border exchanges in goods and innovation. This would hamper the global production of green products and impair the spread of climate technology, likely slowing the pace of the green transition.
- Another channel relates to the supply of critical minerals, which is highly vulnerable to geopolitical risks and trade restrictions, in a context of increasing demand and oligopolistic market structure. The sensitivity of transition policies to GEF is particularly acute in Europe, due to its upstream position in green supply chains.
- GEF could crystalise further the uneven distribution of international financing of sustainable investments globally. Divergent sustainable finance regulatory frameworks, together with fragmentation concerns among investors, would cause funding difficulties in developing countries. Geopolitically motivated

barriers to trade and investment could also worsen the conditions for the green transition, by reducing the size of the market and incentives for R&D.

Attempting to understand the economic implications of GEF and climate transition together involves analytical challenges.

- It calls for continued improvement of the tools used to evaluate climate policies, paying particular attention to the role of investment and innovation, especially as the literature is mostly inconclusive regarding the optimal policy mix to achieve the transition.
- Developing more granular and forward-looking Inter-Country Input-Output (ICIO) tables could make it easier to estimate the macroeconomic impact of trade fragmentation and green transition policies.

1 Uncoordinated climate policies can increase GEF

Climate transition policies are set to modify increasingly and permanently the structure of economies. They may have significant implications for global trade and financial flows. Transition policies are historically uncoordinated. Uncooperative transition strategies can lead to retaliatory measures and pose a GEF risk.

1.1 Transition policies are historically uncoordinated and appear increasingly uncooperative

Concerns about climate change have prompted governments to take action beyond using macroeconomic policy tools or correcting market failures. Carbon-pricing and non-market-based policies[1] differ greatly across countries and result in differing explicit and implicit carbon prices and abatement costs.[2] Carbon-pricing measures are uncoordinated globally. In 2022, 73 carbon pricing mechanisms were in force worldwide, covering 23% of global emissions of greenhouse gases.[3] They differ significantly in terms of types (e.g. ETS vs carbon tax) and the administrative level of implementation (Figure 1). Price levels and coverage of these schemes also differ considerably (World Bank, 2023). The lack of coordination extends to other market and non-market-based policies (Figure 2).

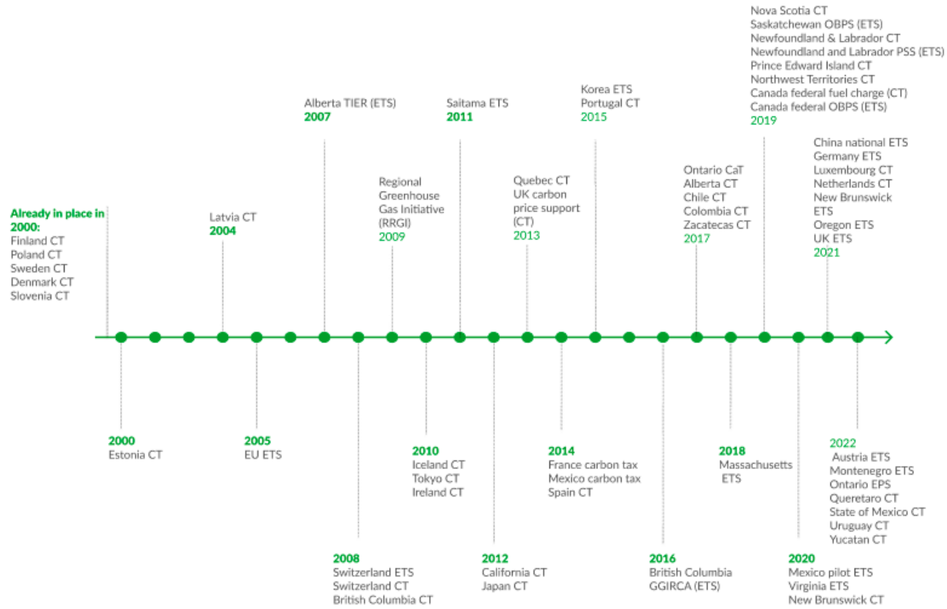
1 Such as for instance ban and phasing-out of fossil fuels or feed-in tariffs.

2 Effective carbon prices and abatement costs can arise directly through carbon taxes or emissions trading systems, or implicitly through the introduction of more stringent regulations and standards.

3 Details are provided in the World Bank Carbon Pricing Dashboard.

Box 1
Brief overview of climate transition policies

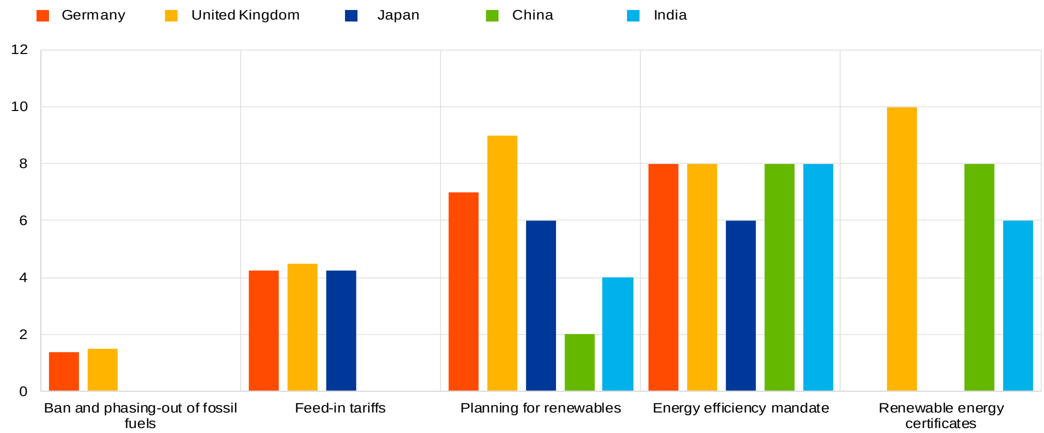
Figure 1. Timeline of the introduction of carbon pricing in OECD countries for the period 2000-22



Sources: World Bank Carbon Pricing Dashboard and Banco de España calculations.
Note: For further details, see Santabárbara and Suárez-Varela (2022).

Figure 2. Level of adoption of selected non-market-based policies by country (2022)

(index)



Source: Own elaboration based on Climate Actions and Policies Measurement framework - CAPMF - database (see OECD, 2022).
Notes: The values range from 0 to 10 and measures environmental policy stringency, defined as the degree to which policies incentivise emissions reductions. A score of 0 indicates the absence of a specified policy, resulting in the corresponding country's bar being omitted from the chart. Subsequent levels are assigned based on the in-sample distributions. For example, a score of 10 denotes that the policy variable is at or surpasses the 90th percentile threshold.

Differences in climate transition policies across countries are not new. They are enshrined in international environmental law conventions through the principle of "common but differentiated responsibilities" (CBDR). The CBDR within the UN Framework Convention on Climate Change (UNFCCC) acknowledges the different capabilities and responsibilities of individual countries in addressing climate change in view of their social and economic conditions. The 2015 Paris Agreement requires parties to (i) prepare, communicate and maintain successive nationally determined contributions (NDCs); and (ii) pursue domestic mitigation measures with the aim of achieving their NDCs. However, NDCs currently differ in ambition and in aggregate fall short of securing the Paris target of 1.5°C (IPCC, 2022). This ambition gap is compounded by implementation gaps because the Paris Agreement does not provide any enforcement mechanism at the international level.

A broad body of literature addresses the economic implications of those differences. In addition, differences in transition policies are not an issue per se: ambitious climate policies by some countries could inspire others, even if there is some delay.[4] This is the rationale underpinning proposals for climate clubs (Nordhaus, 2015; G7, 2022).[5] In practice, the more cooperative the international environment, the lower the negative side effects of different transition policies.

There is no clear recipe for the right policy mix of transition policies. Carbon pricing is generally considered the first-best option, while a subsidy-only strategy is generally deemed ineffective in discouraging brown activities (Hassler et al., 2021). Some have found that carbon taxes complemented by R&D subsidies can generate enough innovation for the transition (Acemoglu et al., 2012; Aghion et al., 2016). Others have advocated combining subsidies and taxes for an optimal green policy mix (Kruse-Andersen and Sorensen, 2022) or suggested sequencing policies, subsidising green innovation first and then introducing carbon pricing (Fries, 2023). Climate policy choices are also dependent on country's initial macroeconomic conditions and political context, as is argued for instance for the US Inflation Reduction Act (IRA) (Bistline et al., 2023).

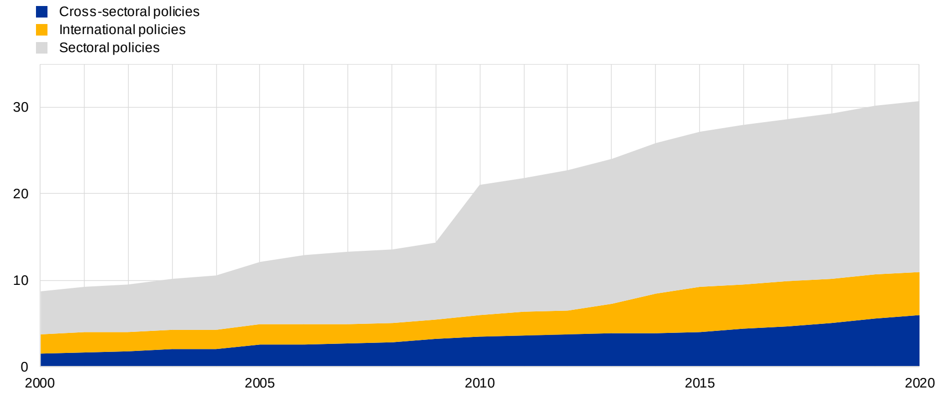
Governments are increasingly adopting uncooperative approaches through sectoral policies (Figure 3). Strategic considerations mean that countries seek to attract investments that give them a competitive edge in key sectors, as the green transition will likely usher in an industrial and technological revolution with far-reaching economic implications (Terzi, 2022). In this "new era of industrial policy" (Shih, 2023), countries are deploying a wide array of measures. They include "spending-based measures" (IMF, 2023a) which encompass both supply-side measures, designed to lower production or R&D costs (through grants, subsidies, tax incentives or tax credits), and demand-side measures intended to nudge household consumption towards specific products or services (tax credits for purchasing electric vehicles, for example). Measures also extend to customs and regulatory measures as well as tariffs, reflecting a broader trend of inward-looking strategies that could undermine the principles of mutual benefit and cooperation in the global economy.

[4] Some studies show that the EU has the ability to promulgate regulations that shape the global business environment (the "Brussels effect"), including on sustainability and climate transition matters (see Bradford, 2019).

[5] A climate club is defined as "an agreement by participating countries to undertake harmonised emissions reductions". Nonparticipants are penalised, for instance through uniform tariffs on their exports to the club region (Nordhaus, 2015).

Figure 3. Environmental policies: average for IPAC countries, 2000-20

(number of adopted policies, by bloc)



Source: Climate Actions and Policies Measurement framework - CAPMF - database (see OECD, 2022).
Note: IPAC countries comprise the 52 countries participating in the International Program for Action on Climate (IPAC).

1.2 Climate transition policies entail international spillovers which could lead to frictions and geoeconomic fragmentation

Climate transition policies transmit across borders, primarily through trade and investment channels, with restrictions or incentives in one country affecting the global markets for goods, services and capital. Border restrictions or changes in behind-the-border regulations as part of climate change policies can bias competition. Carbon tariffs and stricter environmental standards could disadvantage foreign producers that do not adhere to similar criteria, thereby reshaping global supply chains and market access. Conversely, if external costs are not suitably internalised by adequate carbon pricing, this could disadvantage foreign producers that do not benefit from such fossil subsidies, thereby affecting global supply chains and market access. Such measures may lead to continued concentration (i.e. lack of reallocation) of production and trade imbalances, risking trade disputes and retaliatory measures that could fragment international markets. Furthermore, differentiated regulatory landscapes can create barriers to entry for firms, potentially widening the economic divide between countries – notably between advanced and developing economies. Additionally, climate policies can influence international migration patterns, thereby impacting global environmental and economic landscapes.

Differing climate policies can result in carbon leakage, i.e. in production transfers to countries with less stringent environmental regulations (OECD, 2020). Increased abatement costs of high-emitting industries in countries or regions that impose more stringent climate policies may lead to those regions exporting less of those “dirty” goods (see Box 2) and importing more, resulting in a reallocation of production across countries and regions while leaving global emissions unchanged or even increased.

Avoiding carbon leakages effectively represents a collective action problem at the global level. Uniform global carbon pricing would ensure that the marginal cost of reducing emissions is equalised across economies. However, divergent ambitions of mitigation strategies, the lack of coordination of national actions and the diversity of instruments pose a problem for collective action. Without sufficient international coordination, carbon border adjustment, i.e. imposing surcharges on imports, is a partial solution.

Uncoordinated climate transition policy packages can lead to significant frictions and provoke retaliatory measures. Certain tools, particularly those affecting subsidies, are more likely to impact external competitiveness and fuel tensions in international trade relations. Subsidy escalation, heightened protectionism and potentially also full-blown trade wars would disproportionately harm less advanced economies, exacerbating global economic disparities (Clausing and Wolfram, 2023; Kleimann et al., 2023).

Recent climate policy initiatives highlight that these risks are real. One example is the EU Carbon Border Adjustment Mechanism (CBAM). While it aims at maintaining the level playing field for European exporters of ETS products facing different climate ambitions in their export markets, it is seen by developing countries as not respecting the spirit of the CBDR principle. The US IRA is another example of a transition package that gives rise to concerns and tensions among trading partners. As Box 3 on the implications of the US IRA suggests, policies aimed at boosting the green transition can distort sectoral trade flows and lead to a reallocation of production in the green sectors mainly in response to financial incentives and not necessarily according to a country's comparative advantage.

Box 2
International trade spillovers, reallocation of polluting industries and the EU CBAM

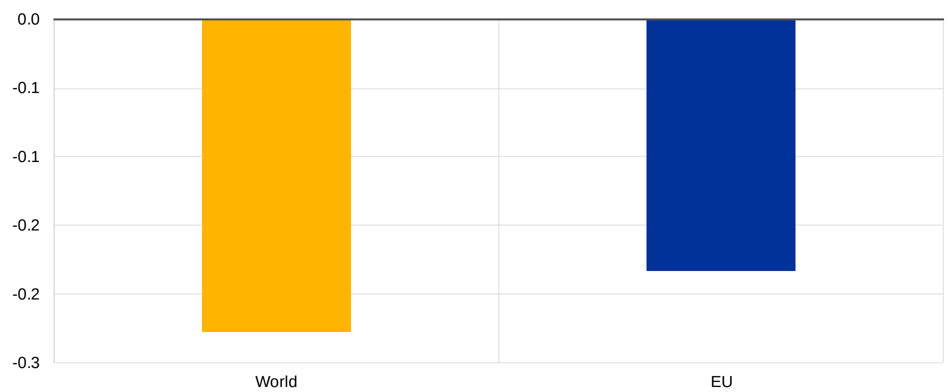
This box examines the risk of carbon leakage and trade spillovers that may arise from uncoordinated mitigation policies, with an emphasis on the EU. The pollution haven hypothesis (PHH) posits that trade liberalisation can lead to a reallocation of more pollutant-intensive trade towards countries with more lenient environmental regulations, effectively turning them into "pollution havens". The literature has not reached a consensus on the extent to which environmental regulation influences the composition of trade. Some studies provide evidence in favour of the PHH (e.g. Antweiler et al., 2001; Copeland and Scott Taylor, 2004; Aichele and Felbermayr, 2015; Cherniwchan, 2017), while other, earlier, research finds no such support (Grossman and Krueger, 1991; Low and Yeats, 1992).

We examine the spillover effects of stringent environmental regulations on international trade by focusing on goods classified as "dirty" or more polluting based on their environmental impact, using the product classification of Low and Yeats (1992). The empirical strategy employs a gravity equation model estimated using a sample of 140 countries for the period 2002–18. Our findings indicate that a 1% increase in environmental stringency is associated with a decrease of 0.183 percentage points, on average, in exports of dirty products for European trade flows and of 0.228 percentage points for all countries (see Figure 4). These findings align with those encountered in other regions of the world (e.g., Levinson and Scott Taylor, (2008), and Ederington and Minier, (2005) for the United States). Overall, there is evidence that more polluting industries being reallocated was linked to differences in transition policies.

The EU's CBAM is an effective instrument to prevent carbon leakage. The European Commission, Council and Parliament reached an initial deal on an adjustment mechanism in December 2022. This then became effective in October 2023 with a transition period. Under the mechanism, European importers of a subset of products subject to ETS will be required to purchase emission certificates at the ETS price, covering the emissions embodied in the imported products. Nonetheless, the efficacy of CBAMs is contingent upon several factors, such as the scope of sectoral coverage, the selection of reference emissions (whether domestic or from the source country), the reference carbon price, trade and sectoral structures, as well as trade elasticity. These determinants of CBAMs' effectiveness have been extensively analysed in studies like Monjon and Quirion (2011), Böhringer et al. (2012), Mörsdorf (2002) and Bellora and Fontagné (2023). In developing the CBAM, the EU has been cautious to design it in a way that is compliant with the World Trade Organization (WTO) rules, notably by ensuring that products produced in the EU and in third countries are treated equally (European Commission, 2024). First, the CBAM is being phased in gradually, to provide businesses and other countries with legal certainty and stability. Moreover, it will initially apply only to a selected number of goods in sectors at high risk of carbon leakage. Due to the complexity and traceability of carbon in GVCs, the selected goods mainly cover basic materials and basic material goods, for which it is easier to assess the CO2 content compared to a finished product with multiple intermediate components (Fontagné et al. 2022). Finally, the effective carbon prices paid outside the EU will be deducted from the CBAM adjustment to avoid double pricing.

Figure 4. Effect of an increase of 1% in environmental stringency on exports of more polluting goods

(percentage points)



Source: Banco de España staff calculations.
Note: For further details, see Peiró, et al. (2022) and Suárez-Varela and Rodríguez-Crespo (2022).

Box 3
The international impact of the US IRA[6]

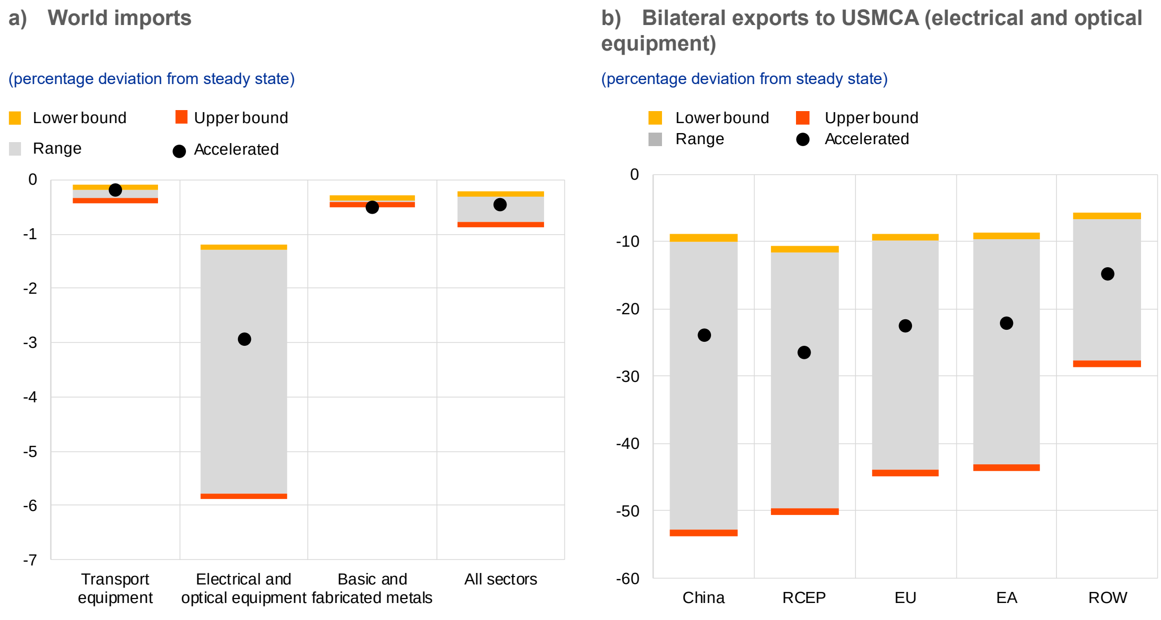
This box quantifies the global economic effects of the US Inflation Reduction Act (IRA) under different assumptions on the strength of the green transition. The box uses the Baqaee and

[6] For more details, see Attinasi, Boeckelmann and Meunier (2023c).

Farhi (2024) multi-country multi-sector model to estimate the non-linear effects of the trade barriers induced by the domestic content requirements of the IRA, where tax credits are granted for the purchase of electric vehicles (EVs) and renewable energy equipment if they are produced in North America. To reflect the growing significance of green sectors, the magnitude of the shock is rescaled under three different sets of assumptions outlined by the International Energy Agency: (i) a conservative scenario based on stated policies, (ii) an accelerated scenario that also includes announced policies, and (iii) a net-zero scenario based on policies required to reach net-zero carbon emissions by 2050.

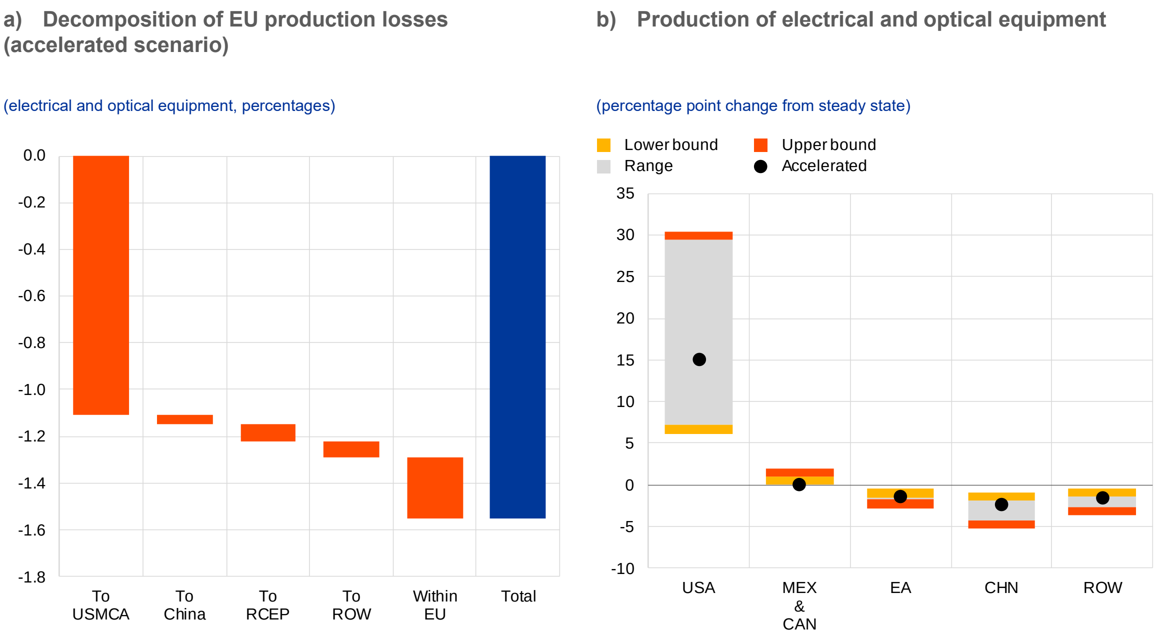
While trade losses at global level are limited, losses in bilateral trade with the United States due to the IRA could be substantial for the EU and China. Aggregate trade losses range from 0.2% (conservative) to 0.9% (net zero) (Figure 5, panel a). Losses can be substantial in sectors targeted by the IRA, notably the electrical and optical equipment sectors where losses reach 6.0% in the net-zero scenario. For example, China would lose between 10% (conservative) and 50% (net zero) of its exports to the United States-Mexico-Canada Agreement (USMCA) area in electrical and optical equipment, and the EU similarly between 10% and 45% (Figure 5, panel b). These results are driven by the fact that US trade partners are affected by not only the loss of access to the US market, but also by the limited possibilities to divert their production to other locations. As shown in Figure 6, panel a, while production losses for the EU are due mainly to lower exports to the USMCA area given the IRA-induced barriers, exports to other countries also diminish. This reflects second-round effects of the IRA, mostly in the form of excess supply of goods produced by the targeted sectors due to forgone exports amid lower demand for upstream products.

Figure 5. Impact of the IRA on trade



Sources: Baqaee and Farhi (2024), ADB IO table and ECB staff calculations.
Notes: Non-linear impact simulated through 25 iterations of the log-linearised model. Electric vehicles (EV) are a sub-sector of “transport equipment”; EV batteries and renewable energy equipment of “electrical and optical equipment”; and processed rare earth minerals of “basic and fabricated metals”. USMCA = United States-Mexico-Canada Agreement; RCEP = Regional Comprehensive Economic Partnership; EA = Euro area; ROW = rest of the world. RCEP does not include China.

Figure 6. Impact of the IRA on production



Sources: Baqaee and Farhi (2024), ADB IO table and ECB staff calculations.
Notes: Non-linear impact simulated through 25 iterations of the log-linearised model. USMCA = United States-Mexico-Canada Agreement; RCEP = Regional Comprehensive Economic Partnership; ROW = rest of the world. RCEP does not include China.

The IRA could entail a large relocation of production capacities towards the United States. According to our calculations, the United States would gain from positive relocation effects, increasing production by 6% to 30% in electrical and optical equipment. Relocation effects would also be positive for Mexico and Canada (3% to 19%); by contrast, the IRA will likely entail production losses for the EU (between -0.5% and -3%) and China (between -1% and -5%).

While the rest of the world loses, the IRA would benefit the United States through additional output and lower strategic dependence on China. Reported in nominal terms, the IRA would trigger by 2030 the relocation to the United States of USD 280 billion worth of annual output across all sectors (accelerated scenario) mainly at the expense of China (-USD 210 billion) and, to a lesser extent, the EU (-USD 70 billion). At the global level, the IRA translates into net annual output losses concentrated mostly in the green sectors, thus suggesting that the IRA could slow the green transition at global level. At the same time, it should be recognised that the re-evaluation of domestic security priorities across countries could lead to higher global investments into green technologies and a broadening of the global production base in green sectors. In light of these considerations, the estimated economic effects presented in this box likely represent a lower bound for both winners and losers.

2 GEF can hinder the pace and scope of climate policies

GEF could affect the availability and global distribution of critical minerals and capital flows that are crucial for climate policies. More broadly, a reshaping of global value chains along geopolitical blocs would diminish the cross-border exchanges needed for the green transition, from goods to the diffusion of green technologies.

2.1 GEF could disrupt the supply of critical raw materials essential to the energy transition

The supply of critical raw materials (CRM) is highly concentrated, making it particularly vulnerable to GEF. While demand for CRM is projected to grow massively in the decades ahead (IEA, 2021), mining and processing of CRM is geographically concentrated in countries that are not politically aligned with the EU (see Box 4). For instance, according to the U.S. Geological Survey 73% of all cobalt is mined in the Democratic Republic of the Congo, 69% of rare earth elements (REE) are mined in China, and half of the global nickel supply is mined in Indonesia. Mineral processing is even more concentrated, with China playing a dominant role (Box 4). In addition, a few mining companies control a significant share of global production. For instance, four companies control half of the supply of cobalt and five companies half the supply of nickel (IRENA, 2023). The analysis of the ownership interests in extractive companies suggests that the supply of certain CRM is mainly controlled by entities based in large economies competing with the EU (Faubert et al., 2024).[7] The geographic concentration of supply raises concerns that dominant countries may leverage their market position to pursue other strategic priorities (Buysse and Essers, 2023). This underpins the need to enhance the EU's strategic autonomy (Ioannou et al., 2023).

Market concentration coupled with GEF could heighten price volatility and impede access to these resources. Alvarez et al. (2023) find that dispersion in commodity prices in general has increased sharply across regions, primarily due to GEF. Should GEF constrain the flow of commodities − including CRM − across markets, this may result in serious macroeconomic risks from increased price volatility, especially for the green transition.

Several countries have implemented comprehensive CRM strategies. Geopolitical powers such as the United States, the EU, Japan and China have recently published updated reports aimed at securing their access to critical minerals (see, for example, Agency for Natural Resources and Energy, 2020; U.S. Department of State, 2022; European Commission, 2023a). Such strategies consist

[7] For instance, nickel, copper and cobalt production is concentrated among non-European shareholders, notably American, Australian, British and Chinese, and more than three-quarters of the capital of rare earth and lithium mining companies is held by non-European investors (Faubert et al., 2024).

in identifying those minerals that are especially susceptible to supply disruptions and aim at increasing energy security as well as boosting domestic capabilities. They also seek to reduce dependencies by (i) increasing the production of critical minerals located on their territory; (ii) diversifying their supply to nearby partner states in countries not considered to be their geopolitical rivals; (iii) stockpiling critical minerals and increasing recycling; and (iv) even reducing demand through so-called “sufficiency policies” (IRENA, 2023; European Commission, 2023a).

To make itself more strategically autonomous, the EU has recently enacted legislation aiming at strengthening the security of its CRM supplies. The Critical Raw Material Act, entered into force in 2024, sets ambitious targets for production and supply diversification.[8] However, this strategy faces significant challenges. The CRM act sets up that no third country should account for more than 65% of the EU’s supply at any stage of the value chain, but this is currently the case for more than half of all strategic raw materials (European Commission, 2023b). Moreover, developing the European mining industry will require substantial funding, as the EU accounts for only 2% of the world’s mineral exploration investment (Hache and Normand, 2024). In response, Mario Draghi's proposals for enhancing European competitiveness endorse the CRM Act and recommend establishing a dedicated EU CRM Platform to support the strategy, leverage market power, and help address financing gaps.[9]

Box 4
The EU transition strategy and GEF risks

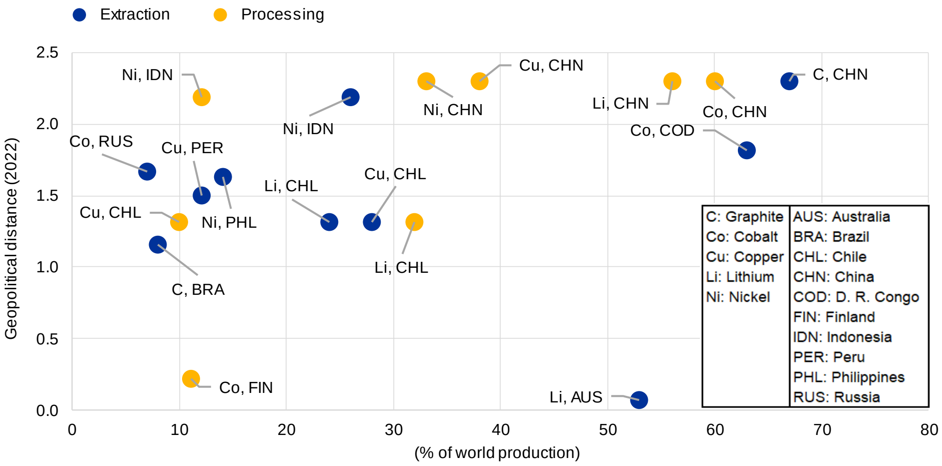
The sensitivity of climate transition policies to GEF is acute for the EU. This is due to its position as an importer in most CRM markets and industries, especially from China (European Commission, 2023b). Besides, the EU lacks the extraction capacity necessary to compete with major players or to ensure its consumption needs (Figure 7). Also, while the EU’s position in refining is better, with Finland refining 11% of world’s cobalt, it is still surpassed by emerging economies.

This sensitivity is compounded by the geopolitical distance between the EU and several CRM-rich countries. An analysis of CRM exporters’ geopolitical distance from the EU, as measured by countries’ voting patterns at the UN General Assembly (Bailey et al., 2017), reveals the geoeconomic risks to the supply of certain CRM (Faubert et al., 2024). Figure 7 shows, for instance, that a large share of lithium and cobalt production comes from countries that are geopolitically distant from the EU.

[8] See: Critical Raw Materials Act, European Commission, EC website.

[9] The primary purpose of this CRM platform would be to enhance the annual monitoring of supply chain risks and provide early warnings on dependencies. Additionally, it could aggregate demand for the joint purchasing of CRM and design financial products aimed at securing upstream supply both within the EU and in third countries (Draghi, 2024).

Figure 7. The EU's vulnerability to geopolitical risk in relation to the main producer countries



Sources: Bailey et al. (2017), European Commission (2023b) and Faubert et al. (2024).
Notes: The geopolitical distance, also known as state ideal point, comes from Bailey et al. (2017). This metric reflects state positions towards the US-led liberal order, based on a dynamic ordinal spatial model, using UN General Assembly votes as inputs. The indicator has no unit and ranges from 0 to 6. Only the two main producing countries are shown for each mineral and production stage.

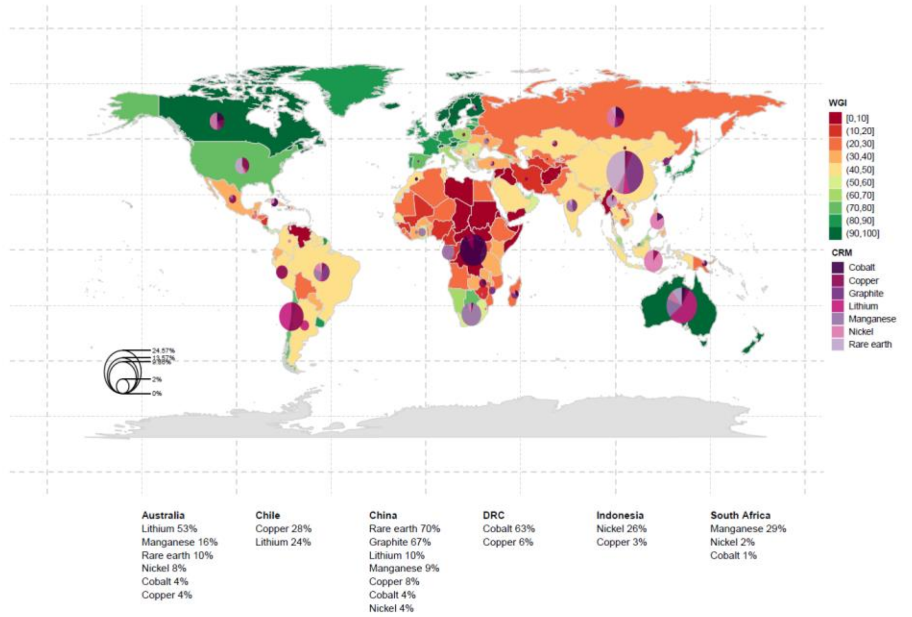
Strategies to reduce the vulnerabilities of transition policies to GEF are not quick wins. While Europe has some CRM deposits, lead times of up to 15 years from exploration to production make it close to impossible to reduce dependencies in the short run. In addition, mining operations come with severe socio-environmental impacts that can trigger social and political resistance.[10] Reorienting CRM trade towards reliable partners may also imply higher costs and prices, with implications for domestic inflation and monetary policy (Ioannou et al., 2023).

Overall, the pace of the low-carbon transition is highly sensitive to the risks of GEF. Figures 8 and 9 below illustrate that some countries with high market shares for minerals perform poorly on the World Governance Index (WGI), a rough proxy for country risk. Governance tensions in these economies could lead to disruptions in the CRM supply chain (IRENA, 2023).[11]

[10] See, for instance, the article entitled "EU green-tech homeshoring plans face resistance in Spain", DW (March 2023).

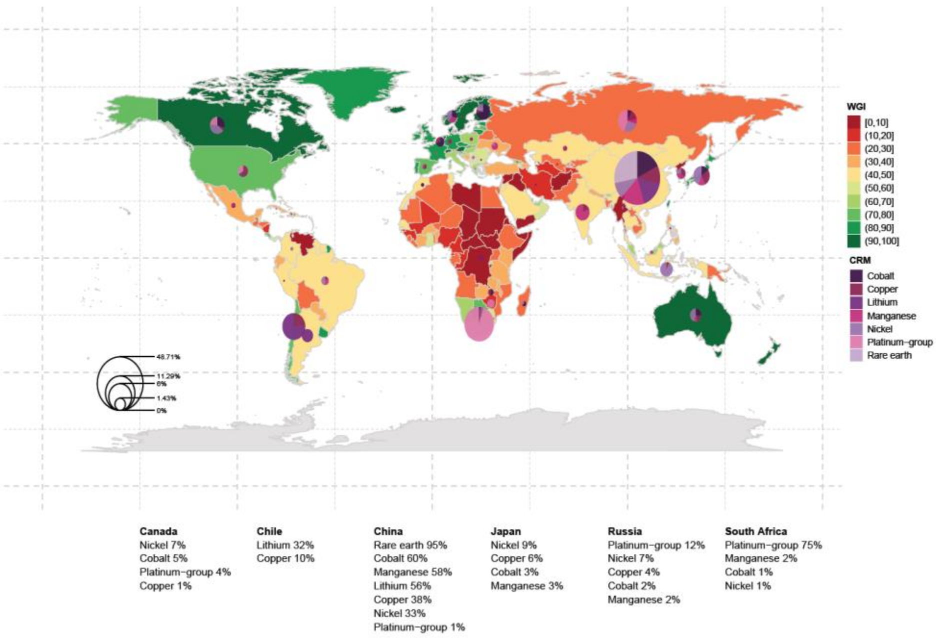
[11] Figures 8 and 9 below were constructed in two steps. The first stage involved retrieving the critical mineral data for the extracting and refining stages from Annex 7 to the European Commission (2023b, pp. 78-108) report. We then selected the key minerals for the energy transition, namely cobalt, copper, natural graphite, lithium, manganese, platinum-group metals (PGMs) and rare earth (IRENA, 2023). Finally, we calculated the average weight of these critical minerals by country for both the extracting and refining stages. In the second stage, we retrieved the Worldwide Governance Indicators (WGI) of Kaufmann et al. (2010) in its six dimensions: (i) voice and accountability, (ii) political stability and absence of violence/terrorism, (iii) government effectiveness, (iv) regulatory quality, (v) rule of law, and (vi) control of corruption. We then mapped an aggregate index covering all six dimensions, representing the country's risk.

Figure 8. Worldwide CRM at the extraction stage, by country governance score



Sources: European Commission (2023b) and Kaufmann et al. (2010).
Notes: WGI – Worldwide Governance Indicators; CRM – critical raw materials; DRC – Democratic Republic of the Congo. The reference year for the WGI is 2022, while for the CRM, this is the five-year average for 2016 to 2020. The pie chart legend displays the average CRM market share, and the text legend gives the pie chart breakdown for the top six countries. In the breakdown, the value is zero if no market shares are reported for a mineral.

Figure 9. Worldwide CRM at the processing stage, by country governance score



Sources: European Commission (2023b) and Kaufmann et al. (2010).
Notes: WGI – Worldwide Governance Indicators; CRM – critical raw materials. The reference year for the WGI is 2022, while for the CRM, this is the five-year average for 2016 to 2020. The pie chart legend displays the average CRM market share, and the text legend gives the pie chart breakdown for the top six countries. In the breakdown, the value is zero if no market shares are reported for a mineral.

2.2 GEF can compound biases in the allocation of financing for sustainable investments

GEF may hinder private financing of climate change by creating regulatory divergences, reducing cross-border investment flows, and fostering uncertainty. Yet, the financing of climate needs cannot be provided without mobilising the private sector. The International Energy Agency estimates that, by 2030, climate mitigation investment needs will increase to about $2 trillion per year in emerging markets and developing economies (EMDEs) —about 40 percent of global investment needs (IMF, 2024), without even considering adaptation finance needs and broader sustainable financing needs. While International Financial Institutions (IFIs) can offer larger official financing and access to climate funds, the magnitude of sustainable finance needs makes private sector involvement indispensable. For instance, the Resilience and Sustainability Trust (RST) set up by the International Monetary Fund in October 2022 aims to help low and middle-income countries respond to climate challenges but its resources amount to USD 50 billion. Beyond direct financing, IFIs aim to play a catalytic role by leveraging private capital flows to scale up sustainable finance. Such efforts are embedded in international initiatives such as the Paris Pact for People and the Planet, which seek to mobilise and align public and private funding for climate and sustainability goals.

GEF could also exacerbate the unequal distribution of financing sources for sustainable investments. Globally, sustainable investment flows remain unevenly distributed, with emerging markets and developing economies (EMDEs) attracting significantly less sustainable finance compared to conventional funding (OECD, 2023). By the end of 2022, sustainable funds allocated only 6% of their investments to EMDEs, against 11% for conventional funds. While ESG investments have grown rapidly, firms in EMDEs are clearly at a disadvantage due to systematically lower ESG scores, and hence lower allocations from ESG funds. This situation is not explained by differences in the size, industry composition or financial performance of EMDE firms (IMF, 2022, 2023b).

GEF may reinforce regulatory divergence. More stringent environmental, social and governance (ESG) regulations in advanced economies may add frictions and result in less fluid capital flows to EMDEs and more fragmented value chains, at least in the short to medium term. Indeed, all else equal, when subject to more stringent requirements, investors and firms may become reluctant to be active in countries where access to sustainability-related information is lacking.[12] If, on top of this, GEF causes divergence in sustainability-related regulatory frameworks, these negative externalities may be magnified with negative consequences on EMDEs' ability to tap international sustainable capital markets.

GEF could further crystalise this situation through at least two channels, which are mutually reinforcing as far as EMDEs are concerned. One relates

[12] Besides, some sustainable finance regulations set up in high-income countries can have extraterritorial effects, as is the case with EU legislation. The Corporate Sustainability Reporting Directive (CSRD) stipulates that businesses located outside the EU will also be subject to its requirements if they meet specific thresholds related to their financial presence in the EU.

directly to the dynamics of capital flows. GEF weighs on investor sentiment and investor perception of the risk/reward benefit and hence on the cost of financing of a sovereign (see, for example, Csonto and Ivaschenko, 2013). In the current global environment, international investor surveys reveal that geopolitical concerns have risen significantly in their risk mapping (e.g. Natixis, 2023). Higher risk perception is likely to induce higher financing costs, and possibly a shift in financing volume for some countries perceived as not aligned (Moro and Zaghini, 2023; Di Tommaso, Perdichizzi and Zaghini, 2024). Econometric evidence also shows that green FDI, both in renewable energy and EVs, is less likely to occur between politically distant countries (IMF, 2024). Lower capital inflows could be critical for some countries' ability to source international funding for their transition plans. Exposed to more volatile capital flows, countries may resort more to capital flow management measures. This may adversely affect the financing of the green transition, as there is some (tentative) evidence that foreign investors tend to invest relatively less in such economies (Moro and Zaghini, 2023). The second channel of transmission involves divergent regulatory frameworks of sustainable finance. Such divergence is not new: the field of sustainable finance has been evolving fast in the past decade and jurisdictions have moved at a different pace and are using different regulatory strategies. Several recent global initiatives aim at improving the interoperability of taxonomies and disclosure standards.[13] Yet they still leave ample room at this stage for differences in regulations across jurisdictions, leaving firms to face a hard-to-navigate regulatory landscape in several areas: alignment of standards; scope of companies the standards will be applied to; pace of adoption and application of standards.

[13] Efforts have focused on (1) defining a common understanding (common language) of the scope and content of sustainable, and more recently, transition finance, by developing taxonomies; (2) regulating/improving the transparency of other approaches and tools developed to align financial investments with climate and other sustainability goals (green or sustainability-linked bonds, labels or benchmarks, climate and transition metrics, ESG ratings); and (3) facilitating the accessibility of information needed to better assess sustainability risks, opportunities and impacts, notably through disclosure of sustainability-related information by financial and non-financial corporations. For instance, the International Sustainability Standards Board (ISSB) was set up in 2021 to develop a global sustainability reporting standard that would form the baseline of disclosure requirements that jurisdictions could use.

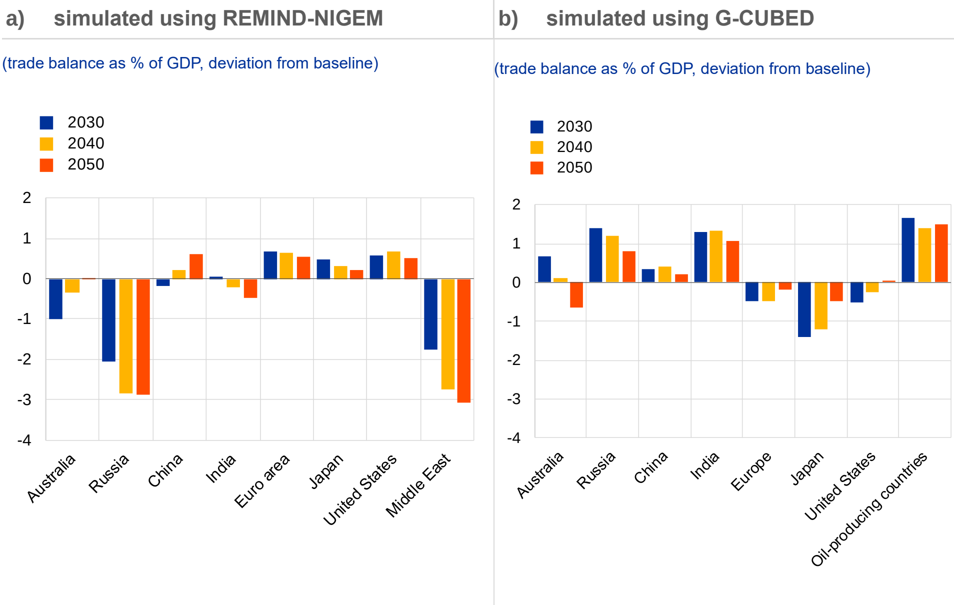
3 Avenues for further research to deepen our understanding of the interplay between GEF and transition policies

3.1 On the need to improve the existing tools to model climate transition policies

Economic models provide a structured framework to quantify the economic effects of climate policies. They can be grouped as follows, depending on their use and typology: (i) on the climate side: computable general equilibrium (CGE) models can model climate policies with a detailed focus on energy sectors, with integrated assessment models (IAM) extending CGE by combining climate and economic models; (ii) on the trade side: gravity models can be used to model trade flows and may include climate policy variables, multi-country multi-sector (MCMS) models feature detailed country and sectoral linkages and can be used to assess the impact of climate policies along global value chains; and (iii) on the macro side: dynamic macro models can capture short-term dynamics while including frictions which may delay optimal adjustments following policy shocks, more recently some macro-sectoral models make it possible to include sectoral changes and their impact at the macro level. Notwithstanding the different nature of models, sometimes results may differ within the same model class. For example, the impacts of NGFS transition scenarios on the external sector are materially different when using one macro model (Figure 10, REMIND-NiGEM) or another macro model (Figure 10, G-CUBED).[14]

[14] Some of the differences stem from the assumptions and modelling of investment. In REMIND-NiGEM, investment at the aggregate level is modelled as a simple accelerationist equation depending on expected output and cost of capital. In G-CUBED, investment decisions stem from intertemporal optimisation of income flows whereby agents smooth more spending patterns over time. In G-CUBED, investment across countries is therefore more reactive to a carbon tax, as agents anticipate the future returns on investments, whereas in REMIND-NiGEM, cost of capital is the result of short-term interest rate dynamics (that stem from monetary policy) and investment premia which are more or less fixed. In the end, since investment and its financing affect external accounts trajectories in the transition scenarios, the simulated current account balances differ.

Figure 10. External sector impact of the NGFS net-zero scenario



Source: NGFS-NIESR McKibbin-BDF simulations.
Notes: The two models have different geographical breakdowns: NiGEM includes the euro area as a region whereas G-Cubed includes Western Europe.

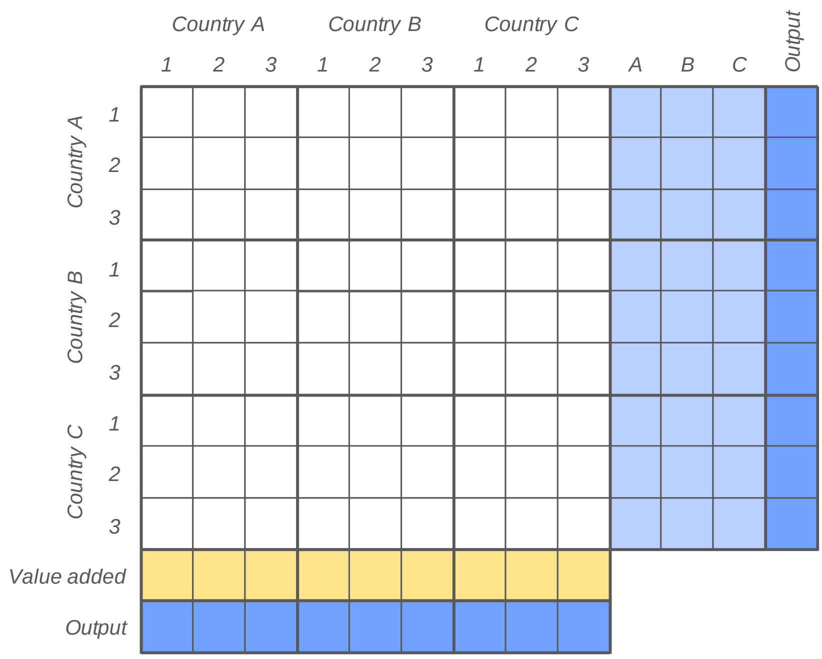
Tools that are used to evaluate climate policies need to be improved, paying particular attention to the role of investment and innovation. In general, CGE/IAM better capture long-term impacts of climate actions, while trade and MCMS models capture sectoral changes but produce generally small macro-impacts. However, most of those models are static and do not include frictions that may slow the adjustment process. Dynamic macro models, on the other hand, better capture the short-term dynamics but often lack the sectoral granularity to explain the transformations of the economy. This indicates a need to develop dynamic models that account for sectoral dynamics over time, while including forward-looking and nominal frictions. Some policy-oriented research has started to focus on this (e.g. GMMET by the IMF; see Carton et al., 2023) but the task is inherently challenging.

Finally, most short-to-medium run models include exogenous assumptions on innovation, while technological progress is endogenous to policy decisions. Models of endogenous technical progress tend to be long term and do not account for the potential rigidities along the transition path. However, the renewable sector has recently evolved very dynamically, its technologies and cost-effectiveness often exceeding expectations (IRENA, 2023). This argues for better integration of such dynamics into the innovation assumptions that underpin macro models.

3.2 On the need to account for structural changes in global production structures

ICIO tables are a cornerstone for estimating the macroeconomic impact of trade fragmentation and green transition policies. ICIO tables describe the sale and purchase relations between producers and consumers − both within and between countries − indicating flows of goods and services across sectors and final users. Figure 11 gives a simplified example with three countries (A to C) and three sectors (1 to 3): white cells are flows of intermediate inputs between producers, light blue cells are flows of final products from producers to consumers, brown cells are value added (gross output minus intermediate inputs), and dark blue cells are gross output. The aim of using ICIO tables in models is to account for global production chains, allowing amplification effects of economic shocks through sectoral inter-linkages as well as substitution effects. In addition, ICIO tables allow for a granular assessment across sectors and countries. For instance, ICIO tables have been used to assess the impact of trade fragmentation, as in Góes and Bekkers (2022), Attinasi et al. (2023a; 2023b) and Campos et al. (2023).

Figure 11. Standard ICIO table



Source: Authors.

Two main issues arise for modelling climate transition polices, however: the limited granularity of the sectors and the fact that they capture the current state of global value chains – and therefore do not account for the structural transformations that the green transition will inevitably entail. The limited sectoral granularity of ICIO tables means we cannot isolate specific products which matter for the green transition, such as electric vehicles, rare earth minerals, or renewable energy equipment. To cite one example, "electric vehicles" come under the broader "motor-vehicles sector, in the OECD ICIO tables, which cover 45 different sectors. This makes it impossible to single out green products and to quantify effects from trade barriers targeting only those specific products. In addition, ICIO tables account for the current state of global value chains. The green transition is likely to have far-reaching implications for the global economy and it will affect not only the (relative) size of economic sectors but also sectoral interdependencies. Therefore, model-based estimates of fragmentation along green products based on current ICIO tables would likely represent a lower bound, as they do not account for the dramatic changes induced by the green transition.

One possible solution is to develop ad hoc ICIO tables that isolate green products while accounting for the sectoral transformations caused by the ongoing green transition.[15] Starting from an existing ICIO table, this entails two steps: (i) expand the sectoral granularity towards green products, and (ii update the sectoral output to reflect higher demand for green sectors. The first step divides sectors of the ICIO table into green and non-green sub-components. For example, the “motor vehicles” sector in an OECD ICIO table can be split into two sub-components: “electric vehicles” and “non-electric vehicles”.[16] The second step attempts to account for the growth potential of the green sectors. It builds on the Leontief inverse matrix, which links final demand with output, and makes it possible to map changes in final demand to changes of sectoral outputs. The scenarios of the International Energy Agency are a possible source for calibrating potential changes in final demand due to the green transition. The resulting ICIO table would represent a hypothetical global economy after the green transition and would isolate green sectors. It could then be used to simulate the impact of fragmentation scenarios along green sectors.

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[15] A joint ECB/Banca d'Italia project is under way to build such ad hoc ICIO tables.

[16] The separation into sub-sectors is based on their respective weights in bilateral trade, using product-level data from the BACI database (Gaulier and Zignago, 2010). For more details, see section 6 of Borin et al. (2023). The methodology of Borin et al. (2023) sets the same weight for all using sectors of the receiving country. Future research could adapt the approach to account for specific linkages between products (for example, for the fact that electric batteries are used more intensively in electric vehicles than in non-electric vehicles).

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