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EMISSIONS EMBEDDED IN GLOBAL TRADE

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June 2022

Contents

The Niskanen Center is a 501(c)3 issue advocacy organization that works to change public policy through direct engagement in the policymaking process.

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Key takeaways

- It is important to consider both production and consumption activity when assessing a country's contribution to global greenhouse gas emissions.
- Developed countries' total emissions have been relatively flat, while those of developing countries have been growing rapidly.
- Large emitters are typically large economies, and they are not necessarily more carbon-intensive.
- Big polluters have a relatively small portion of their production-based emissions embedded in international trade.
- Policies targeted at big polluters' exported emissions will have limited impact on their domestic emissions; significant decarbonization will need to be driven by domestic climate policies.
- International trade is still an important factor in global decarbonization as the total amount of emissions embedded in trade is significant.

Introduction

Emissions generated anywhere on the planet contribute to global warming. But there are no globally uniform climate policies. Instead, decarbonization policies are made at the national or local level. Countries around the world continue to develop and implement unilateral climate mitigation policies as goods and services flow across national borders. As global trade rises, it is important to assess whether addressing emissions in international trade would drive global decarbonization.

This paper provides an overview of global emissions trends, including the emissions trends of developed and developing countries; the world's biggest polluters; and small, open economies. The analyses and data in this paper offer useful insights for policymakers who are seeking to develop climate policies that are effective in driving decarbonization at home and abroad.

The difference between production and consumption-based emissions

Global trade has grown significantly over the last three decades. Global exports in 2014 were more than three times larger than in 1984.[1] International trade — measured as the total amount of global imports and exports, divided by global GDP — has increased from 34.6 percent in 1987 to 53.5 percent in 2017.[2]

The growth of global trade has implications for how to measure an economy's contribution to global emissions. There are two ways to measure a country's contributions to global emissions: [3]

- Production-based emissions. This measures the emissions generated within a jurisdiction. This is also referred to as territorial emissions.
- Consumption-based emissions. Under this measure, a country's total emissions are measured as the total emissions embedded in goods and services consumed within a jurisdiction.

For example, in 2019, the United States' production and consumption-based emissions were approximately 1.4 billion and 1.5 billion tonnes of carbon, respectively.[4] This means that the emissions embedded in all the goods and services consumed within the United States in 2019 were higher than the emissions that occurred within the country. In other words, the United States was a net importer of emissions in 2019, with its net imports of emissions (imports minus exports) accounting for about 7 percent of its production-based emissions.

Total production-based emissions continue to climb in developing countries, fall in developed countries

Over the last 30 years, total production-based emissions in the world have increased significantly. In 1990, emissions were 6,057 million tonnes of carbon (MtC) and that figure remained relatively constant throughout the 1990s. In 2001, total emissions began to start increasing rapidly. The post-2001 uptick

1. Esteban Ortiz-Ospina and Diana Beltekian, "Trade and Globalization," Our World in Data, 2018.

2. Ibid; the estimates were from Penn World Tables (9.1)

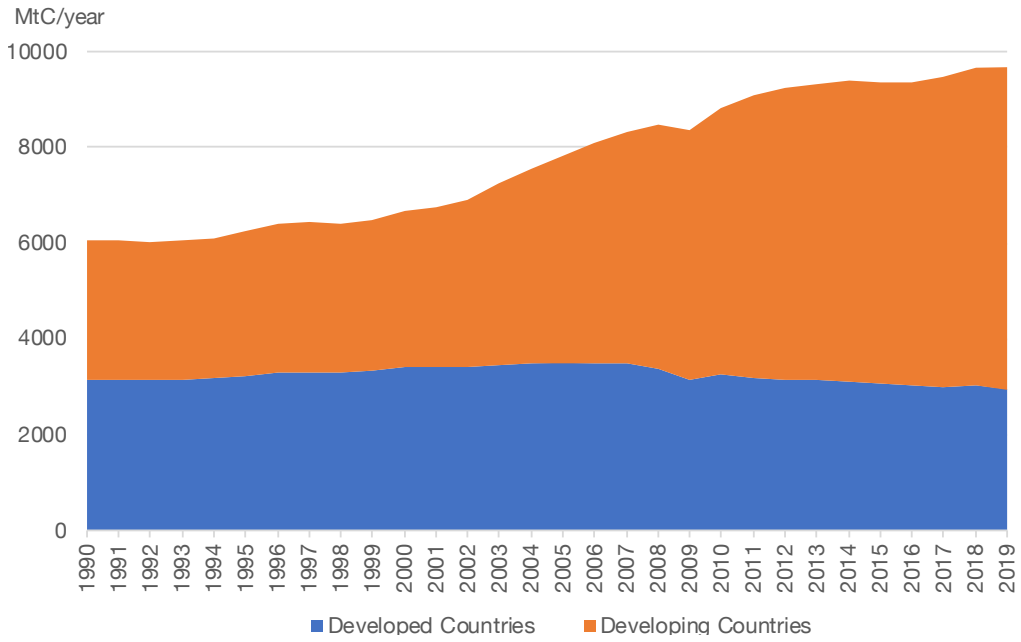
3. G. P. Peters et al., "A synthesis of carbon in international trade," *Biogeosciences* 9 (2012): 3247–3276.

4. Pierre Friedlingstein et al., *Global Carbon Budget 2021* (Global Carbon Project, 2021).

was due entirely to significant growth in emissions in developing countries. Between 2001 and 2019, production-based emissions in developing countries increase from around 3,339 MtC to about 6,737 MtC in 2019. The growth in emissions in developing countries corresponded to economic growth in China and India.[5]

While production-based emissions climbed in developing countries, emissions declined in developed countries. Emissions in developed countries were 3,394 MtC in 2001. By 2019, total production-based emissions in developed countries were less than 3000 MtC. In that year, developing countries generated more than twice as many production-based emissions as developed countries.[6] (Figure 1)

Figure 1: Total Production-based Carbon Emissions by Developed and Developing Countries



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Source: Global Carbon Budget 2021

Note:

1. Author has renamed territorial emissions from the data source to production-based emissions.
2. Production-based emissions data is from Friedlingstein et al., 2021.[7]
3. Production-based carbon emissions in the Global Carbon Budget data include emissions from fossil fuel combustion, oxidation, and cement production, but exclude emissions from international aviation and maritime transport.
4. Classifications of developed and developing countries are based on the United Nations' 2021 country classifications list; author included economies in transition under the developing countries classification.

There are several reasons why developing countries' production-based emissions are much higher than those of developed countries. First, approximately 80 percent of the global population lives in developing countries.[8] As the economies of developing countries continue to grow, their total production-based

5. Ibid.

6. Ibid.

7. Ibid.

8. *UNCTAD Handbook of Statistics* (United Nations Conference on Trade and Development, 2017).

emissions will continue to increase if there is no significant decarbonization. Second, developed countries outsource some of their production to developing countries. Third, developing countries typically adopt more carbon-intensive production processes and technologies than developed countries.

Consumption-based emissions track closely with production-based emissions

One concern about the declining trend in emissions in the developed countries is the possibility that rich countries are not really cutting their emissions, but are simply outsourcing manufacturing that generates greenhouse gases to developing countries.[9] However, the data indicates that the growth in developing countries' production-based emissions is mostly driven by growing domestic consumption, not by emissions exports from developed countries.

It is true that developed countries' total consumption-based emissions are higher than their total production-based emissions. In 2019, consumption-based emissions in developed countries were 3,285 MtC, while production-based emissions were slightly lower than 3,000 MtC. This indicates that developed countries do outsource some emissions to developing countries. However, the change in consumption-based emissions in developed countries tracked closely to the change in production-based emissions. The difference between developed countries' consumption-based and production-based emissions has grown slightly from 180 MtC in 1990 to 500 MtC in 2006, and has more recently declined to 348 MtC in 2019.[10]

On the other hand, production-based emissions of developing countries tend to be higher than consumption-based emissions. Production-based emissions of developing countries were 2,896 MtC in 1990 and increased to 6,737 MtC in 2019.[11]

If the growth in developing countries' production-based emissions were mostly driven by emissions exports from developed countries, then their production-based emissions would grow rapidly while consumption-based emissions would stay relatively flat. However, as production-based emissions in developing countries have grown, so too have consumption-based emissions: from 2,534 MtC in 1990 to 6,098 MtC in 2019.[12] The change in consumption-based emissions in developing countries tracked closely to the change in production-based emissions. This indicates that while developed countries do export some emissions to developing countries, domestic consumption is the main driver of the growth in developing countries' production-based emissions. (Figure 2)

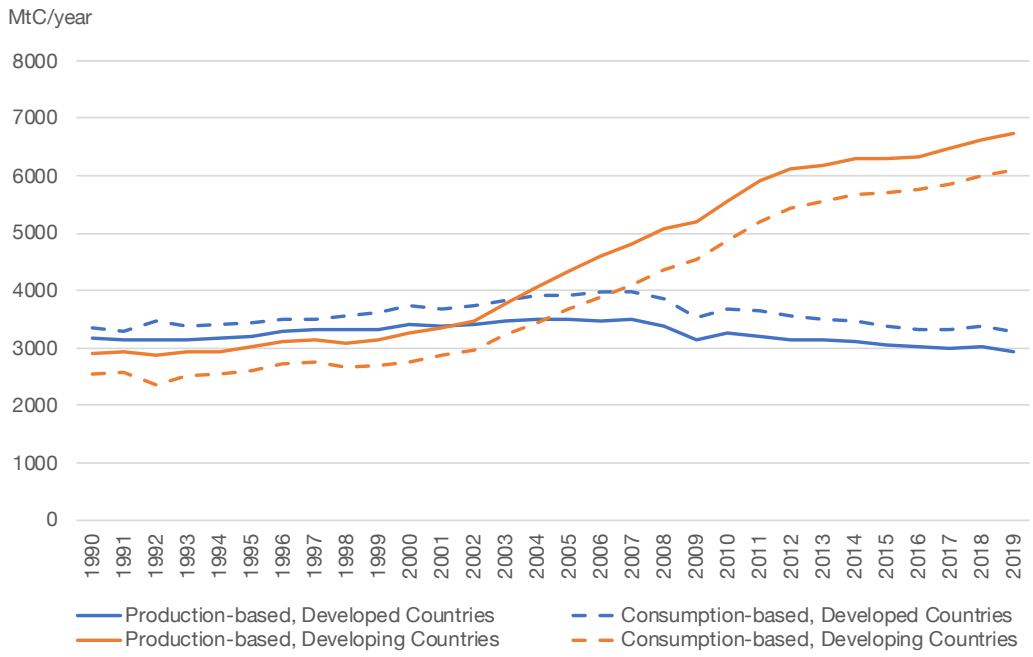
9. Arvind Ravikumar, "Carbon border taxes are unjust," *MIT Technology Review* (July 2020).

10. Friedlingstein et al., *Global Carbon Budget 2021.*

11. Ibid.

12. Ibid.

Figure 2: Total Production and Consumption-based Carbon Emissions by Developed and Developing Countries



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Source: Global Carbon Budget 2021

Note:

1. Author has renamed territorial emissions from the data source to production-based emissions.
2. Production-based emissions data is from Friedlingstein et al. 2021.[13]
3. Consumption-based emissions data are from Peters et al. 2011.[14]
4. Production-based carbon emissions in the Global Carbon Budget include emissions from fossil fuel combustion, oxidation, and cement production, but exclude emissions from international aviation and maritime transport.
5. Classifications of developed and developing countries are based on the United Nations' 2021 country classifications list; author included economies in transition under the developing countries classification.

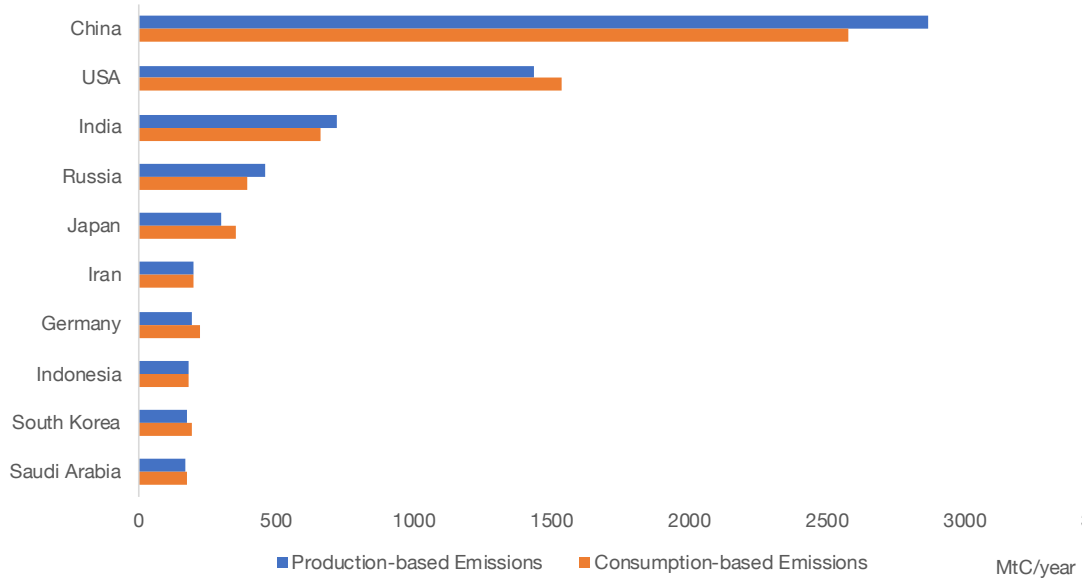
Large emitters have economies that are larger — not necessarily dirtier

In 2019, China, the United States, and India were the top three emitters (by production-based emissions) in the world, followed by Russia, Japan, Iran, Germany, Indonesia, South Korea, and Saudi Arabia. These same countries were also the top 10 by consumption-based emissions in 2019. (Figure 3)

13. Ibid.

14. Glen P. Peters et al., "Growth in emission transfers via international trade from 1990 to 2008," *Proceedings of the National Academy of Sciences* 108 (April 2011): 8903-8908.

Figure 3: Top 10 Countries by Production-based and Consumption-based Carbon Emissions, 2019



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Source: Global Carbon Budget 2021. Production-based emissions data from Friedlingstein et al. 2021.[15] Consumption-based emissions are from Peters et al. 2011.[16]

This, however, does not indicate that these economies are necessarily "dirtier." Rather, these countries' total emissions generally reflect the fact that their economies are larger. In fact, how the top 10 countries compare in "carbon intensity" is significantly different from how they compare in their total emissions. Carbon intensity is a useful metric that measures emissions per unit of economic output.

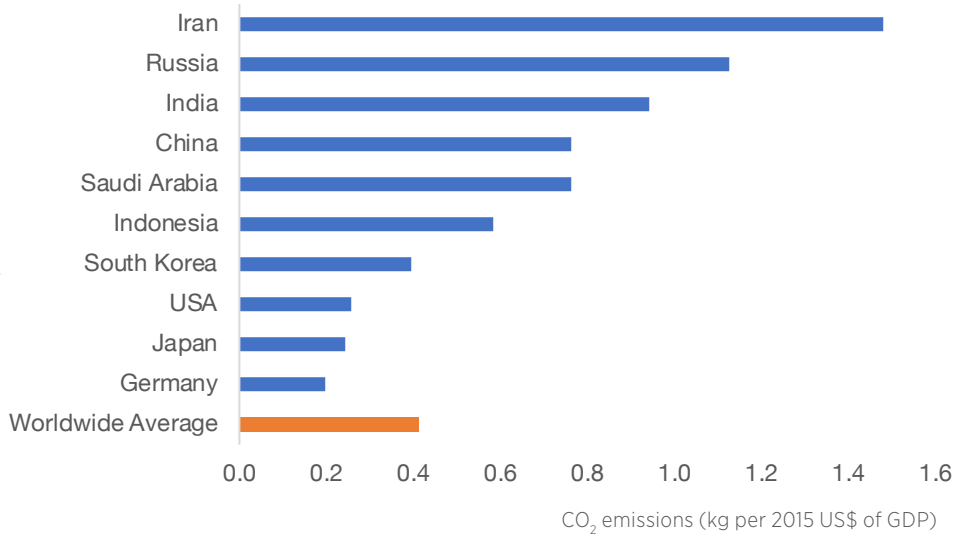
Measured by carbon intensity, the top three "dirtiest" countries among these 10 were Iran, Russia, and India. Unsurprisingly, three of the top five on this list were oil-and gas-producing and exporting countries — Iran and Russia were joined by Saudi Arabia. China, which generated the most production-based emissions, ranked fourth in terms of carbon intensity. The carbon intensity levels of these top five countries were much higher than the worldwide average, and Iran in particular stands out. This is mostly driven by its large oil and gas production and the high energy-intensity of its industrial production.[17] The developed countries on the list —the U.S., Japan, and Germany — were much less carbon-intensive than the worldwide average level. (Figure 4)

15. Friedlingstein et al., *Global Carbon Budget 2021.*

16. Peters et al., "Growth in Emission Transfers."

17. "The Carbon Brief Profile: Iran," Carbon Brief, February 2020.

Figure 4: Carbon Intensity of the Top 10 Production-based Emissions Countries, 2018



Source: World Bank

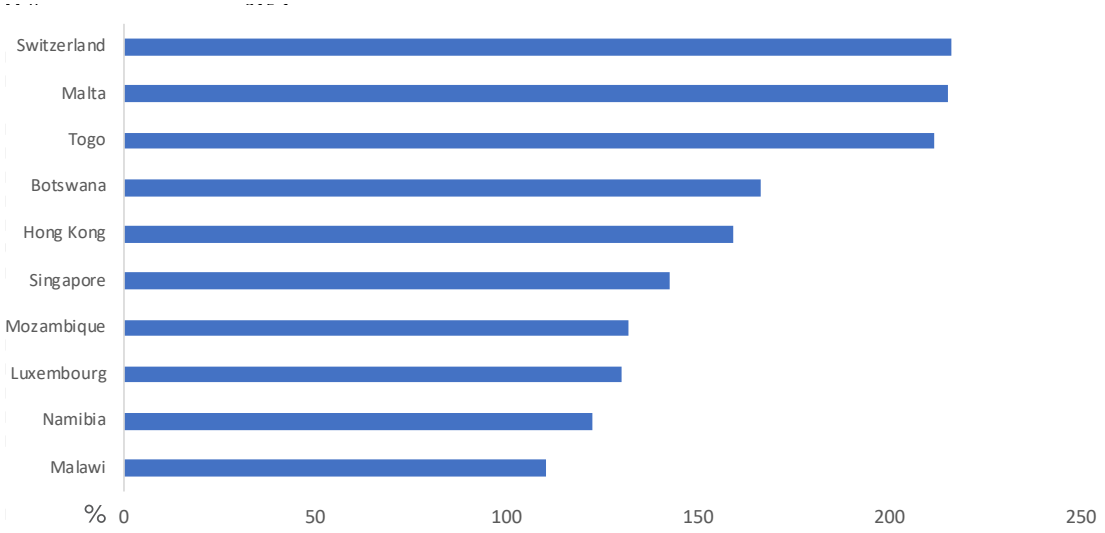
Note: The list of top 10 countries by production-based emissions is based on the 2019 data from Figure 3; carbon intensity data of these top 10 countries and the worldwide average carbon intensity level are based on World Bank data on 2018 CO_2 emissions per unit of GDP.

Small, open economies tend to import most of their emissions

Although production- and consumption-based emissions in the aggregate track closely across both developed and developing countries, there is a group of economies that import a significant amount of their emissions. These small and open economies import a significant amount of production from overseas, which results in a large wedge between consumption and production-based emissions.

This can be illustrated using the ratio of emissions associated with a country's net imports — the total amount of imported goods minus the total amount of exported goods — to its total amount of production-based emissions. The top three countries according to this measure in 2019 were Switzerland, Malta, and Togo. All these countries' net imports as a percentage of their production-based emissions were higher than 100 percent. This indicates that these countries rely heavily on imports for their consumption. It is important to note that this metric does not reflect how much a jurisdiction contributes to total global emissions. (Figure 5)

Figure 5: Top 10 Jurisdictions by Net Imports as a Percentage of Production-based CO_2 Emissions, 2019



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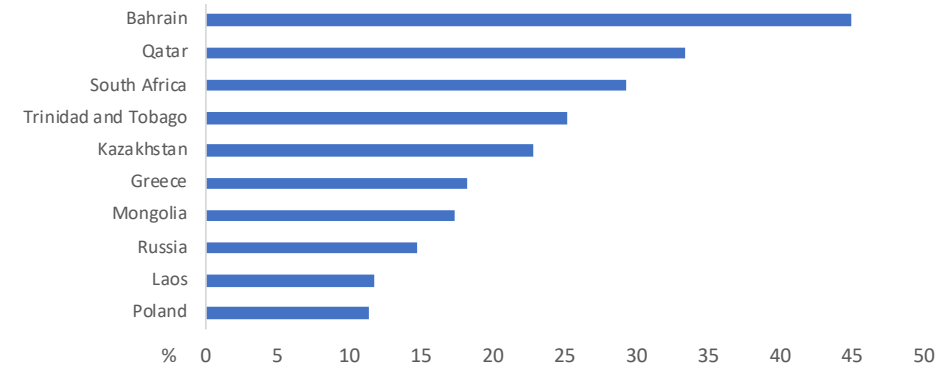
Source: Our World in Data

Note: Based on the data on the share of CO_2 emissions embedded in trade. Positive values denote net importers of emissions.

There is also a group of countries that tend to export a large share of their emissions. The top three countries by their net exports as a percentage of their production-based emissions in 2019 were Bahrain, Qatar, and South Africa. This metric gives us an idea of which jurisdictions have relatively high emissions associated with their net exports as a percentage of their production-based emissions. Most of these countries tend to export natural resources, which tend to be highly carbon-intensive. Again, this metric does not reflect how much a jurisdiction contributes to total global emissions. (Figure 6)

Figure 6: Top 10 Jurisdictions by Net Exports as a Percentage of Production-based CO_2 Emissions, 2019



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Source: Our World in Data

Note: Based on the data on the share of CO_2 emissions embedded in trade.

Big emitters generate most of their emissions at home

Approximately 20-30 percent of global emissions are embedded in international trade,[18] meaning most emissions are still entirely domestic. The world's 10 biggest emitters export only a small portion of their production-based emissions for foreign consumption. For example, in 2018, the share of the United States' total production-based emissions for domestic consumption was 91 percent. Even for China, a big net exporter, 83 percent of production-based emissions were associated with domestic consumption. (Table 1)

Table 1: Emissions Embedded in International Trade in 2018, Largest Emitters

	Share of a country's total production-based emissions for domestic consumption	Share of a country's total production-based emissions for foreign consumption	Share of a country's total consumption-based emissions sourced from domestic production	Share of a country's total consumption-based emissions sourced from foreign production
China	83%	17%	91%	9%
USA	91%	9%	79%	21%
India	82%	18%	85%	15%
Russia	71%	29%	89%	11%
Japan	83%	17%	73%	27%
Germany	69%	31%	59%	41%
Indonesia	82%	18%	78%	22%
South Korea	62%	38%	68%	32%
Saudi Arabia	83%	17%	78%	22%

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Source: OECD, Trade in Embodied CO2 Database (TECO2)

Note: Countries selected had the most production- and consumption-based emissions in 2019. The latest year of data available on TECO2 is 2018. Iran's data is not available on TECO2.

Big polluters rely heavily on domestic production for their total consumption, importing only a small portion of emissions from overseas. For example, 91 percent of China's consumption-based emissions in 2018 were from domestic production. The United States relied more on imports than China for total consumption, with 21 percent of its consumption-based emissions sourced from foreign production. Among the world's big polluters, Germany relied on imports the most for its total consumption, with 41 percent of its consumption-based emissions imported from abroad.

Policy implications

The United States has a much lower carbon intensity than other top polluters in the world. As shown in Figure 4, among the top 10 polluters in 2019, the United States ranked eighth in carbon intensity. Given the lower carbon intensity of products manufactured in the United States, the idea of levying tariffs on dirtier imports from China and other trading partners has gained traction lately.[19] Proponents argue

18. Daniel Moran et al., *The Carbon Loophole in Climate Policy, Quantifying the Embodied Carbon in Traded Products* (KGM & Associates, Global Efficiency Intelligence, ClimateWorks Foundation, August 2018).

19. Josh Siegel, "Congress is eyeing a bipartisan climate trade policy — thanks to Trump," Politico, February 24, 2022.

such a move would reward U.S. manufacturers for their clean production processes and push trading partners to reduce their emissions.

However, implementing punitive measures against more carbon-intensive trading partners might have a limited impact on global emissions, as the world's biggest polluters only export a small percentage of their emissions. As noted above, about 83 percent of China's production-based emissions were for domestic consumption in 2018. In other words, China exported only about one-fifth of its emissions for foreign consumption. The United States' imports from China accounted for about four percent of China's total production-based emissions in the same year.[20] Additionally, punitive measures such as import tariffs levied on carbon-intensive imported goods would have unintended consequences, including harming domestic consumers, provoking retaliatory tariffs from trading partners, and violating World Trade Organization rules.[21]

Four percent of China's emissions is not an insignificant amount given China's high level of total emissions. Addressing emissions in trade matters, but U.S. policymakers should also focus on policies that address domestic emissions in the United States.

Conclusion

Production- and consumption-based emissions are important metrics for assessing a country's contribution to global emissions. Over the last three decades, developed countries' total production-based emissions have been slowly declining, whereas developing countries' production-based emissions have been rising rapidly as these economies continue to grow. While developed countries do outsource some of their emissions to developing countries, the significant growth in developing countries' production-based emissions has been mostly driven by their domestic consumption.

Unilateral policies aimed at addressing emissions embedded in big polluters' exports won't do much to change these countries' domestic emissions, as the bulk of them are not embedded in international trade. Meaningful decarbonization will have to be driven by national climate polices that regulate emissions occurring within national borders.

Although a small portion of big polluters' emissions are embedded in international trade, the total level of emissions is not an insignificant amount. When looking to address emissions embedded in trade, policymakers should implement well-designed policies such as a border-adjusted carbon tax instead of punitive or protectionist measures.

20. Trade in Embodied CO2 Database (TECO2) (OECD, November 2021).

21. Shuting Pomerleau, "Be wary of protectionism when addressing climate change in trade," Niskanen Center, February, 2022.