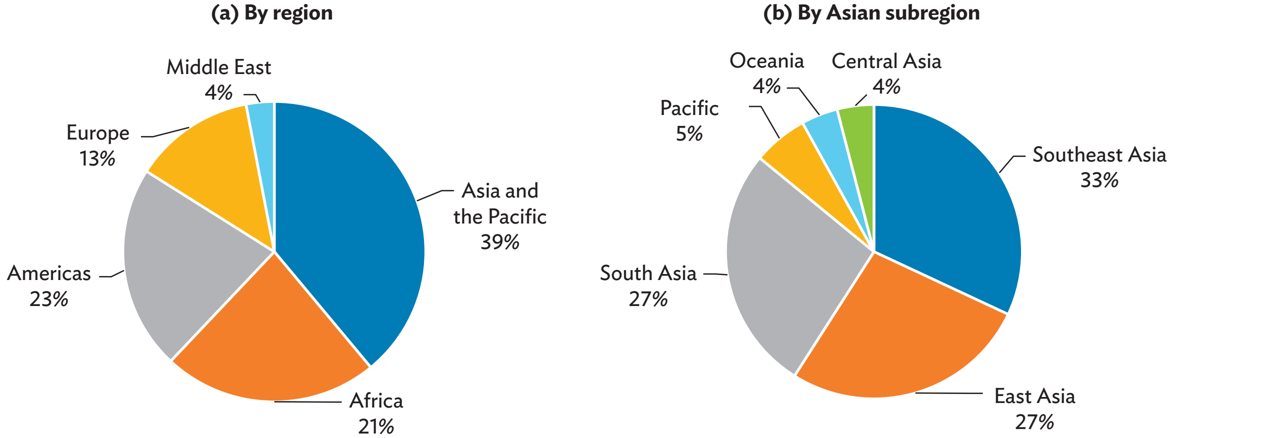
7 THEME CHAPTER
Trade, Investment, and Climate Change in Asia and the Pacific

Introduction

Asia and the Pacific is on the frontline of climate change, with the region subjected to more extreme weather events and many people working and living in low-lying coastal cities.[103] Asia is experiencing the highest temperatures in the last 30 years, with average temperatures in 2021 reaching 0.86°C above the 1981–2010 average, and 2020 the warmest year on record since 1900 (WMO 2022). Extreme precipitation events such as storms, floods, and landslides, which led to over 48 million people directly affected and 4,000 lives lost in 2021 in the region, are becoming more frequent (WMO 2022). Almost 40% of disasters worldwide have occurred in Asia, much higher than just over 20% each in Africa and the Americas (Figure 7.1). Southeast Asia, East Asia, and South Asia are the most affected subregions. The Pacific is increasingly affected by rising sea levels as many Pacific island countries are low-lying or just a few feet above sea level.

Rising temperatures from climate change present significant economic risks in Asia. Various estimation exercises present diverse economic impact assessments depending on the methodologies employed. Common to those exercises, however, is that Asia is expected to suffer larger economic losses than the world average from rising temperatures. Only developed Asian economies will experience economic losses below the world average. It is therefore crucial that Asian economies address these challenges.

Figure 7.1: Number of Disasters, 2000–2021



Notes: Disaster includes natural occurrences like animal accident, drought, earthquake, epidemic, extreme temperature, flood, glacial lake outburst, insect infestation, landslide, mass movement (dry), storm, volcanic activity, and wildfire. Americas include Latin America and North America.

Source: ADB calculations using data from Centre for Research on the Epidemiology of Disasters - CRED. EM-DAT The International Disaster Database. http://www.emdat.be (accessed January 2023).

[103] Unless otherwise specified, Asia and the Pacific, or Asia, refers to the the 49 regional members of Asian Development Bank (ADB). List of economies is available at ADB. Asia Regional Integration Center. Economy Groupings. https://aric.adb.org/integrationindicators/groupings.

Higher frequency of extreme weather events in Asia will affect economic activities, particularly trade and investment. Trade and investment have played an outsized role in the economic development of the region. Many of its economies have relied on exports and foreign direct investments (FDI) as engines of economic growth (Stiglitz 1996; World Bank 1993). The region accounts for 35% of world trade in 2020, up by 10 percentage points from 10 years ago, and a third of global FDI in 2019. [104] Without climate change mitigation and adaptation efforts globally, potential disruptions to transportation and production will hamper Asia's trade and FDI performances, and hence its economic growth.

Asia also sits at the center of global production networks. Besides the traditional manufacturing powerhouses, many developing economies in the region—such as Cambodia, the Lao People's Democratic Republic, and Viet Nam—are increasing their participation in global value chains (ADB 2021a). The coronavirus disease (COVID-19) pandemic alerted the world to the fragility of global supply chains. Similarly, any disruptions to production procedures either upstream or downstream due to extreme weather events caused by climate change will impede economic activities in the region. Such events can cause production losses, while rising temperatures and increasing water scarcity can affect agricultural productivity (ADB 2021b).

The region's experience with severe earthquakes and floods portends a gamut of impacts of climate change-related disasters. The disruption to infrastructure from flooding provides insights into the negative effects of climate change. The March 2011 earthquake in Japan, for example, damaged the nuclear power plant in Fukushima. Although its impacts were mainly local with the four most affected prefectures contributing less than 5% of Japan's gross domestic product (GDP), the disaster decreased real GDP growth in Japan by 0.47 percentage points due to industrial linkages between the prefecture and other regions, which is substantial considering Japan's average growth of about 0.6% during 2000–2010.[105] Similarly, the floods in northern Thailand in July 2011 inundated seven industrial parks and affected 800 companies (Haraguchi and Lall 2015). Damages and economic losses caused by tropical cyclones to some of the Pacific island countries over the past decade also attest to the severe impact of climate change. Recent floods in Pakistan, which affected 33 million people and brought enormous damage to infrastructure and agriculture, are a devastating reminder of part of the region's acute vulnerability to climate change.

Asia is a large contributor to global carbon dioxide (CO_2) emissions. The region alone is now responsible for about half of global annual CO_2 emissions. Asia's outsized contribution to climate change is a byproduct of its economic success, which has led the region into a crucial dilemma: how to balance potential trade-offs between economic growth and environmental costs. Many studies have examined the relationship between economic growth and environmental outcomes. The environmental Kuznets curve posits an inverse-U shaped relationship between per capita income and environmental quality. However, this relationship is not so easy to interpret as these two variables are highly endogenous and related to other factors (Copeland and Taylor 2004).

Trade and investment play a critical role in Asia's economic growth and development and can significantly affect climate change by influencing how much is produced, what is produced, and how goods and services are produced (given technology's effect on the emission intensity of production) and transacted.

[104] Based on the Direction of Trade Statistics of the International Monetary Fund and United Nations Conference on Trade and Development's World Investment Report 2022 Statistical Annex Tables.

[105] What is more pertinent are the linkages the firms in these prefectures had with the rest of Japan. A study by Carvalho et al. (2021) shows that the negative impact of the earthquake was propagated through the network, affecting not only the customers and suppliers or affected firms, but even their customers (i.e., customers' customers) and their suppliers (i.e., suppliers' suppliers).

The Trade/Investment and Climate Change Nexus

A Conceptual Framework

This theme chapter examines the impact of trade and investment on climate change using a framework that decomposes main drivers into economic scale, industrial structure, and technological advancement. Carbon emissions from Asia can increase as production and trade expand (economic scale) and the share of carbon intensive industries and exports increases (industrial structure), and decrease as production becomes less emission-intensive (technological advancement).

- *Economic scale effect* examines how carbon emissions will increase when production "scales" up or increases, without any changes in the technology (e.g., emission intensity) or industrial composition. This occurs as the economy's production increases along with economic growth (furthered by trade and investment), which in the case of Asia has been supported by exports and integration into the global economy.

- *Industrial structure effect* examines how the economy's share of production in carbon intensive sectors changes, keeping the economic size and the technology level constant. This can be driven by specialization in trade and FDI in carbon intensive industries. FDI may be attracted by less stringent environmental policies and regulations.

- *Technological advancement effect* captures the change in the emission intensity of production holding the scale and industrial structure of the economy constant. Emission intensities can decline when the businesses adopt new technology (such as decarbonization) or employ environmental goods and services to lower carbon emissions per unit of output.

A gap between the private and the social cost of carbon emissions is a challenge for climate policy. As a global public "bad," climate change poses a fundamental problem in that its costs or benefits are not captured in market prices (Nordhaus 2018). The public good is being depleted because the private cost of carbon emissions does not fully reflect the overall social cost. Indeed, firms have the incentive and capacity to increase emissions for their own benefit, generating negative externalities without any compensation mechanism. The social cost of carbon is a crucial metric for understanding these impacts. In essence, the social cost of carbon encapsulates the cost of damages created by one extra ton of CO_2 emissions (Nordhaus 1992). It reflects the multiple economic and human welfare outcomes affected by climate change, such as lower agricultural yields, rising sea levels, and decline in human productivity and health. By providing a standardized measure to weigh the benefits of climate mitigation against its costs, the social cost of carbon can provide a price signal for carbon intensive goods, services, and processes; induce firms to adopt low carbon technologies; and encourage innovation in cleaner sectors.

Narrowing the gap between the private and the social cost of carbon emissions is essential. While multiple forms of carbon pricing instruments exist, they all aim to create a price signal for greenhouse gas (GHG) emissions. In practice, initiatives can be classified into two main groups. Enforcement mechanisms, on the one hand, are conducted through regulations and administrative measures by setting emissions standards and pollution limits as are often called "command and control." Market-based mechanisms, on the other hand, use price signals in inducing less carbon-emitting production and consumption activities. For example, carbon taxes could be levied on fossil fuel producers in proportion to the carbon content of their products. Emission trading systems aim to establish limits on carbon emissions and enable trading of units or define a baseline and reduce emissions below it and are a prominent market-based mechanism. Bilateral agreements, regional alliances, and other instruments are also increasingly used in international carbon trading under Article 6 of the Paris Agreement. There is potential to further strengthen them in the region, to the extent that market-based mechanisms can facilitate trade in carbon assets, establish common standards and guidelines, and increase technology transfer and diffusion.

The chapter discusses policy recommendations to ensure that trade and investment activities become part of climate solutions. Economies can promote "green trade," of low carbon intensive products and environmental goods and services. Strengthening environmental regulations could help reduce CO_2 emissions through both industrial structure and technique effects by inducing more investments in clean industries and technologies. Regional and international cooperation should supplement domestic efforts. Some of the focus can be on ensuring that investment and trade agreements support national environmental and climate policies, or on promoting new models of cooperation.

There are two important points the chapter does not consider. First, a complicated nexus exists between climate change and trade and investment, and that relationship can be bidirectional: that is, trade and investment can contribute to climate change, but climate change can also impact trade and investment. The chapter focuses on how trade and investment could contribute to climate change and its solutions, leaving the latter to other studies such as simulations and modeling by WTO (2022) and Brenton and Chemutai (2021).

Second, the chapter starts from the premise that trade is not only beneficial for economic development but also can be part of the climate change solution. According to literature, the gains from trade—efficiency, price reductions, product variety—can outweigh the environmental costs (Shapiro 2016). Antweiler, Copeland, and Taylor (2001) show that trade openness is beneficial to the environment if the technique effect is greater than the composition and scale effects. Indeed, higher income from increased trade can enable economies to import technologies for production that are less polluting. Meanwhile, Managi, Hibiki, and Tsurumi (2009) concluded that trade openness can have a negative impact on CO_2 emissions in nonindustrialized economies where the scale and composition effects played the dominant role. While some climate activists propose curtailing trade and economic activities so that less resources are used and emissions reduced,[106] this may not consider the crucial roles played by power generation, transportation, industrial production, construction, and trade, which significantly affect people's welfare. Making a value judgment on economic growth versus environmental protection is beyond the scope of this chapter.

Emissions from Production, Demand, and Trade[107]

Asia's CO_2 Emissions Embodied in Production and Demand

Asia's CO_2 emissions embodied in production and demand both increased over time. According to the estimation using the CO_2 emissions embodied in international trade (TECO$_2$) data set of the Organisation for Economic Co-operation and Development (OECD) described in Box 7.1, Asia's CO_2 emissions embodied in both production and consumption have almost tripled since 1995, with the former rising faster than the latter (Figure 7.2). This largely reflects the region's rapid economic growth and expansion of economic size, which has involved heavy resources consumption and manufacturing and production of goods. Asia's fast incorporation into global value chains during the process of industrialization, while contributing to economic growth and prosperity, has contributed to this byproduct. This suggests that the adoption of emissions-mitigating production technologies that could have lowered the carbon intensity of production (i.e., CO_2 emissions per unit of output) may have been insufficient to offset the economic scale and industrial structure effects for the region. Meanwhile, Asia's CO_2 emissions embodied in consumption has not grown as much as its production side has, leading to net CO_2 emissions embodied

[106] The argument put forward by activists can be captured under the "degrowth" movement. The World Economic Forum provides a good explanation of the degrowth movement. See Masterson (2022).

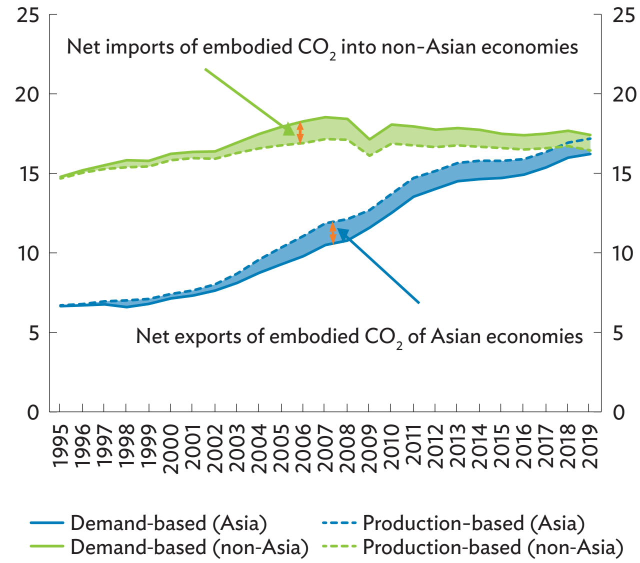
[107] In this section, Asia refers to the 20 Asian economies with available data in Organisation for Economic Co-operation and Development's (OECD) carbon dioxide emissions embodied in international trade (TECO$_2$) data set. Asia is broken down into the following subregions: Central Asia (Kazakhstan); developed Asia (Australia, Japan, and New Zealand); East Asia (Hong Kong, China; the People's Republic of China; the Republic of Korea; and Taipei,China); South Asia (Bangladesh, India, and Pakistan); and Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam).

in exports to the rest of the world. In 2019, Asia's production-based CO_2 emissions were 17.2 giga tonnes, and after exporting 4.5 giga tonnes and importing 3.5 giga tonnes, the region ended up consuming 16.2 giga tonnes of CO_2 emissions.

On the other hand, the rest of the world's CO_2 emissions embodied in production and demand have been relatively stable. After gradually increasing until 2008, CO_2 emissions embodied in production and consumption in the rest of the world stabilized and even declined slightly afterward.

Asia has consistently been a net exporter of CO_2 emissions while the rest of the world has been a net importer. In Figure 7.2, the gap between production-based CO_2 emissions and demand-based CO_2 emissions is the net export or import position of CO_2 emissions for the respective regions. The size of the gap for Asia and the rest of the world is exactly the same by definition. Net exports from Asia (and net imports to the rest of the world) increased significantly in the 2000s but has been relatively stable since 2008.

Figure 7.2: Production- and Demand-Based Carbon Emissions—Asia versus Non-Asia (giga tonnes CO_2)



CO_2 = carbon dioxide.

Note: The shaded areas in the graph represent the absolute difference between production-based (CO_2 emissions based on production, i.e., emitted by economies) and demand-based (CO_2 emissions embodied in domestic final demand, i.e., consumed by economies) CO_2 emissions.

Source: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set.

Box 7.1: Carbon Dioxide Emissions Embodied in International Trade Data Set

The carbon dioxide (CO_2) emissions embodied in international trade data set of the Organisation for Economic Co-operation and Development (OECD) covers those embodied in international trade and domestic final demand. This data set explicitly defines types of emissions based on three allocation methods: territorial-based emissions accounting, production-based emissions accounting, and final demand-based emissions accounting. This data set is novel in that it covers gaps in the International Energy Agency's CO_2 database for all economies to account for CO_2 emissions from fuel combustion, includes CO_2 emissions from fuel combustion by nonresident household and industries, and provides estimates of CO_2 intensity for each bilateral trade relationship.

OECD's Inter-Country Input–Output data are broken down between 66 economies and the rest of the world on an annual time series from 1995 to 2019 for 45 industries (25 industry aggregates). In 2018, these 66 economies cover 92.9% of global gross domestic product, 71.0% of population, 91.4% of exports, 89.2% of imports, and of 89.8% of production-based CO_2 emissions from fossil fuels.

Methodology

To estimate CO_2 emissions embodied in international trade and final demand, the same input–output analysis methodologies used to calculate indicators of Trade in Value Added and Trade in Employment are applied.

Territory-based emissions are based on the International Energy Agency's CO_2 emissions from fuel combustion data set, which covers 46 unique fuel products, 34 unique flows from combustion sectors, and 138 individual economies matching the target economies in the OECD Inter-Country Input–Output database.

Source: OECD. Carbon Dioxide Emissions Embodied in International Trade. https://www.oecd.org/sti/ind/carbondioxideemissionsembodiedininternationaltrade.htm (accessed November 2022).

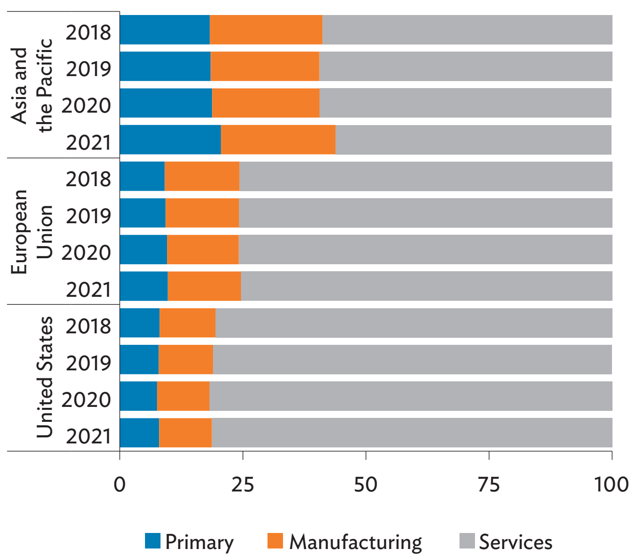
Asia's persistent position as a net CO_2 emissions exporter reflects the region's role as a major provider of products to serve global demand. Consumption demand in advanced economies might have not been met without Asia's rapid expansion of production capacity, which also increased CO_2 emissions as a byproduct. This global imbalance between production and demand of CO_2 emissions, including both consumption and investment between economies and regions, also underlies global discussions on resource transfer and appropriate compensation mechanisms for reducing the CO_2 emissions embodied in production.

The region's economic structure relying more on the manufacturing sector than on the primary and services sectors also partly explains Asia's high CO_2 emissions embodied in production. Asia's manufacturing share of gross domestic product (GDP) exceeds 20%, which is much higher than 11% for the United States (US) and 15% for the European Union (EU) (Figure 7.3). The heavy reliance on industrial inputs for the manufacture of goods, with the share of industrial inputs out of total imports at about 60%, also contributes to Asia's large contribution to CO_2 emissions (Figure 7.4). The effect of this factor is likely to diminish as more Asian economies develop and transition to more services-driven and digital economies.

Asia's CO_2 Emissions Embodied in Trade

CO_2 emissions embodied in Asia's exports and imports have also increased over time. In line with production, the region's CO_2 emissions embodied in exports have also increased. Relative to other regions, Asia's CO_2 emissions embodied in gross exports increased significantly from 1995 to 2019 (Figure 7.5a). Since the 2010s, however, the increasing trend has moderated. The CO_2 emissions embodied in exports can come from domestic sources or foreign industries upstream in the production chain. The total CO_2 emissions in gross exports have risen from 1,516 million tonnes to more than 4,506 million tonnes over 20 years—almost a threefold increase. The emissions embodied in exports from Europe and North America have stayed relatively constant over the last 2 decades with the overall trend decreasing, especially since 2008–2009.

Figure 7.3: Gross Domestic Product by Economic Activity (% of GDP)

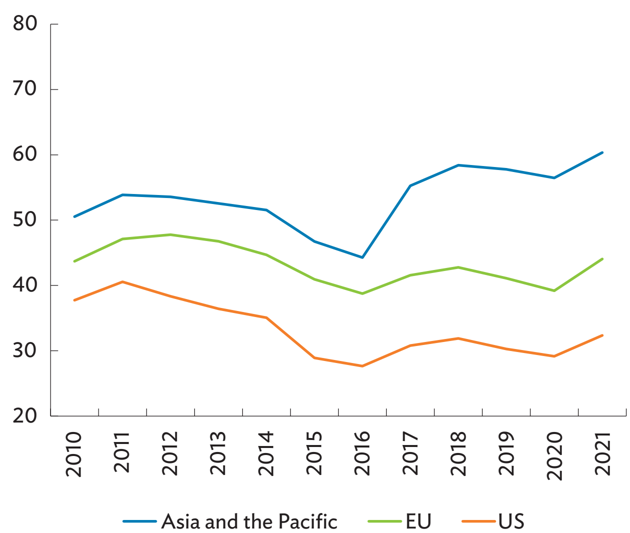


GDP = gross domestic product.

Note: Weighted using gross national income.

Sources: ADB calculations using data from World Bank. World Development Indicators. https://datatopics.worldbank.org/world-development-indicators/ (accessed December 2022); and domestic sources.

Figure 7.4: Share of Industrial Inputs in Total Imports—Asia and the Pacific, European Union, United States (%)



EU = European Union (27 members), US = United States.

Notes: Industrial inputs consist of food and beverages (primary and processed, mainly for industry), industrial supplies not elsewhere classified, and fuel and lubricants, based on Broad Economic Categories commodity classification. Values expressed as percentage of the region's total merchandise goods imports.

Source: ADB calculations using United Nations. Commodity Trade Database. https://comtrade.un.org (accessed December 2022).

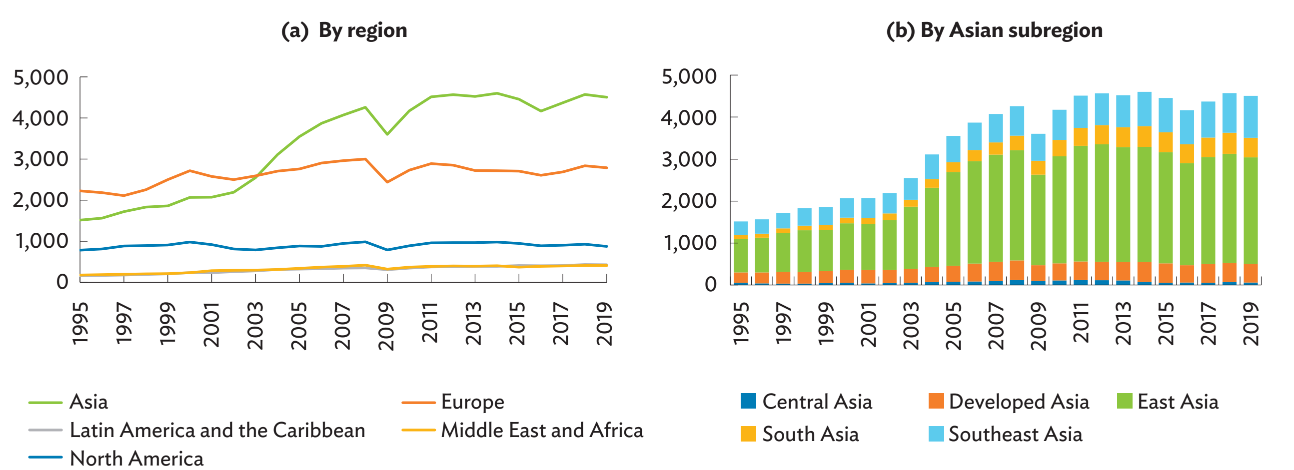
The embodied CO_2 emissions in Asia's exports surpassed Europe's in 2003, led by East Asia. East Asia (excluding Japan) dominates the share of CO_2 emissions embodied in exports, comprising 56.3% of Asia's total CO_2 emissions in 2019 (Figure 7.5b). CO_2 emissions embodied in exports from East Asia increased from 797 million tonnes in 1995 to 2.5 billion tonnes in 2019. In this subregion, the People's Republic of China (PRC) has the highest CO_2 emissions from gross exports, which have steadily increased over the years. Southeast Asia has the next highest, comprising 22.1% of Asia's total CO_2 emissions. The CO_2 emissions embodied in exports from South Asia also increased substantially over the same period, by about fivefold. Export-related CO_2 emissions from developed Asia (Australia, Japan, and New Zealand) have increased more slowly than the rest of the region.

A similar pattern is seen in CO_2 emissions embodied in Asia's imports. Europe had the highest total CO_2 emissions embodied in its gross imports until 2011, when Asia overtook the region (Figure 7.6a). At this point, the embodied CO_2 emissions in Asia's and Europe's imports were about 3,300 million tonnes. Since 2011, the CO_2 emissions in Asia's imports continued to rise, having more than doubled over the last 25 years.

In the region, East Asia has the highest CO_2 emissions embodied in its gross imports. The subregion comprises 46.3% of Asia's total embodied CO_2 emissions in gross imports in 2019 (Figure 7.6b). East Asia's share is dominated by the PRC, which has the highest CO_2 emissions embodied in gross imports. Southeast Asia has the next highest CO_2 emissions, comprising 23.9% of Asia's total CO_2 emissions embodied in gross imports in 2019. The gap between Asia's CO_2 emissions embodied in gross exports and gross imports represents the region's net CO_2 emissions exports, which is tantamount to the gap between production and demand-based CO_2 emissions that was discussed in relation to Figure 7.2.

The increasing CO_2 emissions embodied in Asia's exports and imports partly reflect the growing importance of regional value chains. A sizable portion of CO_2 emissions in Asia's exports and imports are going to or coming from within the region. In 2019, the embodied CO_2 emissions in East Asia's exports primarily went to economies within its own subregion (433 million tonnes) and other Asian subregions (730 million tonnes) (Figure 7.7). This was driven mainly by the PRC's major role in regional value chains. Southeast Asia and developed Asia have the next highest CO_2 emissions going to Asian destinations (at 604 million tonnes and 296 million tonnes). CO_2 emissions to foreign destinations, especially the EU and the US, are relatively low.

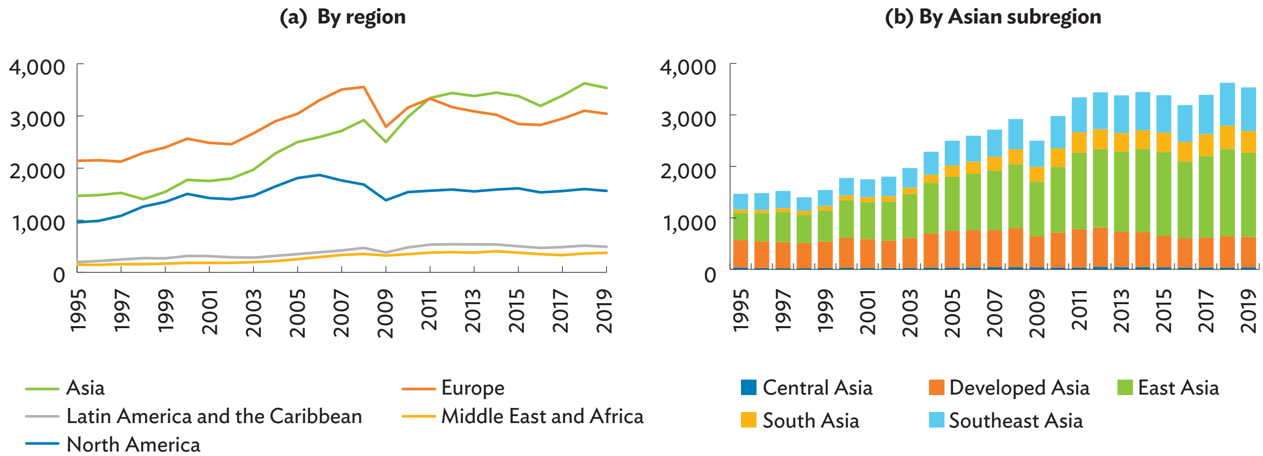
Figure 7.5: Embodied Carbon Emissions in Exports (million tonnes)



Notes: Developed Asia includes Australia, Japan, and New Zealand. East Asia excludes Japan.

Source: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set.

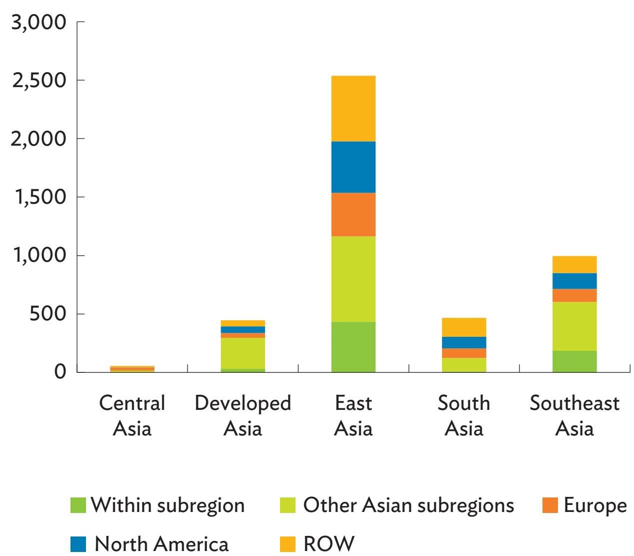
Figure 7.6: Embodied Carbon Emissions in Imports (million tonnes)



Notes: Developed Asia includes Australia, Japan, and New Zealand. East Asia excludes Japan.

Source: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set.

Figure 7.7: Asian Subregions' Carbon Emissions Embodied in Exports by Destination, 2019 (million tonnes)



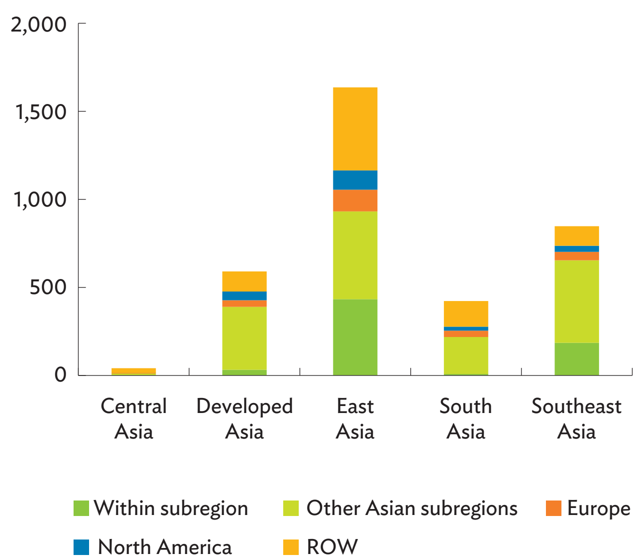
ROW = rest of the world.

Notes: Developed Asia includes Australia, Japan, and New Zealand. East Asia excludes Japan.

Source: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set.

Similarly, a large portion of Asia's CO_2 emissions embodied in imports came from Asian sources in 2019 (Figure 7.8). East Asia has the highest CO_2 emissions embodied in gross imports from within Asia, followed by Southeast Asia and developed Asia—which includes Australia, Japan, and New Zealand. This again is attributable to well-developed regional value chains in the East Asia and Southeast Asia subregions and the region at large.

Figure 7.8: Asian Subregions' Carbon Emissions Embodied in Imports by Source, 2019 (million tonnes)



ROW = rest of the world.

Notes: Developed Asia includes Australia, Japan, and New Zealand. East Asia excludes Japan.

Source: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set.

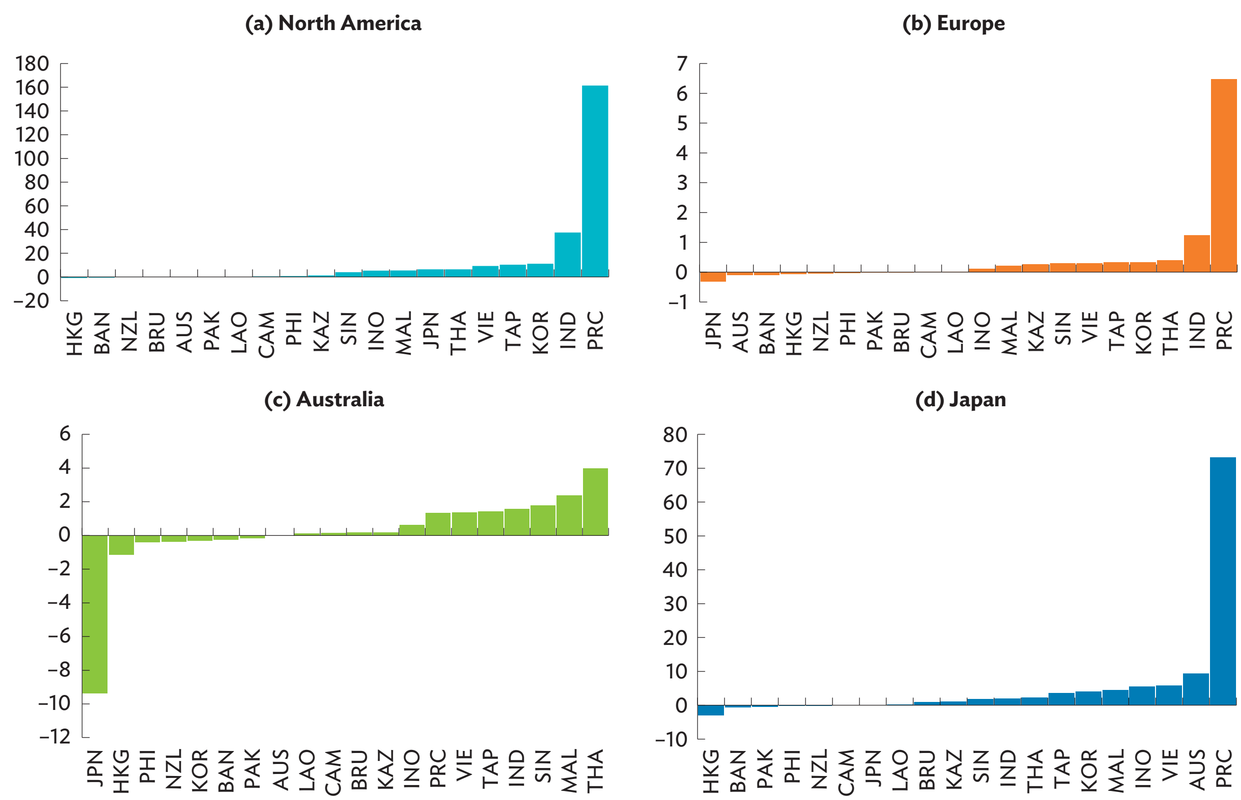
Asia's CO_2 Emissions Balance versus Other Regions

The gap between domestic production and demand is international trade, which also moves CO_2 across borders. Just as an economy's demand is not expected to balance with its own supply of products, CO_2 emissions from its production will generally not equal CO_2 emissions embodied in its consumption. This is primarily a consequence of the international division of labor and the gains from specialization and trade. The discrepancy between production-based CO_2 emissions and demand-based CO_2 emissions displayed in Figure 7.2 thus should not be referred to as carbon leakage unless it reflects production shifts caused by regulatory discrepancies. The pollution haven hypothesis posits that companies move production to economies with laxer environmental regulations.

Many Asian economies have a positive CO_2 balance with developed economies in Europe, North America, and within the region (Figure 7.9). A positive CO_2 balance means the economy has more CO_2 emissions in its production than in its consumption—i.e., it is a net exporter of carbon emissions. On average, the PRC is the largest net exporter of CO_2 emissions to North America (161.5 million tonnes), Europe (6.5 million tonnes), and Japan (73.2 million tonnes) over the period 2014–2019. As the PRC exports many final products to these destinations, it comes as no surprise that it has such a large positive CO_2 balance with these trade partners.

It turns out that many Asian economies also have a negative CO_2 balance with the PRC, i.e., they are net importers of CO_2 emissions from the PRC (Figure 7.10). Among Asian economies, Japan and India are the largest net importers of CO_2 emissions from the PRC, reflecting

Figure 7.9: Average Annual Net Carbon Emissions Balance by Major Trade Partners, 2014–2019—Asian Economies (million tonnes)



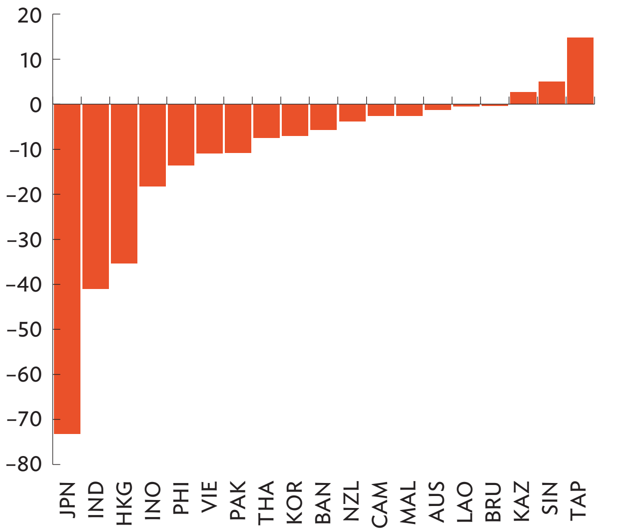
AUS = Australia; BAN = Bangladesh; BRU = Brunei Darussalam; CAM = Cambodia; CO_2 = carbon dioxide; HKG = Hong Kong, China; IND = India; INO = Indonesia; JPN = Japan; KAZ = Kazakhstan; KOR = Republic of Korea; LAO = Lao People's Democratic Republic; MAL = Malaysia; NZL = New Zealand; PAK = Pakistan; PHI = Philippines; PRC = People's Republic of China; SIN = Singapore; TAP = Taipei,China; THA = Thailand; VIE = Viet Nam.

Notes: The average net CO_2 balance is taken between 2014 and 2019. A positive CO_2 balance means the economy has more CO_2 emissions in its production than consumption, i.e., it is a net exporter of carbon emissions.

Source: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set.

their trade deficits with the PRC. In contrast, Kazakhstan; Singapore; and Taipei,China are still net exporters with the PRC, with Taipei,China the largest due to its role as a supplier of semiconductor and electrical parts.

Figure 7.10: Net Carbon Emission Balance with the People's Republic of China, 2014–2019 (million tonnes)



AUS = Australia; BAN = Bangladesh; BRU = Brunei Darussalam; CAM = Cambodia; CO_2 = carbon dioxide; HKG = Hong Kong, China; IND = India; INO = Indonesia; JPN = Japan; KAZ = Kazakhstan; KOR = Republic of Korea; LAO = Lao People's Democratic Republic; MAL = Malaysia; NZL = New Zealand; PAK = Pakistan; PHI = Philippines; SIN = Singapore; TAP = Taipei,China; THA = Thailand; VIE = Viet Nam.

Notes: The average net CO_2 balance is taken between 2014 and 2019. A positive CO_2 balance means the economy has more CO_2 emissions in its production than consumption, i.e., it is a net exporter of carbon emissions.

Source: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set.

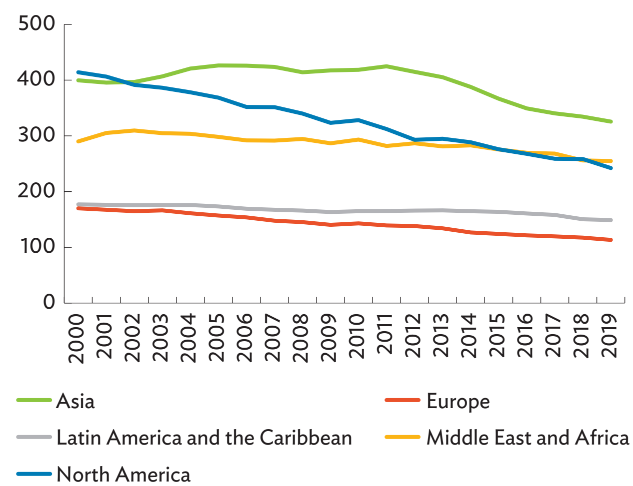
Impact of Industrial Structure and Technique

Emission Intensity of Production

The emissions intensity of an economy reflects both industrial structure and technological advancement effect and is a crucial factor characterizing the pathway toward net-zero goals. Even with a large production base (economic scale effect), an economy's industrial structure can include large shares of relatively fewer carbon intensive sectors to achieve a less carbon intensive industry profile (industrial structure effect), and it can also reduce carbon emissions in a specific sector if it has low emissions per unit of production in that sector (technological advancement effect). A low emission intensity can be achieved by adopting more sustainable production processes, using fewer carbon intensive energy sources, and adopting decarbonization technologies such as carbon sequestration. Barrows and Ollivier (2021) show that Indian firms increased their CO_2 emissions growth when foreign demand grew but also were able to decrease their emissions growth by lowering emission intensity through fuel switching and technological upgrades.

Production has become cleaner over the past 2 decades in all regions. This could be a result of better technology, stricter environmental regulations (to control pollution of businesses), and growing environmental consciousness. Production-based CO_2 emissions relative to GDP—also called the emission factor—have decreased globally (Figure 7.11). While North America had the highest CO_2 emission factor at the start of the century, it has since declined steeply from 414 tonnes per million US dollars in 2000 to 243 tonnes per million US dollars in 2019. In 2003, Asia overtook North America and had the highest emission factor since then.

Figure 7.11: Production Carbon Emission Factor by Region (tonnes CO_2 per $ million)



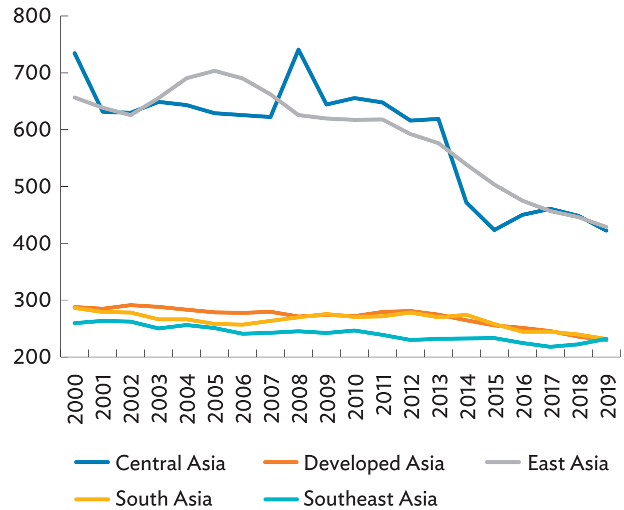
CO_2 = carbon dioxide, GDP = gross domestic product.

Notes: The production carbon emission factor shows an economy's intensity of CO_2 emissions, in tonne CO_2 per $ million of GDP. It is calculated by dividing an economy's production-based carbon emissions by its GDP (purchasing power parity) at constant 2017 $. Regionwide aggregates are computed by dividing the regional sum of emissions across economies by the regional GDP.

Sources: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set; and World Bank. World Development Indicators. https://databank.worldbank.org/source/world-development-indicators (accessed January 2023).

The decline of Asia's emission factor is driven largely by Central Asia and East Asia (Figure 7.12). The fall is a consequence of strong GDP growth accompanied by a gradual reduction in annual CO_2 emissions over the years. Rising income also tends to be associated with the growth of the services sector of an economy and likely enables an economy to adopt greener technologies or enforce stricter environmental regulations. South Asia and Southeast Asia had a relatively stable emission factor over the past 2 decades. Compared with 2000, their latest emission factor is lower—by about 7%. For developed Asia, it is close to 28%.

Figure 7.12: Production Carbon Emission Factor by Asian Subregions (tonnes CO_2 per $ million)



CO_2 = carbon dioxide, GDP = gross domestic product.

Notes: The production carbon emission factor shows an economy's intensity of CO_2 emissions, in tonne CO_2 per $ million of GDP. It is calculated by dividing an economy's production-based carbon emissions by its GDP (purchasing power parity) at constant 2017 $. Subregional aggregates are computed by dividing the subregional sum of emissions across economies by the subregional GDP.

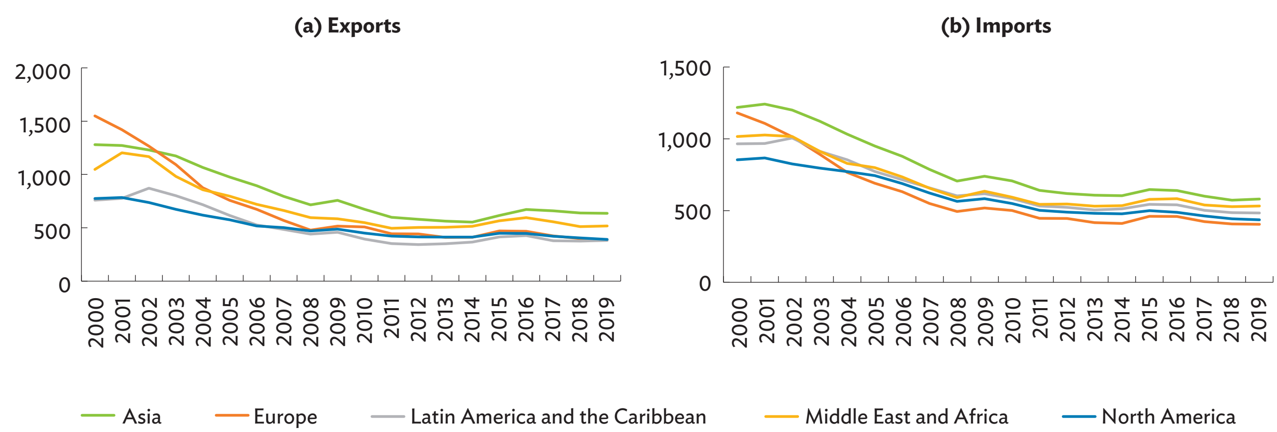
Sources: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set; and World Bank. World Development Indicators. https://databank.worldbank.org/source/world-development-indicators (accessed January 2023).

Emissions Intensity of Trade

In a similar pattern to the emission factor described in the previous section, the carbon emission intensity of Asia's exports and imports also has been decreasing over the past 2 decades. The carbon emission intensity of exports, or the CO_2 emissions per export value, has been decreasing globally (Figure 7.13). In general, the carbon emission intensity of exports declined in all regions and by 2019 reached 635 tonnes of CO_2 per million US dollars in Asia, 391 tonnes per million US dollars in North America, and 387 tonnes per million US dollars in Europe. Since 2002, Asia has the highest average carbon emission intensity of exports globally.

High CO_2 intensity in Asian exports and imports is partly due to the high shares of traded products coming from carbon intensive industries. Figures 7.14a and 7.14c show industries covered in OECD's $TECO_2$

Figure 7.13: Carbon Emissions Intensity of Gross Exports and Imports, by Region (tonnes CO_2 per $ million)



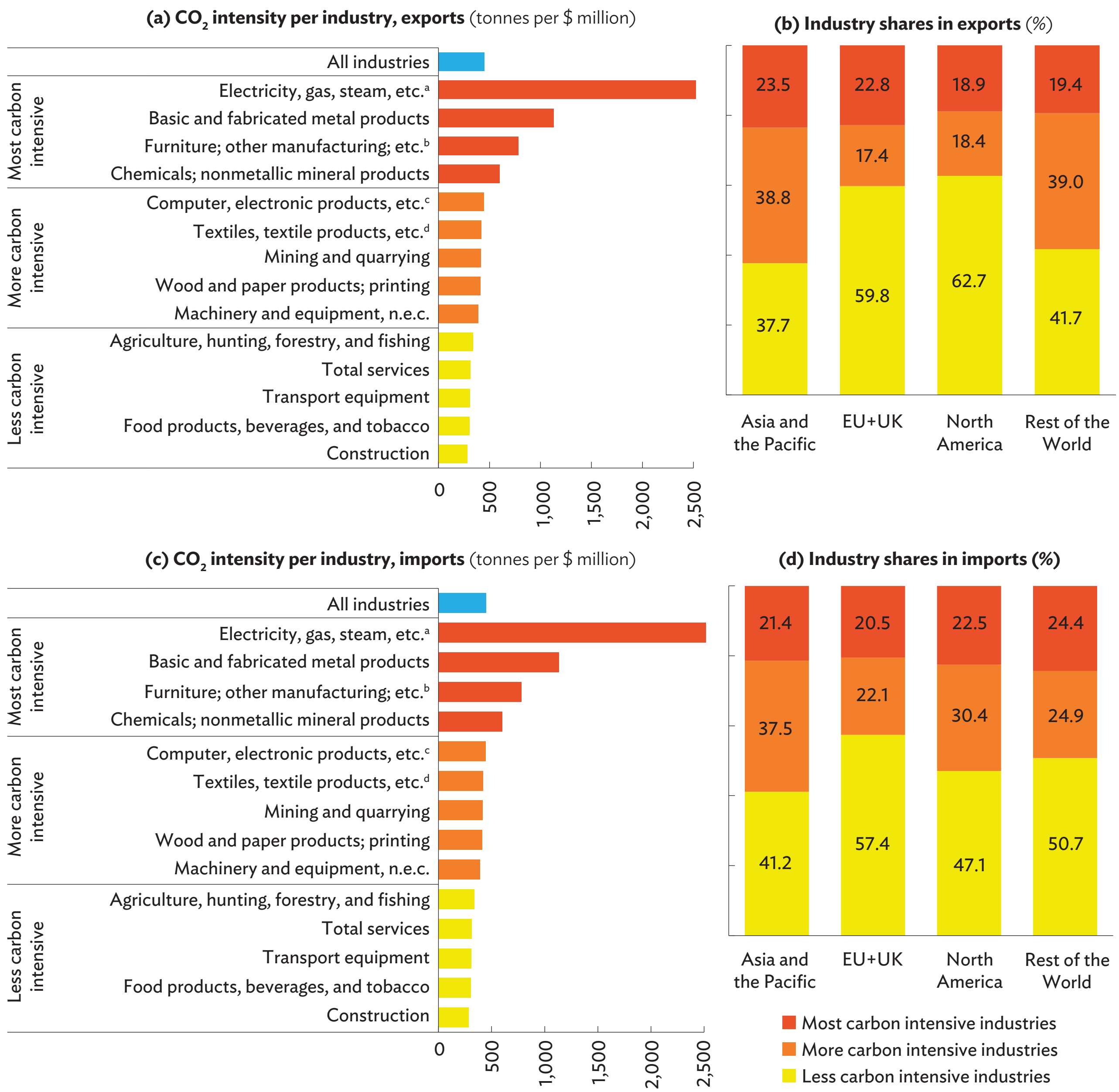
CO_2 = carbon dioxide.

Note: Emission intensity of exports (imports) are CO_2 emissions per export (import) value.

Source: ADB calculations using data from Organisation for Economic Co-operation and Development. Carbon dioxide emissions embodied in international trade ($TECO_2$) data set.

data categorized into sectors that are either most carbon intensive, more carbon intensive, or less carbon intensive. In 2018, the share of carbon intensive exports from Asia was 62.3%, while for the EU and the United Kingdom (EU+UK), it was 40.2%, and for North America 37.3%. Meanwhile, the share of carbon intensive imports in Asia was 58.8%, which is also higher than the shares of the EU+UK and North America (Figures 7.14b and 7.14d). The bias toward carbon intensive sectors in Asia's exports and imports partly reflects the region's industrial structure of production, with higher dependence on the manufacturing sector relative to the primary and services sectors.

Figure 7.14: Carbon Emissions Intensity per Industry and Trade Shares per Region, 2018



CO_2 = carbon dioxide, EU = European Union (27 members), n.e.c. = not elsewhere classified, UK = United Kingdom.

[a] Includes air conditioning and water supply; sewerage, waste management and remediation activities.
[b] Includes repair and installation.
[c] Includes optical products and electrical equipment.
[d] Includes leather and footwear.

Source: Kang, Gapay, and Quizon (2022) using data from Organisation for Economic Co-operation and Development. OECDstat: Carbon dioxide emissions embodied in international trade ($TECO_2$) data set. https://stats.oecd.org (accessed December 2021).

The emission intensity of Asia's exports in most carbon intensive sectors is generally higher than in other regions. As seen in Figure 7.15, in the most carbon-intensive sectors many Asian economies have higher CO_2 emission intensity than in the US and EU economies, led by the utility sector (electricity, gas, steam and air conditioning; sewerage, waste management and remediation activities). However, some Asian economies have lower emission intensity than developed economies, even in carbon intensive sectors. For example, utilities in Japan, Singapore, and Thailand recorded lower carbon emission intensity compared with both the world average and the levels in the US and several EU economies in 2018. Likewise, Brunei Darussalam and Cambodia showed lower emission intensity than the US, Canada, and some other EU economies in basic metals and fabricated metal products. This heterogeneous pattern of sectoral carbon intensity across economies is also seen for chemicals and nonmetallic mineral products (Figure 7.15).

Figure 7.15: Carbon Emissions Embodied in Exports By Sector, 2018 (tonnes per $ million)

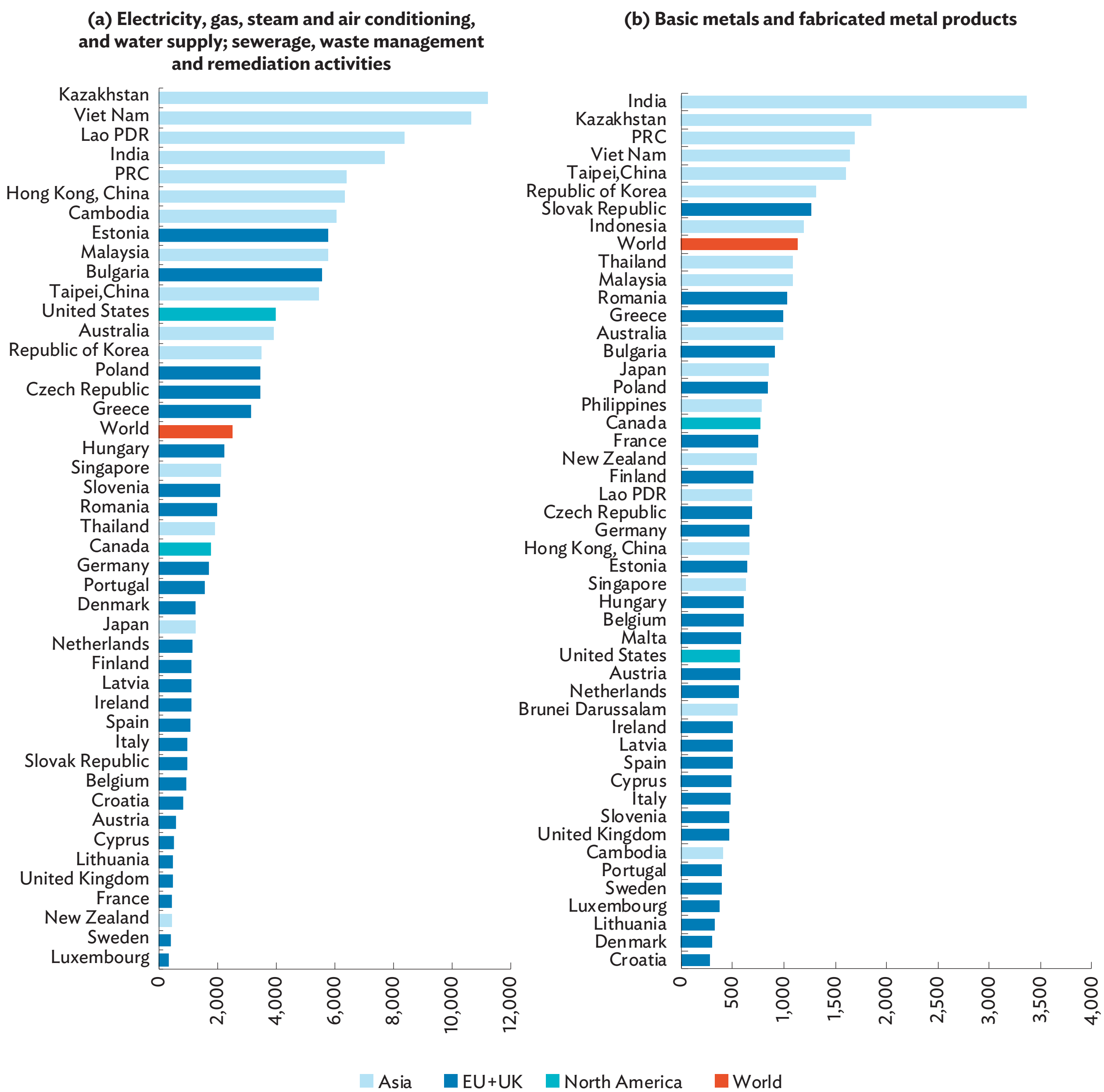


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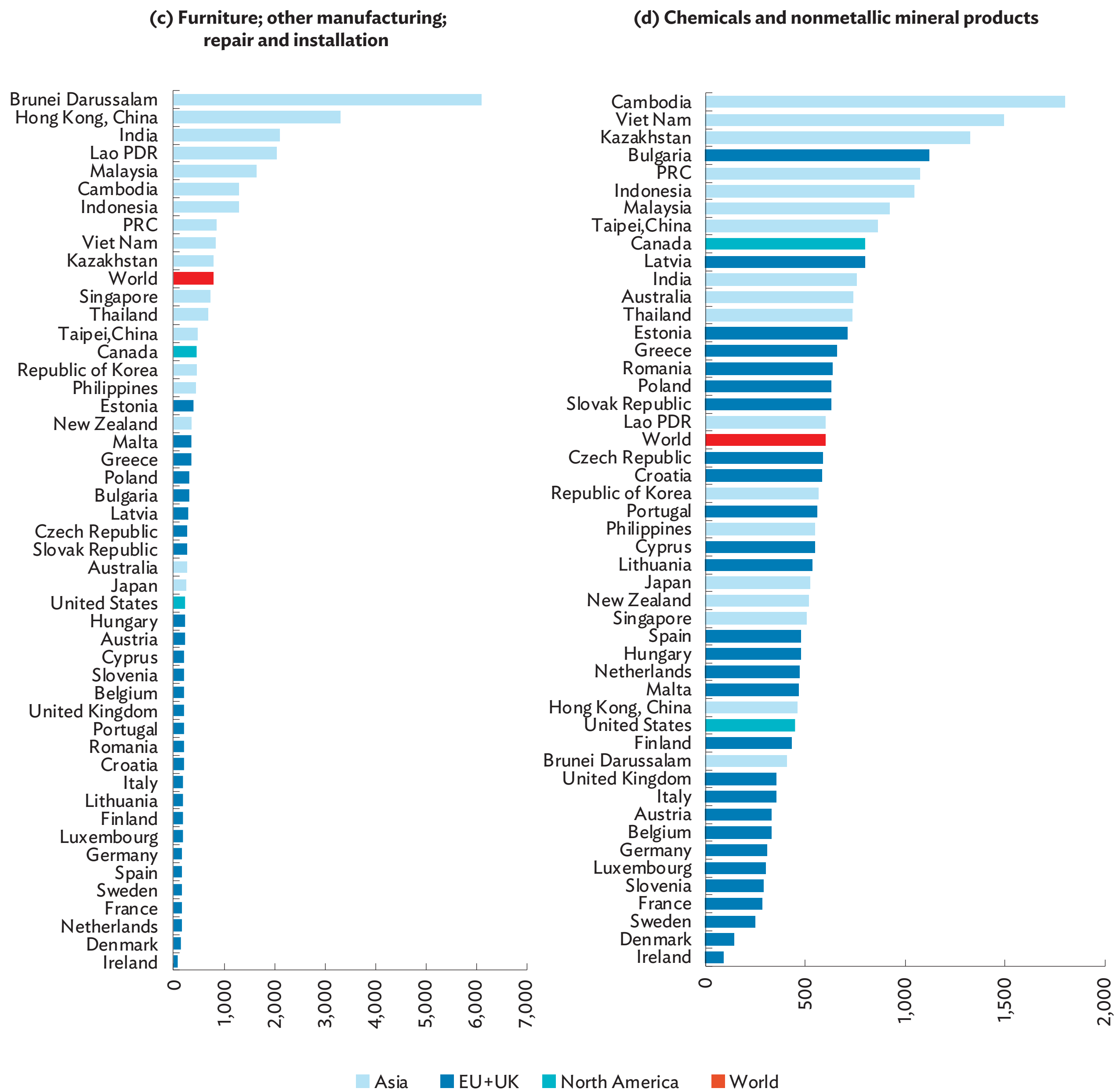
Figure 7.15 *continued*



EU = European Union (27 members), Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China, UK = United Kingdom.

Source: Kang, Gapay, and Quizon (2022) using data from Organisation for Economic Co-operation and Development. OECDstat: Carbon dioxide emissions embodied in international trade (TECO$_2$) data set. https://stats.oecd.org (accessed December 2021).

The ranking of the economies in each industry shows that there is no consistent pattern in the relative positions of their emission intensities. The carbon emission intensity of an industry can differ because of the energy sources used in production and the production technology itself. Some economies can have higher carbon emission intensity in one industry than another as a result of the status of technological development, which reflects each sector's production capability and an economy's capacity to reduce emissions in that sector.

Foreign Direct Investment Impact on Environmental Outcomes[108]

Multiple Channels to Define

The nexus between FDI and climate change involves multiple channels and requires thorough assessment. The economic benefits and costs of FDI inflows in terms of economic growth, productivity spillovers, technology transfer, and employment have been well studied (Haskel, Pereira, and Slaughter 2007; Iwasaki and Tokunaga 2016; Liu and Wang 2003; Meyer and Sinani 2009; Nair-Reichert and Weinhold 2001; Newman et al. 2015; Ning, Wang, and Li 2016; Xu and Sheng 2012). Still, there is little consensus on the relationship between FDI and climate change. Most of the literature focuses attention on (i) the relationship between FDI flows and environmental regulations, and (ii) the environmental impacts of FDI on host economies (Cole, Elliott, and Zhang 2017; Dean, Lovely, and Wang 2009; Demena and Afesorgbor 2020; Erdogan 2014; Pazienza 2014).

Today, there is not a common definition of green FDI used by governments and market participants. Typically, green or low-carbon FDI refers to the transfer of technologies, practices, or products such that their own and related operations, and use of their products and services, generate significantly lower GHG emissions (UNCTAD 2010). As such, green FDI may include goods in renewable energy (including solar, wind, biomass, hydroelectric, geothermal, marine, and other renewable power generation), recycling activities and low-carbon technology manufacturing. More comprehensive definitions combine two components to define green FDI, including (i) FDI in environmental goods and services, and (ii) FDI in environmental-damage mitigation processes (Golub, Kauffmann, and Yeres 2011). For the latter, the identification of environmental damage mitigation processes can be challenging. Identifying investments that promote cleaner and more efficient technologies requires detailed and comparable information on emissions at the economy, sector, and process level, which are needed to create a common benchmark. FDI in capital equipment to reduce carbon use in the production of goods can be considered as part of investment in environmental-damage mitigation processes.

To address this gap, we construct a measure of "carbon intensive" or "non-carbon intensive" FDI based on the pollution intensity of industries. We define carbon intensive industries as those whose CO_2 emissions are above the median carbon emissions across industries in a given year (Box 7.2). For each economy, industries are classified as "non-carbon intensive" or "carbon intensive" as a function of the average carbon emissions of that industry each year. As a robustness check, alternative definitions of carbon intensive FDI were used, with similar results. We consider time invariant sectoral classifications, definitions of the median for the major sectoral groups (primary, manufacturing, services) and classifications based on pollution abatement by industry (Bialek and Weichenrieder 2021).

Trends of Carbon and Non-Carbon Intensive FDI

Trends for greenfield FDI flows suggest that Asia hosts a greater share of FDI from carbon intensive industries than any other region. On average, Asia accounted for 33.1% of inward carbon intensive FDI flows from 2008 to 2016 (Figure 7.16a). This is followed by North America (29.7%) and Europe (22.5%). Shares of carbon intensive industries do not seem to change substantially over time. For non-carbon intensive industries, Europe accounts for nearly half of global FDI inflows from 2008 to 2016 (Figure 7.16b). Asia is the second most important destination for investments in non-carbon intensive industries, making up about 20% of the investments for the period. The share of non-carbon

[108] For this section, Asia and the Pacific, or Asia, excludes Oceania (Australia and New Zealand) given the different effect these economies would have compared with the rest of Asian economies.

Box 7.2: Classification of Carbon Intensive and Non-Carbon Intensive Industries

The classification of industries by carbon dioxide (CO_2) emissions is important for assessing how foreign direct investment (FDI) impacts the profile of carbon emissions in home (sending) and host (recipient) economies. For the purposes of this chapter, industries are classified into two categories (carbon intensive and non-carbon intensive) according to the relative level of carbon emissions of each industry and year.

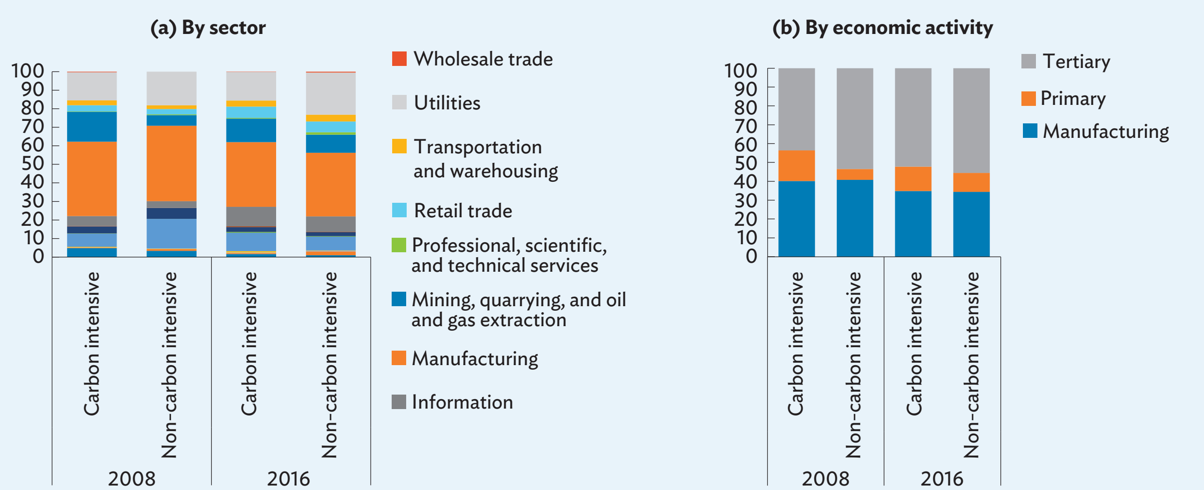
World Input-Output Database figures are used to identify CO_2 emissions by industry and year. The database covers 43 economies for 56 sectors classified according to the International Standard Industrial Classification (ISIC), Revision 4. Out of 56 industries, 7 are used in this study. These are further classified into broader categories representing "manufacturing," "information and communication," and "financial and insurance activities," based on the ISIC of All Economic Activities, Revision 4.

One step further classifies these broad categories into sectors: agriculture, industry, and services. To classify the industry, category, and sector as carbon intensive, the level of CO_2 emissions is evaluated around the median. The median of CO_2 emissions is based on the industry and year.

The box figure shows the sectoral composition of carbon intensive industries FDI in 2008 and in 2016 for global greenfield investment. Manufacturing accounts for the largest share of FDI for both carbon intensive and non-carbon intensive industries. In 2008, mining and quarrying accounted for the second-largest share of carbon intensive FDI, followed by electricity, gas, and water supply. Meanwhile, electricity, gas, and water supply, as well as real estate sectors make up the largest share of FDI in non-carbon intensive industries. Overall, the sectoral composition of FDI remained stable from 2008 to 2016. For the major sectoral classification, manufacturing accounts for sizable FDI over both time periods, with a growing share of investments in tertiary sectors.

As a robustness test, alternative classifications of carbon and non-carbon intensive industries were adopted. Results under alternative classifications are mostly consistent with the findings presented in this section.[a]

Composition of Carbon and Non-Carbon Intensive Industry FDI (%)



FDI = foreign direct investment.

Sources: ADB calculations using data from Financial Times. fDI Markets; Groningen Growth and Development Centre. World Input-Output Database (WIOD). https://www.rug.nl/ggdc/valuechain/wiod/?lang=en (accessed November 2022); and WIOD methodology based on Timmer et al. (2015).

[a] Several definitions of carbon and non-carbon intensive industries were considered for the analysis, yielding similar results. First, an industry is defined as carbon intensive if emissions are above the median of the 2-digit Nomenclature of Economic Activities industries for the pooled data set (time invariant). Second, a similar definition is considered but the median is determined each year (time variant). Third, an industry was defined as carbon intensive if carbon emissions are above the median of a major sectoral group (primary/manufacturing/services). Fourth, a similar definition using major sectoral groups is used but the median is defined each year. Last, we employ the classification of Bialek and Weichenrieder (2021) who used pollution abatement as their basis for their classification. This classification is also time invariant.

Source: ADB staff.

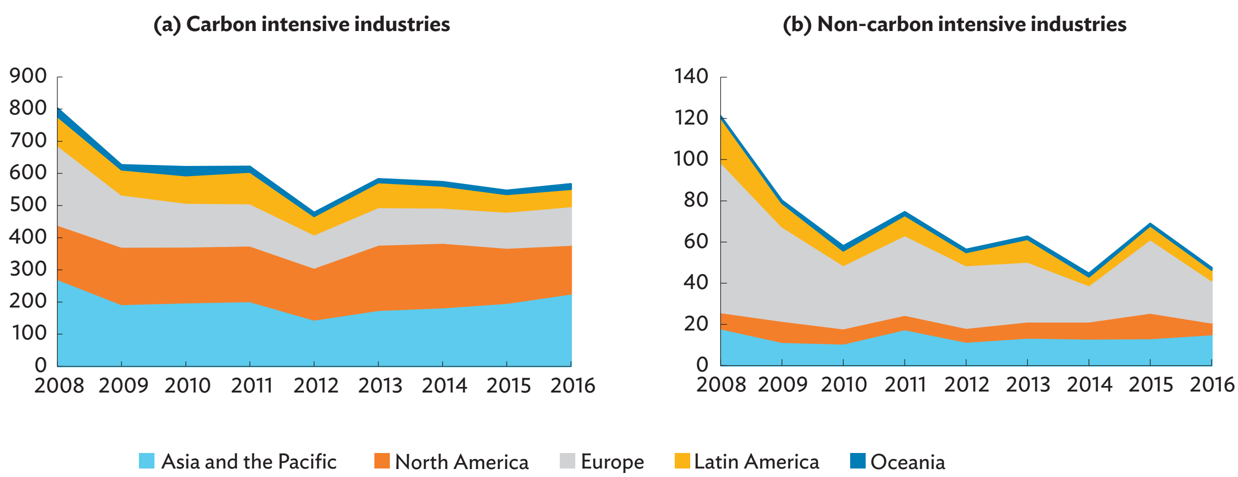
intensive FDI to Asia has also increased over the years. FDI from non-carbon intensive sources represented 7.3% of Asia's total greenfield investment, above North America (4.4%) and below Europe (20.6%).

Nevertheless, the share of inward FDI in highly carbon intensive industries relative to non-carbon intensive industries remains moderate in Asia. An estimation of the ratio of inward investment in the top 25% (top quartile) carbon intensive industries over the bottom 25% (bottom quartile) underscores regional differences. From 2011 to 2016, Asia's average ratio of investment in carbon to non-carbon intensive industries (29.3) remained within the global average, higher than Europe, but lower than other regions. While the concentration of greenfield FDI in manufacturing and less energy efficient industries could influence the overall outcomes, regional differences also reflect the large heterogeneity in carbon emissions across industries and economies.

By Asian subregion, East Asia received the largest share of carbon intensive FDI for Asia from 2008 to 2016 (Figure 7.17). On average, carbon intensive industry FDI flows to East Asia account for 42.8% of the region's total, followed by Southeast Asia (33.5%). In recent years, increasing participation of FDI from carbon intensive industries is observed for Central Asia. Investments on non-carbon intensive industries have been dominated by East Asia and Southeast Asia, which together account for three-fourths of the region's investment. The ratio of inward FDI in the top and bottom carbon intensive industries (by quartile) depicts a more uniform picture across Asian subregions. From 2011 to 2016, the average ratio of investment in carbon to non-carbon intensive industries for Central Asia (30.8), East Asia (26.7), South Asia (37.4), and Southeast Asia (34.4) was relatively similar and stable over time although the annual fluctuation could be affected by some large investments made in extractive industries for a particular year.

Jobs created by greenfield FDI are mostly concentrated in carbon intensive industries. Following the pattern for capital expenditure on greenfield projects, Asia accounts for the largest share (44.3%) of jobs created by FDI in carbon intensive industries from 2008 to 2016, followed by Europe (27.4%) and North America (25.1%) (Figure 7.18a). For non-carbon intensive industries, Europe is dominant with 53.9% of job creation (Figure 7.18b), followed by Asia (28.6%), where the share has gradually increased. Still, FDI in carbon intensive industries remains the largest source of job creation for all regions.

Figure 7.16: Carbon Intensive and Non-Carbon Intensive Foreign Direct Investment by Host Region ($ billion)

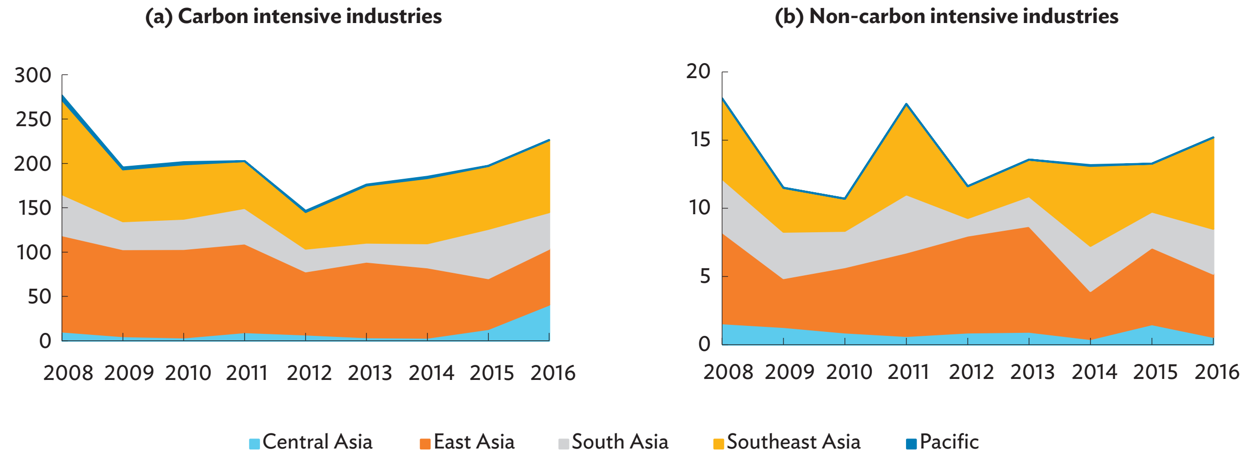


FDI = foreign direct investment.

Notes: Figure shows share of FDI by geographic location of destination economy from 2008 to 2016. The left panel shows the shares for carbon intensive industries while the right panel shows the share for non-carbon intensive industries. The graph does not include data from Africa and the Middle East.

Sources: ADB calculations using data from Financial Times. fDI Markets; and Groningen Growth and Development Centre. World Input-Output Database. https://www.rug.nl/ggdc/valuechain/wiod/?lang=en (accessed November 2022); and methodology based on Timmer et al. (2015).

Figure 7.17: Carbon Intensive and Non-Carbon Intensive Foreign Direct Investment by Asian Subregions ($ billion)

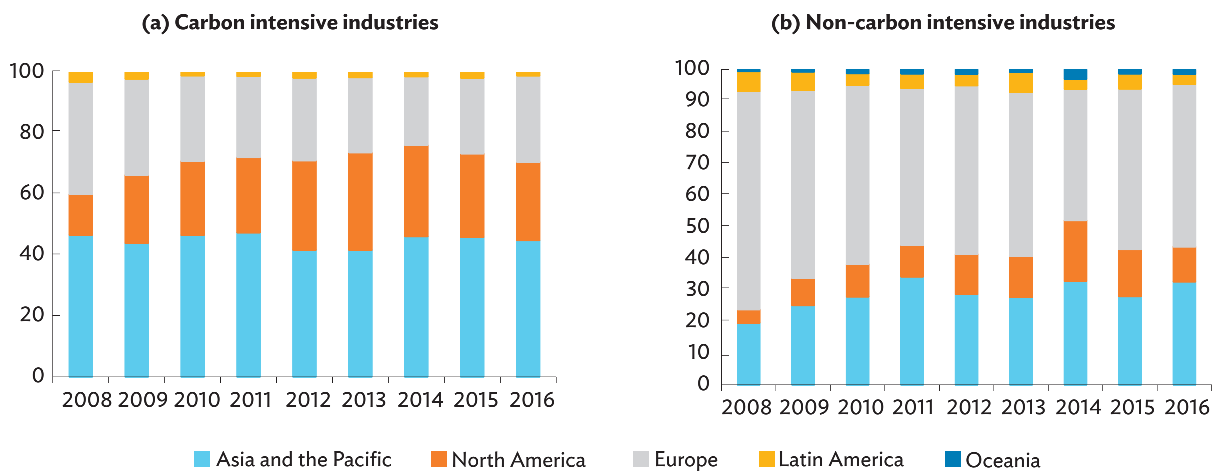


FDI = foreign direct investment.

Notes: Figure shows share of FDI flowing to Asia and the Pacific by Asian subregion from 2008 to 2016. The left panel shows the shares for carbon intensive industries while the right panel shows the share for non-carbon intensive industries.

Sources: ADB calculations using data from Financial Times. fDI Markets; and Groningen Growth and Development Centre. World Input-Output Database. https://www.rug.nl/ggdc/valuechain/wiod/?lang=en (accessed November 2022); and methodology based on Timmer et al. (2015).

Figure 7.18: Job Creation in Greenfield Foreign Direct Investment for Carbon Intensive and Non-Carbon Intensive Industries (%)



Notes: Figure shows share of job creation by geographic location of destination economy from 2008 to 2016. The left panel shows the shares for carbon intensive industries while the right panel shows the share for non-carbon intensive industries. The graph does not include data from Africa and the Middle East.

Sources: ADB calculations using data from Financial Times. fDI Markets; and Groningen Growth and Development Centre. World Input-Output Database. https://www.rug.nl/ggdc/valuechain/wiod/?lang=en (accessed November 2022); and methodology based on Timmer et al. (2015).

Asia's FDI in carbon intensive industries is more reliant on intraregional sources. A glance at FDI flows to Asia by investor region shows that intraregional flows (Asian economies investing in Asia) account for the largest share (44.9%) of carbon intensive industry investments in the region (Figure 7.19a). North America represented, on average, 28.5% of Asia inward investment in carbon intensive industries, whereas the share from Europe fell from 25.8% in 2008 to 15.9% in 2016. For non-carbon intensive industries, European economies account for a substantial majority of FDI flows into Asia (Figure 7.19b). Asian investors account on average for

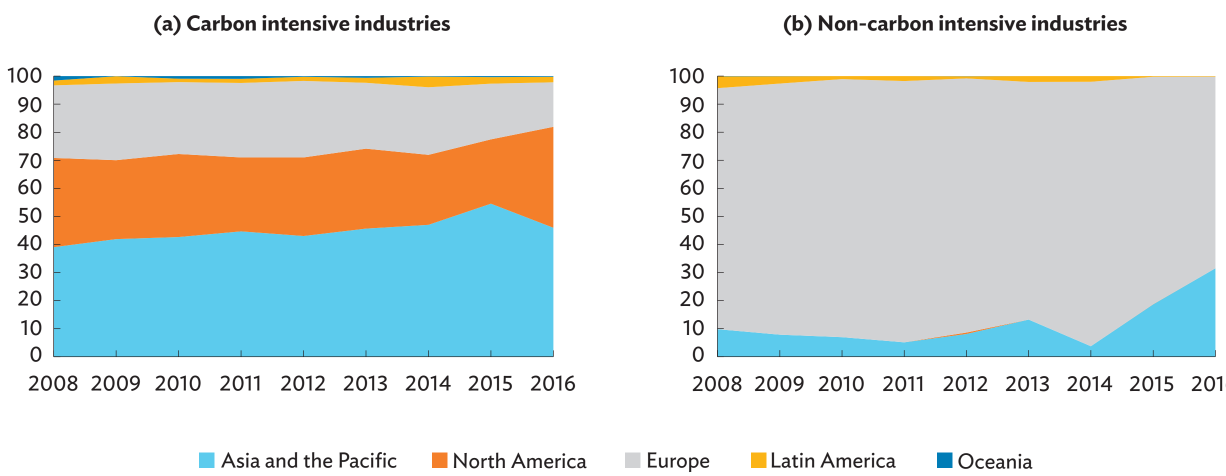
11.7% of Asia's inward investment in non-carbon intensive industries, but the share had increased to 31.5% by 2016, and most likely increased further after. Much like trade, FDI in Asia reflects patterns of specialization with a focus on manufacturing and other carbon intensive industries. There also exists room for strengthening policy efforts in fostering FDI in less carbon intensive industries. Policies in the form of investment incentives (fiscal, financial), easing foreign investment restrictions in less polluting industries, and targeted investment promotion strategies could be effective in directing investments toward greener industries.

Asia's FDI in environmental goods and services is growing. Regional estimates on the share of FDI in environmental goods, based on the classification system of the Asia-Pacific Economic Cooperation (APEC), suggest that the volume remains smaller than for other industries (Figure 7.20a). However, investment into these sectors has increased in most regions. Asia's estimated share of FDI in environmental goods and services grew from 3.4% 2005 to 11.4% for greenfield investment, with a clear uptick in recent years. Estimates for mergers and acquisitions are about the same magnitude (10%), with higher fluctuation across years. A breakdown of the most important environmental goods and services highlights the major role of renewable energy investments (Figure 7.20b). Between 2005 and 2021, an average 41.6% of FDI in environmental goods and services in Asia was destined to solar electric power and 20.5% to wind electric power.

FDI and Environmental Regulations

Environmental standards can be a factor for multinationals when locating subsidiaries. Studies have shown that regions with lax environmental regulations may have a comparative advantage in pollution intensive production, thereby attracting FDI to polluting industries from economies with more stringent environmental regulations (Millimet and Roy 2016; Motta and Thisse 1994; Ranocchia and Lambertini 2021; Xing and Kolstad 2002). This phenomenon is known as the pollution haven hypothesis. At the same time, some foreign firms may prefer to relocate to an economy with higher environmental standards if such a move raises its rival domestic firm's costs by more than its own (Dijkstra, Matthew, and Mukherjee 2011) or to prevent entry by a domestic competitor. Elliott and Zhou (2013) refer to this effect as environmental regulation induced FDI. The effect on outward investment is also

Figure 7.19: Sources of Greenfield Foreign Direct Investment for Asia and the Pacific (%)

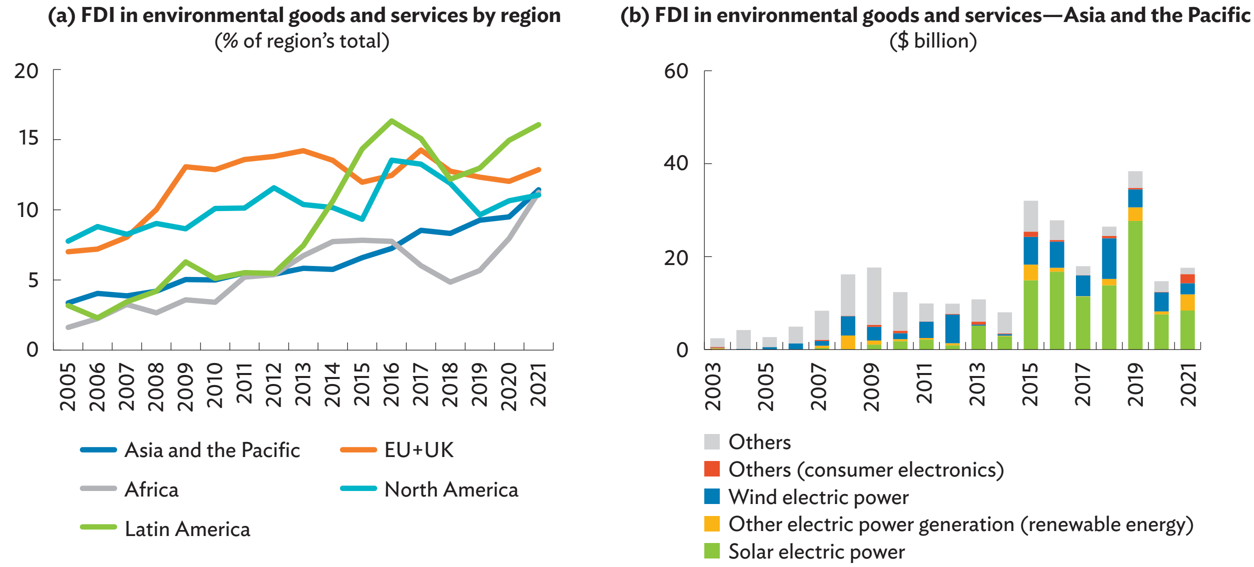


FDI = foreign direct investment.

Notes: Figure shows the composition of investor source for FDI flowing into Asia and the Pacific from 2008 to 2016. The left panel shows the shares for carbon intensive industries while the right panel shows the share for non-carbon intensive industries. The graph does not include data from Africa and the Middle East.

Sources: ADB calculations using data from Financial Times. fDI Markets; Groningen Growth and Development Centre. World Input-Output Database (WIOD). https://www.rug.nl/ggdc/valuechain/wiod/?lang=en (accessed November 2022); and WIOD methodology based on Timmer et al. (2015).

Figure 7.20: Estimated Greenfield Foreign Direct Investment toward Environmental Goods and Services (3-year moving averages)



EU = European Union (27 members), FDI = foreign direct investment, M&A = merger and acquisition, UK = United Kingdom.

Notes: Estimates for firm-level FDI into environmental goods and services were based on the list of environmental goods from the Asia-Pacific Economic Cooperation (APEC), which uses the Harmonized System codes and includes goods. To reflect investment in potential environmental services or sectors, codes listed in the APEC list were matched with the International Standard Industrial Classification of All Economic Activities using a concordance key from the Organisation for Economic Co-operation and Development and then to the North American Industry Classification System. The complete list of sectors for both greenfield and M&A FDI is in Chapter 8: Statistical Appendix.

Sources: ADB calculations using data from Bureau van Dijk. Zephyr M&A Database; and Financial Times. fDi Markets.

ambiguous. Local regulations could lead a firm to increase or reduce its investment in both the home economy and in the economy where environmental standards are less stringent (Eskeland and Harrison 2003). Other drivers, including institutional factors, industries, and investor characteristics are also important.

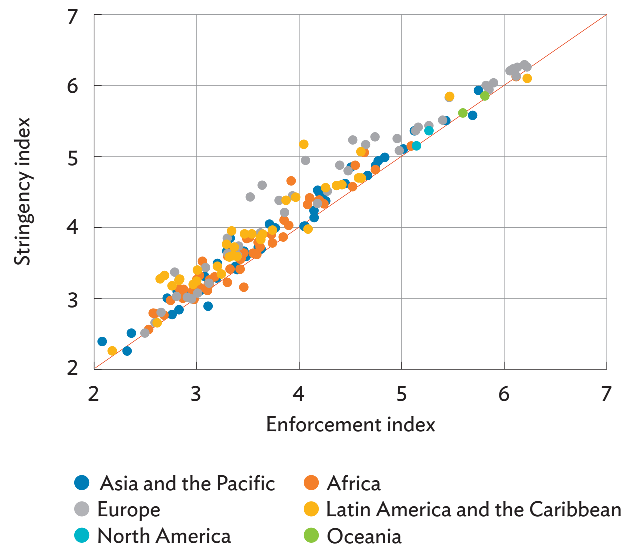
To untangle this nexus, empirical analyses have studied the channels that link investment and environmental outcomes. These include the impact of environmental costs on FDI location, evidence on the pollution haven hypothesis, and the impact of FDI on domestic environmental policies (Cole, Elliott, and Zhang 2017; Erdogan 2014; Rezza 2015). How environmental regulations are measured influences whether these linkages are supported. More recently, the benefits of FDI on domestic environmental standards have been explored. This perspective, also known as the pollution halo effect, is based on the notion that FDI can benefit the local environment around the site of investment (Wei, Ding, and Konwar 2022).[109] The pollution halo effect encompasses policy options that encourage the diffusion of clean technologies through FDI. This can take shape as environmental spillovers from foreign to local firms that drive rapid reductions in CO_2 emissions.

Measures of environmental regulations and environmental performance are wide-ranging. Commonly used regulatory measures include environmental levies, investment in industrial pollution treatment and pollution abatement projects, the number of administrative cases filed by environmental authorities, and the number of public servants working in environmental protection agencies (Bu et al. 2013; Pan et al. 2020; Zhang and Fu 2008). Cross-economy indicators suggest that environmental enforcement is related to

[109] Wei, Ding, and Konwar (2022) find that 40 articles on the environmental performance of FDI in the People's Republic of China support the pollution halo effect, and argue that FDI leads to better environmental performance through a pollution abatement effect, but not through enhancements in green total factor productivity.

environmental stringency, subject to some regional differences (Figure 7.21). Measures of environmental policy are also important at the domestic level. These include, for example, participation in international environmental treaties or carbon emission systems (Shao, Yu, and Chen 2022; Xu, Wu, and Shi 2021; Yu and Li 2020) or the use of environmental regulation policy tools. Certain province-level regulations also have been used to identify causal effects of environmental regulations on FDI flows.[110] Likewise, several measures of environmental performance have been used, from air pollutants and quality emissions (CO_2, sulfur dioxide [SO_2], PM10, and PM2.5) (Cole, Elliott, and Zhang 2017; Liu and Zhang 2022; Wang and Chen 2014; Yang et al. 2021). Other studies have focused on energy consumption, energy intensity, and environmental total factor productivity as indicators of environmental performance (Bu et al. 2013; Elliott, Sun, and Chen 2013; Hübler and Keller 2010; Xie, Yuan, and Huang 2017; Zhou et al. 2019). While a broad number of indicators have been proposed, no single measure can reflect all aspects of environmental regulation or performance.

Figure 7.21: Correlation of Stringency and Enforcement of Environmental Regulations



Notes: Data correspond to the latest available year. Red line represents the 45-degree line. Based on the survey data of World Economic Forum (WEF) on stringency of environmental regulations (EOSQ160) and enforcement of environmental regulations (EOSQ161) in 2018. The index covers 134 economies and 16,658 respondent firms.

Source: WEF. Environmental indicators in the WEF Executive Survey.

Is the Region a Pollution Haven for FDI?

While evidence is wide-ranging, most studies support the presence of a pollution haven effect in Asia. Economies like Japan and the Republic of Korea have strict, well-enforced environmental regulations, while environmental stringency and enforcement is considerably weaker in parts of developing Asia. Most evidence from the PRC favors the pollution haven hypothesis, as FDI inflows tend to be located in the PRC regions with weaker environmental regulations (Cheng, Li, and Liu 2018; He 2006; Lin and Sun 2016; Zhang and Fu 2008) and tougher regulations reduce the probability of entry of foreign enterprises (Li, Lin, and Wang 2022). Some research suggests little effect from environmental regulations on FDI, as in Japan (Elliott and Shimamoto 2008) or even an increase in inward FDI following stricter regulations (Shao, Yu, and Chen 2022).

Evidence of the pollution haven hypothesis for Asia's outward investment is more mixed. While increasing environmental stringency in home economies could lead to FDI relocation or firm exit, the evidence for Asia is limited (Greaney, Li, and Tu 2017; Kirkpatrick and Shimamoto 2008). More recent studies find a positive effect on the probability of foreign firms to stay once environmental regulations are tightened (Shao, Yu, and Chen 2022; Tai and Yan 2022).

These findings suggest that multinationals may respond differently to increasing environmental stringency. For example, firms with higher motivation or environmental capabilities may invest more in environmentally stringent locations (Javorcik 2004; Meyer and Sinani 2009). Export-oriented FDI is also more sensitive to environmental regulations than local market-oriented FDI (Tang and Tan 2015). FDI can facilitate both a "race to the bottom" and a "race to the top" (Patala et al. 2021; Ullah et al. 2022).

110 A popular regulation to study in the PRC is the Two Control Zone policy and its impact on firm location. For example, Cai et al. (2016) use the Two Control Zone policy, where the PRC government in 1998 assigned certain provinces to be acid rain and sulfur dioxide (SO_2) pollution control areas, as a natural experiment in which assigned regions can be thought of as being more strictly regulated. They find that the implementation of the policy led to reduced FDI into the more strictly regulated regions.

Environmental Impact of FDI into Asia

The relationship between FDI and the environment is characterized by both positive and negative externalities. FDI into Asia has led to greater environmental degradation and carbon emissions (Behera and Dash 2017; Borga et al. 2022). In India, a 1% increase in inward FDI may have increased CO_2 emissions by 0.86% from 1980 to 2003 (Acharyya 2009). This is consistent with impact assessments in the Association of Southeast Asian Nation (ASEAN) economies, where inward FDI is associated with an overall increase in CO_2 emissions (Baek 2016; Tang and Tan 2015). FDI is also associated with lower environmental standards in SO_2 emissions, air quality, and industrial waste (Cole, Elliott, and Zhang 2011; Liu and Zhang 2022). Other studies have found mixed results or some beneficial effects of FDI on the environment (Jiang et al. 2018; Liu, Hao, and Gao 2017; Zhang and Zhou 2016).

Foreign investment can support cleaner production processes and green technological development. The benefits of FDI for promoting green technological innovation and energy efficiency in the region have been documented (Chen et al. 2014; Li et al. 2016, 2017; Piperopoulos, Wu, and Wang 2018). One example of cleaner production is the use of desulfurization equipment in coal-fired power-generating units. While costlier than normal production processes, using such equipment can generate energy more efficiently and emit less emissions. Evidence suggests that foreign investment largely increases usage of desulfurization in the energy sector (Huang et al. 2019). The environmental impact of the PRC's FDI has often been discussed particularly in the context of the Belt and Road Initiative (Box 7.3).

Box 7.3: Outbound Foreign Direct Investment of the People's Republic of China and the Belt and Road Initiative

The Belt and Road Initiative (BRI) of the People's Republic of China (PRC) provides an example of outbound foreign direct investment policy that is increasingly linked to the climate change agenda. Economic motives for the BRI are to absorb some of the PRC's productive capacity, create regional production chains, and increase energy security. Its impact on economic growth and social and environmental outcomes continues to be widely discussed (Khan et al. 2020; Liu et al. 2020; Mahadevan and Sun 2020; Tian et al. 2019).

Some environmental concerns over the BRI are related to high energy consumption for construction and maintenance of infrastructure projects, mostly from fossil fuels (Zhang et al. 2017). The effect on carbon emissions in host economies has been the subject of discussion. Early assessments suggest that the BRI could lead to a modest increase in global carbon emissions in host economies. The PRC benefits from outsourcing part of its production abroad, while host economies absorb this production and related emissions (Maliszewska and van der Mensbrugghe 2019).

More recently, some assessments suggest that the BRI also can contribute to improving the environmental quality of economies that have received investments (Cao, Teng, and Zhang 2021). Indeed, economies with lower environmental quality could have benefited from technology transfers and more stringent environmental regulations. The launch of the PRC's pilot emissions trading scheme may also have accelerated the transfer of carbon intensive production activities abroad and increased the scale of investments in economies where PRC firms have an affiliate (Yu, Cai, and Sun 2021). Other studies suggest that the impact of the PRC's outward foreign direct investment on green total factor productivity has been positive, with a larger effect on economies with stronger institutions (Wu et al. 2020).

Overall, there is wider awareness of these assessments, and the PRC has worked toward integrating green development and environmental protection into its BRI projects. A Coalition for Green Development on the Belt and Road was proposed in 2017 to this effect, considering the complexities of measuring the environmental impact and implementation of transnational infrastructure. Efforts in host economies to better identify bankable projects and incorporate environmental impact assessments also contribute to better environmental outcomes of BRI projects.

Source: Cole, Elliott, and Zhang (2022).

FDI and Energy Transition in Asia

FDI can be a vehicle for more efficient energy consumption, energy intensity, and transfer of energy-saving technologies. FDI in and from Asia has been found to reduce energy intensity and carbon emissions. While a positive link between FDI and energy consumption is not uncommon (Azam et al. 2015; Mudakkar et al. 2013), recent evidence from the PRC and Bangladesh suggests that FDI has boosted renewable power generation (Ahmad et al. 2019; Murshed et al. 2022; Tiwari, Nasreen, and Anwar 2022). As a result of investments in more efficient and cleaner energy sources, FDI has had an impact on plant energy intensity. Evidence for Indonesia shows that foreign ownership increased energy usage while reducing plant energy intensity (Brucal, Javorcik, and Love 2019). Evidence also shows how FDI inflows can improve energy efficiency, as measured by total factor energy efficiency (Ren, Hao, and Wu 2022) and promote regional convergence in energy efficiency (Zhao, Zhang, and Li 2019). These examples also highlight that positive spillovers from FDI on energy are related to the institutional context of the host economies, with more positive effects in high income economies (Dong, Gong, and Zhao 2012). From an energy efficiency perspective, policies to encourage even access to FDI can improve overall efficiency and reduce regional efficiency differences.

Environmental spillovers from FDI can be realized through the adoption of more advanced technologies and better management practices. For example, cleaner production partnerships through FDI have been effective. Hong Kong, China and the Guangdong region successfully introduced cleaner production technologies, by promoting management systems to improve energy efficiency and reduce effluent discharges and production costs (Jiao et al. 2020). Environmental technologies can also be transferred back to the home economy through outward investment, a process referred to as reverse green technology spillovers (Liu et al. 2021; Ren, Hao, and Wu 2022).

While the potential for positive environmental spillovers is large, they may not materialize in the short term. As a short-term strategy for Asia to meet net-zero goals, encouraging FDI in the renewable energy sector may be important. Active investment policies to redirect FDI toward renewables could be part of the region's strategy to meet climate goals. This may offset the negative impact of FDI on other environmental outcomes. It also takes into account the positive impact that FDI may have on energy intensity.

Challenges in Greening Trade and Investment

Pathways toward Cleaner Production and International Trade

Asia needs to intensify national and international efforts to expand energy efficient and emission reducing production capacity and trade. In the short-term, carbon intensity of production and trade could be lowered further by engaging cleaner technologies, where knowledge transfer through regional and international cooperation can play a crucial role. In the mid-to-long term, moving up the value ladder by accelerating industrial transformation into high-end, high value-added manufacturing and services would not only contribute to economic growth but sustainable development. Potential carbon leakage due to heterogeneity in environmental regulations and carbon pricing mechanisms may not be the main source of cross-border CO_2 emission imbalances, but it still calls for stronger multilateral and regional policy cooperation.

Trade and investment need to be part of the climate solution. Trade and investment, while moving goods and services and production capacities across borders, can bring clean technologies and the know-how embedded in them. Insufficient regulatory harmonization and international cooperation, however, could get in the way of streamlining cross-border economic transactions of green technologies and increasing interoperability in key areas for trade such as certification and emissions accounting systems. Lack of price signals for CO_2 emissions also remains a major barrier to providing strong incentives to reduce carbon emissions.

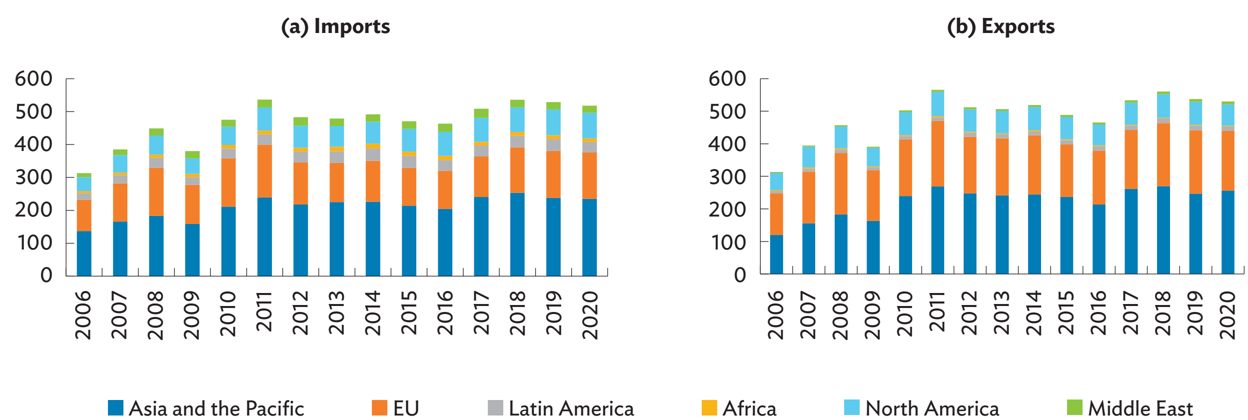
A reduction in emission intensity can be brought about by adopting green technologies to abate carbon emissions. Economies can adopt these technologies through two channels—trade of environmental goods and services, and technology transfer from foreign investment and firms. This can bring down the cost of adopting new green technologies and drive innovation as reflected in the decline in solar photovoltaic panel and wind energy costs (Figure 7.24).

Current Status and Main Challenges

Trade in environmental goods and services have been increasing since 2005. Asia's imports, using the APEC list of environmental goods, have been increasing over the years, and the region has consistently accounted for about 40%–45% of the global imports (Figure 7.22). The Asia total for imports of environmental goods increased from $137 billion in 2006 to $235 billion in 2019, reflecting a rising trend in consumption of environmental goods in the region. As the PRC and the Republic of Korea increased production of these goods, the share of the region's exports has also increased from below 40% in 2006 to almost 50% in 2020. Yet, it is striking that the total value of environmental goods imports and exports globally has remained consistent at about $530 billion in the last 5 years. As for services trade, using a definition by Sauvage and Timiliotis (2017), as applied in Figure 7.23, the share of environmental services exports in total services exports increased from just under 8% in 2010 to almost 12% in 2020. Similar growth in environmental services imports is also observed. Most of this is driven by the EU economies, with Asia and the Pacific capturing only about 1.7% of services exports and about 1.4% of services imports in the last decade. As a result, the region's share of total environmental services trade has been decreasing and this is in contrast to growth in trade from the EU, non-EU, and North American economies. Most of the environmental services trade in Asia is from Japan, the Republic of Korea, and Singapore.

The price of solar modules has been declining in the top five producing economies, not only in the developed economies—Germany, Japan, and the US—but also in developing Asian economies such as the PRC and the Republic of Korea (Figure 7.24). Indeed, prices of solar modules are converging to below $1 per watt. Trade can enable the spread of low-cost renewable energy and foreign firms can bring these technologies when they enter new markets. Environmental goods such as solar panels and wind turbines can increase the use of green technology, and this can significantly reduce an economy's emission intensity.

Figure 7.22: Total Environmental Goods Imports and Exports by Region ($ billion)

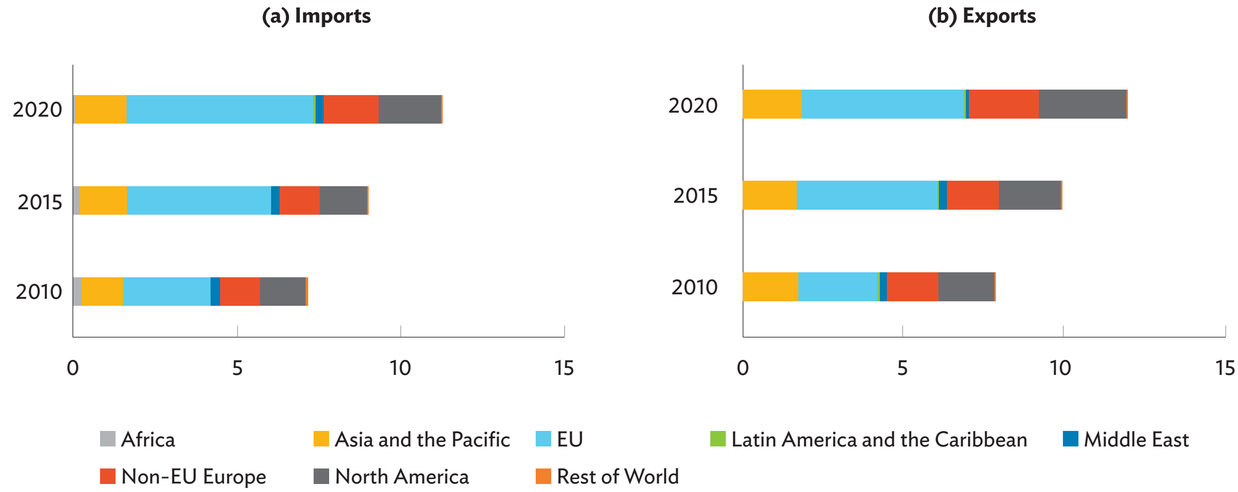


EU = European Union (27 members).

Note: Environmental goods are defined according to the Asia-Pacific Economic Cooperation (APEC) List of Environmental Goods.

Source: ADB calculations using United Nations. Commodity Trade Database. https://comtrade.un.org (accessed August 2022).

Figure 7.23: Share of Regional Environmental Services in Total Imports and Exports (%)

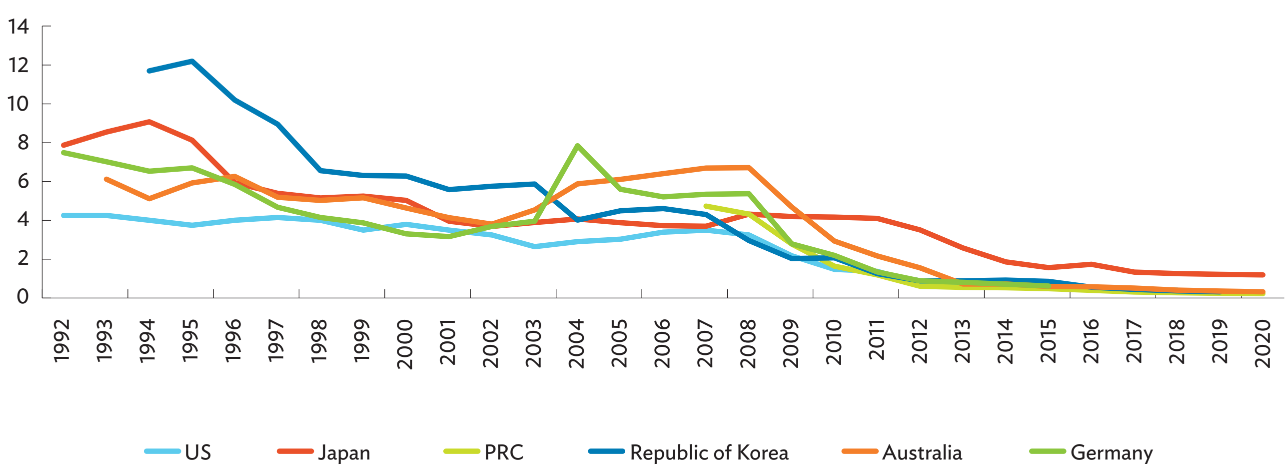


EU = European Union (27 members).

Note: Environmental services are defined according to the list in Annex 2 of Sauvage and Timiliotis (2017).

Source: ADB calculations using data from World Trade Organization. Statistics on trade in commercial services. https://www.wto.org/english/res_e/statis_e/tradeserv_stat_e.htm (accessed August 2022).

Figure 7.24: Price of Solar Modules in the Top Producing Economies ($ per watt)



PRC = People's Republic of China, US = United States.

Sources: International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS). National Survey Reports of PV Power Application: Solar Module Prices. https://iea-pvps.org/national-survey-reports/ (accessed November 2022); International Energy Agency Photovoltaic Power Systems Programme (2021); Taghizadeh-Hesary, Yoshino, and Inagaki (2018); and Organisation for Economic Co-operation and Development. OECDstat: Exchange Rates. https://stats.oecd.org/ (accessed November 2022).

Despite the benefit of encouraging more trade in environmental goods, efforts at the international level have stalled and trade barriers remain. Discussions on liberalizing trade in environmental goods and services began in 2001 at the World Trade Organization (WTO) Doha Round and was formalized in 2014 when a group of WTO members started negotiations for the Environmental Goods Agreement. Little has been achieved on this front besides some regional progress through the APEC Vladivostok Declaration on environmental goods, where APEC members agreed to a 5% limit on tariffs on 54 environmental goods by 2015. This commitment, however, is voluntary and unenforceable. More importantly, high income economies already have low import tariffs on these environmental goods compared with lower middle income and low income economies. In the area of services, negotiations are particularly challenging given the difficulty of defining "environmental," which remains ambiguous (Sauvage and Timiliotis 2017).

Asymmetric information about environmental attributes of products and the environmental impacts of enterprises has led to a rise in eco-labeling and certification. Consumers can encourage greening of businesses by rewarding environmentally responsible firms and products. Demand for environmentally friendly products has grown and is expected to increase. However, the institutional frameworks to respond to this demand are still nascent in many Asian economies. Standards and national labeling programs, based on established environmental benefits and with robust verification schemes, transparent standard-setting processes, and scientific validation are relatively recent. Mandatory labeling and information schemes, which have been shown to increase awareness and influence consumer preferences, are uneven across the region. And many small and medium-sized enterprises (SMEs) have limited technical, financial, and organizational capacity to transform their products and processes into more environmentally sound ones to obtain an eco-label.

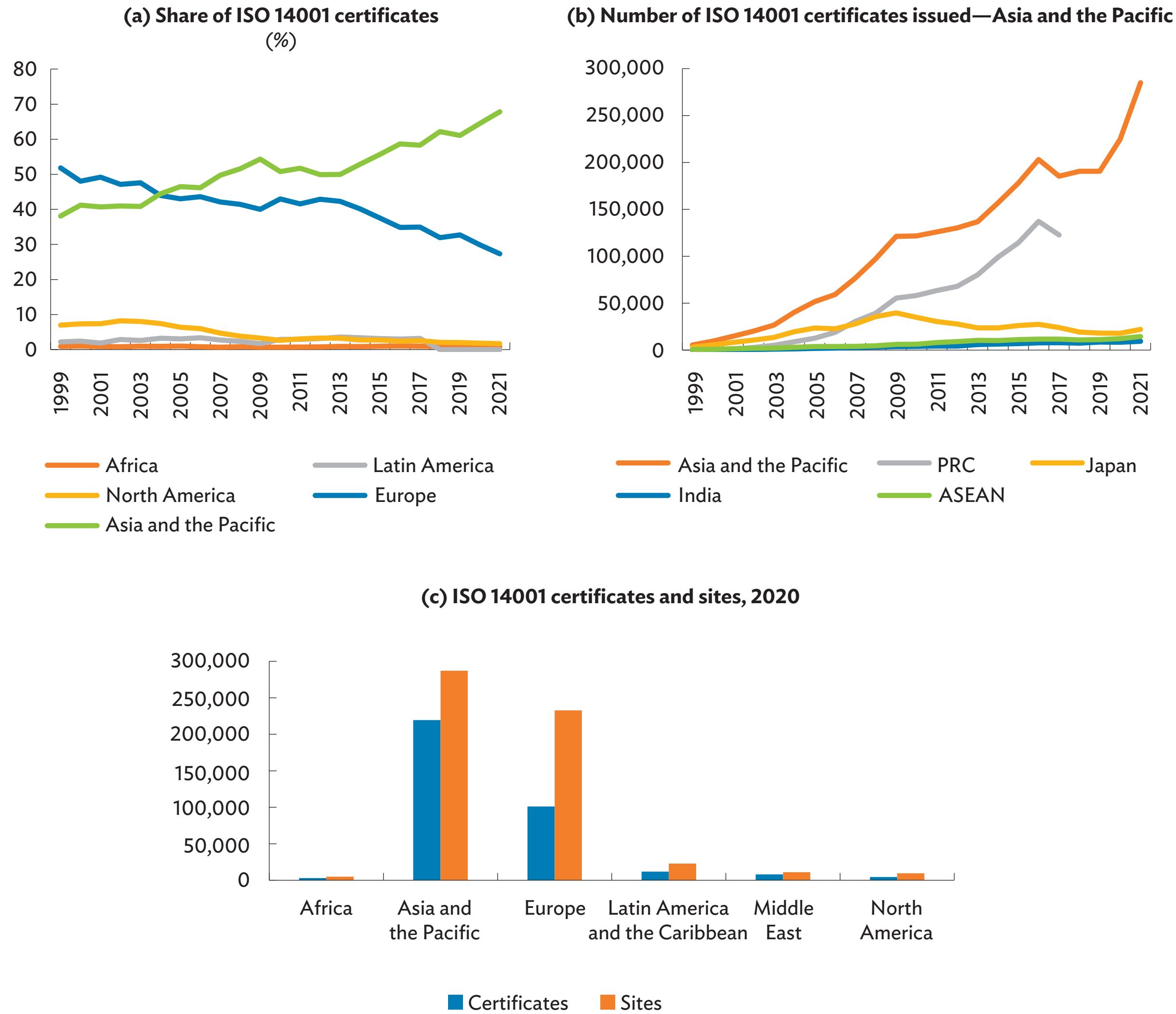
Export-oriented firms in Asia are seeking certification for their products as an international trade strategy. Supply chain pressures have also been effective in driving green business development. Market demand for environmental goods, services, and technologies from downstream buyers or businesses is growing. Multinational firms are implementing stricter global environmental standards and promoting greener business practices. This has led many upstream businesses in Asia to adopt high-quality environmental management systems. One indicator of this is the rising share of ISO 14001 certificates issued to companies in Asia, particularly in the PRC (Figures 7.25a and 7.25b), which aim to ensure that companies have a framework for environmental management and control. Some governments have also encouraged green supply chain management through public procurement policies that incentivize domestic SMEs to adopt greener practices.

While more firms in Asia are obtaining certification, the certification needs to involve a broader scope of firms and facilitate green trade. In 2020, Asia had 63% of all businesses with ISO 14001 certificates globally and over 50% of sites where business activities are supported by the certificate (Figure 7.25c). Much of the growth in Asia is in the PRC and to a lesser extent in Japan (Khanna 2020). Notwithstanding this progress, the growing number of ISO 14001 businesses in Asia may not fully reflect the pace of greening businesses since the certificate is voluntary and requires large, fixed costs.[111] Thus, the certificates are best used as a supplementary metric in assessing a firm's environmental management. Moreover, while product certification can be a valuable tool for green trade, it can also be a barrier. Product certification can be costly and increase the regulatory burden on supply chain participants.

Climate change provisions are increasingly important in trade agreements, but further progress can be achieved. The number and level of detail of environmental provisions in regional trade agreements (RTAs) notified to the WTO has increased significantly over the years. According to the TRade and ENvironment Database, and as shown in Figure 7.26a, the average number of environmental provisions included in preferential trade agreements increased dramatically from 2 in 1990 to 87 in 2018. However, Figure 7.26b shows that chapters on environment and climate change are limited in comparison to those dedicated to trade facilitation reforms, with the highest share reported in the Pacific and Oceania, reflecting the vulnerability of the subregion to climate change risks and disasters. While explicit provisions on climate change in RTAs have increased, these are still fewer—and tend to be less detailed—than other types of environmental

111 The costs of an ISO 14001 certification involve staff training, collection of information of past and current activities, consultant and certification fees, and a dedicated staff to ensure compliance.

Figure 7.25: Environment-Related Certifications by Region and in Asia and the Pacific



ASEAN = Association of Southeast Asian Nations, ISO = International Organization for Standardization, PRC = People's Republic of China.

Notes:

(i) ISO 14001 sets out the criteria for an environmental management system and can be certified to. It maps out a framework that a company or organization can follow to set up an effective environmental management system.

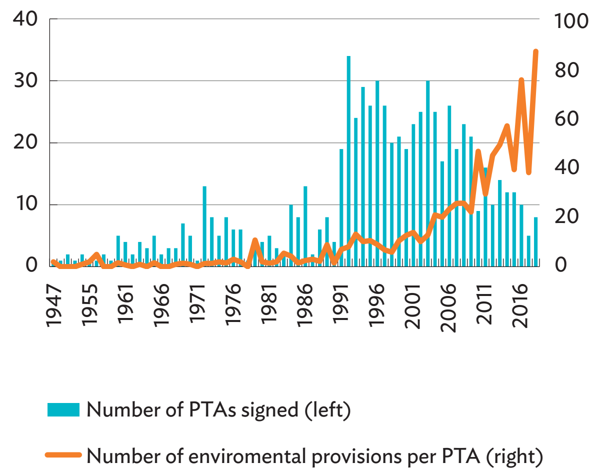
(ii) "Certificates" are the documents issued by ISO when the business demonstrates conformity to the standard. "Sites" are the locations where the business carries out the activity.

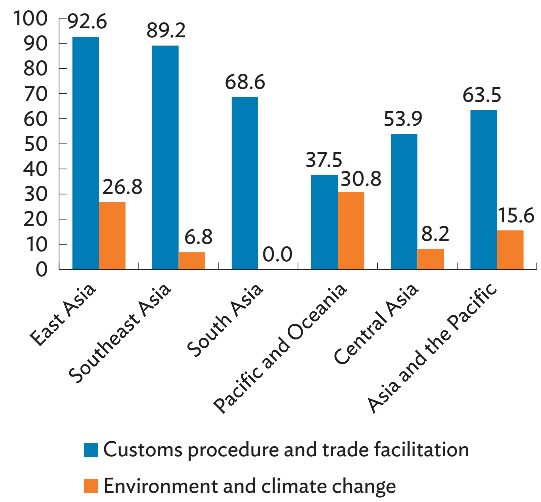
Source: ISO. Committee 09: ISO Survey of Certifications to Management System Standards—Full Results. https://isotc.iso.org/livelink/livelink?func=ll&objId=18808772&objAction=browse&viewType=1ISO survey (accessed October 2022).

provisions (WTO 2021). Explicit provisions on climate change are usually complemented by provisions on renewable and alternative energy, the transition to a low emission economy, and institutional arrangements to ensure implementation. Although empirical evidence on the environmental effectiveness of climate change provisions in RTAs is scarce, research suggests that environmental provisions in RTAs reduce emissions (Baghdadi, Martinez-Zarzoso, and Zitouna 2013; Martinez-Zarzoso and Oueslati 2018).

Asia's international investment agreements contain fewer environmental and climate-change related references than other regions. Less than 10% of bilateral investment treaties in Asia contain environmental and climate-related references

Figure 7.26: Preferential Trade Agreements and Environmental Provisions





PTA = preferential trade agreement, RTA = regional trade agreement.

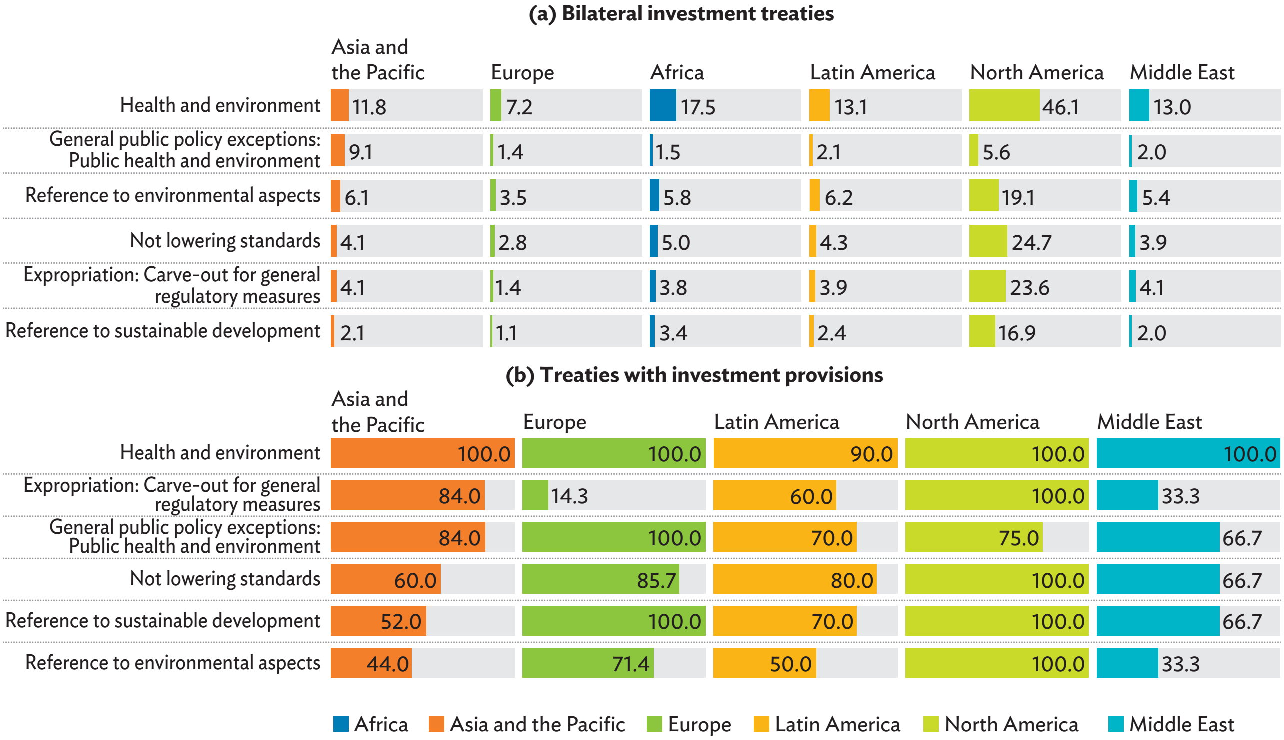
Sources: ADB. Asia Regional Integration Center. Free Trade Agreement Database. https://aric.adb.org/database/fta (accessed May 2022); Brandi et al. (2020); Kim et al. (2022); and World Trade Organization. Regional Trade Agreements Database. https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx (accessed May 2022).

(Figure 7.27a). Most of them reserve policy space for environmental regulation and greater environmental cooperation. Other regions show a similar pattern, except for North America. The contrast between Asian regional agreements with investment provisions is stark, as nearly half of them have incorporated climate-related references whether in Asia or in other regions (Figure 7.27b).[112] While intraregional investment agreements in Asia tend to contain fewer environmental references than extraregional ones, agreements incorporating climate measures have been increasing since the early 2000s. India, Japan, Singapore, Azerbaijan, the PRC, and the Republic of Korea have the highest shares of agreements with environmental elements, while Australia relies more on trade agreements to conduct climate policy.

There is growing momentum on the use of carbon pricing instruments to reduce GHG emissions cost-effectively and achieve net-zero targets, however, the region has yet to seize the momentum fully. Worldwide, a total of 68 carbon taxes and emissions trading schemes (ETSs) are operating and three more are scheduled for implementation (World Bank 2022). In Asia and the Pacific, there are six economy-wide direct carbon pricing initiatives that are being implemented. Japan and Singapore employ a carbon tax while Kazakhstan, New Zealand, the Republic of Korea, and the PRC have launched an emissions trading scheme (ETS) (Figure 7.28). In addition, Viet Nam and Indonesia are making significant progress in introducing a carbon price in their jurisdictions (Pangetsu 2022). Despite this progress, several challenges remain for the adoption of effective carbon pricing mechanisms. Carbon taxes may

112 In this chapter, international investment agreements refer to both bilateral investment treaties (BITs) and regional trade agreements or treaties including investment chapters or investment provisions.

Figure 7.27: International Investment Agreements with Environmental Reference, by Region and Treaty Element
(% share of total)



Source: ADB calculations using data from United Nations Conference on Trade and Development (UNCTAD). Investment Policy Hub: International Investment Agreements Navigator. https://investmentpolicy.unctad.org/international-investment-agreements (accessed May 2022).

lack public or political support, have less predictable impacts, and disproportionately affect certain industries or income groups. Cross-border mechanisms are likely to raise trade tensions. On the ETS front, the absence of consistent monitoring and accounting rules, concerns about the quality of carbon credits and environmental integrity in some carbon markets, lack of involvement of local stakeholders, and perverse incentives to lower emission reduction targets are some of the challenges to expanding and implementing the Paris agreement.

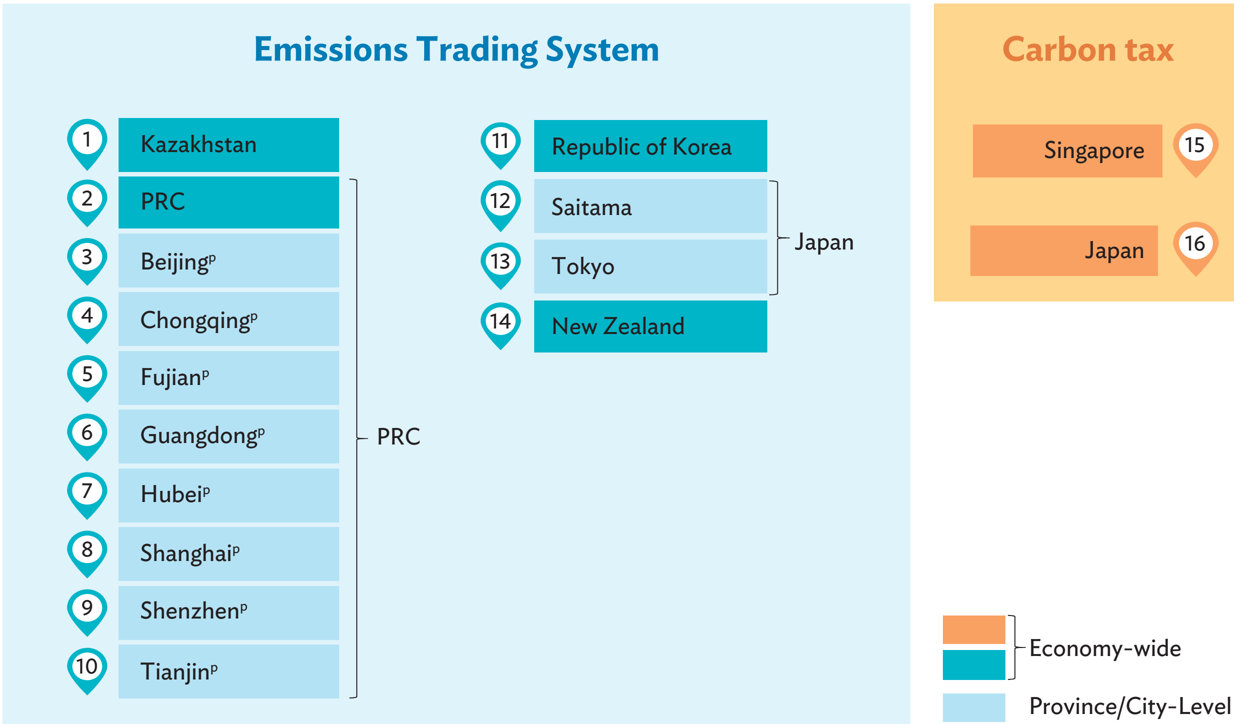
How Can Trade and Investment Policies Be Integrated with Climate Action?

Trade and FDI in Asia contribute to CO_2 emissions through economic scale, industrial structure, and technological advancement effects. Asian economies are now confronted by the effects of climate change. Economies thus should make trade and investment policies "climate smart" or "climate sensitive" to ensure that trade and FDI can be part of the solution rather than the problem. All else equal, Asia will generate more CO_2 emissions and contribute to climate change due to the scale of economic growth and development. It may be more important to consider how economies can tilt the balance toward greener industries and more sustainable production practices. Ultimately, economies are confronted to consider how changes in the relative prices of goods, services, and technology can make production techniques greener.

Policy makers in Asia can focus on four policy areas that support climate action in the context of trade, investment, and climate change:

(i) Promote trade in environmental goods and services;

Figure 7.28: Carbon Pricing Initiatives Implemented in Asia and the Pacific



p = pilot, PRC = People's Republic of China.

Note: As of April 2022.

Sources: Duggal (2022); and World Bank. Carbon Pricing Dashboard. https://carbonpricingdashboard.worldbank.org/map_data (accessed January 2023).

(ii) Nurture green businesses;
(iii) Enhance bilateral, regional, and international regulatory cooperation; and
(iv) Develop carbon pricing mechanisms (carbon tax, emission trading system, and border carbon adjustment).

Promoting Trade in Environmental Goods and Services

A reduction in emission intensity can be brought about by adopting green technologies to abate carbon emissions. Economies can adopt such technologies through two possible channels—trade in environmental goods and services, and technology transfer from foreign investment and firms. That this can bring down the cost of adopting new green technologies and drive innovation is reflected in the decline in solar photovoltaic panel and wind energy costs (Figure 7.24).

Efforts at the international level should be reinforced to lower trade barriers on environmental goods and services. In a simple partial equilibrium study, De Melo and Solleder (2022) show that import volumes by low-income economies can rise by 5.8% if tariff rates on the APEC list of environmental goods are halved and by 14.7% if tariffs are fully eliminated. In addition, environmental services such as sanitation, environmental protection, engineering, and scientific services are crucial inputs to climate mitigation efforts. For instance, even with lower cost solar panels, their placement and installation will still require firms to pay for engineering consulting services that may be scarce and expensive. APEC leaders have recently reaffirmed their commitments to freer trade of environmental services during the 2021 APEC Ministerial Meeting. Noting that "these services are now more important than ever to prevent, protect against and remedy environmental degradation" (APEC 2021a), the ministers endorsed the Reference List of Environmental and Environmentally Related Services based on the CPC

2.1 classification (APEC 2021b). However, encouraging trade of environmental goods will require going beyond the list of environmental goods and services that receive some form of preferential treatment.

Expanding the list of environmental goods and services based on a global value chain approach is critical to promote greener trade. The APEC list of environmental goods is the only negotiated list of environmental goods. Used as the basis for WTO negotiations on the Environmental Goods Agreement, it consists of only 54 products at the HS-6 product code level and broadly corresponds to three categories: renewable energy production, environmental monitoring analysis and assessment, and waste management and systems.[113] There are few or no goods to manage energy efficiency and resource efficiency. APEC has considered adding 21 new environmental goods to the list (APEC 2021c), but adoption remains voluntary among members. Further efforts are therefore needed to expand the list by adopting a global value chain approach that takes into account not only final goods but also raw materials, services and intermediate inputs, including waste and recycling (APEC 2021c).

Agreeing on a common definition of environmental goods is challenging. The list-based approach followed by APEC and the WTO has some limitations and challenges (Aisbett et al. 2022). The approach crucially relies on readily observable physical characteristics of goods and depends on there being unambiguous alignment between such physical characteristics and environmental impact (for example, solar panels or wind turbine components). Defining the product at the broad HS 6-digit level code invariably leads to the inclusion of both environmental and nongreen goods, or could include dual-use goods (such as tanks that store fossil fuels or green hydrogen) that are economy- and context-specific. Given also that green technologies are rapidly changing, what may be agreed to be "environmentally preferred" and considered appropriate for inclusion in the list may not stay relevant in the future. Finally, the current lists of goods are mostly industrial goods of interest to advanced industrial economies and producing economies such as the PRC and do not include sustainable agricultural goods that might be more useful to developing economies.

An alternative to a list-based approach is to follow a general definition of an environmental good. The OECD and Eurostat (the Statistical Office of the European Communities) have developed a general definition of an environmental industry that includes activities to limit or reduce environmental damage to water, air and soil, and technologies, products, and services that preclude environmental risks or minimize pollution (OECD and Eurostat 1999).[114] The definitional approach also has its limitations, in particular being based on the process and production methods (PPMs) of the good, which does not leave identifiable characteristics on the product itself and can be burdensome to prove.

In overcoming negotiating challenges, in the short term, economies may consider a combination of different options as a way forward for the liberalization of trade in environmental goods.

- **Unilateral liberalization.** Since liberalization of trade in environmental goods provides dual wins, jurisdictions can undertake it without the need for reciprocal treatment, as a priority over negotiating delays in an attempt to extract concessions from trading partners. A unilateral approach allows lists of environmental goods to be tailored to the specific circumstances of the liberalizer, and of being easier to amend in light of ongoing technological change. As an illustration, the UK has adopted this approach,

[113] The WTO Environmental Goods Agreement negotiations have identified between 300 and 400 potential HS6 product categories and 10 sectors for preferential liberalization, but negotiations have stalled.

[114] The full definition of an environmental industry by the OECD and Eurostat is "activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil as well as problems related to waste, noise and eco systems. Clean technologies, processes, products and services which reduce environmental risks and minimise pollution and material use are also considered part of the environmental industry" (OECD and Eurostat 1999).

eliminating tariffs on over 100 environmental goods since leaving the EU. A successful implementation of unilateral liberalization is nevertheless conditional on the capacity of the implementing economy to conduct adequate life cycle or process and production method-based assessments. In the longer run, it will also be important to ensure consistency (or at a minimum, interoperability) with the approaches of trading partners in the application of other forms of trade and climate governance, including certification schemes.

- **Deep regulatory collaboration** with a relatively small group of like-minded jurisdictions for the development of common definitions of environmental goods or emission accounting systems, can help overcome the downsides to unilateral approaches and reduce nontariff barriers (NTBs). This could involve anything from the detailed assessment of proposed environmental goods, as is the case in the Agreement on Climate Change, Trade and Sustainability, through to codevelopment of embedded emissions accounting frameworks and agreed definitions of environmental goods, as is being discussed for the Australia–Singapore Green Economy Agreement (Steenblik and Droege 2019). Regulatory collaboration is particularly important to reduce the potential for embedded emissions accounting systems and certification schemes to become significant NTBs if not developed collaboratively to maximize consistency and interoperability.

- **Targeted collaboration** on specific groups of goods associated to the net-zero transition, in the line of the APEC Scoping Study on New and Emerging Environmental Goods provides a valid way forward. This could be supplemented with more complex and rigorous approaches to specific goods that are of high importance but have important process and production method considerations, such as for example, hydrogen and derivatives. Different ways of making hydrogen and ammonia have dramatically different emissions implications—with some so polluting that the life-cycle implications are on par or worse than the fossil fuels they replace. The EU has previously recommended certification to identify environmental goods in this sort of situation.

Nurturing Green Businesses

With better access to green technologies, goods, and services, it will be less costly for businesses to be less carbon intensive. The environmental market in Asia is growing and there are more businesses adopting systems for environmental management and resource-use efficiency and reducing the environmental impact of their production (Khanna 2020). To facilitate this trend, policy makers could employ both regulatory measures and market-based mechanisms. It is important to consider the advantages and disadvantages of regulatory approaches such as environmental laws, regulations and standards, and market-based mechanisms such as emission trading systems and carbon taxes. The section below examines some of these aspects. Regulatory measures could often expand trade opportunities and enhance interoperability but can also impose trade barriers at the same time. Important factors in adopting carbon-reducing mechanisms include their flexibility, level of ambition, and comparability with other economic mechanisms. Some evidence suggest market-based mechanisms are more likely to meet these criteria better. They could allow companies to plan ahead their production and emissions paths and envisage more ambitious goals for climate action via voluntary actions and cooperation.[115]

Regulation and Policy Incentives

Environmental laws and regulations have been effective in regulating pollution and inducing a switch to renewables and other less-polluting inputs. Renewable energy standards, tax credits, and low-cost financing led to growth in renewable energy use in developed economies. A combination of stringent regulations, encouraging environmental self-regulation among firms, and providing regulatory relief and

[115] One concern with the use of regulatory approaches rather than market-based mechanisms is the difficulty to quantify the implicit cost resulting from the regulations. While some methodologies have been developed in this direction (Dang and Mourougane [2014] present a literature review), these costs are notoriously variable and difficult to estimate.

public recognition for such efforts has been effective for greening businesses in developed economies. Typically, regulations tend to be of the command and control type, which limit incentives for pollution abatement and innovation in green technologies. Other mechanisms, such as performance-based standards, market-based instruments, and responsible business systems have been more effective in promoting energy transition. Increasing public scrutiny, public disclosure programs, and other nonregulatory mechanisms have also encouraged companies to improve environmental performance (ADB 2020a).

Innovation to design new technologies that lower pollution and increase resource efficiency will be key. Many economies in the region need to catch up with innovation through adoption and adaptation of existing green technologies and indigenous technology development. Research and development policy incentives to innovate in the environmental sectors, curbing policy distortions on free trade in clean technologies, and removing subsidies on fossil fuels can help accelerate the pace of green technology innovation. Stringent but flexible environmental regulations can also induce innovation and increase competitiveness.

Certification can be critical to make trade greener and inform how products contribute to mitigating environmental or climate change challenges. The fundamental motivation for certification is to correct information failures for consumers regarding the attributes of a certain product. They are particularly prevalent where process and production methods endow the product with attributes that are difficult or impossible to verify based on the characteristics of the final product. Market participants can include private buyers with supply chain decarbonization commitments, investors with "green investment" requirements, and governments seeking to ensure that markets deliver particular policy objectives such as emissions targets through regulatory and/or incentive schemes. The case of hydrogen is an example of recent progress in developing certification (Box 7.4).

While certification can be an important tool to help facilitate green trade, it also has substantial potential to become an NTB. The balance between trade facilitation and trade inhibition depends on good design choices and targeted regulatory collaboration. While product certification can be valuable in facilitating green trade, it also has potential costs. Obtaining certification inevitably places a regulatory burden on supply chain participants, ultimately increasing costs for consumers. This burden can become large enough that certain suppliers are unable to service markets, and certification becomes an NTB to trade. To avoid unnecessary costs, several aspects need to be considered in certification design and implementation.

Box 7.4: Certification and Net-Zero Goals: The Case of Hydrogen

Hydrogen is the most prominent example of a product for which certification schemes to support trade are under development. Accurate and reliable certification of climate mitigation credentials for such products is particularly important because hydrogen production can be very polluting. Whether derived directly from fossil fuels or by electrolysis using electricity with high embedded emissions, replacing fossil fuels with dirty hydrogen products can be as bad, or worse, than business as usual (Longden et al. 2022). On the other hand, genuine renewable hydrogen with clean supply chains can be a major tool in efforts to mitigate climate change (IRENA 2021). Certification can support other regulatory and policy efforts such as preferential liberalization of environmental goods.

For hydrogen certification, a requirement that renewable electricity needs to meet European Union (EU) Renewable Energy Directive II (RED II) may be challenging to translate to non-EU jurisdictions. Refining evolving European certification schemes requires particular care to ensure that RED II equivalence is applied in ways that do not introduce biased or arbitrary barriers based on producer geographic location.

Source: Aisbett et al. (2022).

Certification scheme design includes decisions in multiple dimensions. These criteria include boundaries of what processes and scope will be included in environmental accounting; whether the scheme will certify that a product has cleared a threshold or the quality of information about the product; whether the public or private sector will run the scheme; whether it will be mandatory or voluntary; and whether certification will be required to be performed by a third party. Table 7.1 compares these features across several schemes. The following sections describe each design feature with further examples.

A certification scheme with lower regulatory burden is preferable. In a competitive market, regulatory compliance costs will be passed on to consumers, raising the costs of the energy transition. Furthermore, if a scheme has a high regulatory burden, then some producers may be excluded. This is likely to disproportionately affect small producers and producers in economies that lack existing regulatory infrastructure. While private/voluntary certification schemes can cause market access problems for some producers, public/mandatory schemes are more likely to constitute a technical barrier to trade in the eyes of global trade rules. A balance and some degree of flexibility in how supply

Table 7.1: Examples of Low-Emissions or Green Certification Schemes

Scheme Owner	Product(s)	Supply Chain Coverage	Public/Private	Threshold/ Information	Mandatory/ Voluntary	Third Party?
CertifHy Phase II	Hydrogen	Well-to-gate (factory)	Public–private	Threshold	Voluntary	Third party
Government of Australia	Hydrogen	Well-to-gate (factory)	Public	Information	Voluntary	Third party
Government of the People's Republic of China	Hydrogen	Cradle-to-gate (factory)	Public	Threshold	Voluntary	Third party
Vietnam Green Label Scheme (Huyen 2016)	Paper, laptops, batteries, printers, ceramic building materials, hair care products, soap, architectural coating products, laundry detergent, dishwashing detergent, shopping bags, food packaging, fluorescent lightbulbs, printer cartridges	Cradle-to-grave	Public	Threshold	Voluntary	Third party
Philippine Energy Labeling Program (Government of the Philippines, Department of Energy 2022)	Energy-consuming products, including refrigeration systems, air conditioners, and televisual and lighting products	Cradle-to-gate	Public	Information	Voluntary	Third party
Japan Eco Mark (Eco Mark Office 2022; Huong 2016)	511 product categories, including office equipment, furniture, electric products, construction materials, household items and services	Cradle-to-grave	Public–private	Threshold	Voluntary	Third party
Korean Eco-Labelling Program (Huong 2016)	165 product categories, including office equipment, furniture, electric products, construction materials, household items, and automobile-related goods	Cradle-to-grave	Public	Threshold	Voluntary	Third party
Government of the Republic of Korea (Proposed) (Stangarone 2021)	Hydrogen	Well-to-gate (factory)	Public	Threshold	Voluntary	Third party

Source: Aisbett et al. (2022).

chain participants prove they meet scheme requirements is inherent to avoiding implicit discrimination.

Mandatory certification is more likely as national emissions commitments become more stringent. Following the European example, jurisdictions may use tradable certificates to track progress toward emission reduction goals. Only certificates recognized by jurisdictional regulations will contribute toward official emissions goals. The EU Renewable Energy Directive II (RED II) represents one such scenario, where hydrogen guarantee of origin certificates will be used as a mechanism to track progress toward emission reduction goals (Barth et al. 2019). The Republic of Korea's Renewable Portfolio Standard Scheme, pursuant to its 2012 Renewable Energy Act, is emerging and is expected to help the economy reach its 2050 Carbon Neutrality Scenario (Seol, Kim, and Lee 2022).

Multiple certification schemes can be costly in the long term. If different markets use different and noninteroperable certification systems, supply chain participants may face higher regulatory burdens (Daugbjerg 2012). Issues arising from multiple certification schemes are not merely theoretical. Numerous certification schemes for hydrogen and its derivatives are emerging in jurisdictions that are aiming to be either producers or consumers of these products, with many being developed by industry associations. The multidimensional design choices discussed previously illustrate the vast potential for rules of different schemes to diverge. As of now, there is little chance of a uniform global hydrogen standard or certification scheme in the short to medium term.

Development finance institutions and multilateral development banks will have a key role to play in catalyzing sustainable finance in Asia to support green businesses—particularly in developing economies. Given their convening power and experience, these institutions can help to develop

Box 7.5: Innovative Approaches to Climate Financing and Catalyzing Private Sector Investments

Multilateral development banks and bilateral partners will have to be innovative to encourage more private sector participation in climate financing.

The Asian Development Bank (ADB) is partnering with the private sector to catalyze more climate financing in two initiatives. The first is Project Regeneration, a partnership with Singapore's sovereign wealth fund Temasek, HSBC, and Clifford Capital Holdings. Project Regeneration aims to solve critical bankability issues by addressing policy and regulatory constraints and source concessional financing for sustainable infrastructure. Its initial focus on Indonesia and Viet Nam is to mobilize private sector capital for renewable energy, water and waste, and sustainable transport projects. The second initiative is the Climate Innovation and Development Fund, a $25 million blended finance facility supported by ADB, the Bloomberg Family Foundation, and the Goldman Sachs Charitable Gift Fund. It will support the clean energy transition in South Asia and Southeast Asia, initially focusing on India and Indonesia.

Another innovative scheme is the Energy Transition Mechanism (ETM), which ADB is piloting in Southeast Asia to accelerate the move out of coal to clean energy. The ETM was launched in November 2021 at COP26 to create scalable and collaborative investment facilities for energy transition. It has three goals: the early retirement of coal-fired power plants; scaling up clean, renewable energy solutions; and ensuring the transition is just and affordable. Concessional funds can mobilize large amounts of private financing, creating a pool of low-cost capital to retire or repurpose coal plants. It can simultaneously unleash new investment in clean energy, the electricity grid, and energy storage. Economy-specific ETM funds will be supported by donor funds and capital from private institutional investors, international finance institutions, and other public or private sources. Feasibility studies have been conducted for Indonesia, the Philippines, and Viet Nam to develop optimal business models and transaction structures. Once scaled up, ETM has potential to be the largest carbon reduction model in the world. For example, if 50% of coal power plants can be retired over the next 10–15 years in Indonesia, the Philippines, and Viet Nam, then 200 million tonnes of carbon dioxide emissions per year will be removed—equivalent to taking 61 million cars off the road.

Source: ADB staff based on ADB (2021c); ADB. Energy Transition Mechanism. https://www.adb.org/what-we-do/energy-transition-mechanism-etm (accessed August 2022).

investable projects, reassure investors, and use their financial resources to reduce risks for other investors. Furthermore, they can initiate innovative approaches that could help to attract private investors and broaden the investor base (Box 7.5).

Bilateral, Regional, and International Cooperation

Leveraging on national efforts to cultivate the ground for environmental goods and services production and trade through technological development and streamlined procedures, regional cooperation is essential for the development of a green and sustainable trading system. Facilitating trade in environmental goods, ensuring interoperability and regulatory coherence, and fostering green investments are key areas for action.

While Asia's regional trade agreements (RTAs) are gradually embracing environmental provisions, more efforts should be made to strengthen their coverage and depth, to contribute more to making trade greener and reducing CO_2 emissions (Abman, Lundberg, and Ruta 2021; Baghdadi, Martinez-Zarzoso, and Zitouna 2013; Brandi et al. 2020; Martinez-Zarzoso and Oueslati 2018). Exploring new innovative avenues for international cooperation including through the green economy agreements will also help forge focused and deep collaborative arrangements in addressing common climate challenges. International investment agreements can also promote climate action by affecting investment decisions. However, many international investment agreements by Asian economies have yet to mainstream climate change related issues. As investment frameworks become more ambitious in climate policy, policy makers may consider introducing substantive standards on environmental protection and access to investor–state dispute mechanisms in climate-related cases. New generation international investment agreements could also consider facilitating market access and investment facilitation in green industries.

Breaking through the Barriers

Interoperability of certification systems could be a pathway to lowering regulatory burden and facilitating trade conditional on consistent accounting of embedded emissions (Box 7.6). Embedded emissions—emissions over the supply chain or parts thereof—are a central part of certification aimed at supporting net-zero transition. Alignment

Box 7.6: Toward Consistent Methodologies for the Calculation of Embedded Emissions

Consistent methodologies for the calculation of embedded emissions are an important step toward interoperability. Where methodologies for calculating emissions within each module can be considered equivalent across certification schemes, emissions estimates from supply chain modules across jurisdictions can be combined to calculate the total embedded emissions within the certification scheme boundary. Basing modules on national carbon accounting methodologies is consistent with the modular approach and could support cross-border supply chain embedded emissions calculations (Reeve and Aisbett 2022).

Jurisdictions including Australia, Singapore, and the European Union are currently investigating or developing public embedded emissions accounting frameworks. These can provide the embedded emissions accounting basis for both public and private certification schemes in these jurisdictions, and so support the interoperability of schemes within jurisdictions. Regulatory collaboration to align these frameworks across jurisdictions can further enhance interoperability. Examples of where such collaboration is either happening or planned include the Australia–Singapore Green Economy Agreement, the Joint US–EU Statement on Trade in Steel and Aluminum, and the International Partnership for the Hydrogen Economy.

Source: Aisbett et al. (2022).

of embedded emissions accounting boundaries is a fundamental requirement if certification schemes are to be interoperable. Interoperability can best be supported by taking a modular approach to boundary definition for embedded emissions accounting (White et al. 2021). The modular approach means that embedded emissions are calculated for the distinct "modules" comprising the supply chain. The total embedded emissions for any chosen certification scheme boundary are then calculated by adding the emissions from the relevant modules.

Mutual recognition agreements (MRAs) for conformity assessments can facilitate access to markets. MRAs for conformity assessment should be differentiated from the mutual recognition principle/automatic mutual recognition.[116] Automatic mutual recognition implies that the certification system in a first jurisdiction is also recognized in its entirety as valid in a second jurisdiction, and vice versa. In this case, goods or service providers do not have to register or certify again beyond their home jurisdiction. For example, if there was a mutual recognition for low-emissions hydrogen certification between Bhutan and the Republic of Korea, hydrogen certified as low emissions in Bhutan could be marketed and sold as such in the Republic of Korea and vice versa. MRAs are government-to-government agreements that can be used when full equivalence (mutual recognition) or other forms of interoperability cannot be achieved. MRAs establish procedures that enable parties to recognize each other's competent conformity assessment bodies and to accept their results for regulatory purposes (NIST 2020). While specific MRAs among Asian economies for environmental goods are still very early in development, experiences from Europe's Implementation of Mutual Recognition Agreements on conformity assessment and the Protocol on European Conformity Assessment Document and from the US for other types of products, could provide useful examples (EU 1998; NIST 2020). Even when certification systems are not interoperable, MRAs can significantly decrease regulatory burdens by allowing a single verification by a given conformity assessment body to provide the information required for multiple certification schemes.[117]

The Important Role of Trade Agreements

Regional trade agreements can foster greener trade through various channels, including environmental, climate change mitigation, and trade facilitation provisions. The drastic increase in environmental provisions in regional trade agreements over the last 3 decades (Figure 7.30) contributed to removing barriers to climate-friendly goods and services, and facilitating the adoption of green technologies. Complemented by provisions on alternative energy or net-zero transition goals, trade agreements also outline other areas for climate mitigation. Trade facilitation efforts supported by relevant trade agreement chapters can also reduce waiting time at ports and border-crossing points, thereby reducing transport congestion and GHG emissions from idle vehicles. Policy reforms, such as increased transparency, simplified customs procedures, and improved border agency coordination, offer the opportunity to lower GHG emissions by reducing delays at the border, particularly at land borders. Delays or slow movement of vehicles crossing borders can significantly increase air pollution. For example, the California-Baja California land border crossing is reported to result in an average of 457 metric tonnes of CO_2 emissions each day, equivalent to consumption of more than 51,400 gallons of gasoline (NBC San Diego 2021). Computer modeling, estimating emissions from trucks at the US–Mexico border in 2015, found that the improved efficiency of customs and inspection processes can lower GHG emission by 31%–36%. Emissions go up significantly when the traffic volumes go up at the border (Reyna et al. 2016).

[116] The EU Commission states on its website that "the mutual recognition principle should not be mistaken for mutual recognition agreements that facilitate access to markets between the EU and non-EU economies" (European Commission. Single Market and Standards: Mutual Recognition of Goods. https://single-market-economy.ec.europa.eu/single-market/goods/free-movement-sectors/mutual-recognition-goods_en).

[117] Certification systems are interoperable when at least some of the information from one scheme can be used toward meeting the requirements of another.

Among the trade facilitation measures in the WTO Agreement, digital trade facilitation has the highest potential impact in mitigating carbon emissions. The indicative impact of trade facilitation measures on climate change is summarized in Annex 7a.[118] This highlights the importance of accelerating the digitalization of trade. Digital trade facilitation measures, or paperless trade, can limit transportation for physical delivery and lower time and transaction costs, thereby reducing GHG emissions. Duval and Hardy (2021) estimate that going paperless could eliminate between 9 million and 23 million tonnes of CO_2 emissions annually in Asia and the Pacific. These estimates, however, do not account for other indirect CO_2 emissions from the electricity used to maintain the servers needed for paperless trade. In addition, the saving of 23 million tonnes of CO_2 emissions, while large, is still miniscule compared with the 17 billion tonnes of CO_2 annual emissions by Asia. Most importantly, the overall impact of trade facilitation on CO_2 emissions remains unclear as gross trade volumes will increase while the emission intensity of trade will decline.[119]

More efforts are needed to strengthen the RTAs' greening function through broader and deeper commitments to climate action. While RTAs have increasingly acknowledged the importance of environmental sustainability, environmental provisions are limited in scope and depth for developing Asian economies. Climate change provisions in Asian RTAs have increased from 0 in 2002 to 61 in 2022 (34% of RTAs involving Asian economies).[120] Looking ahead, expanding their coverage and depth, including on implementation and enforcement matters, will be useful to ensure their effectiveness in achieving climate goals.

Economies could also consider incorporating a separate chapter in RTAs on climate change and the environment instead of having various provisions scattered across multiple chapters to enhance the transparency and clarity of commitments.

Environment chapters in trade and economic partnership agreements have been a feature of many so-called deep trade agreements (DTAs). Globally, 274 such agreements and 84 involving Asian economies contain environment chapters.[121] These chapters in DTAs differ from so-called joint statements of intent, a more general, entry level form of collaboration. Environment chapters in DTAs have standing in international law and are more binding and detailed than joint statements of intent. The downside is that substantially greater government resources are required to negotiate them. In practice, however, many of the provisions in the environment chapters of DTAs are declaratory. Environment chapters in modern DTAs also address the goal of expanding consumer rights and social welfare obligations on exporters. However, the emphasis on constraint rather than creation limits the usefulness of many existing DTAs as tools for an international green industrial policy (Aisbett 2022). Another initiative is the Agreement on Climate Change, Trade and Sustainability, whose negotiating parties include Fiji and New Zealand. Despite the title, this is a relatively traditional trade agreement approach focusing on tariff elimination on environmental goods and services, disciplining fossil fuel subsidies through trade mechanisms, and establishing voluntary eco-labeling guidelines. These three objectives sit comfortably within the scope of DTAs as they do not emphasize shared supply chains or novel technologies/industries.

118 The relative ranking of measures reported in Annex 7a only provides a cursory preview into the whole trade facilitation and climate change scenario. This qualitative assessment is not based on quantitative estimates of the absolute intensive and extensive impact of these measures and should therefore not be taken as the be-all and end-all. A comprehensive economic modeling is needed to evaluate and capture the complex relationships and dynamic effects of trade facilitation on climate change through trade.

119 Empirical studies have found that further trade liberalization can increase GHG emissions. Using a comprehensive panel data, Managi (2004) derived an elasticity of 0.579 on the impact of trade liberalization to GHG emissions. Similarly, Corong (2008) showed that a tariff reduction imposed by the Philippines brought an increase of 0.12% in carbon emissions. By reducing trade costs, trade facilitation can potentially have a similar impact as tariff elimination. A simulation conducted by ADB and UNESCAP find that full implementation of both binding and nonbinding measures of the WTO Trade Facilitation Agreement reduces trade costs by 7% (ADB 2021d). Trade facilitation will also have implications for export participation of economies (Lee, Rocha, and Ruta 2021).

120 ADB calculation based on the TRade and ENvironment Database, including 14 variables on climate change.

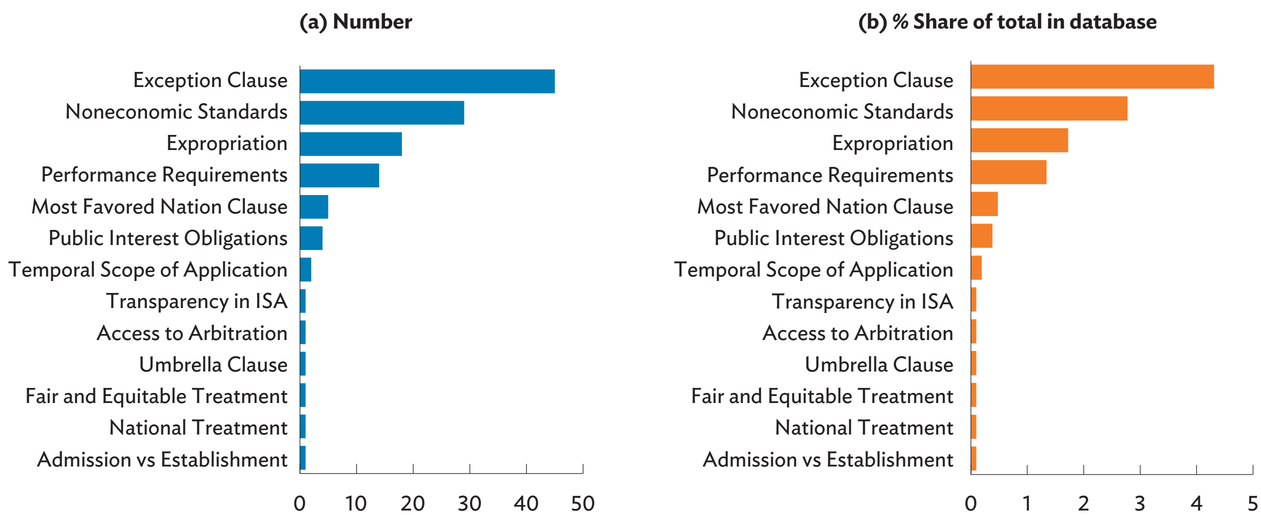
121 Computed based on data from World Bank. Deep Trade Agreements: Data, Tools, and Analysis. https://datatopics.worldbank.org/dta/ (accessed September 2022). Asia includes Australia; Bangladesh; Brunei Darussalam; India; Indonesia; Japan; Malaysia; New Zealand; the Philippines; Singapore; the Republic of Korea; Taipei,China; Thailand; and Viet Nam.

Change through International Investment

Economies in the region are slowly committing to improving their investment policy frameworks in response to climate change. International investment agreements (IIAs) are now seen as policy tools for guiding climate policy in foreign investment. In the absence of specific environmental provisions in IIAs, the gradual introduction of references related to climate change underpins the growing need to fill the gap for states and investors. Climate-related litigation is also on the rise, stressing the need for aligning IIAs with net-zero commitments. Over 100 investor–state dispute settlement cases involved fossil fuel industries, many of them involving large awards (UNCTAD 2022). However, the current framework is not yet well aligned with the decarbonization agenda. Existing treaties may divert investments toward climate-risky projects by providing insurance against possible government climate action and by dissuading governments to take climate action in the first place (Aisbett et al. 2018). Also, emission-intensive investments are more prone to seek protection through IIAs.

While environmental and climate dimensions in new generation investment agreements are more common, their scope remains limited. Many trade agreements and investment chapters in recent free trade agreements contain environmental provisions describing formal commitments and cooperation to enforce environmental laws (Monteiro 2016).[122] In IIAs, references are often made to reserving policy space for environmental regulation, expropriation, not lowering environmental standards to attract investment, environmental disputes and investor–state dispute settlement, environmental impact assessments, and support for environmental cooperation. To the extent that governments adequately incorporate these aspects in investment provisions, they can make commitments more binding in the wake of the Paris Agreement. In the case of Asia, such aspects are concentrated in a few provisions, which often grant extensive rights to the investors (Figure 7.29). Empirical analysis based on ADB's IIA database suggests that the inclusion of environmental references in bilateral investment treaties (BITs) could have a positive effect on FDI flows, particularly in non-carbon intensive industries (Box 7.7).

Figure 7.29: International Investment Agreements with Environmental Reference, by Provision



BIT = bilateral investment treaty, ISA = investor–state arbitration.

Note: The total number of BITs in ADB's database on international investment agreements is 1,044.

Source: ADB calculations using data from ADB. International Investment Agreement Database. https://aric.adb.org/database/iias (accessed May 2022).

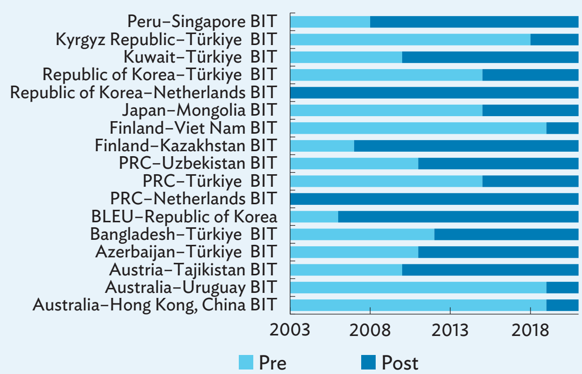
[122] Recent instruments such as Norway's Model Bilateral Investment Treaty or the Japan–Switzerland Free Trade Agreement contain detailed preambular language, a general exception clause, and a right to regulate clause, which express a commitment to replace sustainable development at the core of international investment law.

Box 7.7: Assessing the Investment Effects of Environmental and Climate Change Elements of International Investment Agreements

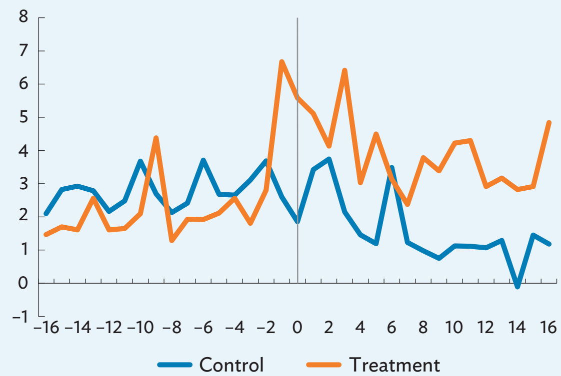
Analysis on the effects of climate change and environmental-related provisions in international investment agreements is relatively recent. While literature on the role of the agreements has suggested some positive impact on foreign direct investment (FDI) flows (Busse, Königer, and Nunnenkamp 2010; Neumayer and Spess 2005), some studies suggest the effect is comparable to regional and preferential trade agreements (Heid and Vozzo 2020; Kox and Rojas-Romagosa 2020). Recent work also explores the causal effect of investment regimes on foreign direct investment (FDI) flows (Bhagwat, Brogaard, and Julio 2021; Falvey and Foster-McGregor 2017; Strezhnev 2018). Most of these studies, however, focus on the aggregate impact of international investment agreements on FDI.

We explore this question through a difference-in-difference approach to assess the role of newly enforced agreements, including environmental elements. We use FDI firm-level data from fDi Markets and Zephyr, and textual analysis from investment provisions in ADB's International Investment Agreement database for Asia and the Pacific, which includes bilateral investment treaties (BITs) and investment chapters in regional trade agreements. A treatment variable is defined for BITs that were terminated and replaced by a new BIT including environmental references (box figure 1). An initial comparison of average green FDI flows in the treated and control groups suggests an increase around the time of the signing of the new treated BITs (box figure 2).

1: Pretreatment and Posttreatment Periods of Treated Economy-Pairs



2: Average FDI Flows (Logged), by Treated and Control Groups



BIT = bilateral investment treaty, BLEU = Belgium–Luxembourg Economic Union, FDI = foreign direct investment, PRC = People's Republic of China.

Notes: Time period for treated and control group readjusted, with the treatment year being set to time = 0. For treatment group, green FDI flows were averaged across economy-pairs before and after the treatment year. The same procedure is applied for the control group.

Source: Avendano et al. (2022).

Our estimation method draws from the recent literature using a difference-in-difference model to tease out a causal impact of BITs, expressed as:

$$FDI_{ijt} = a_{ij} + b_t + \delta Env\_BIT_{ijt} + \beta \mathbf{X}_{ijt} + \epsilon_{ijt}$$

Where $\mathrm{FDI}_{\mathrm{ijt}}$ pertains to the log + 1 of FDI flows by entry mode (M&A and greenfield) and type (total FDI and non-carbon intensive FDI as previously defined in this chapter) from economy *i* to economy *j*, a_{ij} corresponds to panel fixed effects (i.e., reporter, partner), b_{t} corresponds to the time fixed effects, and $\mathrm{Env\_BIT}_{\mathrm{ijt}}$ is the treatment variable, which takes the value of 1 if a terminated BIT is replaced with a BIT with environmental reference and 0 (control group) otherwise. The control group is defined by economy-pair observations involving at least one BIT member where no change in policy (i.e., inclusion of environmental elements in BIT) was observed.[a] Meanwhile, $\mathbf{X}$ pertains to a vector of additional control variables, with the set akin to Falvey and Foster-McGregor (2017). In particular, a measure of bilateral economic size (i.e., ln$(GDP_{it} + GDP_{jt})$), and a dummy for preferential trade agreement is included. Multilateral resistance is captured through the inclusion of time-varying fixed effects (e.g., reporter-year, partner-year). As an alternative and sensitivity check, multilateral resistance terms as introduced in Baier and Bergstrand (2009) were also applied.

continued on next page

Box 7.7 continued

Results shown in the table suggest that the inclusion of climate change and environmental elements in BITs has a moderate but positive effect on FDI flows. Baseline results for the full sample suggest that the effect of new environmental elements in BITs is positive and significant for total FDI and green FDI. For individual economies, the inclusion of environmental elements in BITs has a positive effect for Australia; Hong Kong, China; the Republic of Korea; and Viet Nam, particularly for green FDI inflows. Notably, environmental elements in international investment agreements for these economies are typically not included in the preamble but in specific provisions, such as expropriation and performance requirements. Effects (not shown) are similar for the case of outward green FDI flows.

Our analysis also indicates that the modernization of BIT provisions could be a viable reform path for some economies to uphold climate and environmental objectives. Bilateral action may be faster in bringing reforms and could be complemented by other multilateral reform processes (UNCTAD 2022). Ultimately, no one-size-fits-all model exists for an environmental provision in international investment agreements. Economies need to carefully assess their situation when deciding the type of investment agreement reform needed for effective climate mitigation.

BITs with Environmental Content and FDI Flows: Difference-in-Difference Estimates

	Total FDI			Green FDI			Observations
	(1)	(2)	(3)	(4)	(5)	(6)	
Treatment Effect	Ln(Total FDI)	Ln(M&A Deals)	Ln(Greenfield Capital Expenditure)	Ln(Total FDI)	Ln(M&A Deals)	Ln(Greenfield Capital Expenditure)	
Full sample							
SE not clustered at economy-pair level	0.255**	0.415***	0.182	0.231***	0.141***	0.138**	23,217
	(0.114)	(0.107)	(0.117)	(0.065)	(0.051)	(0.058)	
R-squared	0.566	0.438	0.546	0.559	0.453	0.529	
Reporter-year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Partner-year FE	Yes	Yes	Yes	Yes	Yes	Yes	
SE clustered at economy-pair level	0.255	0.415	0.182	0.231	0.141	0.138	23,217
	(0.261)	(0.257)	(0.253)	(0.171)	(0.121)	(0.159)	
R-squared	0.566	0.438	0.546	0.559	0.453	0.529	
Reporter-year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Partner-year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Narrow sample*, all flows							
All standard errors clustered at the economy-pair level							
BB-MR FE*	0.635	0.983**	0.589	0.697*	0.443*	0.525	9,376
	(0.506)	(0.404)	(0.515)	(0.379)	(0.238)	(0.349)	
R-squared	0.311	0.247	0.295	0.270	0.249	0.226	
Economy-year FE	0.273	0.237	0.247	0.254	0.117	0.173	9,376
	(0.450)	(0.428)	(0.451)	(0.296)	(0.202)	(0.280)	
R-squared	0.644	0.568	0.626	0.664	0.595	0.631	
Narrow sample*, by type of flow and for selected Asian economies							
All standard errors clustered at the economy-pair level							
Inflows in Asia							
Republic of Korea	-0.771	0.477	-0.884	-1.056	0.408**	-1.345	890
	(1.063)	(0.807)	(1.029)	(1.314)	(0.188)	(1.401)	

continued on next page

Box 7.7 continued

Narrow sample*, by type of flow and for selected Asian economies							
All standard errors clustered at the economy-pair level							
Inflows in Asia							
Australia	0.127	1.010*	0.266	0.415***	0.323**	0.496***	342
	(0.280)	(0.570)	(0.206)	(0.139)	(0.151)	(0.156)	
Hong Kong, China	-0.307	-0.110	-1.402	2.341***	2.159***	-0.160	208
	(0.857)	(0.509)	(1.079)	(0.287)	(0.269)	(0.246)	
Uzbekistan	-0.294	-0.285*	-0.249	0.094	-0.056	0.089	436
	(0.314)	(0.142)	(0.310)	(0.126)	(0.099)	(0.116)	
Viet Nam	1.206***	0.507*	0.398	0.935***	0.749***	0.327**	493
	(0.214)	(0.275)	(0.244)	(0.138)	(0.142)	(0.147)	
Partner FE	Yes	Yes	Yes	Yes	Yes	Yes	
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	

BB-MR = Baier and Bergstrand multilateral resistance term, BIT = bilateral investment treaty, FDI = foreign direct investment, FE = fixed effect, M&A = merger and acquisition, SE = standard error, *** p<0.01, ** p<0.05, * p<0.1.

Notes: The independent variable reported in the table represents treatment effects for the full and narrow samples, where treatment variable takes the value of 1 if a terminated BIT is replaced with a BIT with environmental references and 0 otherwise. Full sample includes all BIT pairs, while narrow sample includes economy-pairs of BITs with at least one of the Asian economies in the treatment group. Following Falvey and Foster-McGregor (2017), other independent variables included are bilateral economic size and a dummy for preferential trade agreement (not reported).

Sources: ADB calculations using data from United Nations Conference on Trade and Development. Investment Policy Hub: International Investment Agreements Navigator. https://investmentpolicy.unctad.org/international-investment-agreements. Bureau van Dijk. Zephyr M&A Database; and Financial Times. fDi Markets (all accessed August 2022).

[a] For example, as the new Republic of Korea–Türkiye BIT includes environmental elements, observations are assigned to treatment group, whereas observations for other unchanged BITs involving these two economies are assigned to the control group.

Source: Avendano et al. (2022).

Looking ahead, governments should consider a more ambitious approach in embracing new investment agreements. A model agreement or "opt-in" mechanism—a multilateral agreement where economies can flexibly join to modify old agreements—including substantive standards on environmental protection and climate change should be part of the reforms to existing agreements. The use of exceptions for climate policy measures and damage or compensation caps to discourage carbon-intensive investments should also be considered. Besides regulatory measures, Asian agreements could expand to cover other areas to support climate mitigation policies, including market access for climate investment and investment facilitation in green industries (OECD 2022).

New Modes of Cooperation

Beyond standard trade and investment agreements, new modalities of international cooperation are emerging to encourage environmental protection. A wave of novel international green economy collaborations covers topics such as the identification, certification, and liberalization of green products. Current examples range from joint statements of intent to memorandums of understanding, joint-funded research projects, and negotiations of comprehensive international agreements. These international green economy collaborations (known as IGECs) are better understood as international green industrial policy than as deep trade agreements (Aisbett et al. 2022).

The need for international green industrial policies can be an important driver of IGECs. Such policy initiatives (often referred to as GIPs) are increasingly popular for tackling challenges beyond green goods certification and liberalization. One way to understand green industrial policies is through their function in solving market failures that inhibit the emergence and growth of green technologies and industries. While domestic GIP has much to contribute, it is limited by the fact that many industries comprise regional and global value chains (World Bank 2020). This, in turn, means that many of the relevant market failures are international in nature.

Memorandums of understanding (MOUs) and joint statements of intent (JSIs) are entry level forms of international green economy collaboration. MOUs and JSIs are low cost in terms of bureaucratic resources and low risk as they generally are not legally binding (Munoz 2021; Talmon 2021). They can be a stepping stone toward more ambitious collaboration such as legally binding agreements. The 2021 Japan–Australia partnership on decarbonization through technology is an example of JSI. Both economies are leading proponents of international collaboration on the green economy.[123] In typical content, JSIs outline the industries, technologies or supply chains of focus, forms of collaboration, and relationship to other regulation and governance (Munoz 2021). Joint research and development are a popular component, making innovation a key part of collaboration. In some cases, such as in the EU, JSI can also include deep regulatory collaboration commitments. While JSIs have advantages, they also are limited in what they achieve. As official public statements, they serve as signaling devices to both industry and other jurisdictions, although the strength of that signal is limited by the low cost of reneging on the statements.

Green economy agreements (known as GEA) offer an innovative, promising avenue for cross-border collaboration to tackle climate change. New and more practical approaches are looming and policy makers can consider these for strengthening their climate policy. GEAs offer the possibility of combining green industrial policy objectives with the depth, commitment, and legal standing of deep trade agreements. A prominent example is the proposed Singapore–Australia GEA (Box 7.8). The Singapore–Australia GEA is undoubtedly a piece of international green industrial policy as emphasized also in the Joint Vision Statement. Its vision speaks to one of the drivers of international green economy collaboration: the need for deep regulatory collaboration. It also focuses on doing business and trading in environmental goods and services across borders. While these elements are more consistent with traditional DTAs, they are substantially more ambitious than most (Laurens, Brandi, and Morin 2022). To be more successful, GEAs require significant institutional resources and capacity. Applying this in the context of ADB's developing member economies might require a modified approach that accommodates resource constraints and allows flexibility and learning.

Carbon Pricing Mechanisms

Carbon Tax and Carbon Markets

Carbon pricing is an integral component of the broader climate policy architecture that can help economies reduce emissions cost-effectively. Embodied commonly in tax and carbon markets and in adjustments to prices at borders, carbon pricing helps internalize the external costs of GHG emissions, thereby incorporating climate costs into production and consumption decisions. Carbon pricing can disincentivize the use of fossil fuels, making deployment of renewables more attractive. It can generate revenue for green recovery and growth and promote diffusion of advanced low carbon technologies (ADB 2021c). Crucially, it can also support the energy transition, foster regional cooperation, improve energy security, and reduce vulnerability to international energy price shocks (ADB 2022). There is robust evidence that carbon pricing instruments have been effective at promoting

[123] Government of Australia, Department of Industry, Science and Resources. Japan–Australia Partnership on Decarbonisation through Technology. https://www.minister.industry.gov.au/ministers/taylor/media-releases/japan-australia-partnership-decarbonisation-through-technology.

Box 7.8: Singapore–Australia Green Economy Agreement

The text below is an excerpt from a joint media release on the Singapore–Australia Green Economy Agreement (GEA), with bold emphasis by authors to highlight Green Industrial Policy elements that are typically not found in deep trade agreements (DTAs), "while the italics highlight" more traditional DTA aspects.

October 2021

Our vision is to enhance the livelihood of our communities whilst ***transitioning to greener economies and addressing the challenges of climate change.***

The GEA will deliver on this vision by reducing barriers to the trade in environmental goods and services; fostering convergence on regulations and standards; ***exploring new opportunities in green growth sectors;*** *adopting environmental measures that facilitate trade and investment in a manner consistent with existing international trade and investment obligations;* ***and ensuring our smooth and inclusive transition into a green economy that creates good jobs for our people.***

We envisage an agreement that is practical, ambitious, and ***innovative, where technologies catalyze business and commercial opportunities, intergovernmental and public-private partnerships implement new cooperative projects, pathfinder initiatives scale up to benefit the broader region, and effective solutions assist us [to] achieve our ambition of net zero emissions as soon as possible.***

Our joint work will result in practical applications and benefits to the real economy and workforce. They aim to ***accelerate the adoption of low-carbon and green technologies, low-carbon and renewable energy, and decarbonized production processes. Our industry consultations and pilot proof of concept projects will ensure the GEA supports job creation, supply chains, and market development in green sectors. Drawing on cutting-edge knowledge****, the GEA will improve the compatibility of our systems to ease doing business and trading in environmental goods and services across our borders.*

Source: Government of Singapore, Green Economy Agreement (2021).

low-cost emission reductions.[124] Carbon pricing is also associated with higher labor productivity, health outcomes, and material conditions. There is a broad landscape of carbon pricing instruments, and carbon taxes and emissions trading schemes (ETSs) are the two most common direct pricing instruments alongside baseline-and-crediting mechanisms (Box 7.9).

The momentum seems to have been maintained during the COVID-19 pandemic in the economies that considered and planned carbon pricing instruments before the pandemic. It is also worth noting that the carbon pricing mechanisms were largely resilient to suppressed economic activities during the pandemic, with several economies increasing their carbon tax rates and adopting more ambitious trajectories. Many economies in Asia made an ETS their choice of direct carbon pricing instrument. ETSs may be more attractive as they are more flexible in design, making it easier to accommodate political economy considerations, and they are inherently countercyclical, in that the demand and price of allowances will fall during recessions, just when regulated firms need relief. ETS design can retain industry support by allocating a portion of the emission permits free of charge and accommodating industrial interests in a tailored allocation formula. The allocations are expected to be phased out over the long term.

124 Intergovernmental Panel on Climate Change. Sixth Assessment Report of Working Group III, Mitigation of Climate, Chapter 13.6.3.

Box 7.9: The Landscape of Carbon Pricing Instruments

Carbon taxes and emissions trading schemes (ETSs) are the two most common direct pricing instruments. Both are "flexible" policy instruments since they give regulated entities different options. A carbon tax will require businesses to pay a tax on their carbon emissions or will act as an incentive for them to reduce emissions. The effect of an ETS will depend on its design: regulated entities will have to submit permits equivalent to their emissions, which can either be bought or allocated for free, under a certain cap or threshold. Carbon trading allows buyers and sellers to exchange allowances and carbon credits for a price. When used as an instrument for compliance, buyers use carbon markets to source more cost-effective emission reductions. The key difference between these two instruments is that under a carbon tax the price of emissions is fixed but the quantity is not. In an ETS, the quantity of emissions is fixed but the price is not. However, designing the system well can be more important than the choice between systems.

Baseline-and-crediting mechanism is another way of pricing carbon as it puts a price on the emission reduction by setting a baseline for emissions and issuing credits only after emission reductions have been verified below the predetermined baseline. These can be developed on a national basis, such as the China Certified Emission Reductions or include the use of international carbon crediting mechanisms such as under Article 6 of the Paris Agreement. Independent standards used by companies and other organizations for voluntary purposes are also based on baseline-and-crediting. Baseline-and-crediting mechanisms are typically used to create flexibility for domestic or international emissions trading systems or for organizations' voluntary greenhouse gas emission offset purposes.

Source: Duggal (2022).

Border Adjustment Mechanism

Border carbon adjustment (BCA) can take many forms as an environmental trade policy, depending on the sectors it considers, the scope of emissions it covers, the appropriate price level, and the adjustment mechanism. It is based on the premise that an unintended consequence of introducing carbon pricing could be carbon leakage given its impact on trade and investment. For instance, if carbon pricing is introduced in a jurisdiction without coordination with trading partners, it could lead to higher production costs for domestic producers, and may make it difficult for them to compete with imports that are not subject to carbon pricing. One possible outcome is that more of the local demand will be met through more emission-intensive imports, which would result in higher emissions. Internationally coordinated and agreed approaches for introducing carbon pricing, particularly for emission-intensive trade-exposed sectors, offer the most effective solutions for addressing carbon leakage concerns.

The EU is the closest toward implementing a BCA through its Carbon Border Adjustment Mechanism (CBAM). Other economies—Canada, the US, and the UK—are also contemplating to implement or are exploring a BCA.[125] The CBAM will impose a carbon price on imports of emissions-intensive and trade-exposed goods to ensure that they have a similar carbon price to domestically produced products.[126] While the exact CBAM implementation details need to be finalized and there are issues about its design and compatibility with WTO rules (Marcu, Mehling, and Cosbey 2020), the European Council has approved the mechanism (Box 7.10). Bellora and Fontagne (2022) show that although the CBAM could succeed in reducing carbon leakage, the EU would lose competitiveness in its export markets while downstream industries could be subject to higher intermediate costs.

125 Cosbey, Bernstein, and Stiebert (2021) present a closer discussion of the different BCAs discussed in Canada and the US.

126 In the European Commission's initial proposal, the CBAM will at first cover these five emissions-intensive and trade-exposed sectors: cement, aluminum, fertilizers, electricity generation, and iron and steel. The commission selected these sectors because they have a high risk of carbon leakage and high carbon emissions. The administrative feasibility of covering the sectors in the CBAM from the start of implementation was also taken into account. Hydrogen and a limited number of downstream products were later added in the proposal.

Box 7.10: The Process of Implementing the European Union's Carbon Border Adjustment Mechanism

The European Union (EU) target is to reduce its carbon emissions by 55% in 2030 from 1990 and become climate-neutral by 2050. One of its main instruments for achieving this is the Emission Trading Scheme (ETS). Emission-intensive trade-exposed sectors are included in the EU ETS but receive free allocation of emission permits. As the EU increases its climate actions, it is seeking to phase out free permits and introduce a carbon border adjustment mechanism (CBAM).

After several rounds of negotiations, the European Council on 15 March 2022 agreed to a general approach. The CBAM, while meant to complement the EU ETS, was formulated to combat carbon leakage and ensure that imports have a similar carbon price as domestically produced products. Through the CBAM, the EU also aspires to catalyze and incentivize climate action globally. On 13 December 2022, the European Council and the European Parliament reached a provisional agreement, postponing the CBAM transition period to 1 October 2023 from the earlier expected start date of 1 January 2023. Both institutions need to confirm and formally adopt the agreement before it becomes final.

The EU plans to implement the CBAM in two stages. First, the CBAM will be introduced from October 2023 with reporting and monitoring obligations only for importers in a transition period that will last until 2025. Then from 2026, the CBAM will be fully applied, with price adjustments on imported products. The CBAM will be phased in gradually in parallel with the gradual phase out of free allowances under the revised EU ETS (European Council 2022). The CBAM will initially include cement, aluminum, fertilizers, electric, and iron and steel as well as hydrogen, some precursors, and a limited number of downstream products. Indirect emissions would also be considered for inclusion, under certain conditions.

Sources: Duggal (2022); and Tan, Tayag, and Quizon (2022).

The CBAM's relevance, effectiveness, and potential impact need careful calibration. The introduction of the CBAM may cause problems for developing economies. An UNCTAD (2021) study finds that introduction of the CBAM could alter trade patterns in favor of economies where production is relatively carbon efficient and reduce export from developing economies in favor of developed economies with less carbon intensive production. Economies where emissions-intensive and trade-exposed products have a large share of exports will be particularly exposed. In addition, economies would be more vulnerable in adapting to the CBAM if they rely on the EU as an export market and if they do not have the capacity to track and report production-related carbon emissions. Economies with limited capacity to adjust to a low-carbon paradigm may also be at higher risk of economic impact from the CBAM. A risk index can be constructed based on the exposure and vulnerability of the economies to the CBAM. Simulation results in a dynamic computable general equilibrium model-based estimation suggest that the CBAM could widen the gap between developed and developing economies in GDP and welfare, worsening the unequal income and welfare distributions between rich and poor economies (He, Zhai, and Ma 2022).

The mechanism also has potential to conflict with the principle of voluntary mitigation efforts. The principle of "common but differentiated responsibilities and respective capabilities," established with the UN Framework Convention on Climate Change, has underpinned the voluntary nature of nationally determined contributions, which embody efforts by each economy to reduce national emissions and adapt to the impacts of climate change (Zhang 2021). The CBAM mechanism currently under contemplation risks departing from this key principle, with significant implications for climate-related global discussions in the future.

Some questions on operational details still remain. These include (i) the lack of consideration for the breadth and depth of environmental regulations implemented by exporting economies apart from the carbon pricing mechanism, (ii) the inadequacy of economy-wide border adjustment levies in differentiating the heterogeneity of the carbon intensity of production at the firm level, and (iii) the inability to properly internalize the global social cost of emissions—the global public "bads"—into the production cost or sales price, given the bilateral nature of different adjustment levies.

Questions also arise about whether a BCA mechanism can be imposed unilaterally and be compatible with WTO rules. One view is that a BCA is considered WTO compatible as the jurisdiction utilizes a BCA mechanism to charge an import fee on foreign producers at the border. However, the jurisdiction might also consider keeping free allowances or providing export rebates to safeguard domestic producers against competitive disadvantage in domestic or foreign markets, raising concerns about compliance with WTO rules. Recycling CBAM revenues to help those developing economies subject to CBAM imposition could help avoid such controversies and support their transition into green economies through technological development and green investment.

The scope of CBAM needs to be carefully vetted. Given uncertainties associated with the relevance and efficiency in mitigating carbon leakages, the sectoral coverage of CBAM needs to be minimized, with a scientific and enforceable implementation structure in place until its effectiveness can be sufficiently verified. This is also important so as not to stoke welfare-degenerating retaliatory responses from the trading partners of CBAM-imposing economies. At the same time, discussion and concerted efforts to achieve global solutions as the first best option should intensify to minimize the risks that a unilateral adjustment mechanism could spread and prevail.

The Asian region retains low overall risk and vulnerability to the CBAM given its relatively small share of trade with the EU, yet certain subregions or economies may be relatively more affected. Based on estimated composite index of exposure and vulnerability to CBAM, Africa, the Middle East, and non-EU Europe have the highest potential risk for the EU's CBAM adoption as they have stronger trade linkages with the EU, particularly in carbon intensive goods (Tan, Tayag, and Quizon 2022).[127] However, Asia has relatively higher levels of CO_2 emissions, which could make its products more likely to be subjected to the CBAM in the future. It also has more economies with lower statistical capacity, making it more difficult to trace and trade CO_2 emissions. Certain Asian subregions are more exposed in that they trade more carbon intensive goods with the EU (such as Central Asia due mostly to high exports of aluminum and fertilizer to the EU) or they may struggle to adapt to CBAM implementation (such as the Pacific and South Asia due to the absence of carbon emission reducing mechanisms and low statistical capacity to measure and report emissions). Examining individual indicators compiled also reveals that while some economies may be weaker than others in the same indicator, their risk may derive from different sources. Some economies are more exposed in iron and steel or aluminum exports to the EU, while others are more vulnerable as they lack statistical infrastructure or environmental data (Annex 7c provides more details).

Efforts should be made to mitigate the potential that CBAM reduces exports and hurts domestic economies. Asian economies need to be closely monitoring developments given the looming possibility that some regions and advanced economies are likely to adopt the CBAM. Presently, the main risks to CBAM are from the importance of EU trade to domestic economy and reliance on the EU for emission-intensive and trade-exposed exports. Technical and financial support can be provided to increase the productive capacity of other sectors to reduce the reliance on emission-intensive and trade-exposed sectors. Diversification of export destinations would also help mitigate risk exposure to the introduction of CBAM by specific trading partners. Finally, technical assistance and capacity building through international cooperation and collaboration are needed to help economies implement carbon pricing and increase their statistical capacity. Detailed implementation arrangements and its future evolution

[127] Following Eicke et al. (2021), Tan, Tayag, and Quizon (2022) used 19 indicators across four dimensions to compute for the composite risk index: (i) exposure to CBAM; (ii) reliance on trade with the EU; (iii) emission levels and lack of decarbonization efforts; and (iv) statistical capacity to measure, report, and verify emissions. Annex 7c provides the methodology and detailed results.

of CBAM yet remain to be seen.[128] In the long term, however, the region needs to explore ways to transform the challenges of the changing trade environment into opportunities by increasing green investments and embracing cleaner production technologies.

Benefits of International Carbon Markets in Addressing Potential Cross-Border Carbon Leakages

A global approach presents multiple benefits and can more effectively support carbon emission reductions. An international framework on cross-border carbon measures or a global carbon pricing mechanism can be considered first-best solutions to address existing deficiencies in unilateral approaches. To the extent that BCAs bring domestic benefits at the expense of other economies, and partial measures do not necessarily prevent carbon leakage, more comprehensive methods can be considered. Within global approaches, consideration of environmental effectiveness, costs, and feasibility for implementation are important. For international emissions trading, theoretically a top-down approach through a global cap-and-trade system still offers the best outcome for reducing carbon emissions. Nevertheless, bottom–up approaches by means of decentralized efforts for establishing ETS remain a plausible alternative, and can be building blocks for supporting the eventual establishment of a global carbon market.

Bottom–up approaches to support the development of international carbon markets has proven more effective. Intermediate architectures through direct and indirect linking can be a cornerstone of an international climate policy framework. Compared with a fragmented approach, direct or indirect linking of ETSs can reduce mitigation costs by fostering partial or full convergence in carbon prices and improve efficiency and performance. Analysis of the economic effects of direct and indirect linking of ETS suggests that the greater the difference in carbon prices across regions, the greater the gains from linking (Dellink et al. 2014).[129] Linking can also reduce carbon leakage. For this, it is important to assess the tradeoffs between direct and indirect approaches and the conditions in which linking can lead to price convergence (Flachsland, Marschinski, and Edenhofer 2009; Grull and Taschini 2012). Recent research shown in Box 7.11 also suggests potential benefits of international carbon markets for the region.

Design features will continue to be important for implementing a multilateral or global carbon pricing mechanism. In the case of scaling up cap-and-trade systems via linking, features include identifying the setting and trajectory of emission cap levels, ceilings for permit prices, the sectors covered, and the rules on banking in and borrowing of emission allowances. Some features are important for attaining certain outcomes. Experience suggests that the banking of allowances in ETS systems can make them more welfare-improving than other schemes (Kuusela and Lintunen 2020). Information requirements for setting such programs can also be important. They include data on historical emissions, projections on future emissions under different scenarios, estimates for the technical feasibility of reductions in covered and uncovered sectors, and estimates on marginal abatement cost curves. Economies in the region should also continue to work toward improving systems for monitoring, reporting, and verifying emissions.[130]

[128] One hypothetical scenario for the mechanism is it becomes widely adopted by the region's trading partners and its industrial coverage expands.

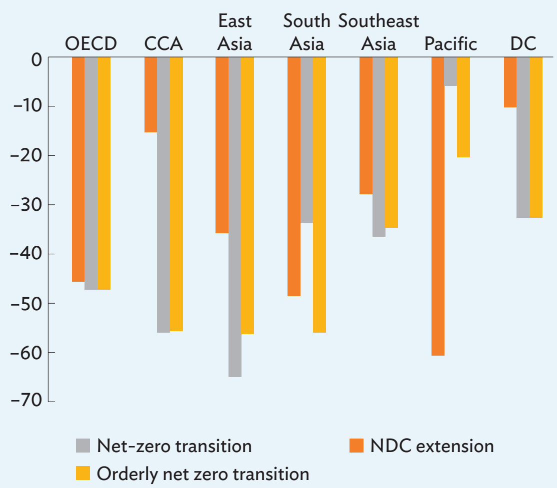
[129] Estimates also suggest that indirect linking could bring substantial benefits. Allowing developed economies to meet up to 50% of their domestic commitments through the use of offsets would trigger major carbon price convergence (Dellink et al. 2014).

[130] Several initiatives aim at enhancing facility-level monitoring, reporting and verification in ASEAN. Examples are provided in Government of Japan, Ministry of Environment. Activities for the ASEAN Region. https://www.env.go.jp/earth/ondanka/pasti/en/activity/asean.html and European Union. Enhanced Regional EU-ASEAN Dialogue Instrument (E-READI). https://www.eeas.europa.eu/eeas/enhanced-regional-eu-asean-dialogue-instrument-e-readi_en (both accessed January 2023).

Box 7.11: Reaching Net Zero through an International Carbon Market: Evidence for Asia and the Pacific

Kim et al. (2022) use a recursive computable general equilibrium model to simulate the effects of the net-zero transition on several economic indicators under various scenarios. Computable general equilibrium models are grounded in economic theory and calibrated with real-world economic data to capture interdependencies between different parts of the economy through a set of equations. The recursive-dynamic model employed by the authors computes equilibriums period-by-period by solving these equations. Different scenarios are compared with a baseline or business-as-usual scenario to investigate the economic effects of the net-zero transition between 2022 and 2050. In particular, the adoption of an international carbon market in conjunction with carbon pricing (the Orderly Net Zero Transition scenario) is examined in the study. Under this scenario, the adoption of an international carbon market in Asia means that economies can make carbon credit transactions, while the differentiated carbon prices follow those suggested by the International Energy Agency to reach the net-zero target (IEA 2021).

Change in Greenhouse Gas Emissions by Scenario, 2022–2050 (% difference from business-as-usual)



CCA = Caucasus and Central Asia, DC = developed countries, NDC = nationally determined contributions, OECD = Organisation for Economic Co-operation and Development.

Source: Kim et al. (2022).

Overall, the authors find that achieving targets on nationally determined contributions and net zero would induce limited costs in real gross domestic product (GDP) in comparison with the sizable reduction in greenhouse gas (GHG) emissions in developing Asian economies. Among Asian subregions, the Orderly Net Zero Transition scenario would produce the largest benefits in GHG emission reduction in East Asia, Central Asia, and South Asia. In 2022–2050, emissions would be less than half of the business-as-usual baseline in these three subregions. GHG emission reductions would be over 30% from the baseline in Southeast Asia and around 20% in the Pacific under the same scenario. However, the Pacific is the only subregion where the Orderly Net Zero Transition scenario would generate economic gains, as real GDP is estimated to increase by 0.17% relative to the baseline. Real GDP would decline between 2022 and 2050 in all other Asia and Pacific subregions, ranging from −0.63% to −3.37% relative to the business-as-usual scenario, with East Asia and Southeast Asia recording the smallest drops (−1.59% and −0.63%).

In most subregions, the study shows that allowing international carbon trading among Asian economies would help reduce the costs (in real GDP) resulting from the adoption of differentiated carbon pricing. Economic losses in real GDP in Asian developing economies would therefore be modest in comparison to the substantial reductions in GHG emissions achieved through carbon pricing and the introduction of an international carbon market.

In addition to the findings of Kim et al. (2022), it can be shown that reducing GHG emissions would bring substantial economic and human benefits such as avoided crop yield losses and premature deaths. Results derived from the World Induced Technical Change Hybrid (WITCH) model, which relies on a macroeconomic structure that considers the energy sector and models carbon mitigation policy alternatives for major GHGs, demonstrates this (Emmerling et al. 2022). Simulations show that 400,000 premature deaths a year would be avoided by 2050 through air pollution reduction under the most ambitious scenarios, with carbon budgets of less than 1,360 giga tonnes of CO_2 between 2020 and 2100. These deaths would be mostly avoided in the PRC and India. The Accelerated Net Zero scenario, which assumes Global Net Zero with a carbon budget of 1,150 giga tonnes of CO_2 between 2020 and 2100, would result in a further 300,000 avoided deaths by 2030. This scenario would also avoid damages that account for up to 40% of GDP in India and South Asia, and up to 30% in Southeast Asia and Indonesia. Overall, the WITCH model reveals that the costs of mitigation are considerably lower than the benefits resulting from climate action.

Source: Kim et al. (2022).

Significant momentum has been created to operationalize international carbon markets, primarily due to the adoption of Article 6 Rules. Article 6 of the Paris Agreement lays the foundation for international carbon markets and can be a key element of the broader climate policy toolbox that economies in the region can deploy to accelerate climate action.[131] Article 6 includes two market-based approaches, with Article 6.2 being a bilateral or multilateral bottom-up approach to market mechanisms, an Article 6.4 whereas 6.4 is a top-down centrally government mechanism under the United Nations Framework Convention on Climate Change (UNFCCC). Article 6.2 provides an accounting framework for managing cooperative approaches that lead to a transfer of internationally transferred mitigation outcomes. It allows economies to sell extra carbon emission reductions they have achieved compared with their target. Article 6.2 covers, among other mechanisms, emission trading between states, linking of ETSs or agreed baseline-and-crediting mechanisms.[132] Article 6.4, on the other hand, creates a new mechanism with a governance structure subject to centralized oversight, similar to the Clean Development Mechanism (CDM). Looking ahead, Article 6.4 will take up CDM modalities and adopt elements of the CDM if parties and international regulators are willing to do so (ADB 2020b; Duggal 2022).

International cooperation under Article 6 has the potential to reduce the total implementation cost of nationally determined contributions by more than $250 billion per year in 2030 (Edmonds et al. 2019).

International carbon markets are gradually introducing innovative and more flexible instruments. As new mechanisms under Article 6 take shape, economies in the region will need support to take full advantage of these opportunities. For example, Switzerland recently signed bilateral agreements with Thailand, Vanuatu, and other emerging economies for Article 6 trading.[133] Under such schemes, host economies receive financial support from buyer economies to invest in climate mitigation activities, generating internationally transferred mitigation outcomes that count in the buyer economies' nationally determined contributions. Projects in host economies involve, for example, introducing sustainable agricultural practices or securing electricity access through renewable energy. Sweden and Nepal have signed an MOU to cooperate under the Mobilizing Article 6 Trading Structures Program (GGGI 2022). These bilateral agreements, particularly under Article 6.2, will become increasingly common, while the centralized mechanism under Article 6.4 may require more time to put in place the necessary rules and infrastructure for carbon credits.[134]

Voluntary Carbon Markets (VCMs) provide an opportunity to enhance climate action and efforts to harmonize standards and core principles in the VCM are ongoing. There is a growing momentum to take advantage of the voluntary carbon market with an increase in voluntary commitment from the private sector to achieve net-zero targets. However, challenges remain in the VCM, in particular with regard to establishing credible baselines or counterfactual scenarios in the absence of investment through carbon finance. Technical assistance and capacity building may be needed to understand different types of carbon markets and the technical options and key issues in their implementation.

One key area for harmonization is the assessment of offset units. For example, the Integrity Council for the Voluntary Carbon Market (Integrity Council) is working to set global threshold standards for carbon credits.[135] Another important goal will be to ensure that the design features of the VCM are compatible with the international regulatory framework under

131 ADB (2020b) provides a complete analysis of Article 6 of the Paris Agreement.

132 See Box 7.9 for a description of ETS (or cap and trade) and baseline-and-credit (or offsetting) mechanisms.

133 Switzerland Federal Office for the Environment. Bilateral Agreements on Emission Reductions and Carbon Storage Abroad. https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/climate--international-affairs/staatsvertraege-umsetzung-klimauebereinkommen-von-paris-artikel6.html (accessed June 2022)

134 UNFCCC. Article 6.4 Supervisory Body. https://unfccc.int/process-and-meetings/bodies/constituted-bodies/article-64-supervisory-body (accessed June 2022).

135 ICVCM. The Integrity Council for the Voluntary Carbon Market. https://icvcm.org/ (accessed June 2022).

Article 6, domestic carbon pricing policies as well as nationally determined contributions implementation plans and long-term strategies. One approach provided by standards for the voluntary market is the separation between “adjusted units” and “support units.” Adjusted units would be subject to authorization by the host economy and an adjustment of the host economy’s emissions balance to reflect the export of mitigation outcomes. Support units imply a financial assistance for mitigation activity in the host economy that supports reducing emissions and the achievement of the host economy’s nationally determined contributions targets. Discussions at the UNFCCC (COP27) meeting resulted in a non-adjusted unit for Article 6.4 (mitigation contribution A6.4 emission reduction).

Regional carbon market alliances can be critical for limiting the potential of emission leakage and perceptions of competitive distortions. With a broad landscape of carbon market instruments and new approaches emerging under Article 6, opportunities for regional collaboration are increasing. A regional carbon market for both ETS and international carbon markets can bring various benefits, from improving liquidity and facilitating trade of carbon assets to increasing transparency and efficiency through common standards. This is particularly the case when ETSs of two or more jurisdictions are linked, allowing them to trade carbon allowances. Linking the ETSs can increase the liquidity of a carbon market, offer regulated entities additional abatement opportunities, and reduce the cost of achieving the combined emissions caps of the linked ETSs. A notable example is the linking between the California and Quebec ETS. Where full linking is not feasible, governments may choose more indirect forms of linking. Indirect linking occurs, for instance, when allowing carbon credits for flexibility for compliance buyers from one standard or mechanism in several ETSs. Regional carbon market alliances outside of ETS linking—such as the Eastern African and West African Alliances on Carbon Markets and Climate Finance—can also foster a regional approach to international carbon markets and increase capacity to access climate finance for implementing nationally determined contributions. This regional approach may also be suitable for selected industries, such as international aviation, where a single global mechanism is essential for avoiding competitive distortions.

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Annex 7a: Potential Impact of Trade Facilitation on Greenhouse Gas Emissions

Groups	Subgroups	Measures	Impact on Mitigating GHG Emissions (Low-1/Mid-2/High-3)	Possible Channel
General Trade Facilitation	**Transparency** (5 measures)	Publication of existing import–export regulations on the internet	3	Lesser trips required to comply with requirements; reduction in paper use
		Stakeholders' consultation on new draft regulations (prior to their finalization)	1	Allows for continuous sharing of information in trade facilitation projects
		Advance publication/notification of new trade-related regulations before their implementation (e.g., 30 days prior)	3	Lesser trips required to comply with requirements; reduction in paper use
		Advance ruling on tariff classification and origin of imported goods	2	Speeds up clearances and thus reduces waiting time
		Independent appeal mechanism (for traders to appeal customs rulings and the rulings of other relevant trade control agencies)	1	Unbalanced discretionary power of customs may contribute to delay in the release of goods
	Formalities (8 measures)	Risk management (for deciding whether a shipment will be physically inspected)	1	May speed up movement of shipments
		Pre-arrival processing	3	Reduction in time spent at the border
		Post-clearance audits	1	Improve trader's compliance and facilitate clearance procedures
		Separation of release from final determination of customs duties, taxes, fees, and charges	2	Reduction in time spent at the border
		Establishment and publication of average release times	1	Lengthy release times will advocate for reducing border delays
		Trade facilitation measures for authorized operators	3	Allows qualified operators to benefit from preferential measures like rapid release times, fewer physical inspections, and reduced documentary requirements
		Expedited shipments	3	Reduces waiting time
		Acceptance of copies of original supporting documents required for import, export, or transit formalities	2	Reduces waiting time
	Institutional arrangement and cooperation (5 measures)	Establishment of a national trade facilitation committee or similar body	1	Ensures coordination of various stakeholders for seamless implementation of trade facilitation
		National legislative framework and/or institutional arrangements for border agencies cooperation	2	Provides avenue to expedite crossing of shipments and therefore reduce waiting time
		Government agencies delegating border controls to customs authorities	2	Provides avenue to expedite crossing of shipments and therefore reduces waiting time
		Alignment of working days and hours with neighboring economies at border crossings	2	Provides avenue to expedite crossing of shipments and therefore reduces waiting time
		Alignment of formalities and procedures with neighboring economies at border crossings	2	Provides avenue to expedite crossing of shipments and therefore reduces waiting time
	Transit facilitation (4 measures)	Transit facilitation agreement(s) with neighboring economy(ies)	2	Reduction in time spent at the border
		Customs authorities limit the physical inspections of transit goods and use risk assessment	2	Reduction in time spent at the border
		Support pre-arrival processing for transit facilitation	2	Reduction in time spent at the border
		Cooperation between agencies of economies involved in transit	2	Reduction in time spent at the border

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Annex 7a continued

Groups	Subgroups	Measures	Impact on Mitigating GHG Emissions (Low-1/Mid-2/High-3)	Possible Channel
Digital Trade Facilitation	**Paperless trade** (10 measures)	Automated Customs System (e.g., ASYCUDA)	3	Reduction in waiting time; elimination of printed paper; elimination of physical delivery
		Internet connection available to customs and other trade control agencies at border crossings	2	Indirect, but enabler
		Electronic single window system	3	Reduction in waiting time; elimination of printed paper; decrease in the number of procedures involved; lesser trips required to comply with requirements
		Electronic submission of customs declarations	3	Reduction in waiting time; elimination of printed paper; elimination of physical delivery
		Electronic application and issuance of import and export permit	3	Reduction in waiting time; elimination of printed paper; elimination of physical delivery
		Electronic submission of sea cargo manifests	3	Reduction in waiting time; elimination of printed paper; elimination of physical delivery
		Electronic submission of air cargo manifests	3	Reduction in waiting time; elimination of printed paper; elimination of physical delivery
		Electronic application and issuance of Preferential Certificate of Origin	3	Reduction in waiting time; elimination of printed paper; elimination of physical delivery
		E-payment of customs duties and fees	3	Reduction in waiting time; fewer trips required to comply with requirements
		Electronic application for customs refunds	3	Elimination of printed papers; fewer trips required to comply with requirements
	Cross-border paperless trade (6 measures)	Laws and regulations for electronic transactions are in place (e.g., e-commerce law, e-transaction law)	2	Enable the shift from manual to electronic processes
		Recognized certification authority issuing digital certificates to traders to conduct electronic transactions	2	Help facilitate the use and boost confidence on the security of electronic transactions
		Electronic exchange of customs declaration	3	Reduction in waiting time; elimination of printed paper
		Electronic exchange of Certificate of Origin	3	Reduction in waiting time; elimination of printed paper
		Electronic exchange of Sanitary and Phyto-Sanitary (SPS) Certificate	3	Reduction in waiting time; elimination of printed paper; reduction in cargo storage time
		Paperless collection of payment from a documentary letter of credit	3	Reduction in waiting time; elimination of printed paper
Sustainable Trade Facilitation	**Trade facilitation for SMEs** (5 measures)	Trade-related information measures for small and medium-sized enterprises (SMEs)	2	Fewer trips required to comply with requirements; reduction in paper use
		SMEs in Authorized Economic Operators scheme (i.e., government has developed specific measures that allow SMEs to benefit from the scheme more easily)	3	Allow qualified SMEs to benefit from preferential measures like rapid release times, fewer physical inspections, and reduced documentary requirements
		SMEs access single window (i.e., government has taken actions to make single windows more accessible to SMEs, e.g., by providing technical consultation and training services on registering and using the facility)	3	Reduction in waiting time; elimination of printed paper
		SMEs in a national trade facilitation committee (i.e., government has taken actions to ensure that SMEs are well-represented and made key members of national trade facilitation committees)	1	Ensures coordination of various stakeholders for seamless implementation of trade facilitation
		Other special measures for SMEs	1	Other measures may include reduction in inspection and paperwork for a specific minimum shipment value

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Annex 7a continued

Groups	Subgroups	Measures	Impact on Mitigating GHG Emissions (Low-1/Mid-2/High-3)	Possible Channel
	Agricultural trade facilitation (4 measures)	Testing and laboratory facilities available to meet SPS of main trading partners	2	Decrease in the number of procedures involved
		National standards and accreditation bodies are established to facilitate compliance with SPS	2	Reduction in cargo storage time; decrease in the number of procedures involved
		Electronic application and issuance of SPS certificates	3	Reduction in waiting time; elimination of printed paper
		Special treatment for perishable goods at border crossings	3	Reduction in waiting time; reduce risk of spoilage
	Women in trade facilitation (3 measures)	Trade facilitation policy/strategy to increase women's participation in trade	1	Information on trade procedures and requirements are accessible to women to reduce burdensome procedures
		Trade facilitation measures to benefit women involved in trade	1	Trade facilitation measures, like the use of digital tools, can ease customs transactions for women entrepreneurs
		Women membership in the national trade facilitation committee or similar bodies	1	Membership of women in committees can help in women's participation in the implementation of trade facilitation measures
Other Trade Facilitation	**Trade finance facilitation** (3 measures)	Single window facilitates traders' access to finance	3	Reduction in waiting time; elimination of printed paper; fewer trips required to comply with requirements
		Authorities engaged in blockchain-based supply chain project covering trade finance	2	Elimination of printed paper; fewer trips required to comply with requirements
		Variety of trade finance services available	1	Available finance options decline
	Trade facilitation in times of crisis (5 measures)	Agency in place to manage trade facilitation in times of crises and emergencies	3	Ensure speedy movement of critical goods and essential supplies
		Online publication of emergency trade facilitation measures	2	Fewer trips required to comply with requirements; reduction in paper use
		Coordination between economies on emergency trade facilitation measures	3	Ensure speedy movement of critical goods and essential supplies.
		Additional trade facilitation measures to facilitate trade in times of emergencies	3	Ensure speedy movement of critical goods and essential supplies.
		Plan in place to facilitate trade during future crises	3	Ensure speedy movement of critical goods and essential supplies

GHG = greenhouse gas, SME = small and medium-sized enterprise, SPS = sanitary and phytosanitary.

Note: A low score (=1) represents a negligible impact on GHG emissions reduction, an intermediate score (=2) represents an indirect impact (or a catalytic impact for green trade facilitation), and a high score (=3) represents a direct impact on abating GHG emissions.

Source: Kim, Basu-Das, and Ardaniel (2022) based on ADB (2021d).

Annex 7b: Analyzing the Environmental Content of International Investment Agreements

To analyze references in international investment agreements that relate to environmental protection and climate change, two main sources were used: United Nations Conference on Trade and Development's (UNCTAD) International Investment Agreement (IIA) Navigator and the Asian Development Bank's (ADB) IIA Agreement database.

UNCTAD's IIA Navigator. The navigator provides a global mapping of the treaty elements of investment treaties and other treaties with investment provisions. The mapping includes information on environmental references in the preamble such as specific references to sustainable development, general public policy exceptions for the environment, and environmental clauses. The following table provides a summary of the categories in the UNCTAD mapping covering references to environmental aspects.

ADB's IIA Database: The IIA Tool Kit provides information on 15 investment provisions for investment treaties concluded by economies in Asia and the Pacific. The database includes a mapping of the relevant article and text for each treaty provision, allowing for textual analysis of the environmental content in the treaty. The following table provides information on the textual information included to identify environmental references.

Information on environmental elements of international investment agreements in the UNCTAD and ADB databases offers a comprehensive view. In general, UNCTAD identifies more agreements including environmental elements than the ADB database. This may be explained by a broader definition of environmental content and the inclusion of the preamble not captured in the database. Also, a number of international investment agreements in ADB database are not mapped by UNCTAD.

Treaty Elements with Environmental Reference in UNCTAD IIA Navigator

Item	Description
Preamble > Reference to environmental aspects	Preamble contains reference to environmental investment aspects or related concepts such as plant life or animal life, biodiversity, climate change, or others.
Preamble > Reference to sustainable development	Preamble contains a reference to the concept of sustainable development.
Exceptions > General public policy exceptions > Public health and environment	Treaty allows the contracting parties to derogate from WTO Agreement on Trade-Related Investment Measures treaty obligations in order to protect the environment (i.e., "human, animal or plan life or health," "conservation of living or nonliving exhaustible natural resources," "prevention of diseases or pests").
Other clauses > Health and environment	Treaty uses the terms "environment" or related terms such as "ecological," "animal," or "plant" in any of its provisions (except the preamble), including general exceptions, reaffirmations of the right to regulate for health and/or environmental purposes, nonbinding clauses, and any others.
Other clauses > Not lowering standards	Treaty contains a provision prohibiting or discouraging the contracting parties from attracting investment through the relaxation of labor, environmental, health, safety, or other domestic standards.
Standards of treatment > Expropriation > Carve-out for general regulatory measures	Treaty carves out from the notion of expropriation regulatory measures of general application undertaken to protect legitimate public welfare objectives (including the environment).

IIA = international investment agreement , UNCTAD =United Nations Conference on Trade and Development, WTO = World Trade Organization.

Source: UNCTAD. Investment Policy Hub: International Investment Agreements Navigator. https://investmentpolicy.unctad.org/international-investment-agreements (accessed August 2022).

Environmental References in the ADB Database

Related Topics/Areas	Main Reference
Energy, environmental, animal, plant, natural, environmentally, UNFCCC	UNCTAD (2004). Key Terms and Concepts in International Investment Agreements: A Glossary
Emissions, emission, GHG, carbon, carbon footprint, Paris Agreement	OECD (2022). Investment Treaties and Climate Change
Air, pollution, waste, disposal, sanitary, phytosanitary, pest, pests, national treasures, archaeological, pollutants, contaminant, contaminants, flora, fauna, habitat, historical monuments, historical monument	Gordon and Pohl (2011). Environmental Concerns in International Investment Agreements: A Survey

GHG = greenhouse gas, OECD = Organisation for Economic Co-operation and Development, UNFCC = United Nations Framework Convention on Climate Change, UNCTAD =United Nations Conference on Trade and Development.
Source: ADB compilation.

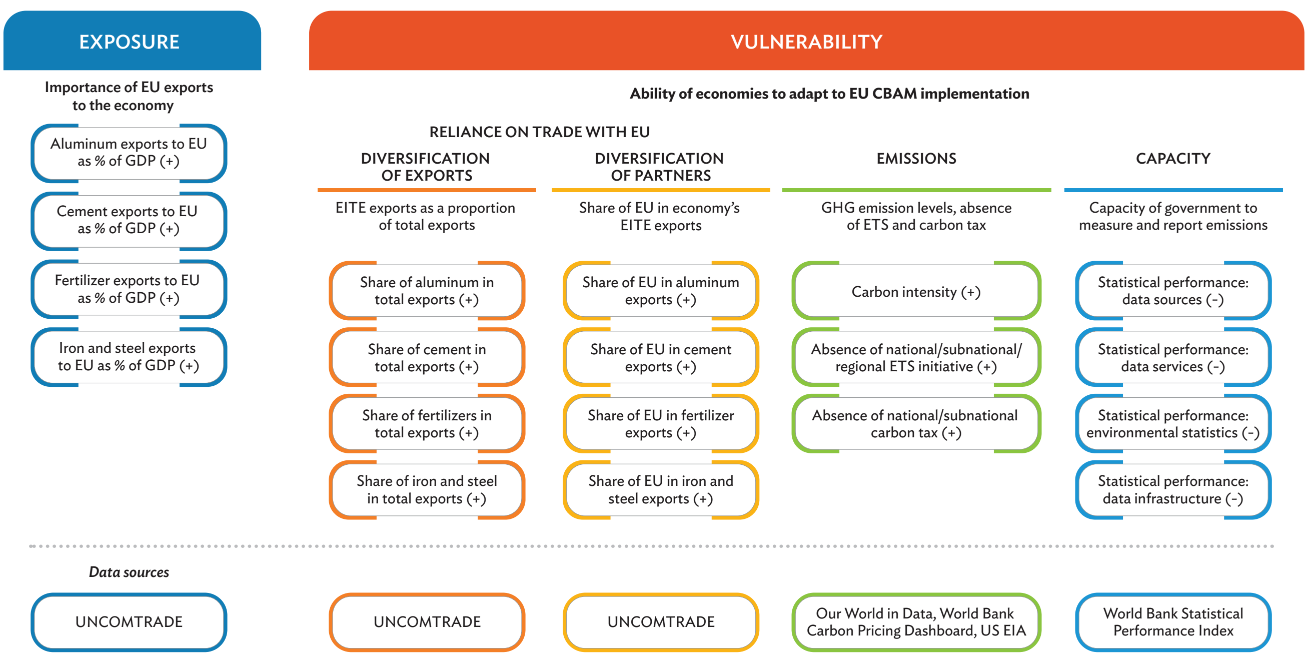
Annex 7c: Measures of Asia's Exposure and Vulnerability to the European Union' Carbon Border Adjustment Mechanism[1]

The potential risks to Asian economies from the European Union's (EU) implementation of the Carbon Border Adjustment Mechanism (CBAM) is based on two concepts: exposure (importance of EU trade for domestic economy) and vulnerability (measured by the economy's ability to adapt to CBAM). The methodology to estimate the relative risk index based on these two concepts follows Eicke et al. (2021).

The risk index uses 19 indicators across four dimensions: (i) exposure to CBAM; (ii) reliance on trade with the EU; (iii) emission levels and lack of decarbonization efforts; and (iv) statistical capacity to measure, report, and verify emissions (as shown in the figure below). The framework of Eicke et al. (2021) was modified by adding or replacing indicators, but the overall concept of combining exposure and vulnerability was followed in estimating the risk indexes. The indicators for each dimension are captured in the box figure. The indicators are normalized using a min-max normalization for all sample years (2015–2019) and for all economies.

An overall risk index was calculated as the simple average of the dimensional indexes. The indexes were aggregated further by region and Asian subregions and presented as a simple average over 2015–2019. The pandemic years 2020–2021 were not included to avoid extreme values during the crisis that might skew the estimated risk indexes.

Framework to Measure Economies' Risk to EU CBAM Implementation

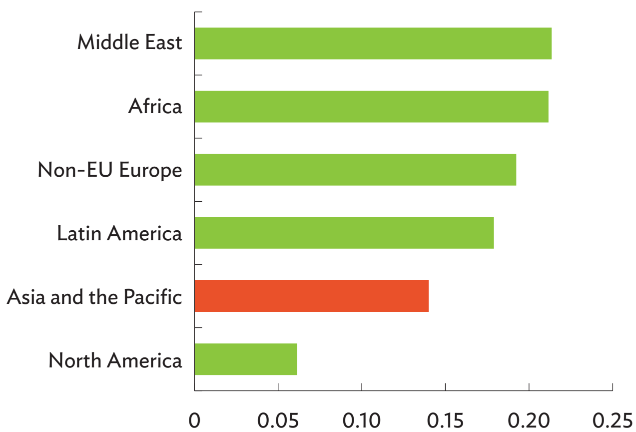


CBAM = Carbon Border Adjustment Mechanism; EITE = emissions-intensive and trade exposed goods (aluminum, cement, iron and steel, and fertilizers); ETS = emission trading scheme; EU = European Union (27 members); GDP = gross domestic product; GHG = greenhouse gas; US EIA = United States Energy Information Administration; UNCOMTRADE = United Nations Commodity Trade Database.
Source: Tan, Tayag, and Quizon (2022) based on Eicke et al. (2022).

[1] Taken from Tan, Tayag, and Quizon (2022).

The Asian region has a low overall risk of exposure and vulnerability to CBAM because its trade with the EU is a small proportion of the region's trade. Africa, the Middle East, and non-EU Europe are the regions with the highest potential risk for CBAM adoption. These regions have stronger trade linkages with the EU, particularly on emission-intensive and trade-exposed goods, and so are more likely to be affected. However, compared with other regions, Asia has relatively higher carbon dioxide (CO_2) emissions, which could make its products more likely to be subjected to the CBAM. It also has more economies with lower levels of statistical capacity, which could make it more difficult to trade CO_2 emissions.

Overall Risk Index to EU CBAM Implementation, By Region

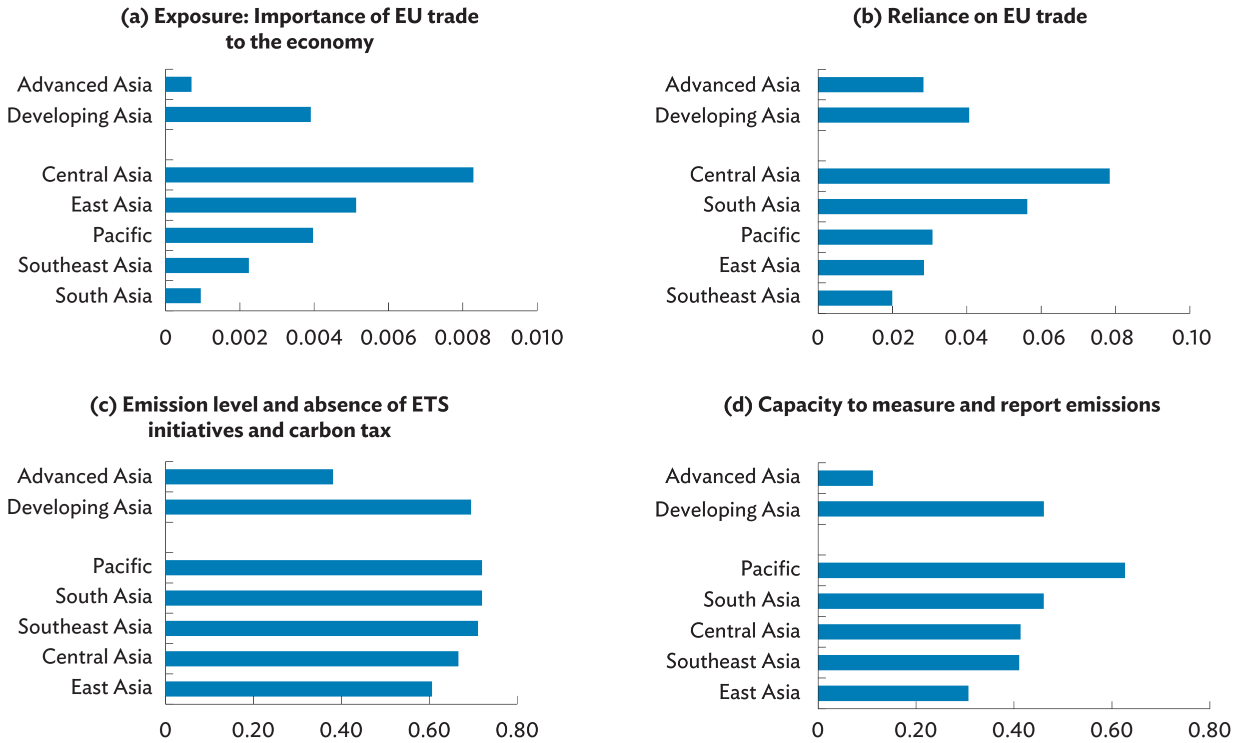


CBAM = carbon border adjustment mechanism, EU = European Union (27 members).

Source: Tan, Tayag, and Quizon (2022).

Within Asia, Central Asia, the Pacific, and South Asia face the highest overall potential risk to CBAM. Central Asia has the highest level of exposure as EU trade is relatively more important to their economies. In particular, Central Asia's exports of aluminum and fertilizer to the EU as a share of its GDP are the highest among Asian subregions (as shown below). The Pacific subregion posted the highest emission-related risk index given its high carbon intensity of power generation, although carbon emission levels across the Pacific are generally low both in absolute and per capita terms. The Pacific's statistical capacity to measure and report emissions is the lowest among Asian subregions, mainly due to less developed data infrastructure—legislation, standards, skills, and partnerships—and lack of financial resources to deliver useful data products and services. South Asia has the next highest risk in three of the four dimensions. In general, economies in developing Asia have higher risk than developed Asia as their exports are less likely to be diversified, they have higher emissions, have not implemented an ETS or carbon tax, or lack statistical capacity.

Risk Index to EU CBAM Implementation By Dimension—Asia and the Pacific



CBAM = Carbon Border Adjustment Mechanism, ETS = emission trading scheme, EU = European Union (27 members).

Note: Risk index is calculated for data between 2015 and 2019.

Source: Tan, Tayag, and Quizon (2022).