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A Global Gateway to Secure Supply Chains?

The role of EU infrastructure partnerships in combatting external trade risks

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With its Global Gateway Initiative, the EU seeks to create new strategic partnerships by supporting infrastructure investments around the globe. It represents an integral part of the EU's ambitious plan to enhance its strategic autonomy through trade diversification and new long-term alliances. However, financial constraints, escalating geopolitical tensions and the burden of Europe's own colonial past set tough restrictions for such a strategy. Global Gateway investments thus require careful scrutiny concerning their priorities and long-term effects on the EU's strategic goals, in particular the management of the twin transition. This cepStudy investigates potential economic impacts from a supply chain perspective.

Key results:

- Infrastructure investments focused on reducing costs of existing trade routes will do little to enhance Europe's trade diversification and to reduce its vulnerability towards supply chain disruptions.
- For Global Gateway to be successful, it must be developed into an engine of economic growth for partner countries, by channeling resources into infrastructure critical for the deployment of strategic net-zero technologies (e.g. pipelines for renewable gases, electricity grids) and for the general structural modernization of the partner economies (e.g. ICT).
- The investment programs must be integrated into an overarching EU resilience strategy, involving a deepening of regulatory collaboration with partners, a common roadmap for the reduction of regulatory (tariff and non-tariff) trade barriers and cooperation in strengthening local institutions.
- To become an attractive partner and curb the global influence of China, the EU must offer economic partnerships at real eye level, requiring a willingness to share technological knowledge and to provide partner countries with a near-term perspective for value chain upgrading.

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1 Background

The EU's ambitious goal to decarbonize its industrial base in the midst of fundamental geoeconomic shifts sets new expectations for trade policy. With the paradigm of an "open strategic autonomy", elaborated in its 2021 trade policy review,[1] the EU intends to align the idea of a rules-based world trade with the needs of its own green transformation. In addition to strengthening its multilateral influence, the EU is attempting to bolster the liberal international order by developing new bilateral alliances. The aim is to diversify supply channels, in particular for strategically important raw materials and industrial goods for carbon-neutral ("net-zero") technologies. This would reduce the EU's one-sided external dependencies and thus increase the room for maneuver at both the economic and the political level. Negotiating new free trade agreements is one important instrument for this, but not the only one. In the case of many low- and middle-income third countries, a basic priority is to create local capacities for exports by supporting infrastructure development.

Announced in December 2021, the Global Gateway Initiative [2] therefore exhibits strategic importance for the future of EU external trade. Global Gateway is an almost global EU investment strategy to finance infrastructure development in third countries. Between 2021 and 2027, a total of up to 300 billion euros from public and private funds is to be mobilized for this purpose. With this instrument, the EU is entering into direct competition with similar initiatives by other economic powers, above all China's Belt and Road Initiative. Global Gateway is therefore both part of an economic diversification strategy and a pawn in the geopolitical chess game. Previous analyses have largely focused on the latter aspect. However, this perspective ignores its potential role as a shield against long-term economic risks. Global Gateway encompasses investments in productive resources of partner countries, whose social return in the form of new, stable trade relations can highly influence the overall success of the EU Green Deal. Without a successful diversification of external supply channels, the EU will only have the choice between accepting its vulnerability (and thus susceptibility to economic blackmail) or isolation.

This study aims to close this gap with a trade-centered view on Global Gateway. The focus is on the effects of external infrastructure investments on international supply chains in net-zero technologies. Table 1 provides an overview of the input requirements of selected net-zero technologies. External dependencies currently exist not only for numerous important mineral raw materials, but also for a range of industrial intermediates such as battery materials, solar cells, and semiconductors. The contribution of single Global Gateway projects to overcoming these dependencies cannot be assessed individually, given the vagueness of published project plans. Instead, the study poses more fundamental questions: Which types of infrastructure are most relevant for this purpose? Which trade effects can be expected from an improved infrastructure quality? Methodologically, the study combines a quantitative analysis of the determinants of trade flows at macro level with a qualitative case study of an EU-Africa partnership in the field of renewable hydrogen. In this way, it sheds light on both general economic impact factors and the role of supply chain-specific challenges.

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[1] European Commission (2021a). Trade Policy Review - An Open, Sustainable and Assertive Trade Policy. Communication to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank. COM/2021/66 final.

[2] European Commission (2021b). The Global Gateway. Joint Communication to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank. JOIN(2021) 30 final.

Table 1: Characteristics of selected net-zero technologies

	Output		Input		
Name of technology	**Type**	**Fields of application**	**Main components**	**Critical raw materials**	**Systemic role in the green transformation**
Advanced biofuels	Kinetic energy	Transport	Processors, pumps, storage tanks	Copper, nickel	Use of renewable energy sources in the transport sector
Battery storage	Electrical energy	All sectors	Anode, electrolyte, cathode	Graphite, cobalt, copper, lithium, manganese, nickel, niobium, phosphorus, silicon, titanium	Improved synchronisation of energy supply and demand
Carbon capture, storage and use	Stored carbon	Energy sector, industry	Compressors, pipelines	Cobalt, copper, manganese, nickel	Avoidance of CO_2 emissions into the atmosphere, reduction of CO_2 concentration in the atmosphere (Direct Air Capture)
Energy transport	Energy transport	Energy sector	Measuring devices, power cables, pipelines	Copper, nickel	Improved synchronisation of energy supply and demand
Heat pumps	Heat	Building heating, industry	Compressors, condensers, evaporators	Fluorite, copper, nickel, platinum group, silicon	Expanding the use of renewable electricity by sector coupling
Solar photovoltaics	Electrical energy	All sectors	Solar cells	Boron, gallium, copper, nickel, silicon	Low-emission provision of energy
Water electrolysis	Hydrogen	Industry (especially chemicals, steel), transport	Anode, electrolyte, cathode	Graphite, cobalt, copper, nickel, platinum group, rare earth metals (including scandium, yttrium), strontium	Expanding the use of renewable electricity by sector coupling
Wind energy	Electrical energy	All sectors	Generators, gearboxes, rotor blades	Boron, copper, manganese, niobium, rare earth metals (including dysprosium, neodymium), silicon	Low-emission provision of energy

Sources: European Commission (2023a); JRC (2023)[3]; Marscheider-Weidemann et al. (2021)[4]; own representation.

2 The EU Global Gateway Initiative

2.1 Origin and motivation

In a complex and disrupted international policy arena, where the liberal order upon which European institutions were built has been eroding, the Global Gateway initiative stands as a central pillar of the EU's efforts to adapt its posture within the global arena. Through the Global Gateway, the European Union aims to implement a series of initiatives to strengthen its role in an increasingly regionalized world, by improving relations with key regional powers and neighbouring countries, while simultaneously bolstering a sustainable, comprehensive, and rules-based international economic order.

Unveiled in December 2021[5], the Global Gateway intends to boost the European green agenda, support infrastructure development worldwide and enhance connectivity in various fields including digital technology, climate and energy, transportation, health, education, and research. Its first milestone was an Africa-Europe Investment Package, providing 150 billion euro for cooperation with African partners.[6] As shown in Table 2, in 2023, the EU launched 87 key flagship projects worldwide. For 2024, there are 138 new projects in the pipeline.[7] Generally, as highlighted by the European Commission

3 JRC (2023). Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study. Joint Research Centre of the European Union. Luxembourg. doi:10.2760/334074, JRC132889.

4 Marscheider-Weidemann, F.; Langkau, S.; Baur, S.-J.; Billaud, M.; Deubzer, O.; Eberling, E.; Erdmann, L.; Haendel, M.; Krail, M.; Loibl, A.; Maisel, F.; Marwede, M.; Neef, C.; Neuwirth, M.; Rostek, L.; Rückschloss, J.; Shirinzadeh, S.; Stijepic, D.; Tercero Espinoza, L.; Tippner, M. (2021). Raw materials for future technologies 2021. DERA Rohstoffinformationen 50.

5 See European Commission (2021b).

6 European Commission (2024). EU-Africa: Global Gateway Investment Package.

7 European Commission (2023a). Global Gateway flagship projects – Infographics.

President, Ursula Von der Leyen, the Global Gateway intends to create links with third countries and not dependencies, by implementing a sustainable long-term model of connectivity in line with the European economic and strategic interests but also its basic democratic values. In brief, the EU intends to boost economic growth by financially supporting ambitious and sustainable projects across the world to intensify relevant partnerships and trade links, reinforce the liberal global order and respond to external challenges, being it the recovery from the COVID-19 pandemic, increasing competition from China and its Belt and Road Initiative, or the energy crisis caused by the Russian invasion of Ukraine.[8]

Table 2: Number of Global Gateway flagship projects launched by thematic area

	Projects launched	
Thematic area	**Year 2023**	**Year 2024**
Energy & Climate	49	61
Transport	17	32
Digital sector	11	18
Health	7	14
Education & Research	3	14
Total	**87**	**138**

Source: European Commission (2023a).

2.2 Structure and governance

The financial structure of Global Gateway is based on a complex system of mixed financing. Out of the total budget of 300 billion euros between 2021 and 2027, 135 billion euros are expected to be mobilized by the European Fund for Sustainable Development Plus (EFSD+), with the EU providing 40 billion euros in loan guarantees, of which 26.7 billion euros will come from the European Investment Bank (EIB) and 13.3 billion euros from the EFSD+ new window. Further 145 billion euros are to be gathered by existing European financial and development institutions, mainly by the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) as well as by member states' aid programs. Finally, 18 billion euros are based on grants by the EU Neighborhood, Development and International Cooperation Instrument (NDICI), the European Commission's instrument for scheduling, financing and implementing its development.[9] Moreover, the option of creating a common European Export Credit Facility is considered for the future.[10]

A large share of the foreseen sums does actually not consist of public investments, but will have to come from private investors, to be incentivized by the leveraging effect of public loan guarantees. Moreover, a large part of the public money earmarked for Global Gateway consists of funds and projects already planned by member countries and EU institutions before the launch of the initiative, which were simply rebranded under the Global Gateway umbrella.[11] In this respect, while it's

8 European Commission (2021c). 2021 State of the Union Address by President von der Leyen
9 Real Instituto Elcano (2024a). Global Gateway: what we know and what it means for Latin America and the Caribbean.
10 Tagliapietra, S. (2024). The European Union's Global Gateway. An institutional and economic overview. The Word Economy.
11 Wientzek, O., Nitschke, J., Bout, L. (2023). "Global Gateway" slowly gathers momentum. Country Report, Konrad-Adenauer-Stiftung.

undeniable that Global Gateway represents a significant endeavour to enhance European outreach at the global level, it might also be a successful strategy for its internal goals. In fact, by often complementing actions that are already in member states' pipelines, Global Gateway has the potential to contribute to the EU's efforts in building more resilient institutions, fostering intra-EU coordination and cultivating a more competitive market.[12]

The projects promoted by Global Gateway are delivered by the so-called Team Europe, which is composed of EU institutions, Member States and European financial institutions, in cooperation with the business world and civil society. Generally, it is up to the President of the Commission, the High Representative for Foreign Affairs and single Commissioners to develop specific plans within the Global Gateway. Yet the latter has also a Board, which is in charge of delivering strategic guidance to the Team Europe. Moreover, to ensure the involvement of the private sector, the Global Gateway can count on a Business Advisory Group (BAG), launched in September 2023, which gathers input from the private sector to maximise the impact and effectiveness of projects and mobilize investments.[13] The BAG's group is composed of 59 members from private companies, trade and business associations and 10 observers from the network of European financial institutions and export credit agencies.[14] It underpins the EU's will to provide the private actors with a primary role in defining the set of actions to be taken in the defined areas and regions of interest: Africa, Asia and Latin America/Caribbean (see below).

2.3 Focus areas of current flagship projects

In line with the EU's geopolitical ambitions, the geographical coverage of Global Gateway is broad, covering not only Asia, which was the key focus of the connectivity agenda that preceded the initiative[15], but also Africa, Latin America and Eastern European neighbour countries. The key principle behind the strategic plans of Global Gateway is that the European approach should not be predatory but based on mutual development and interests. In other words, while the initiatives proposed aim to implement transformative policies for a sustainable development in both the EU and partner regions or countries, the practical approach is to consider local interests and needs and include local partners and institutions.[16] Between 2023 and 2024 around 9 projects out of 10 were launched in Africa, Asia and Latin America.[17]

As announced at the EU-AU (African Union) summit on 17-18 February 2022, the African continent plays a central role on the EU agenda. Team Europe intends to invest around 150 billion euro in the region, primarily through the Africa-Europe Investment Package.[18] In particular, the EU aims at

[12] See European Commission (2021d). Global Gateway Partnerships
[13] European Commission (2023b). Global Gateway Governance
[14] To become member of BAG, companies or organizations need to respond to a call for applications. Members are then appointed by the Directorate-General for International Partnerships (DG INTPA) and the Directorate-General for Neighborhood and Enlargement Negotiations (DG NEAR). See: Global Gateway Business Advisory Group
[15] European Commission (2018). Connecting Europe and Asia - Building blocks for an EU Strategy. Joint Communication to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank. JOIN(2018) 31 final.
[16] Okno-Heijmans, M. (2022). Global Gateway: Positioning Europe for a Sustainable Future. Cligendael Institute.
[17] European Commission (2023c). Global Gateway projects by region
[18] Tagliapietra, S. (2024). The European Union's Global Gateway: An institutional and economic overview. The World Economy.

strengthening the digital ecosystem to develop a single digital market between Africa and Europe[19] and support renewable energies to increase climate resilience[20] as well as electricity interconnections and transmission lines for creating an Africa Single Electricity Market (AfSEM).[21]

When it comes to Asia and the Pacific, the EU has around 41 projects in the pipeline to foster a sustainable model of economic development.[22] In particular, leveraging the ASEAN Green Initiative[23], Team Europe is endeavouring to invest in environmental protection and biodiversity preservation, and it is also supporting projects for a clean energy transition and the improvement of connectivity.

In Latin America and the Caribbean, Global Gateway involves around 58 projects, mainly focused on the need to foster smarter, cleaner, and more secure connections.[24] In particular, Global Gateway aims at promoting public-private partnerships and investments in various infrastructure projects, as well as the promotion of digital transition and connectivity to enhance productivity, address the digital divide and facilitate an inclusive digital transformation and research capabilities (e.g. BELLA Network initiative).[25] Concerning the green agenda, the EU is actively involved in reducing deforestation and in implementing the use of renewable resources (e.g. NewGen plant Point Lisas).

In brief, the goal of Global Gateway is to facilitate sustainable and long-term economic growth, while position the EU as a strategic and reliable partner in an increasingly competitive global arena. Indeed, considering China's ascendance as a major economic power and Russia's challenges to the rules and norms underpinning the global liberal order, the Global Gateway represents a tool to deepen EU trade connections, while boosting a rule-based global market in line with the European standards.

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19 European Commission (2022). EU-Africa: Global Gateway Investment Package -Infrastructure

20 Tagliapietra, S. (2024). The European Union's Global Gateway: An institutional and economic overview. *The World Economy*.

21 European Commission (2023d). Powering Africa's future: key documents officially adopted to pave the way for a sustainable African Single Electricity Market and a Continental Power System Masterplan

22 Okano-Heijmans, M. (2023). The EU's Connectivity Strategy 2.0: Global Gateway in the Indo-Pacific. In The Transformation of the Liberal International Order: Evolutions and Limitations (pp. 23-53). Singapore: Springer Nature Singapore.

23 AGI (2024). ASEAN Green Initiative.

24 Znojek B., (2023). EU Advances Engagement with Latin America and the Caribbean, PISM Bulletin no 84 (2203). Hobbs C., Melguizo A., Muñoz V., Torreblanca J., (2023). The EU and Latin America, Convergences and divergences, EUISS, Brief 12.

25 European Commission (2023e). EU-Latin America and Caribbean Digital Alliance

Table 3: Global Gateway flagship projects in selected regions

Area[26]	Region	Number of Projects	Examples of Flagship Initiatives
Climate and energy	Latin America and the Caribbean	31	**Amazonia+** aims at enhancing the capacity of Amazon basin countries to reduce CO2 emissions and adapt to climate change negative externalities. These plans entail reducing deforestation and forest degradation while enhancing the preservation of biodiversity.
	Middle East, Asia and the Pacific	21	Leveraging the **ASEAN Green Initiative**, Team Europe is endeavoring to invest in projects aimed at environmental protection and biodiversity preservation, while simultaneously driving forward a clean energy transition. Similarly, aligning with the **ASEAN Initiative on Sustainable Connectivity**, the EU is striving to support ASEAN electric grid interconnections to enhance access to renewable energy sources, alongside efforts to improve connectivity through submarine cables.
	Africa	63	The **Africa-Europe Green Energy Initiative** aims to engage European and African public and private sector actors to increase electricity production and access to energy, promote energy efficiency, support reforms for a conducive regulatory environment for private investment, and foster market integration
Digital	Latin America and the Caribbean	6	As part of the **BELLA Network initiative**, the EU has co-financed the EllaLink project, a high-speed submarine cable spanning 6,000 km, aimed at connecting European and Latin American research and education communities, reaching approximately 65 million people in the LAC region
	Middle East, Asia and the Pacific	7	The Global Gateway Initiative on **Digital Connectivity** will enhance Central Asian businesses and citizens' access to a secure, internet through trusted satellite connectivity.
	Africa	21	The **Africa Europe Digital Innovation Bridge** aims at strengthening the digital ecosystem within African countries, by facilitating an African data econ-omy and data sovereignty and by possibly developing a single digital market between Africa and Europe
Education and research	Latin America and the Caribbean	2	Global Gateway Initiative on **Social Cohesion and Tackling Inequalities in Latin America and the Caribbean**.
	Middle East, Asia and the Pacific	3	**Global Partnership for Education** (GPE) focuses on the provision of good quality, inclusive and equitable education.
	Africa	12	**AU-EU Innovation Agenda** to strengthen innovation ecosystems
Health	Latin America and the Caribbean	10	**EU-LAC Partnership on vaccine production** and health systems resilience in Latin America and the Caribbean
	Middle East, Asia and the Pacific	2	**One Health** in Cambodia to strengthen international and regional cooperation in the fight against pandemics, by promoting digital health and technical skills.
	Sub-Saharan Africa	10	**Digital Health for Health Systems Strengthening and Universal Health Coverage (UHC) in Sub-Saharan Africa**
Transport	Latin America and the Caribbean	9	Support for improving the **Caribbean Maritime Intra-Regional Transport**
	Middle East, Asia and the Pacific	8	**Global Maritime Technology Cooperation Centers** for meet energy-efficiency and greenhouse-gas targets of the International Maritime Organization.
	Africa	29	**Northern Strategic Transport Corridor** to improve regional connectivity and trade by connecting Kenya to neighboring Uganda, Rwanda, Burundi and the Democratic Republic of Congo.

Source: European Commission 2023-2024 and own representation.

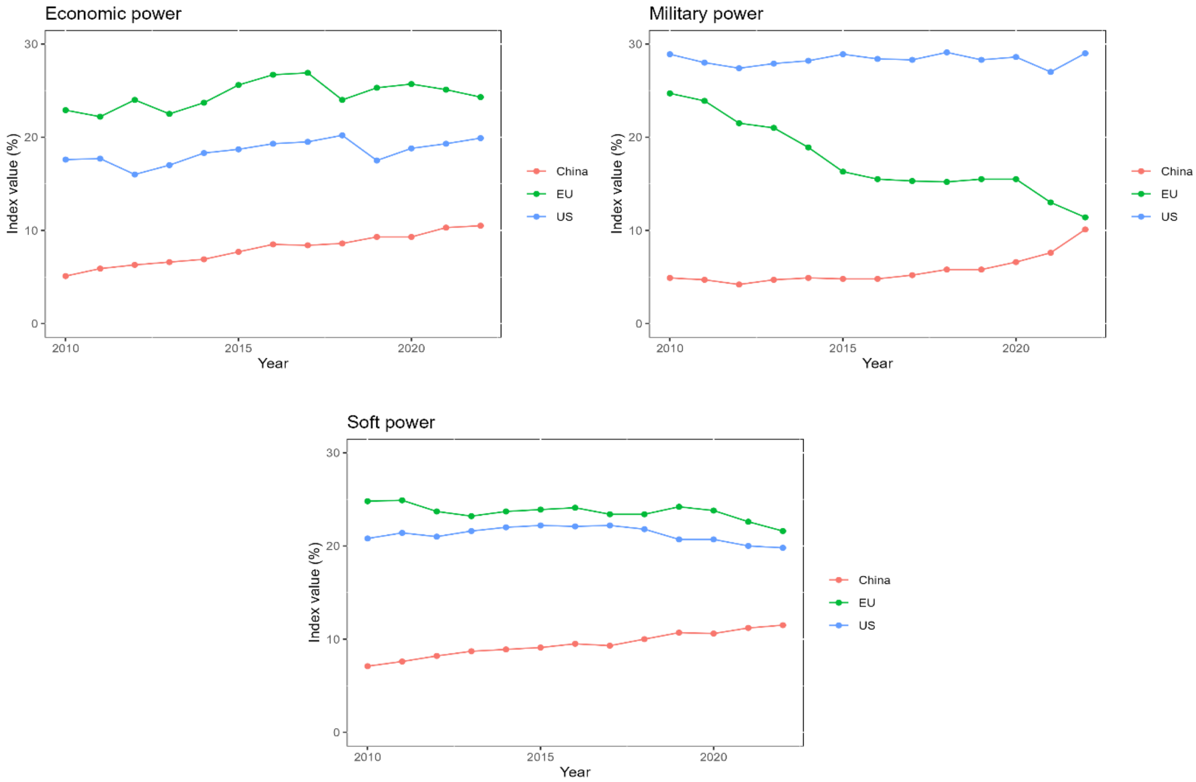
2.4 Geopolitical relevance

Within a complex international arena, a key goal of Global Gateway is to reshape the positioning of the European Union vis à vis strategic partners in Africa, Latin America and Asia. In 2022, according to the Elcano Index[27], the EU had a shared global economic presence of 24.3%.[28] The shared presence is calculated in comparison to other global actors through an index which synthesizes aggregated values related to the external projection of economic, security/defence and soft power. The aggregate result

[26] Table built upon data from European Commission (2023c). Global Gateway projects by region and European Commission (2023a) Global Gateway flagship projects - Infographics
[27] Real Instituto Elcano (2024b). Elcano Global Presence Index.
[28] For construction and methodology see: Olivié, I., Gracia Santos, M. (2023). The Elcano Global Presence Index: methodology.

achieved by the EU in 2022 indicates that the EU as a whole could outperform both the USA and China in terms of relevant foreign investments, exports and development cooperation. In 2022, the share of United States to the Global economic ranking was of 19.9%, while the share of China was 10.5%.

Figure 1: Countries' Global Presence in Economic, Military and Soft power (Elcano Index)



Source: Real Instituto Elcano (2024b), own representation.

Yet, China's global presence in the economic and military sphere has been growing quite fast, while the EU has lost ground, especially in the aftermath of the debt crisis and then in the course of the COVID-19 Pandemic (see Figure 1). Against this background, one rationale behind the EU decision to bolster investments in the abovementioned regions is to counter Chinese competition. Ideally, it allows the EU to diversify its external trade connections and create new long-term ties by promoting sustainable economic development in the partner countries. In a time of war in the Ukraine, when significant EU resources are requested to support military effort against Russia, it is even more important for the Global Gateway to become an economic success. For this reason, the next chapter analyses how the above-mentioned infrastructural investments can result in trade-related gains for the EU.

3 Infrastructure development and international trade

3.1 Public infrastructure in trade analyses

Research into the relationship between public infrastructure and international trade has in recent years been the subject of a range of empirical studies. The theoretical framework of trade economics provides the motivation for this research. In the gravity model of trade theory, the extent of bilateral trade between two countries is understood as a function of their respective economic mass and their distance, analogous to the physical law of gravity. The concept of distance encompasses more than just spatial distance but is understood holistically as the set of factors that influence the total cost of trade between two countries. In addition to factors directly affecting trade, such as tariffs and other trade policy measures (e.g. cost-inducing product standards, approval procedures), this also includes the public infrastructure of the countries involved.

Infrastructure is defined differently by authors depending on the object of investigation. Martin and Rogers (1995) define public infrastructure as "any facility, good, or institution provided by the state which facilitates the junction between production and consumption".[29] Such a definition encompasses more than just the physical infrastructure created under the influence of the state, such as roads, bridges and communication networks. It also accounts for the role of institutions as intangible infrastructure, i.e. the influence of the state on the rules and procedures shaping economic life. These are also of potential relevance for cross-border trade, as they can influence the transaction costs of the trading partners.

For the definition of public infrastructure in the context of our trade analysis, we propose a three-part classification. The narrowest classification is the **transport-enabling infrastructure**. It comprises the transport infrastructure for all modes of transport and types of tangible goods (road, rail, ports, airports, pipelines and electricity grids). It directly influences the cost of the physical exchange of goods. In addition, the physical communication infrastructure, i.e. mainly internet access, mobile networks and satellite communication, is included. It influences the costs of the communication necessary for the initiation and processing of trade transactions. Such a wider delimitation can be characterized as **transaction-enabling infrastructure**, as it represents a requirement for the complete economic transaction.

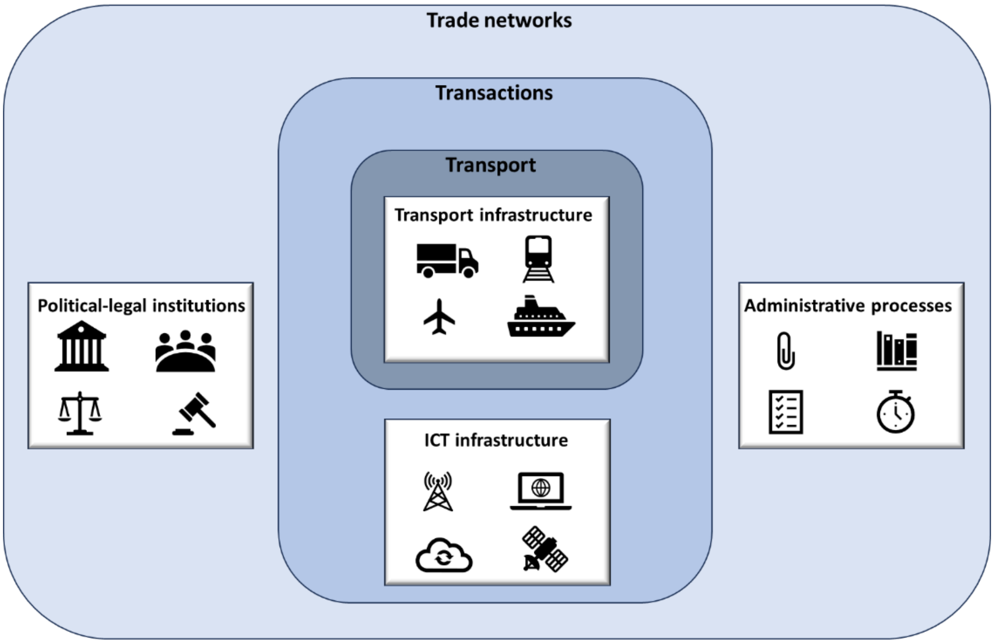
Transactions do not take place in a vacuum but are an expression of networks that have been created between people and institutions in the countries involved. The establishment of such networks requires more than just physical infrastructure. In addition to historically determined intangible factors such as language and cultural rules, state influence is also relevant in this respect. On the one hand, this manifests itself in the importance of political and legal institutions. Trust in the rule of law of the partner country and the functioning of its judicial system is an important prerequisite for establishing trade relations. It reduces the perceived risk that contractual provisions are not effectively enforceable. The reliability of the regulatory framework (e.g. consistency of trade policy) and the perceived stability of the political system in the partner country are also decision factors for establishing long-term trade relations. Another potentially relevant intangible factor is the work of the public administration in partner countries, i.e. the efficiency of administrative processes and the general level of trade-related bureaucracy. This applies above all to cases in which cross-border trade results immediately from foreign direct investment in the partner country, e.g. firm-internal trade of multinational corporations. We refer to this broadest definition of public infrastructure as **network-enabling infrastructure**.

A further refinement of this three-level delineation of trade-relevant infrastructure can consist of differentiating between the dimensions of quantity and quality. In principle, it is to be expected that these dimensions have a complementary effect. For instance, the level of trade-related costs is not only shaped by the extent of network expansion (e.g. density of the road network, ICT network coverage), but also by the quality of the materials used (e.g. road surfaces, use of fiber optic cables). In principle,

[29] Martin, P., & Rogers, C. A. (1995). Industrial location and public infrastructure. Journal of international Economics, 39(3-4), 335-351.

such a distinction could also be made for intangible infrastructure, e.g. by distinguishing between capacity and efficiency of public administration services. Figure 2 illustrates our theoretical concept. We use it below as a motivation for our own empirical model.

Figure 2: Three-stage concept of trade-relevant infrastructure



Source: own illustration

3.2 Existing evidence on trade effects

The bulk of econometric studies analyzing the influence of infrastructure on international trade flows are based on the application of gravity models. However, there are significant differences in the details. The different understanding of what constitutes trade-relevant infrastructure is also reflected in the design of the practical measurements. The country indicators considered as infrastructure variables are very diverse. Some of them are aggregated in index form. The weighting of the indicators during aggregation has an additional influence on the results. A further differentiation is the extent to which the influence of the infrastructure of the exporting country, the importing country or both trading partners is measured.

In a comprehensive meta-analysis of previous research findings, Celbis et al. (2014) report that around 82% of the papers examined found a significant positive effect of infrastructure on trade flows.[30] On average, a significantly stronger effect is measured for infrastructure in the exporting country than for infrastructure in the importing country. An improvement in a country's infrastructure therefore has a stronger positive effect on exports than on the country's imports. Investments in domestic infrastructure are therefore suitable for improving a country's trade balance. As part of a meta-regression analysis, Celbis et al. (2014) show that this result also applies when methodological differences between the studies and a possible publicity bias are accounted for. As a possible explanation, they argue that isolated infrastructure improvements in one country reduce the trade costs for all exported goods from the perspective of exporting companies in that country. By contrast, from the perspective of

[30] Celbis, G., Nijkamp, P., & Poot, J. (2014). Infrastructure and trade: A meta-analysis. Region, 1(1), 25-64.

importing companies in the partner country, the cost reductions only affect a part of their global import portfolio. The resulting change in behavior should therefore be stronger for exporters than for importers.

Their results also point to significant differences in the effects between infrastructure categories. On average, significantly stronger effects on the volume of trade are measured for land transport infrastructure than for maritime transport and air transport infrastructure. In principle, the results also suggest that a differentiated measurement of individual infrastructure components leads to stronger effects than composite infrastructure indices. This underlines the importance of differentiated measurement and the general decision on how to define infrastructure in a specific case. The results also show that the effects depend on the level of development of the countries under consideration. The infrastructure in the exporting country has a stronger effect on trade if the exporting country is a developing country. This points to a possible non-linearity in the effect of infrastructure on trade flows. Infrastructure improvements in countries with previously underdeveloped infrastructure could therefore have a systematically stronger trade-creating effect. From a dynamic perspective, this effect could be reinforced by the interaction between infrastructure and overall economic growth (see next subsection). In general, this supports the focus and objectives of the Global Gateway.

After the meta-analysis by Celbis et al. (2014), a few additional papers on this topic were published. Bensassi et al. (2015) examine the effects of infrastructure on a region's international exports for a sample of Spanish regions, accounting for availability and access to logistics services.[31] Their measurement of infrastructure is limited to the land transport infrastructure in the exporting region. The average lengths of the regional road and rail networks are used as an indicator. The estimates show a significant positive effect of this indicator on exports. Donaubauer et al. (2016) construct a multi-categorial index mixing data on public infrastructure stocks with private consumption accounts (e.g. electricity consumption, registered passenger cars).[32] For the four infrastructure categories (Transport, ICT, Energy and Finance) considered, they ascertain significant positive effects on bilateral trade volumes for aggregates of consumption goods, capital goods and intermediates.[33]

Yushi and Borojo (2019) estimate the effect of infrastructure and quality of institutions on trade among African countries and with the rest of the world from 2000 to 2014.[34] They combine transport and communication infrastructure in an aggregate indicator. In addition, they consider the quality of economic institutions and the border and transport efficiency of trading partners, also measured as aggregated indices. The central result is that all three indicators have a significant positive influence on trade flows. This applies both to the question of whether trade takes place and to the volume of trade.

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31 Bensassi, S., Márquez-Ramos, L., Martínez-Zarzoso, I., & Suárez-Burguet, C. (2015). Relationship between logistics infrastructure and trade: Evidence from Spanish regional exports. Transportation research part A: policy and practice, 72, 47-61.

32 Donaubauer, J., Meyer, B. E., & Nunnenkamp, P. (2016). A new global index of infrastructure: Construction, rankings and applications. The World Economy, 39(2), 236-259.

33 Donaubauer, J., Glas, A., & Nunnenkamp, P. (2015). Infrastructure and trade: A gravity analysis for major trade categories using a new index of infrastructure (No. 2016). Kiel Working Paper.

34 Yushi, J., & Borojo, D. G. (2019). The impacts of institutional quality and infrastructure on overall and intra-Africa trade. Economics, 13(1), 20190010.

Rehman et al. (2020) investigate the impact of different categories of infrastructure on the trade balance of South Asian countries.[35] They consider indices on transportation, communication and energy infrastructure. They show that a higher infrastructure quality not only has a positive effect on exports, but also on the trade balance of the countries studied, thus confirming the results of Celbis et al. (2014). Han and Li (2022) examine the effects of transport infrastructure differentiated by international and country-internal trade based on a global sample in the period from 2000 to 2016.[36] They identify a significantly stronger infrastructure effect on international than on internal trade. In addition, they show that infrastructure improvements also have a positive effect on real income. This effect is significantly stronger in the country with improved infrastructure than in its trading partners. This again points to the interrelationships between trade, infrastructure, and macroeconomic growth.

Overall, the empirical literature provides convincing evidence for a robust positive effect of infrastructure improvements on international trade flows. At the same time, however, the results of the previous analyses show that it is important to differentiate precisely according to initial conditions and impact channels. Depending on the type of infrastructure, the general level of development of the countries under consideration and their trade portfolio, the quantitative effects can differ significantly.

This stresses the need for additional research. Firstly, this concerns the need for more detailed analyses of trade determinants in individual product groups. Given the discrepancies in the relative importance of transport costs among different product groups, it cannot be assumed that infrastructure improvements exert a homogenous effect on trade in all goods. Secondly, the interactions between trade flows, infrastructure development and general economic growth should be examined more closely, especially for developing countries. Both are very important aspects, especially for the evaluation of the Global Gateway Initiative. The strategic prioritization that the EU has undertaken in its Green Deal implies a particular interest in strengthening supply chains in strategically important net-zero technologies. Moreover, the current project portfolio not only aims at reducing trade costs, but also at supporting the general economic development in the recipient countries (see Section 2).

3.3 The infrastructure-growth-trade nexus

The nature of the relationship between infrastructure investment and general economic growth has been extensively researched. In addition to the immediate demand stimulus provided by infrastructure spending, the literature has highlighted some positive long-term supply-side effects. Aschauer (1989) has shown in a seminal paper that the stock of nonmilitary public capital is an important determinant of macroeconomic productivity.[37] The core infrastructures such as highways, streets, water systems are of central importance. Barro (1990) points at the complementarity between private and public capital.[38] Productive government expenditures can stimulate private capital accumulation and thus long-term growth. Other studies also highlight the contribution of public infrastructure investments to

35 Rehman, F. U., Noman, A. A., & Ding, Y. (2020). Does infrastructure increase exports and reduce trade deficit? Evidence from selected South Asian countries using a new Global Infrastructure Index. Journal of Economic Structures, 9, 1-23.

36 Han, Z., & Li, H. (2022). Transportation infrastructure and trade. Japan and the World Economy, 64, 101162.

37 Aschauer, D. A. (1989). Is public expenditure productive? Journal of monetary economics, 23(2), 177-200.

38 Barro, R. J. (1990). Government spending in a simple model of endogenous growth. Journal of political economy, 98(5, Part 2), S103-S125.

reducing economic inequality within countries.[39] It improves access of people and capital in deprived regions to central markets and is thus central for overcoming regional poverty traps.

Many recent studies put emphasis on the effects of modernizing the infrastructure stock in developing economies. The role of ICT infrastructure is of specific interest. Broadband internet connections and mobile networks not only offer developing countries the prospect of improved (internal and external) connectivity, but also enable them to leapfrog analog development stages in many places and thus contribute to their general technological catch-up process. From an economic perspective, investments in a modern ICT infrastructure can become a catalyzer of structural change by reducing communication costs and promoting the development of knowledge-intensive service sectors such as financial services.[40] This in turn increases the inflow of Foreign Direct Investment (FDI) and thus indirectly contributes to the expansion and modernization of the general capital stock.[41]

At the same time, studies point to the major deficits in the development of basic infrastructure in developing regions. Local transportation and electricity infrastructure is identified as a major obstacle to economic growth, particularly in regions like Sub-Saharan Africa.[42] The quality of infrastructure services (e.g. security of electricity supply, quality of road surface) plays apparently a more decisive role than the state of capacity expansion.[43] This is explicable by the entry hurdles set for integrating such regions into global production networks. Reliability of basic services is an important prerequisite for participation in global supply chains with tight delivery schedules and thus for export-led growth in developing economies. This is also reflected in the importance of infrastructure quality for inflows of FDI. In this respect, there are signs of a complementary effect of ICT and traditional infrastructure such as roads and electricity.[44] This points to the need to specifically address infrastructure bottlenecks for realizing economic growth potentials.

However, a model of infrastructure development solely driven by the supply of external capital and know-how is in many cases not an adequate solution. Firstly, in addition to its questionable political legitimacy, such a model harbors the risk that infrastructure development will focus on the short-term trading interests of external investors. In the worst case, this can delay the economic structural change in recipient countries necessary for long-term productivity growth. For example, the expansion of a transport infrastructure geared towards the global export of natural resources can hinder the industrial modernization of exporting countries[45] and their regional economic integration[46] due to its asymmetrical cost effect. Secondly, inadequate involvement of local actors makes the long-term maintenance of infrastructure more difficult and entails the risk of ignoring the knowledge needs of

39 Calderón, C., & Servén, L. (2004). The Effects of Infrastructure Development on Growth and Income Distribution. World Bank Policy Research Working Paper 3400.

40 Odedokun, M. O. (1996). Alternative econometric approaches for analysing the role of the financial sector in economic growth: Time-series evidence from LDCs. Journal of Development Economics, 50(1), 119-146.

41 Mensah, J. T., & Traore, N. (2024). Infrastructure Quality and FDI Inflows: Evidence from the Arrival of High-Speed Internet in Africa. The World Bank Economic Review, 38(1), 1-23.

42 Azolibe, C. B., & Okonkwo, J. J. (2020). Infrastructure development and industrial sector productivity in Sub-Saharan Africa. Journal of Economics and Development, 22(1), 91-109.

43 Ehizuelen, M. M. O. (2021). China's Infrastructure Financing and the Role of Infrastructure in Awakening African Economies. Journal of Comparative Asian Development (JCAD), 18(2), 1-25.

44 See Mensah and Traore (2024).

45 Nkurunziza, J. D. (2021). The Commodity Dependence Trap. Geneva, UNCTAD, background document to the Commodities and Development Report.

46 Bonfatti, R., & Poelhekke, S. (2017). From mine to coast: Transport infrastructure and the direction of trade in developing countries. Journal of Development Economics, 127, 91-108.

local industry. A sustainable upgrading of infrastructure quality requires the establishment of specialized local service providers which serve as a transmitter of the external knowledge brought by infrastructure modernization to the local economy. This in turn requires external investors to have profound knowledge of local business structure and economic institutions.

A bottom line of the literature is that external infrastructure investments can only have a growth-promoting effect when they are part of an integrated model of economic cooperation on equal footing. In fact, studies point to a positive effect of development-focused infrastructure upgrades such as the "aid for trade" program on the export performance of countries.[47] **Since capacity-enhancing growth also increases the long-term potential of recipient countries as trading partners for critical industrial products, it is in the EU's best interest to choose such cooperation models as a guiding principle for Global Gateway projects**. Moreover, in the geoeconomic rivalry with China, such a development-oriented model represents an important asset for Europe to position itself as a credible alternative to the dubious amalgamation of economic interests and political hegemony present in China's Belt and Road Initiative.[48]

4 Empirical analysis

4.1 Methodology

The motivation for our own empirical analysis of the trade effects of the Global Gateway is the limited transferability of literature results. Firstly, this concerns the almost exclusively macroeconomic focus of existing studies. They provide no indications of how the structure of EU's trade with Global Gateway partner countries could develop, especially in the product segments of net-zero technologies which are critical for the EU's future industrial base. Secondly, in view of the long-term nature of the investment projects, an analysis should not be limited to their direct impact on trade (decreasing trade costs) but should also highlight potential indirect trade effects through increased input demand.

When restricting the trade analysis to certain product groups, a decision on the level of detail must first be made. A common international classification of traded products is the Harmonized System (HS). It forms the basis for the work of customs authorities worldwide and is therefore highly detailed. It exhibits a hierarchical structure and distinguishes between four levels. Given the variety and the strong technological dynamics of the relevant supply chains, identifying products at the highest level of detail would involve a very high selection effort and considerable uncertainty. We therefore choose a medium level, the so-called product chapters (2-digit codes), as a basis for delimitation. It includes product aggregates with general relevance for the technologies under consideration.

Based on this demarcation, we select four categories of goods for our analysis. **Category 1 comprises base materials**. By this we mean products located at the first processing stages within the supply chains, i.e. material inputs for producing the relevant end products. We define them as an aggregate of several product chapters (see next Subsection). The remaining categories are located further downstream in the supply chains. **Category 2 contains mechanical machinery, category 3 electrical equipment and category 4 vehicles and vehicle parts**. In their entirety, the selected categories represent

[47] Vijil, M., & Wagner, L. (2012). Does aid for trade enhance export performance? Investigating the infrastructure channel. The World Economy, 35(7), 838-868.

[48] Flint, C., & Zhu, C. (2019). The geopolitics of connectivity, cooperation, and hegemonic competition: The Belt and Road Initiative. Geoforum, 99, 95-101.

the industrial parts of the supply chains of net-zero technologies very well (see Table 1 in Section 1). One exception is the very first step, trade in resources extracted directly from nature (e.g. mineral ores, fossil resources). They are excluded, as resource trade is characterized by strong idiosyncratic features. For its evolution, future discoveries of resource deposits will play a critical role, whose geography cannot be reasonably predicted at present.[49]

Another important decision concerns the selection of infrastructure variables. Its fundament is the concept developed in Subsection 3.1. Accordingly, we understand trade-relevant infrastructure as a multidimensional construct that, in addition to transport-enabling infrastructure, also considers the development of the communication infrastructure, the political-legal institutions and the burden of administrative processes as important framework conditions for the formation of trade networks. For the practical measurement of these four dimensions, we follow the approach of Yushi and Borojo (2019). For this purpose, individual indicators are first selected from recognized secondary sources for each dimension. Then, a weighted average is calculated from these as an aggregated measure for each dimension. The weights are determined by means of a Principal Component Analysis (PCA). The aggregated measures can thus be interpreted as latent variables behind the observable indicators. In this way, a total of five infrastructure measures are included as explanatory factors in the subsequent trade analysis.[50]

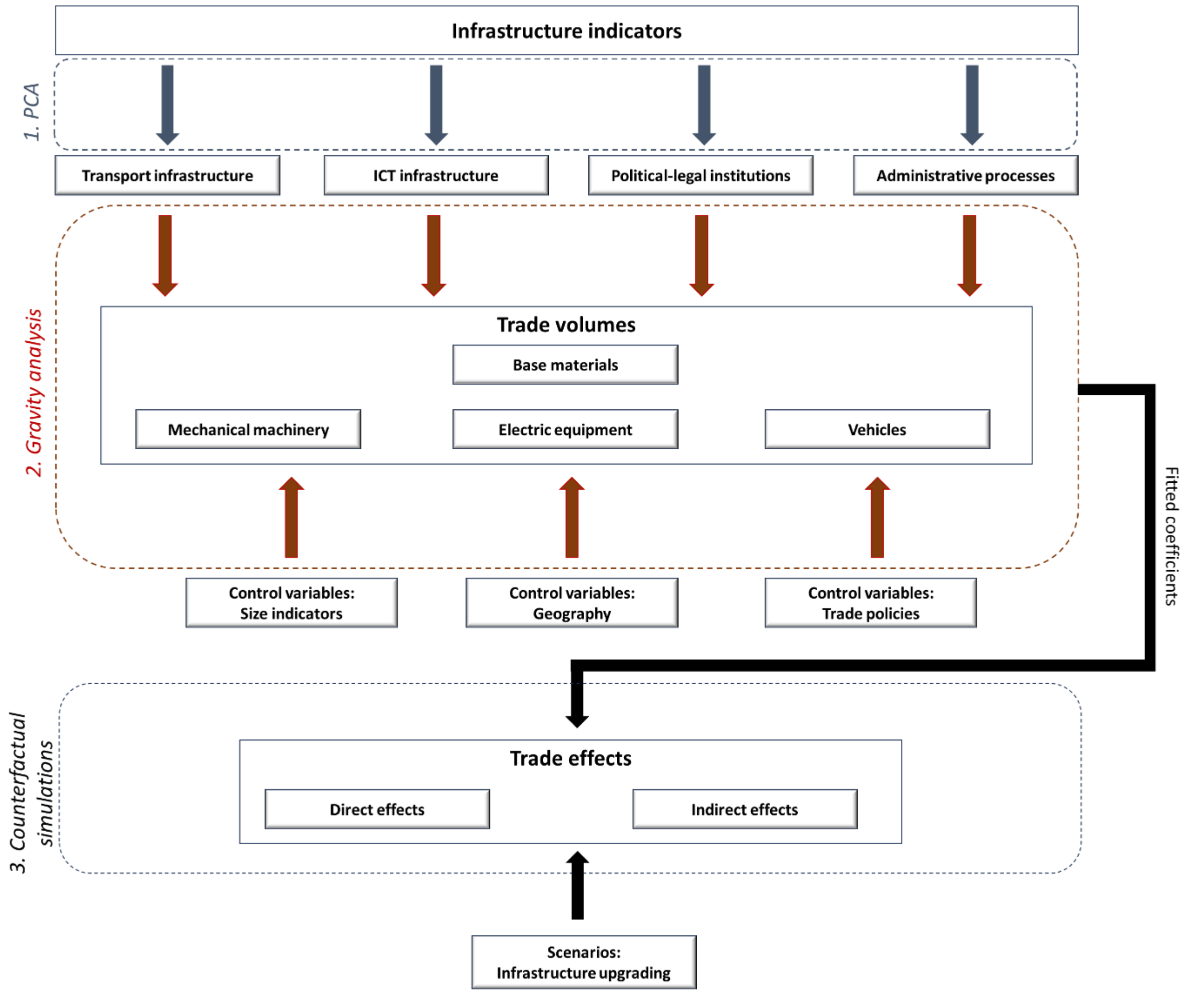
The basis for the investigation of a relationship between product-level trade and infrastructure is the gravity model commonly used in the empirical trade literature. It is theoretically well-founded and provides clearly interpretable estimators. We consider our infrastructure variables as a component of trade costs, in addition to the standard indicators such as spatial distance, tariff levels and historical ties. We run separate regressions for each of the four product categories considered, to illustrate any product group-specific effects of the infrastructure variables and the other explanatory factors. Geographically, our gravity analysis is not limited to the dedicated Global Gateway regions but covers trade between EU Member States and all third countries. In this way, we gain a larger number of observations and, above all, more variation in the infrastructure variables as a basis for improved statistical evidence.

Afterwards, we use the results of the gravity estimations for counterfactual simulations. Specifically, we investigate the impact of infrastructure quality improvements in the global gateway regions on expected trade flows, by applying the gravity model fitted with the coefficient estimators. In this way, we gain insight into the expected magnitude of trade creation effects and, conversely, into the extent of infrastructure improvements necessary for a significant trade boost. The result is a differentiated picture of trade impacts across product groups and infrastructure components. Figure 3 illustrates the sequence of our multi-stage approach.

[49] Nevertheless, the first processing stage of such raw materials is included in the base materials category, e.g. in the case of rare earth metals, the trade in rare earth oxides extracted from ores. As the example of cobalt processing in China shows, trade in these products is less tied to the spatial distribution of natural resource deposits.

[50] Administrative efficiency is split into a measure of trade-related administrative burdens and into a measure of the administrative costs of business formations. This allows us to handle the exclusion restriction involved in our estimation strategy (see Subsection 4.3).

Figure 3: Steps in the trade analysis



Source: own illustration

4.2 Data and indicator construction

The trade data for the analysis come from the UN Comtrade Database.[51] It provides high-resolution information on exports and imports at product level for all global reporting countries. To construct our four product aggregates, we choose the HS codes shown in Table 3. For these product groups, all trade flows between EU members and third countries worldwide were retrieved for the last twenty observation years, based on the reporting by the member states.

A critical step marks the choice of infrastructure indicators. We explored a wide range of international databases in search of suitable indicators, including the World Bank Development Indicators[52], the Worldwide Governance Indicators[53], the Doing Business Index[54], the Global Competitiveness Index by the World Economic Forum[55] and the statistics of the International Road Federation[56]. The search revealed a clear trade-off between the level of detail and the extent of temporal and spatial availability

51 UN Comtrade (2024). UN Comtrade Database. United Nations.
52 World Bank (2024a). World Development Indicators. World Bank Group.
53 World Bank (2024b). Worldwide Governance Indicators. World Bank Group.
54 World Bank (2019). Ease of Doing Business Index. World Bank Group.
55 WEF (2020). Global Competitiveness Report 2020. The World Economic Forum.
56 IRF (2023). World Road Statistics. International Road Federation.

of data. This was further complicated by the fact that a significant proportion of the Global Gateway target countries are developing countries. When selecting indicators for each of the four infrastructure dimensions included in our analysis (transportation, ICT, political-legal institutions, administrative processes), our aim was to ensure the broadest sample of countries and the most up-to-date observations possible. Consequently, indicators which cover infrastructure quality in more general terms were preferred over indicators that reflect more specifically the focus of current Global Gateway projects but are highly patchy or not available for recent years.

Our analysis should therefore not be regarded as an evaluation of specific flagship projects, but as an impact analysis of general infrastructure improvements caused by Global Gateway. Specifically, only indicators were selected which were available for more than 100 countries and for at least three consecutive years since 2015. Table 3 lists the indicators selected on this basis. Results of the PCAs undertaken to determine the weights of the single indicators are reported in Table A1 in the Appendix. In all cases, the first extracted components account for a share of more than 75 % of the total variation. We apply these as index measures.

We use national accounts data available from the Word Bank to measure the economic mass of the trading partners. Traditionally, economic mass is approximated by GDP in gravity analyses. For our analysis at product group level, however, this would not be a suitable measure for supply-side trade potential, as it does not contain any information on economic structure and specialization. In addition, Baldwin and Taglioni (2014) have shown that the approximation by value added measures alone is a source of bias, as the trade flows, as dependent variables, are not measured in value added but in product values.[57] Following Baldwin and Taglioni (2014), we therefore compile our economic mass measures from several components. We measure the supply-side potential of the exporting country as the sum of its value added in medium- and high-tech manufacturing and its global imports in the four product categories that we consider. This serves as a proxy for the (not directly observable) production value of the relevant future technologies in the exporting country. The demand-side potential of the importing country is measured as the sum of GDP and global imports of the four product categories considered (excluding the bilateral imports from the respective trading partners, to avoid the creation of an endogeneity issue). Population size and land area are taken into account as further non-economic mass measures, e.g. to control for potential productivity effects.

Standard gravity model variables are included in our regression model as additional control variables. The spatial distance between the trading partners, measured via the CEPII's great circle approach[58], and a dummy variable to capture common borders are included as natural measures of trade costs. To map political trade barriers, we record bilateral tariff rates at product group level, taken from the global tariff database of UNCTAD Trains accessible through the World Integrated Trade Solutions (WITS).[59] We also account for the existence of regional trade agreements as a dummy variable, taken from Mario Larch's Regional Trade Agreements Database.[60] We thus ensure that the measured influence of infrastructure quality does not erroneously reflect the effects of growing trade cooperation.

57 Baldwin, R. E., & Taglioni, D. (2014). Gravity chains: Estimating bilateral trade flows when parts and components trade is important. Journal of Banking and Financial Economics, 2(2), 61-83.

58 Mayer, T., & Zignago, S. (2011). Notes on CEPII's distances measures: the GeoDist database. CEPII Working Paper 2011-25.

59 UNCTAD (2024). UNCTAT Trains – Tariff data by country (bulk download). United Nations Conference on Trade and Development.

60 Larch, M. (2024). Regional Trade Agreements Database.

As potential cultural factors, the existence of a common language and of past colonial ties are included in the model as dummies, both taken from the *GeoDist* dataset of the CEPII.[61] The resulting data set contains a total of 25,626 observations and covers the period from 2015 to 2019.

Table 3: List of variables and data sources

Variable name	Description	Data source
	Trade flow measures	
trade_base materials	Bilateral trade volumes in HS chapters inorganic chemicals (HS-Code: 28), iron and steel (72), articles of iron or steel (73), copper articles (74), nickel articles (75), aluminium articles (76), lead articles (78), zinc articles (79), tin articles (80), other base metals (81)	UN Comtrade (2024)
trade_mechanical machinery	Bilateral trade volumes in HS chapter 84	UN Comtrade (2024)
trade_electric equipment	Bilateral trade volumes in HS chapter 85	UN Comtrade (2024)
trade_vehicles	Bilateral trade volumes in HS chapters 87.88. and 89	UN Comtrade (2024)
	Trade partner size measures	
mass_x	Exporter supply potential: value added in medium- and high-tech manufacturing + total imports of base materials, mechanical machinery, electric equipment, vehicles	World Bank (2024a); UN Comtrade (2024)
mass_m	Importer demand potential: GDP + total imports of base materials, mechanical machinery, electric equipment, vehicles	World Bank (2024a); UN Comtrade (2024)
pop_x	Exporter population size	World Bank (2024a)
pop_m	Importer population size	World Bank (2024a)
area_x	Exporter land area	World Bank (2024a)
area_m	Importer land area	World Bank (2024a)
	Bilateral trade cost measures	
Distance	Great-circle distance (see Mayer & Zignago, 2011)	CEPII (2024)
Border	Existence of common border (dummy)	CEPII (2024)
common language	Existence of common official language (dummy)	CEPII (2024)
former colony	Existence of former colonial relation (dummy)	CEPII (2024)
tariff rate	Weighted average of (product-group) specific tariffs	UNCTAD (2024)
RTA	Existence of joint trade agreement (dummy)	Larch (2024)
	Infrastructure measures: transport	
quality of trade-infrastructure	Perceived quality of transport- and trade related infrastructure (Pillar from Logistics Performance Index)	World Bank (2024a)
road quality	Perceived quality of roads (survey)	WEF (2020)
road network density	Relation of road length to land area	IRF (2024)
share of paved roads	Relation of length of paved roads to total road length	IRF (2024)
access to electricity	Share of population with access to electricity	World Bank (2024a)
	Infrastructure measures: ict	
broadband subscriptions	Share of population with broadband subscriptions	World Bank (2024a)
telephone subscriptions	Share of population with telephone subscriptions	World Bank (2024a)
internet users	Share of population using the internet	World Bank (2024a)
mobile subscriptions	Share of population with mobile subscriptions	World Bank (2024a)
secure internet servers	Number of secure internet servers per 1 million people	World Bank (2024a)
	Infrastructure measures: political-legal institutions	
political stability	Perceived protection against political instability and/or politically-motivated violence, including terrorism.	World Bank (2024b)
government effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence	World Bank (2024b)

61 CEPII (2024). GeoDist. Centre d'Etudes Prospectives et d'Informations Internationales.

	from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	
regulatory quality	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	World Bank (2024b)
control of corruption	Perceived protection against the risk that public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests	World Bank (2024b)
rule of law	Perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence	World Bank (2024b)
Infrastructure measures: administrative burden - trade		
time to export: border compliance	Time associated with compliance with the economy's customs regulations and with regulations relating to other inspections related to the export process	World Bank (2019)
time to export: documentary compliance	Time associated with compliance with the documentary requirements related to the export process	World Bank (2019)
time to import: border compliance	Time associated with compliance with the economy's customs regulations and with regulations relating to other inspections related to the import process	World Bank (2019)
time to import: documentary compliance	Time associated with compliance with the documentary requirements related to the import process	World Bank (2019)
Infrastructure measures: administrative burden - business formation		
business formation: costs	Cost of business start-up procedures	World Bank (2019)
business formation: procedures	Start-up procedures to register a business	World Bank (2019)
business formation: time	Time required to start a business	World Bank (2019)

Source: own representation

4.3 Model and estimation strategy

Based on the theoretical framework of the gravity model, the functional relationship of all metric variables in the model is log-linear. This means that dependent variables and regressors are included in the model in logarithmic form. Hence, all estimated coefficients exhibit the form of dimensionless elasticities, facilitating their interpretation and comparison.[62] In principle, such a model can be easily estimated using least squares estimation methods. However, the zero values represent a potentially distorting feature. Not all countries traded with each other in all products in every year. Simply eliminating existing zero values would negate their non-random nature, and thus also a potential influence of infrastructure on the existence of trade relationships between countries.[63] There are several ways to account for this issue in the estimation. Following existing examples, we choose the Heckman approach.[64] In a two-stage estimation procedure, it distinguishes between explanations for the extensive margin (do countries trade with each other?) and the intensive margin (how much do trading countries trade with each other?). For the practical estimation, we need to specify a variable only included as an explanatory variable in the first stage, the selection equation (exclusion restriction). Following Yushi

62 In general, an elasticity is defined as the percentage change caused in the value of a dependent variable by a 1 % increase in the value of an explanatory factor.

63 Portugal-Perez, A., & Wilson, J. S. (2012). Export performance and trade facilitation reform: Hard and soft infrastructure. World development, 40(7), 1295-1307.

64 Heckman, J. J. (1979). Sample selection bias as a specification error. Econometrica: Journal of the econometric society, 153-161.

and Borojo (2019), we choose the administrative burden of business formation as a variable. It serves as a proxy for entry costs and thus as a determinant of trade-creating business activities.

Moreover, for an unbiased estimate, it must be considered that the extent of trade between two countries potentially not only depends on bilateral trade costs, but also on the alternative costs of trading with other countries. Anderson and van Wincoop (2003) have shown that this can be achieved by introducing so-called multilateral resistance terms as a correction to the measures of bilateral trade costs.[65] In constructing the measures, we follow the model of Portugal-Perez et al. (2012). Furthermore, we add year dummies as explanatory factors to control for the influence of time trends and year-specific fluctuations on trade. The specified model was estimated based on a 2-step least squares procedure in the statistical program R, using the statistical package *sampleSelection*.

4.4 Results

4.4.1 Descriptive results

Before turning to the regression results, it is important to gain general insights into the patterns of trade flows and relevant infrastructure variables. Given our interest in the implications of the Global Gateway Initiative, we focus on third countries targeted as destinations by Global Gateway flagship projects. To this end, we went through the current versions (from December 2023) of the official EU flagship project documents[66] and identified all those countries as "Global Gateway countries" for which project plans related to infrastructure capacities are announced.[67] This led us to a selection of 70 countries worldwide. To indicate the current economic relevance of this set of countries from EU perspective, we analyze their roles in past global trade of EU members.

Figure 4 presents the evolution of the shares of Global Gateway countries in EU imports from third countries for our four product groups of interest. First of all, it has to be noted that despite the impressive number of countries, their aggregate shares in EU imports lied well below 20% for all product groups and time periods considered. This is an implication of the development-oriented strategy of Global Gateway. With the exception of Japan, investments are not targeted at high income economies. Important traditional EU trade partners like the US are thus not included in these figures. Of course, given the role of Global Gateway as a counterinitiative to "Belt and Road", China is not included as an investment destination either.

At the same time, the images reveal interesting product discrepancies and time trends. Over the last ten years, Global Gateway countries exhibited the biggest relevance as exporters in the segments of base materials and electric equipment. However, while market shares in base materials stagnated, market shares in electric equipment showed a positive trend for some years. Hence, for this segment, some signs of a gradual shift towards downstream products can be noticed. The division of Global Gateway countries into world regions reveals that this trend is highly region-specific. It is almost exclusively caused by a strong increase in market shares of countries from South-eastern Asia. The remaining two downstream segments each show idiosyncratic patterns. The overall trend of market

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[65] Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. American economic review, 93(1), 170-192.

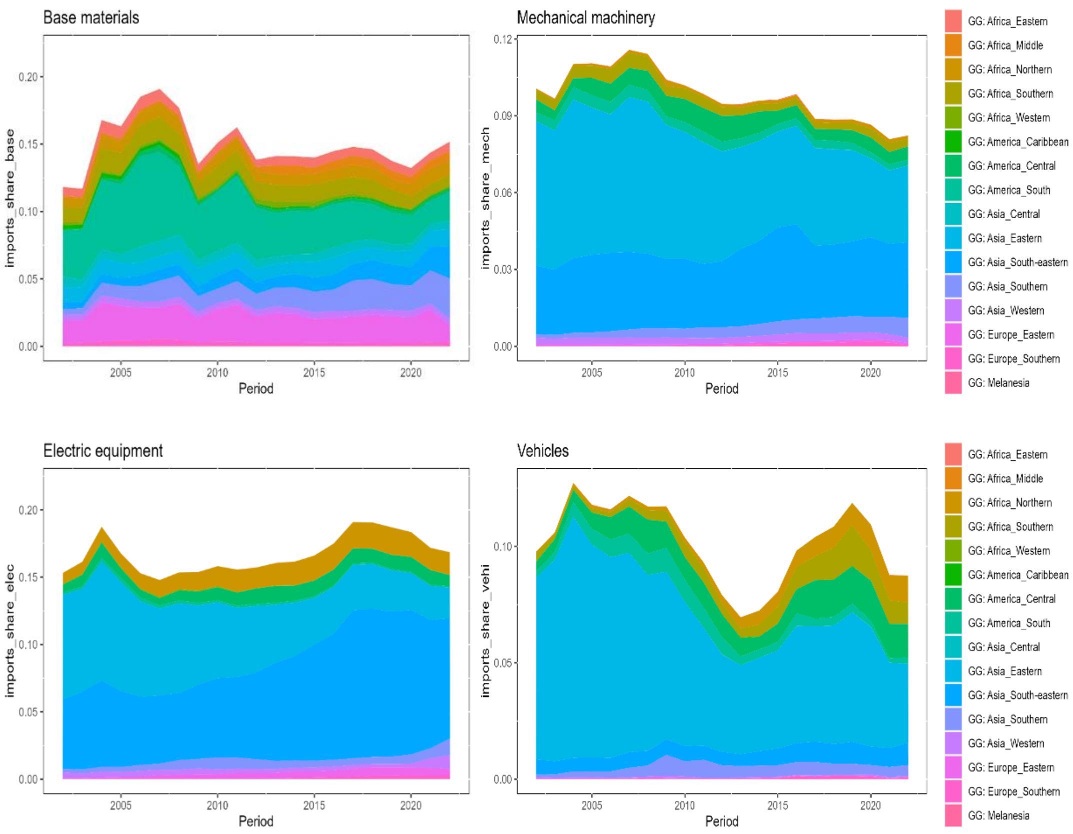
[66] European Commission (2023a). Global Gateway flagship projects – Infographics. Publication Date: Dec 18, 2023.

[67] Precisely, we included all countries for which projects in the fields "Digital sector" and "Transport" were reported. Moreover, countries with projects in the field "Climate&Energy" were included if the projects involve investments in energy infrastructure.

shares in EU imports of mechanical equipment has been negative in recent years, largely due to a contraction of imports from Eastern Asia. Finally, shares in vehicle imports exhibit a volatile pattern, with imports from Southern Africa, Central America (including Mexico), and Eastern Asia as main driving forces.

Overall, these patterns confirm the need for a product-differentiated analysis of EU trade with Global Gateway countries. The fact that trends in regional exports differ by product group hints at product differences in the influence of the underlying explanatory factors, potentially including the role of infrastructure.

Figure 4: Shares of Global Gateway countries in EU imports by world region



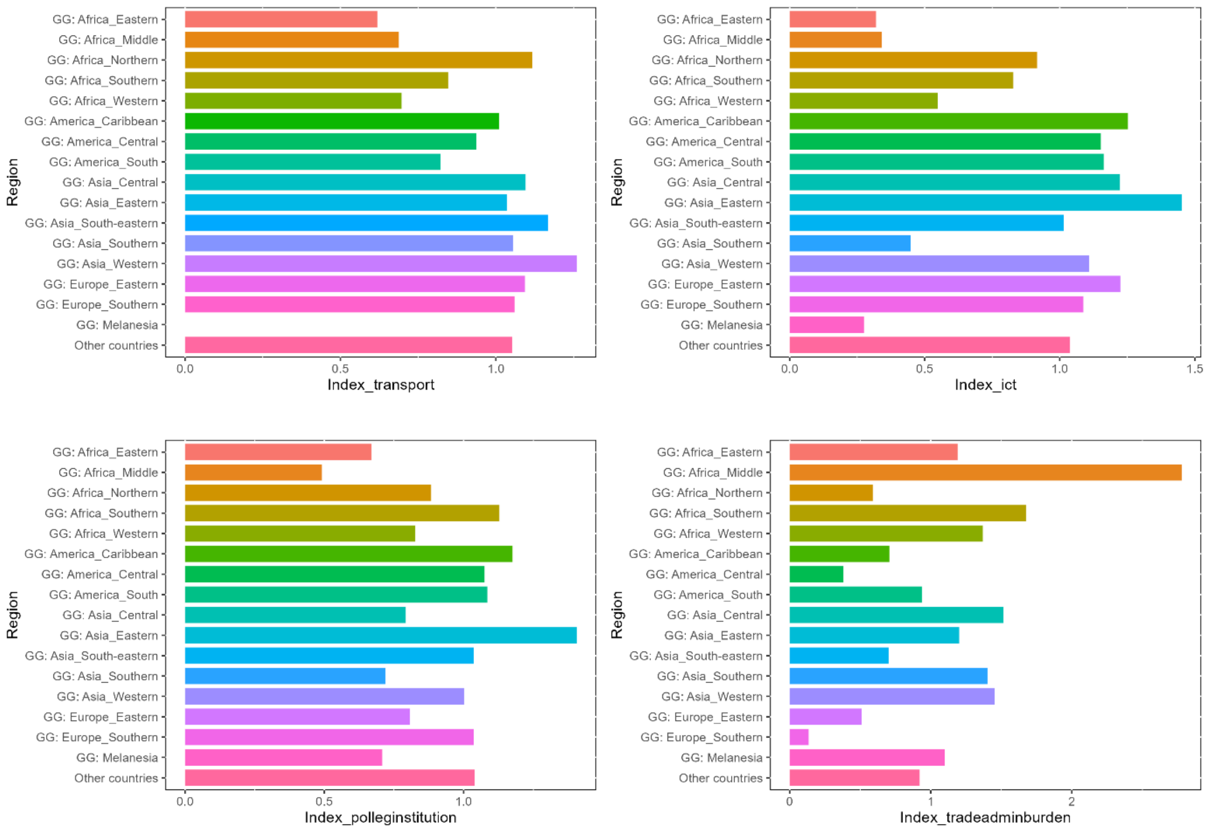
Source: UN Comtrade (2024); own calculations.

Concerning infrastructure quality, starting conditions also strongly differ between regions. Figure 5 depicts regional averages of our four infrastructure indices (see Subsection 4.2) for Global Gateway countries, calculated for the year 2019 and (for comparability) centered around the global average of all third countries.[68] In general, pronounced discrepancies are noted both across continents and infrastructure dimensions. For instance, while only a few regions surpassed the global average regarding the quality of political-legal institutions, most regions exhibited an above-average performance in the segment of ICT infrastructure. Global Gateway countries from Eastern and South-eastern Asia were among the best performers in all infrastructure dimensions except for the burden of trade administration indicator. This is also the indicator with the most significant regional discrepancies, featuring

[68] Accordingly, for the transport, ICT and political-legal indicator, a value larger (smaller) than one indicates that the regional performance was better (worse) than the global third country average. For the burden of trade administration indicator, being an inverse quality measure, the opposite holds.

Global Gateway countries from Middle Africa as negative and Global Gateway countries from Southern Europe as positive outliers. Figures A1-A5 in the Appendix highlight the underlying global differences at country level in the form of world maps.

Figure 5: Average results of infrastructure indices for Global Gateway countries by world region



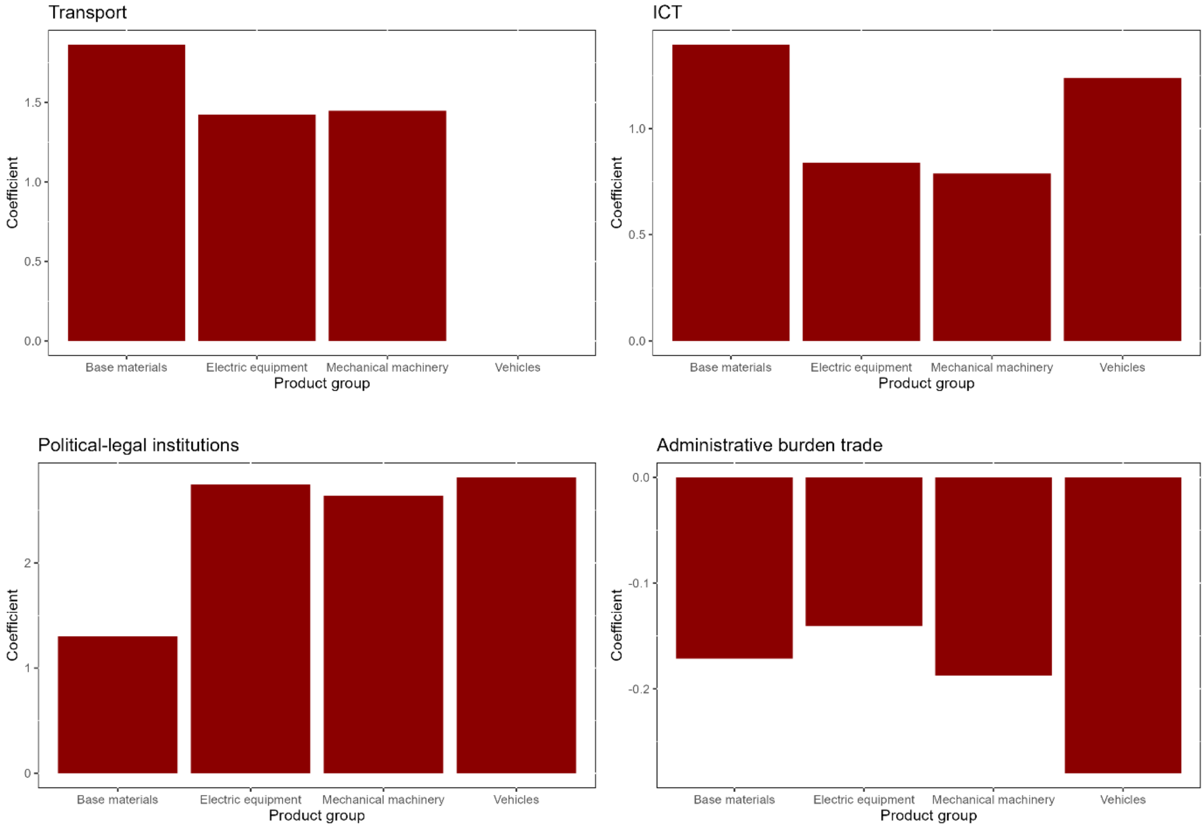
Sources: World Bank (2019;2024a,b); IRF (2023); WEF (2020); own calculations. Transport index: No values for Melanesia.

4.4.2 Gravity estimations

Complete results of the gravity estimations are presented in Table A2 in the Appendix. In general, signs of the estimated coefficients match theoretical expectations. Our economic mass measures show consistently positive effects in all regressions, in line with typical gravity outcomes. Increased spatial distance is diagnosed to affect bilateral trade in all considered product groups negatively, as predicted by economic theory. The existence of common trade agreements is shown to consistently strengthen bilateral trade. The measured impacts of other indicators of bilateral trade costs are more nuanced. Higher tariff rates are estimated to reduce trade volumes in all product groups except for mechanical equipment. The significance of having a common language, a common border or a common colonial past differs substantially between product groups. This nourishes the idea that the geographical shape of supply chains is affected by a complex interplay of cultural factors and technological requirements.

Concerning our main variables of interest, the infrastructure measures, the distinction between product groups is likewise insightful. While the signs of the respective coefficients are all as expected, the size of the estimated effects differs considerably. Figure 6 plots a comparison of coefficients for the outcome equations. Accordingly, the strongest positive impact of transport infrastructure is expected for base materials. For mechanical machinery and electric equipment, the measured impact is smaller but still highly significant, while it is insignificant for vehicles. Intuitively, this discrepancy might reflect differences in the relative importance of transport costs for location decisions between product groups. As base materials tend to exhibit a lower degree of product differentiation and embodied knowledge than the other categories considered, cost competition is particularly strong. Hence, the cost-reducing effect of utilizing a well-developed transport infrastructure is particularly influential on location decisions. This is further supported by the fact that coefficients for spatial distance and tariff rates are also most pronounced in the case of base materials, suggesting a generally high importance of trade costs. The insignificance of this term in the case of vehicles might be explicable by the dominance of network-related effects over spatial costs, like maintaining a trade network of trusted and highly specialized producers of vehicle parts and components.

Figure 6: Coefficient estimates for infrastructure variables in gravity model (outcome equations)



Source: own calculations. Insignificant estimates not depicted.

By contrast, the state of development of the ICT infrastructure is shown to be highly significant for trade in all product groups. Again, the size of the effect is the highest in the case of base materials. In this respect, vehicles come second. This is also the only group where the ICT infrastructure effect exceeds the transport infrastructure effect. The results in general stress the fact that local ICT is an important and autonomous factor to be considered in global supply chain development. This can be viewed as confirmation of the EU approach to consider ICT investments a separate and important pillar of the Global Gateway Strategy. The quality of political-legal institutions is likewise revealed to be an unanimously important driver of trade. In this respect, the effect size is least pronounced for base materials. Again, this might hint at a stronger dominance of plain cost advantages over “softer” infrastructure factors in the case of upstream materials. Finally, the administrative burden of trade procedures is shown to consistently exert a restraining influence on the volume of trade flows.

Finally, we need to address the potential issue of reverse causality. In the literature, this is frequently discussed as a scenario where eliminating trade barriers induces countries to invest more heavily in their trade-related infrastructure, to be prepared for an expected surge of trade flows.[69] Such an effect would imply that our estimated coefficients for the infrastructure variables are suffering from a simultaneity bias. While the possibility of its existence cannot be swept aside, there are at least reasons to believe that the setup chosen limits its extent. First, we control for both tariff rates and the existence of trade agreements as indicators of trade openness. Second, intra-EU trade is not part of our sample. As investment incentives following a trade increase are likely to be most pronounced for highly integrated partners, this should also exert a moderating effect on a simultaneity bias.[70] Third, we performed estimations of alternative model variants including time lags (first and second) of our infrastructure measures. Its results are presented in Table A3 in the Appendix. Significance and general magnitude of the coefficient estimates are unaffected. This time persistency of estimates supports our belief that any reverse influence is only a minor source of distortion.

4.4.3 Simulation of trade effects

The previous estimation results can be used to analyze the expected isolated effects of infrastructure improvements on trade flows. Specifically, we are interested in how enhanced infrastructure quality in Global Gateway countries is predicted to affect imports by EU Member States. This effect will not be homogeneous across Member States, due to different infrastructure investment intensities and country differences in the portfolios of trading partners. For our simulations, we focus on the intensive margin. This means we consider volume changes in existing trade relations instead of predicting the emergence of new ones. Concerning the initial infrastructure impulse, we restrict our analysis to improvements in transport and ICT infrastructure quality, as these are the two dimensions within our concept that can be directly targeted by the Global Gateway investments. We distinguish between two scenarios for infrastructure improvement. As a benchmark for both cases, we consider average transport and ICT infrastructure quality in the BRICS countries, reflecting the state of infrastructure development in growing emerging economies. As the set of Global Gateway countries includes many developing economies, average infrastructure quality index measures for Global Gateway countries lie clearly below the BRICS benchmarks.

In our scenarios, we examine what would happen to trade if Global Gateway investments managed to raise average transport and ICT infrastructure quality in Global Gateway countries to the BRICS levels. In reality, such an endeavor would take the form of a gradual long-term transition, with potentially delayed trade effects. In our comparative-static simulations, it is simplified to a one-time shift, under the premise of unchanged framework conditions (see below). Due to the heterogeneity of trade patterns across countries, the effect of this average shift is highly sensitive to the specific distribution of quality improvements among countries. In this respect, our two scenarios reflect opposing approaches. In the scenario “**general strengthening**”, we consider a situation where the increase in average infrastructure quality is achieved by a homogeneous percentage increase for all Global Gateway countries (including those above the previous average). By contrast, in the scenario “**development focus**”, the same average increase is achieved by raising infrastructure quality only in Global Gateway countries below the previous Global Gateway median, but to a larger extent than in the other

[69] See Portugal-Perez & Wilson (2012).
[70] See Donaubauer et al. (2015).

scenario.[71] The two scenarios thus reflect different strategic priorities (focusing on overall improvement vs. specifically supporting the least developed).

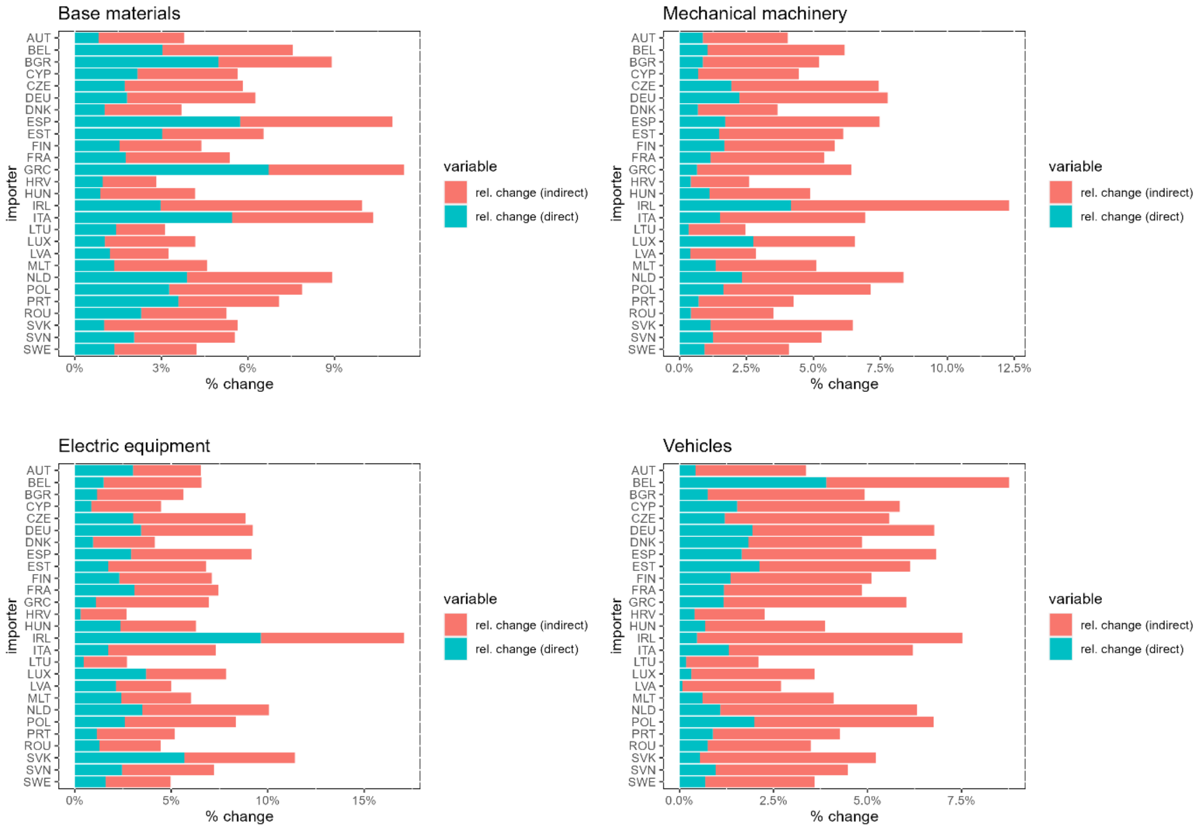
For each product group, the direct effects on the volumes of bilateral trade flows are obtained by applying the estimated infrastructure elasticities to the scenario-specific changes in infrastructure quality. Moreover, through the influence of the economic mass variables on trade, there are also indirect supply chain effects covered. As the economic mass of exporters in our model is defined as the sum of value added and imports of all product groups by the exporting country, direct effects on trade strengthen the overall export potential. Moreover, they also raise the economic mass of the importers, causing a general rise of demand potential. This, in turn, causes additional positive trade effects across all product groups, governed by the elasticities of trade to the economic mass of exporters and importers. This can be viewed as reflecting supply chain relationships: infrastructure improvements in country A enhance the supply of products to country B. This, in turn, boosts production in country B, causing additional import demand for upstream products and thus increased trade with all its partner countries.[72]

Figure 7 presents detailed results on percent changes in EU imports from third countries caused by the scenario “**general strengthening**”, based on reference trade data from 2022 and distinguished by Member State and product group. It documents strong structural variety in effect sizes, both regarding direct and indirect effects. On average, the strongest effects are witnessed for electric equipment. This is largely due to the particularly intense trade relationships of the EU with Global Gateway countries from Eastern Asian (Japan) and South-eastern Asia (Malaysia, Vietnam) in this segment. Nevertheless, effects are highly country specific, with Ireland representing a clear outlier. The category with the second largest average effect is base materials. Its distribution shows a quite different geographical pattern. The largest relative import gains are expected for the Mediterranean countries Greece, Spain and Italy. This is partly a consequence of strong trade ties to Northern African Global Gateway countries in this segment. Vehicles is the category with the smallest average effect, resulting from small direct impacts. This is partly related to the overall limited role of Global Gateway countries as EU partners in vehicle trade (see Subsection 4.4.1), but mostly due to the absence of a significant trade effect of transport infrastructure for this segment.

71 For all below-median countries, we apply the same relative upward shift in this scenario.

72 For simplicity, we assume a perfectly complementary relationship between domestically produced and imported inputs in downstream production, implying that increased imports of intermediates and capital goods translate into a proportional increase of domestic production. Ideally, the nature of these input-output-relationships should be estimated by means of country- and product-specific production functions. However, due to the absence of sufficiently disaggregated Input-Output-Data for many developing countries, this is presently not feasible.

Figure 7: Effects of Global Gateway scenarios on EU imports – Scenario: general strengthening

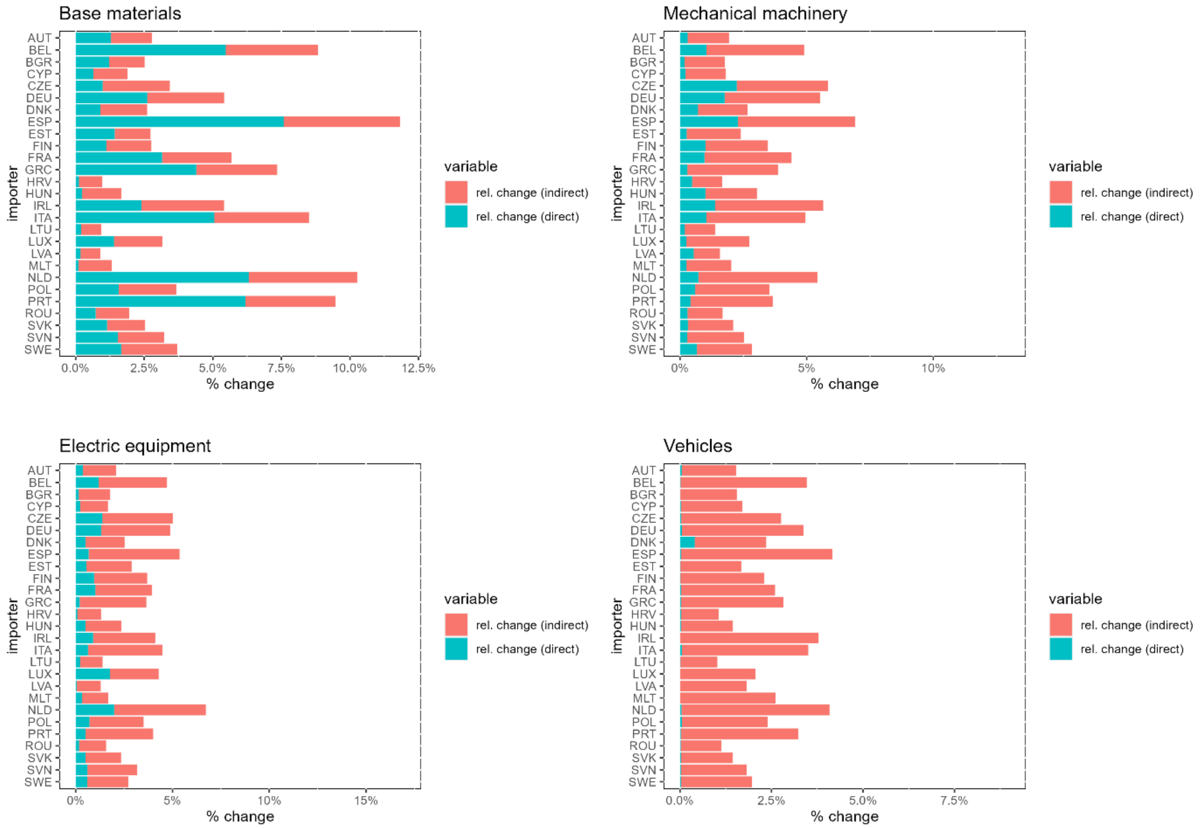


Source: own calculations.

The results of the alternative scenario “**development focus**” are depicted in Figure 8. **In all categories but base materials, average effects are of clearly more modest scale compared to the scenario “general strengthening”.** This is a consequence of the quality lead of the EU’s most important suppliers over the remaining Global Gateway countries. As many of them stand out with a comparatively well-developed transport and ICT infrastructure, they do not benefit from further quality improvements in this scenario. Instead, relative trade gains are focused on economically small developing countries with (at least in the short-run) limited capacities to contribute to the EU’s supply security (for a discussion of long-term structural effects, see Subsection 4.4.4). These are most limited in the case of vehicles. With base materials, this is different, reflecting the typical industrial specialization of these countries on upstream products. Increased trade in base materials, in turn, initiates indirect trade effects for the other product groups.

Moreover, the geographical distribution of effects also differs strikingly between the scenarios. Interestingly, imports of Member States with former colonial ties to Global Gateway countries like France, the Netherlands, Portugal, and Spain appear on average to be less sensitive to the scenario specification. This is potentially reflecting the fact that past trade relationships were less related to infrastructure quality in these cases.

Figure 8: Effects of Global Gateway scenarios on EU imports – Scenario: development focus

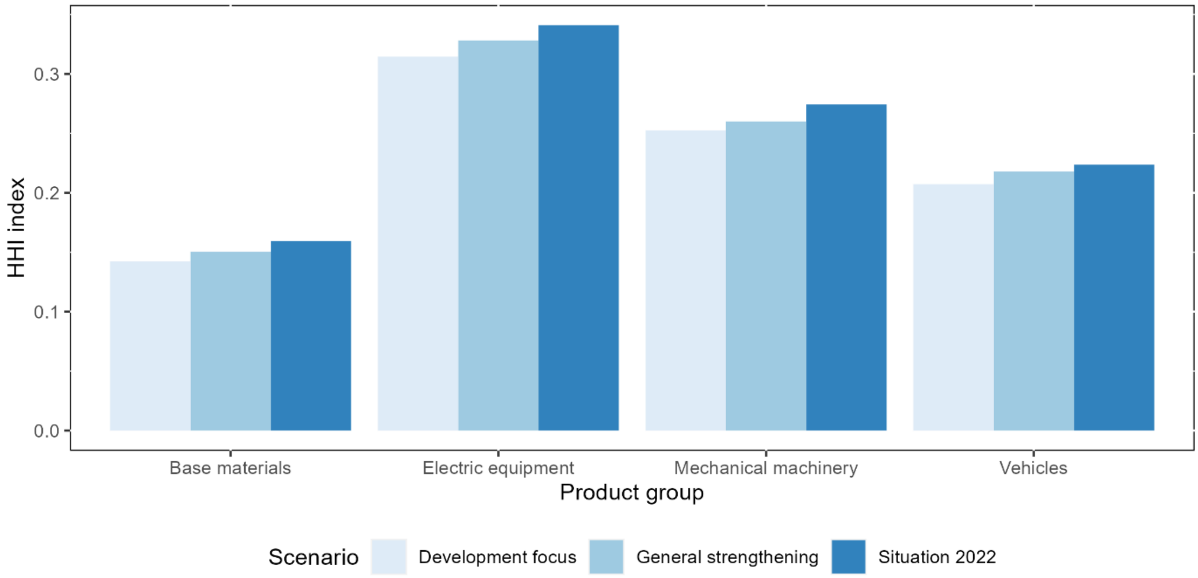


Source: own calculations.

From a resilience perspective, total volumes of EU trade with Global Gateway countries are not the only relevant indicator. To assess the implications of a scenario for EU supply security, its impact on the geographical diversification of trading partners also needs to be considered. Establishing a more diversified portfolio of third country suppliers can help to hedge against country risks and to reduce exposure to external supply shocks transmitted through trade networks. A standard inverse measure of diversification is the Herfindahl–Hirschman index (HHI) of concentration.[73] We apply it to the distribution of exporting country shares in EU third country imports. Figure 9 depicts the results by product group and scenario. As to be expected, the highest supply concentration is determined for electric equipment, reflecting Europe's strong dependence in semiconductors and batteries on Eastern Asia. The comparatively small supply concentration in base materials is due to the heterogeneity of products involved. **Both Global Gateway scenarios are predicted to lower supply concentration throughout all product groups.** In this respect, the impact of the "**development focus**" scenario is slightly higher. This is due to the stronger stimulation of trade with previously minor trade partners. **Nevertheless, overall effects are in each case of a modest magnitude.**

[73] Rhoades, S. A. (1993). The Herfindahl Hirschman index. Fed. Res. Bull., 79, 188.

Figure 9: Spatial concentration of external EU suppliers



Source: own calculations.

Finally, as an illustrative example for a resilience perspective, we can use our framework for simulating the short-term trade effects of unexpected supply disruptions. Given its geopolitical relevance, we are specifically interested in a "China shock". For all the product groups considered, the UN Comtrade data reveals that China has been the single most important supplier of the EU in 2022. In the following, we analyze the implications of an exogenous drop in worldwide Chinese exports of the products concerned, e.g. as an outcome of sudden export restrictions. In doing so, we compare overall trade effects across our previous scenarios, again distinguishing between direct and indirect effects.

Table 4 shows the consequences of a homogeneous drop in product exports by 50%, represented in the form of percentage changes of total EU imports. The strongest overall impact is observed for electric equipment. This is reflecting Europe's particularly large dependence on China in this product group. It also exhibits the biggest indirect effects, due to a likewise large China dependence of the EU's other trading partners. In scenario comparison, the results of the Global Gateway scenarios differ only very slightly from the values determined for the actual situation in 2022. **This confirms the assessment that the trade effects of the considered infrastructure upgrade will only slightly reduce Europe's direct dependence on its most important trading partners**. Interestingly, concerning the direct effects, the "**development focus**" scenario consistently shows slightly lower losses than the benchmark, while they are the highest for the "**general strengthening**" scenario. This is reflecting the stronger import diversification effect of the "**development focus**" scenario (see above). **At the same time, indirect effects are in both Global Gateway scenarios even stronger than in the benchmark scenario.** This is explicable by the fact that the trade impulses of the infrastructure improvements have raised the demand in third countries for Chinese products.

Table 4: Simulated impact of a 50% drop in Chinese exports on EU imports

	Scenario					
	Situation 2022		General strengthening		Development focus	
Product group	Direct effects	Indirect effects	Direct effects	Indirect effects	Direct effects	Indirect effects
Base materials	-2.82 %	-3.59 %	-2.83 %	-4.15 %	-2.80 %	-4.09 %
Electric equipment	-15.46 %	-5.92 %	-15.56 %	-6.59 %	-15.38 %	-6.29 %
Mechanical machinery	-9.36 %	-4.63 %	-9.41 %	-5.17 %	-9.31 %	-5.01 %
Vehicles	-3.04 %	-3.22 %	-3.06 %	-3.64 %	-3.04 %	-3.46 %

Source: own calculations

4.4.4 Discussion

At first glance, the results are sobering. Our analysis confirms the idea that infrastructure improvements in Global Gateway countries can raise their bilateral trade with the EU in the product groups considered. **However, the extent of trade effects is too limited to seriously enhance Europe's resilience to future supply chain disruptions**, in this case to shocks originating from China. This is not due to a lack of ambition in the infrastructure scenarios considered. Given the large number of developing economies among the Global Gateway countries, raising the average infrastructure quality to the level of emerging economies would represent a significant achievement. The question whether infrastructure funding is targeted more broadly or concentrated on the countries with the worst starting conditions also makes no significant difference.

Instead, the effects are curbed by two factors. **The first factor is the comparatively low initial level of trade between the EU and Global Gateway countries.** In sum, they accounted in recent years in all product groups for less than 20 % of EU imports as countries of origin, partly even for less than 10% (see Subsection 4.4.1). **The second factor are the strong trade relationships between the Global Gateway countries and China.** Unlike a decline in bilateral trade costs, e.g. through tariff reductions, infrastructure improvements tend to have a cost-reducing effect on trade with all partners. This means there are no systematic effects of trade diversion to be expected. EU investments in the infrastructure of Global Gateway countries thus run the risk of supporting progress in their trade integration with other third countries, above all with China. The fact that many Global Gateway countries already possess strong trade linkages with China reinforces this effect. As a result, Europe's indirect supply chain dependencies on China may even increase, as our results indicate.

At the same time, it must be emphasized that our simulations only constitute an analysis of isolated effects. The overall effects could be stronger if the infrastructure investments also strengthen other important factors influencing trade. **The first important channel is macroeconomic productivity effects**. It is an explicit goal of the EU not only to improve infrastructure as part of the Global Gateway Initiative, but also to support countries on their path to stable and sustainable economic growth in the long term (see Section 2). If it proves to be successful, this will also have additional positive effects on bilateral trade with the EU in the long term, as demonstrated by the significance of the economic mass variables in our estimations. The literature shows that this depends less on the total amount of funds invested and more on their targeted use (see Subsection 3.3). For the developing economies among the Global Gateway countries, it is especially crucial that infrastructure investments are fostering structural change. The aim must be to improve their prospects of participating in knowledge- and value added-intensive parts of global supply chains, also to avoid the risk of creating new resource traps. One way to achieve this is by focusing on specific infrastructure bottlenecks essential for strategic net-zero technologies (see Section 1), like pipelines for gaseous renewable energy carriers and transmission capacities of electricity networks. Another strategy is to focus on infrastructure components generally suited for promoting long-term value chain upgrading, i.e. extending participation in international supply chains to more value added-intensive products and production steps.[74] For instance, recent studies show that investments in the improvement of ICT infrastructure, in particular the expansion of internet broadband connections, can become a driver of economic modernization. In any case, investment programs must be tailored to the specific starting conditions in recipient countries and involve a high degree of coordination with and involvement of local stakeholders, to ensure their firm embeddedness in local development agendas (see Subsection 3.3).

The second important channel is trade policies. The reduction of tariffs and non-tariff trade barriers specifically strengthens trade between the global gateway countries and the EU. Unlike in the case of pure infrastructure upgrades, this can also help to reduce China's influence via trade-diverting effects. In our gravity estimations, the influence of the tariff rate variable is predominantly significant. However, the dummy indicating the existence of bilateral trade agreements is also highly significant throughout. This suggests that the dismantling of non-tariff barriers such as quotas and discriminatory product standards also plays an important trade-creating role within the framework of such agreements.

With the instrument of Economic Partnership Agreements (EPAs), the EU has long been pursuing a policy of asymmetrical trade integration with developing countries. The concept goes back to the Cotonou Partnership Agreement concluded in its original form in 2000 between the EU and a large number of states from the African, Caribbean and Pacific (ACP) region.[75] It enables the EU and individual ACP countries to negotiate development-oriented trade agreements. These involve a reciprocal but asymmetrical reduction of trade barriers over time, as well as increased development cooperation ("aid for trade") to facilitate market opening. ACP partners receive immediate free access to the EU market for their industrial products, while trade opening is only partial and gradual. The EU supports the ACP partners in the implementation of standards and customs procedures, among other things. According to the EU, such agreements are currently in force or provisionally applied with 32 ACP countries.[76] To flank private sector cooperation via Global Gateway projects, one of the EU's priorities should be to expand, deepen and consolidate such agreements. The emphasis should be placed on prospects for value chain upgrading of partner countries, for example by exchanging knowledge through increased R&D cooperation and working together on the further development of technical standards.

The third channel is intensified cooperation in the development of institutions, i.e. the intangible forms of infrastructure. Our gravity estimations reveal a consistently significant importance of both political-legal institutions and the effectiveness of customs authorities for the volume of trade. This not only has practical significance for the transaction costs and risks of economic exchange. It is also part of the global competition between political and social systems. It is Europe's historical mission to convey the importance of fundamental institutions such as the rule of law, freedom of expression and accountability as the foundation of entrepreneurial initiative and economic prosperity. At the same time, the burden of its colonial legacy puts it in a very difficult position. The impression of paternalism

74 Gereffi, G. (2019). Economic upgrading in global value chains. Handbook on global value chains, 240-254.
75 https://www.consilium.europa.eu/en/policies/cotonou-agreement/#cotonou
76 https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/negotiations-and-agreements_en

and tutelage must be avoided, especially towards developing countries. In the course of China's economic success, the autocratic temptation has also increased for comparatively liberal countries Against this background, attempts to transfer European political institutions directly to countries with completely different social and economic starting conditions are fruitless. Under the premises of a multipolar world, no non-European country will allow the EU to dictate the path of its own institutional development. **The only way forward is to build long-term partnerships on an equal footing, tailored to the development needs of the respective partner**. Practical help in removing specific institutional obstacles should take priority over grand promises and visions. Against this background, the EPAs with their focus on technical assistance are a very important tool for both EU trade and foreign policy.

Finally, **it is important to embed the Global Gateway Initiative in the context of multilateral cooperation**. With its global orientation, it not only touches on the spheres of influence of geopolitical rivals, but also on those of traditional and potential allies. An institutionalized coordination of the strategic orientation of Global Gateway beyond the EU makes sense. It can improve the cost-benefit balance of major infrastructure projects by promoting synergies and avoiding redundancies between Global Gateway and similar initiatives by friendly third countries.[77] It also avoids the emergence of diplomatic irritations. In the context of the recently reawakened initiatives for transatlantic cooperation (e.g. raw materials club[78], agreement on suspension of steel and aluminium tariffs[79]), this should above all include exchanges with the USA. Common interests should at least in this area be strong enough to be robust against changing political constellations on both sides of the Atlantic.

5 Case study: An EU-African hydrogen partnership

5.1 European needs

Renewable hydrogen i.e. hydrogen produced through electrolysis based on electricity from renewable sources, has gained increasing prominence in the energy and industrial policy debate, particularly due to its (almost) emission-free production and its flexibility in use. It is not only an energy source, but also an industrial feedstock, creating an opportunity to decarbonize particularly emission-intensive hard-to-abate sectors like steel and parts of the chemical industry.[80]

Current hydrogen production pathways are still far from being climate neutral. Around 96% of the hydrogen used in the EU in 2022 is "grey" hydrogen produced by steam reforming of natural gas, a process accompanied by considerable CO_2 emissions.[81] For this reason, already in 2020, the EU Hydrogen Strategy defined an ambitious roadmap for making the EU turn towards renewable hydrogen by 2050.[82] According to the Strategy, renewable electricity is projected to significantly reduce the carbon footprint of EU consumption, although it may not completely eliminate it.[83] Moreover, the EU's intention to boost the dissemination of green hydrogen was also made clear in the Hydrogen and

77 Küsters, A., Wolf, A., Poli, E. (2024). Challenges to transatlantic digital infrastructure: An EU perspective. IAI Papers. Istituto Affari Internazionali.

78 Bloomberg (2024). EU, US to align global minerals push against China's supply grip. February 9, 2024.

79 Reuters (2023). Biden extends EU steel, aluminum tariff exemption for 2 years. December 28, 2023.

80 Wolf, A. (2023a). Establishing hydrogen hubs in Europe. cepInput No.1/2023.

81 European Commission (2023). Energy, Climate Change, Environment - Hydrogen.

82 European Commission (2020). A hydrogen strategy for a climate-neutral Europe, COM/2020/301 final

83 Hassan, Q., Algburi, S., Sameen, A. Z., Salman, H. M., & Jaszczur, M. (2024). Green hydrogen: A pathway to a sustainable energy future. International Journal of Hydrogen Energy, 50, 310-333.

Decarbonized Gas Market package within the EU Fit-for-55, which aims at supporting the build-up of EU pipeline infrastructure and hydrogen markets.[84] Then, it was the publication of the REPowerEU Communication in May 2022 that strengthened the EU's ambitions regarding hydrogen development significantly.[85] In the aftermath of the Russian invasion of Ukraine, hydrogen did not only emerge as a crucial pathway for decarbonization but also as a geopolitical strategic alternative to supplies from Russia. According to REPowerEU, the EU could save 310 billion cubic meters of natural gas by 2030, of which 27 billion could be replaced by renewable hydrogen.[86] However, only half the hydrogen (10 million tonnes) is envisaged to come from EU-internal resources. The rest is supposed to be imported. Besides the fact that Europe possesses natural comparative disadvantages in renewable energy generation (limited potential of wind and sun), this is primarily motivated by the long-term space restrictions the continent is facing in capacity building.[87] Against this background, there are good reasons why Africa could become the centre of an import strategy (see below).[88]

Any import strategy must cope with the costs of setting up a transcontinental hydrogen transport infrastructure. Estimates indicate that the costs of producing renewable hydrogen domestically by 2030 could be between 335 and 417 billion euros, while the development of the supply chain beyond European borders could cost around 500 billion euros.[89] For this reason, the European Hydrogen Bank was established in March 2023 to support capacity investments, including a perspective for auction-based promotion of hydrogen imports. Yet, it is important to stress that so far it is uniquely promoting domestic production.[90] Moreover, the Commission is committed to advancing the development of three corridors for the transport of renewable hydrogen: one from the North Sea area, one with Ukraine, and one through the Mediterranean, with Italy acting as European strategic energy hub.[91] Hence, it is not by chance that Italy, which is holding the 2024 G7 Presidency, has made Africa the core of its own agenda, pushing for more investments in the continent in different areas, specifically in the energy sector. In particular, as foreseen in its national strategic plan, the so called "Piano Mattei", Italy aims at becoming the connector between northern European renewable hydrogen importers and northern African countries, which are set to play a pivotal role as suppliers of cost-competitive renewable hydrogen.[92]

5.2 African potential on green hydrogen

As EU Member States need to cut greenhouse emissions, the Global Gateway Africa – Europe Investment Package is set to turn African nations into potential partners to achieve a clean energy

[84] Ovaere, M., & Proost, S. (2022). Cost-effective reduction of fossil energy use in the European transport sector: An assessment of the Fit for 55 Package. Energy Policy, 168, 113085.

[85] European Commission (2022). REPowerEU: affordable, secure and sustainable energy for Europe. Communication COM(2022) 108 final.

[86] Tertre, G. M., & Saveyn, B. (2022). The Investment Needs for REPowerEU. F. Cerniglia and F. Saraceno eds, 129-144. Bonciu, F. (2022). The Implications of the REPowerEU Plan in Accelerating the Implementation of the European Union's Hydrogen Strategy. Romanian Journal of European Affairs, 22(2), 100-114.

[87] Dalla Longa, F., & van der Zwaan, B. (2024). Autarky penalty versus system cost effects for Europe of large-scale renewable energy imports from North Africa. Energy Strategy Reviews, 51, 101289.

[88] Chatzimarkakis, J. (2022) Africa-EU: A strategic partnership, Hydrogen Europe

[89] Cassa Depositi e Prestiti (2024). Decarbonizzare l'industria italiana: quale ruolo per l'idrogeno verde?

[90] European Commission (2023). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Hydrogen Bank. COM(2023) 156 final.

[91] Cassa Depositi e Prestiti (2024). Decarbonizzare l'industria italiana: quale ruolo per l'idrogeno verde?

[92] Governo Italiano (2024). Piano Mattei, Cinque Pilastri.

transition.[93] Within this framework, renewable hydrogen will play a pivotal role. The aim is to establish at least 40 Gigawatts of electrolyser capacity across the African continent by 2030. According to the International Energy Agency (IEA), the continent can produce up to 5 000 mega tonnes of hydrogen annually, which equals the current global annual energy supply.[94] Moreover, the proximity to Europe and the existence of a gas pipeline infrastructure between Northern Africa and Italy/Spain implies an advantage in terms of transport costs. Forecasts expect a further significant reduction of these costs over time through scaling and learning effects.[95] Against this background, Fraunhofer CENIS (2023)[96] identify a business case for hydrogen imports from the MENA region by 2030, provided that the bulk of transport volumes is handled by pipelines.

To date, however, limited and unreliable access to energy sources is negatively impacting human and economic development.[97] Still 46% of Africans do not have access to electricity in their homes.[98] At the same time, the number of African citizens, which is already close to a fifth of the world population, is expected to reach 2.1 billion by 2040, with more than half a billion living in cities. Due to the increasing population, rising living standards and new industrial needs, energy demand in African economies is expected to grow by 60% by 2030.[99] Over the coming decades, the energy potential of Africa will need to be fully deployed to address fundamental social challenges and fight against climate change.

Yet, the simple answer to energy shortage should not be to invest in a carbon-intensive path. The latter would be detrimental in terms of the high price Africa will have to pay to face the consequences of climate change, which is among the first causes of migration within and outside the continent.[100] Instead, as mentioned by the Agenda 2063: the Africa We Want[101], the development of sustainable energy sources should be preferred over traditional fossil fuels, for embracing a sustainable development path in the continent and attract new investments. In this way, the continent can engage in technological leapfrogging, skipping the stage of fossil-intensive growth and catching up in the global run for low-emission technologies.[102] Sustainable energy can benefit local economies, create new jobs, boost research and development while mitigating the devastating impact of climate change.

Certainly, to successfully realize such a strategy, there is a need to develop infrastructure and boost capacity building and institutional stability to incentivize private and public capacity investments. Indeed, the cost related to the implementation of renewable energy sources in Africa cannot be covered by local authorities and public sources in general. There is the need for international partners and private sector investments to tap into the inadequate energy infrastructure of the continent, which is

93 European Commission (2024). EU-Africa: Global Gateway Investment Package.
94 International Energy Agency (2022). Africa Energy Outlook 2022.
95 Roland Berger (2021). Hydrogen transportation – the key to unlocking the green hydrogen economy. Roland Berger Focus.
96 See Fraunhofer CINES (2023).
97 Iyke, B. N. (2024). Climate change, energy security risk, and clean energy investment. Energy Economics, 129.
98 United Nations Conference on Trade and Development (2023). Commodities at a glance: Special issue on access to energy in sub-Saharan Africa.
Irena, (2023). The Renewable Energy Transition in Africa: Powering Access, Resilience and Prosperity
99 International Energy Agency (2022). Africa Energy Outlook 2022.
100 Okoh, A. S., & Onuoha, M. C. (2024). Immediate and future challenges of using electric vehicles for promoting energy efficiency in Africa's clean energy transition. Global Environmental Change, 84, 102789. Marais, H. & Giliam, J., 2022. Building climate resilience: Opportunities and considerations for Africa in a net-zero future. Deloitte Africa, November 2022
101 African Union (2015). African Agenda 2063, pp 16.
102 Kneebone, J. (2022). Redrawing the EU's energy relations: Getting it right with African renewable hydrogen. Policy Paper, European University Institute.

causing high energy loss, representing a barrier to the upscaling of renewable variables. However, although Africa will need around 25 billion USD[103] annual investments to partially eradicate energy poverty, it has so far registered low investments in energy infrastructure. This has resulted in low maintenance and inefficient distribution as well as higher costs for supply. According to the IEA, between 2010 to 2020, Africa received only 3% of the global sum of energy investments, of which only 0.5% were spent on transmission and distribution networks.[104] This trend was worsened by the COVID-19 Pandemic, when national governments in Africa had to boost public spending on health and social needs. Hence, before talking about renewable energy transition and enabling technologies for renewable hydrogen, there is a need of investments in basic grid infrastructure, which is of fundamental importance for strengthening African power systems and reduce energy losses and outage risks.[105]

At the same time, investments in innovative technologies such as renewable hydrogen should follow a holistic approach to boost a just energy transition that can create economic opportunities along the value chain and contribute to a broad socio-economic development, while fostering decarbonisation. Certainly, funding is essential. Yet, energy strategies need to be tailored in a way that can favour capacity building as well as social equity to ensure no one is left behind. In other words, to reach their full potential and navigate out of the current global economic crisis, African countries must enable key institutional settings to allow investments in their market. This means for governments to put clean energy on top of their political agendas, developing sound financial institutions, and open their markets. Indeed, impactful economic actions can only grow when investors find adequate conditions to optimize their financial return. On the contrary, inadequate governance, lack of accountability and poor institutional settings decrease investors' confidence in financing projects in the continent.[106] In this respect, according to the model developed by the International Energy Agency, to implement a sustainable scenario the use of energy-efficient technology and renewables will need to be boosted across the continent, replacing traditional sources.[107] As highlighted by Deloitte, African energy demand is likely to increase by 75% by 2030. In this respect, 27% of power will need to be generated by the sun and the wind, with the need for an increase in investments into low carbon sources by 40% compared to the current situation.[108]To achieve the above scenario, pushing forwards the development of the clean energy sector and related infrastructure, there is however the need for African governments to build an enabling environment for investments, including efficient institutions and transparent governance.

5.3 Policy strategies and project plans

Considering that the majority of African countries are still basing their energy generation on oil and natural gas, which accounts for almost 95% of electricity generation, an effective green transition will require huge private and public investments as well as political support.[109] When it comes to policy strategy, the Africa-Europe Green Energy Initiative is one of the most important components of the Global Gateway. This initiative aims to engage both the European and African public and private

[103] International Energy Agency (2022). Africa Energy Outlook 2022.
[104] Deloitte (2023). Africa's energy outlook Renewables as the pathway to energy prosperity.
IEA (2023). Doubling energy investment in Africa requires urgent action to bring down financing costs and boost access to capital.
[105] International Energy Agency (2023). The Renewable Energy Transition in Africa: Powering Access, Resilience and Prosperity
[106] UNCTAD (2023). World Investment Report 2023.
[107] International Energy Agency (2022). Africa Energy Outlook 2022
[108] Deloitte (2023). Africa energy outlook 2023.
[109] IEA (2022). Africa Energy Outlook 2022.

sectors. Specifically, on the EU side, the Initiative involves member states, European financial and development institutions, such as the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD). The goal is to promote electricity production and general access to energy, by supporting the deployment of adequate reforms to stimulate a regulatory environment conducive to investors, while fostering market integration.

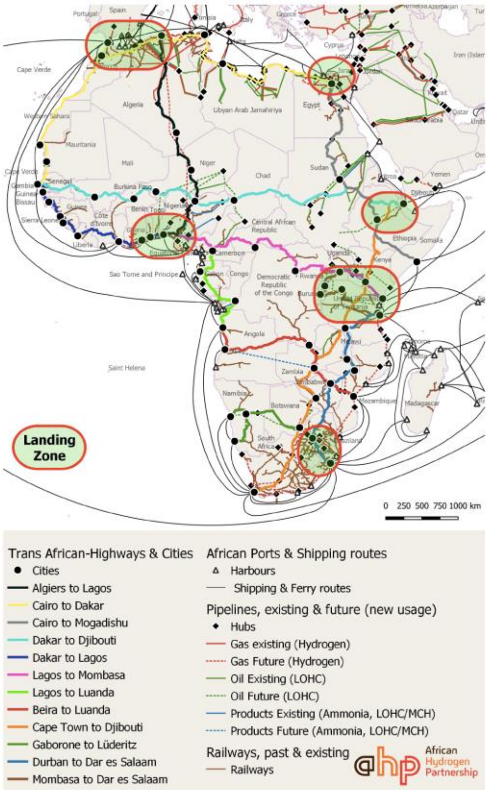
Whitin its ambitious series of projects, the Africa-Europe Green Energy Initiative aims also at promoting a renewable hydrogen economy. For instance, in 2023 it launched a call for proposals worth up to 100 million euros for hydrogen power plants in Morocco and it is also supporting the development of a Power-to-X (P2X) hydrogen power reference plant through a public-private partnership, with significant involvement from Germany to attract private investment.[110] Moreover, the EU has signed a memorandum of understanding with a number of African countries to support their green energy conversion. For instance, within the Brussels-Windhoek partnership, the first-ever EU-Namibia business forum took place in Brussels on 24-25 October 2023 to promote investment opportunities especially in the areas of renewable hydrogen and sustainable raw materials. The EU allocated 37 million euros in grant on a partnership with Namibia, which also benefits from a number of multi-country programmes.[111] In particular, Germany and the United Kingdom are already present in Namibia with the HYPHEN Hydrogen Energy project on green hydrogen, which is worth 8.3 million euros for an annual production of 300 thousand tons of hydrogen.[112] Germany has also developed a partnership with South Africa, providing 15 million euros for the HySHiFT renewable hydrogen project for the production of synthetic aviation fuel, involving German and South African companies.[113] Similarly, the Global Gateway is promoting a series of green initiatives in Kenya. In particular, the European Commission has recently launched in cooperation with the Kenyan government the Green Hydrogen Strategy and Roadmap for Kenya, which defines a roadmap for allowing the country to develop a renewable hydrogen industry by 2032, while tackling important component of the domestic market development, job creation and direct investments. In terms of funding, the EU is committed to grant around 12 million euros to leverage public and private investments in the Kenyan renewable hydrogen industry.[114]

At the same time, there is also an interesting mobilization of private initiatives. Most notably, in the aftermath of the COP28 in Dubai, Hydrogen Europe, which is a Global Gateway member, the MENA Hydrogen Alliance, and the African Hydrogen Partnership strengthened their cooperation on clean hydrogen in order to triple renewable energy capacity by 2030 and double energy efficiency for boosting green hydrogen. Their aim is also to facilitate new investments. In fact, although global financing of energy transition technologies reached 1.3 trillion USD in 2022, there is a need to increase investments by four times to boost the development of infrastructure in the Middle East and Africa to allow trading of hydrogen across borders. One way is the repurposing of the existing gas pipelines connecting MENA countries, namely Morocco and Tunisia, Libya, Algeria, Egypt, and Saudi Arabia to Europe.[115] This is a primary project involving Italy, thanks to its central position in the Mediterranean Sea. While Italian companies' investments in green energy projects seem to be limited, the Italian Piano Mattei on

[110] European Commission (2024). Africa-Europe Green Energy.
[111] European Commission (2024). EU-Namibia Partnership.
[112] Energy Capital &Power (2023). Top Green Hydrogen Projects in Africa in 2023.
[113] GBA (2022). Germany provides 15 million for Hyshift green hydrogen project in South Africa
[114] European Commission Press Corner (2023) Green Hydrogen Strategy and Roadmap for Kenya
[115] Hydrogen Europe (2023). Hydrogen Europe, MENA Hydrogen Alliance, and African Hydrogen Partnership strengthen international H2 cooperation

energy involves the reconversion of existing pipelines to allow Rome exporting hydrogen from Africa to northern European countries. In particular, Italy is counting on the SoutH2Corridor, a European 3,300 km hydrogen pipeline, which aims to provide the EU with 20% of the hydrogen needs by 2030, connecting Africa to Europe and using 70% of repurposed gas pipelines.[116] Yet, considering the calculated growing needs for hydrogen in the next 30 years, new pipelines connecting MENA to Europe will need to be built. An idea, quoted by Braun et al. (2023), is to develop the 'EastMed' pipeline", connecting Cyprus and Greece to the rest the EU via Italy. This pipeline could be linked to Saudi Arabia, Egypt and even Israel, yet it would require solving a series of high-level political issues between Turkey and Cyprus as well as between Saudi Arabia and Israel.[117]

Figure 10: Planned African hydrogen corridors



Source: African Hydrogen Partnership.

5.4 Overall assessment

According to the IEA, the energy transition towards a green way of production and consumption has increased across the globe. This, however, does not mean that all countries are walking the same path at the same speed. To be realistic, the global consumption of carbon-based fuels will reach its peak by 2030 but then it should be set to decline thanks to new incoming fossil-free technologies financed by increased governments' support and private investments.[118] A decline in the costs of renewable energy technologies achieved by exploiting scale economies, will result in a new impetus of investments,

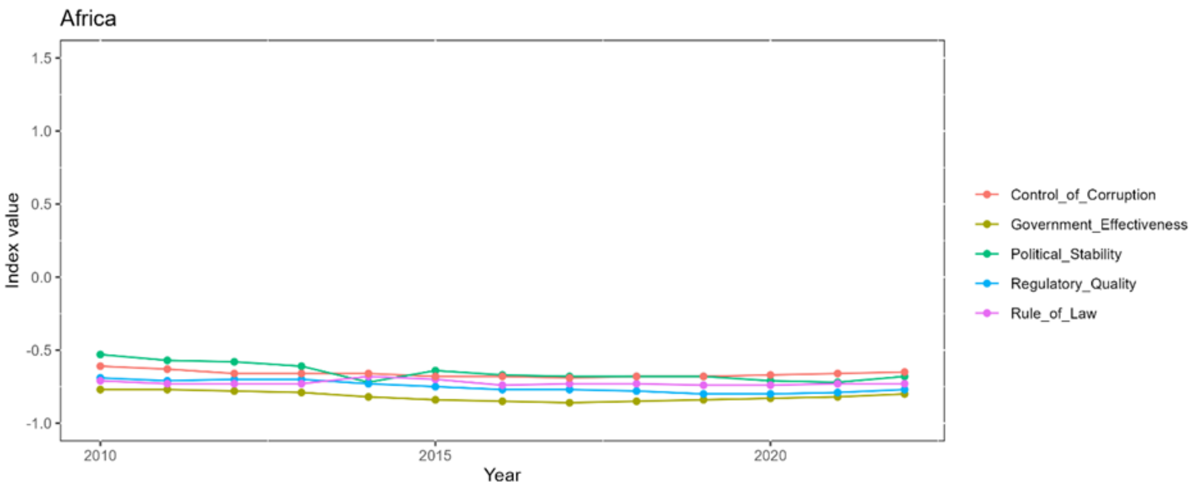
[116] For more information of the South2Corridor initiative please see: South2Corridor

[117] Braun J.F. et all, (2023). Clean Hydrogen Deployment in the Europe-MENA Region from 2030 to 2050. A Technical and Socio-Economic Assessment, Fraunhofer Cines.

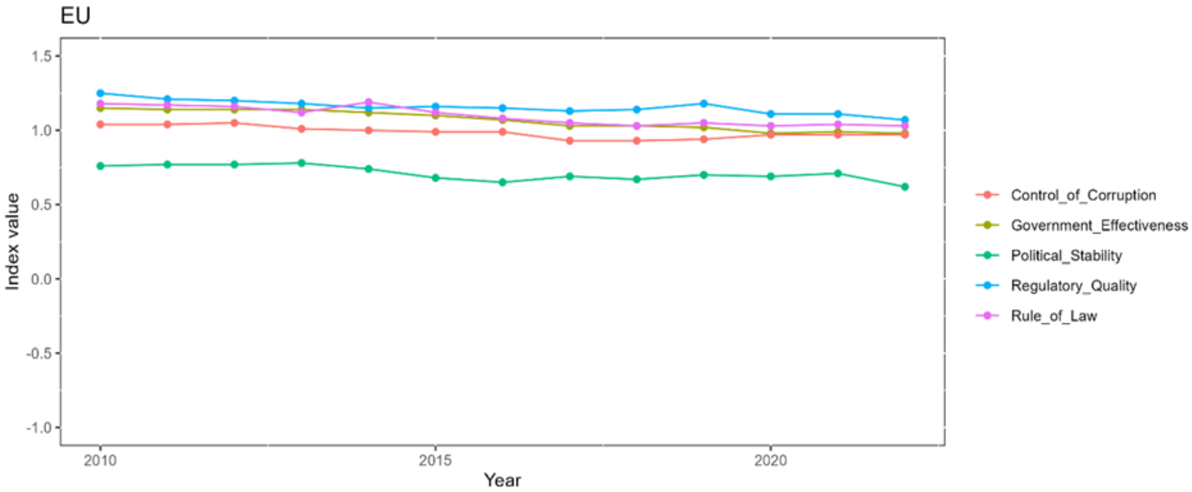
[118] IEA (2023). World Energy Outlook 2023

especially in Africa. However, beyond investments and economic return, there is, first of all, the need to reach political stability in countries that are going to become green energy partners.[119] This task, however, seem to be the most challenging. Throughout history, African governments have faced difficulties in implementing long-term visions or plans, establishing policy certainty and clarity, and sufficiently investing in a broader enabling environment to stimulate private sector activity. This is one of the main reasons undermining the incentives and effectiveness of many impact investments from private capital. Therefore, it is crucial for African governments to adopt appropriate policies, not only to encourage investment for economic growth but also to ensure access to clean and reliable energy sources for the millions of people who presently depend on traditional biomass fuels or coal for cooking and heating. Yet, the need for political stability is equally relevant in the EU. The European Parliamentary elections involve the danger that extreme right-wing parties might win a number of seats and undermine the focus devolved by the EU institutions to green energy. At the same time, beyond stability, there is the need for government effectiveness, with good quality public services and civil service and a high degree of independence from political pressure. According to the World Bank Index when it comes to governance capacity and more specifically to political stability, government effectiveness, regulatory quality, rule of law and control of corruption, EU governments scored on average much higher than African governments. Still, as highlighted in the table below, in the last ten years the results have shown a slight downward trend.

Figure 11: World Bank Governance Index (country averages in Africa and the EU)



[119] Gottfried, S., Sabhat, C. A., Poli, E., Raveh, A., Zatcovetzky, I., & Yirga, N. (2022). From Geo/Bio-Politics to G2G Agreements and Public–Private Partnership: the Unique Role of the Israeli Eco-System in Ethiopia.



Source: World Bank (2023b).

Although Africa has registered significant progress in terms of regulatory frameworks for boosting investments, there is still ample room for improvement when it comes to rule of law, effective regulations and stable institutions. As highlighted in the figure above, although in recent years Africa countries on average have been achieving better governance performance, there is still the need to significantly improve the general performance. Moreover, several African countries still do not have any specific policies in place for renewable resources, let alone for renewable hydrogen. This bears the risk of losing an important opportunity to modernise their country and obtain access to cheaper and cleaner energy in the long run. Hence, to significantly boost investments, which can hardly be covered by national funds, adequate regulatory frameworks are needed, with the adoption of policies at the local level that target energy access, emission reductions, climate change mitigation, and adaptation goals.[120] In conclusion, while the EU Global Gateway offers the potential of exploiting largely untapped opportunities for developing green energy capacities and pushing energy transition, which can benefit both the European Union and the African continent by creating positive economic and social spillovers, there is also a need for concrete institutional enablers. In this respect, the role of multilateral development banks and institutions, such as the African Development Bank but also impact investments funds, such as the Africa Impact Fund and philanthropic organisations (e.g. Bil & Melinda Gates Foundations) are central in catalysing and scaling up the impact of investments in renewable hydrogen. At the same time, the use of tax incentives by national governments, the implementation of legislations that create recognized labels for investors and promote financial inclusion as well as a safe investing environment are fundamental. To sum up, to improve the long-term African and European energy outlook, there is a need for African countries to promote a set of sound institutions and regulations to facilitate investments opportunities.

6 Conclusion

The Global Gateway Initiative is in scale and scope the so far most ambitious endeavor of the EU in the field of external infrastructure cooperation. Despite the impressive figures circulating, the empirical results of our study point to a fundamental insight: the expected success can hardly be measured in terms of the total amount of euros invested. In a long-term perspective, the Global Gateway can only be considered a success if it becomes a building block of the overarching strategy of the EU Green Deal

[120] Deloitte, (2023). Africa's energy outlook Renewables as the pathway to energy prosperity.

and the associated industrial transformation. To this end, the planned investment projects must not only serve to strengthen diplomatic ties with the partner countries, but also make a practical contribution to the spatial diversification of future important supply chains, especially for net-zero technologies.

In this respect, our product-specific analysis of trade determinants dampens short-term expectations. For the infrastructure components analyzed (transport, ICT, political-legal institutions, administrative efficiency), a significant positive effect of infrastructure quality on the export performance of trading partners was detected almost across the board. However, even when assuming an ambitious infrastructure upgrade, isolated trade effects are too small to noticeably increase the geographical diversification of EU imports. Moreover, a general decrease of trade costs in partner countries is also likely to strengthen their trade with China, which could even raise indirect EU dependencies in global supply chains. To mitigate Europe's vulnerability to external supply shocks in the field of critical industrial products like semiconductors and batteries, efforts within the Global Gateway must therefore not be limited to reducing trade costs for existing supply routes.

Instead, the Global Gateway must be turned into an engine for sustainable economic growth in partner countries. Setting a focus on infrastructure essential for the green transformation (e.g. pipelines for renewables gases, electricity grids) or for the structural modernization of the economy (in particular ICT networks) are suitable strategies. This serves not only to strengthen the general export potential of the partner countries, but also their economic ties to the EU through participation in common specialized supply chains. Such an infrastructure strategy should be accompanied by increased cooperation at other levels. This primarily concerns the reduction of regulatory (tariff and non-tariff) trade barriers and cooperation in strengthening local institutions. Our case study of an EU-Africa hydrogen partnership points to the great importance of institutional upgrading as a precondition for the establishment of stable supply chains. However, this can only happen in an open dialogue with the partner countries.

In general, the Global Gateway should be integrated into an overarching EU resilience strategy, featuring strategic trade partnerships with complementary partners as central tools. These partnerships need to be shaped on an equal footing, in view of opposing development models practiced by geopolitical rivals such as China. In the evolving multipolar world, the EU can only become an attractive partner for low- and middle-income countries if supply chain integration is compatible with the countries' macroeconomic development targets. Infrastructure projects and accompanying steps towards trade facilitation must be aligned with the goal of medium-term value chain upgrading as a guiding principle. The willingness for continuous technological and regulatory knowledge exchange with partner countries, e.g. through joint work on technical standards and local sourcing of production inputs, is a necessary requirement on the European side. In its current ambitions to strengthen partnerships with regions like Africa, the EU is well advised to formulate an attractive growth offer in line with these principles.

7 Appendix

Table A 1: Results of Principal Component Analyses

Index: Transport					
			Eigenvectors		
Variables	*Vector 1*	*Vector 2*	*Vector 3*	*Vector 4*	*Vector 5*
quality of trade infrastructure	0.470	-0.174	0.279	-0.215	-0.791
access to electricity	0.466	-0.211	0.127	0.838	0.141
road quality	0.467	-0.189	0.416	-0.470	0.593
road network density	0.361	0.932	0.031	0.027	0.013
share of paved roads	0.462	-0.146	-0.856	-0.173	0.052
			Contributions		
Eigenvalue	2.100	0.701	0.255	0.158	0.099
proportion of variance	0.882	0.098	0.013	0.005	0.002
cumulative proportion	0.882	0.980	0.993	0.998	1.000
Index: ICT					
			Eigenvectors		
Variables	*Vector 1*	*Vector 2*	*Vector 3*	*Vector 4*	*Vector 5*
broadband subscriptions	0.484	-0.060	0.315	0.650	-0.490
telephone subscriptions	0.465	-0.214	0.623	-0.580	0.117
internet users	0.486	-0.139	-0.254	0.321	0.760
mobile subscriptions	0.465	-0.210	-0.669	-0.351	-0.411
secure internet servers	0.312	0.942	-0.026	-0.121	0.016
			Contributions		
Eigenvalue	2.016	0.825	0.430	0.225	0.132
proportion of variance	0.813	0.136	0.037	0.010	0.003
cumulative proportion	0.813	0.949	0.986	0.997	1.000
Index: Political-legal institutions					
			Eigenvectors		
Variables	*Vector 1*	*Vector 2*	*Vector 3*	*Vector 4*	*Vector 5*
control of corruption	0.453	-0.202	-0.732	0.313	-0.346
government effectiveness	0.460	-0.189	0.151	-0.791	-0.322
political stability	0.404	0.912	0.035	0.041	-0.041
regulatory quality	0.453	-0.257	0.655	0.520	-0.172
rule of law	0.463	-0.159	-0.105	-0.064	0.864
			Contributions		
Eigenvalue	2.133	0.554	0.292	0.182	0.153
proportion of variance	0.910	0.061	0.017	0.007	0.005
cumulative proportion	0.910	0.972	0.989	0.995	1.000

Index: Administrative burden - trade				
			Eigenvectors	
Variables	*Vector 1*	*Vector 2*	*Vector 3*	*Vector 4*
time to export: border compliance	0.503	-0.462	0.484	0.547
time to export: documentary compliance	0.505	0.424	0.506	-0.555
time to import: border compliance	0.497	-0.531	-0.530	-0.436
time to import: documentary compliance	0.494	0.570	-0.478	0.449
			Contributions	
Eigenvalue	1.809	0.620	0.461	0.364
proportion of variance	0.818	0.096	0.053	0.033
cumulative proportion	0.818	0.914	0.967	1.000

Index: Administrative burden - business formation			
			Eigenvectors
Variables	*Vector 1*	*Vector 2*	*Vector 3*
business formation: costs	0.537	0.823	-0.186
business formation: procedures	0.584	-0.522	-0.622
business formation: time	0.609	-0.225	0.761
			Contributions
Eigenvalue	1.509	0.704	0.476
proportion of variance	0.759	0.165	0.075
cumulative proportion	0.759	0.925	1

Source: own calculations

Table A 2: Estimation results gravity model

	Dependent variables							
	Ln(trade_base materials)				Ln(trade_mechanical machinery)			
	Selection		*Outcome*		*Selection*		*Outcome*	
	Estimate	*t-value*	*Estimate*	*t-value*	*Estimate*	*t-value*	*Estimate*	*t-value*
Regressors								
Intercept	-17.845	-39.283***	-36.027	-47.214***	-17.494	-29.609***	-42.256	-82.056***
Ln(mass_x)	0.199	9.456***	0.474	13.386***	0.320	11.702***	1.009	39.767***
Ln(mass_m)	0.503	40.708***	1.287	66.437***	0.400	26.038***	1.062	87.586***
Ln(pop_x)	0.380	14.536***	0.779	18.166***	0.185	5.746***	0.503	16.590***
Ln(pop_m)	-0.052	-3.670***	-0.020	-0.926	0.026	1.431	0.098	6.337***
Ln(area_x)	0.047	4.119***	0.190	11.012***	0.023	1.568	0.027	2.226*
Ln(area_m)	-0.051	-5.963***	-0.038	-3.039**	-0.024	-2.228*	-0.016	-1.709
Ln(distance)	-0.512	-23.583***	-1.431	-50.460***	-0.309	-11.371***	-0.909	-45.667***
Border	3.014	0.091	1.096	5.756***	3.026	0.057	1.543	10.545***
Common language	0.187	3.229**	0.492	5.532***	0.421	5.116***	0.537	8.412***
Former colony	0.407	2.735**	1.428	11.366***	0.866	2.557*	0.917	9.677***
Ln(1+tariff rate)	-1.257	-4.171***	-3.932	-8.148***	-1.189	-3.327***	-0.134	-0.382
RTA	0.129	5.096***	0.612	15.613***	0.106	3.249**	0.281	9.797***
Ln(index_transport)	0.592	8.004***	1.864	14.892***	0.750	8.301***	1.448	16.022***
Ln(index_ict)	0.378	7.089***	1.395	15.623***	0.261	3.989***	0.788	12.325***
Ln(index_pol_legal)	0.985	11.786***	1.302	9.928***	0.869	8.697***	2.640	28.121***
Ln(index_trade_ad_burd)	-0.100	-14.328***	-0.171	-17.487***	-0.032	-3.313***	-0.187	-27.177***
Ln(index_entry)	-0.089	-2.879**	-	-	-0.073	-1.862	-	-
Period: 2016	0.005	0.144	-0.101	-1.824	-0.015	-0.337	-0.065	-1.622
Period: 2017	-0.075	-2.055*	-0.221	-3.945***	-0.076	-1.654	-0.117	-2.884**
Period 2018	-0.061	-1.656	-0.108	-1.920	-0.060	-1.287	-0.142	-3.469***
Period 2019	0.005	0.126	-0.213	-3.804***	0.004	0.077	-0.164	-4.006***
Inverse mills ratio	-	-	0.753	7.064***	-	-	0.937	8.586***
Adj. R^2	0.586				0.737			
No. observations	25,626				25,626			

	Dependent variables							
	Ln(trade_electric equipment)				Ln(trade_vehicles)			
	Selection		*Outcome*		*Selection*		*Outcome*	
	Estimate	*t-value*	*Estimate*	*t-value*	*Estimate*	*t-value*	*Estimate*	*t-value*
Regressors								
Intercept	-14.837	-26.053***	-41.924	-69.325***	-15.864	-39.246***	-46.617	-55.830***
Ln(mass_x)	0.279	10.445***	0.908	30.998***	0.303	15.208***	1.196	30.799***
Ln(mass_m)	0.363	24.128***	1.132	76.132***	0.409	38.117***	1.246	63.391***
Ln(pop_x)	0.194	5.936***	0.622	17.821***	0.359	14.737***	0.789	17.152***
Ln(pop_m)	0.024	1.321	0.113	6.194***	-0.024	-1.791	-0.053	-2.282*
Ln(area_x)	0.018	1.211	-0.010	-0.670	-0.051	-4.709***	-0.033	-1.770
Ln(area_m)	-0.025	-2.392*	-0.065	-6.129***	-0.019	-2.438*	-0.014	-1.018
Ln(distance)	-0.280	-10.497***	-1.004	-42.900***	-0.512	-26.575***	-1.430	-44.566***
Border	3.184	0.060	1.454	8.460***	3.461	0.105	0.783	3.726***
Common language	0.057	0.787	0.102	1.366	0.328	5.799***	0.780	8.160***
Former colony	1.133	3.054**	1.402	12.590***	0.694	4.635***	1.126	8.171***
Ln(1+tariff rate)	-1.711	-5.171***	-2.879	-7.356***	-0.809	-3.519***	-2.657	-6.521***
RTA	0.115	3.543***	0.331	9.864***	0.009	0.395	0.196	4.534***
Ln(index_transport)	0.228	2.463*	1.424	13.899***	-0.132	-1.917	-0.030	-0.227
Ln(index_ict)	0.114	1.731	0.838	11.282***	0.333	6.699***	1.237	12.750***
Ln(index_pol_legal)	1.157	11.263***	2.745	25.184***	1.207	15.560***	2.815	19.537***
Ln(index_trade_ad_burd)	-0.010	-1.129	-0.141	-17.436***	-0.065	-10.162***	-0.280	-26.869***
Ln(index_entry)	-0.126	-3.212**	-	-	-0.204	-7.110***	-	-
Period: 2016	0.051	1.143	-0.081	-1.726	0.013	0.393	-0.092	-1.529
Period: 2017	-0.043	-0.963	-0.118	-2.496*	-0.045	-1.336	-0.177	-2.910**
Period 2018	0.012	0.262	-0.152	-3.206**	-0.129	-3.770***	-0.296	-4.845***
Period 2019	0.102	2.126*	-0.144	-3.022**	-0.002	-0.050	-0.210	-3.457***
Inverse mills ratio	-	-	1.734	11.830***	-	-	2.680	25.310***
Adj. R^2	0.673				0.591			
No. observations	25,626				25,626			

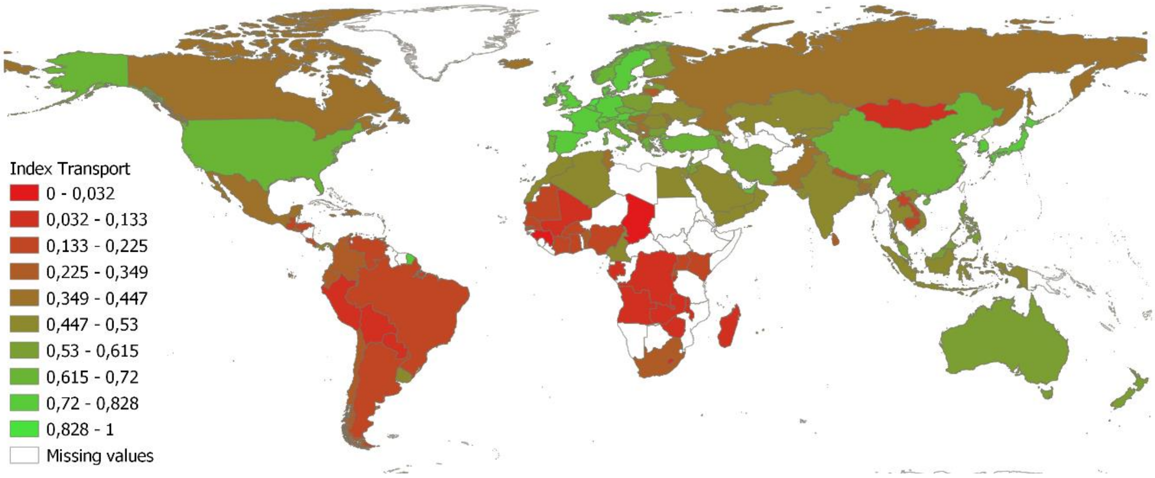
Source: own calculations. Significance codes: 0.001 '***' 0.01 '**' 0.05 '*'.

Table A 3: Estimation results gravity model – alternative lag specifications

	Dependent variables							
	Ln(trade_base materials)				**Ln(trade_mechanical machinery)**			
	Specification 1		*Specification 2*		*Specification 1*		*Specification 2*	
	Estimate	*t-value*	*Estimate*	*t-value*	*Estimate*	*t-value*	*Estimate*	*t-value*
Ln(index_transport)_lag	1.970	14.096***			1.498	14.885***		
Ln(index_ict)_lag	1.446	14.690***			0.801	11.310***		
Ln(index_pol_legal)_lag	1.125	7.706***			2.448	23.398***		
Ln(index_trade_ad_burd)_lag	-0.156	-14.363***			-0.180	-23.585***		
Ln(index_transport)_lag2			2.022	12.463***			1.535	12.922***
Ln(index_ict)_lag2			1.367	12.193***			0.761	9.391***
Ln(index_pol_legal)_lag2			0.817	4.909***			2.331	19.480***
Ln(index_trade_ad_burd)_lag2			-0.137	-10.767***			-0.173	-19.561***
Adj. R^2	0.589		0.591		0.736		0.734	
No. observations	19,699		14,381		19,699		14,381	
	Ln(trade_electric equipment)				**Ln(trade_vehicles)**			
	Specification 1		*Specification 2*		*Specification 1*		*Specification 2*	
	Estimate	*t-value*	*Estimate*	*t-value*	*Estimate*	*t-value*	*Estimate*	*t-value*
Ln(index_transport)_lag	1.450	12.451***			0.050	0.339		
Ln(index_ict)_lag	0.836	10.012***			1.028	9.560***		
Ln(index_pol_legal)_lag	2.479	19.867***			2.622	16.350***		
Ln(index_trade_ad_burd)_lag	-0.144	-15.716***			-0.275	-23.850***		
Ln(index_transport)_lag2			1.501	11.119***			0.125	0.722
Ln(index_ict)_lag2			0.728	7.647***			0.885	7.186***
Ln(index_pol_legal)_lag2			2.117	14.915***			2.315	12.688***
Ln(index_trade_ad_burd)_lag2			-0.140	-13.287***			-0.272	-20.339***
Adj. R^2	0.666		0.665		0.593		0.594	
No. observations	19,699		14,381		19,699		14,381	

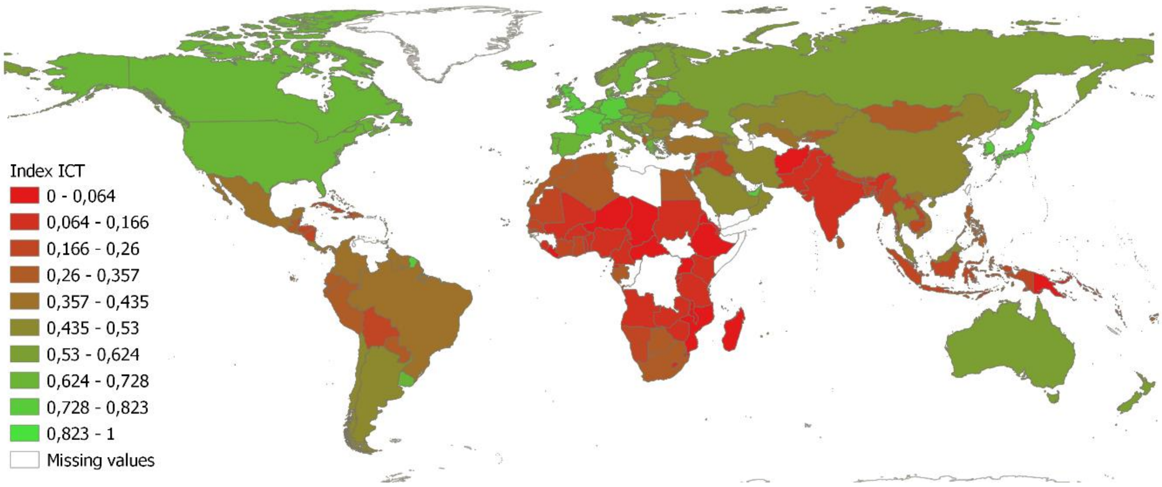
Source: own calculations. Results for control variables not depicted. Significance codes: 0.001 '***' 0.01 '**' 0.05 '*'

Figure A 1: Results index Transport



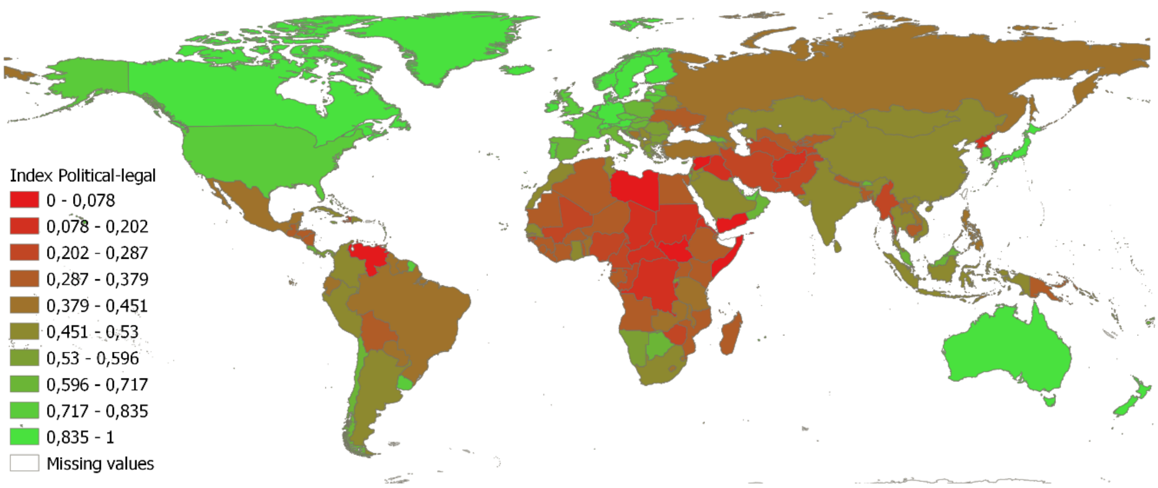
Source: own representation. Scaled from 0 (worst) to 1 (best). Results for year 2019.

Figure A 2: Results index ICT



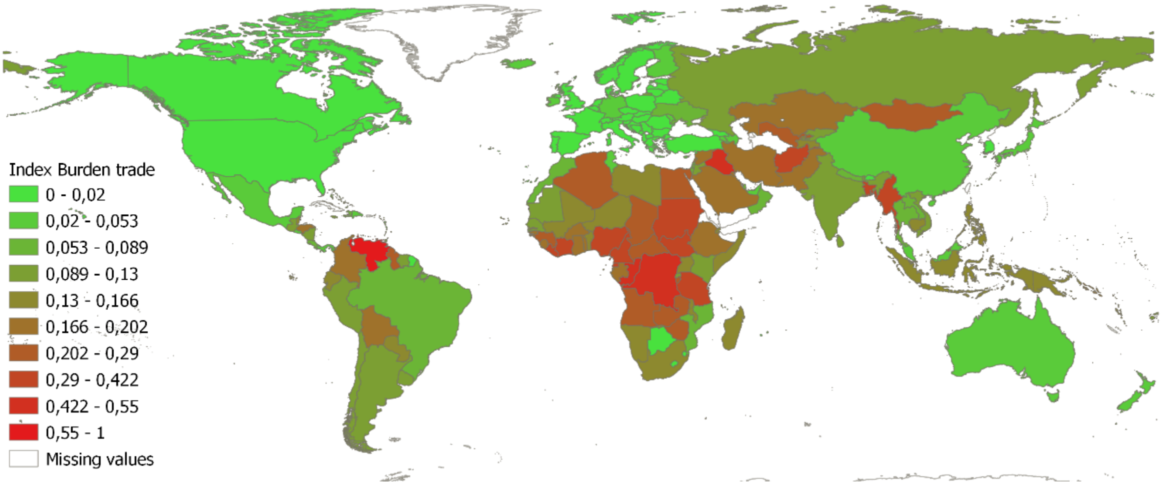
Source: own representation. Scaled from 0 (worst) to 1 (best). Results for year 2019.

Figure A 3: Results index Political-legal institutions



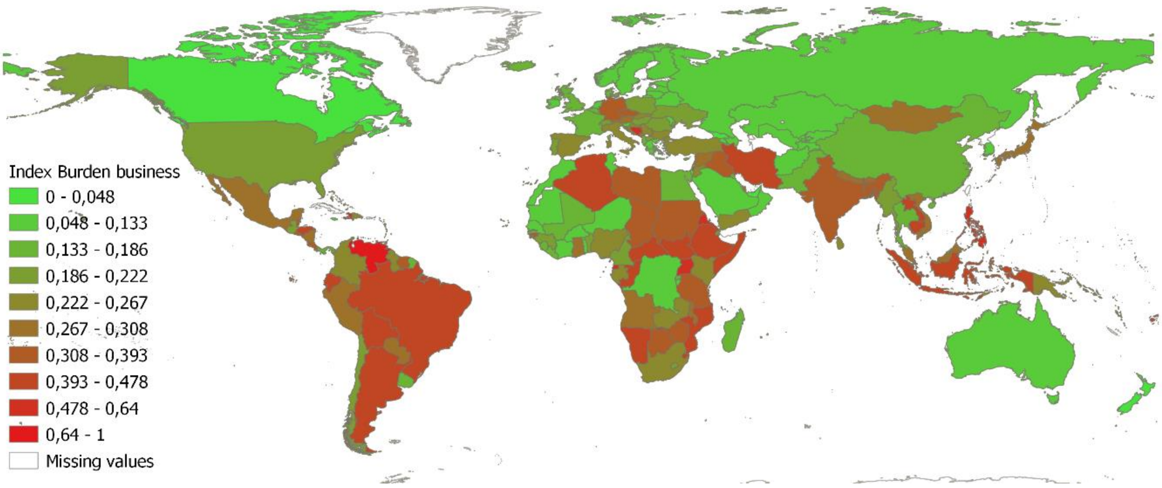
Source: own representation. Scaled from 0 (worst) to 1 (best). Results for year 2019.

Figure A 4: Results index Administrative burden - trade



Source: own representation. Scaled from 0 (best) to 1 (worst). Results for year 2019.

Figure A 5: Results index Administrative burden – business formation



Source: own representation. Scaled from 0 (best) to 1 (worst). Results for year 2019.

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