Part III

Energy and Transportation in the Maritime Realm of the Atlantic Basin

Chapter Six

Atlantic Maritime Transportation and Trade: Impacts on Shipping Transport Emissions and International Regulation

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The chapter analyzes the expanding maritime transport in the Atlantic Basin (stimulated by the evolution of global value chains and logistics) and the massive growth of the shipping industry in recent decades. Since the mid-1990s, however, the development of regulation to address shipping's environmental impact and to restrict the sector's atmospheric emissions has been slow. This chapter reviews the role of the International Maritime Organization (IMO) and its current regulatory framework, assesses the difficulties and complexities associated with it, and evaluates IMO regulatory efforts to date. It also proposes a strategic line of action for the EU: to push forward with the regulation of maritime emissions unilaterally—faster than the US or the IMO seem inclined to move—and then partnering with interested collaborators in the Southern Atlantic, in Africa and Latin America.

Emissions from intercontinental maritime transport are significant, and are currently linked to industrial emissions through international trade. More specifically, trade in raw materials and manufactured goods have seen spectacular increases in the last decade because of the logistics and container transportation revolutions. Over 90 percent of physical merchandise traded by volume takes place via maritime transport along the world's sea lanes, which include two-thirds of the global oil trade, one-third of the gas trade, and the large majority of other global material flows.[1] Manufactured goods are not the most important part of maritime transport, but they are relevant in terms of value and their contributions to the world fragmentation of production.

As the transport revolution has reduced unit costs and increased volumes of transported freight, it has also facilitated, and been fed by, one of the central phenomenon of contemporary globalization: the fragmentation of production

1. Paul Isbell, "The Emergence of the Atlantic Energy Seascape: Implications for Global Energy and Geopolitical Maps" in *The Future of Energy in the Atlantic Basin*, eds. Paul Isbell and Eloy Alvarez Pelegry (Washington, DC, 2015), pp. 259-267.

and the emergence and continuing evolution of global value chains (GVCs). This phenomenon creates a feedback effect: to take advantage of wage differences and shifting global demand, GVCs stretch across the globe and reach into all continents; however, the result is that more transportation is required in all its varieties—maritime, terrestrial and air—which in turn promotes intermodality. The ultimate consequence is that—in spite of the greater and rising efficiency of transportation and a reduction of emissions per unit transported—the significant marginal increase of transported freight volumes stemming from such efficiencies actually raises the absolute levels carbonization and GHG emissions. Indeed, the reduction of such transport costs implies an externalized cost in the form of CO_2 emissions, in terms of both path (direct) and derivative (indirect) emissions (i.e., construction, ports, etc.).

The solution is to establish regulatory instruments targeting the emissions of maritime transport in the same way that such instruments have been established to reduce the emissions of terrestrially (or land-based) transport. In this sense, the Atlantic Basin has two advantages. First, the volume of Atlantic Basin maritime transport is much lower than that of the world's other ocean basins connecting Asia and the Americas (the Pacific Basin) and Europe and Africa with Asia (the Indian Ocean Basin). Second, the European Union (EU), together with the countries of the Atlantic Basin, could lead this regulatory effort to reduce maritime transport emissions even in the face of US isolationism vis-a-vis the Paris Agreement. Just as the economic crisis of 2008-2010 negatively affected the demand for transportation and caused a supply crisis which provoked the failure of a few shipping companies, the renegotiation or suspension of free trade agreements (e.g. NAFTA or the TPP) could stall the expansion of GVCs, or even bring them to an irreversible halt. Although this would bring a reduction of transport demand and attendant emissions, it would not be a desirable solution, given the negative consequences on economic growth, the development of the emerging economies, and levels of global welfare. We need a balanced solution, one that allows economic growth and trade to be compatible with maritime emissions reductions.

The first sections of this chapter analyze the evolution of maritime transport in the aftermath of significant growth in both international trade and GVCs—two of the principal vectors of contemporary globalization—and concludes with a discussion of possible regulatory solutions in the Atlantic Basin. These sections also analyze the container revolution in transportation, the evolution of Atlantic Basin maritime transport, recent improvements in logistics, the expansion of GVCs, as well as key determinants of maritime transport like investment requirements and energy costs. The later sections of the chapter address themselves to: (1) current and potential future regulatory efforts to reduce maritime emissions; (2) the difficulties faced by the maritime industry in this regard; and (3) the different positions of the various maritime industry pressure groups.

The Container Revolution and the Decline in the Cost of Maritime Transport

Ever since containerized freight began in the late 1950s—with the introduction of the first container (which we could call a humble steel box) transported by ship in 1956—international trade in manufactured goods has continued to grow, dominating shipping in terms of value. Since 1968, container-carrying capacity has increased 1,200 percent: from the first vessel's capacity of 1,530 TEU[2] to the latest generation vessels of 19,000 TEU or higher.

Since the first container's voyage, this method of freight transport grew steadily; five decades later container ships would carry about 60 percent of the value of goods shipped via sea.[3] The capacity of container ships has also increased, along with their efficiency. Today there are nearly 5,000 container ships in the global fleet—most of which are operated by members of the World Shipping Council—and there are 445 new vessels on order.[4] As result, container ships have grown in size from just 1,500 TEU in 1976 to capacities in excess of 12,000 TEU today, while some ships currently on order will be capable of carrying 18,000 TEU.

Not only are today's ships able to carry more goods in one voyage than in the past; they are also much more fuel-efficient. The fuel efficiency of container ships (with 4,500 TEU capacity on average) improved 35 percent between 1985 and 2008. It is estimated that, on average, a container ship emits around 40 times less CO_2 than a large freight aircraft, and over three

2. Twenty-foot equivalent unit or TEU.

3. World Shipping Council, "About the Industry. History of Containerization," 2017, http://www.worldshipping.org/about-the-industry/history-of-containerization (accessed June 23, 2017).

4. World Shipping Council, "About the Industry. Liner Ships," 2017, from *Alphaliner - Cellular Fleet July 2013,* http://www.worldshipping.org/about-the-industry/liner-ships (accessed July 5, 2017).

times less than a heavy truck. Container shipping is estimated to be two and a half times more energy efficient than rail and 7 times more so than road.[5]

In any case, despite the overall conclusion that fuel price is an important driver of design efficiency there are differences between the types of maritime transport in the historical trends of ship design efficiency. For bulk carriers, design efficiency has improved considerably. Such efficiency increased 28 percent in 10 years during the 1980s; however, beginning in 1990, design efficiency gradually deteriorated until 2013. Such changes stem from the evolution of: (1) the main engine power; (2) capacity; or (3) the speed of ships. By contrast, for tankers this efficiency improvement has been lower: 22 percent over the same 10 years. After 1988, however, there was a gradual deterioration in efficiency, which lasted until around 2008, after which efficiency improvements in tankers again became apparent.

The efficiency of container ships depends on both ship size and the year. Comparison is difficult over time because of the dramatic increase in the size of container ships. The largest container ship in the 1970s carried 50,000 dead-weight tonnage (dwt); in the 1980s, 60,000 dwt; in the 1990s, 82,000 dwt; and in the 2000s, 165,000 dwt. There were large swings in the average efficiency of new constructions in the 1970s, a marked decline to the mid-1980s, when it rebounded. From 2000, however, the design efficiency of new container ships deteriorated steadily. But then, in 2006, the fastest container ships ever built entered the fleet.[6] In any case, the largest container ships were built before the last economic crisis. In 2010, the South Korean shipping company was the first to introduce a 10,000 TEU class carrier ship, travelling between Asia and Europe. But the aftermath the crisis saw a decline in transport demand and led to the bankruptcy of some companies owning these new large ships, as occurred with the Hanjin shipping line in 2016. Such bankruptcies caused turbulence in global shipping and the shipping price of a 40-foot container from China to the US rose to 50 percent in a single day.[7]

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5. World Shipping Council, "About the Industry. Container Ship Design," 2017, http://www.worldshipping.org/about-the-industry/liner-ships/container-ship-design (accessed June 23, 2017).

6. Jasper Faber, Maarten 't Hoen, "Historical trends in ship design efficiency," Delft, CE Delft (March, 2015)http://www.cleanshipping.org/download/CE_Delft_7E50_Historical_trends_in_ship_design_efficiency_DEF.pdf (accessed June 28, 2017).

7. The Guardian, https://www.theguardian.com/business/2016/sep/02/hanjin-shipping-bankruptcy-causes-turmoil-in-global-sea-freight (accessed September 17, 2017).

According to the current global data, there are 5,985 active ships (including 5,131 which are fully cellular)[8] annually transporting 20,894,673 TEU (of which over 98 percent is transported in fully cellular ships) and 257,805,686 DWT (deadweight tonnage). From the regional perspective, weekly capacities are now 135,501 TEUs in the Transatlantic Region, 442,261 TEUs in the Trans-Pacific and 397,435 TEUs in FEAST-Europe. Therefore, the Atlantic region is the least important in terms of container trade, relative to other major sea lane regions.[9]

Some studies conclude that the introduction of containers has been more important for international trade than free trade agreements (FTAs). In a group of 22 industrialized countries, containerization explains a 320 percent rise in bilateral trade over the first five years after adoption and a 790 percent increase over 20 years. By comparison, a bilateral free-trade agreement raises trade by 45 percent over 20 years, while GATT membership adds 285 percent.[10] In any case, the more recent bilateral and regional agreements, including the NAFTA, have played only a minor role in the growth of world trade. Reforms in emerging market economies, for example, have contributed much more to the expansion of trade than FTAs.[11]

The economic effects of containerization are clear. From a transportation technology perspective, containerization resulted in the introduction of intermodal freight transport. This is because the shipment of a container can travel along multiple modes of transportation—ship, rail or truck—without any freight handling required when changing modes. By eliminating sometimes as many as a dozen separate handlings of the cargo, the container resulted in a tighter linking of the producer to the customer. Since containerization resulted in a reduction of the total resource costs of shipping a good from the (inland) manufacturer to the (inland) customer, its impact is not adequately captured by looking only at changes in port-to-port freight costs.[12]

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8. Ship fitted throughout with fixed or portable cell guides for the carriage of containers. OECD Glossary of Statistical Terms https://stats.oecd.org/glossary/detail.asp?ID=4244 (accessed September 18, 2017).

9. ALPHALINER TOP 100, 2017 https://alphaliner.axsmarine.com/PublicTop100/index.php (accessed June 22, 2017).

10. Daniel M.Bernhofen D., El-Sahli Z., Kneller R., "Estimating the Effects of the Container Revolution on World Trade," Lund University, Working Paper (February 13, 2013), p.19. http://www.lunduniversity.lu.se/lup/publication/704527ec-23e1-4561-a611-a582cffefb4c (accessed June 18, 2017).

11. Gene Grossman, "What trade deals are good for," *Harvard Business Review*, (May 24, 2016) https://hbr.org/2016/05/what-trade-deals-are-good-for (accessed June 26, 2017).

12. Ibid. p.4.

On the other hand, with the blockade of the Suez Canal (as a consequence of the Six Day War in 1967), large oil tankers were introduced (at the same time as liquefied natural gas). This development, however, only partially replaced the transport of energy by land-based intercontinental pipelines (i.e., the gas pipelines between Algeria and Europe, Russia and Europe, and the Persian Gulf and China by way of Iran); despite the increasing transport capacity of gas pipeline flows, due to long sea distance and the flexibility offered by maritime transport to purchase oil in transit, transatlantic maritime energy transport flows continued to be more difficult to replace with other transport systems.

This container revolution—along with innovations in transport logistics, new port infrastructures, intermodality and information and communications technology (ICT)—has led to a reduction in shipping costs. This reduction in costs has, in turn, stimulated the displacement and fragmentation of production, and the emergence of global value chains. Even more important than costs have been the knock-on effects on efficiency. In 1965, dock labor could move only 1.7 tons per hour onto a cargo ship; five years later a container crew could load 30 tons per hour.[13]

However, this reduction in transport costs fails to reflect the increase in external costs (or externalities) arising from CO_2 emissions, both those generated by maritime transport and those produced by the construction of large transport ships. The internalization of such externalities through the regulation of emissions is one of the solutions currently being worked on at the international level by the International Maritime Organization (IMO) and will be analyzed in the second part of this chapter.

Maritime Transportation and Trade in the Atlantic Basin

Data on the volumes of maritime trade routes indicate that the Atlantic Basin is less traversed when compared to the main routes between Asia and Europe (across the Indian Ocean Basin) and between Asia and North America (across the Pacific Basin). Among the Atlantic Basin trade routes, the North Atlantic route between Europe and North America is currently the most important (see Table 1).

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13. Richard Baldwin, "Trade and Industrialisation After Globalisation's 2nd Unbundling: How Building and Joining a Supply Chain are Different and Why It Matters," NBER Working Paper 17716, (December, 2011) http://www.nber.org/papers/w17716 (accessed June 18, 2017).

Table 1. Leading Global Maritime Trade Routes, TEU, 2013

Atlantic Basin Routes	West Bound	East Bound	North Bound	South Bound	Total
North Europe-North America	2,636,000	2,074,000			4,710,000
North Europe/Mediterranean-East			795,000	885,000	1,680,000
North America-East Coast South			656,000	650,000	1,306,000
Other top routes					
Asia-North America	7,739,000	15,386,00			23,125,00
Asia-North Europe	9,187,000	4,519,000			13,706,00

Source: Adapted from "World Shipping Council" http://www.worldshipping.org/about-the-industry/global-trade/trade-routes. Note: Trade between an origin group of countries and a destination group of countries is referred to as a trade route. The figure presents the top maritime trade routes in terms of TEU shipped in 2013.

The Inter-American Development Bank (IDB) analyzed the effects of the economic crisis on maritime transport and the consequences on supply due to the bankruptcy of some shipping companies. The effects of this new supply and demand scenario are even more remarkable in Latin America and the Caribbean (LAC), where connectivity limitations and below-average logistics performance are considerable barriers to integration and growth in maritime trade. Infrastructure shortcomings, operational inefficiencies, high port costs, lack of integration in logistics platforms (e.g. electronic single windows) result in higher regional maritime transport costs.[14] In the case of LAC countries, therefore, there is space to increase efficiency through investments without significantly increasing emissions.

As we will see below, connections between ports and liners are important to maintain high efficiency and lower transportation costs. Reviewing the most important ports listed in the "Top 100,"[15] one finds that the first Atlantic port in terms of total cargo traffic (both in total volume and number of containers handled) is Rotterdam. In terms of container traffic, among the first 30 world ports, six are European—Rotterdam (11), Antwerp (14), Hamburg

14. Erick Feijóo, Iván Corbacho, Krista Lucenti, and Sergio Deambrosi, "Staying afloat? Opportunities in the maritime transport sector in the Americas," Inter-American Development Bank blogs, June 13, 2017, https://blogs.iadb.org/integration-trade/2017/06/13/staying-afloat-opportunities-in-the-maritime-transport-sector-in-the-americas/ (accessed July 9, 2017).

15. The American Association of Port Authorities, "World Port Rankings 2015 ," Alexandria, Va., 2015, http://www.aapa-ports.org/unifying/content.aspx?ItemNumber=21048 and http://aapa.files.cms-plus.com/Statistics/WORLD%20PORT%20RANKINGS%202015.xlsx (accessed July 12, 2017).

Table 2. Top 100 Ports, Cargo Volume (metric tons) and Container Traffic (TEUs), 2015

TOTAL CARGO VOLUME TONS, 000s					CONTAINER TRAFFIC TEUs (Twenty-Foot Equivalent Units), 000s			
RANK	PORT	COUNTRY	MEASURE	TONS	RANK	PORT	COUNTRY	TEUs
5	Rotterdam	Netherlands	Metric Tons	466,363				
					11	Rotterdam	Netherlands	12,235
14	South Louisiana	United States	Metric Tons	235,058	14	Antwerp	Belgium	9,654
16	Houston	United States	Metric Tons	218,575				
					17	Hamburg	Germany	8,821
					23	New York / New Jersey	United States	6,372
					24	Bremen/Bremerhaven	Germany	5,547
27	Itaqui	Brazil	Metric Tons	146,647				
28	Metro Vancouver	Canada	Metric Tons	138,228	28	Valencia	Spain	4,615
29	Hamburg	Germany	Metric Tons	137,824	29	Algeciras - La Linea	Spain	4,516
32	Santos	Brazil	Metric Tons	119,932	32			
34	New York/New Jersey	United States	Metric Tons	114,933	34	Santos	Brazil	3,780
					35	Savannah	United States	3,737
					36	Felixstowe	United Kingdom	3,676
37	Itaguai	Brazil	Metric Tons	110,362				
					38	Gioia Tauro	Italy	3,512
					39	Piraeus	Greece	3,360
					40	Balboa	Panama	3,078
41	Amsterdam Ports	Netherlands	Metric Tons	98,776			Turkey	3,062
44	Algeciras - La Linea	Spain	Metric Tons	91,950	44	Tanger	Morocco	2,971
46	Marseilles	France	Metric Tons	81,920	46			
					47	Colon	Panamá	2,765
48	New Orleans	United States	Metric Tons	79,661				
49	Beaumont	United States	Metric Tons	79,081				
51	Corpus Christi	United States	Metric Tons	77,724				
					52	Cartagena	Colombia	2,607
						Le Havre	France	2,556
55	Bremen/Bremerhaven	Germany	Metric Tons	73,447	55	Virginia	United States	2,549
					58	Southampton	United Kingdom	2,349
59	Long Beach	United States	Metric Tons	70,911				
60	Valencia	Spain	Metric Tons	69,601				
62	Le Havre	France	Metric Tons	68,289	62	Genoa	Italy	2,243
					63	Dublin	Ireland	2,217
					64	Houston	United States	2,131
						Charleston	United States	1,973
68	Baton Rouge	United States	Metric Tons	62,399	68	Barcelona	Spain	1,965
71	Grimsby and Immingham	United Kingdom	Metric Tons	59,103				
					72	Manzanillo	Panama	1,821
73	Trieste	Italy	Metric Tons	57,161				
79	Virginia	United States	Metric Tons	52,402	79	Chennai	India	1,571
					80	Zeebrugge	Belgium	1,569
81	Lake Charles	United States	Metric Tons	51,431				
					83	Montreal	Canada	1,446
84	Genoa	Italy	Metric Tons	51,299	84			
85					85	Buenos Aires (incl. Exolgen)	Argentina	1,428
86					86	Freeport	Bahamas	1,400
87					87	Sines	Portugal	1,332
88	Sao Sebastiao	Brazil	Metric Tons	49,539				
					90	La Spezia	Italy	1,300
					91	Marseilles	France	1,220
92	Plaquemines	United States	Metric Tons	48,541				
93	Dunkirk	France	Metric Tons	46,592				
94	Barcelona	Spain	Metric Tons	45,921	94	San Juan	Puerto Rico	1,211
95	London	United Kingdom	Metric Tons	45,430				
					96	London	United Kingdom	1,185
98	Bergen	Norway	Metric Tons	43,591				
100	Paranagua	Brazil	Metric Tons	43,275	100	Limon/Moin	Costa Rica	1,106

NOTE: The cargo rankings based on tonnage should be interpreted with caution since these measures are not directly comparable and cannot be converted to a single, standardized unit.
Sources: Agência Nacional de Transportes Aquaviários - ANTAQ(Brazil), Institute of Shipping Economics & Logistics ; U.S. Army Corps of Engineers' Waterborne Commerce Statistics Center, Secretariat of Communications and Transport (Mexico), Waterborne Transport Institute (China); AAPA Surveys; various port internet sites.

Elaborated by the authors for the Atlantic case. Source: The American Association of Port Authorities, “World Port Rankings 2015 ,” Alexandria, Va, 2015, http://www.aapa-ports.org/unifying/content.aspx?ItemNumber=21048 and http://aapa.files.cms-plus.com/Statistics/WORLD%20PORT%20RANKINGS%202015.xlsx (accessed July 12, 2017).

(17), Bremen/Bremerhaven (24), Valencia (28), Algeciras-La Linea (29)[16]—and one is in the US—New York/New Jersey (23).

Logistics Improvement and the Expansion of Global Value Chains (GVCs)

When considering international trade, the traditional view is that each country is producing finished products that are exported to consumers in another country. This type of trade represents only one quarter of the total trade in goods and services. Today, three quarters of international trade consists of firms buying inputs and investment goods or services that contribute to the production process.[17]

What is more, international production, trade and investment are increasingly organized within so-called global value chains (GVCs) in which the different stages of the production process are dispersed across different countries. Globalization motivates companies to restructure their operations internationally through outsourcing and offshoring of activities.[18]

Global Value Chains

The development of GVCs is associated with the decline in the cost of shipping and its rising efficiency. This is particularly true of the intercontinental transport of manufactures between Asia, Europe and Latin America. Furthermore, technological advances—especially in the realm of information and communications technology—have also reduced trade and coordination costs. On the other hand, foreign direct investment (FDI) has also been a major driver of the growth of GVCs.[19]

In short, the emergence of GVCs continues to change the conditions of trade, and the international relations associated with it. These GVCs are

16. Algeciras-La Linea is a hub for distributing containers.

17. OCDE Trade and Agriculture Directorate, "Trade policy implications of GVC," November 2015 http://www.oecd.org/tad/trade-policy-implications-gvc.pdf (accessed July 5, 2017).

18. OCDE "Global Value Chains," http://www.oecd.org/sti/ind/global-value-chains.htm (accessed July 5, 2017).

19. OCDE-WTO-UNCTAD, *Report to G-20 on Implications of Global Value Chains for Trade, Investment, Development and Jobs. Prepared for the G-20 Leaders Summit Saint Petersburg (Russian Federation),* August 6, 2013, p.9 http://www.oecd.org/trade/G20-Global-Value-Chains-2013.pdf, (accessed July 28, 2014).

detected by observing how countries increasingly need foreign inputs for exports from their own firms that in turn can be reprocessed in partner countries.

Between 30 percent and 60 percent of G20 exports consist of intermediate inputs traded within GVCs. Compared 2009 with 1995, GVC participation has increased in almost all G20 economies, and particularly in China, India, Japan and Korea.[20]

For the European countries of the G20, like Germany and France, this share has also increased, (although less for Italy), as a result of the GVCs connecting these countries to Asia and Latin America. In Latin America, Mexico has the highest share of imported inputs used for exports (30 percent), mainly because of its strong trade ties with US. However, this share is somewhat lower for both Argentina and Brazil (around 10 percent in 2009). This implies that the exports originating in Asia and the EU use more intensively imported intermediate inputs than do the exports of the LAC region. Indeed, the exports of Asia and the EU incorporate 12 and 15 percentage points more foreign value-added, respectively, than the exports of Latin America. This suggests that the countries from these two regions are more involved in sequentially linked production processes than the countries in the LAC region.[21]

Global Value Chains, Maritime Security and International Relations

The significance of GVCs to international relations can found in the relationship between countries' participation in GVCs and their overall strategic approaches to certain aspects of foreign policy.

An empirical observation of G20 countries allows us to focus on this relationship. Between 30 percent and 60 percent of the exports of G20 countries in 2009 consisted of intermediate inputs traded within GVCs. It should be noted that of these countries, Saudi Arabia had the lowest share of imported inputs used to produce exports (around 1 percent in 2009), followed by Russia (5 percent), Brazil (9.5 percent) and United States (10 percent). By contrast, Canada, China, France, Germany, India, Italy, Korea, Mexico and Turkey all exceed 20 percent.[22]

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20. Ibid. p .8.

21. Juan S. Blyde, ed., *Synchronized Factories. Latin America and the Caribbean in the Era of Global Value Chains* (New York, 2014), p.17 https://link.springer.com/book/10.1007%2F978-3-319-09991-0 (accessed July 2, 2017).

22. OCDE-WTO-UNCTAD, ibid. pp. 8-9.

However, we should distinguish *backward* participation within GVCs—that is, the foreign value- added content of exports (also referred to as vertical specialization)—from *forward* participation in GVCs (the percentage share of a country's exports that are destined to be used as inputs other countries' exports).

Backward GVC participation corresponds to the value added of inputs that were imported to produce intermediate or final goods/services to be exported. The countries with the highest backward participation in 2011 were China, Korea, Mexico and Italy. Those with the lowest were Saudi Arabia, Brazil, Indonesia and Russia (see Table 3).

Backward GVC participation could be seen as proxy indicator for a country's broad strategic tendencies in foreign policy because countries that have strong backward GVCs have a greater strategic need for relative stability in the realm of maritime transport than those countries with less. This is because products exported from countries with strong backward GVC linkages are mostly parts or components with high value added coming from non-continental partners countries, which are assembled and re-exported.

This is the case for Korea and China, countries with the highest backward participation (see Table 3) and both highly dependent on the world's sea lanes. The case of Mexico is somewhat different due to the large amount of land transported trans-border trade with US. Although Mexico does not use maritime transport for trade with the US, the need for stability of land transportation becomes even more important in its case.

On the other hand, *forward* participation in GVCs represents the percentage of a country's exports used as inputs in the exports of third countries. Among the countries with the highest forward participation in 2011 were Saudi Arabia, Russia, Japan and Indonesia; among those with the lowest were China, Mexico, Turkey and Argentina (see Table 3).

This suggests that Saudi Arabia, Brazil, Indonesia and Russia—countries with relatively high forward participation (see Table 3)—participate more, on average, than Asian or European countries do as a supplier of value added to those farther downstream in the chain. On average, countries with highest levels of forward GVC participate more than Europe and Asia in international value chains as suppliers of primary inputs, while Europe and Asia participate more than the exporters of primary products as suppliers of manufacturing inputs.

Table 3. G20 Countries, GVC Participation, Total, Backward and Forward, % of Exports, 2011

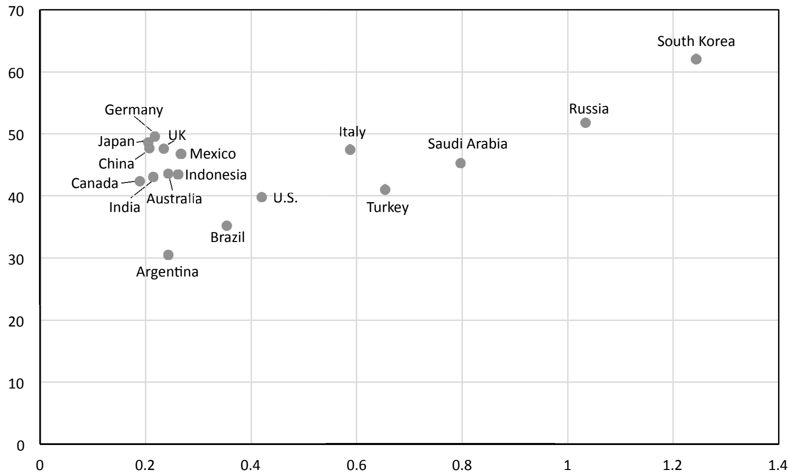
Country	Total GVC participation	Backward	Forward
G20 Countries with the Lowest Levels of Backward GVC Participation			
Saudi Arabia	45.3	3.3	42
Brazil	35.2	10.7	24.5
Indonesia	43.5	12	31
Russia	51.8	13.7	38.1
Argentina	30.5	14.1	16.4
Australia	43.6	14.1	29.5
Japan	48.6	14.6	32.8
United States	39.8	15	24.9
G20 Countries with the Highest Levels of Backward GVC Participation			
Korea	62.1	41.6	20.5
China	47.7	32.1	15.6
Mexico	46.8	31.7	15.1
Italy	47.5	26.4	21.1
Turkey	41	25.7	15.3
Germany	49.6	25.5	24.1
India	43.1	24	19.1
Canada	42.4	23.4	19
UK	47.6	22.9	24.7

Source: Elaborated from OECD/WTO (2016), "Trade in value added (Edition 2016)," OECD-WTO: Statistics on Trade in Value Added (database). http://dx.doi.org/10.1787/2644abe4-en (Accessed on 02 July 2, 2017).

Maritime transport is also very important for these countries with high forward participation. However, because they are exporters of primary products the value added is lower. Such countries are also more flexible in their response (either using alternative routes or oil tankers and bulk carriers) than the countries with backward links that need more secure and stable maritime routes for liner vessels.

There is also an interesting relationship between the *total participation* (i.e., backward *plus* forward) in GVCs and the armed forces per capita (see Figure 1). G20 Countries that have a strong total participation in GVCs tend to have less armed forces per capita. On the contrary, countries (G20) that have less participation in GVCs tend to have more armed forces per capita. Korea is an exception given the long and permanent confrontation on its peninsula. As an outlier, Korea is the G20 country with more participation in the GVCs and with more armed forces per capita.

Figure 1. Total GVC Participation and Armed Forces (as % of population), G20 Countries, 2015



Elaborated by the authors. Source: Table 3 and armed personnel, https://data.worldbank.org/indicator/MS.MIL.TOTL.P1 (accessed September 22, 2017), population https://data.worldbank.org/indicator/SP.POP.TOTL?view=chart (accessed September 22, 2017).

One could posit that countries that are less integrated into GVCs tend to follow more isolationist and unilateral strategies, and countries that are most highly integrated into GVCs tend to pursue more co-operative strategies with their neighbors and trading partners. As a result, such countries would be more open to multilateral strategies.

In the case of the Atlantic Basin, however, following the United States' renunciation of multilateralism and that country's recently announced departure from the Paris agreement, the EU (with a relatively high level of backward GVC participation) might seek to contribute to the stability of the maritime realm by forging some Atlantic Basin agreements on carbon emissions in the maritime industries.

Intermodal Interdependence between Maritime and Terrestrial Transportation

The efficiency of maritime transport and supply chains is based on the ability to arrive in the minimum time and at the minimum cost from the point of production to the point of distribution and sale. However, in a world in which international supply chains are no longer the relatively simple port-to-port affair that they once were, the overall effectiveness of international supply chains is also linked to—and dependent on—the efficiency of the inland distribution of international cargo arriving to a country by sea.

Contemporary international supply chains require an intermodal transportation network. An intermodal network consists of ships, trains, airplanes, trucks or even bicycles in cities (the latter closely linked to increasingly rapid and non-polluting distribution systems and e-commerce). The connections or transfer points between modes are called intermodal connectors. Service interruption or capacity failure anywhere on the network could lead to delays in shipments and increased costs. A failure in one mode is effectively a failure of the entire chain. Sufficient land-side capacity to keep cargo moving is essential for liner vessels to maintain their schedules.

To achieve maximum efficiency, investment in ports, containers, roads, trains, different types of vehicles, Wi-Fi and smartphones become necessary. These investments in turn benefit from the GVCs since the imported inputs are the basis for the value added of the goods and services that are exported.

There are some notable differences between U.S. and EU in transport connections and intermodal networks. The U.S. is the largest trading nation in the world and as such represents one of the largest markets for shipping liner companies and their customers. This makes the efficiency of the U.S. intermodal network very important to the efficiency of the global shipping liner network and to global supply chains. The Marine Transportation System National Advisory Council (MTSNAC) is a chartered federal body tasked with advising the Secretary of Transportation about matters related to the US intermodal network and its connections to maritime transport. The MTSNAC has been a World Shipping Council member since 2000.[23] In 2009, MTSNAC completed a report[24] that provided the Secretary with a series of recommendations to improve the marine transportation system, with a particular emphasis on intermodal freight movement.

Europe is another very large and important market. However, the European intermodal network poses unique challenges because many countries are land-locked, or do not have deep-water ports that can accommodate liner vessels. This means cargo often must transit long distances by truck, rail or barge, often through several countries, between the actual origin or desti-

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23. World Shipping Council, http://www.worldshipping.org/industry-issues/transportation-infrastructure/u-s-intermodal-network.

24. Marine Transportation System. National Advisory Council, "2009 Report to Secretary of Transportation ," Washington D.C. January 2009 www.worldshipping.org/pdf/MTSNAC_Report_2009_FINAL.pdf (accessed July 3, 2017).

nation and the port served by the liner vessel.[25] To close the gaps between member States, the EU adopted a new transport infrastructure policy in January 2014 that connects the continent from East to West, and North to South.[26] European Coordinators—high level personalities with long standing experience in transport, finance and European politics—are leading the drive to build the core network corridors, which represent the strategic heart of the trans-European transport network (TEN-T) and therefore deserve a concentrated amount of effort and attention for their financing, required cooperation, efficiency and quality. Core network corridors[27] were introduced to facilitate the coordinated implementation of the core network. They bring together public and private resources and concentrate EU support from the Connecting Europe Facility (CEF)[28] particularly to: remove bottlenecks, build missing cross-border connections and promote modal integration and interoperability.

The second generation of the work plans of the 11 European Coordinators (as approved in December 2016) establish the basis for action until 2030.[29] The links among different corridors such as the Atlantic and the Mediterranean will improve the intermodal network in Europe and tighten European connections with the Atlantic Basin.

Despite this deficit of corridors in Europe, there are isolated examples that reflect the existence of GVCs involving companies from both regions, in particular within the car industry (for the production and sales of parts and finished cars). Volkswagen has plants in both Latin America (Argentina, Brazil and Mexico) and Central and Eastern European (CEE) countries (Poland, Hungary, Czech Republic and Slovakia). Audi AG belongs to the Volkswagen group producing in Hungary, and has close intra-firm relations with Volkswagen do Brazil, Volkswagen de Mexico and Volkswagen Argentina. Renault's Slovenian subsidiary exports models to France, where

25. World Shipping Council, http://www.worldshipping.org/industry-issues/transportation-infrastructure/europe-intermodal-network (accessed June 25, 2017).

26. European Commission, Mobility and Transport, https://ec.europa.eu/transport/themes/infrastructure_en (accessed July 9, 2017).

27. European Commission, Mobility and Transport, https://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/corridors_en (accessed July 9, 2017).

28. The Connecting Europe Facility (CEF) is a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level https://ec.europa.eu/inea/en/connecting-europe-facility (accessed September 24, 2017)

29. European Commission, Mobility and Transport, Transport Infrastructure: Second Generation of the Work Plans https://ec.europa.eu/transport/node/4876 (accessed July 9, 2017).

they are finished and re-exported as French cars to subsidiaries in Latin America.[30]

Therefore, with better infrastructure in Latin America and better corridors in Europe, an improvement of the GVCs between the two regions can be expected and, consequently, an increase of maritime transportation. However, infrastructure is a necessary but not a sufficient condition; often it is growth in GVCs which creates pressures for better infrastructure (as has been the case with the transport corridor plans in Europe).

Trade in the Face of GHG Emissions from the Maritime Industry

Shipping is the least environmentally damaging mode of transport when its productive value is taken into consideration.[31] For example, international shipping accounts for 2.2 percent of the global emissions of carbon dioxide (CO_2). However, air-borne CO2 emissions from the shipping industry are a growing source of the overall greenhouse gas (GHG) emissions.[32] Together with combustion emissions of nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM) and non-methane volatile organic compounds (NMVOC), the CO_2 emissions of the world's commercial shipping fleet contribute to environmental problems that include global warming, sea level rise, ocean acidification and eutrophication,[33] as well as adverse effects on public health.[34]

30. EU-LAC Foundation, *Latin America, the Caribbean and Central and Eastern Europe: Potential for the economic Exchange*, (Hamburg, May 2014) https://eulacfoundation.org/en/documents/latin-america-caribbean-and-central-and-eastern-europe-potential-economic-exchange (accessed August 20, 2017).

31. IMO, http://www.imo.org/en/OurWork/Environment/Pages/Default.aspx (accessed July 8, 2017).

32. EMSA, http://www.emsa.europa.eu/main/air-pollution/greenhouse-gases.html (accessed July 8, 2017).

33. Ocean acidity is an indicator of the amount of carbon dioxide dissolved in water. Increased atmospheric CO_2 concentrations lower oceanic pH and carbonated ion concentrations rendering the oceans much less hospitable to many forms of marine life. Eutrophication is a process driven by the enrichment of water by nutrients. Phosphorus and compounds of nitrogen are responsible for the increased growth, primary production and biomass of algae that lead to degradation of ecosystem health and biodiversity. Nitrogen oxides from ships contribute to eutrophication as they are transferred via the atmosphere through precipitation.

34. Cullinane K and Cullinane S, "Atmospheric Emissions from Shipping: The Need for Regulation and Approaches to Compliance" (2013) 33 Transport Reviews, p. 377.

Maritime transport is not immune to the effects of climate change. Sea level rise is a major concern for coastal communities.[35] Adaptation plans for these regions are of paramount importance to the availability of maritime transport. Clearance under bridges near coasts will be reduced and port infrastructure will be threatened by changed sea level conditions. Other climate factors related to global warming involve more frequent and intense extreme weather conditions that will entail longer waiting times and less reliable shipments that directly translate into sizable losses of gains from trade.[36]

These prospective changes have led the IMO to regulate the contribution to atmospheric pollution of the shipping industry. However, it was not until 1988 that the issue was included in the work program of the IMO's Marine Environment Protection Committee (MEPC).

The contribution of the shipping industry to climate change was put forth in the Third IMO Greenhouse Gas Study.[37] For the period 2007-2012, the annual average CO_2 emissions for international shipping accounted for 2.6 percent of the global total. However, total GHG emissions from shipping accounted for 3.1 percent of the global total. Nitrogen oxides (NOx) and sulfur oxides (SOx) are responsible for indirect formation of ozone and aerosol warming at the regional scale. For the same period, NOx and SOx emissions from international shipping represented 13 percent and 12 percent of global NOx and SOx from anthropogenic sources, respectively.[38] International shipping is the dominant source of the total shipping emissions of CO_2 and other GHGs.[39] CO_2, other GHGs, and combustion emissions of NOx, SOx, PM and NMVOC correlate with fuel consumption. Fuel is consumed for propulsion power, electrical production and auxiliary systems

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35. The Washington Post, https://www.washingtonpost.com/news/energy-environment/wp/2017/06/26/sea-level-rise-isnt-just-happening-its-getting-faster/?utm_term=.de827243819f (accessed July 8,2017).

36. An increase in transport costs of 10 percent would decrease trade by 20 percent. Andreas Kopp, "Transport costs, trade and climate change," in Regina Asariotis and Hassiba Benamara (eds), *Maritime Transport and the Climate Change Challenge* (Earthscan 2012).

37. IMO, "Third IMO GHG Study 2014, Reduction of GHG from ships," MEPC at its 67th session.

38. IPCC Fifth Assessment Report, IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

39. Third IMO GHG Study 2014: "nitrous oxide (N_2O) emissions from international shipping account for the majority (approximately 85 percent) of total shipping N_2O emissions, and methane (CH_4) emissions from international ships account for nearly all (approximately 99 percent) of total shipping emissions of CH_4."

Table 4. Bottom-up CO2 Emissions from International Shipping, by Ship Type, in 2012

Ship Type	Fuel Consumption ('000 tons of oil eq)	CO2 emissions (million tons)
Vehicle*	7,900	25
Ro-Ro**	9,300	29
Refrigerated bulk	5,700	18
Other liquid tankers	300	1
Oil tanker	39,700	124
Liquefied gas tanker	15,700	46
General cargo	21,700	68
Ferry-RoPax***	9,900	27
Ferry-pax only****	3,700	1
Cruise	11,100	35
Container	66,000	205
Chemical tanker	17,500	55
Bulk carrier	53,400	166

* cargo-carrying transport ships whose capacity is measured in vehicle units.

** Ro-ro (roll-on/roll-off): wheeled cargo carrier.

*** Ro-pax: vehicle-and-passenger ferry.

**** Pax-only: passenger-only ferry.

Source: Elaborated from IMO, "Third IMO GHG Study 2014, Reduction of GHG from ships," MEPC at its 67th session p.6.

and mainly by three types of ships: oil tankers, container ships and bulk carriers. For all ship types, the main engines (propulsion) are the dominant fuel consumers.[40]

Airborne emissions from shipping can be reduced by improving fuel efficiency, that is, reducing fuel consumption. Better fuel efficiency implies reduced fuel costs. However, the interest of the maritime industry in taking unilateral action to maximize fuel efficiency is diminishing as the "growth in the sheer volume of shipping has far outweighed any fuel efficiency savings."[41]

40. IMO, "Third IMO GHG Study 2014, Reduction of GHG from ships," MEPC at its 67th session p.3.

41. Cullinane K and Cullinane S, "Atmospheric Emissions from Shipping: The Need for Regulation and Approaches to Compliance," (2013) 33 Transport Reviews, p. 377.

Operational measures such as developing better logistics, port efficiency and avoiding less than full back-hauls or ballast voyages entail bigger profits as they positively affect productivity. The industry has already taken advantage of these operational measures. Technical measures such improving engines for better fuel efficiency or improving the hull design require research investments that the industry is not willing to assume. There are no incentives left to the industry to offset environmental externalities relating to air emissions.

Tellingly, the Third IMO GHG study also concludes that:

> Emissions projections demonstrate that improvements in efficiency are important in mitigating emissions increase. However, even modeled improvements with the greatest energy savings could not yield a downward trend. Compared to regulatory or market-driven improvements in efficiency, changes in the fuel mix have a limited impact on GHG emissions, *assuming that fossil fuels remain dominant*. (Authors' emphasis)

According to the United Nations Conference on Trade and Development (UNCTAD) Review of Maritime Transport in 2016: "The world fleet grew by 3.5 percent in the 12 months to 1 January 2016 (in terms of dead-weight tons (dwt)). This is the lowest growth rate since 2003, yet still higher than the 2.1 percent growth in demand, leading to a continued situation of global overcapacity."[42] Nevertheless, this is clearly only a cyclical phenomenon: projections of maritime transport demand foresee a rapid increase in future demand for unitized cargo transport.

Indeed, maritime CO_2 emissions are projected to increase significantly in the coming decades. The Third IMO GHG Study projects an increase of anywhere between 50 percent and 250 percent during the period to 2050.[43] Although CO_2 emissions from shipping industry have accounted for anywhere from 2 percent to 3 percent of the global totals, without any further action, such maritime emissions are expected to rise to 5 percent by 2050.[44] Furthermore, methane (CH_4) emissions are also expected to increase rapidly as the share of LNG in the fuel mix increases.[45]

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42. UNCTAD Review of Maritime Transport 2016, http://unctad.org/en/PublicationsLibrary/rmt2016_en.pdf (accessed July 8, 2017).

43. IMO, "Third IMO GHG Study 2014, Reduction of GHG from ships," MEPC at its 67th session p. 20.

44. EMSA, http://www.emsa.europa.eu/main/air-pollution/greenhouse-gases.html (accessed July 20, 2017).

45. On the other hand, as a result of Tier II and III engines entering the fleet, NOx emissions are projected to increase at a lower rate than CO2 emissions. Particulate matter

This increase in emissions is not compatible with the Paris Agreement's central aim of keeping a global temperature rise this century well below 2 degrees Celsius above pre-Industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. The IMO, as the international organization entrusted with the prevention of pollution by ships, is bound by the Kyoto Protocol to pursue limitation or reduction of GHG emissions from marine bunker fuels. However, the IMO's regulatory efforts to date are far from achieving a reduction in emissions in line with the goals set forth in the Paris Agreement.

International Regulation of Maritime Industry Emissions

Part XII of the Law of the Sea Convention (LOSC) on the Protection and Preservation of the Marine Environment is an essential component of the Convention and serves as the framework for the regulation of marine pollution carried out by the IMO. The negotiation of this part of the LOSC played an important role at United Nations Convention of the Law of the Sea (UNCLOS) III.[46]

Prior to the adoption of the LOSC, states were merely empowered to regulate marine pollution,[47] but not obliged to do so. Coastal states had no prescriptive power beyond the territorial sea to regulate operations of ships, while flag states had an ill-defined duty to regulate marine pollution. Indeed, there was no definition of the prescriptive jurisdiction, rendering it not protective enough of the interests of coastal states. There was also no requirement to comply with international standards, and a number of important flag states were not a part of the International Convention for the Prevention of Pollution from Ships (MARPOL) or other international instruments regulating vessel-source pollution.

The adoption of the LOSC entailed the introduction of a general duty on states to protect and preserve the marine environment[48] and a redefined framework for regulation of marine pollution. The LOSC also specifies that rules and standards regarding vessel-source pollution shall be established

(PM) is also expected to experience an absolute decline, at least up to 2020, while SOx emissions are projected to decline through 2050 as the result of the imposition of sulfur caps.

46. M.H. Nordquist and others, *United Nations Convention on the Law of the Sea, 1982: a commentary* (Martinus Nijhoff 1991).

47. A.E. Boyle, 'Marine Pollution Under the Law of the Sea Convention' (1985) 79 The American Journal of International Law 347, p. 347.

48. Article 192 of the Law of the Sea Convention (LOSC).

through the competent international organization—that is, the IMO. The MARPOL Convention is the response of states to that obligation. The regulation of air pollution from ships in MARPOL is constructed upon the framework for jurisdiction set up in the LOSC.[49]

The LOSC framework for vessel-source pollution establishes the extent to which states may regulate this type of pollution. While elaborating Part XII of the LOSC on Protection and Preservation of the Marine Environment, difficulties arose when it came to creating a regime for vessel source pollution.[50] Maritime states had an interest in making the regime of flag state jurisdiction prevail over the jurisdiction regime of coastal states. They feared that unilateral regulation of vessel-source pollution by coastal states would hinder their navigational freedom and increase their operating costs. A coalition of developed and developing coastal states with no shipping interests fought this position at UNCLOS III but maritime states were able to limit any effort of expanding coastal state jurisdiction over vessels.[51]

Flag States

The resulting regulation of vessel-source pollution in the LOSC reflects the pressure displayed by maritime interests, given that flag states bear the primary responsibility of prescribing and enforcing rules on vessel-source pollution. The obligations of flag states with respect to vessels flying their flag (art. 94 LOSC) include maintaining a register of the ships and assuming jurisdiction under its internal law over each ship sailing with respect to administrative, technical and social matters. This provision also establishes that flag states shall adopt measures on matters relating to, among others, the construction (relevant for controlling air pollution from ships) and manning of the ship, the use of signals, the surveillance of the ship, the qualifications of the masters and officers, the training of the crew and acquaintance of the crew with the applicable international regulations concerning the safety of life at sea and prevention of marine pollution. In taking measures to prevent marine pollution, flag states must conform to generally accepted international regulations, procedures and practices. By means of this provision, the LOSC makes international standards compulsory for all ships through the rule of reference.

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49. MARPOL, article 9.3: "the term 'jurisdiction' shall be construed in light of international law in force at the time of application or interpretation of the present Convention."

50. Tan AKJ, *Vessel-Source Marine Pollution*, p. 199.

51. Ibid.

It is important to note, however, that while the top five ship-owning economies are Greece, Japan, China, Germany and Singapore, the top five economies by flag registration are Panama, Liberia, the Marshall Islands, Hong Kong and the Republic of Korea.[52] As a general trend, ship-owners began to flag their vessels in foreign registries during the 1970s (and even earlier) with the objective of being subject to less stringent safety and environmental regulation.

The registries of developed states have traditionally required that the vessels registered in their registries be owned and flagged by the flag state nationals. These are closed registries which traditionally have required vessels to comply with stricter regulations, entailing added costs to the operation of the ship. Registering a ship in an open registry—rather than in one's own national (closed) registry—is a practice with significance for the ratification and implementation of relevant conventions dealing with vessel-source pollution.

Coastal States

Coastal states are empowered to adopt laws and regulations for the prevention, reduction and control of vessel-source pollution—but they are not bound to do so. The measures that a coastal state can prescribe over vessel-source marine pollution vary according to the distinct ocean zones. They include discharge standards, CDEM standards[53] and navigational standards.

Deriving from national and international standards (including CDEM and general navigational standards), coastal states enjoy unlimited prescriptive and enforcement authority—within both its ports and internal waters—for the prevention and reduction of marine pollution, and for the control of the marine environment. However, a coastal state's authority could be limited by bilateral treaties of friendship, commerce or navigation that guarantee port access.

Within its territorial sea, a coastal state is sovereign, although its authority is circumscribed by the interests of maritime states in free navigation. The laws and regulations that the coastal states can adopt for vessels in their territorial sea shall not apply to the design construction, or to the manning and/or equipping of foreign ships unless they are giving effect to generally accepted international rules and standards. Therefore, coastal states can pre-

52. UNCTAD, http://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=1650 (accessed July 25, 2017).

53. Construction, design, equipment and manning.

scribe national discharge standards (and national navigation standards) but not national CDEM standards. Enforcement of these standards consists in undertaking physical inspections and instituting proceedings against a vessel in violation of those standards.

On the other hand, the jurisdiction of coastal states within their respective exclusive economic zone (EEZ) is highly circumscribed. This jurisdiction is limited to adopting regulations that give effect to generally accepted international rules and standards established by the IMO. This provision leaves no room for states to adopt national discharge, CDEM or navigation standards unless they are prescribed for special[54] or ice-covered areas.

IMO Action on Maritime Emissions

It is to this jurisdictional framework (i.e., EEZs) that the international rules on air-borne emissions from ships established by the IMO need to respond. MARPOL is the IMO's instrument dealing with operational discharges from ships, that is, discharges stemming the normal operation of a vessel.[55] It was in the late 1980s that the IMO started work on the prevention of air pollution from ships.[56] In the early stages, the IMO had recognized the scientific evidence of the negative effects on the environment and human health of emissions to the atmosphere from numerous sources. Ships were regarded as co-responsible for this type of pollution, as one of the sources that generates air pollution.

The international rules on air-borne emissions from ships were added to MARPOL by the means of a Protocol adopted at a Conference of the Parties held in London in 1997. The Protocol of 1997 added Annex VI to MARPOL and it was entitled Regulations for the Prevention of Air Pollution from Ships. The Conference also adopted the Technical Code on Control of Emissions of Nitrogen Oxides from Marine Diesel Engines (NOx Technical Code). Annex VI entered into force in 2005.

Annex VI of MARPOL limits the main pollutants in a ship's exhaust gas (SOx and NOx), prohibits deliberate emissions of ozone depleting substances, regulates shipboard incineration and emissions of volatile organic

54. The IMO shall determine whether an area requires special measures for recognized technical reasons in relation to its oceanographical and ecological conditions.

55. Otherwise known as the 1973 International Convention for the Prevention of Pollution from ships.

56. IMO, *MARPOL: Annex VI and NTC 2008 with Guidelines for Interpretation* (2013), p. 1.

compounds from tankers. Annex VI also contains CDEM standards concerned with the replacement or modification of diesel engines, exhaust gas cleaning systems and shipboard incinerators.

Amendments to MARPOL adopted in 2011 added a chapter to Annex VI on Regulations on Energy Efficiency for Ships. These amendments responded to the aforementioned mandate of the Kyoto Protocol according to which a number of steps were to be taken in order to tackle GHG emissions from shipping. A first step consisted in assessing GHG emissions from ships. Once a study was issued, the IMO Assembly urged the MEPC to "identify and develop the mechanism or mechanisms needed to achieve the limitation or reduction of GHG emissions from international shipping."[57] This provision also urged the MEPC to give priority to the establishment of a GHG emission baseline, the development of a methodology to describe the GHG efficiency of a ship in terms of a GHG emission index for that ship, the development of guidelines by which the GHG emission indexing scheme may be applied in practice and the evaluation of technical, operational and market-based solutions.

The amendments to Annex VI introduced the regulation of GHG emissions from ships into MARPOL. This regulation establishes different degrees of obligations for ship-owners. It applies to all ships of 400 gross tonnage and above. All ships with these characteristics must keep on board a ship-specific Ship Energy Efficiency Management Plan (SEEMP). The MEPC adopted guidelines for the development of the SEEMP in which it recognizes that "there are a variety of options to improve efficiency—speed optimization, weather routing and hull maintenance, for example—and that the best package of measures for a ship to improve efficiency differs to a great extent depending upon ship type, cargoes, routes and other factors."[58] Because of this, ship-owners have discretion to adopt the energy efficiency measures that they consider appropriate and the goal they aim at achieving. The guidelines emphasize that the goal setting is voluntary. The purpose of this Plan is to provide "a possible approach for monitoring ship and fleet efficiency performance over time."[59] Thus, what will move ship-owners to adopt energy efficiency measures is economic gain rather than a prescriptive requirement.

57. Resolution A.963(23) of 5 December 2003 para. 1.

58. Resolution MEPC.213(63) 2 March 2012 para. 4.1.2.

59. Ibid.

There are binding obligations in Annex VI to limit GHG emissions from ships. These, however, apply only to newly constructed ships or ships that have undergone major conversion. Ship-owners shall meet the required Energy Efficient Design Index (EEDI). The EEDI is determined by a formula that varies according to the ship's size and type. The requirements of the EEDI are to be attained over time. They are applied in four phases, each with a higher rate for reduction of emissions. The reason for the progressively stringent targets is the expectancy that technology advancements will allow for ships with lower GHG emissions. In order to improve technology so that it is possible for ships to comply with the required EEDI, Annex VI establishes that parties shall promote the development of technology. The IMO is obliged to review the targets set in each phase in order to evaluate if they are attainable given the status of the technological developments. In the case where the technology allows for more stringent targets, these should be reviewed. In the same way, if technology has not improved as expected, the targets will need to be review if they are unattainable.

Amendments to MARPOL adopted in 2016 will require that all ships of 5,000 tonnage and above record and report their fuel oil consumption. The data collection will be reported to the flag states which then will transfer it to an IMO Ship Fuel Consumption Database. These amendments are another step into the IMO's three-step approach to reduce GHG emissions. The step following the data collection is analysis. Such analysis will determine what further measures shall be required.[60]

The IMO's regulations on GHG emissions are widely regarded as insufficient to address the expected increase in shipping emissions. They are far from achieving a reduction in emissions that is line with the goals of the Paris Agreement. For this reason, action in this regard might arrive in the form of a unilateral, regional response.

Unilateral EU Action instead of Multilateralism

The first instrument to ever regulate sulfur oxides and nitrogen oxides from the burning of fossil fuel is the 1979 Convention on Long-Range Transboundary Air Pollution. This instrument provided a regional response to sulfur and nitrogen oxide emissions for North America and Europe. The 1985 Protocol on the Reduction of Sulfur Emissions or their Transboundary Fluxes

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60. IMO, http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Data-Collection-System.aspx (accessed August 10, 2017).

to the Convention did not specify its scope, resulting in the potential inclusion of emissions from ships. However, when the time came to further the reduction of sulfur emissions with a new protocol, the parties to the Convention agreed not to tackle emissions from ships under this regime and instead to pursue emissions reductions within the context of IMO in order to generate a global response to the issue. Similarly, another protocol to this Convention established a series of targets to reduce national annual nitrogen oxide emissions. Because the scope of this Protocol referred to stationary *and* mobile sources of nitrogen oxides, ships are included in the definition of mobile sources. Nevertheless, the parties to this Convention never directly addressed emissions from shipping because they already agreed that such emissions would be better regulated at the global level through the IMO.

The IMO began work on air pollution from ships in 1988 following a submission from Norway. At the same time, the Second International Conference on the Protection of the North Sea issued a declaration from the ministers of North Sea states that compelled them to initiate actions to improve quality standards of heavy fuel oil and reduce marine and atmospheric pollution at the IMO. After further submissions by Norway in 1990, which included an overview on air pollution from ships, the MEPC developed a draft Annex to MARPOL over the course of six years. The draft was adopted in 1997 and it added Annex VI to MARPOL, which set the standards for the sulfur content of fuel oil used on board ships, established standards for the construction and design of ship engines allowing a maximum of nitrogen oxide emissions at a given speed and prohibited deliberate emissions of ozone depleting substances.

Regional initiatives have proven to be very important for the global regulation of sulfur and nitrogen oxides. In the same way, the lack of a global regulation providing an effective response to reducing shipping emissions has lead the EU to consider including maritime CO_2 emissions in its Emission Trading Scheme (ETS). Indeed, the EU institutions are currently conducting a revision of the ETS Directive for the period 2021–2030 in which maritime emissions are included in the ETS in the absence of an agreement at the IMO. In 2015, the European Parliament submitted a legislative proposal aiming at achieving at least a 43 percent reduction in GHG by 2030 in comparison with 2005 levels. To this end, in the adoption of its first reading position it was agreed that maritime CO_2 emissions should be accounted for in EU ports and during voyages to and from them. These measures would also imply the creation of a maritime climate fund to offset shipping emissions, improve energy efficiency and encourage investment in technologies cutting CO_2 emissions from the sector.[61]

The EU's first step towards cutting domestic GHG emissions from shipping is the Regulation 2015/757 on the Monitoring, Reporting and Verification of Carbon Dioxide emissions from Maritime Transport.[62] This regulation amends Directive 2009/16/EC and from 2018 it will apply to all ships above 5,000 tonnage voyaging to, from and between ports under the jurisdiction of EU member states.

Ship-owners have expressed their discontent with the inclusion of shipping emissions in the EU ETS as they will be charged for carbon pollution in EU waters. They have argued through the International Chamber of Shipping and the European Community Shipowners' Association that this will put unrealistic pressure on the IMO that will hurt a global sector.[63] However, cargo owners and European ports have supported the initiative as they are willing to commit to the challenge.[64]

Conclusion

In maritime transport, energy commerce occupies the first place in terms of volume. The volume of manufactured products has been traditional lower, although since the 'container revolution' there has been a steady increase in container volumes. An analysis of the container category of maritime transport reveals that: a) the Atlantic basin is relatively less important in container transportation than other ocean basins despite the tight and dense connection between Europe and America; b) intermodality in maritime and land transport is the central axis of development of GVCs; c) the EU has an intermodal network that poses unique challenges because many countries are landlocked, or they do not have deep-water ports to accommodate liner vessels;

61. European Parliament, http://www.europarl.europa.eu/legislative-train/theme-resilient-energy-union-with-a-climate-change-policy/file-revision-of-the-eu-ets-2021-2030 (accessed August 20, 2017).

62. Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC.

63. Ship and Bunker, https://shipandbunker.com/news/emea/113801-european-parliament-approves-inclusion-of-shipping-in-european-ets (accessed August 20, 2017).

64. Transport and Environment, https://www.transportenvironment.org/news/shipowners-isolated-maritime-industry-supports-eu's-'first-move'-regulate-co2 (accessed August 20, 2017).

and d) the increase in container transportation, associated with its efficiency and lower costs, has implications for the increase of CO_2 emissions that must be resolved within a global governance framework.

The regulation of emissions from shipping is still in its early stages. While developments at the IMO are slow, action is increasingly required to offset the impact of increasing GHG emissions from shipping. Because of this, the EU has stepped in to develop a regional regime as the framework for the regulation of these emissions, as the LOSC allows for such a regime. The EU's work on shipping emissions has received strong support from EU institutions as well as from European ports and cargo owners.

The Atlantic Basin is, despite being less important than other basins in terms of maritime volume transported, capable of driving such global environmental policies. The EU should incorporate maritime emissions into its overall regional emissions regime and into its emissions trading system. The EU's heavy weight in global trade will draw much of global transportation within its regulatory reach. The EU should then also attempt to engage in Atlantic Basin collaboration on investment in maritime transport infrastructure and maritime emissions reduction with other partners in the Atlantic Basin, particularly in Africa and Latin America, but also in North America, despite current US reticence toward international energy and climate cooperation (possibly even through an extension to the maritime realm of the existing 1979 Convention on Long-Range Transboundary Air Pollution). Finally, as has been highlighted by the Atlantic Future research project, experiences in the Atlantic Space provide case studies that together may be considered a laboratory for multilateralism at global level.[65]

65. Jordi Bacaria and Laia Tarragona, eds., *Atlantic Future. Shaping a New Hemisphere for the 21st century: Africa, Europe and the Americas* (Barcelona, 2016). https://www.cidob.org/es/publicaciones/serie_de_publicacion/monografias/monografias/atlantic_future_shaping_a_new_hemisphere_for_the_21st_century_africa_europe_and_the_americas (accessed August 22, 2017).