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WEI LINHAI

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DISSERTATION

ENVIRONMENTAL SUSTAINABILITY OF PRC INTERNATIONAL TRADE

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The dissertation contains the results of my own research. The use of ideas, results, and texts of other authors are linked to the corresponding source.

Wei LINHAI

魏林渤

Research supervisor: Roman Zvarych, Doctor of Economics, Professor

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АНОТАЦІЯ

Вей ЛІНЬХАЙ. **Екологічна сталість міжнародної торгівлі КНР**. – Кваліфікаційна наукова праця на правах рукопису.

Дисертація на здобуття ступеня доктора філософії за спеціальністю 292 «Міжнародні економічні відносини». – Західноукраїнський національний університет, Тернопіль, 2024.

У дисертації запропоновано нове вирішення важливого науково-прикладного завдання – розвиток теоретичних засад екологічної стійкості міжнародної торгівлі та формуванні на цій основі перспектив екологічної стійкості прикладної моделі Китаю.

В кваліфікаційній роботі досліджено генезис теорій міжнародної торгівлі, зокрема запропоновано вдосконалену класифікацію теорій міжнародної торгівлі. Доведено, що екологізація торговельних відносин відіграє вирішальну роль у стимулюванні економічних перетворень у країні, а незбалансована торгівля зберігає диспропорції між націями та становить загрозу довгостроковій стійкості економічної системи. Наголошено, що уніфікованість уподобань між націями в поєднанні з різною забезпеченістю факторами виробництва та товарною інтенсивністю відіграли вирішальну роль у визначенні цін на товари. В результаті, зауважено, що капітал, який вважається дефіцитним фактором виробництва, отримає більше переваг від протекціоністських заходів ніж від вільної торгівлі. Констатовано, що в екологічному контексті результати торгівлі можуть бути як сприятливими, так і шкідливими. Акцентовано, що закріплення країни в секторі природних ресурсів із постійною віддачою на масштабі обмежує можливості для диверсифікації економіки через дефіцит ресурсів.

В досліджені адаптовано модель конкурентних переваг Портера до екологічного розвитку держави. Підтверджено, що конкурентоспроможність нації в певній галузі залежить від здатності галузі до інновацій та вдосконалення, а ключову роль відіграють ресурси і можливості місцевого ринку та умови попиту до яких адаптовуються постачальники і виробники. В кваліфікаційній роботі запропоновано наукові підходи щодо оцінки екологічного впливу на

торговельну політику, зокрема на частці продукту та частці ринку в загальному експорті, індексі порівняльних переваг, диверсифікації експорту та експортної спеціалізації.

В дисертації запропоновано концепцію екологічної стійкості в системі міжнародних економічних відносин, що включає аналіз на відміну від теорій, що розглядають економічну систему як закриту та лінійну систему, вплив навколишнього середовища.

В кваліфікаційній роботі обґрунтовано переваги моделі матеріального балансу економічно відкритої циркулярної підсистеми. Констатовано, що політику прийняття рішення згідно моделі аналізу витрат і вигод, яку використовують для розподілу ресурсів через її соціальну ефективність, потрібно корегувати на вигоди та витрати необхідні для збереження навколишнього середовища, що може слугувати базою для схвалення лише тих інвестиційних проєктів в яких загальна поточна вартість неекологічних вигод, неекологічних витрат та чистої вартості екологічних змін є додатною.

В роботі проаналізовано розвиток різних типів стійкості економіки в умовах взаємозаміщення природнього і промислового капіталу. Зауважено, що досягнення сталого розвитку потребує взаємозв'язку природного капіталу, промислового капіталу, людського капіталу та соціального капіталу протягом певного періоду часу. Доведено, що процес розвитку має бути зосереджений не лише на збільшенні загального капіталу, а й на пріоритетності раціональної структури капіталу, уникаючи перетину екологічних порогів, а економічний прогрес, при цьому, не повинен виходити за рамки, накладені природою.

В кваліфікаційній роботі запропоновано уточнення процесу декаплінгу та впливу на використання і споживання природних ресурсів на міжнародну торгівлю. В дослідженні «декаплінг» розглядається через практику використання меншої кількості ресурсів на одиницю економічної продукції та мінімізацію екологічних наслідків, пов'язаних із використанням ресурсів та економічною діяльністю. Зауважено, що досягнення декаплінгу вимагатиме суттєвих змін державної політики, корпоративної поведінки та громадського споживання.

Аргументовано, що зменшення впливу на навколишнє середовище не завжди вирішує дефіцит ресурсів або виробничі витрати, в деяких випадках він може посилити ці проблеми.

Удосконалено класифікацію природних ресурсів з врахуванням їхніх унікальних властивостей і характеристик, включенням відновлюваних та невідновлюваних ресурсів, земельних, мінеральних, біологічних та атмосферних ресурсів.

Доведено, що структура міжнародної торгівлі Китаю зазнала значних трансформацій, особливо під впливом явища міжнародної фрагментації виробництва і ця тенденція передбачає спеціалізацію на окремих стадіях виробництва в багатьох країнах.

Проаналізовано використання та споживання природних ресурсів, доведено необхідність спільних зусиль міжнародної спільноти для напрацювання спільної політики. Зауважено, на важливості врахування сталості та екологічного впливу експлуатації ресурсу.

Аргументовано, що для досягнення сталості міжнародної торгівлі Китаю важливо впроваджувати ефективні стратегії управління та захисту ресурсів, такі як просування циркулярної економіки, підтримка збереження ресурсів і посилення нагляду за навколишнім середовищем.

В роботі виокремлено тенденції розвитку та перебудови міжнародної торгівлі, зокрема зазначено оцінка впливу фрагментації на економічну конвергенцію. Використання кореляційного аналізу відкритості торгівлі та ймовірності конфліктів, дозволило оцінити вплив технологічних удосконалень на скорочення викидів CO_2.

Обґрунтовано, що початок пандемії COVID-19 спровокував значний зсув світової торгівлі із характерними коливаннями, зокрема стимулював фрагментацію та дивергенцію показників не лише під час фаз відновлення, але й під час уповільненні торгівлі з меншою інтенсивністю. Встановлено, що в усіх географічних регіонах світу в 2023 р. спостерігалося зниження зростання

експорту, проте воно було менш динамічним в ЄС та США та більш динамічним в Азії, зокрема КНР.

Доведено, що торгівля значно сприяє прогресу глобальної економічної конвергенції та зменшенню бідності. Підтверджено, що країни з економікою, що розвивається, суттєво виграли від зростання, завдяки торгівлі, що привело до скорочення розриву в доходах із розвиненими країнами. Так, торгівля сприяла загостренню нерівності в розвинених країнах через збільшення попиту на кваліфіковану робочу силу та урбанізацію економічної діяльності. В той час, як інтеграція країн, що розвиваються в глобальні ланцюги створення вартості та зменшення торговельних бар'єрів сприяли розвитку та зростанню доходів.

Аналіз даних підтвердив, що поточні моделі торгівлі демонструють підвищену волатильність і різноманітність порівняно з історичними нормами. Так, збої, спричинені COVID-19, стали каталізатором помітних змін у динаміці світової торгівлі. На таку трансформацію впливали такі системні фактори, як геополітична напруженість і стратегії управління ризиками, а конвергенція цих елементів підвищила перспективу суттєвих змін у парадигмі глобальної торгівлі, розпочавши нову еру викликів і можливостей для усіх учасників глобальної економіки.

Доведено, що торгівля виконує життєво важливу роль у протистоянні кліматичній кризі та екологічним проблемам, незважаючи на її потенціал у сприянні викидам парникових газів і забрудненню навколишнього середовища. Наголошено, що реалізація надійної екологічної політики має ключове значення для пом'якшення негативного впливу торгівлі на навколишнє середовище та сприяння сталим торговельним практикам. Для цієї політики вкрай важливо враховувати взаємопов'язаний і глобальний характер екологічних проблем.

Окреслено, що Китай розробив комплексні стратегії для впровадження найбільшої у світі системи торгівлі викидами, що охоплює понад 1700 енергетичних компаній і 3 мільярди тон викидів парникових газів. Основною метою цього ринку є регулювання та скорочення викидів парникових газів та сприяння екологічно безпечному розвитку з низьким вмістом вуглецю.

У кваліфікаційній роботі розроблено модель екологічно стійкої торговельної стратегії для КНР, яка ґрунтується на екологічних, політичних і соціальних факторах впливу на торгівлю, умовах збереження ресурсів, напрямах ресурсної дипломатії та торгової політики; містить пропозиції щодо екологічної реструктуризації економіки і шляхи міжнародного співробітництва КНР; охоплює вектори сприяння технічним інноваціям та умови використання економічних стимулів для екологічної стійкості.

Зазначено, що управління та експлуатація ресурсів перетинаються з національними інтересами та безпекою, що може перерости в геополітичну напругу між державами (проаналізовано конкуренцію за морські ресурси в Південному та Східно-Китайському морях, яка призвела до напруженості між Китаєм, Японією, В'єтнамом, Філіппінами). Ця напруга несе в собі ризик перерости у військове протистояння або навіть розпалити збройний конфлікт, що загрожує міжнародній політичній стабільності.

Сконцентровано увагу на важливості відповідального використання природних ресурсів у торгових цілях та підкреслено необхідність уникати надмірної експлуатації та споживання ресурсів, оскільки це може завдати значної шкоди навколишньому середовищу, впливаючи на сталість і стабільність торгової діяльності. Досліджуючи сталий розвиток і використання ресурсів, запропоновано шляхи заохочення сталого зростання міжнародної торгівлі через врівноваження економічного прогресу із збереженням навколишнього середовища.

Наголошено, що країни повинні визнати ключову роль, яку відіграють природні ресурси в міжнародній торгівлі, і вжити активних заходів для їх збереження та управління ними. Зауважено, що пріоритет розвитку промислової структури та технологічних інновацій, сприяння міжнародному співробітництву та обмінам, а також колективне вирішення проблеми дефіциту ресурсів і екологічних проблем є важливими кроками на шляху до досягнення сталого розвитку міжнародної торгівлі. Обґрунтовано, що нехтування обмеженням надмірного використання та споживання природних ресурсів загрожує їх

виснаженням і завдає шкоди навколишньому середовищу, що зрештою загрожує сталості та стабільності міжнародної торгівлі. Крім того наголошено, що на рівновагу світового ринку значною мірою впливають попит і пропозиція природних ресурсів, що призводить до коливань цін і впливає на баланс міжнародної торгівлі.

Встановлено, що стратегія сталої торгівлі для Китаю узгоджується з декількома ключовими політичними пріоритетами, окресленими китайським урядом, зокрема з такими принципами, як надання пріоритету добробуту людей, сприяння інноваціям, просування збалансованого та сталого розвитку та досягнення соціальної гармонії. Запропоновано, доповнити цю стратегію екологічної стійкості міжнародної торгівлі та здійснювати міжнародну політику Китаю, незалежно від того, чи є вона у формі багатосторонніх угод, двосторонніх і регіональних угод, односторонніх дій, регіональних партнерств чи інших правових інструментів, пов'язаних саме з екологічною сталістю. Запропоновано, для вирішення зростаючу кількість торговельних скарг і конфліктів за участю Китаю, сприяти регулярним двостороннім діалогам, які є важливими шляхами розв'язання проблем.

Ключові слова: глобалізація, глобальне середовище, декаплінг, екологічна сталість, експорт, імпорт, КНР (Китай), лібералізація торгівлі, міжнародна торгівля, навколишнє середовище, природні ресурси, сталий розвиток, торговельна інтеграція, торговельні обмеження, циркулярна економіка.

ANNOTATION

***Wei LINHAI*. Environmental sustainability of PRC international trade**. – Qualifying thesis manuscript copyright.

Dissertation for the degree of Doctor of Philosophy in specialty 292 – "International Economic Relations" – West Ukrainian National University, Ternopil, 2024.

The dissertation offers a new solution to an important scientific and applied objectives – the development of the theoretical foundations of environmental sustainability of international trade and the formation of prospects for the environmental sustainability of China's applied model on this basis.

In the qualifying work, the genesis of theories of international trade was researched, in particular, an improved classification of theories of international trade was proposed. It has been proven that the greening of trade relations plays a crucial role in stimulating economic transformations in the country, and unbalanced trade preserves disparities between nations and poses a threat to the long-term stability of the economic system. It is emphasized that the uniformity of preferences among nations in combination with different supply of factors of production and commodity intensity played a decisive role in determining the prices of goods. As a result, it is noted that capital, which is considered a scarce factor of production, will benefit more from protectionist measures than from free trade. It has been established that in the ecological context the results of trade can be both favorable and harmful. It is emphasized that the country's positioning in the natural resources sector with constant returns to scale limits opportunities for economic diversification due to resource scarcity.

The model of Porter's competitive advantages was adapted to the ecological development of the state. It has been confirmed that the competitiveness of a nation in a certain industry depends on the ability of the industry to innovate and improve, and the key role is played by the resources and capabilities of the local market and the conditions of demand in the local market to which local suppliers and manufacturers adapt. The qualification work offers methodological approaches to the study of the

environmental component of international trade, which are based on the assessment of the impact of trade policy changes, in particular on the product share and market share in total exports, the index of comparative advantages, export diversification and export specialization.

The dissertation proposes the concept of environmental sustainability in the system of international economic relations, which includes an analysis of the impact of the environment in contrast to theories that consider the economic system as a closed and linear system.

The merits of the material balance model of an economically open circular subsystem are substantiated in the qualification work. It is established that the decision-making policy according to the cost-benefit analysis model, which is used to allocate resources due to its social efficiency, needs to be adjusted to the benefits and costs necessary for environmental protection, which can serve as a basis for approving only those investment projects in which the total current cost of non-ecological benefits, non-ecological costs and the net cost of environmental change is positive.

The paper analyzes the development of various types of sustainability of economy in conditions of mutual substitution of natural and industrial capital. It is noted that the achievement of sustainable development requires the interconnection of natural capital, industrial capital, human capital and social capital over a certain period of time. It has been proven that the development process should be focused not only on increasing the total capital, but also on prioritizing the rational capital structure, avoiding the crossing of ecological thresholds, and economic progress, at the same time, should not go beyond the limits imposed by nature.

In the qualifying work, clarification of the decoupling process and the impact on the use and consumption of natural resources on international trade is proposed. In the study, "decoupling" is considered through the practice of using fewer resources per unit of economic output and minimizing the environmental consequences associated with the use of resources and economic activity. It is noted that achieving decoupling will require significant changes in state policy, corporate behavior and public consumption.

It has been argued that reducing environmental impact does not always solve resource scarcity or production costs, and in some cases it can exacerbate these problems.

The classification of natural resources has been improved, taking into account their unique properties and characteristics, including renewable and non-renewable resources, land, mineral, biological and atmospheric resources. It has been proven that the structure of China's international trade has undergone significant transformations, especially under the influence of the phenomenon of international fragmentation of production, and this trend involves specialization at certain stages of production in many countries.

The use and consumption of natural resources has been analyzed, the need for joint efforts of the international community to develop a common policy has been proven. The importance of taking into account the sustainability and environmental impact of resource exploitation was noted. It is argued that in order to achieve the sustainability of China's international trade, it is important to implement effective resource management and protection strategies, such as promoting the circular economy, supporting resource conservation, and strengthening environmental supervision.

The work highlights the trends in the development and restructuring of international trade, in particular the assessment of the impact of fragmentation on economic convergence. Using a correlation analysis of trade openness and the probability of conflicts, it was possible to estimate the impact of technological improvements on the reduction of CO2 emissions. It is substantiated that the onset of the COVID-19 pandemic triggered a significant shift in world trade with characteristic fluctuations, in particular, it stimulated fragmentation and divergence of indicators not only during recovery phases, but also during the slowdown of trade with lower intensity. It was found that all geographic regions of the world saw a decline in export growth in 2023, but it was less dynamic in the EU and the US and more dynamic in Asia, especially PRC.

Trade has been proven to contribute significantly to the progress of global economic convergence and poverty reduction. It has been confirmed that developing

economies have benefited significantly from growth, thanks to trade, which has led to a narrowing of the income gap with developed countries. Thus, trade contributed to the increasing of inequality in developed countries due to increased demand for skilled labor and the urbanization of economic activity. While the integration of developing countries into global value chains and the reduction of trade barriers have contributed to development and income growth.

Analysis of the data confirmed that current trading patterns exhibit increased volatility and diversity compared to historical norms. Thus, the disruptions caused by COVID-19 have become a catalyst for marked changes in the dynamics of global trade. This transformation was influenced by systemic factors such as geopolitical tensions and risk management strategies, and the convergence of these elements raised the prospect of significant changes in the global trade paradigm, ushering in a new era of challenges and opportunities for all participants in the global economy.

It has been proven that natural resources play a key role in international trade, significantly influencing the economic development of countries and the dynamics of their trade. In this context, consideration of the importance and role of natural resources in the field of international trade was deepened. It is emphasized that the use of environmentally friendly energy technologies and giving priority to innovations in development strategies can increase the nation's energy efficiency.

It has been established that most countries rely on imported energy to meet their domestic needs, increasing the importance and role of energy resources in world trade. As a result, fluctuations in the supply and prices of these resources have a significant impact on international markets and economic growth.

Trade has been proven to play a vital role in addressing the climate crisis and environmental challenges, despite its potential to contribute to greenhouse gas emissions and environmental pollution. It was emphasized that the implementation of sound environmental policies is key to mitigating the negative impact of trade on the environment and promoting sustainable trade practices. It is crucial for this policy to take into account the interconnected and global nature of environmental problems. It outlines that China has developed comprehensive strategies to implement the world's

largest emissions trading system, covering more than 1,700 energy companies and 3 billion tons of greenhouse gas emissions. The main goal of this market is to regulate and reduce greenhouse gas emissions and promote environmentally sound, low-carbon development.

It was developed a model of an environmentally sustainable trade strategy for the People's Republic of China in the qualification work, which is based on environmental, political and social factors influencing trade, conditions for resource conservation, areas of resource diplomacy and trade policy; contains proposals for ecological restructuring of the economy and ways of international cooperation of the People's Republic of China; covers the vectors of promoting technical innovation and the conditions for the use of economic incentives for environmental sustainability. The study determined the impact of the use and consumption of natural resources on international trade and proposed ways of developing the environmental sustainability of international trade of the PRC.

The need for a holistic approach to resource management and conservation was noted in order to counter the adverse impact of overexploitation and overconsumption of resources on the environment. This approach should include supporting sustainable development, strengthening environmental standards, promoting resource conservation and recycling, and fostering environmentally friendly production and consumption practices. The following steps have been substantiated as important for promoting resource conservation: improving resource management, increasing the efficiency of resource use, promoting technological innovation, researching alternative resources, promoting international cooperation, collective resolution of resource and environmental problems, as well as formulating and improving policies and regulations to promote sustainable use of resources and promotion of economic progress.

It is noted that the management and exploitation of resources often intersect with national interests and security, which can turn into geopolitical tension between states (the competition for marine resources in the South and East China Seas is analyzed, which has led to tensions between China, Japan, Vietnam, the Philippines). This tension

carries the risk of turning into a military confrontation or even igniting an armed conflict, which threatens international political stability.

Attention is focused on the importance of responsible use of natural resources for commercial purposes and the need to avoid excessive exploitation and consumption of resources is emphasized, as this can cause significant damage to the environment, affecting sustainability and stability of commercial activities. Investigating the sustainable development and use of resources, ways of encouraging the sustainable growth of international trade through balancing economic progress with environmental preservation are proposed.

It was emphasized that countries should recognize the key role played by natural resources in international trade and take active measures to conserve and manage them. It was noted that prioritizing the development of the industrial structure and technological innovations, promoting international cooperation and exchanges, as well as collectively solving the problem of resource scarcity and environmental problems are important steps on the way to achieving sustainable development of international trade. It is well-founded that neglecting to limit the excessive use and consumption of natural resources threatens their depletion and harms the environment, which ultimately threatens the sustainability and stability of international trade. In addition, it was emphasized that the balance of the world market is largely influenced by the demand and supply of natural resources, which leads to price fluctuations and affects the balance of international trade.

China's sustainable trade strategy is found to be aligned with several key policy priorities outlined by the Chinese government, including prioritizing people's well-being, promoting innovation, promoting balanced and sustainable development, and achieving social harmony. It is proposed to complement this strategy of environmental sustainability of international trade and implement China's international policy, regardless of whether it is in the form of multilateral agreements, bilateral and regional agreements, unilateral actions, regional partnerships or other legal instruments specifically related to environmental sustainability. It is proposed to promote regular

bilateral dialogues, which are important ways of solving problems, to solve the growing number of trade complaints and conflicts involving China.

Key words: circular economy, decoupling, environment, environmental sustainability, export, global environment, globalization, import, international trade, natural resources, PRC (China), sustainability, trade integration, trade liberalization, trade restrictions.

CONTENT

INTRODUCTION

Actuality of theme. The advancement of global trade and ecological sustainability are two crucial components of societal well-being and economic progress, with a close interconnection. The swift expansion of global trade can somewhat facilitate the advancement of environmental conservation. Enhancing environmental conservation will incentivize entrepreneurs to opt for manufacturing and selling more eco-friendly goods, thereby expanding trade opportunities for environmentally friendly products; however, under specific circumstances, global trade and the environment may also be at odds. Environmental conservation has introduced fresh standards and demands for the progression of global trade. Environmental statutes and regulations limit or even forbid the global trade of numerous goods. International trade that does not adhere to sustainable development will significantly harm the local ecological environment. With the escalating concern over environmental pollution and the growing influence of ecocentrism, the international community's comprehension of ecological civilization is advancing. A new trend labeled as "ecological" is emerging across various industries and sectors. This trend aims to evaluate all activities in economic and social progress through an ecological lens. The primary objective is to achieve a balanced development of the economy, society, population, resources, and the environment. Ever since the concept of "sustainable development" was introduced by the World Commission on Environment and Development in 1987, China has been progressing towards an "ecological" approach. The strategies of "winning through quality," "market diversification," and "technological trade revitalization" in the 1990s were all influenced, either directly or indirectly, by the goals of resource conservation, reduction of ecological harm, and stabilization of economic growth.

The connection between trade, the environment, and sustainability is crucial for the development of regions, countries, and the global economy. China, as a prominent trading nation, has made significant strides in expanding its international trade, thanks to its commitment to open trade policies. Studies have pinpointed the key drivers behind the shifts in environmental sustainability within China's international trade. These studies have also outlined how China has managed to increase its trade volume

while promoting sustainable environmental practices. Furthermore, the analysis has shed light on the impact and significance of the continuous growth in trade on China's environmental sustainability. By examining the data on the size and composition of China's international trade, researchers have been able to identify the changes that influence the link between international trade and environmental sustainability. The dissertation provides evidence for the theoretical and methodological framework of international trade and its role in environmental sustainability. It discusses system characteristics such as the development of international trade in relation to total GDP, analysis of the structure of international trade patterns, and the geographical direction of international trade. Additionally, it explores the principles of environmental sustainability including total industrial waste gas emissions and their treatment, generation, disposal, and comprehensive utilization of industrial solid waste, as well as industrial wastewater emissions, industrial chemical oxygen demand emissions, and industrial ammonia nitrogen emissions.

This problem actualizes the problem of environmental sustainability of PRC international trade and requires the development of environmentally sustainable trade strategy.

Analysis of recent research and publications. The relationship between international trade and environmental sustainability has been extensively researched by various scholars. A study conducted by A. Andriamahery and Md. Qamruzzaman (2022) focused on the influence of renewable energy consumption, energy innovation, and total trade on environmental sustainability in specific countries in the Middle East and North Africa region, using the environmental Kuznets curve as a basis. The authors recommended the adoption of eco-friendly technologies, the reduction of subsidies for nonrenewable energy sources, and the implementation of green trade policies to promote sustainable development. Another study by W. Wang, M. Abdur Rehman, and Sh. Fahad (2022) analyzed the effects of renewable energy, trade openness, industrialization, technology, and economic development on the ecological footprint in G-7 nations, utilizing the STIRPAT model for theoretical support.

The empirical findings indicated that the utilization of clean energy has a positive impact on reducing environmental pollution in both the short and long term. Additionally, production and trade activities were found to have a detrimental effect on ecological quality due to the excessive use of resources. The study conducted by H. Khan, L. Weili, and I. Khan (2022) examined the relationship between trade openness, innovation, quality institutions, and environmental sustainability across 176 countries. Through various statistical methods such as OLS regression, fixed effect, and generalized method of moments, it was revealed that trade openness, renewable energy consumption, and foreign direct investment are linked to lower carbon emissions. On the other hand, institutional quality indicators were shown to have a significant impact on environmental sustainability, although improvements are still needed to reach optimal levels. The results suggest the promotion of renewable energy sources as a key strategy to enhance environmental sustainability.

Arslan, Khan, and Latif (2022) conducted a study on China's natural resource rents, environmental sustainability, and sustainable economic growth. The findings suggested that natural resources contribute to environmental sustainability but may hinder economic growth. On the other hand, financial development, merchandise trade, and urban population growth were linked to environmental degradation. In a separate study, Liu, Lei, and Zhou (2022) explored the impact of green trade on the environment in 277 Chinese cities from 2004 to 2013. Their research revealed that green trade can reduce pollution levels, while total trade openness has a less positive effect on the environment. Additionally, green imports and exports were found to benefit the Chinese environment, with green ordinary trade outperforming green processing trade.

Separate issues of waste management and social corporate responsibility, including in the context of environmental management and investment activities, are highlighted in the works of a number of scientists, in particular: D. Birkbeck, P. Chasek, H. Daly, D. Downie, I. Dragulanescu, P. Ekins, M. Fischer-Kowalski, H. Gao, E. Heckscher, D. Hummels, N. Lardy, J. Lin, I. Lishchynskyy, B. Ohlin, O. Sokhatska, J. Stiglitz, A. Virkovska, Ch. Weiming, L. Wengang, M. Wilson, J. Wu,

S. Yakubovskyi, O. Yatsenko, R. Yuan, D. Yuqin, X. Zhang, H. Zhou, I. Zvarych, R. Zvarych.

At the same time, the mentioned studies and publications do not sufficiently reveal the process of environmental sustainability of PRC international trade, which determines the relevance of this scientific study.

Connection of research with scientific programs, plans, topics. The dissertation is a component of scientific research of the West Ukrainian National University, in particular: fundamental state budget funding researches "National concept of eco-security of society and inclusion of the circular economy in the conditions of the pandemic" (state registration number 0121U109485); "Concept of recovery and green reconstruction of Ukraine" (state registration number 0124U000003); implementation of the international project (Erasmus+ Module Jean Monnet) "European inclusive circular economy: post-war and post-pandemic module for Ukraine (EICEPPMU)" 2022-2024, registration number 101085640); business funding research on the topic "Transformation of business in conditions of sustainable development of the global economy" (Contract No. MEV-33-2023 dated 05/10/2023); business funding research on the topic "Scientific and professional consulting of the enterprise on issues of social responsibility and organization of recycling" (Contract No. MEV-81-2021 dated 01/10/2021); business funding research on the topic "Formation of the company's ecological brand in foreign markets" (Contract No. MEV-37-2024 dated 25/04/2024).

The purpose and objectives of the research. The purpose of the dissertation is the scientific substantiation of the theoretical concepts of environmental sustainability of international trade in the context of the development the applied model for the implementation the environmentally sustainable trade strategy for China.

Based on the purpose of the research, the following objectives are set in the research:

- to research the genesis of international trade theories;
- to define the concept of environmental sustainability in the system of international economic relations;

- to research the decoupling and impact of natural resource utilization and consumption on international trade;
- to analyse the trends in international trade development and reshaping;
- to evaluate the status and role of natural resources in international trade;
- to analyse the environmental sustainability in international trade;
- to define the impacts of natural resource utilization and consumption on international trade;
- to propose the ways of developing the environmental sustainability of PRC international trade;
- to elaborate the model of environmentally sustainable trade strategy for China.

The object of research is a process of PRC international trade.

The subject of research is a set of theoretical and applied aspects that determine the process of environmental sustainability of PRC international trade.

Methods of research. To achieve the defined purpose, the dissertation thesis used a set of research methods (theoretical, historical, empirical, and others), the unity of which made it possible to fulfil all the outlined tasks. The following methods are used in the dissertation: the method of theoretical generalization – for generalizing the genesis of theoretical approaches to research international trade theories; the historical method for defining theoretical identification the environmental sustainability of international trade; the method of dialectical cognition – to research the concept of environmental sustainability in the system of international economic relations; the method of analogies and comparative analysis – to analyse the trends in international trade development and reshaping; methods of induction and deduction – for formulating hypotheses, their verification, generalization of results and substantiation of conclusions; methods of analysis, synthesis and data processing – to evaluate the status and role of natural resources in international trade; monitoring method – to analyse the environmental sustainability in international trade; method of visualization of data, main provisions and research results.

The informative and factual basis of the dissertation is statistical data and analytical materials of the World Trade Organization (WTO), United Nations, Environmental assessment Agency (Hague), World Bank, UN Conference on Trade and of Development (UNCTAD), the International Monetary Fund, the National Bureau of Statistics of China, other international organizations and analytical centers, national green strategies, legislative acts of developed countries on waste management, scientific articles by scientists, monographs, Internet resources.

Scientific novelty of the research results consists in establishing the theoretical foundations of international trade and the formation of environmental sustainability prospects in the context of the development of the applied model for the implementation of environmentally sustainable trade strategy for China.

The following most important scientific results were obtained in the research:

for the first time:

– developed the model of environmentally sustainable trade strategy for China, which is based on environmental, political, social impact factors in the concept of environmental issues on trade, sustainable development and resource conservation, resource diplomacy and trade policy; opportunities and challenges for natural resources in international trade, suggestions for China's economy environmentally restructuring, ways for China's international cooperation; ways for integration of China's business operations and introducing into China upstream research and development; China's manufacturing sector`s factors by vectors to promote technical innovation and policy to create and enable incentives;

improved:

– the concept of environmental sustainability in the system of international economic relations by analysis of the economic system as closed and linear system; justification the materials balance model of economic open and circular subsystem; and development the types of sustainability;

– terminology, in particular, the essential characteristics of "environmental international trade", aspects of "decoupling"; classifications of international trade theories by developing methodological approaches to environmental international

trade; and adaptation the Porter's competitive advantage model to state environmental developing;

– evaluation of the status and role of natural resources in international trade by comparison of China's total primary energy production, total energy consumption total mining industry production, total agricultural output value, total resources availability in total share of import and export;

further developed:

– main properties and characteristics of decoupling and impact of natural resource utilization and consumption on international trade by classification of natural resources; ways of utilization and consumption of natural resources; contribution of international trade to reducing extreme poverty;

– analysis of trends in international trade development and reshaping; impact of fragmentation on economic convergence; correlation analysis between trade openness and conflict probability; impact of technology improvements on reducing CO_2 emissions and covered emissions;

– opportunities of the environmental sustainability of PRC international trade; which allowed to outline the ways of environmental sustainability; and find out the components of sustainable trade strategy for China.

The practical value of the results. The practical significance of the results of the dissertation is that the main theoretical provisions of the study of the key areas of environmental sustainability of international trade and the ways of implementation of environmentally sustainable trade strategy for China can be used in the practical activities of business units and in further scientific developments.

Personal contribution of the applicant. Dissertation work is self-exploration research. The theoretical propositions, proposals and results presented for defence were obtained by the author personally. From the scientific publications published in co-authorship, the work uses only those provisions that are the result of the author's personal research.

Approbation of the results of the dissertation. The main results of the dissertation were discussed at international scientific and scientific-practical

conferences: International scientific and practical conference of young scientists "Economic and social development of Ukraine in the XXI century: national vision and challenges of globalization" (Ternopil, 2021); International scientific and practical conference of young scientists and students "Innovative processes of economic and socio-cultural development: domestic and foreign experience" (Ternopil, 2021); International scientific and practical conference of young scientists "Economic and social development of Ukraine in the XXI century: national vision and challenges of globalization" (Ternopil, 2022); International scientific and practical conference of young scientists and students "Innovative processes of economic and socio-cultural development: domestic and foreign experience" (Ternopil, 2022); International scientific and practical conference of young scientists "Economic and social development of Ukraine in the XXI century: national vision and challenges of globalization" (Ternopil, 2023); International scientific and practical conference of young scientists and students "Innovative processes of economic and socio-cultural development: domestic and foreign experience" (Ternopil, 2023); International scientific and practical conference of young scientists and students "Innovative processes of economic and socio-cultural development: domestic and foreign experience" (Ternopil, 2024).

The main scientific developments regarding the model of environmentally sustainable trade strategy for China will be approved by the Department of International Economic Relations in a scientific and technical report based on the results of: fundamental state budget funding research "Concept of recovery and green reconstruction of Ukraine" (state registration number 0124U000003); and business funding research on the topic "Formation of the company's ecological brand in foreign markets" (Contract No. MEV-37-2024 dated 25/04/2024).

Publications. The main results of the dissertation research were published in 11 articles with a total volume of 6.3 p.s. (of which the author personally owns 3.6 p.s.), including: 1 – publication in Journals indexing in Scopus; 3 – publications in Journals of category "B" of the List of scientific and specialized publications of Ukraine by

specialty: 292 “International Economic Relations”; 7 – publications in Conference Paper Collections.

The structure and volume of thesis. The dissertation consists of an introduction, three sections, conclusions, a list of reference, and annexes. The total volume of the dissertation is 166 pages, of which 143 pages are the main text. The thesis contains 2 tables, 32 figures and 4 appendices on 7 pages. The list of reference includes 171 sources on 16 pages.

CHAPTER 1
THEORETICAL AND METHODOLOGICAL BASIS OF THE RESEARCH ENVIRONMENTAL SUSTAINABILITY OF INTERNATIONAL TRADE

1.1. The genesis of international trade theories

Adam Smith's Wealth of Nations highlights the importance of nations embracing free trade rather than solely focusing on amassing trade surpluses and gold. By implementing the concept of division of labor, countries can specialize in producing goods in which they have a comparative advantage, while importing goods that would be more costly to produce domestically. The removal of trade barriers enables the expansion of markets beyond national borders, resulting in mutually beneficial exchanges that enhance the well-being of all participating nations. David Ricardo later introduced the theory of comparative advantage. He demonstrated that countries could gain from trade, even without having absolute advantages. Similar to Smith's concept of the “invisible hand”, Ricardo also assumed that capital would not flow across borders [21; 23]. The comparative advantage model highlights the importance of maintaining low labor costs in economies with excess labor in order to benefit from free trade. In contrast, the neoclassical model views the current distribution of returns as natural market results, eliminating the necessity for workers to demand higher wages. Furthermore, the neoclassical model fails to address how existing social disparities influence market outcomes, leading to an inability to explain inequalities within the labor market [26]. Additionally, the neoclassical theory overlooks the capital accumulation and historical resource transfer from colonies to Europe, which has significantly contributed to the modernization and economic growth of Europe [27].

International institutions have recognized Ricardo's comparative advantage theory as the economic rationale behind developing countries' decision to liberalize their trade. The theory suggests that achieving full capacity utilization can result in efficiency gains and specialization in producing goods and services that align with the country's comparative advantage (see fig. 1.1). By embracing trade liberalization, a

country can potentially boost its aggregate output, leading to improved welfare for all involved parties. Adam Smith and David Ricardo, the pioneers of "free trade," emphasized the immobility of capital in their model and viewed the exchange of capital- or labor-intensive goods as a viable alternative to factor mobility [28]. Larger market and efficiency-seeking corporations aim to strengthen their position in both domestic and global markets in order to secure monopolistic rents, thereby enabling them to reshape production and trade patterns to their advantage. The mainstream economists fail to scrutinize the origins of wealth and power in these nations, as well as the coercive measures employed to impose an "open trade" policy on colonies during the XIX century. It appears that economic and trade relations play a crucial role in driving economic transformations within a nation. In an ideal scenario within a capitalist economic system, international trade and production should be carried out by small private enterprises that lack the ability to manipulate and dictate prices. The aim is for trade between countries to be mutually beneficial for all parties involved. However, in reality, this may not always hold true, as economically, technologically, and militarily dominant nations often engage in unequal relationships and even adopt neocolonialist practices. Such imbalanced trade perpetuates disparities between nations and poses a threat to the long-term sustainability of the capitalist system [29].

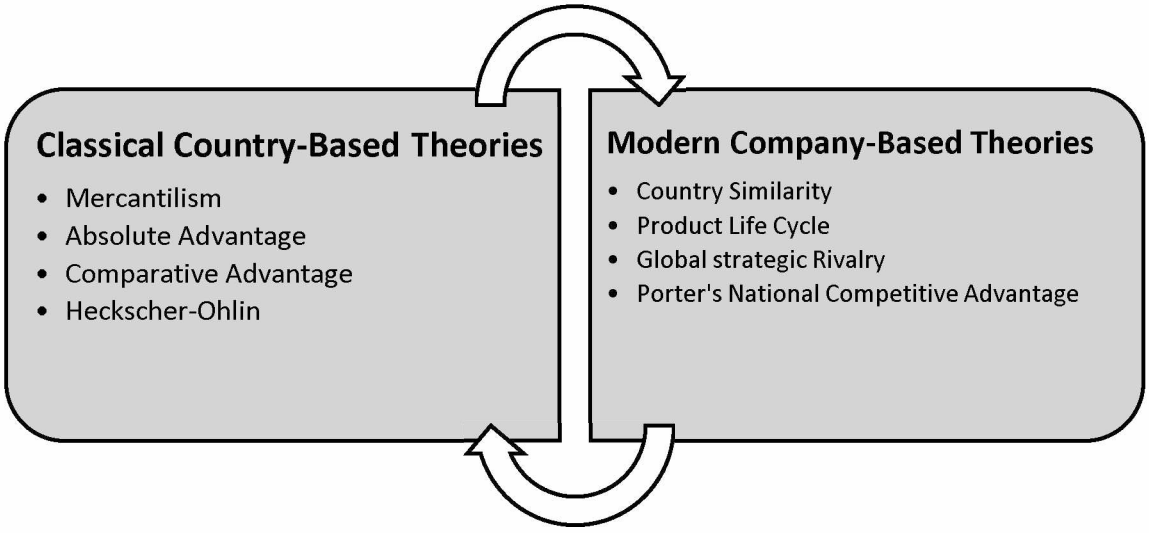

Fig. 1.1. Classifications of international trade theories

Source: [author]

Traditional Theoy of International Trade. The emergence of trade theories and the evolution of international trade have often overlooked the contributions of Mercantilists. Their work style in the 17th century sheds light on their theory in practice. According to Mercantilists, the key to success was to focus on exporting and minimize imports, as this would result in accumulating more bullion, which they considered as the sole indicator of prosperity and well-being. Consequently, their approach implied a framework of protectionist policies in the realm of trade [1].

The physiocrats, a group of economists in the eighteenth century, examined the 'circular flow of wealth' within an economy using an aggregate framework. Francois Quesnay's Tableau Economique (1758) is considered one of the most notable macroeconomic models of that era. Originating in France, this concept was characterized by the belief that government policies should not interfere with natural economic laws and that land is the primary source of wealth. Physiocrats criticized mercantilists not only for their numerous economic regulations but also for their focus on manufacturing and foreign trade. While mercantilists argued that each nation should control trade and manufacturing to enhance its wealth and power, physiocrats believed that labor and commerce should be free from any restrictions [2; 3].

During the Industrial Revolution, economic literature saw a significant shift from mercantilism and Physiocrats to new theories. The publication of Adam Smith's Wealth of Nations in 1776 signaled the advancement of standardized trade theories. According to Smith, each country should focus on producing goods in which it has an absolute advantage over others, a concept derived from the division of labor illustrated by the pin factory. This perspective shifted the focus from solely exporting goods to also considering the benefits of importing. Smith emphasized that the domestic economy is the foundation of wealth, and the goal of trade should be to export more in order to import more, ultimately enhancing overall welfare [23].

Further progress was made with the introduction of the theory of comparative advantage in David Ricardo's “On the Principles of Political Economy and Taxation” (1817). Illustrated by the well-known example of England and Portugal trading wine and cloth, it became evident that absolute advantage was not the sole determining factor

for trade. Instead, it was the comparative advantage that played a crucial role, serving as both a necessary and sufficient condition for trade. According to Ricardo, a country possesses a comparative advantage in producing a particular good if the opportunity cost of producing that good, in terms of other goods, is lower in that country compared to other countries. Consequently, trade becomes mutually beneficial for the participating nations. Smith and Ricardo introduced the concept of utilizing simplified models to comprehend economic matters related to trade. They both advocated for free trade, countering the prevailing Mercantilist theories of protectionism. Their proposition emphasized that allowing trade to flow freely would result in increased prosperity for all [21].

It is worth noting that Ricardo's theory surprisingly overlooked the consideration of income distribution. Despite this omission, Ricardo was aware that the implementation of free trade in England would bring advantages to the workers in the cloth industry while adversely affecting the aristocrats who possessed the majority of agricultural land in the country. Nevertheless, his theories remain robust and exceptional in elucidating the reasons behind international trade among nations specializing in vastly distinct products [12].

Factor Endowment Model of Trade. The Heckscher-Ohlin model, also known as HOS, was developed by Heckscher, Ohlin, and later Samuelson. This model focuses on two countries, two commodities, and two factors of production, while assuming constant returns to scale. It has played a significant role in trade theories by placing factor endowments of countries at the forefront. Unlike the technology-based interpretations of the Ricardian comparative cost model, the Heckscher-Ohlin model links trade patterns to factor endowments and production methods. According to the Ricardian model, countries specialize in goods where they have the greatest relative advantage [19]. However, the Heckscher-Ohlin model does not consider differences in total factor productivity across industries and assumes that all countries possess the same technology within a specific industry. As a result, it predicts that countries will produce a higher proportion of goods that utilize their relatively abundant factors intensively [4].

The uniformity of preferences across nations, combined with the varying factor endowments and commodity intensities, played a crucial role in determining commodity prices. For instance, if a country like A is rich in capital and specializes in producing capital-intensive good X, the price of good X will be lower in comparison to other nations. According to the factor-price equalization theorem in this framework, the immobility of factors across borders results in not only commodity price equalization through trade but also factor price equalization among countries [13].

According to this theorem, there is a corollary that pertains to the concepts of protection and real wages. It asserts that in the context of free trade and factor price equalization, scarce factors of trading nations tend to experience greater losses. In simpler terms, under this model, capital, which is considered a scarce factor, will derive more advantages from protectionist measures rather than from unrestricted trade [17].

Although this model is widely utilized in trade policies, there is minimal empirical evidence backing it. The assumptions of this model have proven inadequate in addressing real-world circumstances. Despite trade activities, there is a lack of proof that prices are being equalized among nations. Leontief's paradox highlighted that trade primarily occurs between countries with similar characteristics. The US imported capital-intensive goods as substitutes, while exporting labor-intensive products. Subsequently, several theories have been proposed, emphasizing the skilled labor force in the US, which is more sought after compared to its trade counterparts [11].

Country Similarity Theory. In 1961, the Swedish economist Steffan Linder formulated the country similarity theory to elucidate the concept of in train industry trade. Linder's theory posited that consumers in countries at the same or similar stage of development would exhibit similar preferences. According to this theory, companies initially focus on producing goods for domestic consumption. However, when they venture into exporting, they often discover that markets resembling their domestic market in terms of customer preferences hold the greatest potential for success. Linder's country similarity theory further asserts that trade in manufactured goods primarily occurs between countries with comparable per capita incomes, and in train industry trade becomes prevalent. This theory proves particularly valuable in comprehending

trade in goods where brand names and product reputations significantly influence buyers' decision-making and purchasing processes [5].

New Trade Theory. There existed an underlying sense of dissatisfaction among individuals dealing with trade data. While traditional theories offered valuable insights, they fell short in providing a comprehensive understanding of the trade dynamics between nations. Much of the trade occurred between economies that were similar, such as the trade between the US and the EU, or the US-Canada trade. This scenario paved the way for the emergence of new trade theories, suggesting that trade was influenced not only by inherent productivity differences but also by the advantages of economies of scale that favored centralizing production. The concept of increasing returns within firms led to the formation of monopoly or oligopoly market structures, consequently resulting in product differentiation. These shifts marked a departure from the fundamental assumptions of constant returns, perfect competition, and homogeneous goods that underpinned the Ricardian and HOS model [6].

With the surge of oligopolistic markets, the theories surrounding strategic trade have gained significant attention from policymakers in advanced nations. The literature distinguishes between national and international economies of scale, further categorizing them as internal and external to a firm. At an international level, internal economies result in production expanding across various locations, thanks to the emergence of global value chains that relocate production to cost-efficient countries. The concept of increasing returns to scale encompasses both static and dynamic economies of scale, emphasizing the importance of considering not only current economies of scale but also those that arise from the process of learning by doing. These factors play a crucial role in determining industry specialization and the formulation of trade policies by countries [7].

The primary challenge faced by the new trade theory was the difficulty in accurately predicting trade patterns compared to traditional theories. The presence of multiple equilibria resulting from increasing returns and strategic behaviors of firms made it challenging to forecast trade patterns using the new trade theories. Consequently, trade outcomes can either be advantageous or detrimental, with a

nation's economies of scale determining their ability to benefit from trade. If a country is limited to a small market for goods with increasing returns, there is a significant risk of experiencing trade-related losses [14].

Intra Industry Trade Theory. The demand for product varieties from the same industries creates opportunities for intra-industry trade [8]. Intra-industry trade is facilitated by varying demand elasticities for the same product across different countries, thereby expanding the benefits of monopolistic competition. The phenomenon of complete specialization and segmented markets, which allows for export dumping, contributes to the occurrence of two-way intra-industry trade. Reciprocal dumping patterns emerged, leading to the development of the "Strategic trade theory" by Brander and Spencer (1985). Internal economies of scale at the national level give countries with a historical advantage in production a competitive edge, enabling them to reach an optimal market position first and produce at lower costs compared to other countries initially. The key is not only being the first mover but also moving quickly and on a large scale [9]. This strategic aspect of trade theory has gained popularity in the policies of advanced countries, where various strategies are employed to prevent other nations from gaining a first-mover advantage.

Technological Trade Theory. Trade theories provide a comprehensive understanding of the relationship between technology, foreign direct investment (FDI), and patterns of trade. The Product Life Cycle (PLC) theory, for instance, highlights how countries that are the source of innovation initially supply the world with these innovative goods. As the product matures and becomes standardized, the technology diffuses to other countries [10]. Additionally, the innovator country begins to import alternative versions or cheaper alternatives of the original product. This phenomenon demonstrates that countries engage in trade due to their varying positions within the production cycle. The Technology gap model further expands on this concept by acknowledging that countries possess different levels of technology. Consequently, technology is transmitted between countries through FDI, leasing agreements, or engaging in research and development activities [15].

Developing nations consistently strive to ascend the technology ladder, aiming to enhance their technological capabilities. However, advanced nations, driven by power and politics, attempt to maintain their dominant position on the technology ladder by impeding others from progressing. They are aware that relinquishing their position on the technology ladder would have detrimental effects on their country, impacting their real exchange rate. Throughout this entire process, it is crucial to consider the relationship between foreign direct investment (FDI) and trade. Empirical evidence demonstrates that countries receiving substantial FDI experience rapid technology diffusion and higher rates of economic growth. The influx of significant foreign investment and the emergence of multinational companies have resulted in international economies of scale. This model provides a plausible explanation for the evolving trade patterns observed in the era of hyper-globalization, as most trade occurs between different units of these multinational corporations. Consequently, trade patterns align with the preferences of these multinational corporations, allowing them to reap the benefits of trade gains [18].

In both the traditional and new trade theory, the impact of trade on growth was not considered. J. R. Hicks was the first to delve into this area, suggesting that even in the HOS world, income growth may differ from output growth due to varying income elasticities of goods across countries. With a technological boost leading to an outward shift of the PPC, an equal increase in exports and imports can result in enhanced income in the economy. Depending on the income elasticities of exportable and importable goods, income growth may surpass or fall short of output growth. Bhagwati (1958) further expanded on this concept with the "Immiserizing Growth" model, illustrating how technological advancements in exportable goods and lower income elasticities of these goods could have a detrimental effect on terms of trade. In such a scenario, income growth lags behind output growth, and overall income decreases due to declining prices [16].

Consequently, based on this framework, your country has experienced a negative shift in the terms of trade due to technological advancements. Prebisch and Singer's theory marked a significant advancement in this area. According to their theory, there

is a persistent trend for the terms of trade of primary goods to worsen over time. It has been noted that nations exporting primary goods have faced a decrease in their terms of trade. This aligns with the notion that global supply is not constant, and as a resource becomes scarce, a substitute becomes available in the market. The combination of agricultural protectionism policies by certain countries promoting free trade, along with the reduced demand for primary goods from developing countries by developed nations, has contributed to the underdevelopment of these nations [20].

Countries that possess abundant natural resources often face challenges in terms of trade. It has been observed that these countries tend to focus on exporting their natural resources, initially benefiting from the profits generated by such exports. However, as time passes, their trade conditions start to deteriorate. This phenomenon is commonly known as the Dutch disease. A prime example of this is the Netherlands, which specialized in exporting petroleum after discovering significant reserves. This shift in focus towards petroleum exports led to a correction in trade terms, resulting in a boost in economic growth and increased demand for the foreseeable future. Unfortunately, when the petroleum reserves eventually depleted, the Netherlands faced difficulties in reverting to their previous manufacturing industries. This can be attributed to the concept of "learning by doing," as explained by Arrow in 1962 [7].

Continuous learning is crucial as it allows us to expand our knowledge and skills. However, when we cease engaging in a particular activity, we tend to lose the expertise we have acquired in that specific domain. This phenomenon is often referred to as the curse of natural resources. The concept is extensively explored in the "Dynamic competitive advantage" model, which emphasizes the importance of carefully selecting industries for specialization. It suggests that our decision should not solely rely on static returns to scale, but also consider the dynamic returns associated with the industry. Once we become entrenched in the natural resources sector, which exhibits constant returns to scale, our options for diversifying our economy and exploring other goods become limited due to the scarcity of resources and space available [22].

After reviewing the aforementioned models, it is clear that the new trade theory advocates for free trade, albeit with a sense of caution. The misuse of power by

developed nations has led to the emergence of two distinct approaches to trade policies. While developing nations are compelled to adhere to the conventional principles of free trade through bilateral negotiations and multilateral organizations, developed nations focus on strategic trade. The existing economic framework's capacity to perpetuate income inequality has reinforced the adoption of asymmetrical policy combinations. These policy combinations shape global trade dynamics, placing countries into different categories and necessitating adherence to specific trade policies. Current models have oversimplified the understanding of this intricate process within a complex global landscape. It is imperative to develop more realistic models that incorporate elements such as political strategies, macroeconomic perspectives, inequality, and other relevant factors into trade theories [24].

Global Strategic Rivalry Theory. The global strategic rivalry theory was introduced in the 1980s by economists Paul Krugman and Kelvin Lancaster. This theory revolves around the efforts of multinational corporations (MNCs) to establish a competitive edge over other global firms within their respective industries. In order to thrive, firms must confront global competition and develop competitive advantages. These advantages, known as barriers to entry, are essential for sustaining a competitive edge. Barriers to entry encompass obstacles that new firms may encounter when attempting to enter a specific industry or market. Corporations may focus on optimizing barriers to entry such as research and development, ownership of intellectual property rights, economies of scale, unique business processes or methods, extensive industry experience, and control of resources or favorable access to raw materials [16].

Porter's National Competitive Advantage Theory. Michael Porter from Harvard Business School introduced a novel model in 1990 to elucidate national competitive advantage within the realm of international trade theories. According to Porter's theory, a nation's competitiveness in a particular industry is contingent upon the industry's ability to innovate and enhance. The theory aims to shed light on the reasons behind why certain nations excel in specific industries. Porter outlined four determinants that are interconnected to support his theory: (1) local market resources and capabilities,

(2) local market demand conditions, (3) local suppliers and complementary industries, and (4) local firm characteristics (see fig. 1.2) [25].

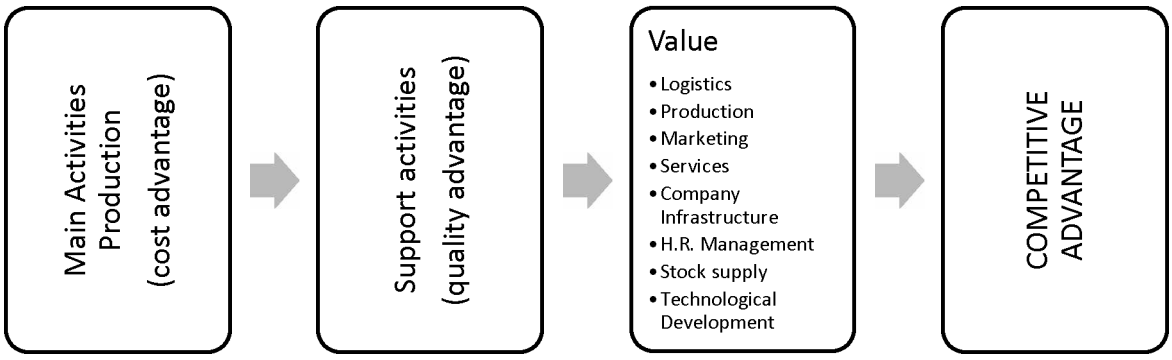

Fig. 1.2. Porter's Competitive Advantage Model

Source: [author]

Around half a century ago, Leontief carried out a calculation and comparison of the overall amounts of capital and labor needed to produce two composite goods in the United States. These goods were exports and competitive imports, each valued at one million dollars. This analysis was documented in two articles by Leontief in 1953 and 1956 [30]. Through examining the relative capital intensity of these goods, Leontief discovered that the United States' involvement in international trade was primarily focused on labor-intensive rather than capital-intensive industries [31]. This phenomenon became known as the Leontief Paradox, as later discussed by Brecx in 1967 [32].

In recent years, China's integration back into the global economy through international trade has been one of the most prominent aspects of its reforms [33]. This trend began in the early 1980s and gained momentum after China joined the WTO in 2001 [34]. From 2001 to 2006, China's foreign trade grew by an average of 28.1% annually, far outpacing the GDP growth rate of 10.1% during the same period. The structure of China's international trade has also undergone significant changes, with a notable impact from international production fragmentation [35]. This phenomenon, characterized by specialization in different stages of production across multiple

countries, has attracted considerable attention from international economists under various labels [36].

According to the classical economic theory, specifically the Heckscher-Ohlin (H-O) Theory, China, being the most labor abundant country by certain criteria, should specialize in labor-intensive production and import capital-intensive goods for economic efficiency [37; 38]. In simpler terms, China is expected to have a comparative advantage in labor but a comparative disadvantage in capital [39]. Numerous studies have been conducted on the comparative advantage of the H-O theory and China's foreign trade [40; 41].

Conventional economists hold the belief that developing countries can reap advantages such as enhanced productivity, increased competition, capital inflows, and economic growth through “free trade” and openness. Nevertheless, there is a lack of empirical evidence to support this claim. Trade openness is measured by assessing the extent to which countries engage in international trade through imports and exports. It is quantified as the ratio of total trade to GDP, serving as a convenient variable frequently employed in cross-country studies covering diverse topics.

The assessment of the impact of trade policy changes often relies on two main methodological approaches: partial equilibrium and general equilibrium. These approaches are implemented through the use of computable partial and general equilibrium models. The partial equilibrium approach focuses on analyzing the dynamics of demand and supply within a specific market, region, sector, or industry. It assumes that all other variables and interactions with other markets, sectors, etc., remain constant. This approach is particularly useful in analyzing the effects of policy changes on the market directly affected by those changes.

Country's Share of World Exports. The share of a nation's total exports in the global total exports represents the proportion that can be utilized to evaluate the fluctuating world market share of a country throughout time. Countries manufacture products according to their available resources and skilled labor force. In cases where a country lacks efficiency in producing a specific item but still requires it, businesses can opt to purchase it from other nations that specialize in its production.

Net Exports = Value of total exports – Value of total imports (1)

Saudi Arabia and Canada serve as illustrations of net exporting countries. They possess ample oil reserves, which they export to businesses in other nations. A net exporter typically maintains a current account surplus overall (see fig. 1.3).

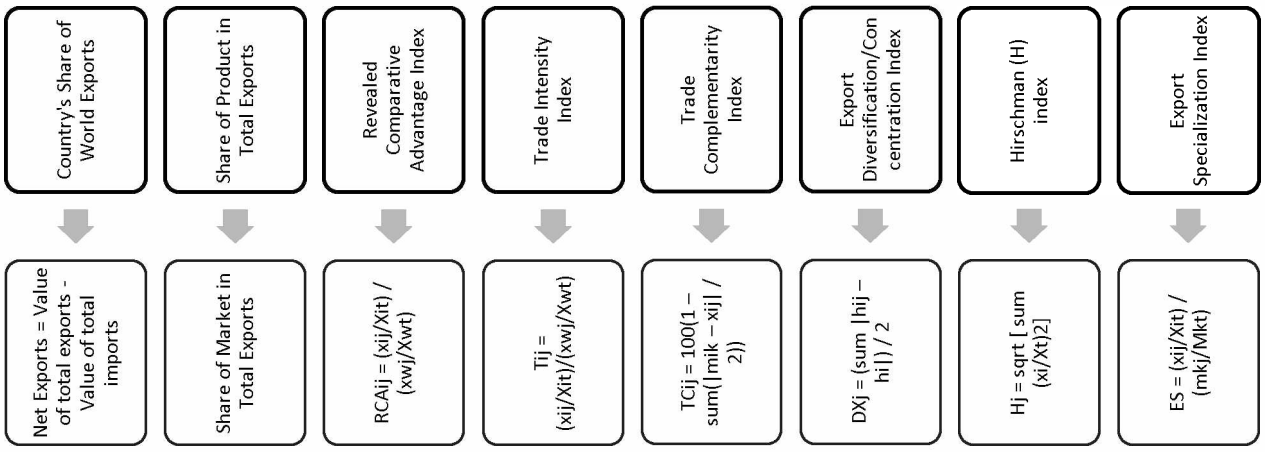

Fig. 1.3. Methodological Approaches to International Trade Research

Source: [author]

Share of Product in Total Exports. The percentage of each exported product (at a selected level of breakdown) in the overall exports of the country is referred to as the share.

Share of Market in Total Exports. The percentage of exports that are sold in each foreign country out of the total exports of the home country.

Revealed Comparative Advantage Index. Revealed comparative advantage (RCA) measures have been utilized to evaluate a nation's potential for exporting. RCA helps determine whether a country is expanding its trade potential by diversifying the products it exports, as opposed to being limited to a static number of competitive export products. Additionally, RCA can offer valuable insights into potential trade opportunities with new partners. However, countries with similar RCA profiles are unlikely to engage in high levels of bilateral trade unless there is intraindustry trade involved. By estimating RCA at a detailed product level, attention can be drawn to nontraditional products that may have successful export potential. The RCA index for

country I and product j is typically calculated by comparing the product's share in the country's exports to its share in global trade:

$$RCAij = (xij/Xit) / (xwj/Xwt) \quad (2)$$

Where *xij* and *xwj* are the values of country i's exports of product j and world exports of product *j* and where *Xit* and *Xwt* refer to the country's total exports and world total exports. If the value is below one, it indicates that the country possesses a revealed comparative disadvantage in the product. Conversely, if the index surpasses one, the country is considered to have a revealed comparative advantage in the product.

Trade Intensity Index. The trade intensity index (T) is a metric utilized to assess if the trade value between two nations exceeds or falls short of what would be anticipated based on their significance in global trade. This index is determined by dividing one country's export share to a specific partner by the partner's share of global exports. The formula for calculating the trade intensity index is as follows:

$$Tij = (xij/Xit)/(xwj/Xwt) \quad (3)$$

Where *xij* and *xwj* are the values of country i's exports and of world exports to country *j* and where *Xit* and *Xwt* are country i's total exports and total world exports respectively. An index greater (lesser) than one signifies a bilateral trade flow that surpasses (falls short of) the anticipated level, considering the partner country's significance in global trade.

Trade Complementarity Index. The Trade Complementarity (TC) index offers valuable insights into the potential for intraregional trade by indicating the degree of alignment between a country's import and export structures. Furthermore, it allows for a comparison of values between countries contemplating regional trade agreements and those that have already established or attempted such arrangements. The TC between countries *k* and *j* is defined as:

$$TCij = 100(1 - sum(|mik - xij| / 2)) \quad (4)$$

Where *xij* is the share of good *i* in global exports of country *j* and *mik* is the share of good *i* in all imports of country *k*. The index is zero when no goods are exported by one country or imported by the other and 100 when the export and import shares exactly match.

Export Diversification/Concentration Index. Export diversification is considered crucial for developing nations due to their heavy reliance on a limited number of primary commodities for export revenue. The volatility in prices of these commodities can significantly impact the terms of trade for exporters in developing countries. Given the imperfect correlation among individual commodity prices, expanding into new primary export products is generally seen as a favorable step. The most significant advantages are typically observed when diversifying into manufactured goods, which can lead to increased and more stable export earnings, job opportunities, knowledge acquisition, and the establishment of necessary infrastructure to support the development of additional export products. The export diversification (DX) index for a country is defined as:

$$DXj = (sum\ |hij - hi|) / 2 \qquad (5)$$

Where *hij* is the share of commodity *i* in the total exports of country *j* and *hi* is the share of the commodity in world exports. The related measure used by UNCTAD is the concentration index or *Hirschman (H) index*, which is calculated using the shares of all three-digit products in a country's exports:

$$Hj = sqrt\ [\ sum\ (xi/Xt)2] \qquad (6)$$

Where *xi* is country *j*'s exports of product *i* (at the three-digit classification) and *Xt* is country *j*'s total exports. The index has been adjusted to consider the quantity of real three-digit products that could potentially be exported. As a result, the highest possible value of the index is 239 (representing the total number of distinct three-digit products in SITC revision 2), while the lowest (theoretical) value is zero, indicating a country with no export activity. A lower index value signifies a lower concentration of a country's exports.

Export Specialization Index. The export specialization (ES) index is a variant of the RCA index, with the denominator typically measured using specific markets or partners. It offers insights into the product specialization revealed in a country's export sector. The index is calculated by comparing the share of a product in a country's total exports to its share in imports from specific markets or partners, rather than its share in global exports:

$$ES = (xij/Xit) / (mkj/Mkt) \quad (7)$$

Where *xij* and *Xit* are export values of country *i* in product *j*, respectively, and where *mkj* and *Mkt* are the import values of product *j* in market *k* and total imports in market *k*. The ES bears resemblance to the RCA as a value below unity signifies a relative disadvantage, while a value above unity signifies specialization in this particular market.

Mainstream trade theories highlight the importance of the trade ratio as a measure of openness and its correlation with economic growth. However, it is essential to recognize that the trade ratio is influenced by various factors within the economy, such as tariffs, government policies, and institutional frameworks. Additionally, variables like local skills and investment climate play a significant role in fostering both economic growth and increased trade. The mainstream trade model's focus on the existing state of affairs limits its ability to address pressing issues like underdevelopment, inequality, imperialism, racism, and environmental challenges.

1.2. The concept of environmental sustainability in the system of international economic relations

The neoclassical perspective of economics, as outlined by Cozzi and Zamagni [46], serves as the foundation for neo-liberal policies. Its primary objective is to maximize welfare, as defined by Varian [47], by providing a greater number of individuals with increased opportunities for consumption. According to the neoclassical theory of growth, the key to alleviating poverty and achieving progress lies in boosting production and disposable income, leading to higher levels of consumption. This approach operates under the assumption that free markets possess the ability to self-regulate [48] and that technological advancements enable endless substitutions between different forms of capital. By mitigating the constraints posed by resource scarcity, sustainable growth can be achieved, ensuring that the level of consumption does not decline over time.

The Solow model serves as a crucial reference point within this theoretical framework. In this context, economic development, synonymous with economic growth, is characterized by a sustained level of consumption that does not decline over time. Furthermore, the sustainability of this development is contingent upon adhering to constraints on resource utilization, as outlined by the Hartwick-Solow rule [49].

The regulation states that if the royalties or user costs generated by the extraction of non-renewable resources are fully saved and reinvested in renewable capital according to an efficient plan, the resulting investment level would be adequate to maintain the economic capital stock value constant over time. This would ensure that production levels and consumption do not decrease, thus promoting sustainable development. Therefore, the limited availability of natural resources, including non-renewable ones, becomes almost irrelevant. It is possible to maintain consumption levels with exhaustible resources decreasing, as long as the capital stock remains constant, guaranteeing sufficient investment in man-made capital in each period [50]. The fundamental premise of these models is the assumption of complete interchangeability between natural capital (comprising renewable and non-renewable resources) and other types of capital (such as physical capital and human-made capital) [51].

According to Solow's perspective, capital experiences diminishing marginal productivity, meaning that at a certain point, growth comes to a halt, resulting in constant per capita consumption. However, the introduction of exogenous technical progress, which is considered external to the model, can counterbalance this trend by allowing the production function to increase and prevent growth from stopping. On the other hand, endogenous growth models, while sharing Solow's fundamental philosophy, eliminate the assumptions of decreasing capital productivity and exogenous technical progress. By removing these assumptions, it is argued that there will be no convergence in growth rates among different countries in the future, and the tendency to continue expanding will persist. In other words, there are no inherent mechanisms that lead to a halt in growth (as it was the diminishing marginal

productivity of capital that previously caused growth to cease, unless offset by exogenous technical progress) [52].

The neoclassical approach presents a model of continuous growth for a closed and linear economic system. In contrast, endogenous growth models, while sharing the basic philosophy of Solow, challenge the assumptions of decreasing productivity of capital and exogenous technical progress. By removing these assumptions, it is argued that there is no guarantee of convergence in growth rates among countries in the future, and instead, a tendency for continued expansion is predicted. This implies that there are no inherent mechanisms that would halt growth, unlike the diminishing marginal productivity of capital in the past. Furthermore, the emphasis on market equilibrium as a means to ensure economic efficiency and maximize well-being has overshadowed long-term studies, effectively eliminating any "pessimistic" considerations commonly found in classical studies [46].

Theoretical conclusions should not be misleading, but it is important to note that the confidence in the market, as advocated by classical economists, was only applicable in the short term. In the long run, the economy would inevitably reach a stationary state, aligning with the basic subsistence level for all individuals. This pessimistic outlook stemmed from the realization that natural resources are scarce and finite. As a result, long-term economic growth would eventually be constrained by the limitations of these resources, putting a halt to further expansion (see fig. 1.4).

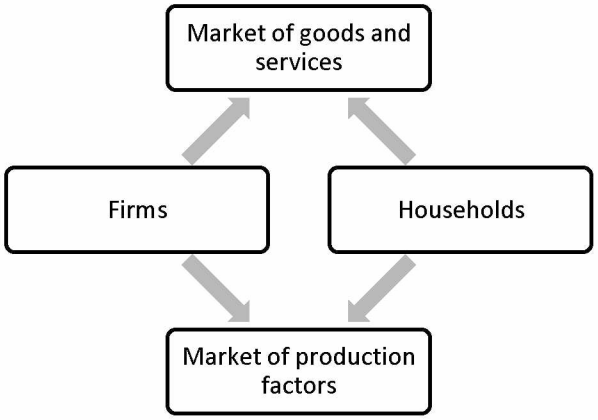

Fig. 1.4. The economic system: a closed system and linear

Source: [53]

The conventional neoclassical economists view the economic system as a closed and linear system, neglecting the interconnection between the economic system and the environment, unlike the classical economists. In this perspective, the environment is seen merely as a means to an end, with resources to be utilized in the production process to align with market equilibrium. The unrestricted use of natural resources is often deemed necessary to sustain economic expansion and generate job opportunities [53].

The lack of attention to long-term considerations, driven by an overconfidence in the efficiency of the market mechanism and technology, has hindered the recognition of natural resources as a limit to growth. Historically, the market has addressed scarcity through price adjustments, which in turn incentivized research and technological advancements. However, this unwavering faith in the market and technology has led to investment decisions that often overlook environmental concerns. The optimistic neoclassical perspective prevalent in the twentieth century resulted in significant environmental degradation. It is important to acknowledge the specific historical context in which neoclassical economists operated. During that time, the world seemed full of promise and progress, with advancements occurring at an unprecedented pace, blinding them to the potential negative consequences. The world was viewed as an open frontier to be conquered, following a "Far West" mentality [54].

The neoclassical growth model was effective as long as the company operated with agricultural structures or pre-industrial methods. During this time, population density was low, production was scattered, and the prevailing culture, particularly in agricultural regions, focused on reusing and recycling material resources. Economic activity residues were reintegrated into the natural cycle of self-purification, maintaining a significant balance between humans, production, consumption, and the environment. However, as the population grew and concentrated in larger urban areas, production and consumption increased, leading to a significant depletion of natural resources and a surge in waste production. This resulted in a disruption of the initial equilibrium and the natural cycle that had previously occurred spontaneously [55].

During the majority of the 20th century, there was a prevailing optimistic perspective regarding the growth of the economy. However, this viewpoint started to face a crisis in the 1960s. It was during this time that the first instances of smog, scarcity, and pollution emerged. These environmental issues clashed with the notion that economic progress would continue indefinitely. The evidence of the detrimental environmental consequences, pollution, and the impact on human health became undeniable [56].

The prevailing reliance on easily replaceable resources through market mechanisms and technological advancements has resulted in the clash between the neoclassical assumption and the finite nature of the natural environment. This realization has brought about an awareness that human communities are interconnected with a much broader ecosystem, encompassing not only humans but also non-human entities [57]. From this perspective, the conventional economy, commonly referred to as the "real" economy, should be viewed as merely a component of a broader economic system known as the "extended" economy. This extended economy encompasses the entire interconnected web of global life, acknowledging the interdependent relationship between the environment and the economy. It encompasses institutions and activities aimed at producing and exchanging goods and services, utilizing limited resources to efficiently meet human needs [53].

In the 1960s, it became evident that there exists a close relationship between economics and the environment [58]. The real economy was viewed as an open and circular subsystem that relies on its ecological foundation for sustainability. This system is constantly growing within a larger, yet finite, closed system that does not allow for the introduction of new matter, but only solar energy. These concepts, which Daly has emphasized in the past two decades, were previously explored by Boulding [54] in his renowned work "The Economics of the Coming Spaceship Earth." This paper outlines the essential transformations required in the field of economics, shifting from a "cowboy economy" mindset of unlimited resources to a more sustainable "spaceman" economy. The concept of a spaceship represents a closed-loop system, emphasizing the need to prioritize recycling, minimize waste, preserve finite energy

sources, and harness renewable energy like solar power [54]. Boulding's synthesis work is structured within the materials balance models, illustrating the connections between the economic system and the environment (see Fig. 1.5).

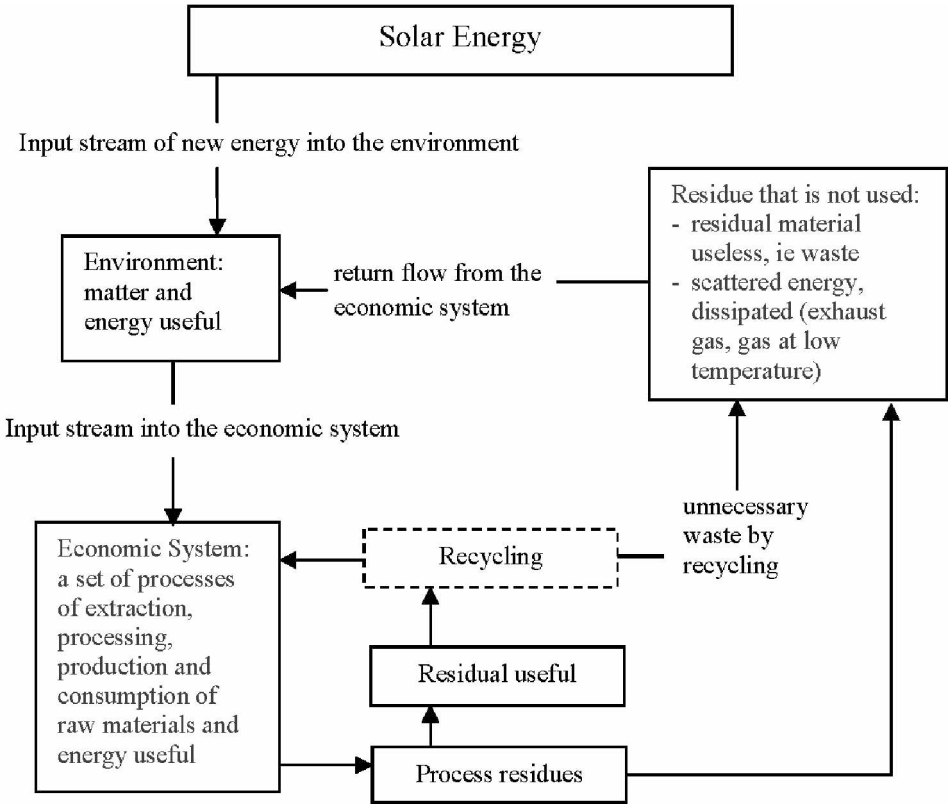

Fig. 1.5. A materials balance model of economic open and circular subsystem

Source: [59]

In this particular model, the economic system operates in an open and circular manner. It involves a series of extraction procedures for both matter and energy from the surrounding environment, followed by basic processing, production, and consumption. As each of these processes concludes, it generates residues that are no longer viable within the environment and are deposited in receptor bodies. The accounting of these residues is regulated by the first and second law of thermodynamics, which emphasize the importance of considering the environmental limitations that the system must adhere to [50]. During the 1960s, the discussion surrounding the environmental and social constraints on economic growth was fueled by the evident repercussions of the "cowboy economy" mindset rather than the

"spaceman" approach. Within the literature, two perspectives emerged: the neo-Malthusian and neoclassical, both stemming from a reevaluation of their core principles. In essence, the critical aspects of the neoclassical theory were thoroughly examined, challenging notions such as unwavering faith in the market, the concept of equilibrium prices, the potential of technological advancements, and the system's capacity to ensure maximum growth. In summary, the primary criticisms of the neoclassical theory were acknowledged in order to preserve its own orthodoxy.

Recent research findings have introduced new components into existing theories, such as the dynamic efficiency assessment incorporating the "E" variable. This highlights the significance of externalities, pollution costs, and the necessity to internalize "external costs" within the private sector. These factors have raised concerns about market functionality and its capacity to reach an optimal equilibrium, leading to discussions on "market failure" and the requirement for public intervention [59]. The Cost-Benefit Analysis model's decision-making rule, which is used for intertemporal resource allocation and is socially efficient (dynamic efficiency), needs to be adjusted to account for any Benefits and/or Costs that may arise from environmental changes caused by the project or policy measure being evaluated. For a project or policy measure to be approved, the total present values of non-environmental benefits, non-environmental costs, and the net value of environmental change must be positive.

Many economists argue that the interconnection between population growth, economic growth, resource utilization, and assimilation capacity necessitates a sustainable development path characterized by economic growth and population control. They advocate for the intentional establishment of a "steady state" situation to prevent reaching a state of absolute physical resource scarcity [57]. Daly's publication was praised for its ability to draw attention to the limitations of nature and the need for a critical examination of the concept of indefinite neoclassical growth. Over time, the author shifted their focus towards analyzing the disparities between growth and development, highlighting the quantitative nature of the former and the qualitative nature of the latter. By proposing the idea of "development without growth," the author

suggests that the only viable path for development is one that acknowledges the biophysical constraints imposed by nature. This is why there is a call to move beyond relying solely on GDP as an indicator of progress, as it primarily measures growth rather than development [59].

From this perspective, Daly discusses the concept of a steady state economy, which can be achieved through several means. Firstly, he emphasizes the importance of birth control, which can be implemented through a permits market for births. Secondly, he highlights the need to maintain the level of entropy within the limits of regeneration systems. Lastly, he advocates for the redistribution of the constant stock of wealth among a constant population. The most well-known articulation of this inevitable conclusion is closely associated with the "Malthusian point of view" as defined by Malthus in 1909. This viewpoint is further elaborated upon in "The Limits to Growth" by Meadows, Randers, and Beherens in 1972 and 1981 [59].

The research findings indicated that despite the significant increase in known reserves of minerals and energy, thanks to new discoveries and advancements in technology, the exponential growth pattern would ultimately result in the depletion of a substantial portion of these resources within a span of less than a century, considering the rate at which consumption is growing annually. Such a scenario would have severe consequences for the very foundation of modern society unless there are substantial changes made to the fundamental physical, economic, and social relationships that have traditionally guided global development. The document authored by Meadows and other scholars from Boston clearly reflects a neo-Malthusian perspective, which asserts the impossibility of sustaining infinite economic growth within the constraints of a finite environment, given the inevitable progressive depletion of the planet's resources. This viewpoint has also been supported by more recent contributions [57].

The concept of sustainable development (SD) has been shaped through practical application and the examination of relevant policies [60; 61]. SD has undergone a process of idea generation and subsequent implementation, exemplified by events like the United Nations Sustainable Development Summit. Over time, SD has transitioned from addressing environmental concerns to encompassing global strategic issues [65].

Drawing from the research conducted by Lele [62], Mebratu [63], Zhang [64], and other scholars, this paper categorizes the evolution and development of SD theory into three distinct periods: the embryonic period (prior to 1972), the molding period (1972-1987), and the developing period (since 1987).

Although the terms "sustainability" or "sustainable" emerged in the 20th century, similar concepts have been in existence for centuries. The notion of sustainable development has a rich history in China, with its roots tracing back to the fundamental idea of Chinese classical philosophy known as 天與人合一 (Heaven and people in one) [66]. As early as the Western Zhou Dynasty (B.C. 1100-771), the emperors recognized the importance of utilizing mountains, forests, and rivers in harmony with the laws of nature, rather than exploiting them excessively. Consequently, various measures were implemented to safeguard natural resources, including the establishment of dedicated management departments, state monopoly enforcement, taxation related to mountains and gardens, and the implementation of bans [67]. Subsequently, ancient civilizations such as Egypt, Mesopotamia, Greece, and Rome deliberated on different causes of environmental degradation, such as farming, logging, and mining [68]. They also proposed certain measures to address these issues. Varro, in the first century AD, suggested that "we can, by care, lessen the evil effects" [69]. The term "sustainability" was first employed in Carlowitz's monograph titled "Afforestation and Economy," published in 1713, which comprehensively tackled the subject of sustainable forestry [70].

The 1809 edition of the German Dictionary defined "sustainability" as the ability for something to remain reliable when all else fails. This early concept of sustainable development was primarily focused on the responsible utilization of natural resources. In 1972, the United Nations organized a world summit in Stockholm, Sweden, in response to the realization that developmental policies focused solely on economic growth were causing significant environmental problems. This summit, known as the first human environment conference, marked the inception of the concept of sustainable development (SD) [71]. Subsequently, in 1987, the World Commission on Environment and Development (WCED) produced a groundbreaking report titled "Our

Common Future," which provided a comprehensive definition of SD. According to the report, sustainable development entails meeting the needs of the present generation without compromising the ability of future generations to meet their own needs [72]. The report extensively examined global issues such as population, food, species and genetic resources, energy, industry, and human habitation. Furthermore, it addressed a range of significant economic, social, and environmental challenges faced by humanity, emphasizing three key perspectives: 1) the inseparability of environmental, energy, and developmental crises; 2) the insufficiency of Earth's resources and energy for human development needs; and 3) the necessity to alter current developmental models for the benefit of present and future generations [72]. While these definitions and viewpoints are concise and broad in nature, they lack direct and practical applicability.

In 1992, the United Nations organized a conference in Rio de Janeiro, Brazil, to discuss environment and development, marking the beginning of Sustainable Development (SD) on a global scale. During the conference, the "Rio Declaration on Environment and Development" and the "Agenda 21" were adopted and signed. Additionally, an agreement was reached to outline the "common but differentiated responsibilities" of developed and developing nations in addressing global environmental challenges, along with the necessity for developed countries to provide financial support and technology transfer to developing nations. This gathering also established objectives and strategies to promote sustainable development and introduced the concept of fostering a global partnership to collectively address global environmental issues. This event marked the first instance in history where the SD strategy was put into practice on a global scale, underscoring the significance of SD in international policy [73]. Since then, SD has garnered widespread support among the global community. Furthermore, the conference viewed SD as a fundamental concept for reconciling the perceived conflict between economic progress and environmental conservation, highlighting the importance of sustainable development in terms of resources and the environment [74]. The conference also stressed the significance of social equity and societal harmony, thereby introducing the social aspect of SD theory.

Building on this theoretical framework, the three pillars of SD were identified as economy, society, and environment [75].

Despite the significant progress made in the field of sustainable development (SD), many scientists have encountered challenges in conceptualizing and measuring SD [76]. In 1999, the National Research Council (NRC) released a report titled "Our common journey: A transition toward sustainability," which introduced the term "sustainability science" and defined it as "the science of sustainable development" [77]. In 2001, an article titled "Sustainability Science" emerged as a pivotal moment in the emergence of Sustainability Science [78]. The article emphasized that sustainability science aimed to elucidate the interplay between natural and social factors and enhance our capacity to steer this interaction towards a more sustainable path. Since then, sustainable development has evolved into a scientific discipline encompassing areas such as agriculture, ecological economics, forestry, and more [79]. Currently, the prevailing consensus among scholars is that natural capital, manufactured capital, human capital, and social capital are the key classifications [80]. In order to attain sustainable development in human society, it is crucial to rely on the availability of these four types of capital and their interconnections over a specific timeframe. The comprehension of the relationships between these four types of capital significantly influences the interpretation and assessment of sustainability. Presently, there exist three primary interpretations regarding the mutual substitution between natural capital and manufactured capital (Fig. 1.6).

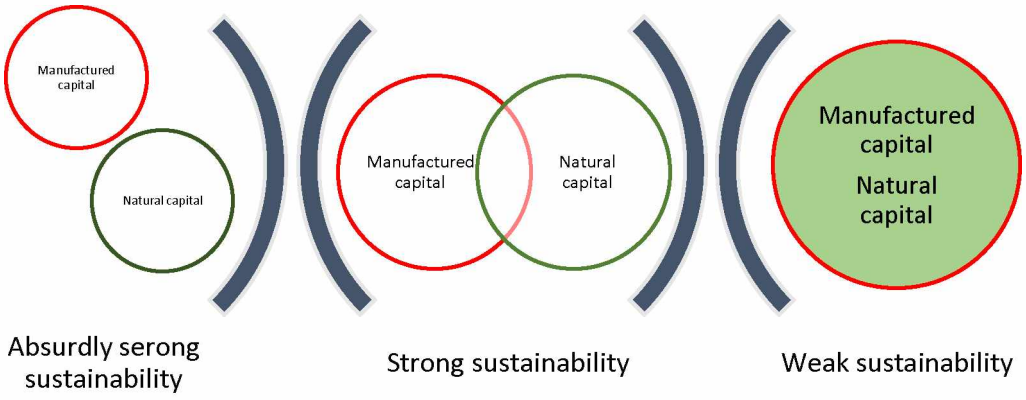

Fig. 1.6. Types of sustainability

Source: [81]

Weak sustainability, an extension of neoclassical welfare economics, posits that manufactured capital can serve as a substitute for natural capital. In this view, the total amount of both manufactured and natural capital is deemed crucial [82]. Consequently, as long as the overall capital stock grows during the development process, sustainability is maintained, even if natural capital deteriorates irreversibly [83]. Strong sustainability emphasizes the importance of natural capital in both production and consumption, highlighting its irreplaceable role. This perspective is rooted in the steady-state economic theory, which asserts that manufactured capital cannot be replicated without the input of natural capital [84]. Consequently, the development process should not solely focus on increasing the overall capital, but also prioritize the rationality of the capital structure while avoiding crossing ecological thresholds [85]. Furthermore, economic progress must not surpass the limits imposed by nature [86]. Absurdly strong sustainability not only holds the belief that natural capital cannot be replaced by manufactured capital, but also advocates for the elimination of the exploitation and utilization of ecosystems. After this concept was developed, some extreme environmentalists proposed the idea that humans and other species are equal [87]. They argue that humans should progress without altering the natural balance. Furthermore, these radical environmentalists support the idea of halting human societal development in order to focus on restoring and preserving nature, although this notion is considered impractical [88].

The benefit of weak sustainability lies in its support for the advancement of science and technology, as well as the interchangeability of natural and man-made capital, which aligns better with the requirements of economic progress. On the other hand, weak sustainability's drawback is its overly optimistic outlook on humanity's capacity to manage nature and technological advancements, assuming that nature has limitless resilience and that all ecosystem functions are replaceable. Conversely, the advantage of extremely strong sustainability is the recognition of the economic system as a part of nature, rather than a separate entity. However, the downside of extremely strong sustainability is the underestimation of technology's role, and the belief that all natural capital is irreplaceable, despite the fact that certain natural resources can be

substituted with man-made alternatives. Strong sustainability, which opposes the two extreme perspectives mentioned earlier, advocates for a balanced approach. Nevertheless, a downside of strong sustainability is the establishment of strict thresholds that must not be exceeded, potentially impeding economic growth, particularly in developing nations. Currently, there is a scarcity of comprehensive studies on the various levels of sustainability development in terms of evaluation criteria and measurement techniques. Most assessments are rooted in the concept of weak sustainability, which involves a simplistic summation of the economic, social, and environmental systems to gauge sustainability levels. An example of this approach is the calculation of Green GDP, which deducts the expenses related to environmental and ecological harm from a country's traditional GDP.

Human society faces various development challenges at different times. With the guidance of the sustainable development theory, practices in this field are constantly evolving, and the goals of sustainable development are continuously being enhanced and enriched [89]. Initially, the objectives of sustainable development revolved around the sustainable utilization of animal and plant resources. However, they have now expanded to include the Millennium Development Goals (MDGs) with a focus on poverty alleviation, and further progressed to the more comprehensive and universally applicable Sustainable Development Goals (SDGs) [90].

During the era of the agricultural economy, there was a growing awareness of the limited regenerative capacity of natural resources. Ancient scholars emphasized the importance of conserving resources essential for human survival, such as forests, fisheries, birds, and animals. 史记_殷本纪 (Records of the Historian – the Yin Dynasty) embodies the sustainable use of animal and poultry resources. 论语_述而 (The Analects of Confucius) and 吕氏春秋 (The Annuls of Lu Buwei) reflect the sustainable use of fishery resources, and 秦律_田律 (Qin Law-Tian Law) reflects the sustainable use of forest resources. In 1980, the concept of sustainable development gained prominence with the introduction of the World Conservation Strategy by the International Union for the Conservation of Nature and Natural Resources (IUCN). The strategy aimed to achieve sustainable development through the conservation of living resources [91].

This marked the beginning of a series of influential actions, conferences, documents, and discussions that shaped a global mindset on sustainable development, including the 21st-century agenda. International groups such as the International Monetary Fund (IMF) and the World Bank recognized environmental issues as a priority and acknowledged them as the foundation and core of sustainable growth [92]. To assess sustainable development, various indicators were established, including the System of Integrated Environmental and Economic Accounting (SEEA), Ecological Footprint (EF), and the Millennium Ecosystem Assessment (MA) from 2001 to 2005, which evaluated the impact of ecosystem change on human well-being [93]. During this period, the focus of sustainable development was primarily on ecological sustainability, aiming for the sustainable utilization of natural resources and environmental protection.

The UN introduced the SDGs in 2015, building on the lessons learned from the MDGs. These goals encompass dignity, humanity, environmental sustainability, economic prosperity, social justice, and global partnerships [94]. Consisting of 17 main goals and 169 sub-goals, the SDGs aim to steer sustainable development efforts worldwide over the course of the next 15 years [95]. The Sustainable Development Goals (SDGs) can be categorized into four aspects: economy, society, environment, and governance. The economy aspect includes goals 8, 9, 10, and 12, while the society aspect encompasses goals 1, 3, 4, 5, 11, and 16. The environment aspect consists of goals 2, 6, 7, 13, 14, and 15, and the governance aspect is represented by goal 17 [96]. Scholars have compared the SDGs with the Millennium Development Goals (MDGs), highlighting several key differences. Firstly, the SDGs are more universal, targeting countries with high, middle, and low income, whereas the MDGs primarily focused on developing countries [97]. Secondly, the SDGs are more comprehensive and specific, addressing specific goals such as combating climate change and conserving marine resources, whereas the MDGs generally emphasized “ensuring environmental sustainability” [98]. Thirdly, the SDGs set higher standards, aiming to “end poverty in all its forms everywhere” compared to the MDGs' goal of “eradicating extreme poverty and hunger”. Additionally, the SDGs prioritize improving the quality of education

rather than just increasing enrollment rates, unlike the MDGs. Fourthly, the SDGs emphasize bidirectional cooperation, with all parties taking subjective initiative and responsibility, whereas the MDGs focused on aid from developed to developing countries. Fifthly, the SDGs introduce the concept of a data revolution, specifically goal 17, which aims to enhance the availability of high-quality and timely data, a concept absent in the MDGs. Lastly, the SDGs call for a transformation of the development paradigm, urging individuals living in extreme poverty to not only survive but also live with dignity, in contrast to the MDGs [97].

1.3. Decoupling and impact of natural resource utilization and consumption on international trade

The shift towards a low carbon, resource efficient Green Economy has emerged as a central theme in global endeavors to foster sustainable development amidst the dynamic landscape of the XXI century. Simplified, decoupling involves minimizing the use of resources like water and fossil fuels for economic growth while separating economic progress from environmental harm. With the global population expected to reach nine billion in the next 30 years, growth is essential to alleviate poverty and provide jobs for the two billion people who are jobless or underemployed. However, this growth should prioritize efficient resource utilization rather than depleting the essential assets that support livelihoods and economic prospects [103].

The previous century witnessed significant advancements in human civilization, driven by scientific and technological breakthroughs. The extraction of construction materials, ores, minerals, fossil fuels, and biomass saw substantial growth, with factors ranging from 3.6 to 34. However, this surge in consumption was not evenly spread and led to severe environmental consequences. Issues such as over-exploitation, climate change, pollution, land-use changes, and biodiversity loss became major global concerns. Consequently, 'sustainability' emerged as a crucial global priority, urging governments, international bodies, and businesses to prioritize environmental, social, and economic balance. It became clear that achieving a sustainable economy

necessitates a reduction in global resource consumption, while also ensuring that economic growth is coupled with environmental preservation [104].

The term 'decoupling' has been utilized in various fields such as electronics, physical cosmology, and linear algebra. In this context, decoupling refers to the practice of utilizing fewer resources per unit of economic output and minimizing the environmental consequences associated with resource usage and economic activities. Figure 1 effectively represents the fundamental elements of decoupling in relation to sustainable development, specifically resource decoupling and impact decoupling (see fig. 1.7).

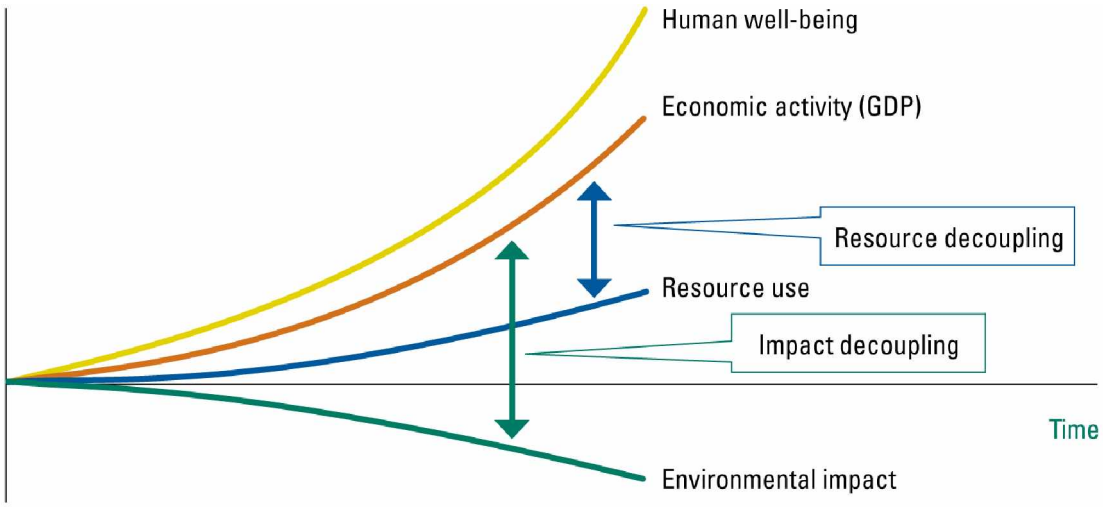

Fig. 1.7. Aspects of "decoupling"

Source: [99]

Achieving decoupling will necessitate substantial modifications in government policies, corporate conduct, and public consumption habits. These modifications will undoubtedly be challenging, and this document does not aim to outline the exact path towards their realization or comprehensively examine all the obstacles associated with this concept. Instead, its purpose is to enhance comprehension of the pivotal concept of decoupling, which forms the basis for the endeavors of the International Resource Panel (IRP) [113].

Human prosperity and its enhancement, both presently and for a continuously expanding global population in the years to come, relies on the accessibility of natural

resources like energy, materials, water, and land. The progress of the economy has been linked to a significant increase in the utilization of these resources. Several of them are dwindling in comparison to the demand, and a few are at risk of severe scarcity in the foreseeable future. Adverse environmental consequences can emerge from any stage of the resource life cycle: during extraction, production, consumption, or post-consumption. Interventions in natural systems, like altering land cover and extracting resources, can result in various impacts. Additionally, unintended consequences of economic activities, such as emissions and waste, can also contribute to these impacts. Therefore, achieving decoupling necessitates considering not only the quantity of resources used in economic processes but also the environmental repercussions of this resource consumption throughout its entire life cycle. These impacts have the potential to disrupt ecosystem services crucial for human welfare [105].

Successfully addressing the primary obstacles of separating resource utilization and detrimental environmental effects from economic operations will significantly contribute to the overarching objectives of meeting the demands of a burgeoning global population, eliminating poverty, and fostering economic progress, while minimizing strain on the world's resource reserves and safeguarding future earth and ecosystem services. To accomplish these aims, it is imperative to decouple natural resource consumption and its accompanying negative environmental consequences from the economic activities necessary to sustain a growing populace, both on a global scale and over the long term [106].

Natural resources encompass a wide range of elements found in nature that can be utilized for various purposes. This all-encompassing definition can include intangible resources like the melody of a bird inspiring a musician or the light of a star guiding a sailor, as well as tangible resources like a stone in a farmer's field. The first two examples are considered 'immaterial resources' as their use does not alter their inherent qualities, making it difficult to assign them an economic value. On the other hand, the stone in the field is a 'material resource' whose value is determined by its characteristics that make it suitable for specific uses. For instance, its value in constructing a wall differs from its value as an obstacle for the farmer plowing the field.

However, if the stone contains gold, its value significantly increases, provided that the farmer is aware of its worth [99].

The qualities and range of applications of immaterial resources remain unchanged, regardless of their utilization. For instance, a bird's song can be appreciated by different composers or birdwatchers, and starlight can serve as valuable information for both ship captains and astronomers. On the other hand, when it comes to material resources, their usefulness for a specific purpose may diminish upon utilization. For example, a rock used to construct a wall cannot be reused for another wall or transformed into gold jewelry (if it contains gold) without destroying the initial wall. Although material resources do not vanish through transformation, their potential usefulness for the same purpose diminishes. The extent to which a resource declines through use or conversion depends on the modifications it undergoes [107].

The OECD was the pioneer international organization to embrace the idea of resource decoupling, considering it a key goal in their policy document "Environmental Strategy for the First Decade of the XXI Century" (approved by OECD Environment Ministers in 2001). The OECD's definition of decoupling involves disconnecting 'environmental bads' from 'economic goods'. The concept of 'eco-efficiency' was introduced by the World Business Council for Sustainable Development (WBCSD) in the past. This term refers to the production of goods and services that are competitively priced, meet human needs, enhance quality of life, and simultaneously reduce environmental impacts and resource intensity throughout their entire life cycle. This approach was already in use, even before the term 'decoupling' was coined, highlighting the importance of considering the entire life cycle of products and services [108].

In a similar vein, the European Union (EU) embraced the Lisbon Strategy for Growth and Jobs in 2005, emphasizing the importance of sustainable natural resource management. The EU was urged to lead the way in promoting sustainable consumption and production on a global scale. Subsequently, the EU adopted the Thematic Strategy on the Sustainable Use of Natural Resources as part of the 6th Environmental Action Program (6th EAP). This strategy aims to promote sustainable resource use by

mitigating the environmental consequences associated with resource consumption, all while fostering economic development. The Strategy acknowledges the need to decouple resource use and its environmental impacts from economic growth.

In the context of developing nations, the Sustainable Development and Human Settlements Division of the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) suggested that sustainable development in these economies could be most effectively achieved through a focus on "nonmaterial economic growth". While the term 'decoupling' was not explicitly mentioned in the report, the distinction between 'material' and 'non-material' economic growth essentially addressed the concept of decoupling growth from resource consumption. Following this line of thought, resource decoupling can be described as enhancing resource productivity, while impact decoupling can be seen as improving eco-efficiency [109].

Resource decoupling involves reducing the amount of primary resources used per unit of economic activity. This process, known as 'dematerialization,' focuses on utilizing fewer material, energy, water, and land resources to achieve the same economic output. By decoupling resources, efficiency in their utilization is improved. Enhanced resource productivity can be quantitatively measured by dividing added value by resource use, such as GDP over Domestic Material Consumption. If this ratio increases over time, it indicates an increase in resource productivity. Another method to illustrate resource decoupling is by comparing the rate of economic output growth with the rate of resource input growth; if the latter is lower, then resource decoupling is taking place [110].

Impact decoupling involves increasing economic output while simultaneously reducing negative environmental impacts. These impacts can occur during resource extraction, production, use, and post-consumption phases. Life cycle analysis (LCA) combined with input-output techniques can help estimate these impacts. The goal of impact decoupling is to decrease environmental harm while still creating economic value. However, measuring impact decoupling on a larger scale, such as at the national

economy or sector level, can be complex due to the multitude of environmental impacts, varying trends, and disputed system boundaries and weighting procedures.

There exists a differentiation between 'relative' and 'absolute' decoupling. Relative decoupling involves a scenario where the growth rate of environmentally relevant parameters is lower than the growth rate of a relevant economic indicator, maintaining a positive association but with an elasticity. This type of decoupling is quite common. On the other hand, absolute decoupling occurs when resource use decreases regardless of the economic driver's growth rate [100]. This is exemplified by the Environmental Kuznets Curve, suggesting that as prosperity increases, the environmental impact of production and consumption decreases [116]. Absolute reductions in resource use are uncommon and can only happen when the growth rate of resource productivity surpasses the growth rate of the economy [101].

This evaluation focuses on resource decoupling and impact decoupling as the two interconnected modes within the decoupling framework utilized by the IRP. Strategically, they vary in several aspects. Resource decoupling aims to address scarcity issues and tackle the sustainability challenge of intergenerational equity by decreasing the rate of resource depletion, while cutting costs through enhancing resource productivity. Resource decoupling is anticipated to also lower the environmental impacts of specific resources throughout their entire life cycle by utilizing them more efficiently [111].

Resource decoupling can be easily quantified and monitored, although it may pose more challenges in terms of implementation compared to impact decoupling. On the other hand, impact decoupling involves utilizing resources in a more efficient, prudent, or environmentally friendly manner. It is important to note that reducing environmental impacts does not automatically address resource scarcity or production costs, and in some cases, it may even exacerbate these issues. A prime example of this is carbon capture and storage (CCS), where the technology currently demands more energy per unit of output, hindering resource decoupling. However, by preventing the release of CO2 into the atmosphere, the overall environmental impact throughout its

life cycle is diminished. This discussion highlights the significance of resource decoupling in two specific scenarios:

1) resource decoupling is particularly important [112]*:*

– when a particular resource is scarce and its further depletion could hinder societal progress. Examples of such resources include oil, rare minerals, or fertile land required for food production to sustain the growing human population [102];

– when a specific resource poses significant environmental risks that cannot be mitigated by improving its usage. In such cases, reducing the consumption of the resource becomes the only viable solution. Historical instances of this include asbestos and chlorofluorocarbons used in cooling devices. Currently, fossil fuels represent a critical case, although the implementation of CCS (Carbon Capture and Storage) technology could partially address the CO_2 issue through impact decoupling.

2) impact decoupling is particularly important [112]*:*

– the utilization of a resource presents imminent dangers to the well-being of both humans and ecosystems. This includes scenarios involving toxic emissions, persistent organic pollutants, or adverse effects on soil fertility;

– there exists considerable potential for technological solutions to effectively avert any harm caused to humans and ecosystems.

Various economic activities have adverse effects on the environment, but some are intentionally created to have positive environmental outcomes, such as forest reserves, agricultural set-asides, or payments for ecosystem services. Changes in technology and society have lessened negative environmental impacts in the past, leading to economic growth becoming disconnected from certain impacts while others have remained the same or worsened. This highlights the challenge of achieving impact decoupling without recognizing that specific actions can have unintended consequences or overlook certain impacts. Consequently, creating a comprehensive set of interventions to separate resource use from all negative environmental impacts at once may prove to be a complex task [113].

Certain studies suggest that the excessive utilization and depletion of natural resources in certain nations can be attributed to international trade. Developed

countries indirectly stimulate the demand for natural resources in developing countries by exporting products that require a significant number of resources. Consequently, this leads to the depletion of natural resources and environmental challenges faced by these developing nations. Conversely, other studies argue that international trade can also facilitate the prudent utilization of resources. Through trade, resources can be allocated and utilized more efficiently across borders, thereby minimizing the risk of resource scarcity. The international trade is significantly influenced by the utilization and consumption of natural resources, primarily through the interplay of supply and demand and the price mechanism. Several research studies propose that the consumption of resources has resulted in a rise in resource prices, potentially impacting the competitiveness and cost framework of international trade. Elevated resource prices can escalate the production expenses of resource-intensive goods and impact their competitive standing in the global market. Conversely, the prudent utilization of resources can bolster the competitiveness of businesses in the international market by curbing production costs and enhancing product quality [114].

There exists a strong correlation between the utilization and consumption of natural resources and international trade. Trade plays a crucial role in advancing the development and utilization of resources, as well as facilitating the flow and allocation of resources. The concepts of comparative advantage and resource endowment elucidate how trade can lead to economic gains by leveraging the advantages of available resources. Research indicates that trade has the potential to boost a nation's economic revenue and gross domestic product, while also enhancing the standard of living for its inhabitants. This is primarily due to trade enabling countries to concentrate on industries where they hold a comparative advantage, thereby enhancing productivity and economic efficiency. The theory of the comparative advantage trap cautions against the inherent weaknesses that trade can bring about. Relying too heavily on comparative advantage can result in countries being stuck in industries that offer little value or are heavily reliant on resources, thus making them more economically vulnerable. Additionally, international trade can contribute to the overconsumption of resources and environmental issues. This could be attributed to the loosening of

environmental regulations in certain countries to attract foreign investments or cut down on production expenses, ultimately leading to the overexploitation of resources and environmental pollution [115].

The theory of comparative advantage is considered the foundation of international trade, highlighting the benefits of trade on economies, including GDP growth and enhanced welfare for residents. Economist Adam Smith's perspective is referenced, along with studies supporting the theory, like Lin Yifu et al.'s empirical analysis and discussions on industrial upgrading. The theory also warns about the potential structural issues resulting from trade, particularly for developing nations, where overreliance on comparative advantage can lead to a cycle of low-end industries and increased economic fragility. Hong Yinxing et al.'s research is mentioned, along with proposed solutions like prioritizing industrial upgrading and technological innovation [117].

The theory of resource endowment elucidates how trade can bring about economic gains by leveraging the comparative advantage of resources. The theory acknowledges the significant contributions of Eli Heckscher and Berthel Olin, among other scholars, and emphasizes that variations in resource endowment can result in the efficient allocation of global production factors and impact economic growth. The concept of the environmental Kuznets curve elucidates the correlation between environmental quality and economic progress. It highlights that as economic development and per capita income rise, environmental quality may initially decline before eventually improving. The authors reference the studies conducted by Grossman and Krueger to support their argument and propose that trade could play a significant role in this phenomenon. The pollution paradise theory and the race to the Bottom theory suggest that trade could result in resource-intensive industries moving to areas with less strict environmental regulations, potentially worsening environmental issues. Various studies, including Copeland and Taylor's examination of the North-South trade model, and Solarin et al.'s research on polluted havens in Ghana, are cited by the authors [118].

Natural resources encompass a wide range of materials and energy sources found in the environment that are essential for the sustenance and progress of human civilization. These resources can be categorized based on their unique properties and characteristics, with common classifications including (see fig. 1.8):

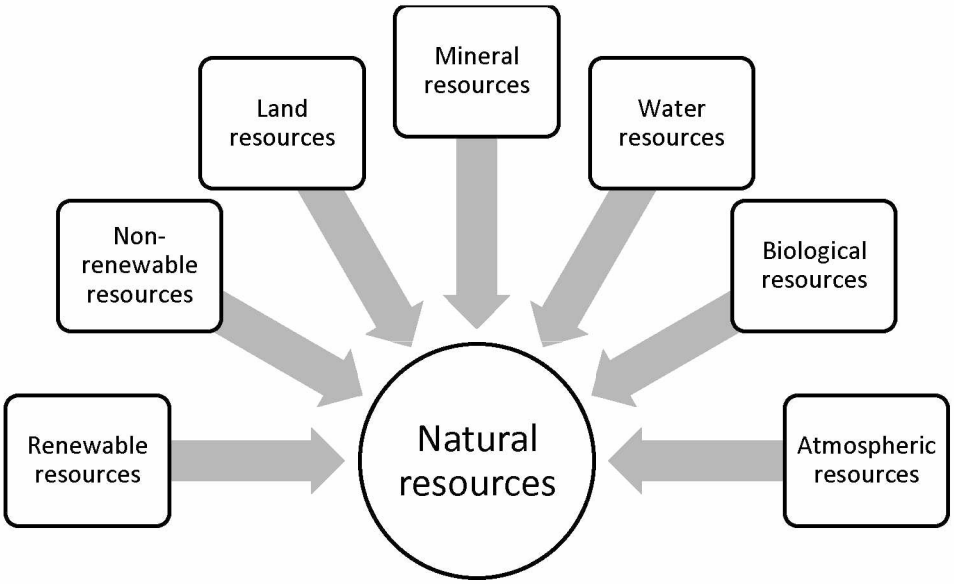

Fig. 1.8. Classification of natural resources

Source: [author]

Renewable resources encompass a wide range of natural resources that have the ability to replenish themselves either through natural processes or through human intervention, as long as they are utilized and managed responsibly. These resources include solar energy, wind energy, water energy, forests, and fishery resources, among others. *Non-renewable resources* encompass resources that have finite quantities and cannot be replenished or recycled once they have been depleted. Instances of such resources include oil, natural gas, coal, iron ore, and more. *Land resources* encompass the various types of land found on the earth's surface, such as arable land, pastures, forests, bodies of water, and more. These areas serve as the fundamental spaces for human activities and sustenance. *Mineral resources* encompass a wide range of minerals, ores, and mineral deposits found in the earth's crust, such as metal minerals, non-metallic minerals, and energy minerals. *Water resources* encompass the freshwater reserves found on our planet, comprising both surface water and groundwater. These

resources serve as a vital foundation for human existence, agricultural activities, and industrial operations. *Biological resources* encompass a variety of living organisms on Earth, including plants, animals, and microorganisms. These resources are essential for providing humans with food, medicine, fibers, and other important products. *Atmospheric resources* encompass the gases and aerosols present in the atmosphere, such as air, oxygen, carbon dioxide, and more. These resources are vital for human respiration and industrial activities. The aforementioned classifications represent typical categorizations of natural resources. Each classification possesses distinct characteristics and utilization approaches, all of which hold immense importance for the advancement and enduring prosperity of human civilization [119].

The utilization and consumption of natural resources refers to the process of human exploitation, utilization and consumption of various resources existing in nature (see fig. 1.9). These resources include water, land, minerals, energy, forests, fishery resources, etc.

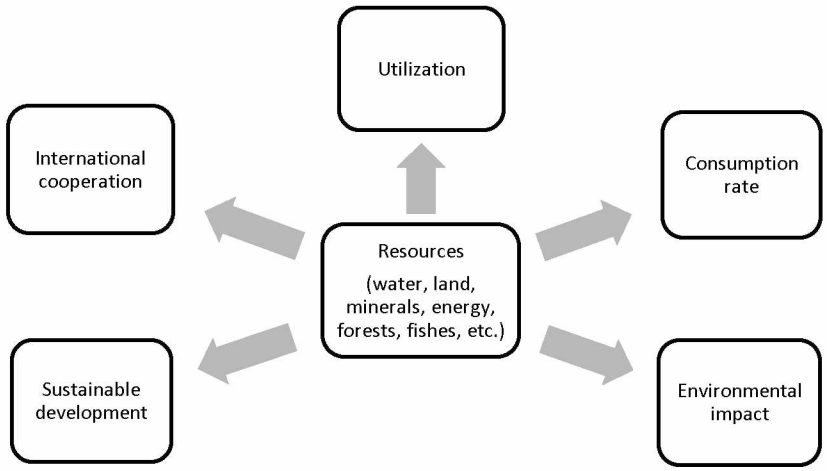

Fig. 1.9. Utilization and consumption of natural resources

Source: [author]

Utilization: natural resources are employed in various ways, such as mining, agriculture, forestry, fisheries, and energy development, among others. Each resource necessitates distinct methods of utilization, yet it is crucial to thoroughly contemplate the sustainability and ecological impact of resource exploitation.

Consumption rate: as the human economy advances and the population expands, the need for natural resources rises, causing a faster depletion of resources. Specifically, non-renewable resources like oil and natural gas cannot be reused once consumed, highlighting the importance of enhancing the responsible utilization and supervision of these resources.

Environmental impact: the utilization and depletion of natural resources significantly affect the environment, causing water pollution, soil erosion, deforestation, and various other environmental problems. Overconsumption can disrupt the ecosystem, impacting biodiversity and contributing to climate change. Therefore, it is crucial to prioritize environmental protection and maintain ecological balance when utilizing resources.

Sustainable development: to attain sustainable development, it is crucial to implement efficient resource management and protection strategies, such as advancing circular economy practices, endorsing resource conservation, and enhancing environmental oversight. Sustainable economic growth and harmonized ecological progress can only be realized through the prudent utilization and safeguarding of natural resources.

International cooperation: the utilization and consumption of natural resources have a global impact, necessitating collaborative efforts from the international community to establish shared norms and policies. By working together, countries can effectively address the challenges associated with resource utilization and consumption, while promoting sustainable development on a global scale [120].

Currently, the utilization and consumption of natural resources on a global scale are encountering numerous challenges and issues. One of these challenges is overexploitation, where non-renewable resources like oil, natural gas, and coal are being excessively exploited. This has led to a decline in resource reserves, significantly impacting the sustainable utilization of resources. Additionally, water scarcity has emerged as a prominent problem, with various regions experiencing water shortages due to excessive groundwater extraction, water pollution, and other factors. Consequently, there is an inadequate supply of water, which adversely affects

agricultural, industrial, and domestic water usage. Furthermore, the depletion of forests due to deforestation has resulted in a decline in forest coverage, which has had a detrimental impact on biodiversity and the delicate ecological balance. Additionally, the rampant overfishing and illegal hunting of biological resources have further intensified the extinction of species and the destruction of ecosystems. Simultaneously, the excessive exploitation of land resources and the discharge of a significant amount of pollutants during industrial production have exacerbated the issues of land and air pollution. To effectively tackle these pressing challenges, it is imperative to adopt a sustainable approach that advocates for the prudent utilization and conservation of resources. This entails implementing measures to bolster environmental protection, fostering the advancement of eco-friendly practices, promoting the adoption of circular economy principles, enhancing resource management and oversight, all with the ultimate goal of achieving sustainable resource utilization and safeguarding the natural environment.

Conclusions to chapter 1

In conclusion, in recent years, China's reintegration into the global economy via international trade has stood out as a key aspect of its reforms. This trajectory commenced in the early 1980s and gained momentum following China's accession to the WTO in 2001. Between 2001 and 2006, China's foreign trade expanded at an average annual rate of 28.1%, surpassing the GDP growth rate of 10.1% over the same period. Additionally, the structure of China's international trade has experienced significant transformations, notably influenced by the phenomenon of international production fragmentation. This trend involves specialization in distinct production stages across multiple nations and has garnered considerable attention from international economists under various monikers.

The notion of sustainable development (SD) has evolved through practical application and the scrutiny of pertinent policies. It has undergone a progression from

conceptualization to realization, exemplified by events such as the United Nations Sustainable Development Summit.

Strong sustainability underscores the significance of natural capital in both production and consumption, emphasizing its indispensable role. This viewpoint is grounded in the steady-state economic theory, which posits that manufactured capital cannot be reproduced without the contribution of natural capital. The Sustainable Development Goals (SDGs) can be classified into four dimensions: economy, society, environment, and governance.

The transition towards a low-carbon, resource-efficient Green Economy has emerged as a central theme in global efforts to promote sustainable development amid the dynamic landscape of the 21st century. In essence, decoupling involves minimizing the use of resources such as water and fossil fuels for economic growth while disassociating economic advancement from environmental degradation. With the global population projected to reach nine billion in the next three decades, growth is imperative to alleviate poverty and provide employment opportunities for the two billion individuals who are unemployed or underemployed. Nonetheless, this growth should prioritize efficient resource utilization rather than depleting the vital assets that sustain livelihoods and economic prospects.

As a result, 'sustainability' has emerged as a paramount global priority, prompting governments, international organizations, and businesses to prioritize the equilibrium of environmental, social, and economic factors. It has become evident that attaining a sustainable economy requires a decrease in global resource consumption, while simultaneously guaranteeing that economic growth is harmonized with environmental preservation.

Some studies suggest that the excessive utilization and depletion of natural resources in certain nations can be attributed to international trade. Developed countries indirectly drive the demand for natural resources in developing nations by exporting products that require a substantial amount of resources. Consequently, this contributes to the depletion of natural resources and exacerbates environmental challenges faced by these developing nations.

Presently, the utilization and consumption of natural resources on a global scale face numerous challenges and issues. One such challenge is overexploitation, wherein non-renewable resources such as oil, natural gas, and coal are being excessively utilized. This has resulted in a depletion of resource reserves, significantly affecting the sustainable utilization of resources.

To effectively address these urgent challenges, it is essential to embrace a sustainable approach that advocates for the judicious use and preservation of resources. This involves implementing measures to strengthen environmental protection, encouraging the adoption of eco-friendly practices, promoting the principles of a circular economy, improving resource management and oversight, all with the overarching aim of achieving sustainable resource utilization and safeguarding the natural environment.

The main scientific results were published in the following scientific articles: 161; 162; 163; 164; 165; 166; 167; 168; 169; 170; 171.

CHAPTER 2.
RESEARCH OF ENVIRONMENTAL SUSTAINABILITY OF INTERNATIONAL TRADE

2.1. Analysis of trends in international trade development and reshaping

The global trade landscape has experienced considerable fluctuations ever since the COVID-19 pandemic began. Various disruptions, both economic and non-economic, have greatly impacted global trade starting from 2020. The fragmentation and heightened diversity in trade performance have been evident not just during the recovery in 2021 and 2022, but also in the recent trade deceleration, albeit to a lesser degree. The recent trends in global trade have been characterized by several key phases. Firstly, there was a significant decline in 2020, the largest since the global financial crisis of 2008/09 and more severe than the economic instabilities of 2015. Secondly, this decline was short-lived, with global trade values bouncing back in 2021 due to a strong recovery in global demand and increasing commodity prices. Thirdly, this rebound continued into 2022, with global trade reaching record levels. However, by the second half of 2022, the rebound began to fade as geopolitical tensions rose, leading to changes in trading patterns. As of 2023, global trade has entered a new phase marked by a notable decline compared to the record levels of 2022. Additionally, ongoing economic risks, geopolitical tensions, lower commodity prices, and evolving economic dynamics are expected to dampen trade growth in the near future.

Global trade in goods and services experienced a significant recovery in 2021, reaching a value of approximately US$ 28 trillion after the devastating impact of the COVID-19 pandemic. This positive trend continued in 2022, with trade further growing to about US$ 32 trillion. However, it is anticipated that the value of international trade will moderately decline to around US$ 31 trillion in 2023. This decline is primarily driven by lower global demand, particularly for goods. Despite this expected decline, there is a silver lining. Trade volumes have shown greater stability in recent years and are projected to remain steady in 2023. Additionally, trade in

services has proven to be more resilient, with its value reaching approximately US$ 7 trillion in 2022. It is expected to witness a further increase of about US$ 500 billion in 2023 (see fig. 2.1). Interestingly, 2023 will resemble 2019 in terms of global GDP expansion accompanied by negative trade growth. The ratio of global exports to global output is predicted to decline by approximately 1.5 percentage points from the all-time record of 30.5 percent achieved in 2022.

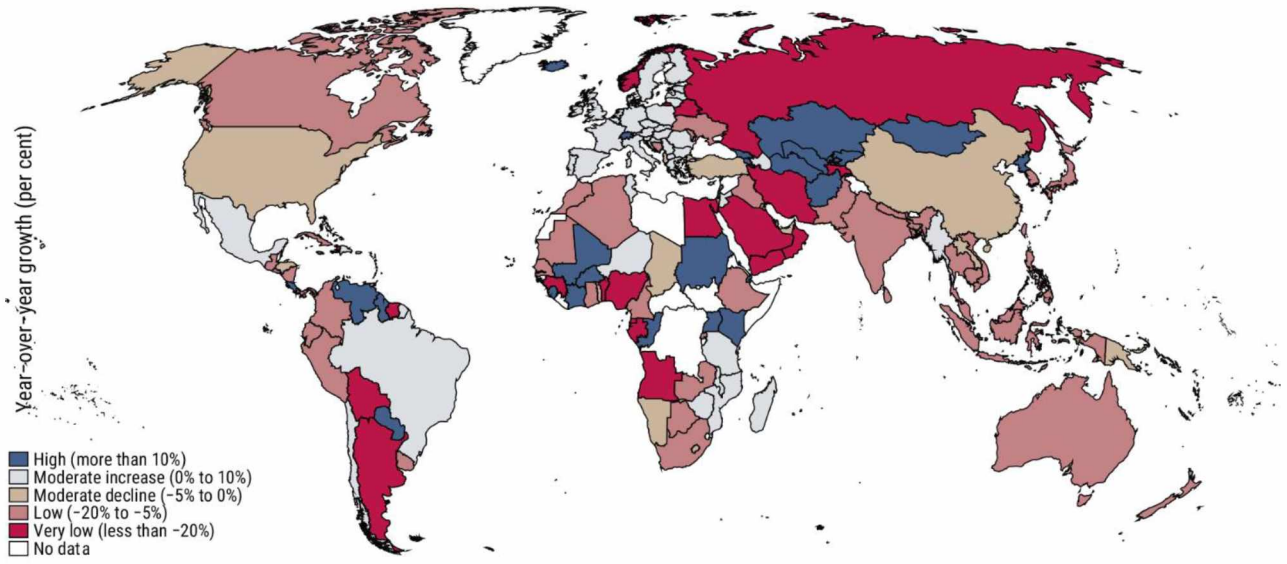

Fig. 2.1. Global export trends, 2023

Source: [UNCTAD calculations, based on data from UNCTADStat].

The first half of 2023 witnessed a significant decline in global trade, affecting numerous economies with negative export growth. Particularly, countries heavily reliant on energy and fuel exports experienced substantial declines. However, geopolitical factors played a role in influencing energy markets, leading to an increase in exports for certain energy-exporting nations. Notably, Brazil, Mexico, the Bolivarian Republic of Venezuela, the European Union, several African countries, and most central Asian economies saw an uptick in their exports during this period. Nevertheless, it is worth mentioning that for many economies with positive export growth, the numbers remained below 10 percent. The decline in international trade has affected both developed and developing countries to different degrees. Trade between developed countries experienced a relatively smaller decline compared to trade in other

directions. Additionally, exports from developed countries to developing countries showed better performance compared to trade originating from developing countries. However, exports from developing economies to both developing and developed countries performed below average during the first half of 2023.

The fragmentation of poverty and inequality presents a significant threat to the progress made in these areas. Fragmentation may bring advantages to a select few nations, but the majority would experience detrimental consequences. According to simulations conducted by the WTO, developing and least-developed economies would suffer greatly under a worst-case scenario of intense geopolitical competition. Instead of witnessing a convergence in GDP, as observed in previous decades, developing economies would face an increasing divergence from the developed world (see fig. 2.2). This would result in substantial absolute GDP losses, while the GDP gap would widen by 3.5 percent. The reason behind this is that vulnerable workers in sectors reliant on exports would be particularly impacted by disruptions in the labor market. Additionally, low-income households, who allocate a significant portion of their incomes to tradable goods and services, would bear the burden of higher prices due to trade barriers.

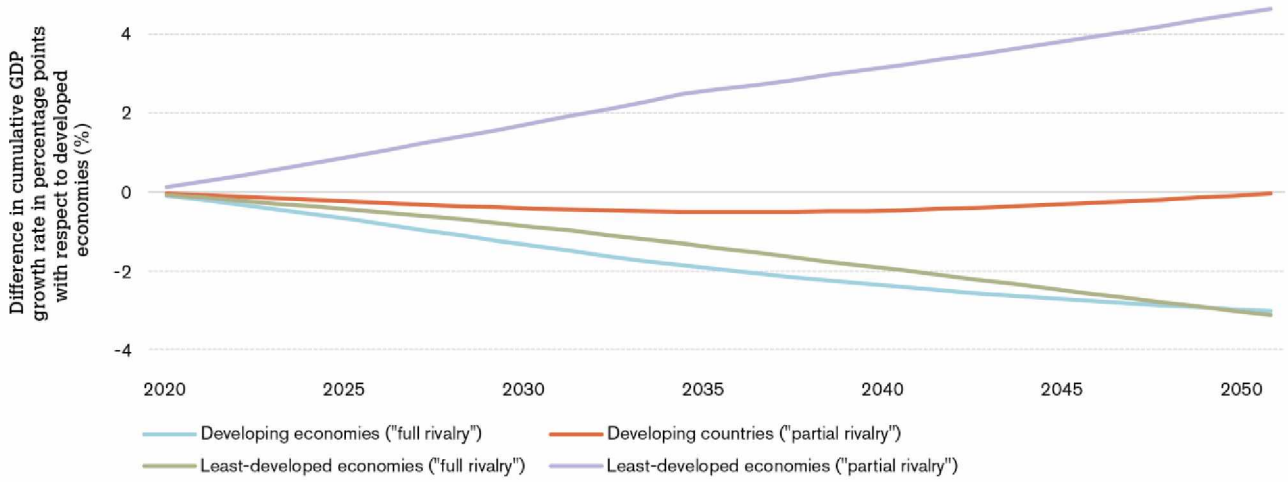

Fig. 2.2. Impact of fragmentation on economic convergence

Source: [121].

It is crucial to note that excluding the three major global economies, these trends appear even more unfavorable. This implies that the demand for imported products in the United States and the European Union was higher than usual, highlighting China's role as a key supplier to developed nations and a significant player in South-South trade. In essence, these patterns underscore the importance of trade among the top global economies in shaping overall trade dynamics. On the other hand, the subpar growth in trade for other developed countries in the first half of 2023 can be attributed to lackluster export performance in certain East Asian developed economies and the decrease in commodity prices.

The trade performance of the European Union and the United States stands out when compared to other regions, as indicated by the regional statistics for Europe and North America. Despite all geographic regions witnessing a decline in export growth during the first half of 2023, the overall trade contraction was comparatively milder in these two regions. In contrast, East Asia and the Rest of Asia regions experienced more significant trade declines. Conversely, Latin America and the Caribbean saw relatively smaller decreases in trade. It is crucial to note that despite negative growth in both intra-regional and extra-regional trade across all regions, the patterns of change have varied significantly. Intra-regional trade lagged behind extra-regional trade in the European, East Asian, and Rest of Asia regions. On the other hand, the decrease in intra-regional trade was minimal in Africa, North America, and the Latin America and Caribbean regions. In these areas, the decline in trade was primarily due to reduced trade with other geographical regions.

The trade plays a crucial role in fostering global economic convergence and alleviating poverty. Emerging economies have greatly profited from growth driven by trade, resulting in a convergence of income with wealthier countries. This has been made possible by their integration into global value chains and the reduction of trade costs. Trade has played a role in the rise of inequality in certain developed countries by boosting the need for skilled labor and relocating economic operations to urban areas. Nevertheless, data indicates that trade liberalization can coexist with economic inclusivity, underscoring the significance of supportive domestic measures. Moreover,

recent studies challenge previous conclusions suggesting that import competition significantly contributed to the recent reduction in manufacturing jobs in some advanced nations.

The World Trade Organization (WTO) has played a crucial role in supervising the decrease in tariffs and non-tariff barriers, thereby facilitating the expansion of trade and promoting economic development. Trade has been a key driver in reducing poverty, as evidenced by the rise in export participation and the decrease in poverty rates in low- and middle-income countries (see fig. 2.3). Extensive trade liberalization has significantly boosted economic growth and enhanced real income, benefiting not only low-income households but also the middle class. Nevertheless, certain regions, like sub-Saharan Africa, have faced slower progress due to limited trade expansion, unlike the successful export-led growth observed in East Asia and Eastern Europe.

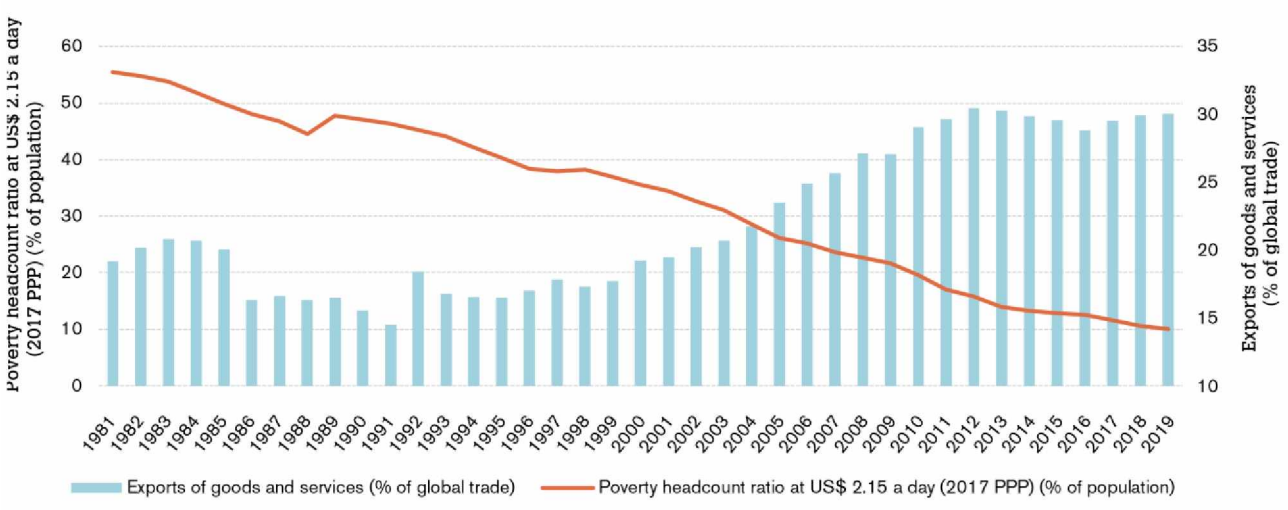

Fig. 2.3. Contribution of international trade to reducing extreme poverty

Source: [WTO calculations, based on the WB World Development Indicators].

Variances in trade patterns can also be observed when it comes to trade within regional trade agreements (RTAs). Trade within RTAs is typically anticipated to be more robust compared to trade with non-member countries. One explanation is that these agreements offer tools that can aid in economic stability, growth, and resilience. Notably, this has been evident in the case of trade within the MERCOSUR agreement, which saw an uptick in the first half of 2023. The Africa Continental Free Trade Area

(AfCFTA), the United States, Mexico, Canada agreement (USMCA), and the intra-European Union trade all demonstrate a relatively better performance in intra-RTA trade. However, the Eurasian Economic Union (EAEU) agreement and the Regional Comprehensive Economic Partnership (RCEP) show a relatively lesser extent of this better performance. On the other hand, the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) experiences a relatively worse performance in intra-RTA trade.

The growth rates of trade among economies have experienced a significant difference, which is a crucial element in current trade dynamics. In the period before 2020, trade growth was relatively consistent across countries, especially when considering high-income countries. However, since 2020, there has been a notable increase in heterogeneity in trade performance. The recovery from the COVID-19 pandemic in 2021 was uneven, and subsequent economic and non-economic shocks in 2022 further amplified the differences in trade growth rates among countries. While heterogeneity in trade performance has historically been prominent among low-income countries, recent trends indicate a substantial rise in heterogeneity among middle and high-income countries. By the beginning of 2023, the disparities have continued to be greater than traditional levels for high-income nations and surpassing averages for middle-income nations. The rise in heterogeneity is influenced by fluctuations in commodity prices, but it is not the sole factor, as trade outcomes also differ significantly among economies with comparable export structures. Despite some alignment in export growth rates among countries by the conclusion of 2022, disparities in trade performance persist well above the pre-pandemic era.

Based on the available evidence, it is evident that current trade trends are still characterized by increased volatility and heterogeneity compared to historical patterns. While it is too early to definitively conclude whether this indicates a significant departure from established global trade trends, it is plausible that the disruptions caused by COVID-19 have triggered a notable shift in global trade. This shift is now being fueled by systemic patterns linked to geopolitical issues and risk-mitigating strategies. The convergence of these factors raises the possibility that global trade patterns will

undergo substantial changes, marking the beginning of a new era with unique challenges and opportunities for economies worldwide. It is crucial to closely monitor these developments in order to comprehend the implications of these evolving trade dynamics for developing countries.

Trade, with the support of a strong multilateral trading system, plays a crucial role in ensuring economic security. It provides firms and households with alternative options to overcome supply shortages. The relationship between trade and conflict is intricate, but trade, especially within the rules-based multilateral system, helps reduce conflicts (see fig. 2.4). This is because third parties affected by bilateral tensions have an incentive to mediate and resolve these tensions. Additionally, international organizations contribute to peace by promoting stability in international relations. Even at a bilateral level, trade can decrease the likelihood of conflict by increasing the costs associated with it. In today's interconnected world, where economies are intertwined through complex supply chains, the benefits of trade are maximized, but so are the costs of severing trade relationships.

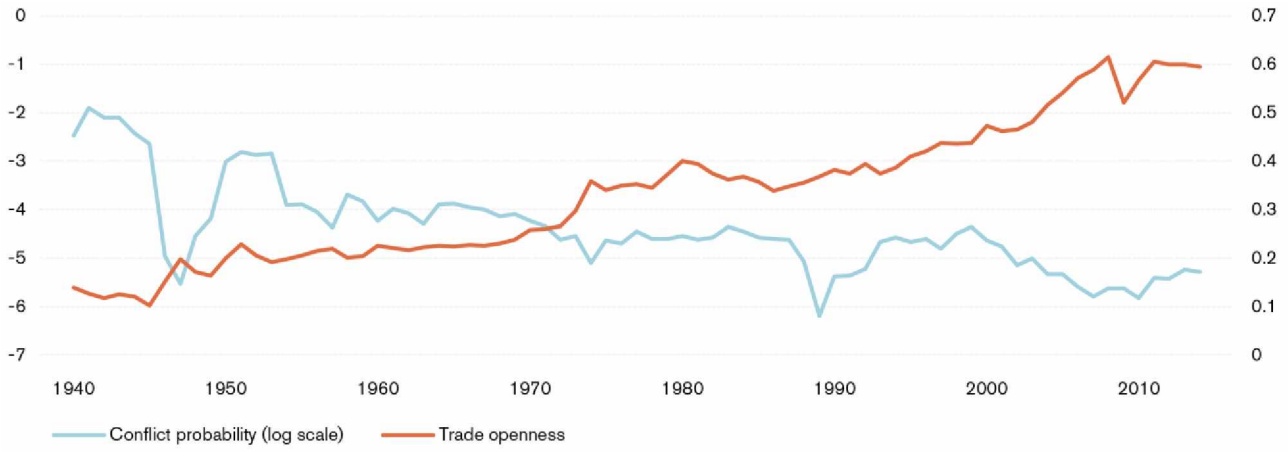

Fig. 2.4. Strong negative correlation between trade openness and conflict probability

Source: [Feenstra, Inklaar and Timmer, 2015; Klasing and Milionis, 2014].

International trade is typically categorized into trade in goods (merchandise) and services. The majority of international trade involves physical goods, with services representing a smaller portion. Over the past decade, the value of goods trade has

fluctuated. Goods trade rose from approximately US$15 trillion in 2010 to around US$18 trillion in 2011, but then remained relatively stable from 2011 to 2014. After a decline in 2015 and 2016, goods trade reached a peak in 2019, only to drop to about US$17 trillion in 2020 due to disruptions caused by COVID-19 and an economic downturn. However, goods trade rebounded in 2021 and reached a peak in 2022 at approximately US$25 trillion. In contrast, trade in services has shown minimal volatility and has steadily increased from around US$4 trillion in 2010 to nearly US$6 trillion in 2019. Trade in services has been experiencing a slower recovery compared to trade in goods since 2020. While the decline in export growth rates for goods was relatively similar between developed and developing countries during the trade slump in 2015/16 and the COVID-19 pandemic, noticeable differences can be seen for services. In contrast to the recovery after the 2015/2016 episode, where developed and developing countries had comparable export growth rates for both goods and services trade, trade growth in 2021/2022 has been higher for developing countries.

International trade has shown impressive resilience, bouncing back quickly from the challenges posed by the COVID-19 pandemic and adjusting to the conflict in Ukraine. Trade played a vital role in the pandemic by ramping up the manufacturing of medical supplies and vaccines, ensuring they reached areas in need. Moreover, the transparent and reliable trading system played a crucial role in alleviating supply chain disruptions and price fluctuations caused by the conflict in Ukraine, as nations could access essential goods like wheat from different sources.

Trade has experienced a transformation towards being more digital, sustainable, and inclusive. The advent of the digital revolution has greatly facilitated the trade of digitally delivered services, resulting in a significant reduction in trading costs for these services (see fig. 2.5). Moreover, the global trade in environmental goods has witnessed a rapid growth, surpassing the overall trade in goods. Additionally, global value chains (GVCs) have expanded to include a greater number of economies, with countries like Cambodia, Romania, and Viet Nam experiencing a notable surge in their participation in GVCs.

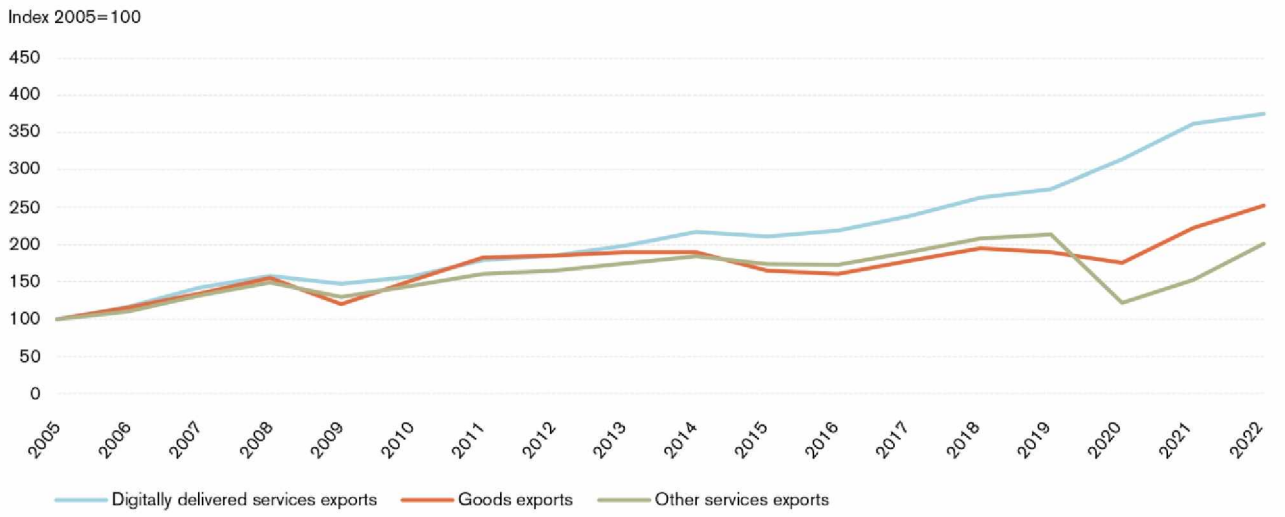

Fig. 2.5. Growth of digitally delivered services exports, 2005-22

Source: [WTO, 2023].

Since 2010, there has been a significant surge in the volume of international trade in goods. Developing countries have outperformed developed countries, nearly doubling their trade volume in goods since 2010. However, developed countries have managed to keep up and not fall far behind during the same period. From 2016 onwards, import volumes have been growing at a relatively faster pace compared to export volumes for developing countries. This can be attributed to the rising consumer demand in these nations. Unfortunately, the growth in trade volumes experienced a substantial slowdown in 2015 and turned negative in 2020 due to the impact of the COVID-19 pandemic. Trade volumes saw a significant rebound in 2021 and have continued to rise in 2022 for both developing and developed countries. Notably, in 2022, imports of developed nations grew at a faster rate compared to those of developing economies. China stands out among major trading nations, with its trade volumes nearly doubling since 2010. Both exports and imports have been increasing steadily, except for the last two years where exports outperformed imports. Despite the challenges faced in 2020, China's trade volumes remained positive. However, after a robust growth in 2021, China's export volumes have stagnated in 2022, while import volumes have decreased. On the other hand, other major economies have experienced slower growth in trade volumes, although the United States' imports have shown strong performance post the COVID-19 pandemic.

The significance of developed countries as suppliers in global markets is diminishing, yet they still represent more than half of the total trade value in goods and approximately two-thirds in services. In 2022, developed nations exported goods worth US$13.5 trillion and services worth around US$4.6 trillion. Conversely, developing countries' exports in 2022 amounted to roughly US$11 trillion for goods and about US$1.9 trillion for services. BRICS nations – Brazil, the Russian Federation, India, China, and South Africa – contributed over 40 percent to the exports of goods and services from developing countries. Despite some growth in exports and imports over the last decade, the contribution of LDCs to global trade remains limited.

The increase in international trade in the last ten years was primarily driven by the growth of trade between developing countries (South-South). Despite declines in trade in 2015 and during the COVID-19 pandemic in 2020, the percentage of South-South trade in global trade has consistently risen from about 17 percent in 2010 to 21 percent in 2022. In terms of value, South-South trade reached US$ 5.3 trillion in 2022 compared to US$ 3.9 trillion in 2019, which is more than half of the trade between developed countries (North-North). More than half of the trade in developing country regions, including imports and exports, was accounted for by South-South trade flows. The percentage varied across regions, with Latin America at around 40 percent and South and East Asia at approximately 60 percent. Notably, a significant portion of this trade was with China. However, in comparison to 2021, the share of South-South trade has slightly declined in most regions, primarily due to a decrease in trade with China. On the other hand, interregional trade (Other South-South) has increased in most developing country regions, except for Latin America, Africa, and East Asia (excluding China). Intraregional trade has been declining in all developing country regions, except for minor increases in Latin America and East Asia (excluding China).

The trade has an impact on emissions through three different effects: the scale effect, which is caused by economic growth; the composition effect, which changes specialization patterns; and the technique effect, which encourages firms to adopt more efficient production technologies. Empirical evidence suggests that the negative scale effect is generally counterbalanced by a positive technique effect (see fig. 2.6), while

the composition effect has a limited influence. Since 1995, advanced economies have only seen a slight rise in total carbon dioxide (CO_2) emissions, as the technique effect has mitigated most of the additional emissions resulting from increased output. On the other hand, emerging economies have witnessed a larger increase in total emissions, primarily due to the scale effect, but have also benefited from advancements in technology (see Annex A).

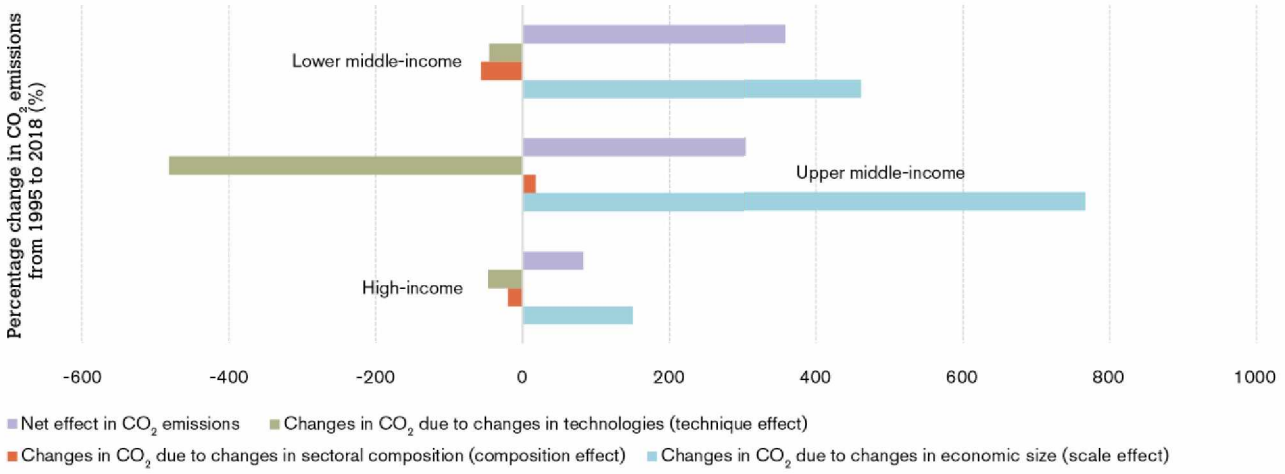

Fig. 2.6. Impact of technology improvements on reducing CO_2 emissions, 1995-2018

Source: [WTO calculation based on OECD Trade in value-added (TiVA)].

International trade in goods can be categorized based on the stage of processing and intended use within the production chain. These goods are classified as primary, intermediate, consumer, and capital goods, with the latter encompassing machinery used for producing other goods. Additionally, goods can be differentiated by broader categories such as natural resources, agricultural products, and manufactures. In terms of the stage of processing, intermediate products accounted for the majority of global trade in 2022, surpassing US$ 10 trillion and representing over 40 percent of the total share. Primary products followed, comprising 20 percent of trade at US$ 5 trillion. In 2022, the value of trade across all categories increased compared to 2021 levels, while the composition across categories remained relatively stable. Trade in primary products experienced setbacks in 2015 and 2020 but witnessed a significant growth of over 30

percent between 2021 and 2022. Similarly, trade in natural resources faced notable declines in 2015 and 2020 but rebounded strongly with an almost 50 percent increase in 2022.

Developed nations dominate global trade, with approximately half of their trade consisting of intermediate goods, while the remaining portion is evenly split between primary, capital, and consumer goods. Export and import patterns are comparable in these countries. In developing regions, a significant portion of trade involves intermediate goods, particularly in the case of BRICS, where it surpasses 40 percent. BRICS nations also allocate 40 percent of their exports to capital and consumer goods, but their imports are more reliant on primary goods (around 35 percent). Conversely, other developing countries lean more towards primary goods in their export activities. In 2022, primary goods made up half of the exports for LDCs. Consumer goods also play a significant role in their exports, while capital and intermediate goods have a smaller presence. Manufacturing is the leading export category for all countries, accounting for over 50% of developing countries' exports and more than 80% for BRICS. Natural resources, particularly in LDCs and developing countries, are the second largest category, with agriculture making up a small percentage. An exception is LDCs' imports of agricultural products, which constituted 16% of their total imports in 2022.

Chemicals, communications equipment, metals, machinery, motor vehicles, and energy products such as oil, gas, coal, and petroleum products make up a significant portion of global trade value. Conversely, light manufacturing industries like textiles, apparel, and tanning represent a smaller percentage of world trade. Agricultural sectors, which encompass food, vegetable and animal products, oils and fats, as well as tobacco and beverages, contribute to less than 10 percent of international trade. In 2022, trade experienced significant growth rates in approximately half of the sectors, with double-digit increases. However, precision instruments, office machinery, and mining witnessed a decline in their trade value. Over the past decade, developing countries have made remarkable progress in expanding their presence in global markets, surpassing developed countries. Since 2015, developing countries have consistently

gained market shares across various sectors. Nevertheless, in certain industries, export market shares have shifted back towards developed countries. This trend is particularly evident in the energy sector, where the emergence of shale oil production in North America has led to increased export shares for developed nations. Additionally, European countries have recently seen a rise in their export shares for non-metallic minerals.

The climate action would be compromised and trade tensions would escalate due to the fragmented environmental policies. There are already indications of these tensions, such as the growing trade concerns regarding environmental measures discussed in WTO committees (see fig. 2.7). Weaker trade relationships would hinder the worldwide dissemination of green technology. The widespread adoption of this technology is crucial for effectively addressing climate change, especially considering that many economies still lack proficiency in this field.

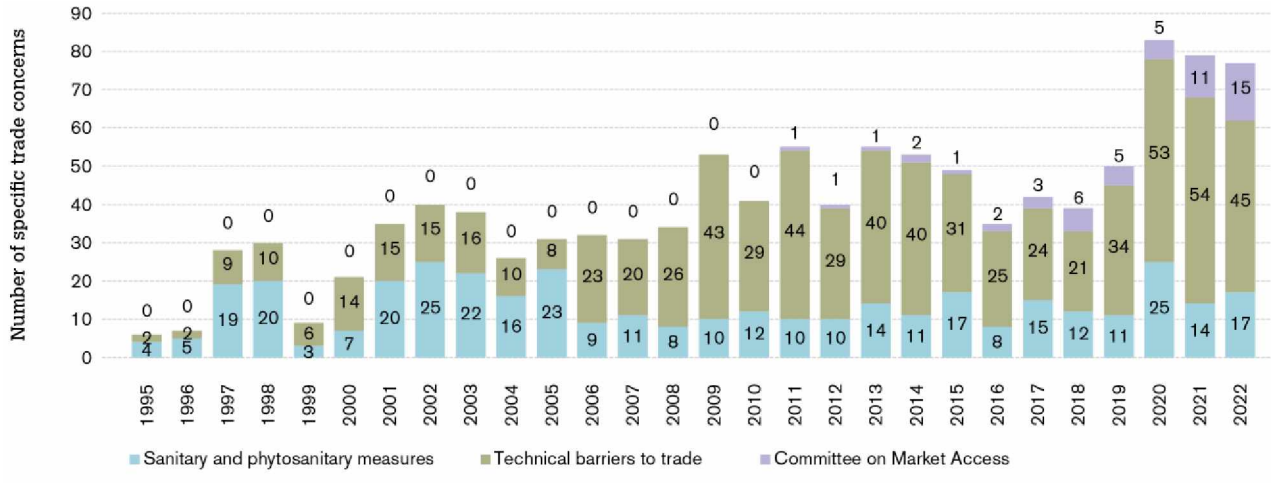

Fig. 2.7. Environmental measures that exceed WTO requirements

Source: [WTO elaboration based on the WTO Trade Concerns Database].

The travel sector, with trade flows nearing US$ 1.5 trillion, stood as the largest services sector before the COVID-19 pandemic, followed closely by the transport sector with over US$ 1 trillion. Unfortunately, in 2020, these sectors suffered greatly, with the travel sector plummeting to nearly a third of its 2019 value. While the transport sector saw significant growth in 2021, the travel sector struggled to recover and only

surpassed the US$ 1 trillion mark in 2022. Since 2015, trade has been on the rise in various other sectors, notably in R&D, professional consulting, telecommunication, and IT services. Despite the fact that developed countries continue to dominate the export of services, there has been a noticeable shift in market share towards developing countries in almost all sectors. However, it is important to note that developed countries still hold a significant market share in travel and government services. In 2015, the market shares of developing countries in areas such as intellectual property rights (IPR), research and development (R&D) professional and consulting, and financial services experienced substantial growth, despite starting from relatively low levels.

2.2. Evaluation the status and role of natural resources in international trade

Natural resources have a significant influence on international trade and greatly contribute to the economic progress of different nations and their trade relationships. Here, we present a comprehensive analysis of the significance and function of natural resources in the realm of international trade. The utilization of green energy-related technology and an innovation-focused development plan can enhance the energy efficiency of a nation. By employing clean and efficient energy exploration methods and embracing innovative energy technologies, we can mitigate the negative impacts of industrial activities and ensure a reliable energy supply for both present and future generations. The adoption of green technology innovation facilitates the effective utilization of natural and human resources, benefiting both economic growth and environmental sustainability. The development of new natural resources and green technologies serves as indicators of progress towards achieving environmental sustainability and economic performance. The growing emphasis on sustainability and the advancement of green energy, driven by natural and economic resource development, has sparked a heightened interest in eco-efficiency and energy conservation. The availability of these natural resources directly influences the growth

of renewable energy sources and the ease of transitioning towards clean energy utilization.

Energy resources such as oil, natural gas, and coal play a crucial role in global trade. These resources serve as a primary source of energy worldwide, and many nations depend on imported energy to fulfill their domestic needs. Fluctuations in the supply and prices of energy resources significantly impact international markets and economic growth. For instance, the Middle East region is a prominent exporter of oil, while other countries heavily rely on importing substantial quantities of oil from this region. This reliance on energy resources underscores their significance in international trade. To shed light on the status and significance of energy resources in global trade, this study utilizes the statistical yearbook compiled by the National Bureau of Statistics of China as a data source. By analyzing the data changes over the past two decades, the aim is to provide insights into the role of energy resources in international trade, as depicted in the accompanying figure (see fig. 2.8):

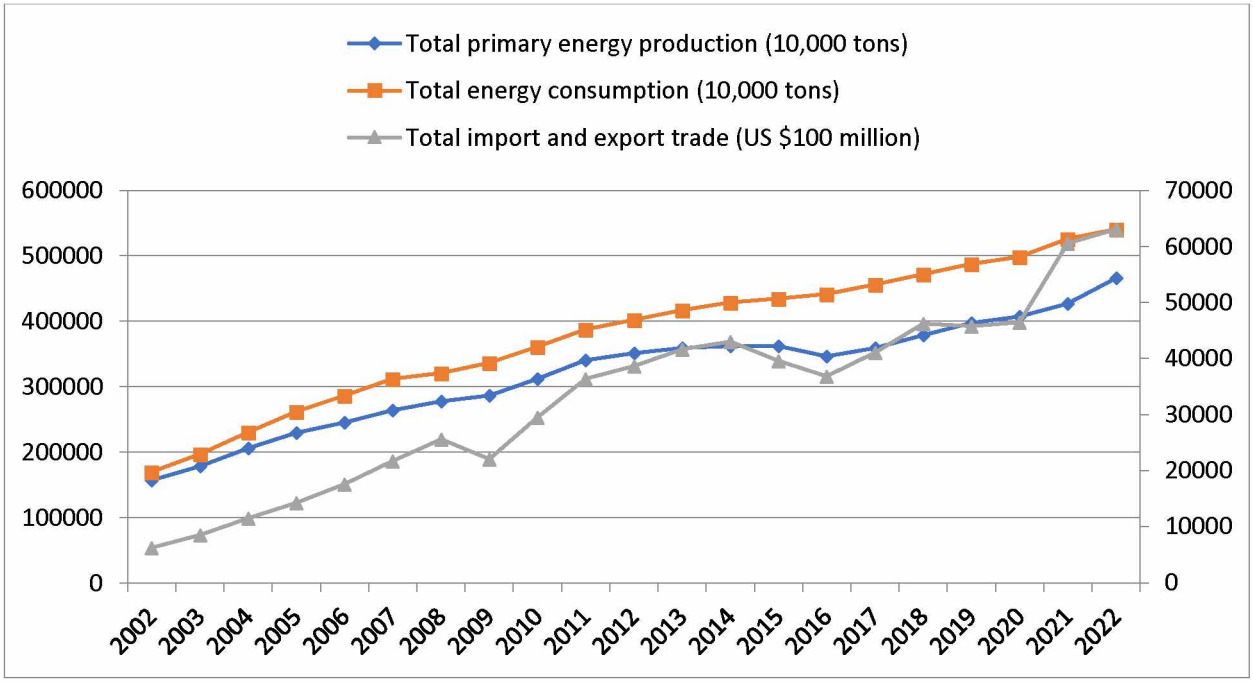

Fig. 2.8. Comparison of China's total primary energy production, total energy consumption and total import and export trade from 2002 to 2022

Source: [Data source National Bureau of Statistics of China database Energy unit: 10,000 tons; Trade unit: $100 million].

Fluctuations in mineral resource prices are closely tied to demand levels. When demand is high, prices tend to increase, and conversely, they decrease when demand is low. This relationship is driven by the principles of supply and demand in a free market economy. The need for minerals is further amplified by economic growth, as expanding economies require more raw materials to fuel industrial activities and infrastructure development. As populations grow, the demand for minerals to support construction and manufacturing also rises. Additionally, advancements in technology play a significant role in driving demand for specific minerals, as new technologies emerge that rely on these resources. The interplay between supply and demand ultimately influences market prices for mineral resources. Technological advancements are driving the need for minerals, as various innovations rely on rare and valuable minerals and metals. The increasing demand for minerals like lithium, cobalt, nickel, and rare earth elements is primarily due to the growing popularity of electric vehicles (EVs), as these elements are essential for manufacturing EV batteries and components. As the EV market continues to expand, the demand for these minerals is expected to rise accordingly. Additionally, the production of wind turbines and solar panels also contributes to this trend, with copper, silver, and rare earth elements being crucial components. The demand for these minerals is projected to increase as renewable energy systems become more widespread. Overall, technological progress is a key driver behind the growing need for minerals in high-tech manufacturing processes.

Mineral resources, such as iron ore, copper, aluminum, and other valuable commodities, play a crucial role in global trade. These resources are essential for the production of industrial goods and the development of infrastructure, which are the backbone of the global economy. Many countries heavily rely on imported mineral resources to support their industrial production and economic growth. On the other hand, some countries have emerged as significant exporters due to their abundant mineral resources. Notably, countries like Australia, Brazil, and others have a substantial impact on the international market and economic development through their mineral resource exports. This paper aims to analyze the status and significance of the mining industry's total energy consumption in international trade, utilizing data from

2005 to 2022, sourced from the National Bureau of Statistics of China's statistical yearbook. The following information provides insights into this analysis, as shown below (see fig. 2.9):

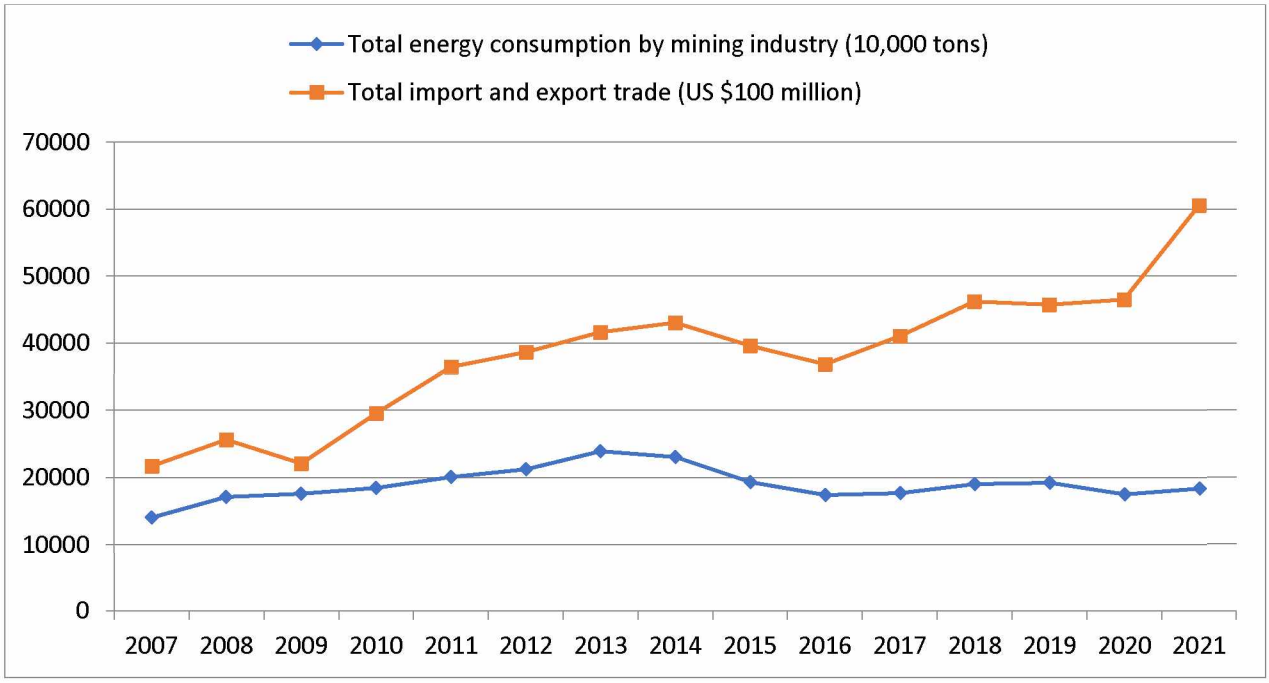

Fig. 2.9. Comparison between total energy consumption of China's mining industry and total import and export trade from 2007 to 2021

Source: [Data source National Bureau of Statistics of China database Energy unit: 10,000 tons; Trade unit: $100 million].

As the global population continues to increase, the demand for agricultural products also rises. The use of chemical inputs can help boost yields and protect crops from pests, ensuring that farmers can produce enough food to sustain the nearly 7.7 billion people currently residing on Earth. However, improper management of agrochemicals can lead to inefficiencies in food systems and pose a threat to ecosystem health. It is crucial for countries to effectively regulate the use of fertilizers and pesticides to prevent negative environmental impacts such as soil erosion, ecosystem damage, and water pollution. Neglecting proper management of pesticides and nutrients could push agricultural systems beyond sustainable limits. Utilizing fertilizers high in reactive nitrogen is essential for optimizing agricultural productivity, however,

nitrogen pollution can lead to extensive environmental harm. Excessive runoff into bodies of water can trigger eutrophication and harmful algal blooms, posing a threat to aquatic life. In addition, improper use of pesticides can deteriorate soil quality and contaminate water sources through runoff. Implementing effective policies and educational initiatives to promote the efficient use of agrochemicals is crucial for transitioning towards more sustainable agricultural practices. The agricultural indicators in the 2022 EPI enable countries to evaluate the effectiveness of their agricultural strategies in enhancing ecosystem health.

The mismanagement of agro-chemicals is causing harm to agricultural lands worldwide. A significant portion of global agricultural land, approximately 64%, faces the risk of pollution from multiple active pesticide ingredients, with 31% being at high risk of pesticide contamination. These high-risk areas often coincide with biodiversity hotspots, highlighting the potential dangers of pesticide mismanagement. The median unadjusted pesticide risk score stands at 3.16 across countries with available data from the EPI, indicating that more than half of the countries assessed are at risk of environmental and human degradation due to pesticide misuse. Studies indicate that implementing educational programs will play a crucial role in assisting farmers in adopting more sustainable pesticide application practices. Global scores in the sustainable nitrogen management index showed a gradual increase from 1961 to 2015. However, there has been little progress in the most recent decade. The current global SNMI score stands at 53.5. While 95 countries have shown improvement in their nitrogen management, 81 countries have experienced a decline. China and India, despite having only 36% of the global population, are responsible for more than half of the world's nitrogen pollution. To combat this issue, developed and transitioning economies, including China and India, must significantly enhance their nitrogen use efficiency. By increasing nitrogen use efficiency by 30%, it is possible to achieve a global SNMI of zero by 2050.

Agricultural resources such as grain, cotton, and coffee play a crucial role in global trade. These resources are essential for meeting the worldwide demand for food and ensuring food security and diverse consumption patterns. Many countries rely on

importing agricultural resources to secure their food supplies, while others have emerged as major exporters due to their abundant agricultural resources. Notably, countries like the United States, Brazil, and Argentina are significant exporters of agricultural products, and their exports have a significant impact on international markets and food security. This study aims to analyze the status and significance of the total agricultural output value (including agriculture, forestry, animal husbandry, and fishery) in international trade based on data changes from 2005 to 2022, using the statistical yearbook compiled by the National Bureau of Statistics of China as the primary data source, as shown in the figure below (see fig. 2.10):

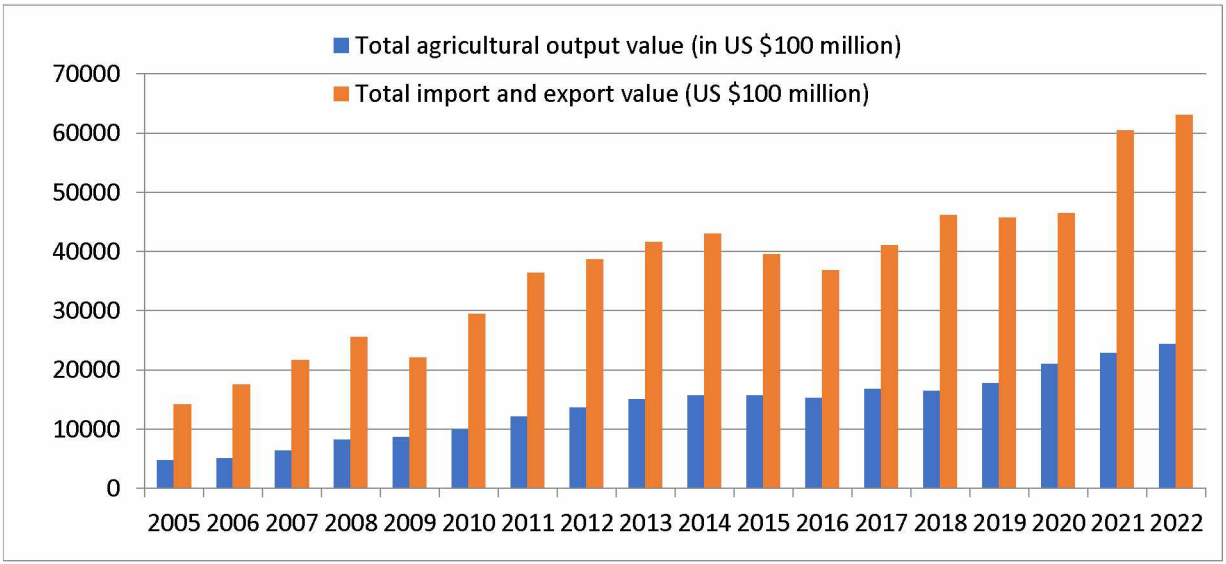

Fig. 2.10. Comparison of China's total agricultural output value and total import and export trade from 2005 to 2022

Source: [Data source National Bureau of Statistics of China database Unit: 100 million US dollars].

Water plays a multifaceted and undervalued role in the global environment, economy, and public health, spanning from groundwater to seawater. It serves as a fundamental resource for various sectors such as agriculture, industry, and urban development. Groundwater, along with other water sources, sustains the biodiversity of terrestrial and wetland ecosystems, acting as a defense against climate-related disasters and providing essential food and cultural heritage. However, human activities

introduce pollutants into water bodies, including organics, nutrients, synthetic compounds, pathogens, heat, and large litter. Wetlands and water bodies play a crucial role in safeguarding groundwater and surface water by naturally processing and absorbing contaminants generated by residential, commercial, and agricultural sources. Pollution not only jeopardizes aquatic life but also diminishes global water accessibility and compromises the overall health of both terrestrial and aquatic ecosystems. This particular category is centered around the issue of wastewater treatment. Inadequate management of wastewater presents significant long-term risks to both public health and the health of ecosystems. Various wastewater treatment technologies, ranging from primary treatment methods such as comminutors and first-degree sedimentation to tertiary treatment methods like chlorination and dechlorination, play a crucial role in ensuring that water is safe for discharge and reuse by eliminating pollutants from wastewater. Enhancing access to wastewater collection and treatment systems for communities, as well as raising global standards for wastewater treatment, not only benefits the environment but also contributes to sustainable development goals.

Many parts of the globe face significant deficiencies in their wastewater treatment capabilities. Out of the 120 countries assessed in the 2022 EPI, two-thirds fall short of the global average score of 24.4. Despite some European countries performing well, major population hubs worldwide are finding it challenging to enhance their Water Resources issue category performance. South Asia and Sub-Saharan Africa have median scores of 0.0, with the Asia-Pacific region slightly higher at 0.3. Robust wastewater treatment systems often necessitate significant investments in infrastructure, particularly in urban areas. The expenses associated with infrastructure and the time required for implementing wastewater treatment may account for the underperformance of developing countries in the Global South. The rapid pace of urbanization, coupled with the escalating demands on already strained water sources, poses challenges for government authorities in swiftly implementing and expanding wastewater treatment facilities. Conversely, developed nations, particularly in Europe and North America, exhibit high rates of wastewater treatment.

Additionally, several countries in the Greater Middle East surpass the average performance in this domain, indicating a harmonization of policy objectives with environmental realities. Notably, this region already faces the highest water insecurity globally, and the impacts of climate change further exacerbate the precariousness of life for its inhabitants.

Water is considered a valuable natural resource in certain areas, leading to a market for its trade. Several countries with abundant water supply export it to fulfill the demands of other nations. However, the international trade of water is not solely influenced by economic factors but also by environmental and social considerations. To shed light on the dynamics of water resource changes in international trade, this study utilizes data from the National Bureau of Statistics of China's statistical yearbook. Specifically, it analyzes the variations in total water resources data from 2005 to 2022, aiming to provide insights into the status and significance of these changes, as shown in the figure below (see fig. 2.11):

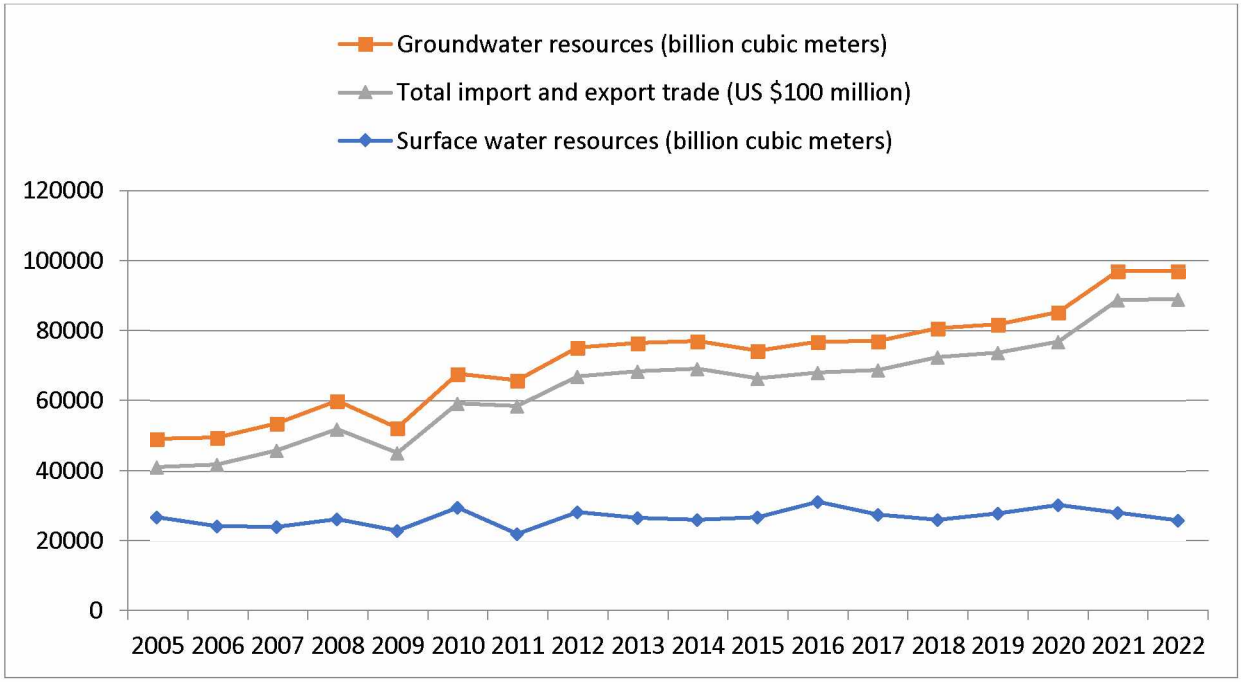

Fig. 2.11. Comparison of total water resources and total import and export trade in China from 2005 to 2022

Source: [Data source National Bureau of Statistics of China Water resources Unit: 100 million cubic meters; Trade unit: $100 million].

Biodiversity plays a crucial role in maintaining the overall health of our planet and supporting the functioning of human societies, economies, and well-being. The economic advantages of biodiversity and ecosystem services, both direct and indirect, are estimated to be around $125 trillion annually. These benefits arise from the protection provided against extreme weather events such as storms and floods, the regulation of climate, and the provision of food, energy, medicine, and raw materials. Additionally, healthy and thriving ecosystems offer immeasurable cultural and spiritual advantages to people worldwide, including aesthetic and ethical value. To ensure the continuation of these invaluable benefits, it is essential to maintain suitable habitat conditions for living organisms, whether they reside in tropical rainforests or deserts. Scientific research and policy discussions consistently highlight the alarming decline of biodiversity and natural habitats worldwide, despite their significant economic and cultural importance. Disturbingly, it is estimated that around one million species are at risk of extinction in the near future. The primary cause of this biodiversity loss is human-induced destruction of habitats, with humans utilizing a substantial portion of global land, freshwater, and primary production in upwelling ocean regions.

Despite the concerning state of the world's ecosystems, the 2022 EPI provides a glimmer of hope that efforts to safeguard critical habitats and enhance ecosystem health are on the rise, albeit at a slow pace. More than a million species are facing extinction risk, with 500,000 terrestrial species lacking the necessary habitat for their survival in the long term. Research indicates that human activities are driving a significant decline in biodiversity, leading to a mass extinction event. Extinction rates are currently soaring to levels up to 1,000 times higher than natural background rates. The 2022 Biodiversity & Habitat indicators evaluate the progress made by countries in protecting biodiversity and habitat, identify countries that are regressing, and highlight the overall global trends. The median Biodiversity & Habitat score increased by 4.2 points worldwide in the last ten years. The most significant change in overall Biodiversity & Habitat scores occurred in the Global West, with a median increase of 7.2 points during the same period. On the other hand, the Greater Middle East region experienced the smallest change in Biodiversity & Habitat score, with a median growth of 2.7 points. The

majority of the global progress can be attributed to improvements in the Protected Area Representativeness Index and the Species Protection Index, which saw median increases of 11.3 and 3.3 points, respectively. However, there was a decrease in median Species Habitat Index scores by 6.5 points.

Biological resources, including wood, fishery resources, and medicinal materials, hold significant value as commodities in global trade. These resources are crucial for meeting the production and consumption demands of nations, contributing to economic development and enhancing living standards. However, the international trade of biological resources necessitates a careful balance between resource protection, environmental preservation, and sustainable utilization. To shed light on the status and significance of changes in biological resources within international trade, this study utilizes data from the National Bureau of Statistics of China's statistical yearbook. Specifically, it examines the correlation between alterations in the total afforestation area from 2005 to 2022 and the dynamics of biological resource trade, as shown in the figure below (see fig. 2.12):

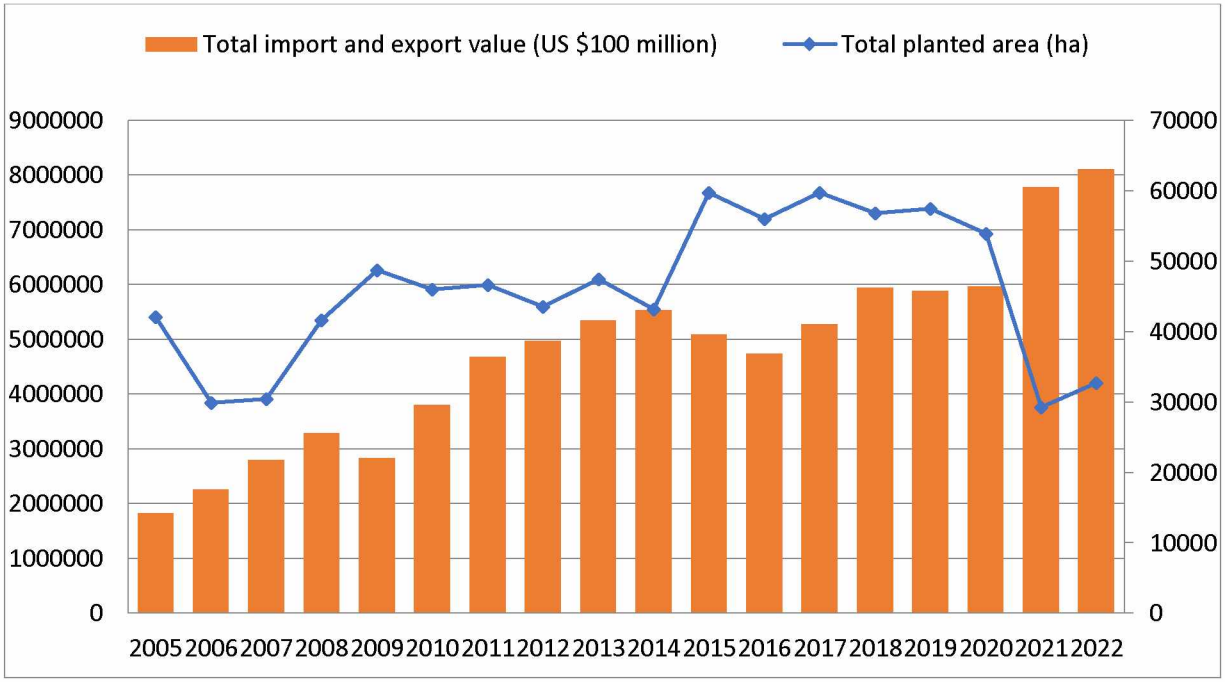

Fig. 2.12. Comparison between total afforestation volume and total import and export trade volume from 2005 to 2022

Source: [Data source National Bureau of Statistics of China database Afforestation unit: hectare; Trade unit: $100 million].

The trade dynamics between nations abundant in resources and those lacking in resources are mutually advantageous, fostering economic growth, technology exchange, and global collaboration. It is crucial for both parties to prioritize sustainable resource management and environmental protection to prevent resource depletion and ecological harm. This trade partnership showcases the interdependence and synergy of resources on a global scale. Firstly, it highlights the significance of complementary trade, where resource-rich countries export commodities like oil and minerals, meeting the import needs of resource-poor nations, resulting in a mutually beneficial relationship. Secondly, this trade collaboration encourages specialization and cooperation, with resource-rich countries focusing on extraction and production, while resource-poor countries concentrate on processing and manufacturing, enhancing productivity and international competitiveness. Lastly, this trade alliance facilitates technology transfer, as resource-rich countries possess advanced resource extraction technologies that can be shared with resource-poor countries through collaboration, elevating their industrial capabilities. Resource-rich countries contribute to economic development by exporting resources, while resource-poor countries enhance their economic structure and industrial development through importing resources. This trade dynamic not only spreads risks and reduces reliance on a single resource but also boosts economic resilience and stability. Overall, trade relationships between resource-rich and resource-poor countries support economic growth and technology transfer, but it is crucial to prioritize sustainable resource management and environmental protection for long-term development.

The fluctuation of prices for resources has a significant impact on global trade, particularly for nations and sectors heavily reliant on these resources. Firstly, changes in resource prices directly influence the flow of imports and exports. When prices increase, exporting nations often boost exports to maximize profits, while importing nations may decrease imports to cut costs. Conversely, when prices decrease, exporting nations may reduce exports to prevent losses, while importing nations may increase imports to capitalize on lower prices. Secondly, price fluctuations can impact a country's trade balance. Higher resource prices can lead to larger trade deficits for

importers and surpluses for exporters, while lower prices can have the opposite effect (see Annex D). Moreover, these fluctuations also affect the economic growth of both exporting and importing nations. While higher prices benefit resource-exporting countries, they may harm resource-importing economies. Conversely, lower prices can negatively impact resource-exporting nations but boost economic growth in resource-importing countries. Resource price fluctuations can significantly influence a country's investment and industrial structure. When resource prices rise, countries that export resources may be prompted to invest more in resource development. Conversely, countries that import resources may increase their investment in alternative resources. On the other hand, lower resource prices can result in reduced investment in resource exporting countries, while importing countries experience an increased demand for resources. As a result, the impact of resource price fluctuations on trade is intricate and varied, with different countries and industries adopting diverse coping strategies. Governments and enterprises must closely monitor resource price fluctuations and adapt trade policies and industrial structures accordingly to effectively navigate the challenges and opportunities presented in different situations.

Trade-based integration in the global market is a crucial indicator of a country's openness, requiring a comprehensive assessment of complex trade relationships beyond the direct trading volumes typically considered by traditional openness indicators. The Trade Openness Index, which evaluates the significance of international trade in relation to a nation's domestic economic output, assigns equal weight to both exports and imports. In 2022, Luxemburg maintained its position as the most open economy to international trade with a trade openness index of 384.48. Following closely behind were Hong Kong SAR (383.79), Singapore (336.86), and Malta (324.63) in the second, third, and fourth positions, respectively. China and India scored 38.14 and 49.37 points on the index, while Japan and the United States of America recorded scores of 36 points or lower. Sudan was identified as the least open economy with a score of 2.7. The Trade Openness Index is calculated by dividing the average of merchandise exports (x) and imports (m) by the Gross Domestic Product (GDP) (y) according to the United Nations Conference on Trade and Development.

$$TOI_{i,t} = \frac{\frac{1}{2}(x_{i,t} + m_{i,t})}{y_{i,t}}$$

In order to examine the dynamics of the association between the dependent variable, trade openness, and the independent variable, ND-GAIN, a quantitative approach such as regression analysis can be employed. The fundamental structure of regression models encompasses unidentified parameters (β), independent variables (X – ND-GAIN), and the dependent variable (Y – trade openness) (refer to table 2.1). In our specific regression model, it essentially elucidates the relationship between trade openness (Y) and a composite function of ND-GAIN (X) and unidentified parameters (β):

$$Y \approx f(X, \beta)$$

Table 2.1

Regression Analysis for Trade Openness and ND-GAIN

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.90724	0.017829	106.9747	1.3E-148	1.872024	1.942455	1.872024	1.942455
X Variable 1	-0.13187	0.05828	-2.26265	0.025028	-0.24698	-0.01675	-0.24698	-0.01675

Source: [authors' calculations]

The regression equation enables the prediction of 'y' values when the value of 'x' is provided, based on two sets of measures ('y' and 'x') from a sample size measures of 'n'. The formula for the regression equation is as follows. (see fig. 2.13):

$$Y = 1.90724 + -0.13187*X$$

Renewable energy deployment plays a crucial role in mitigating greenhouse gas (GHG) emissions by displacing the utilization of fossil fuels in both existing installations and the construction of new fossil fuel facilities. However, for renewable energy to effectively contribute to emission reduction, it requires a robust policy framework that encompasses appropriate incentives and ensures the integration of power generated from renewable sources into the transmission grid, particularly in the case of grid-connected renewables. Over time, policies supporting renewable energy have proven to be increasingly effective, especially as the cost of renewable energy

technologies has declined. This cost reduction has facilitated emissions reductions at remarkably low, and even negative, costs. The primary GHG impact of these renewable energy policies lies in the reduction of emissions from both existing and new fossil fuel power plants. This reduction is achieved through the substitution of electricity generated from fossil fuel sources with that generated from renewable sources.

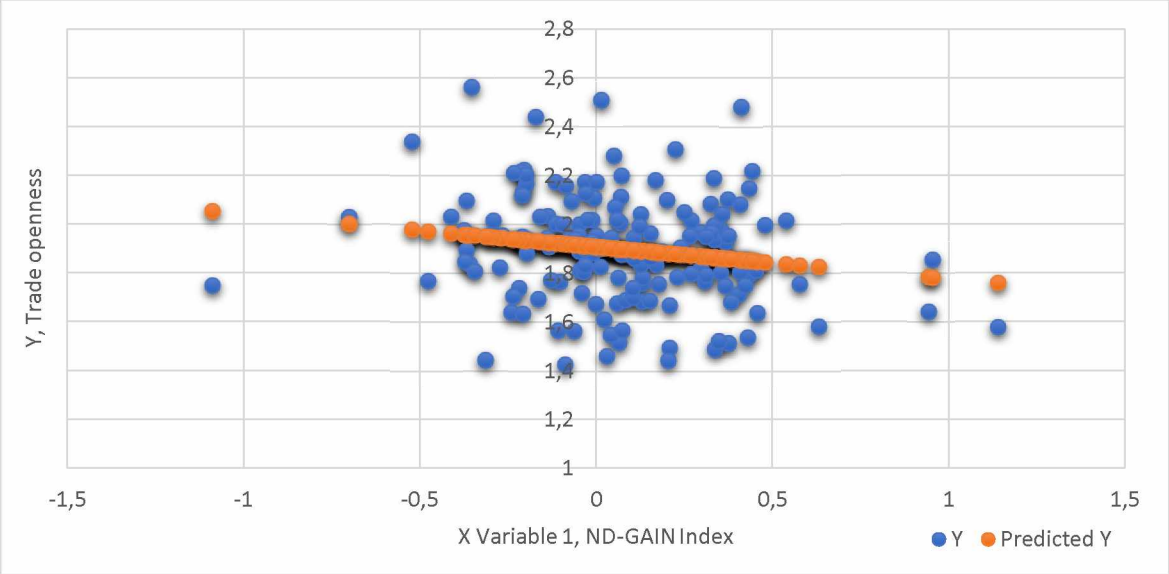

Fig. 2.13. Regression analysis line fit plot for ND-GAIN Index

Source: [authors' calculations]

As the global economy faces increasingly complex crises, policymakers at all levels of the multilateral system are actively seeking solutions to protect against future shocks and address existing asymmetries in the global economy. Developing countries, constrained by the limited size of their domestic markets, have long prioritized establishing closer economic ties with their neighboring countries as part of their development policy agenda. However, the success of these regional ties and cooperation has been inconsistent, with East Asia being the only region that has experienced a more enduring and successful process. Trade regionalization, if effectively designed, can play a significant role in reducing CO_2 emissions associated with trade, especially in China (see fig. 2.14). Between 1995 and 2020, trade-embodied CO_2 emissions increased by 90%, primarily due to pollution offshoring and the growing import of goods from developed regions with significantly higher per capita emissions

compared to developing regions. Therefore, fostering regional trade can contribute to mitigating these emissions.

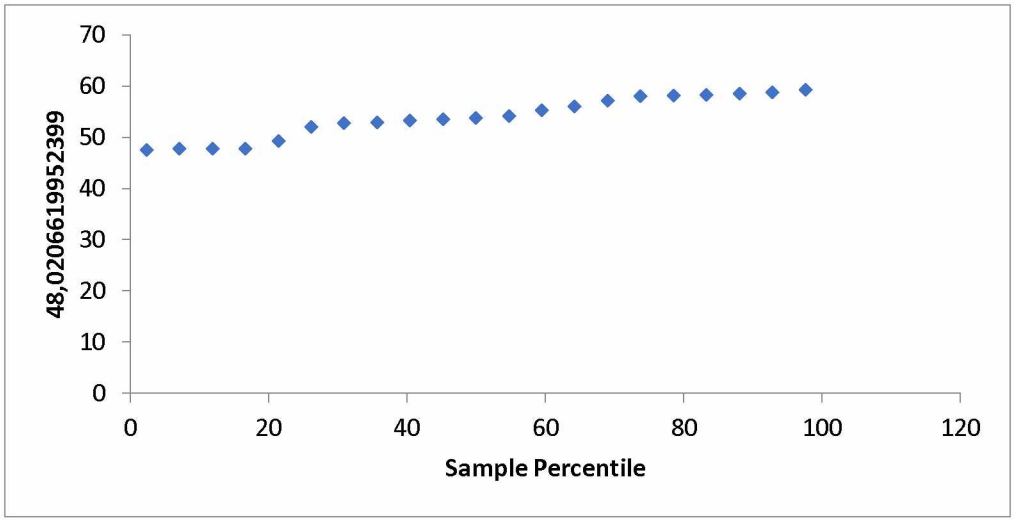

Fig. 2.14. Normal probability plot between trade openness and environmental sustainability of China

Source: [authors' calculations]

In terms of long-term behavior, all the researched countries followed a similar pattern. They experienced a period of reduced trade openness during times of crisis, such as in 2008 and 2020, but subsequently increased their trade openness in the post-crisis period. This aligns with the predictions made by scientists. However, it is worth noting that China did not follow this trend and did not increase its trade openness during the period from 2000 to 2020 (see fig. 2.15).

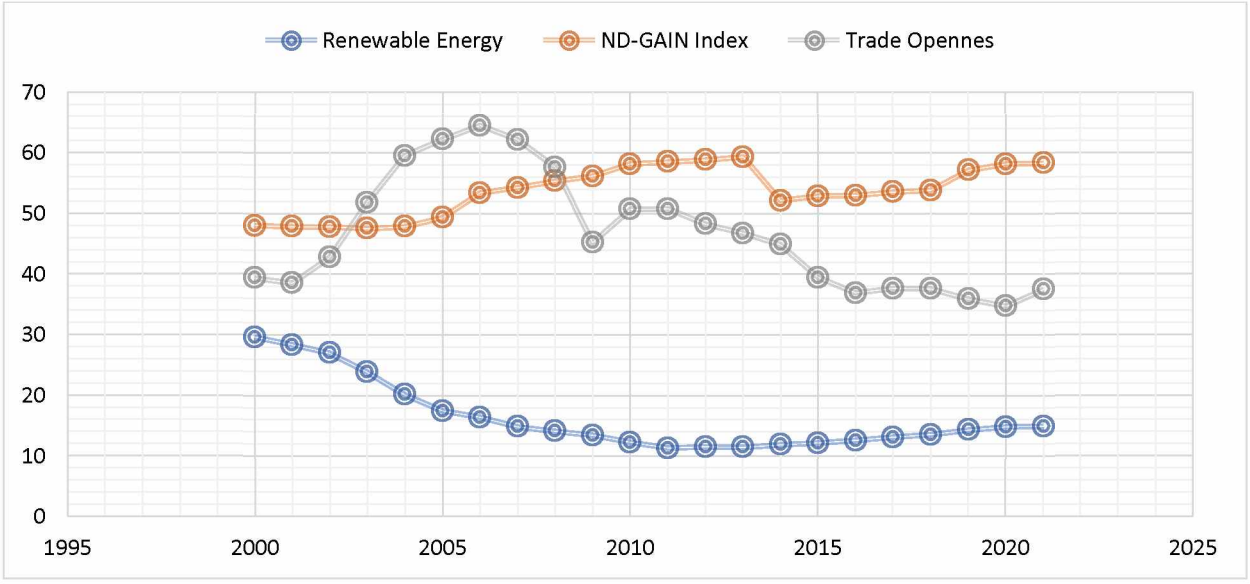

Fig. 2.15. Environmental trade sustainability indexes of China

Source: [authors' calculations]

Based on our hypothesis, countries that are more open to trade are also more energy efficient and environmentally friendly, making them more resilient to climate shocks. This suggests that trade openness and environmental sustainability are interconnected, and countries with higher levels of trade openness tend to exhibit greater energy efficiency and resilience to climate-related challenges. Overall, addressing the complexities of the global economy requires policymakers to prioritize regional cooperation and trade regionalization. By doing so, countries can not only enhance their economic development but also contribute to reducing CO2 emissions and building resilience to climate shocks.

China experienced a significant decline in ND-GAIN in 2014. During this year, the global economy witnessed a slowdown, with many countries entering into recession. This trend can be attributed to the downward phase of a long economic cycle, characterized by the widespread adoption of new technologies that enhanced production efficiency. However, the main immediate cause, or rather the pretext, was the withdrawal of the United States from QE3 in 2014. This withdrawal further exacerbated the challenges faced by resource-based economies, as it led to a decrease in global prices for raw materials, which was a consequence of the underlying fundamental cause. Additionally, China's non-performing loans increased by 42% to $842 billion in 2014. Furthermore, the global repercussions of the "Ukrainian crisis 2014" significantly impacted major global actors, including the policy of nuclear deterrence, Russia's isolation, and the instability of its economy, as well as the deceleration of integration processes in Europe.

2.3. Analysis of the environmental sustainability in international trade

Trade plays a crucial role in addressing the climate crisis and environmental issues, even though it can lead to the release of greenhouse gases and pollutants without proper environmental regulations. Implementing effective environmental policies is key to reducing the adverse effects of trade on the environment and encouraging sustainable trade practices. It is essential that these policies take into account the global

nature of environmental challenges. Fragmentation may impede the spread of innovation in environmental technologies, leading to higher prices due to decreased economies of scale, and causing a slower and more expensive transition towards environmental sustainability. On the other hand, re-globalization, which involves enhanced international cooperation and integration, can promote services trade and enable a broader utilization of digital technologies, thereby reducing the carbon intensity of trade. Enhanced international collaboration is crucial for trade to have a greater impact on environmental sustainability. Re-globalization brings about advantages such as establishing a more cohesive global environmental governance framework. When paired with effective environmental regulations, trade can greatly promote the shift towards sustainability by leveraging green competitive advantages. This will empower developing nations to capitalize on new trading prospects emerging from the green transition. The World Trade Organization can serve as a platform to improve alignment between trade and environmental measures, thus bolstering endeavors to foster sustainable trade practices.

The argument that international trade has significantly contributed to the deterioration of the global environment overlooks the various ways in which trade can actually support environmental sustainability. The intricate connection between trade and environmental sustainability encompasses factors like climate change, air and water quality, natural resource extraction, and biodiversity. Despite the potential for trade to exacerbate environmental challenges through heightened transportation and production, it also plays a role in generating positive environmental impacts by influencing the nature of traded goods and services and by facilitating the advancement and dissemination of environmental technologies.

International trade plays a crucial role in enhancing the efficiency of global production, thereby fostering the growth of global consumption for traded goods and uplifting global living standards. Nevertheless, the expansion of production and consumption can inadvertently give rise to greenhouse gas (GHG) emissions and other environmental challenges. Additionally, the movement of goods and people associated with international trade can have adverse effects on the environment. Studies indicate

that, on average, approximately two-thirds of GHG emissions linked to trade are attributed to production, while one-third is attributed to transportation. The transportation sector contributes to about 25% of global carbon emissions, with international trade in goods and services accounting for roughly 10% of global CO_2 emissions. The movement of goods across borders within global value chains leads to extra packaging and higher fuel consumption. Efforts are being made by both public and private entities to reduce carbon emissions from maritime and aviation transport.

When evaluating the environmental impact of trade, it is crucial to not only consider the pollution linked to trade activities, but also to analyze a scenario where international trade does not exist. In this hypothetical situation, domestic production would need to escalate to meet consumer demands while upholding the same living standards. As a result, the decrease in pollution from reduced trade would be somewhat counterbalanced by the rise in pollution from domestic production. Additionally, in the absence of trade, economies that lack specific resources or production capabilities would be unable to access a wide range of products, while some producing economies would face limitations in expanding investments due to the constraints of their domestic market. Some research indicates that international trade leads to a 5 per cent increase in carbon dioxide (CO_2) emissions, compared to a scenario without trade. Furthermore, the advantages of international trade outweigh its environmental drawbacks from CO_2 emissions by a significant margin. Similar conclusions have been drawn regarding sulphur dioxide (SO_2) emissions, with trade contributing to a 3-10 per cent rise in emissions in comparison to a scenario without trade. International trade not only affects climate change but can also result in adverse environmental consequences such as deforestation, habitat degradation, and unsustainable resource extraction when not properly regulated by governments. Approximately one-third of deforestation-related carbon emissions are linked to international trade, and 30% of global species threats are attributed to this trade activity.

Trade facilitates the division of labor and distribution of resources among different regions, enabling economies to concentrate on their respective areas of expertise. The environmental consequences of trade are contingent upon the particular

activities in which economies possess a comparative advantage. In some instances, variations in property rights systems across economies for accessing natural resources can establish a foundation for trade, influencing trade dynamics and potentially exacerbating the depletion of finite natural resources. The concept of the "pollution haven hypothesis" proposes that companies seek to evade the expenses associated with stringent environmental regulations by shifting their production to economies with more relaxed environmental norms. This theory suggests that environmental policies play a crucial role in determining comparative advantage. Consequently, the liberalization of trade may prompt the transfer of pollution-intensive manufacturing to economies with less stringent environmental regulations. In the context of climate change policies, this relocation could result in "carbon leakage," wherein attempts to decrease greenhouse gas emissions in one region inadvertently lead to increased emissions in another region with less rigorous climate regulations. This phenomenon ultimately leads to a mere transfer of emissions rather than an actual reduction.

The implementation of suitable regulations can result in a decrease in pollution emissions at a global scale through trade. Nevertheless, in the absence of adequate environmental policies, international trade may shift production to economies with less stringent environmental regulations, thereby causing a rise in pollution levels overall. Various research studies have presented conflicting findings regarding the pollution haven hypothesis, with most indicating that stricter environmental regulations lead to a decrease in exports or an increase in imports of pollution-intensive products, supporting the idea of a pollution haven effect. When it comes to carbon leakage, post-analysis has yielded mixed outcomes, largely attributed to the low cost of emissions and the generous allocation of allowances in current emission trading systems. Pre-simulation studies have shown a potential carbon leakage rate of 5% to 30%, meaning that a reduction of 100 units of domestic carbon emissions could result in an increase of 5 to 30 units of carbon emissions overseas. Recent data suggests that carbon leakage is limited, as the emission intensity gap between developed and developing nations continues to narrow.

Figure 2.16 illustrates the carbon emissions embedded in trade. High-income economies typically have a higher consumption than production of carbon-intensive goods and services, making them net importers of carbon emissions embedded in goods and services. In contrast, middle-income economies tend to be net exporters of carbon emissions. This pattern can be attributed to several factors, including the fact that high-income economies often have more stringent climate policies, which leads to carbonintensive industries relocating to middle-income economies with more lenient climate policies. High-income economies also tend to specialize in less carbon-intensive sectors, such as services, that result in fewer production-related emissions. In contrast, carbon-intensive industries are more prevalent in the sectors where many middle-income economies have a comparative advantage. In addition, high-income economies often have more environmentally friendly and energy-efficient technologies, allowing them to generate smaller quantities of emissions for the same amount of production (see Annex B).

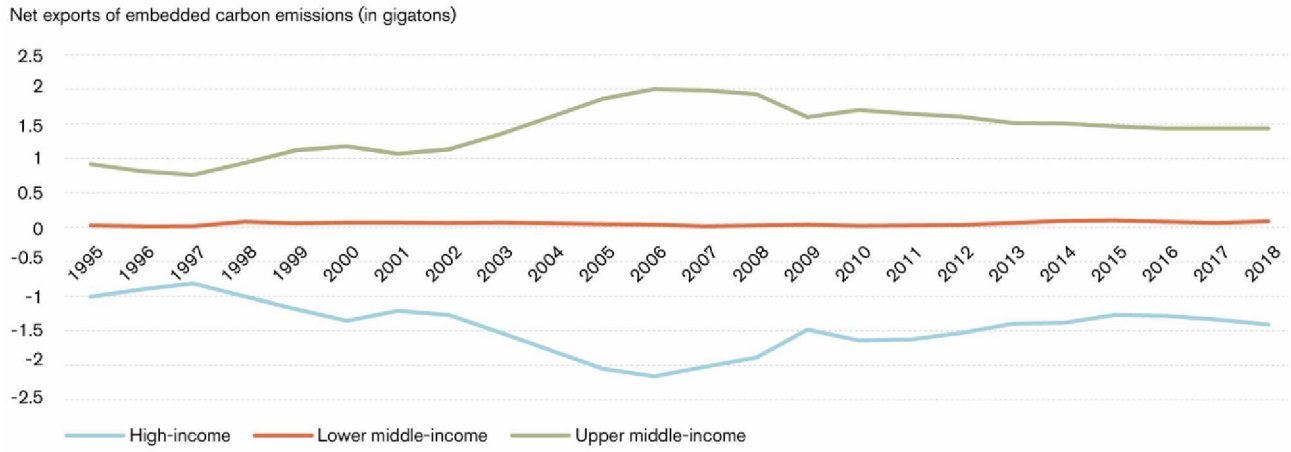

Fig. 2.16. Economies net importers of carbon emissions

Source: [WTO calculation based on OECD database on carbon dioxide emissions embodied in international trade ($TeCO_2$)].

International trade can also bring about direct advantages to the environment through the enhancement of efficiency, the expansion and dissemination of environmental technology, and indirect benefits by elevating incomes and living standards, ultimately leading to improved environmental standards in the long run.

Trade plays a crucial role in spreading environmental technologies across nations, as it enables access to these technologies embedded in goods and enhances energy efficiency through the availability of intermediate inputs. The effectiveness of a country's renewable energy generation largely relies on its ability to access top-notch equipment and machinery from global markets. This is exemplified by the importation of high-quality wind turbines, which offer an unparalleled level of efficiency that cannot be matched by domestically produced alternatives. The trade of environmental goods has shown a more rapid growth compared to the overall trade of goods in the last twenty years. Moreover, having access to intermediate inputs has the potential to enhance the energy efficiency of production processes. In the United States, it has been discovered that the decline in costs related to intermediate imports can account for approximately 8-10 percent of the decrease in the overall energy use-related emissions intensity of nitrogen oxide (NOx) from 1998 to 2014. Furthermore, there are indications that multinational corporations, by means of foreign direct investment, are able to transfer their environmental technologies, such as pollution control, renewable energy, and energy-efficient technologies, to the countries where they operate.

Furthermore, the process of trade liberalization not only increases the market share of larger companies that operate at a more efficient scale, but it also leads to a decrease in pollution per unit of production. Extensive research has consistently shown that exporters tend to have lower pollution levels compared to non-exporters. By opening up trade, firms are able to increase their production capacity and are incentivized to invest more in pollution control measures, making them cleaner. Additionally, reducing trade costs enables more efficient firms to expand their operations and redistribute output among different companies, resulting in a decline in the average emission intensity of an entire industry. This was evident in India between 1990 and 2010, where emission intensity significantly decreased as resources were reallocated from less efficient firms to more efficient ones. International trade has the potential to encourage the development of innovative environmental technologies and investments. By providing access to larger markets, trade can boost production scale and investment revenues. Exporting and import competition can drive firm innovation,

leading to increased spending on pollution control and enhanced production processes to lower emission levels. The expansion of market access through open trade can also facilitate cost reductions in the production of environmental goods, ultimately enabling economies of scale to be realized.

The theory of the Environmental Kuznets Curve suggests that as per capita income rises, the demand for a better environment also increases. Initially, environmental degradation may worsen with higher income levels, but as societies become wealthier, there is a shift towards greater concern for the environment. Evidence indicates that regulation plays a significant role in reducing local pollution as economies progress beyond middle-income levels. Higher-income economies tend to enforce stricter pollution regulations due to several reasons. Firstly, once basic investments in health and education are made, pollution damage becomes a higher priority. Secondly, wealthier societies have more resources, such as technical personnel and budgets, for monitoring and enforcing environmental regulations. Lastly, higher income levels and education empower local communities to uphold higher environmental standards. It is important to note that while local pollution tends to decrease with income above a certain threshold, the relationship is less clear for global pollutants like carbon emissions.

Trade has contributed to the rise in emissions over the past few decades, but advancements in technology have partially mitigated its impact. In order to determine the proportion of emission changes in each country that can be attributed to scale, composition, and technique effects, we employ a standard decomposition method. This method involves comparing the changes in emissions and output between 1995 and 2018 for major economies. The decomposition analysis, as depicted in Figure E.2, reveals that high-income economies have witnessed a marginal increase in their overall CO_2 emissions since 1995. On the other hand, middle-income economies have experienced a more substantial growth in CO_2 emissions, primarily driven by the expansion of their economic size. Nevertheless, the adoption of new production technologies has played a crucial role in counterbalancing the surge in carbon emissions for upper-middle income economies. The presence of a significant technique

effect has also been observed in studies conducted at the firm level. For instance, after the implementation of the North American Free Trade Agreement (NAFTA), the opening of trade between Mexico and the United States resulted in notable decreases in the emissions of inhalable particulate matter with a diameter of 10 micrometres or smaller, as well as SO_2 emissions in US manufacturing plants (see fig. 2.17). This reduction was a direct response to the increased access to the Mexican market and the availability of imported intermediate inputs for US firms. Similarly, the decline in air pollution emissions in the United States from 1990 to 2008 was primarily driven by more stringent environmental regulations, with trade-related factors playing a minor role. The improvement in environmental performance within the Swedish manufacturing industry from 2007 to 2017 was predominantly attributed to the technique effect, while the composition of output actually shifted towards the production of goods with higher pollution intensity.

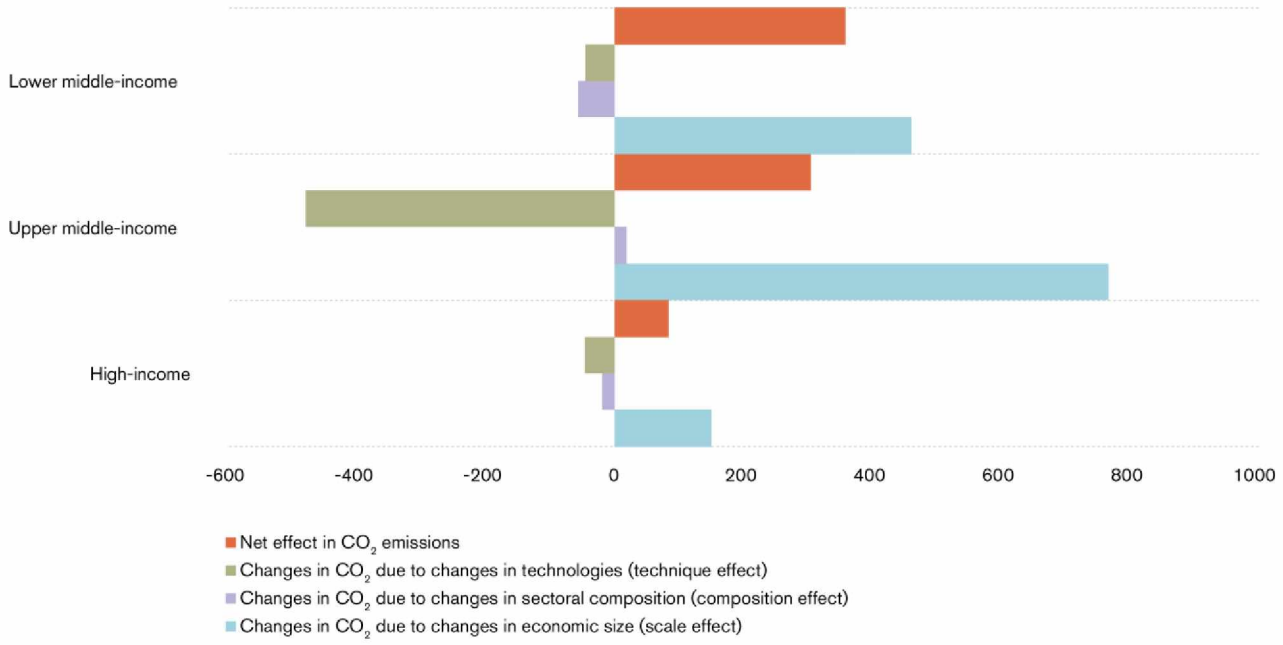

Fig. 2.17. Percentage change in CO_2 emissions from 1995 to 2020, %

Source: [WTO calculation based on calculation based on OECD Trade in value-added (TiVA) and CO_2 emissions embodied in international trade ($TeCO_2$) databases].

Emerging markets often experience an increase in emissions due to trade liberalization, but the technology effect helps counterbalance some of the adverse

environmental consequences. Research conducted in India revealed that the growth in foreign demand led to a rise in CO_2 emissions for Indian manufacturing companies through increased output, yet improvements in emission intensity helped alleviate around 40 percent of this impact, partially attributed to the adoption of new technologies. Similarly, the significant growth in Chinese exports from 1990 to 2010 was linked to the country's pollution levels, resulting in higher infant mortality rates. Nevertheless, the boost in income generated by exports has helped lessen this impact to some extent.

In 2022, the national Ecological Quality Index (EQI) value stood at 59.6, placing the ecological quality in Grade II. This value remained relatively stable compared to that of 2021. The counties with Grade I ecological quality accounted for 27.8% of China's total land area (see fig. 2.18). These counties were primarily located in the Daxing'anling and Xiaoxing'anling Mountain areas, Changbai Mountain, the southeast of the Qinghai-Tibet Plateau, the west of Yunnan-Guizhou Plateau, Qinling Mountains, and Jiangnan hilly areas.

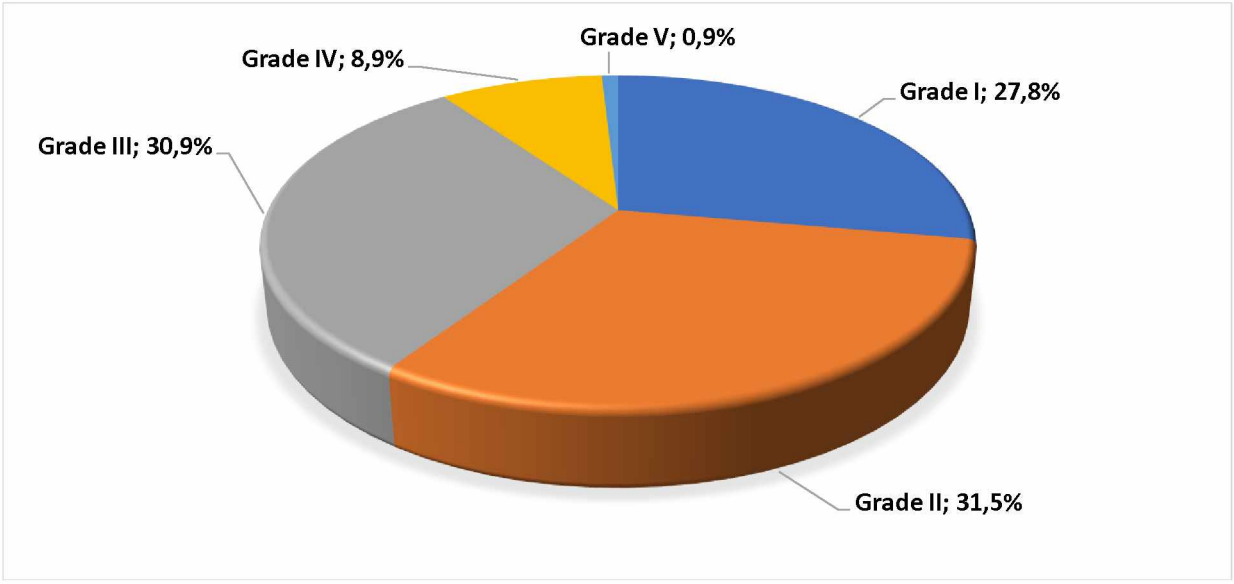

Fig. 2.18. General eco-environmental quality of counties in China in 2022

Source: [125].

Counties with Grade n ecological quality covered 31.5% of the total area, mainly found in the Sanjiang Plain, Inner Mongolia Plateau, Loess Plateau, the northwest of

the Qinghai-Tibet Plateau, Sichuan Basin, Pearl River Delta, and the middle and lower reaches of the Yangtze River. Counties with Grade m ecological quality accounted for 30.9% of the total area, primarily distributed in the North China Plain, the central Northeast Plain, the western Alxa in Inner Mongolia, the western Qinghai-Tibet Plateau, and most parts of Xinjiang. Counties with Grade IV ecological quality covered 8.9% of the total area, while Grade V accounted for 0.9%. These counties were mainly concentrated in central and northern Xinjiang and western Gansu.

China boasts an impressive collection of agricultural biodiversity, including 1,339 cultivated varieties of 528 crop species and over 1,000 economic tree species. Additionally, the country is home to 7,000 ornamental plant varieties and 948 domestic animal breeds. As of the end of 2022, China had successfully preserved over 530,000 copies of crop germplasm resources and 568 local breeds of livestock and poultry for long-term conservation. The evaluation findings for 39,330 species of higher plants in China revealed that 11,715 species require special attention and protection, accounting for 29.8% of the total assessment. Among these, 4,088 species were classified as threatened, 2,875 as near threatened (NT), and 4,752 as data deficient (DD). In addition, the assessment results for 4,767 identified vertebrates (excluding marine fishes) indicated that 2,816 vertebrates need special attention and protection, representing 59.1% of the total assessment. Within this group, 1,050 vertebrates were considered threatened, 774 were classified as NT, and 992 were categorized as DD. Lastly, the assessment results for 9,302 identified macro-fungi showed that 6,538 species of macro-fungi require special attention and protection, making up 70.3% of the total assessment. Among these, 97 macro-fungi were threatened, 101 were NT, and 6,340 were DD.

Carbon pricing currently addresses 20% of worldwide greenhouse gas emissions. However, the majority of efforts fall short of the $40-$80/tCO2e range required to align with the temperature target set by the Paris Agreement, as outlined by the High-Level Commission on Carbon Prices. The private sector is increasingly leveraging carbon pricing to uncover new opportunities for reducing greenhouse gas emissions and minimizing climate-related financial risks. While companies have

traditionally used internal carbon pricing to assess risks associated with mandatory carbon pricing regulations, they are now exploring innovative ways to utilize this tool to better address long-term climate risks and align their investments with climate goals. For example, leading banks are incorporating carbon pricing mechanisms into their credit evaluation processes and analyzing their portfolio's carbon footprint. Additionally, prominent indices are taking into account climate risks and policies, including carbon pricing. Financial institutions are also adopting internal carbon pricing strategies to effectively manage climate-related risks and capitalize on opportunities in their investment decisions. Map (fig. 2.19) shows jurisdictions with carbon taxes or emissions trading systems implemented, under development or under consideration, subject to any filters applied in the table below the map (see Annex C).

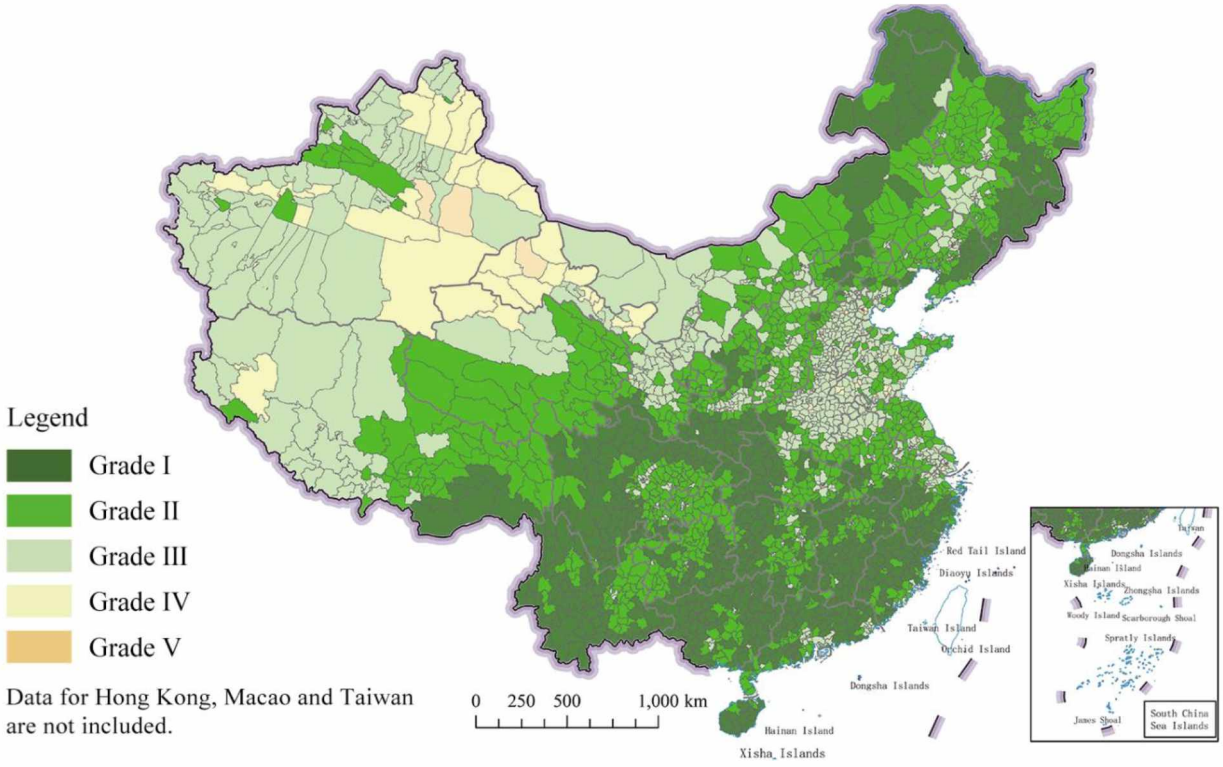

Fig. 2.19. General eco-environmental quality of counties in China in 2022

Source: [125].

China has comprehensive strategies in place for implementing the largest emissions trading system globally, which will encompass over 1,700 power companies and a total of 3 billion tonnes of greenhouse gas emissions (see table 2.2). The primary

objective of this market is to regulate and diminish greenhouse gas emissions while fostering environmentally friendly, low-carbon development. Following a preparatory phase, trading activities will commence and progressively encompass additional high-energy-consuming and high-emission sectors. The national emissions trading system has received approval from China's State Council. Pilot programs have already been initiated in seven provinces and cities within China, with the first one launched in 2013.

Table 2.2

GHG Emissions Coverage

Shenzhen pilot ETS	*Covers 30% of Shenzhen emissions, 0.03% of global emissions*
Shanghai pilot ETS	*Covers 36% of Shanghai emissions, 0.16% of global emissions*
Beijing pilot ETS	*Covers 24% of Beijing emissions, 0.06% of global emissions*
Guangdong pilot ETS	*Covers 40% of Guangdong emissions, 0.52% of global emissions*
Tianjin pilot ETS	*Covers 35% of Tianjin emissions, 0.12% of global emissions*
Hubei pilot ETS	*Covers 27% of Hubei emissions. 0.18% of global emissions*
Chongqing pilot ETS	*Covers 51% of Chongqing emissions, 0.18% of global emissions*
Fujian pilot ETS	*Covers 51% of Fujian emissions, 0.28% of global emissions*
Taiwan carbon fee	*Covers 80% of Taiwan, China emissions. 0.46% of global emissions*
China national ETS	*Covers 31% of China emissions, 9.3% of global emissions*

Source: [author on data of https://carbonpricingdashboard.worldbank.org/].

China is now part of a rising group of regions, including California, the EU, and South Korea, that are implementing market-based strategies to reduce climate emissions in a cost-efficient and effective manner. China is set to establish the biggest carbon market globally, learning from the experiences of these other markets to ensure alignment with national policies. The Chinese government is actively working towards achieving its long-term environmental goals. There are currently 42 national and 25 subnational jurisdictions that have implemented carbon pricing. The European Union Emissions Trading System, the largest carbon market at present, encompasses around 1.75 billion tonnes of emissions.

China's exports to Ukraine in 2022 amounted to $5.73 billion. The primary goods that China shipped to Ukraine included Broadcasting Equipment ($673 million),

Pesticides ($272 million), and Computers ($245 million). Over the last five years, China's exports to Ukraine have experienced a remarkable annual growth rate of 139%, soaring from $73.4 million in 2017 to $5.73 billion in 2022. Ukraine's exports to China reached $2.01 billion in 2022. The primary products exported from Ukraine to China included Corn ($1.06 billion), Iron Ore ($380 million), and Other Vegetable Residues ($351 million). Over the last five years, Ukraine's exports to China have been growing at an average annual rate of 37.5%, rising from $409 million in 2017 to $2.01 billion in 2022. In 2022, China was positioned 22nd in the Economic Complexity Index (ECI 1.12) and held the top spot in total exports with $3.73 trillion. Meanwhile, Ukraine secured the 44th spot in the Economic Complexity Index (ECI 0.5) and ranked 61st in total exports at $47.1 billion for the same year (see fig. 2.20).

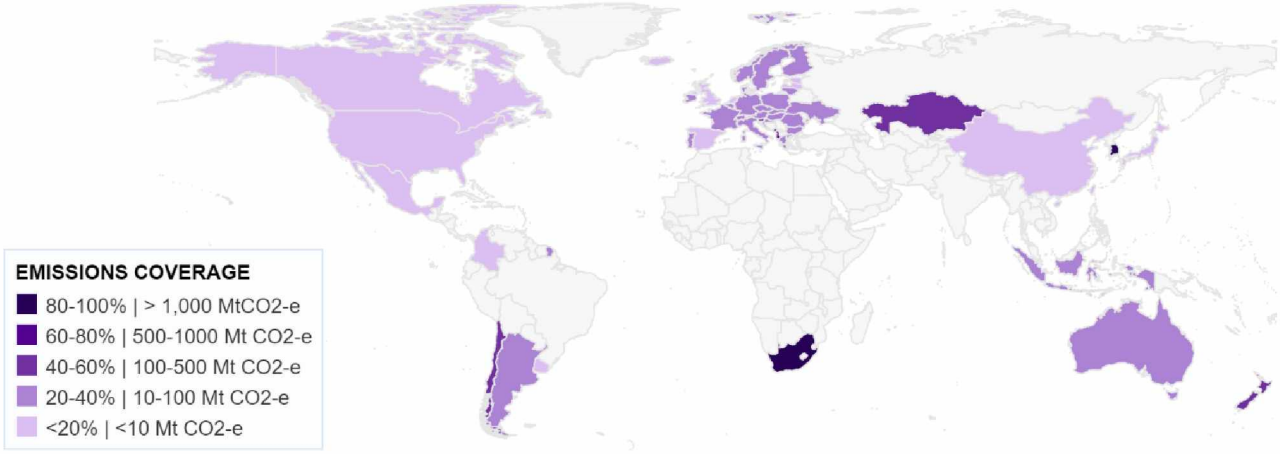

Fig. 2.20. Covered emissions, 2024

Source: [https://carbonpricingdashboard.worldbank.org/].

In April 2024, China recorded exports worth $276M and imports worth $423M from Ukraine, leading to a trade deficit of $147M. Comparing the data from April 2023 to April 2024, China's exports witnessed a significant increase of $68.4M (32.9%) from $208M to $276M. On the other hand, imports experienced a slight decline of $-1.43M (-0.34%) from $425M to $423M. In April 2024, China's primary exports to Ukraine consisted of Electric Batteries ($17M), Electric Generating Sets ($15.2M), Telephones ($14.2M), Electrical Transformers ($8.98M), and Pesticides ($6.1M). Conversely,

China's major imports from Ukraine during the same period included Corn ($106M), Other Vegetable Residues ($57.7M), Seed Oils ($45.6M), Soybeans ($8.4M), and Barley ($3.54M). In April 2024, China's exports were primarily dominated by Zhejiang Province ($88.1M), Guangdong Province ($48.3M), Shandong Province ($40M), Jiangsu Province ($22.1M), and Tianjin ($11.4M). On the other hand, the main import destinations were Fujian Province ($88.8M), Jiangsu Province ($58.9M), Guangxi Zhuang Autonomous Region ($44.7M), Guangdong Province ($37M), and Shandong Province ($33.9M). In April 2024, the surge in China's annual exports to Ukraine can be attributed mainly to the growth in the export of Electric Batteries ($10.6M or 165%), Titanium ($1.62M or 5.42k%), and Glass Working Machines ($1.52M or 433%). Conversely, the decline in China's annual imports from Ukraine during the same period can be primarily attributed to a decrease in the import of Corn ($-421M or -79.8%), Seed Oils ($-62M or -57.6%), and Other Vegetable Residues ($-28.3M or -32.9%).

Ukraine's potential to boost exports of pig iron and semi-finished products to China is hindered by limited domestic production and costly logistics. Nevertheless, by ensuring a secure sea corridor, the country can enhance ore deliveries. Currently, predicting the demand for iron ore in China poses a challenge. Projections for steel production and consumption in China this year remain uncertain, as they heavily rely on the real estate sector's recovery and the effectiveness of the Chinese government's stimulus policies. There are several signs pointing towards a potential decrease in ore imports in 2024. The demand for iron ore might weaken due to an anticipated decline in pig iron production, driven by the PRC's emission reduction requirements. Moreover, the country's economic growth is expected to slow down, with current estimates ranging from 4.5% to 4.7% (compared to 5.2% in 2023). Ukrainian iron ore exports to China held a minimal market share even before the conflict, which has further diminished now. In 2023, China saw a 6.6% year-on-year increase in ore imports, reaching 1.179 billion tons, while steel production rose by 0.6% year-on-year to 1.019 billion tons. Ukraine has the potential to boost exports to the iron ore market in China. The Chinese market offers great opportunities for Ukrainian agricultural and mining products, provided that the sea corridor operates safely and consistently.

Conclusions to chapter 2

To summarize, it is worth saying that the onset of the COVID-19 pandemic marked a significant shift in the global trade arena, characterized by notable fluctuations. Since 2020, a myriad of disruptions, spanning economic and non-economic realms, have exerted substantial influence on international trade. This period has witnessed fragmentation and increased divergence in trade performance, a trend evident not only during the recovery phases of 2021 and 2022 but also in the more recent trade slowdown, albeit with slightly lesser intensity. The trade performance of the European Union and the United States emerges prominently when juxtaposed with other regions, as highlighted by regional statistics for Europe and North America. While all geographic regions saw a downturn in export growth in the first half of 2023, the overall trade contraction was relatively less severe in these two regions. Conversely, East Asia and the Rest of Asia regions experienced more pronounced declines in trade.

Trade significantly contributes to advancing global economic convergence and reducing poverty. Emerging economies have substantially benefited from trade-driven growth, leading to a narrowing of income gaps with wealthier nations. Their integration into global value chains and the reduction of trade barriers have facilitated this progress. Trade has contributed to the exacerbation of inequality in certain developed nations by increasing the demand for skilled labor and shifting economic activities to urban centers. Available evidence suggests that current trade patterns exhibit increased volatility and diversity compared to historical norms. While it's premature to definitively assert a significant departure from established trends, it's plausible that the disruptions triggered by COVID-19 have catalyzed a notable shift in global trade dynamics. This transformation is influenced by systemic factors such as geopolitical tensions and risk-management strategies. The convergence of these elements raises the prospect of substantial changes in global trade paradigms, heralding a new era fraught with both challenges and opportunities for economies worldwide. Close monitoring of these developments is essential to grasp the ramifications of evolving trade dynamics, particularly for developing nations.

Over the past decade, the surge in international trade has been predominantly fueled by the expansion of trade among developing nations (South-South trade). Despite setbacks in 2015 and amidst the COVID-19 pandemic in 2020, the proportion of South-South trade within global trade has steadily increased, climbing from approximately 17 percent in 2010 to 21 percent in 2022.

Natural resources play a pivotal role in international trade, significantly impacting the economic advancement of nations and their trade dynamics. In this context, we offer an in-depth examination of the importance and role of natural resources in the sphere of international trade. Embracing green energy technologies and prioritizing innovation in development strategies can bolster a nation's energy efficiency. Furthermore, energy resources, including oil, natural gas, and coal, hold immense significance in global trade. Serving as primary sources of energy across the globe, many nations rely on imported energy to meet their domestic demands. Fluctuations in the supply and prices of these resources exert substantial influence on international markets and economic growth.

Trade serves a vital function in confronting the climate crisis and environmental concerns, notwithstanding its potential to contribute to the release of greenhouse gases and pollutants in the absence of adequate environmental regulations. The implementation of robust environmental policies is pivotal in mitigating the negative impacts of trade on the environment and promoting sustainable trade practices. It is imperative for these policies to consider the interconnected and global nature of environmental challenges. China has established comprehensive strategies to implement the largest emissions trading system worldwide, covering more than 1,700 power companies and a total of 3 billion tonnes of greenhouse gas emissions. The primary aim of this market is to regulate and reduce greenhouse gas emissions while promoting environmentally friendly, low-carbon development.

The main scientific results were published in the following scientific articles: 161; 162; 163; 164; 165; 166; 167; 168; 169; 170; 171.

CHAPTER 3
PROSPECTS OF DEVELOPMENT THE ENVIRONMENTAL SUSTAINABILITY OF INTERNATIONAL TRADE

3.1. Impacts of natural resource utilization and consumption on international trade

The environment suffers greatly from the detrimental effects of excessive resource exploitation and consumption. These effects include ecological devastation, soil erosion, depletion of water resources, air pollution, greenhouse gas emissions, and potential social conflicts. Firstly, the over-exploitation of resources has resulted in significant ecological damage, such as the destruction of land and deforestation. These activities have severely disrupted the balance of ecosystems and biodiversity. Secondly, over-exploitation has exacerbated desertification and soil erosion, negatively impacting agricultural production and the overall ecological environment. Furthermore, the excessive exploitation of resources also leads to the depletion of water resources, affecting crucial aspects such as agricultural irrigation and urban water supply. Simultaneously, the extraction and utilization of resources emit a significant quantity of detrimental gases and particulate matter, thereby escalating air pollution levels and endangering both human well-being and the ecological balance. Moreover, this conduct contributes to the release of substantial amounts of greenhouse gases, intensifying the impact of global climate change, triggering frequent occurrences of extreme weather events, and adversely affecting ecosystems and human society. Ultimately, the excessive exploitation of resources can also give rise to social conflicts, encompassing resource competition and environmental degradation, which profoundly disrupt social stability and impede sustainable development.

To mitigate the negative effects of overexploitation and resource consumption on the environment, a comprehensive set of resource management and protection strategies must be implemented. These strategies encompass promoting sustainable development, enhancing environmental regulations, encouraging resource

conservation and recycling, and fostering green production and consumption. It is crucial to enhance resource management, boost resource efficiency, drive technological innovation, explore alternative resources, strengthen global collaboration, address resource and environmental challenges collectively, and establish and refine policies and regulations to support the sustainable utilization of resources and the advancement of commerce. By executing these measures, we can achieve sustainable resource use and environmental protection, paving the way for the sustainable progress of human society.

The influence of environmental concerns on trade is complex, primarily evident in the subsequent dimensions:

- *Trade barriers:* environmental standards and regulations are frequently employed as trade barriers. Certain nations may establish stringent environmental criteria to restrict the influx of imported goods and safeguard their domestic markets and the environment. These practices have the potential to create trade imbalances that hinder exports and impede economic growth in developing nations.
- *Green trade and demand for green products:* the rising consciousness towards environmental preservation has led to a surge in the demand for eco-friendly products. Numerous nations are inclined towards purchasing environmentally conscious goods, thereby fostering the advancement of green trade. Consequently, environmental concerns can serve as catalysts for trade expansion, while simultaneously presenting lucrative prospects for the growth of clean technologies and sustainable industries.
- *Environmental taxes and subsidies:* some nations implement environmental taxes on imported goods or offer subsidies for domestically produced eco-friendly products to promote the growth of green industries or deter environmental harm. These measures can impact the global trade landscape, potentially leading to trade conflicts and disagreements.
- *Environmental cooperation and Trade Agreements:* environmental concerns frequently take center stage in international trade discussions and pacts. Several nations incorporate provisions for environmental safeguarding in their trade agreements, aiming to prevent significant harm to the environment and foster sustainable

development and environmental protection. Moreover, global environmental collaboration can effectively mitigate cross-border pollution and resource depletion, while simultaneously fostering a mutually beneficial relationship between trade and environmental preservation.

The emphasis of sustainable development and resource conservation will be on attaining harmonious progress in the economy, society, and environment through effective resource utilization and trade. Additionally, it will delve into the means of advancing international trade's sustainable development by incorporating sustainable development principles and resource conservation measures. When delving into sustainable development and resource conservation, it is crucial to thoroughly examine the following aspects:

— *The application of the concept of sustainable development in the use of resources:* achieving sustainable development necessitates the harmonization of economic, social, and environmental progress in the utilization and utilization of resources. This entails guaranteeing the sustainable utilization of resources through the equilibrium of economic expansion, social fairness, and environmental safeguarding. We can explore strategies to accomplish this objective by endorsing eco-friendly production, supporting resource preservation and recycling, and enhancing environmental regulations.

— *The impact of resource conservation on international trade:* the implementation of resource conservation policies and regulations could significantly influence global trade. Countries may choose to limit the export of specific resources or enhance resource control to safeguard their own resources and environment. Conversely, international collaboration in managing transnational resources may be bolstered to promote sustainable resource utilization and conservation. Analyzing the effects of these policy actions on trade scale and patterns, as well as striving for sustainable resource use and fair trade through international cooperation, is crucial.

— *Coordination of sustainable development and trade policies:* To achieve sustainable development and resource conservation goals, it is essential to create eco-friendly trade policies and support initiatives like recycling resources and reducing

carbon emissions. This could mean incorporating environmental protection clauses in trade deals, crafting green trade promotion strategies, and setting up sustainable supply chains. By examining how these actions benefit both economic growth and resource preservation, we can evaluate their efficiency and viability using case studies or modeling techniques (see fig. 3.1).

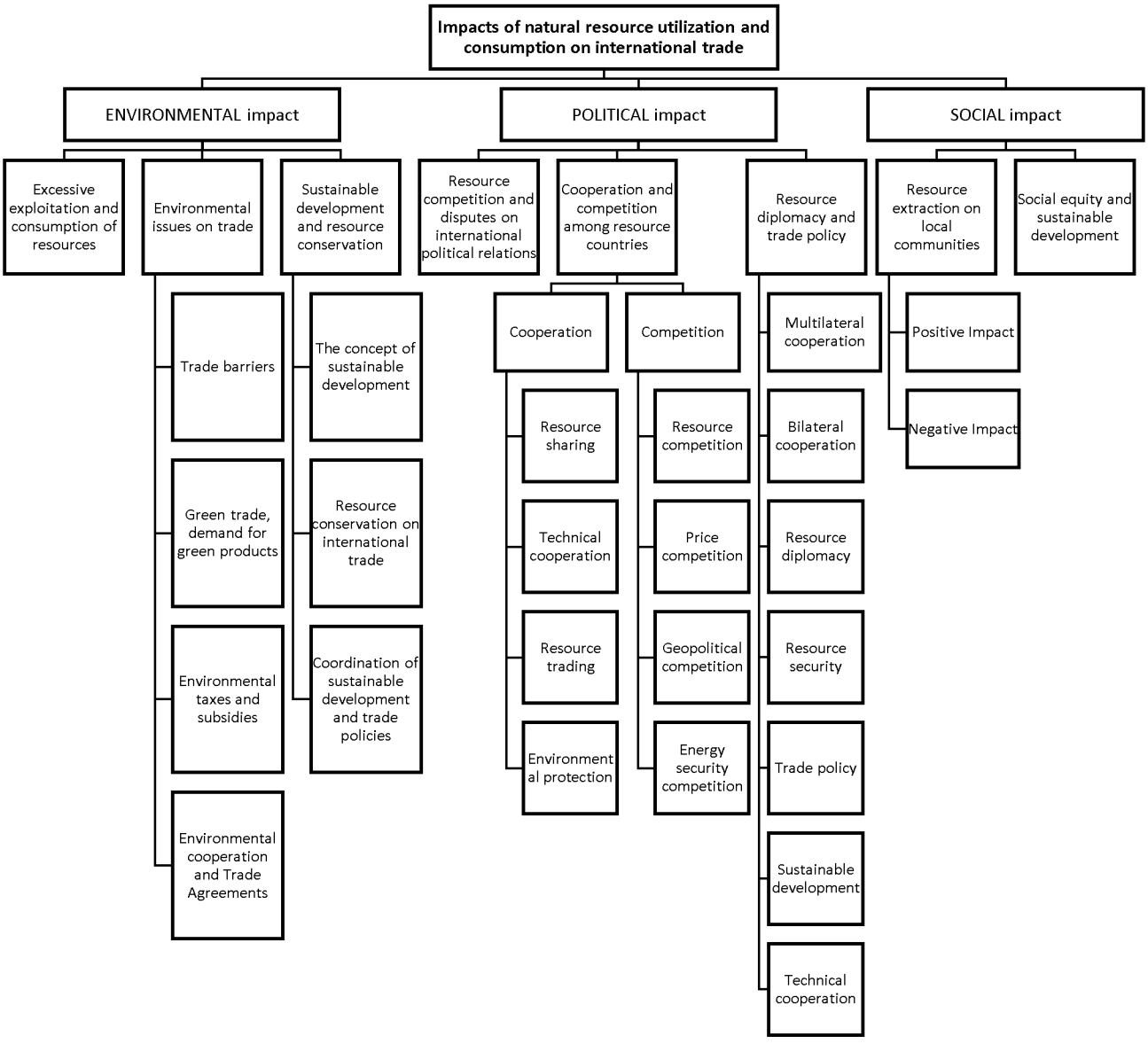

Fig. 3.1. Impacts of natural resource utilization and consumption on international trade

Source: [author].

Resource competition and disputes over resources significantly influence international political relations. The main effects of these competitions and disputes include some aspects. When examining the influence of resource competition and disputes on global political relations, it is crucial to take into account geopolitical tensions. The management and exploitation of resources frequently intersect with national interests and security, potentially sparking geopolitical tensions among nations. For instance, the rivalry over marine resources in the South and East China Seas has resulted in tensions among China, Japan, Vietnam, the Philippines, and other countries. These tensions have the potential to escalate into a military standoff or even incite armed conflict, thereby jeopardizing international political stability.

Resource competition and disputes have a significant impact on the economy. National economic development heavily relies on resources, and how these resources are acquired and utilized directly influences a country's economic well-being. The scarcity and value of resources can alter the supply and demand dynamics in the global market, consequently shaping the global economic landscape. Resource conflicts can result in price volatility, which in turn affects international trade and investments. For instance, sudden fluctuations in oil prices can greatly impact the global economy, particularly in nations heavily reliant on oil. Additionally, trade barriers and sanctions can be used as economic tools between countries, escalating economic rivalries and tensions.

It is crucial to delve into the environmental consequences as well. The extraction and consumption of resources typically result in environmental harm, including deforestation, soil erosion, and various other issues. These environmental challenges can trigger conflicts on a global scale, as resource extraction and utilization often cross international boundaries, creating difficulties in sharing and managing resources. Moreover, excessive exploitation and pollution of resources can endanger ecosystems and biodiversity, underscoring the necessity for international collaboration in addressing transboundary environmental issues and mitigating potential environmental degradation stemming from resource conflicts.

Furthermore, the geopolitical landscape can be further strained by concerns surrounding energy security in the realm of international politics. The unequal distribution of energy resources across different regions can result in certain countries heavily relying on specific energy sources, thereby intensifying the competition for these vital resources. In some cases, nations may exploit energy as a political leverage to exert influence or impose sanctions on others through their control over energy supplies. This approach has the potential to escalate tensions in international relations, potentially leading to conflicts and confrontations that pose a significant threat to both regional and global stability.

The significance of resource competition and disputes on international cooperation and conflict cannot be underestimated. Resource competition has the potential to foster international cooperation, encourage the sharing of resources and collaborative development among nations, and strengthen global interdependence and cooperation. However, resource disputes can also escalate into international conflicts and wars, heightening tensions in international relations and jeopardizing global peace and security. Hence, it is imperative to thoroughly analyze the impact of resource competition and disputes on international cooperation and conflict, and devise strategies to uphold the stability and harmony of international political relations.

Collaboration and rivalry between resource-rich nations play a crucial role in global political and economic dynamics. These two elements work hand in hand, as they give rise to mutually beneficial cooperation agreements as well as competitive behaviors stemming from resource conflicts. Here is an in-depth analysis of the nature of cooperation and competition among resource countries:

1. Cooperation. *Resource sharing:* The collaboration mechanism facilitates the exchange of resources among nations that possess them, leading to joint development and utilization of these resources. This sharing fosters a sense of trust between countries, enabling the optimal allocation of resources and driving economic growth and social advancement. For instance, resource-rich countries lacking in technological expertise can partner with technologically advanced nations to collectively undertake

resource projects, thereby achieving the objective of resource sharing and mutually beneficial cooperation.

Technical cooperation: Technical cooperation plays a crucial role in fostering collaboration among resource-rich nations. By engaging in technical cooperation, these countries can collectively innovate new resource extraction and environmental protection technologies, thereby enhancing the efficiency and sustainability of resource development. This collaborative effort not only elevates the standards of resource extraction and utilization but also mitigates the environmental consequences associated with such activities. For instance, developed nations can share their advanced environmental protection technologies with resource-exploiting countries, thereby fostering joint progress in resource development and environmental preservation.

Resource trading: Resource-rich nations have the opportunity to fulfill their resource requirements and foster economic progress through collaborative resource trading. By engaging in resource trade, countries can leverage the complementary advantages of their resources in the global market, enhancing the efficiency of resource utilization and facilitating international trade development. This type of cooperation promotes the rational allocation of resources and cultivates mutually beneficial trade relationships, thereby driving economic growth for all nations involved.

Environmental protection: Resource-abundant countries have the chance to collaborate in safeguarding their resources and the environment by employing joint mechanisms to minimize the environmental impact of resource extraction. The extraction of resources often results in pollution and ecological harm, but through cooperation, these countries can develop environmental protection policies and standards, implement environmentally friendly mining practices, and lessen the negative consequences of resource exploitation on the environment. This collaboration is essential for the sustainable use of resources and the enduring development of the environment.

2. Competition. *Resource competition:* Competition for scarce resources is a common occurrence among resource-rich countries. This competition revolves around gaining control over these resources and the right to exploit them. Given the scarcity

and strategic significance of these resources, countries may employ various tactics, such as diplomatic negotiations, economic collaborations, and in extreme cases, military interventions, to secure control and development rights. This intense competition often leads to regional tensions and instability in international relations, and in some cases, it can even ignite geopolitical conflicts and wars. For instance, regions abundant in valuable resources often become hotspots for multinational competition, resulting in regional instability and conflicts.

Price competition: Resource countries may engage in competition over prices in order to gain market share and obtain a competitive edge. The fluctuations and competition in resource prices are frequently influenced by factors such as supply and demand, international politics, and geopolitics. Certain countries may adjust their resource prices and provide favorable terms to secure market share and competitive advantages. This price competition can potentially lead to fluctuations and instability in the global market, impacting the international trade order and economic development.

Geopolitical competition: Competition among nations that possess valuable resources can also give rise to geopolitical rivalries, particularly when it comes to disputes over resource control. Regions abundant in resources often become hotspots of contention among multiple countries, and conflicts over territorial claims, maritime rights, and other related matters can be further intensified by the presence of these resources. This geopolitical competition has the potential to escalate regional tensions and strain international relations, necessitating the use of diplomatic channels and international cooperation to alleviate and resolve these issues.

Energy security competition: Energy sources play a crucial role in national security, leading to potential competition among resource-rich nations due to energy security concerns. Nations may adopt different strategies to safeguard their energy supply stability, such as managing supply routes, enhancing energy diplomacy, and pursuing energy diversification plans. This rivalry for energy security has the potential to create tensions and uncertainties in global relations, particularly during times of limited resources or geopolitical instability.

Resource diplomacy and trade policy are a set of policies and strategies developed by resource-rich countries in global relations to protect and advance national resource interests, as well as to encourage the sustainable development, utilization, and trade of resources. These policies play a crucial role in safeguarding national resource interests, fostering resource cooperation and growth, and supporting the sustainable development of resources. Here is a detailed explanation and examination of these policies:

Multilateral cooperation: Participating in international organizations and multilateral cooperation mechanisms plays a crucial role in resource countries' pursuit of resource diplomacy and trade policies. Through active engagement in these mechanisms, resource countries can foster collaborative relationships with other nations, collectively advance international rules and standards in the realm of resources, and enhance cooperation and development in resource exploration and trade. This multilateral cooperation empowers resource countries to wield greater influence on the global stage and enhance the protection and efficiency of their resource interests.

Bilateral cooperation: Signing bilateral agreements and cooperation pacts with other nations is a crucial approach for resource-rich countries to engage in resource diplomacy and trade policies. By fostering bilateral collaboration with other nations, resource-rich countries can establish mutually advantageous and mutually beneficial relationships in resource development, technical cooperation, and resource trade. These bilateral partnerships enable resource-rich countries to enhance resource cooperation and exchanges in specific sectors or regions, thereby maximizing and optimizing resource benefits.

Resource diplomacy: Resource countries can ensure the protection of their national resource sovereignty and interests, as well as effectively address resource disputes and conflicts, by employing diplomatic strategies. Additionally, resource diplomacy serves as a crucial avenue for these countries to foster resource cooperation and exchange. In the realm of international affairs, resource diplomacy plays a pivotal role in safeguarding their own resource interests and resolving resource-related

challenges. Therefore, it becomes imperative to utilize diplomatic channels and engage in international cooperation to maximize and safeguard resource interests.

Resource security: Developing a resource security policy is a crucial step in guaranteeing the stability and security of resource supply in countries rich in resources. These nations must implement a range of strategies, such as diversifying energy supply routes, enhancing energy diplomacy, and safeguarding maritime transportation channels. By doing so, they can ensure the dependability and stability of their domestic resource supply, thereby protecting national economic growth and safeguarding national security.

Trade policy: Resource-rich nations have the ability to enhance the liberalization and facilitation of resource trade, as well as foster international trade and the global circulation of resources through the implementation of trade policies. It is imperative for these nations to actively reduce trade barriers, promote trade facilitation, and enhance trade efficiency through well-crafted trade policies. By doing so, they can effectively optimize and advance resource trade for their own benefit and development.

Sustainable development: Implementing sustainable development strategies is crucial for countries rich in resources to optimize resource advantages and attain sustainable development. These nations must prioritize environmental conservation, ecological equilibrium, and sustainable resource management throughout the resource exploitation process to guarantee a continuous supply of resources and the longevity of both resources and the environment.

Technical cooperation: Resource-rich nations can enhance the efficiency and sustainability of resource development by implementing technical cooperation policies. By fostering the exchange and collaboration of resource technologies, these countries can elevate their technical expertise and effectiveness in resource development. It is crucial for resource countries to forge stronger technical partnerships with other nations to collectively advance and implement cutting-edge resource development and environmental protection technologies. This collaborative approach will not only optimize resource benefits but also foster a win-win situation for all stakeholders involved.

Resource extraction has a multifaceted and varied impact on local communities, encompassing both favorable and potentially adverse consequences. Let's explore the ways in which resource extraction can influence local communities:

– Positive Impact. Resource extraction not only introduces advanced technology and management experience to local communities but also enhances the skill level and management capacity of residents. The sharing of such knowledge not only boosts the employability of locals but also drives the growth of associated industries, thereby bolstering the economic transformation and advancement of the community. Resource extraction projects frequently result in enhancements to infrastructure and public services. To facilitate the activities involved in resource exploitation, significant investments are made by both the government and businesses in infrastructure development. This includes the building of roads, bridges, water supply systems, and power facilities to upgrade the community's infrastructure and improve the quality of life for residents. Additionally, these projects create a higher demand for public services like education, healthcare, and cultural amenities, leading to advancements in these sectors and an overall increase in the social welfare standards of communities.

Furthermore, the extraction of resources can also foster the expansion of local industries. As a result of resource exploitation initiatives, it will stimulate the growth of numerous interconnected industries and complementary services, thereby accomplishing a diversified and harmonized industrial development. This not only contributes to enhancing the economic robustness and adaptability of communities, but also offers residents increased prospects for employment and entrepreneurship, ultimately fostering social stability and fostering a harmonious progression. Ultimately, the exploitation of resources can contribute to raising environmental consciousness and fostering the development of ecological civilization within local communities. Throughout the resource exploitation process, both businesses and governments are required to adhere to environmental regulations and policies, implementing diverse measures to minimize environmental impact and safeguard the ecological environment and biodiversity. By cultivating environmental awareness and advocating for the

construction of ecological civilization, the local residents' understanding of environmental protection and their adherence to behavioral norms can be enhanced, thereby facilitating sustainable development and ecological security within the community.

— Negative Impact. Resource exploitation can result in more than just environmental damage and social conflict. It can also bring about profound social, economic, and cultural challenges. For instance, it may cause the destruction of ecosystems and loss of biodiversity, impacting the local ecological balance and ecosystem function in the long term. Additionally, large-scale land use and development associated with resource exploitation can lead to overexploitation of land resources, land use conflicts, and negative effects on agricultural production, food security, and sustainable development in rural areas. Furthermore, the extraction of resources can result in detrimental health effects on nearby communities, including the contamination of air, water, and soil. These pollutants not only pose a higher risk of diseases but also have adverse consequences on public health. Simultaneously, the exploitation of resources can worsen the disparities within local societies, deepening the divide between the affluent resource-rich individuals and the impoverished. This further intensifies social polarization and perpetuates social injustice.

In order to address these negative consequences, it is imperative to consider the interests of all stakeholders and implement a range of comprehensive measures. Firstly, it is crucial to establish a robust mechanism for environmental protection and ecological restoration. This entails enhancing supervision and management of resource extraction activities, and ensuring effective control and management of environmental risks associated with such activities. Secondly, it is essential to encourage resource mining companies and local governments to prioritize their social responsibilities. They should actively engage in the development of local communities and allocate funds and resources towards community infrastructure and social welfare projects. This will contribute to enhancing the living standards and overall well-being of residents. Simultaneously, it is imperative to establish an effective platform for social dialogue and participation in order to enhance communication and consultation among resource

mining companies, the government, and local inhabitants. This will foster a mutually beneficial partnership, minimize the adverse effects of resource mining on local communities, and facilitate a positive synergy between resource extraction and sustainable community development. Moreover, it is crucial to address the potential environmental repercussions of resource exploitation, such as pollution, soil erosion, and ecological harm, as they can significantly impact the stability of the local ecosystem and environment.

Social equity and sustainable development are of utmost importance in the realm of international trade. The absence of social equity can result in imbalanced economic growth due to resource extraction. For instance, regions abundant in resources may experience economic prosperity, while areas lacking resources may face neglect in terms of environmental protection and social justice. This disparity can have repercussions on international trade relations, as economic activities associated with resource extraction can exacerbate the wealth gap between regions, thereby impacting the fairness and sustainability of trade. Consequently, the promotion of inclusive trade policies and strengthened international cooperation are essential in order to foster equitable distribution and sustainable utilization of resources, ultimately leading to harmonized economic, social, and environmental development.

However, it is worth noting that sustainable development also plays a significant role in international trade. The focus of the research paper could be on highlighting the significance of responsibly utilizing natural resources for trade purposes. It is crucial to avoid excessive exploitation and consumption of resources as it can lead to severe environmental damage, ultimately impacting the sustainability and stability of trade operations. Therefore, by delving into sustainable development and resource utilization, we can examine ways to foster sustainable growth in international trade while maintaining a balance between economic progress and environmental preservation.

In conclusion, it is crucial to simultaneously advance social equity and sustainable development. This can be achieved by crafting trade policies and enhancing global collaboration to ensure the equitable distribution and sustainable utilization of

resources. By doing so, we can attain harmonious progress in the realms of economy, society, and environment. This entails formulating inclusive trade policies, reinforcing cross-border cooperation mechanisms, advocating for resource extraction and trade practices that align with sustainable development principles, and establishing a fairer and more sustainable basis for future international trade relations.

3.2. Ways of developing the environmental sustainability of PRC international trade

According to the International Monetary Fund (IMF), approximately every minute, coal, oil, and natural gas receive subsidies amounting to USD 11 million. In 2020 alone, these fossil fuel subsidies reached a staggering USD 5.9 trillion, equivalent to around 6.8% of the global gross domestic product (GDP). It is projected that by 2025, this figure will rise to 7.4% of GDP, which starkly contradicts the scientific imperative for a carbon neutral economy by 2050 [132]. The escalating subsidies for fossil fuels serve as a prime illustration of a concerning pattern. Rather than directing funds towards a sustainable and future-oriented recovery through COVID-19 economic stimulus packages, policymakers persist in channeling public finances towards unsustainable modes of development. In the absence of well-defined strategies for transitioning to decarbonized economies and novel approaches to gauging economic prosperity that account for these unsustainable practices, the threats to future generations become even more pronounced.

In light of a global crisis encompassing various challenges such as climate change, biodiversity loss, pollution, and social disparities, it is crucial to delve deeper into the connection between trade and the environment. Although the relationship between trade and the environment is intricate, it is essential to prioritize policy coherence in order to effectively address this urgent situation and ensure that no one is left behind. Since the 1960s, social movements have played a crucial role in increasing awareness about pollution caused by humans and advocating for more robust environmental protection measures. While governments have implemented science-

based laws to safeguard the environment, trade regulations have not been thoroughly reassessed.

The Earth Summit emphasized the importance of international trade in reducing poverty and addressing environmental degradation. Agenda 21 and the Rio Declaration on Environment and Development, along with Stockholm's efforts, advocated for a global trade system that takes into account the requirements of developing nations and supports long-term economic growth. The establishment of the World Trade Organization (WTO) through the Uruguay Round marked a significant milestone in the reform of the global trading system. This reform was the most substantial since the establishment of the General Agreement on Tariffs and Trade (GATT) after World War II. Notably, the Uruguay Round also addressed trade-related environmental concerns, highlighting the growing recognition of the importance of sustainable development.

The preamble to the Marrakesh Agreement, which served as the foundation for the WTO, emphasized the significance of sustainable development. During the ministerial meeting in Marrakesh in April 1994, ministers further solidified their commitment to addressing trade and environment issues. They signed a "Decision on Trade and Environment," affirming that there should be no contradiction between maintaining an open, non-discriminatory, and fair multilateral trading system and taking action to protect the environment and promote sustainable development.

The mandate of the WTO Committee on Trade and Environment covers fundamental aspects. The WTO Committee on Trade and Environment addresses key aspects related to environmental policies and trade measures; considers various aspects such as charges, taxes, and product requirements for environmental purposes; focuses on transparency in trade measures and environmental requirements with significant trade impacts; examines the relationship between dispute settlement mechanisms in the multilateral trading system and those in multilateral environmental agreements; analyzes the impact of environmental measures on market access, particularly for developing countries; addresses the issue of exports of domestically prohibited goods; discusses the work programme outlined in the Decision on Trade in Services and the

Environment; provides input on appropriate arrangements for relations with intergovernmental and non-governmental organizations as per Article V of the WTO.

Subsidies create market distortions by not accurately representing the actual production costs, which includes environmental damage. International trade subsidies further create unfair competitive advantages for goods compared to those from countries that do not provide subsidies. Despite facing criticism, the elimination of subsidies continues to be a debated issue. The main sectors where subsidies are prominent include agriculture, fossil fuels, fisheries, and forestry. Despite the high expectations, the global trade negotiations were unable to incorporate trade and environment-related decisions as anticipated. The 2001 Doha Ministerial Declaration stood out from its predecessors by including extensive language on sustainable development and environmental concerns. Alongside efforts to diminish agricultural subsidies and tackle fishing subsidies, the Doha Round aimed to enhance trade in services like business and finance, as well as non-agricultural goods. Regrettably, even after two decades, the negotiations remain unresolved among WTO members [133].

To achieve the nexus between trade and the environment, it is crucial to address subsidies. For instance, governments worldwide provide subsidies amounting to over USD 600 billion annually to support their agricultural sectors. However, research indicates that this support does not align with the collective benefits outlined in the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs). These goals include improving food security and nutrition, reducing poverty, combating inequalities, decarbonizing economies, and protecting biodiversity. Instead of relying on subsidies that primarily benefit industrial agriculture, it is essential to allocate resources fairly and sustainably. This approach can contribute to an SDG-based agri-food transformation, making food and agriculture markets more resilient to shocks and accessible to vulnerable populations. Additionally, the climate crisis necessitates market actors to incorporate environmental costs into the food system. To achieve this, it is imperative to implement coherent policies across the entire food value chain [134].

Furthermore, it is worth noting that approximately 20% of the fish caught are believed to originate from illegal, unreported, and unregulated (IUU) fishing practices. Various projections indicate that by eliminating fishing subsidies, there would be a substantial reduction in overfishing in international waters. It has been found that 77% of this overfishing is attributed to the activities of fishing vessels from China, Taiwan, Japan, Indonesia, Spain, and the Republic of Korea. By putting an end to these subsidies, not only would we expedite the achievement of the Sustainable Development Goals (SDGs), but we would also be able to revive depleted fisheries and safeguard the rights of small-scale artisanal fishers.

Fossil fuel subsidies impact sustainable development in various ways, including climate change, poverty, and governance. Reforming these subsidies is not just a macroeconomic requirement but also a crucial strategy for addressing the climate emergency [135]. Research indicates that phasing out fossil fuel subsidies could lead to a significant decrease in global greenhouse gas emissions, with estimates ranging from 6.4% to 8.2% by 2050 and up to 10% by 2030.

Given the urgency emphasized by scientific research to achieve carbon neutrality by 2050, it is evident that significant changes are required. One such change is the need for the Paris Agreement to effectively address the long-term reduction of greenhouse gas emissions resulting from cross-border transport and trade. Simultaneously, the World Trade Organization (WTO) must play a role in facilitating the expansion of these sectors. It is crucial to recognize that solving the complex climate puzzle cannot be accomplished in isolation. The mounting pressure to establish new regulations and agreements that genuinely prioritize sustainable development and trade poses a considerable challenge to multilateralism, particularly within the WTO. This organization has been grappling with a deadlock for over two decades [136].

WTO members ought to initiate an informal conversation regarding the issue of plastics pollution and the trade of environmentally sustainable plastics. This dialogue aims to foster trade as a means to combat the problem of plastics pollution. Additionally, countries should declare their commitment to gradually eliminate ineffective fossil fuel subsidies, taking into account the unique requirements of

developing nations. Furthermore, it is crucial to advance discussions on this matter within the framework of the WTO [137]. Although there is positive news, the WTO still encounters obstacles in its progress. One particular challenge is the differing opinions on the relevance of its existence and the conflicting perspectives on the benefits of globalization and free trade [138]. Within this array of conflicting narratives, it is crucial to acknowledge the viewpoint that the current support for unsustainable economic growth results in losses for everyone. On one side, inconsistent trade policies may contribute to increased resource consumption and pollution, placing vulnerable communities at a disadvantage and ultimately posing an existential threat to humanity. On the other side, proponents of free trade argue that global value chains promote more efficient utilization of resources, contingent upon domestic environmental policies. The primary challenge lies in reshaping the discourse surrounding the relationship between trade and the environment. It is essential to place greater emphasis on addressing the detrimental impacts of trade or trade agreements on the environment, while also recognizing the specific needs of developing nations [139].

1. In the future, it is crucial for the states to prioritize sustainable development alongside their objectives of trade liberalization. It is important to evaluate harmful subsidies not only based on their impact on trade disruption, but also on their effects on the well-being of people and the environment.

2. To improve the analysis of environmental consequences associated with trade, it is essential to enhance the interaction between science and policy. This can be achieved through collaboration with the UN system and other stakeholders.

3. The current trade regulations should be utilized to support the goals of the Paris Agreement on climate change. States must consider the negative impact of inefficient fossil fuel subsidies on climate action and strengthen disclosure rules for countries.

4. It is crucial to expedite the decision-making process regarding fisheries subsidies. Efforts should be made to reach an agreement promptly in order to address this issue effectively.

Trade policies that fail to consider the detrimental effects of trade on our planet, our sole habitat, are ineffective. Despite our extensive understanding of the increasing dangers posed by social and environmental tipping points, various trade policy-induced crises are generating fresh origins of risks and uncertainties. Although significant changes do not occur instantaneously, adopting a comprehensive approach to the trade-environment interface is not only economically efficient but also a crucial measure for the preservation of our planet.

Natural resources face both challenges and opportunities in international trade. The increasing demand for clean energy, like solar and wind power, is expected to boost the trade of natural resources. Countries rich in natural resources can benefit from economic development opportunities by exporting these resources. Technological advancements, such as advanced mining techniques, are improving resource extraction efficiency and facilitating trade. The growing demand for green buildings is also driving the trade of natural resources like timber, creating opportunities for related industries. Global population growth is increasing the demand for agricultural products, expanding the market for agricultural trade. Additionally, some rare natural resources hold high trade value and are becoming valuable assets in international trade. The stunning natural scenery not only draws in a significant amount of tourists but also boosts the expansion of tourism resources, consequently fueling the advancement of associated industries. For instance, nations with ample solar energy resources can export solar panels and related technologies, leading to economic progress. Similarly, countries rich in forest resources can cater to the global need for wood products. These openings offer extensive possibilities for the utilization of natural resources in global trade, while also injecting fresh momentum into the continuous economic growth of diverse nations.

Natural resources encounter numerous obstacles in international trade, encompassing resource rivalry, disparities in environmental regulations, resource dependency, geopolitical elements, technical hindrances, resource pilferage and illicit trade, market instability, and transportation expenses. The intensifying competition among nations for limited resources results in price volatility and supply instability.

Moreover, disparities in environmental standards and regulations across countries also impact the trade of resource products. Additionally, certain countries excessively rely on a single natural resource, rendering their economies susceptible to fluctuations in resource prices. Furthermore, political instability in regions abundant in resources can influence resource extraction and trade. Technical barriers, such as green trade barriers, augment the technical prerequisites for resource products, making trade more challenging. Furthermore, resource exploitation and illicit trade undermine the sustainable utilization of resources and detriment legitimate trade. Furthermore, the price of natural resources experiences significant fluctuations due to market supply and demand, and the transportation costs of resources also impact trade benefits. Oil resources frequently encounter price fluctuations and supply instability in global trade. Many developing nations heavily rely on mineral resources, making their economic growth susceptible to changes in resource prices. These issues necessitate collaborative action from the international community to tackle, enhance cooperation, and advance equitable trade and sustainable development. We have formulated several suggestions considering the obstacles encountered in global natural resource utilization and consumption, as well as the requirements of China's economic restructuring.

Strengthening environmental protection and ecological progress. It is recommended to enhance environmental protection and ensure the sustainability of natural resources and the ecological environment. It is proposed to establish more stringent laws and regulations regarding environmental protection, strengthen environmental monitoring and governance capacities, and foster the development of ecological civilization. These measures will facilitate the harmonious progress of economic growth and ecological environmental protection.

Promoting green development and circular economy. It is recommended to expedite the advancement of eco-friendly progress, transform the approach to economic growth, enhance the composition of industries, foster the innovation and implementation of eco-friendly technology, and encourage the reuse of resources and reduction of waste. By fostering the growth of a circular economy, the aim is to attain

efficient resource utilization and sustainable development, curbing the excessive exploitation and consumption of natural resources.

Strengthening energy and water resources management. It is recommended to enhance the governance of energy and water resources, enhance the effectiveness of resource utilization, and decrease the level of resource consumption. Through the advancement of energy-saving and emission-reducing technologies, as well as the adoption of clean energy sources, we must decrease energy consumption and pollution emissions. This will safeguard water resources, enhance the efficiency of water resource utilization, and foster sustainable economic growth.

Developing ecological industries and green finance. It is recommended to accelerate the growth of eco-friendly sectors, nurture innovative catalysts for sustainable economy, and encourage environmentally-friendly consumption and production practices. Concurrently, efforts will be made to advance green finance, steer investments towards environmental conservation and green initiatives, and bolster ecological preservation and long-term sustainability.

Strengthen international cooperation and exchanges. China should engage in international cooperation and exchanges to effectively tackle global environmental and resource challenges. By enhancing collaboration with other nations and regions, sharing knowledge and technology, we can collectively advance global environmental governance and support sustainable green development. Embracing the concept of creating a shared future for humanity, we must work together to address environmental issues and benefit from eco-friendly progress.

The growth of global trade is intricately linked to the extraction and consumption of natural resources, creating a symbiotic relationship. As international trade continues to expand and trade structures evolve, the demand for natural resources in different nations undergoes constant fluctuations. Some countries may ramp up resource extraction to meet trade demands, leading to overconsumption and environmental harm. Nevertheless, international trade also facilitates the exchange of technologies and promotes efficient resource utilization, aiding in sustainable resource management and waste reduction. For instance, collaborative energy initiatives enable multiple

nations to invest in and develop new energy sources, like cross-border oil and gas projects, ensuring stable and sustainable energy provisions. Collaboration in water management can assist nations sharing water sources in creating plans to prevent overconsumption and disputes. Similarly, working together on forest conservation can aid in preventing deforestation, safeguarding forest resources, and promoting sustainable wood trade. Joint efforts in mineral resource development can enhance efficiency and minimize environmental harm through shared exploration and extraction. Additionally, international cooperation in clean energy technology, resource recovery and recycling, and climate change can collectively address the effects of natural resource use on trade, fostering sustainable development and environmental protection.

The IEA encourages collaboration among member nations regarding energy policy and technology, with various countries participating in multilateral environmental agreements to collectively safeguard biodiversity and forest resources. This collaborative effort plays a crucial role in addressing the effects of natural resource utilization and consumption on global trade.

(1) Cooperation between China and Madagascar: Tianxin aims to enhance Madagascar's agricultural development by introducing additional international trade channels. This will effectively utilize the local agricultural labor force and natural resources, ultimately improving the living standards of farmers. Simultaneously, Tian Xinli plans to establish a new international trade business line, expanding the sales channels for agricultural products. This initiative will enable China's rural revitalization products to reach global markets, thus empowering agricultural development in line with the "Belt and Road" cooperation resources.

(2) China-Laos Railway: The electrified railway known as the China-Laos Railway spans a distance of 1,035 kilometers, connecting Kunming in Yunnan Province, China, to Vientiane, Laos. Its official inauguration took place on December 3, 2021, marking a significant milestone in the alignment of China's Belt and Road Initiative with Laos' objective of transforming from a land-locked nation to a land-linked one. This railway's establishment will not only enhance trade between China

and Southeast Asian nations but also stimulate regional economic growth. Additionally, it will contribute to the preservation of the environment and the efficient utilization of resources (see fig. 3.2).

Fig. 3.2. Development opportunities the environmental sustainability of PRC international trade

Source: [author].

These instances serve as a clear illustration of the significance and efficacy of international collaboration in mitigating the effects of natural resource utilization and consumption on global trade. By working together, nations can collaboratively establish policies and actions to advance sustainable growth, safeguard natural resources, and foster the sound development of global trade. As a key player in the global trade arena, China has garnered valuable insights and experiences in addressing the repercussions of natural resource utilization and consumption on international trade. China actively engages in and advocates for the creation of new multilateral trade regulations, endeavors to have a voice in rule-setting, and rigorously adheres to and defends multilateral trade regulations. China places significant emphasis on safeguarding strategic resources and considers the protection of national security and

interests as the foundation of its natural resource trade policies. Moreover, the Chinese government promotes the growth of eco-friendly industries by offering policy incentives, financial assistance, and implementing a green trade certification system to motivate businesses to adopt environmentally-friendly practices and enhance the environmental standards of their products. These initiatives serve as a valuable model for other nations, fostering sustainable development and environmental conservation worldwide, while also benefiting the advancement of international trade in a positive manner.

The impact of utilizing and consuming natural resources on international trade is extensive and significant, making it impossible to overlook. It is imperative for countries to recognize the crucial role that natural resources play in international trade and implement proactive measures to safeguard and manage them. In order to achieve sustainable development in international trade, it is essential to prioritize the advancement of industrial structure and technological innovation, foster international cooperation and exchanges, and collectively address resource scarcity and environmental challenges. Failure to address the excessive use and consumption of natural resources will result in depletion and environmental harm, ultimately jeopardizing the sustainability and stability of international trade. Simultaneously, the global market is greatly influenced by the supply and demand of natural resources, thereby impacting the balance of international trade and causing price fluctuations. Additionally, the improper utilization of these resources can result in wastage and unfair trade practices, further compromising the fairness and sustainability of international trade. Nevertheless, by adopting a rational approach towards the use and conservation of natural resources, we can not only foster the growth of green and circular economies but also create more sustainable development prospects for international trade. In order to ensure a harmonious relationship between economic progress and environmental preservation, nations must collaborate to advocate for the responsible utilization of natural resources. This will lead to a positive cycle of economic advancement and ecological conservation. It is crucial to implement effective strategies that support sustainable development and consumption of natural

resources, while also fostering the growth of global trade. Achieving long-term sustainable resource use is essential for making a positive impact on global economic prosperity and environmental health, promoting the sustainable development of human society, and safeguarding the earth we rely on.

3.3. The model of environmentally sustainable trade strategy for China

The challenges faced by China in its current development journey, along with the various global factors shaping its future direction, suggest that the effective policies of the past may not be suitable for ensuring a sustainable and prosperous future. A sustainable trade strategy is essential in the realm of trade policy, necessitating a comprehensive review of existing policies to comprehend how trade and investment can foster economic, social, and environmental welfare in China. This strategic approach aims to tackle the key obstacles hindering China's progression to the next phase of development. If implemented successfully, this innovative strategy will enable China to solidify its leadership role in the twenty-first century.

A sustainable trade strategy that is comprehensive should encompass sustainable trade in goods and services, as well as sustainable investment flows, both inward and outward. It should aim to ensure that these flows, along with their far-reaching impacts on various aspects of China's economy and society, contribute to China's progress. This entails examining trade policy in a broad sense, which includes activities like upgrading the manufacturing sector, participating in mandatory and voluntary standards in China's export markets, analyzing the effects of China's services trade, and reviewing China's approaches to international trade and trade-related cooperation agreements. It requires a close collaboration with China's businesses to guarantee that they can meet and surpass international standards for leadership and create a favorable environment for their overseas investments. Furthermore, it necessitates a clear understanding of the connections between trade and other global issues like climate change.

A sustainable trade strategy for China is based on several key Chinese policy priorities. The Party has emphasized the importance of a scientific concept of development to guide future growth, with a focus on principles such as prioritizing the well-being of the people, fostering innovation, promoting balanced and sustainable development, and achieving social harmony, among others. The objective is to transition from an extensive development model to an intensive one. In line with this policy direction, the trade policy needs to move away from a narrow focus on exports and adopt a sustainability-oriented approach that considers the economic, social, and environmental aspects of sustainable development. Similarly, China's 11th Five-Year plan emphasizes the pursuit of a mutually beneficial opening-up strategy that shifts the focus from quantity to improving the quality of China's growth through globalization. It also underscores the importance of building a resource-efficient and environmentally friendly society, recognizing the interconnections between the environment and a sustainable national economic system.

China's manufacturing sector has undergone significant upgrades over the past few decades. Starting from a focus on heavy industrialization in the early 1990s, China has transitioned towards a more value-added approach by breaking down production processes into different stages that can be carried out in various locations globally. Initially, China concentrated on light manufacturing like textiles and apparel, but by the mid-1990s, the country shifted towards more information-intensive manufacturing, particularly in electronics and communication goods. The majority of this manufacturing is centered around processing trade. Following China's entry into the World Trade Organization (WTO), multinational corporations have expanded their presence in China, incorporating upstream activities like research and development, design, and manufacturing of key components and intermediate products, as well as downstream functions like sales and logistics.

Trade has been a crucial factor in this development - processing trade has accounted for over 50% of China's exports since 1990. More than 70% of China's foreign direct investment (FDI) is directed towards processing trade, making China the top recipient of FDI globally. This investment is drawn to China due to its plentiful,

high-quality, and cost-effective labor force, a massive potential domestic market, as well as favorable policies for foreign capital and trade, among other factors. China's current position on the global value chain offers several benefits. Firstly, it allows for valuable knowledge acquisition through exposure to foreign practices and technologies. Additionally, China's labor-intensive export production machine generates substantial employment opportunities. However, there are also drawbacks to this placement. China faces growing trade friction as it serves as the world's low-cost supplier in an increasingly competitive global market. Furthermore, China has a relatively low share of the value added in the value chain. Lastly, the energy- and resource-intensive processing and manufacturing practices associated with China's position result in significant environmental damage. The need to expedite the enhancement of China's manufacturing sector's environmental standards is motivated by several factors:

(1) Growing competition from other low-cost manufacturers in East Asia and other regions, particularly in the lower segment of the value chain. China's labor cost advantage has diminished, and labor itself is becoming more costly.

(2) Mounting evidence of substantial environmental consequences resulting from resource-intensive and energy-intensive practices.

(3) The aspiration to secure a larger portion of the profits generated by the global value chain and to generate higher-paying employment opportunities for Chinese workers.

However, the process of upgrading primarily occurs within the organization itself and relies heavily on the ability of employees and managers to identify and seize new opportunities in response to evolving demand and technology. Consequently, while governments can play a role in supporting this capacity, their influence is indirect and constrained. Recommended measures may encompass:

— *Embrace a comprehensive approach to foster technological advancement:* Encourage increased research and development by providing financial assistance, fostering collaboration, and prioritizing training and education initiatives. Implement reforms within state-owned enterprises and monopoly entities to enhance their

adaptability to market demands. Bolster the safeguarding of intellectual property rights to incentivize greater investment in innovation and facilitate knowledge transfer.

— *Encourage sustainable industrial development:* The process of upgrading should be supported by regulatory measures that discourage excessive pollution, resource depletion, and energy consumption. This approach not only enhances long-term competitiveness by improving efficiency, but also contributes to public health, energy security, and resource sustainability goals.

— *Encourage the localization of processing trade* by enhancing backward and forward linkages, eliminating obstacles for private sector investment, assisting domestic firms in joining the global value chain, and prioritizing education and training for skilled human resources.

— *Overseas investment plays a crucial role* for domestic companies seeking to acquire cutting-edge technologies, secure international resources, and establish global brands and marketing networks, among other benefits. The following discussion explores ways in which the Chinese government can effectively support this objective, with a primary focus on fostering a favorable perception of Brand China.

From an economic, social, and environmental standpoint, it is crucial to prioritize the acceleration of the upgrading process in China's manufacturing sector. This should be recognized as a fundamental component of any sustainable trade strategy. Services, on the other hand, are distinct from other economic activities such as agricultural production and resource extraction (the primary sector) as well as the manufacturing of goods and energy production (the industrial or secondary sector). Services are often perceived as intangible or, as described by one observer, something that can be bought or sold but not physically dropped on one's foot.

The services industry plays a crucial role in the economic, social, and environmental aspects of a sustainable trade strategy. Services are now acknowledged as key factors influencing productivity in the manufacturing sector, thus impacting the potential for advancement. Advanced financial services can minimize transaction expenses and risks while enhancing resource allocation efficiency among various sectors. Affordable and dependable telecommunications services facilitate knowledge

dissemination and are essential for companies seeking to join global supply chains. Additionally, transportation, retail, and distribution services directly impact shipping and logistics costs, particularly for exported products.

In addition, environmental quality greatly relies on services. Various environmental services such as waste and sewage treatment, corporate environmental management, pollution remediation, remote sensing and monitoring services, and more play a crucial role in avoiding and managing the environmental pressures caused by economic growth. Moreover, there are several management and technology-related services that not only aim at reducing energy and resource inputs but also have positive environmental impacts by minimizing resource use and pollution. Furthermore, the service sector plays a significant role in employment. Since the mid-1990s, the number of individuals employed in China's tertiary industry has surpassed those in the manufacturing industry. While it may be an overgeneralization to claim that service sector jobs are of higher quality than average jobs in primary and secondary sectors, the development of a specialized service sector can indeed create high-quality employment opportunities.

China's service sector, although growing rapidly, still has a smaller share of total GDP compared to other middle income countries. Since 2000, China's services trade has been expanding at a faster pace than the overall growth of the sector, but it has also experienced a widening deficit. In terms of competitiveness, China's service sector falls short, with higher prices and lower quality compared to international standards. However, there are exceptions in the tourism and construction sectors, although their comparative advantage is declining. While transportation and computer and information-related services are becoming more competitive, they still lag behind global competitors. This presents a challenge as high-quality business and environmental services are crucial for the advancement of the manufacturing sector, domestic environmental quality, and China's ability to derive economic and social benefits from service exports.

To address the issue of lack of international competitiveness, one effective solution is to embrace international competition. In the service sector, China abides by

the regulations set forth in the WTO's General Agreement on Trade in Services, as well as regional and bilateral trade agreements that entail a growing number of commitments. While China has allowed unrestricted foreign investment in certain service sectors, there are still numerous barriers in place to protect domestic service providers. The Chinese government has taken proactive measures to ensure that services trade contributes to sustainable development. This includes eliminating fiscal and other forms of support for services in sectors that heavily rely on energy and resources. Additionally, the government encourages investment in various business and environmental services. It is crucial to expedite these efforts and explore alternative policy options to further enhance international competitiveness:

- Eliminating restrictions on urban migration in China could lead to the growth of more large cities with specialized service providers, while promoting the development of environmental services could help alleviate the environmental challenges linked to urbanization.
- Liberalizing strategic sectors and welcoming foreign investment could facilitate the rapid advancement of China's manufacturing sector (business services) and enhance the country's ability to address environmental issues (environmental services). Although this may result in a services trade deficit, the focus should be on improving the quality and reducing the costs of services in critical sectors for China's sustainable development.

China's economic growth and international trade success are undeniable, but its exporters face challenges in meeting various standards in key export markets. These standards range from sanitary regulations to private buyer requirements, all of which are crucial for sustained export growth. To ensure continued success in major markets and to establish Brand China, it is essential for exporters to adapt and comply with these standards. This becomes even more crucial as Chinese exporters aim to move towards higher value products and closer to end consumers. Adhering to environmental and social standards not only benefits export businesses but also contributes to reducing pollution, enhancing public health, promoting resource sustainability, and improving production efficiency in China's export sector.

The quantity and impact of standards, whether imposed by governments as obligatory technical regulations or by the private sector, are steadily rising. Over the past ten years, a multitude of crucial new regulations have been implemented in China's major export markets. These include the European Union's Directives on Restrictions on Hazardous Substances (ROHS), Registration, Evaluation and Authorization of Chemicals (REACH), and Waste Electrical and Electronic Equipment (WEEE). Additionally, Japan has introduced a comprehensive Food Safety Law, while the United States continues to develop new regulations within the framework of the Toxic Substances Control Act and the Federal Insecticide, Fungicide, and Rodenticide Act.

New standards like GlobalGAP, which is becoming more crucial for agri-food exports, are being added to existing ones. Additionally, there are other standards from buyers, like the almost mandatory HACCP sanitary and phytosanitary requirements. These requirements are forming a complex network that Chinese exporters must meet in order to access important markets. Numerous Chinese exporters are grappling with the challenges at hand, although some are successfully navigating through them. In 2006, the implementation of foreign environmental and health and safety standards resulted in a direct cost of US$36 billion, which accounted for 3.7 percent of the total value of merchandise exports. It is worth noting that this figure does not encompass the significantly higher impact of standards on production costs associated with compliance. The majority of these challenges were encountered in China's primary markets, namely the United States, the European Union, and Japan, and were primarily linked to the exportation of mechanical and electrical products, textiles, and agricultural goods. Japan, for instance, reported in 2007 that approximately one-third of the 1,515 food samples rejected for import originated from China. Although only a small fraction of China's exports face issues, occasional high-profile instances of non-compliance can significantly tarnish the reputation of Brand China, particularly when the exports in question are final consumer goods like food and toys. The repercussions extend beyond the export of goods, as China's reputation plays a crucial role in its pursuit of strategic outward investment (see fig. 3.3).

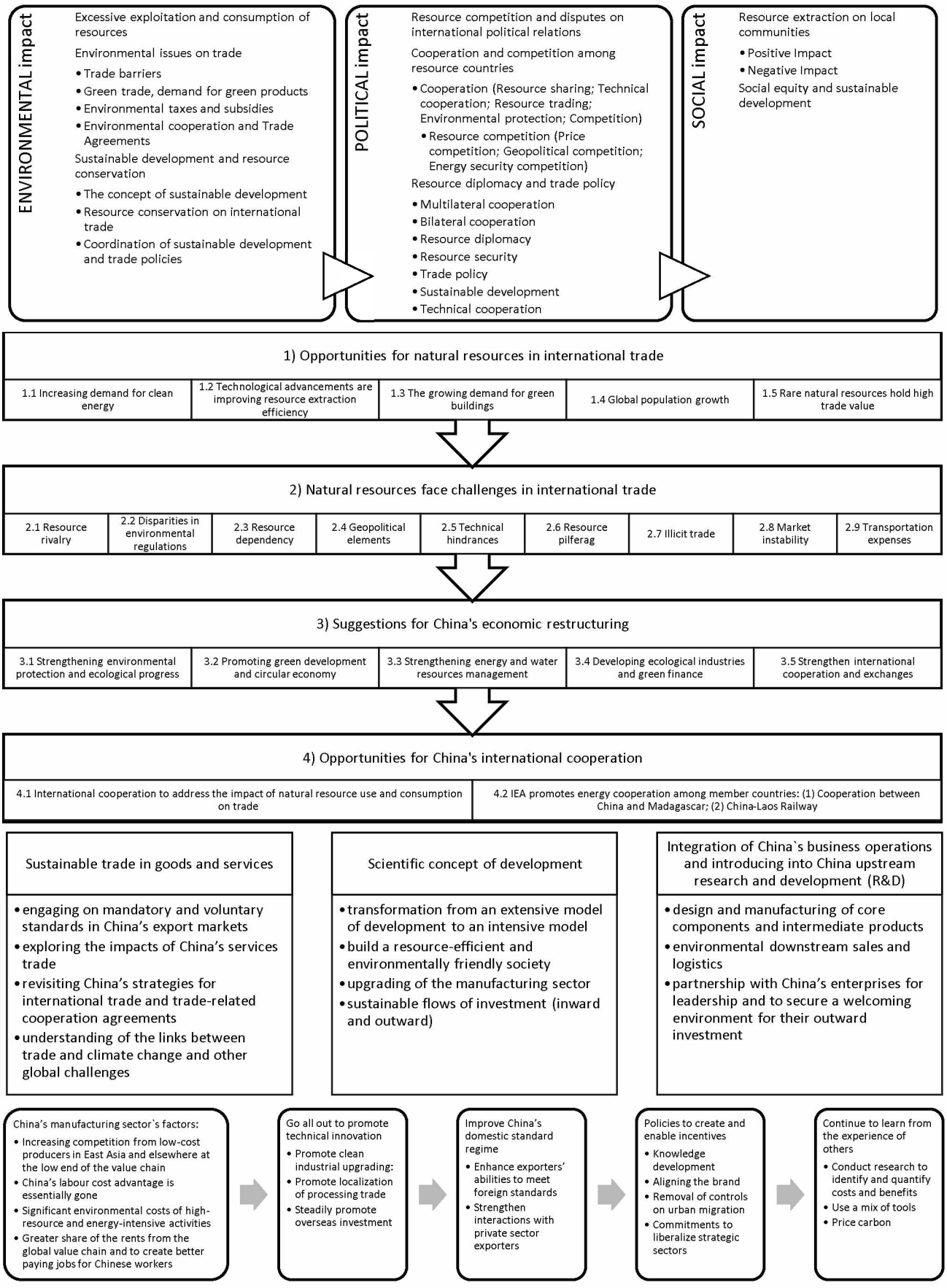

Fig. 3.3. The model of environmentally sustainable trade strategy for China

Source: [author].

There are several strategies that the Chinese government can employ to ensure that standards play a beneficial role in China's environmentally sustainable trade strategy:

— *Enhancing China's domestic standard regime:* By bridging the disparity between domestic standards and international standards, particularly in the domains of health, safety, and environmental protection, and emphasizing enforcement and compliance, China can empower its exporters to meet rigorous foreign demands. This will also help eliminate unscrupulous producers that tarnish the country's reputation. Additionally, China should actively participate in the development and oversight of new international standards.

— *Improve exporters' capacity to adhere to international regulations.* Exporters require more up-to-date information on global standards, as well as the necessary technology and systems they require. Additionally, the government should allocate significant resources towards establishing accredited local facilities for testing and ensuring compliance with international standards.

— *Enhance collaboration with private sector exporters.* Addressing this challenge requires more than just government efforts; it necessitates fostering stronger partnerships between the government, industry associations, and individual exporters. It is crucial for the Chinese standards association to have a comprehensive understanding of the requirements of exporting companies, while exporters should stay informed about the latest domestic and international standards developments and adapt to meet both new and existing requirements.

In order for China to sustain its rapid growth, it must establish global competitiveness strategies that prioritize enhanced resource efficiency and balanced development. A key element of this endeavor lies in the behavior of Chinese multinational corporations (MNCs) overseas, as they can either enhance China's competitive edge or pose a detrimental threat to its reputation. China's successful transition into a prominent global economic and political player necessitates the adoption of credible and verifiable sustainable development practices by its multinational corporations (TNCs). The consequences of failure extend beyond mere

financial losses for individual businesses, encompassing the reputation of Brand China and the overall growth of trade and investment. Notably, several well-known instances in the past five years, spanning industries such as mining, minerals, and consumer products, have highlighted the influence of perception-driven politics on Chinese outward investment.

Exporters and TNCs face a significant challenge in meeting technical regulations, but simply complying with legal requirements is not sufficient. In addition to international and national laws, there exists a more intricate set of rules shaped by the expectations and interests of various global stakeholders. Chinese TNCs, in particular, struggle with this soft law framework, as they are unfamiliar with civil society engagement and uncertain about the evolving role of business in the global community. This lack of adaptation is reflected in China's ranking in the Responsible Competitiveness Index, where it lags behind other BRICS nations due to Chinese TNCs' difficulties in navigating civil society expectations. Many Chinese companies tend to avoid soft law mechanisms like voluntary standards, further hindering their ability to succeed in target markets and host countries.

The collaborative standards initiatives utilized by various TNCs to ensure adherence to sustainable development practices are overseen by non-state actors and public institutions in unofficial capacities. These initiatives aim to establish de facto regulatory compliance through a combination of citizen-led advocacy, responses based on capital-market risks, business pressure from peers, and occasionally the possibility of statutory regulation in important markets. Despite their haphazard development, these initiatives vary in terms of scope, coverage, and quality. Nonetheless, collectively they represent a growing global trend encompassing numerous standards and principles. Some of the initiatives encompass:

- The Equator Principles by the International Finance Corporation for project finance;
- Forestry standards by the Forest Stewardship Council;
- Labour practices standards under SA 8000;
- The Extractive Industries Transparency Initiative;

- Corporate social responsibility standard ISO 26000;
- Oeko-Tex Standard 100, a voluntary private standard focusing on environment and labour in the textile sector.

Undoubtedly, the decision to adopt these standards is a crucial one that relies on various factors such as the specific circumstances of each company, their target markets, their unique capabilities, and their future strategic objectives. Apart from merely complying with the standards, there are other options available, including choosing to establish more suitable standards (which traditionally face resistance from skeptical consumers) or actively participating in the standard-setting process to reshape the existing standards. Pursuing the latter approach not only aids Chinese companies venturing abroad in comprehending the unfamiliar concepts of corporate social responsibility and civil society involvement but also holds the potential to significantly impact the future generation of sustainability standards in global markets.

Ultimately, sustainability standards play a crucial role in balancing out competitive drawbacks or gaining competitive edges for businesses and countries like China that opt for more sustainable development. Various measures can be implemented by the Chinese government to support and empower its multinational corporations in effectively addressing this issue while aligning with the Chinese export sector's priorities within a sustainable trade framework:

— Policies can be put in place to encourage compliance with specific standards or codes in order to qualify for government support, such as tax benefits, access to investment funds, export credit, or foreign exchange reserves.

— Establishing an institute to promote international investment, similar to Japan External Trade Organization, could help the Chinese government enhance knowledge development on sustainability. Additionally, improving training for managers and incorporating sustainability training for diplomatic postings supporting overseas investment could be beneficial.

— Effective Chinese foreign assistance for international investment should be in line with the host country's sustainable development priorities. Strengthening diplomatic capacity to address sustainability issues will be crucial, and China could

benefit from highlighting its sustainable practices in regional and bilateral trade agreements.

It is crucial for governments, including the Chinese government, to view environmentally sustainable trade and international investment as essential components in advancing national development. Rather than simply having a sustainability strategy, the focus should be on integrating an environmental sustainability perspective into trade and investment strategies. It is crucial to consider China's trade policies, whether they are in the form of multilateral agreements, bilateral and regional deals, unilateral actions, regional partnerships, or other trade-related legal instruments. Following China's entry into the WTO, there has been a focus on substantial liberalization through tariff reductions and regulatory changes. Additionally, the subsequent five-year plans have highlighted the importance of multilateral and regional collaboration, as well as a shift towards a more balanced and sustainable approach to development.

Over the past 15 years, China has made significant strides in regional and bilateral engagement by entering into numerous free trade and cooperation agreements. One notable example is the establishment of the China-ASEAN Free Trade area. These agreements aim to promote harmonious regional economic integration, shared regional prosperity, and overall stability. They also offer a platform for exploring innovative trade policies that may be difficult to implement at the multilateral level. In part due to China's remarkable export-led growth, the country has faced a higher number of trade disputes and tensions compared to other nations.

In order to enhance China's manufacturing sector, it is crucial for its commercial policy objectives to extend beyond market access. These objectives should encompass safeguarding Chinese intellectual property overseas and protecting Chinese outward investment. Additionally, they should prioritize shielding high-end products from unfair implementation of standards and technical barriers. Looking ahead, successful regional initiatives could serve as a blueprint for similar endeavors at the global level.

China stands to gain from the improved quality of services, particularly in the realms of business and environmental services. These services can facilitate the

upgrading process and effectively address the environmental consequences of China's future growth. Opening up China's service sectors to foreign service providers through strategic investments could yield both types of benefits. However, it is essential to approach this with broader policy objectives in mind, which may involve safeguarding certain sectors.

In addition to promoting the expansion of China's service exports through outsourcing and temporary movement of individuals, commercial policy can also contribute to this objective. Several countries have imposed stricter regulations on such trade during the recent economic downturn. Therefore, there is an opportunity for China and other interested nations to collaborate and advocate for legal obligations in this particular domain.

In order to tackle the increasing number of trade complaints and conflicts related to China, it is imperative for the government to encourage frequent bilateral dialogues as a means to address and alleviate tensions before they escalate into formal disputes.

Conclusions to chapter 3

Summurizing, to counteract the adverse impacts of overexploitation and excessive resource consumption on the environment, a holistic approach to resource management and preservation is imperative. This approach involves advocating for sustainable development, strengthening environmental regulations, promoting resource conservation and recycling, and nurturing eco-friendly production and consumption practices. Enhancing resource management, improving resource efficiency, fostering technological innovation, investigating alternative resources, fostering international cooperation, tackling resource and environmental issues collectively, and formulating and refining policies and regulations to facilitate sustainable resource utilization and promote economic progress are all essential steps in this endeavor.

Resource competition and disputes exert a significant influence on international political relations, manifesting in several key ways. When analyzing their impact, it's

vital to consider geopolitical tensions. The management and exploitation of resources often intersect with national interests and security, which can escalate into geopolitical tensions among nations. For example, the competition for marine resources in the South and East China Seas, which has led to tensions among China, Japan, Vietnam, the Philippines, and other nations. These tensions carry the risk of escalating into a military standoff or even sparking armed conflict, thus threatening international political stability.

Absolutely, sustainable development is a crucial factor in international trade. A research paper could highlight the importance of using natural resources responsibly for trade purposes. It's vital to avoid excessive exploitation and consumption of resources, as this can cause significant environmental damage, impacting the sustainability and stability of trade activities. Therefore, by exploring sustainable development and resource utilization, we can find ways to encourage sustainable growth in international trade while balancing economic progress with environmental preservation.

Countries must acknowledge the pivotal role natural resources play in international trade and take proactive measures to safeguard and manage them. Prioritizing the advancement of industrial structure and technological innovation, fostering international cooperation and exchanges, and collectively addressing resource scarcity and environmental challenges are essential steps toward achieving sustainable development in international trade. Neglecting to curb the excessive use and consumption of natural resources risks depletion and environmental harm, ultimately threatening the sustainability and stability of international trade. Moreover, the global market's equilibrium is heavily influenced by the supply and demand of natural resources, leading to fluctuations in prices and impacting the balance of international trade. Improper resource utilization can result in wastage and unfair trade practices, further undermining the fairness and sustainability of international trade.

A sustainable trade strategy for China aligns with several key policy priorities outlined by the Chinese government. The Party underscores the significance of adopting a scientific concept of development to steer future growth. This concept

emphasizes principles such as prioritizing the well-being of the people, fostering innovation, promoting balanced and sustainable development, and achieving social harmony, among others.

Furthermore, governments, including the Chinese government, must recognize environmentally sustainable trade and international investment as integral to national development. Instead of merely having a sustainability strategy, the emphasis should be on integrating an environmental sustainability perspective into trade and investment strategies. It's essential to assess China's trade policies, whether they take the form of multilateral agreements, bilateral and regional deals, unilateral actions, regional partnerships, or other trade-related legal instruments. To address the rising number of trade complaints and conflicts involving China, it's imperative for the government to promote regular bilateral dialogues. These dialogues serve as crucial avenues to mitigate tensions before they escalate into formal disputes.

The main scientific results were published in the following scientific articles: 161; 162; 163; 164; 165; 166; 167; 168; 169; 170; 171.

CONCLUSIONS

In conclusion, China's international trade structure has undergone significant transformations, largely influenced by the phenomenon of international production fragmentation. This trend entails specialization in different production stages across multiple countries and has garnered considerable attention from international economists under various names. The concept of sustainable development (SD) has evolved through practical application and the scrutiny of relevant policies. It has progressed from conceptualization to realization, as evidenced by events like the United Nations Sustainable Development Summit.

Strong sustainability emphasizes the critical importance of natural capital in both production and consumption, highlighting its indispensable role. This perspective is rooted in the steady-state economic theory, which asserts that manufactured capital cannot be regenerated without the input of natural capital. The Sustainable Development Goals (SDGs) can be categorized into four dimensions: economy, society, environment, and governance. As a consequence, 'sustainability' has risen to the forefront as a paramount global priority, prompting governments, international organizations, and businesses to prioritize the balance of environmental, social, and economic factors. It has become clear that achieving a sustainable economy necessitates a reduction in global resource consumption while ensuring that economic growth is aligned with environmental preservation.

Some studies propose that the overuse and depletion of natural resources in specific countries can be traced back to international trade. Developed nations indirectly stimulate the demand for natural resources in developing countries by exporting products that necessitate a significant amount of resources. As a result, this exacerbates the depletion of natural resources and intensifies environmental challenges encountered by these developing nations.

Currently, the utilization and consumption of natural resources on a global scale encounter numerous challenges and issues. One such challenge is overexploitation, where non-renewable resources like oil, natural gas, and coal are excessively utilized.

This has led to a depletion of resource reserves, greatly impacting the sustainable utilization of resources.

To effectively tackle these pressing challenges, it's vital to adopt a sustainable approach that promotes the prudent use and preservation of resources. This entails implementing measures to enhance environmental protection, advocating for the adoption of eco-friendly practices, promoting the principles of a circular economy, and enhancing resource management and oversight. These efforts are all aimed at achieving sustainable resource utilization and safeguarding the natural environment.

Furthermore, the onset of the COVID-19 pandemic heralded a significant transformation in the global trade landscape, marked by notable fluctuations. Since 2020, a multitude of disruptions, spanning economic and non-economic domains, have wielded substantial influence on international trade. This period has seen fragmentation and heightened divergence in trade performance, evident not only during the recovery phases of 2021 and 2022 but also in the more recent trade slowdown, albeit with slightly lesser intensity.

When comparing trade performance across different regions, the European Union and the United States stand out prominently, as underscored by regional statistics for Europe and North America. While all geographic regions witnessed a decrease in export growth in the first half of 2023, the overall trade contraction was comparatively less severe in these two regions. In contrast, East Asia and the Rest of Asia regions experienced more pronounced declines in trade.

Trade plays a significant role in promoting global economic convergence and poverty reduction. Emerging economies have greatly benefited from growth driven by trade, resulting in a reduction of income disparities with wealthier nations. Their integration into global value chains and the reduction of trade barriers have facilitated this advancement. However, trade has also contributed to the exacerbation of inequality in certain developed nations by increasing the demand for skilled labor and shifting economic activities to urban centers.

Available evidence suggests that current trade patterns demonstrate heightened volatility and diversity compared to historical norms. While it's premature to

definitively assert a significant departure from established trends, it's plausible that the disruptions triggered by COVID-19 have catalyzed a notable shift in global trade dynamics. This transformation is influenced by systemic factors such as geopolitical tensions and risk-management strategies. The convergence of these elements raises the prospect of substantial changes in global trade paradigms, ushering in a new era replete with both challenges and opportunities for economies worldwide. Close monitoring of these developments is essential to comprehend the ramifications of evolving trade dynamics, particularly for developing nations.

Over the past decade, the growth in international trade has been largely driven by the expansion of trade among developing nations, known as South-South trade. Despite setbacks in 2015 and amidst the COVID-19 pandemic in 2020, the proportion of South-South trade within global trade has steadily increased, rising from approximately 17 percent in 2010 to 21 percent in 2022.

Natural resources indeed hold a crucial position in international trade, exerting significant influence on the economic progress of nations and their trade dynamics. In this context, we provide a thorough exploration of the significance and function of natural resources in the realm of international trade. Embracing green energy technologies and prioritizing innovation in development strategies can enhance a nation's energy efficiency.

Moreover, energy resources, such as oil, natural gas, and coal, carry immense significance in global trade. Serving as primary sources of energy worldwide, numerous nations depend on imported energy to fulfill their domestic needs. Fluctuations in the supply and prices of these resources wield significant influence on international markets and economic growth.

Trade plays a crucial role in addressing the climate crisis and environmental concerns, despite its potential to contribute to the release of greenhouse gases and pollutants in the absence of adequate environmental regulations. Implementing robust environmental policies is essential in mitigating the adverse impacts of trade on the environment and fostering sustainable trade practices. It's imperative for these policies to take into account the interconnected and global nature of environmental challenges.

China has put in place comprehensive strategies to implement the world's largest emissions trading system, encompassing over 1,700 power companies and a total of 3 billion tonnes of greenhouse gas emissions. The primary objective of this market is to regulate and decrease greenhouse gas emissions while fostering environmentally friendly, low-carbon development.

In summary, addressing the negative effects of overexploitation and excessive resource consumption on the environment requires a comprehensive approach to resource management and preservation. This involves advocating for sustainable development, strengthening environmental regulations, promoting resource conservation and recycling, and fostering eco-friendly production and consumption practices. Essential steps include enhancing resource management and efficiency, fostering technological innovation, exploring alternative resources, promoting international cooperation, addressing resource and environmental challenges collectively, and refining policies and regulations to facilitate sustainable resource utilization and economic progress.

Resource competition and disputes significantly impact international political relations in various ways, with geopolitical tensions playing a vital role. The management and exploitation of resources often intersect with national interests and security, potentially leading to geopolitical tensions among nations. For example, in the South and East China Seas, competition for marine resources has caused tensions among China, Japan, Vietnam, the Philippines, and other countries. These tensions could escalate into a military standoff or armed conflict, endangering international political stability.

Certainly, sustainable development plays a pivotal role in international trade. A research paper could underscore the significance of responsibly utilizing natural resources for trade purposes. It's imperative to refrain from excessive exploitation and consumption of resources, as this could result in significant environmental harm, thereby affecting the sustainability and stability of trade activities. Hence, through an examination of sustainable development and resource utilization, we can identify

methods to foster sustainable growth in international trade while maintaining a balance between economic advancement and environmental preservation.

Countries must recognize the pivotal role natural resources play in international trade and take proactive measures to safeguard and manage them. Prioritizing the advancement of industrial structure and technological innovation, fostering international cooperation and exchanges, and collectively addressing resource scarcity and environmental challenges are crucial steps toward achieving sustainable development in international trade. Neglecting to curb the excessive use and consumption of natural resources risks depletion and environmental harm, ultimately jeopardizing the sustainability and stability of international trade. Moreover, the global market's equilibrium is heavily influenced by the supply and demand of natural resources, leading to fluctuations in prices and impacting the balance of international trade. Improper resource utilization can result in wastage and unfair trade practices, further undermining the fairness and sustainability of international trade.

A sustainable trade strategy for China is in line with several key policy priorities outlined by the Chinese government. The Party emphasizes the importance of adopting a scientific concept of development to guide future growth. This concept stresses principles such as prioritizing the well-being of the people, fostering innovation, promoting balanced and sustainable development, and achieving social harmony, among others.

Additionally, governments, including the Chinese government, must acknowledge environmentally sustainable trade and international investment as integral to national development. Rather than merely having a sustainability strategy, the focus should be on integrating an environmental sustainability perspective into trade and investment strategies. It's crucial to evaluate China's trade policies, whether they are in the form of multilateral agreements, bilateral and regional deals, unilateral actions, regional partnerships, or other trade-related legal instruments. To tackle the increasing number of trade complaints and conflicts involving China, it's essential for the government to encourage regular bilateral dialogues. These dialogues serve as crucial avenues to mitigate tensions before they escalate into formal disputes.

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ANNEXES

Annex A

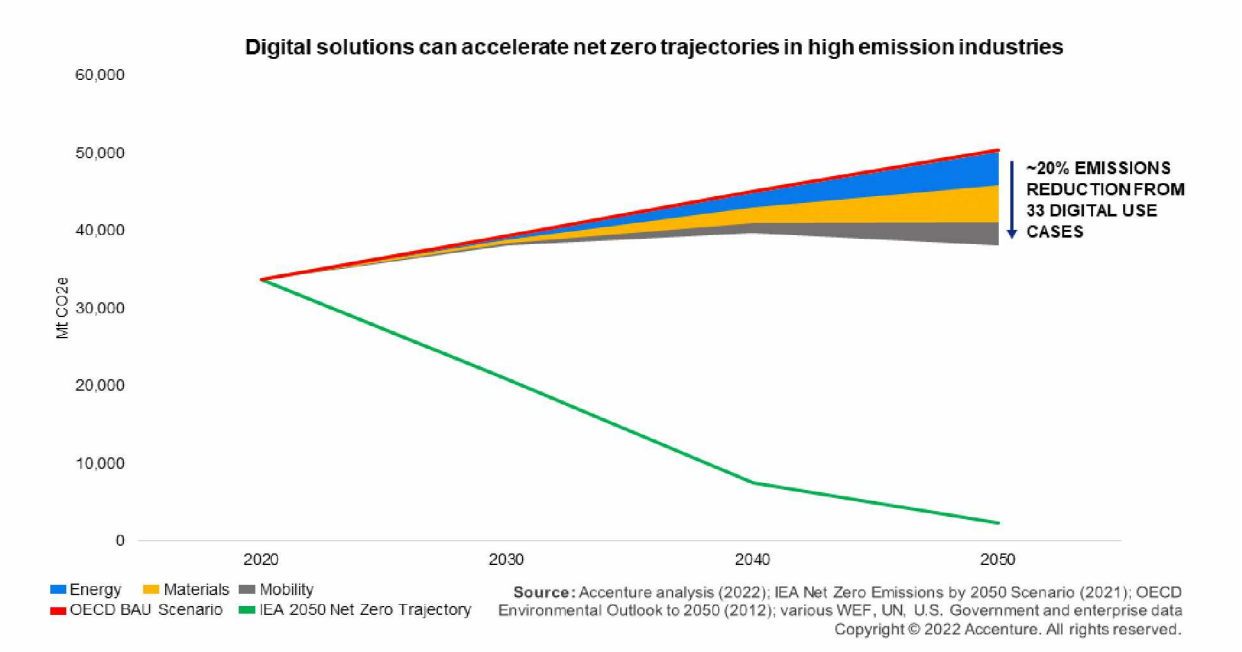

Fig. A1. Digital solutions in emission industries

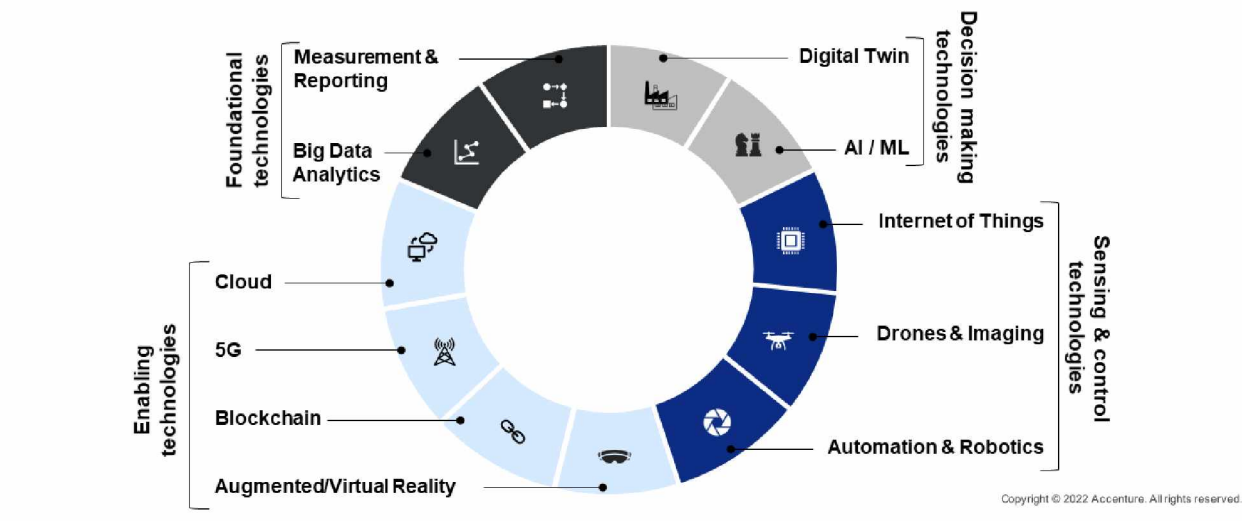

Fig. A2. Digital solutions in emission verification

Annex B

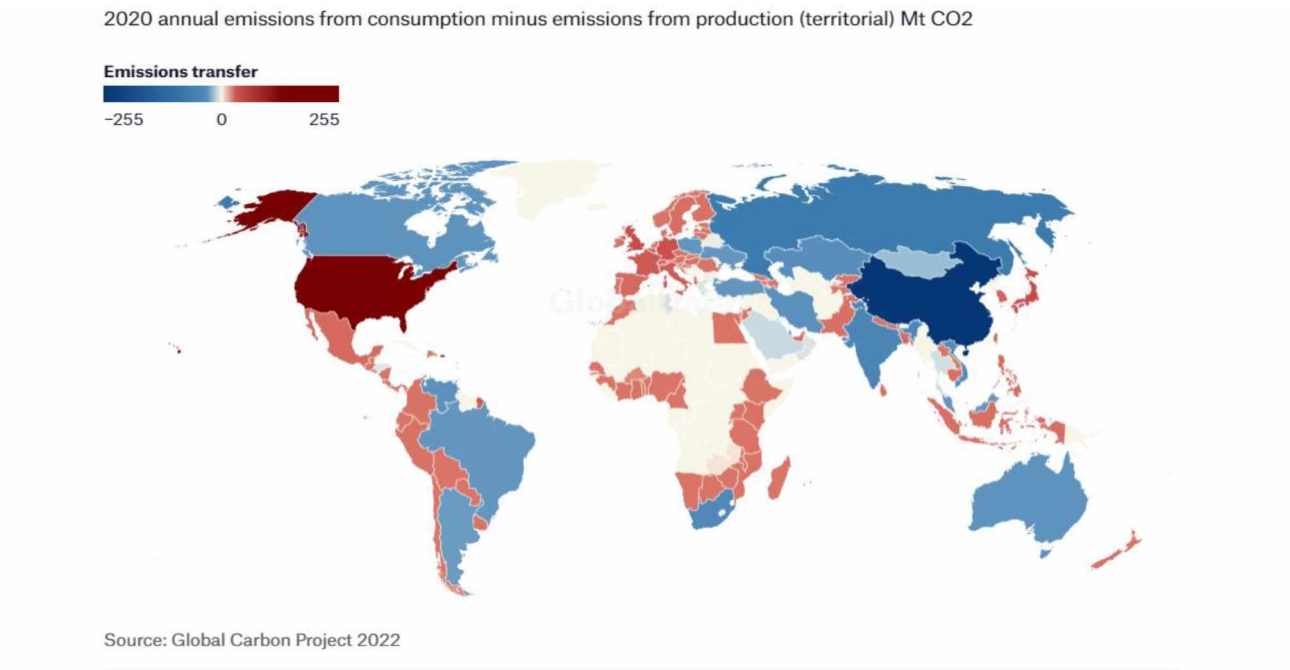

Fig. B1. Global trade emissions

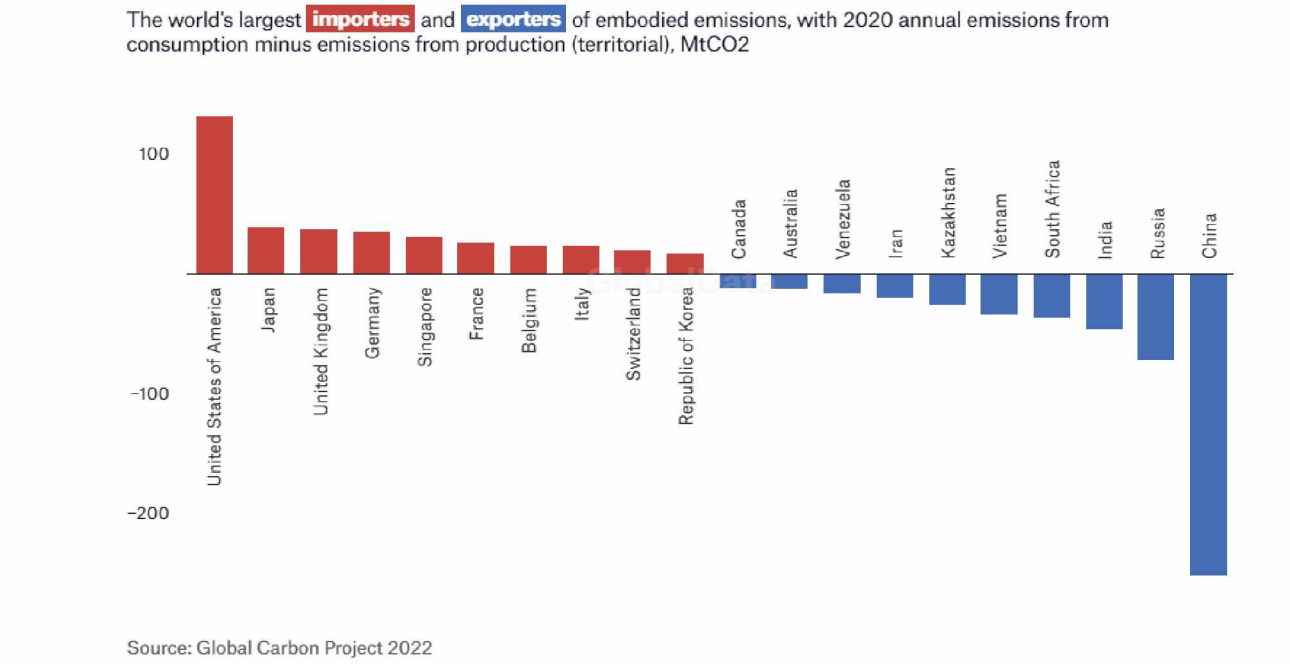

Fig. B2. China's trade emissions

Annex B

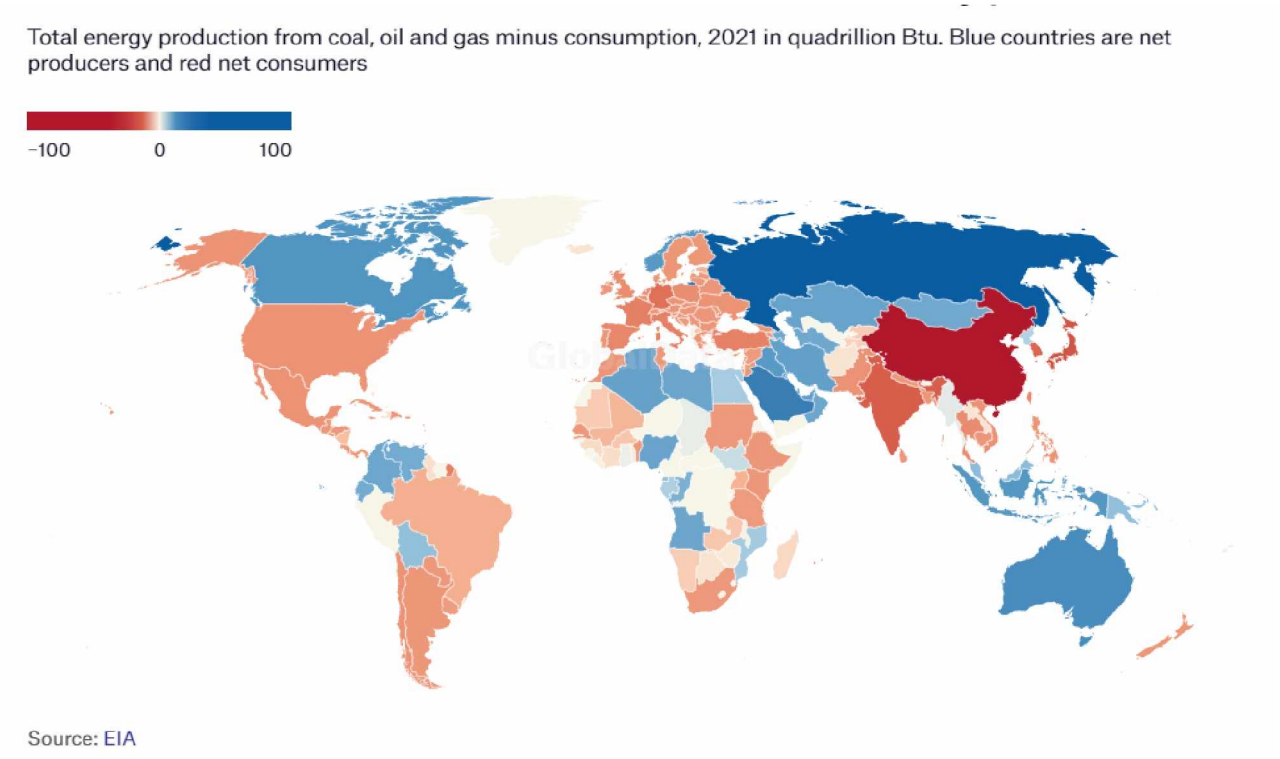

Fig. B3. Global fossil fuels consumption

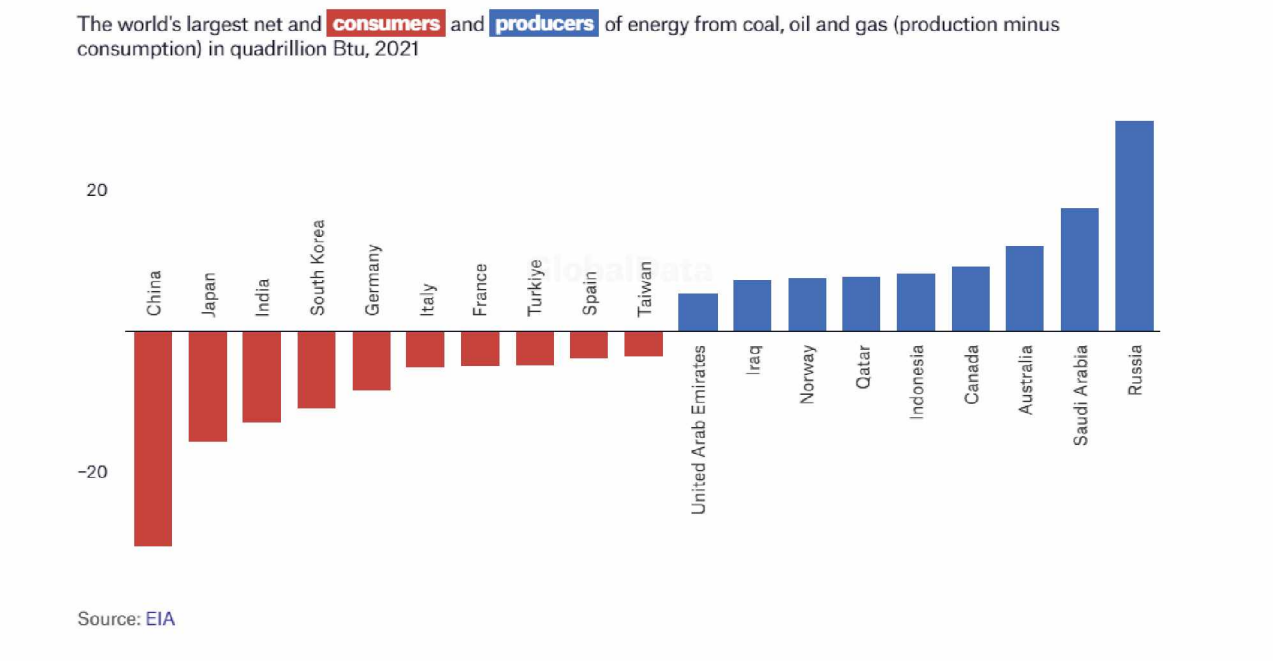

Fig. B4. Global fossil fuels consumption by countries

Annex C

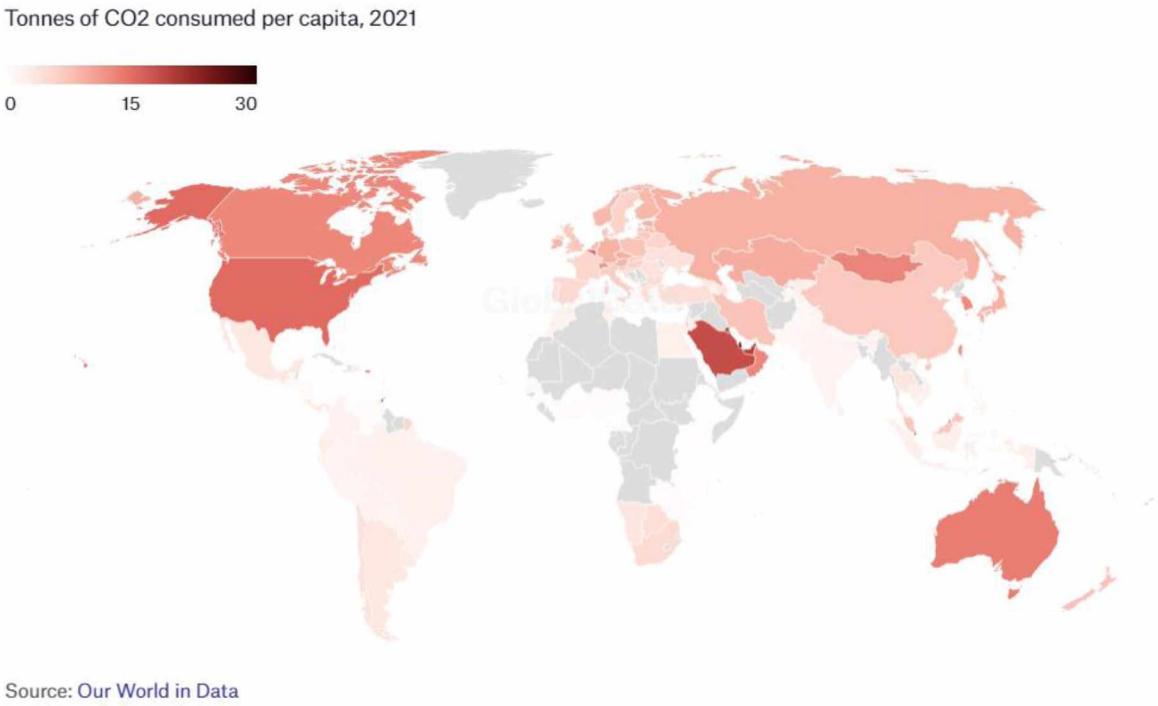

Fig. C1. Global emissions per individual when accounting trade

Annex D

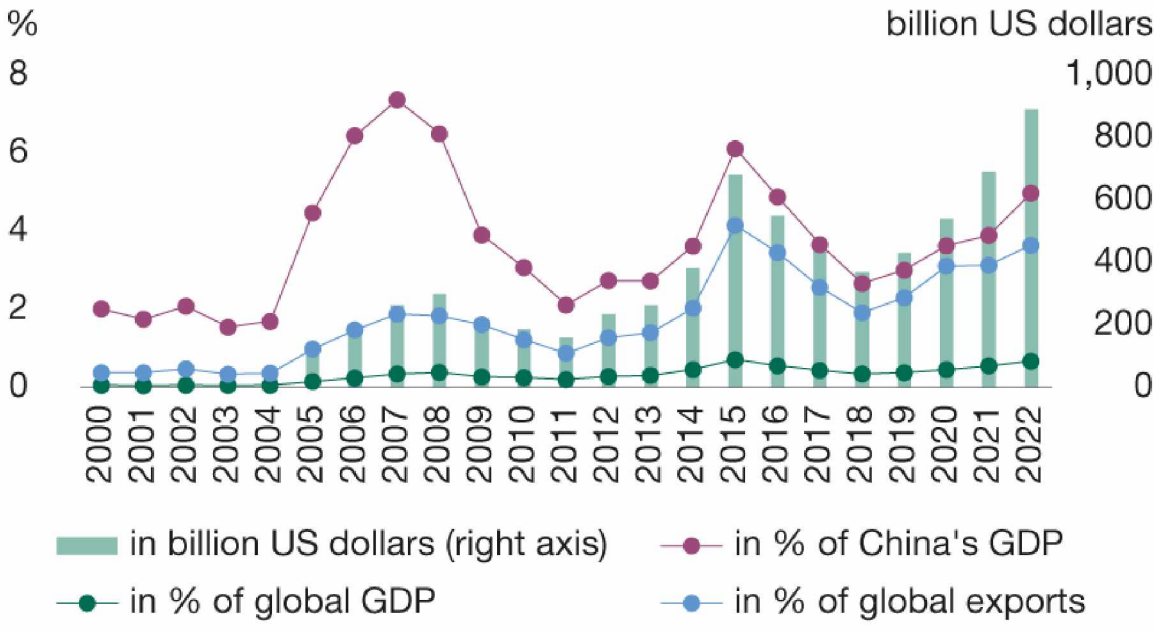

Fig. D1. China's merchandise trade balance over time

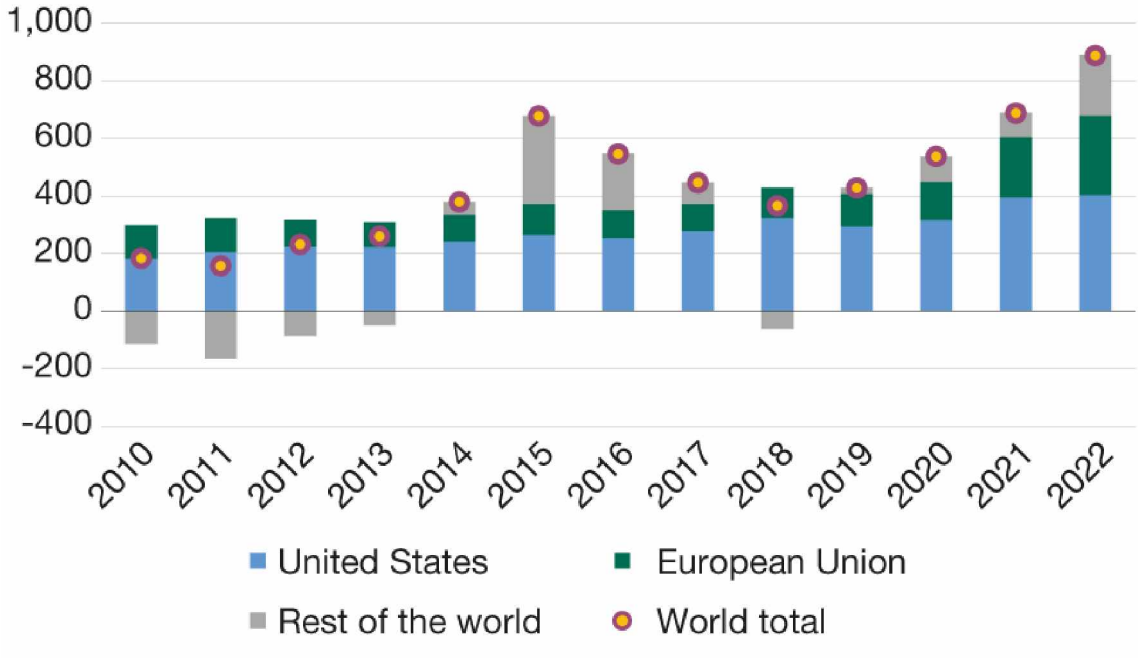

Fig. D2. China's merchandise trade surplus by major trading partners

Annex D

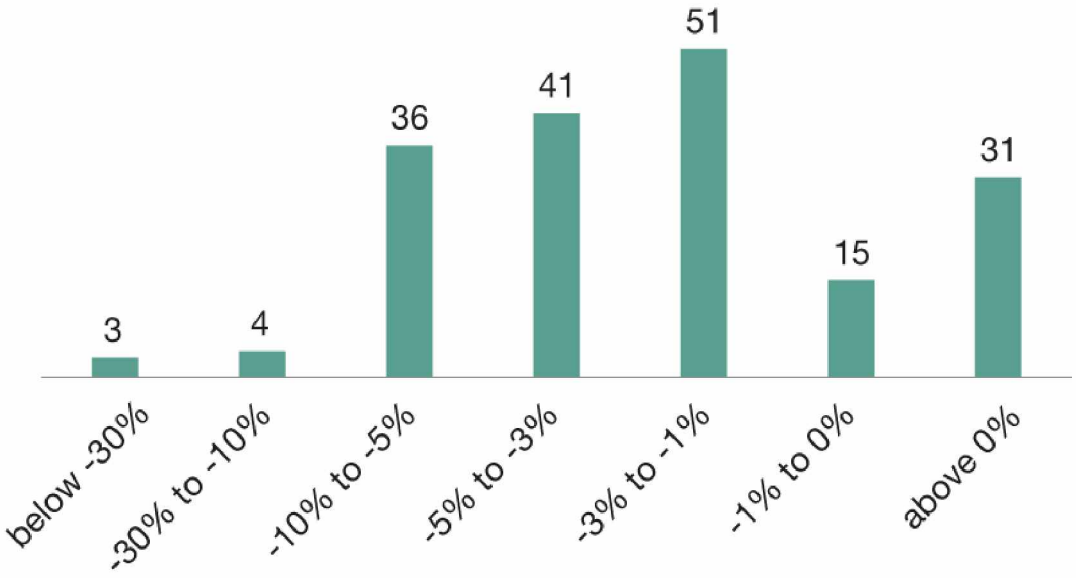

Fig. D3. Distribution of 181 countries' merchandise trade balances with China, 2023

Countries grouped by trade balance with China as shares of their GDP

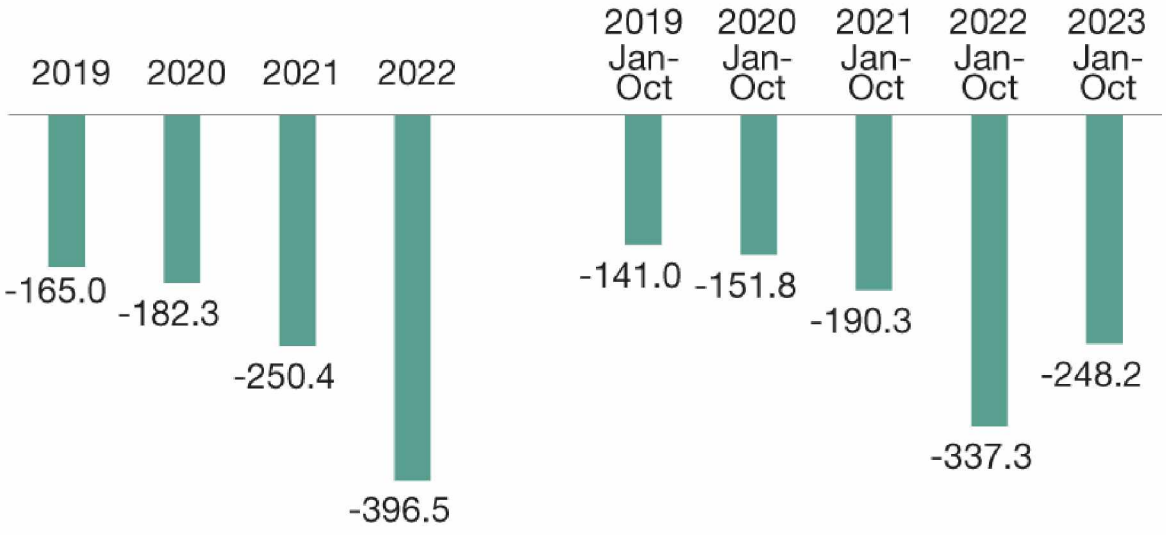

Fig. D4. Trade balance of goods of the EU with China

Annex D

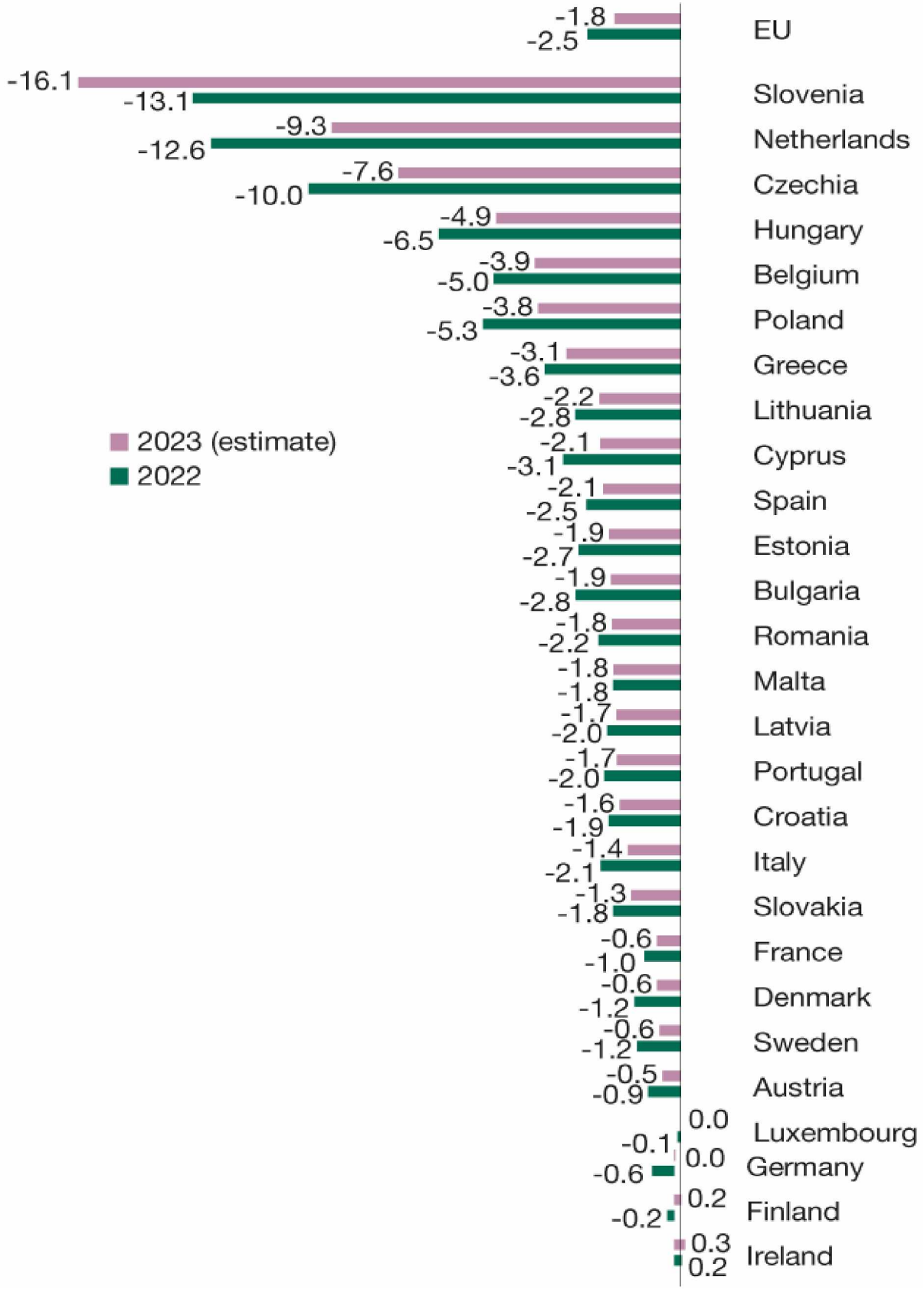

Fig. D5. Trade balance of goods of EU countries with China