The Impact Of Globalisation On International Maritime Transport Activity:

Past Trends And Future Perspectives

Sustainable Intermodal Freight Transportation Research (SIFTR)

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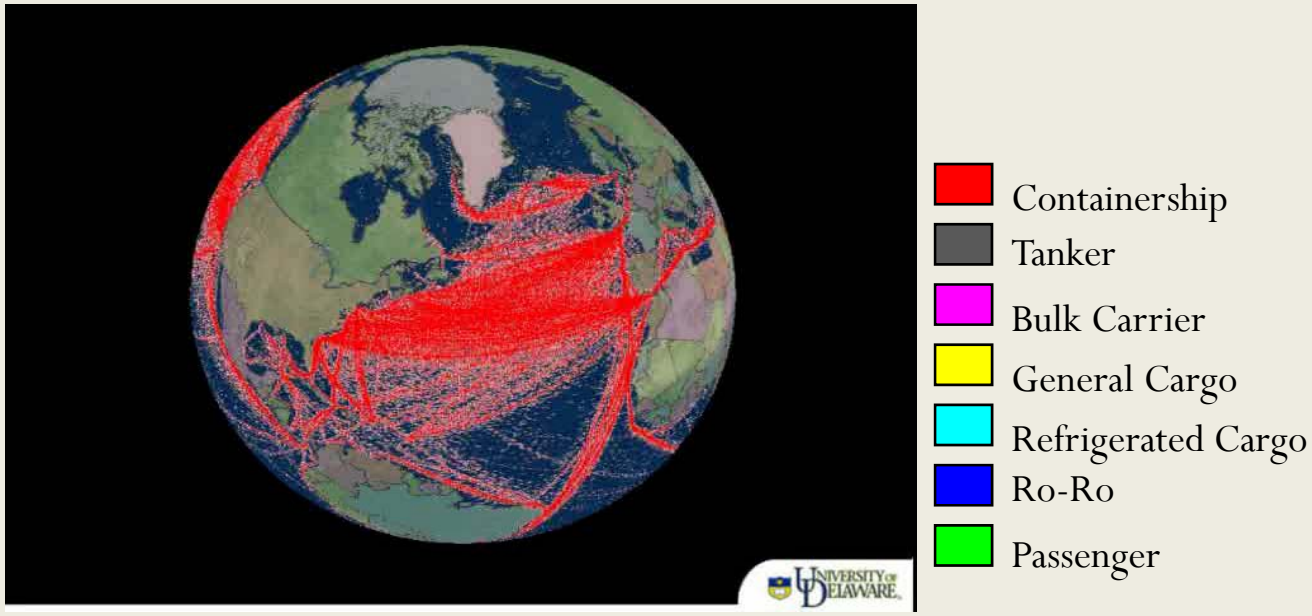


Overview of Paper and Presentation

- Maritime shipping and multimodal goods movement
- Global economic growth coupled with shipping, trade
- Maritime technology responds to globalization signals
- Maritime energy use and environmental impacts
  - Energy and power trends
  - Characterizing fleets using activity-based data vs. statistics
  - Taxonomy of maritime shipping environmental impacts
- Sustainable intermodal freight transport and shipping

Maritime Shipping and Goods Movement
A tradition of stewardship and service to society

They that go down to the sea in ships, that do business in great waters; these see the works of the Lord, and his wonders in the deep.

(Nature) *Psalm 107, KJV*

As by means of water-carriage a more extensive market is opened to every sort of industry ..., so it is upon the sea-coast, and along ... navigable rivers, that industry of every kind naturally begins to subdivide and improve ..., and ... not till a long time after that those improvements extend themselves to the inland parts of the country.

Adam Smith: http://www.adamsmith.org/smith/won-index.htm

Phoenicians

Age of Sail

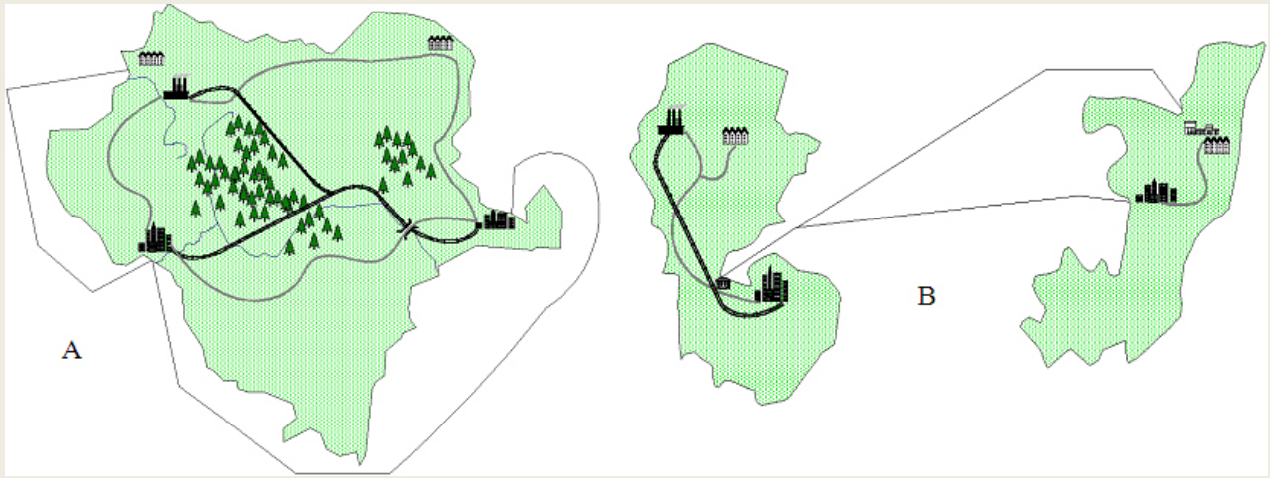
Coal-fired steam

Marine diesel

Ships of the 21st Century?

Ocean shipping among intermodal transport

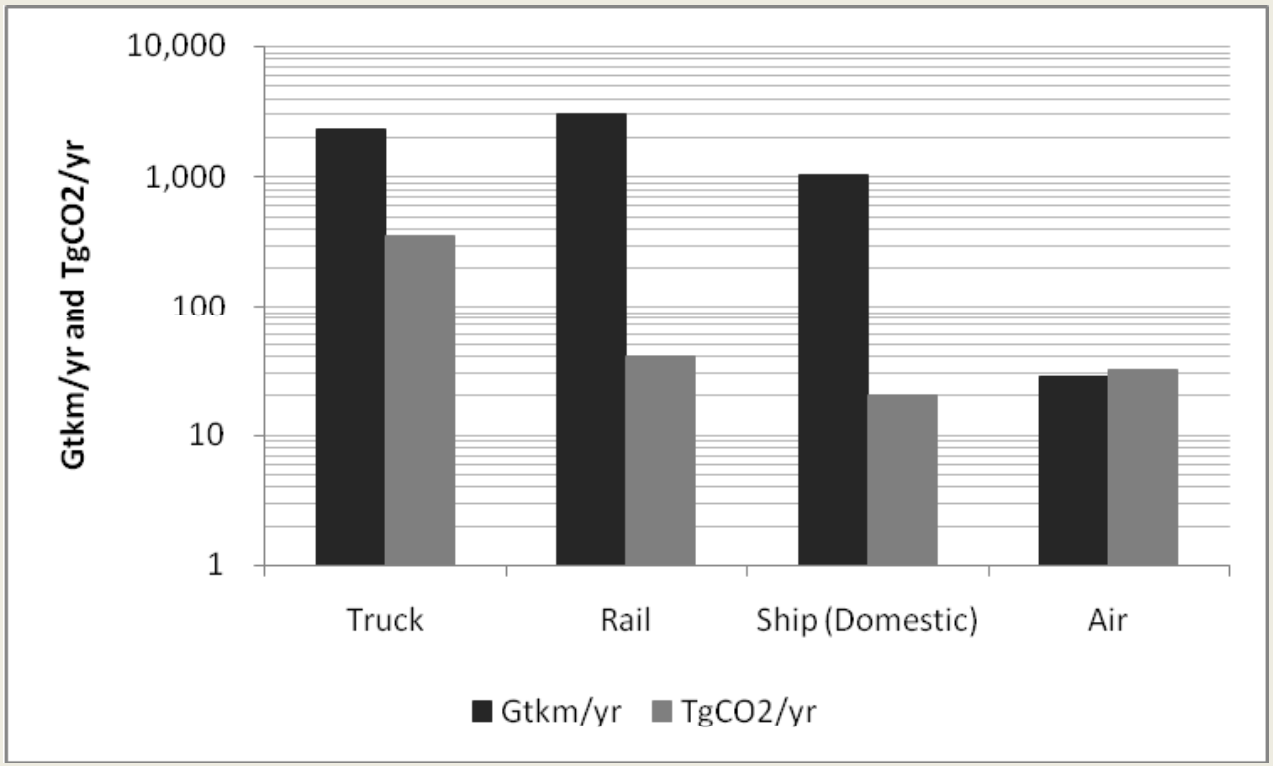
- Global freight transportation system: ocean and coastal routes, inland waterways, railways, roads, and air freight



- Ocean shipping serves both as a substitute and as a complement for other freight modes

Mode share comparisons:
Cargo demand and CO_2 emissions

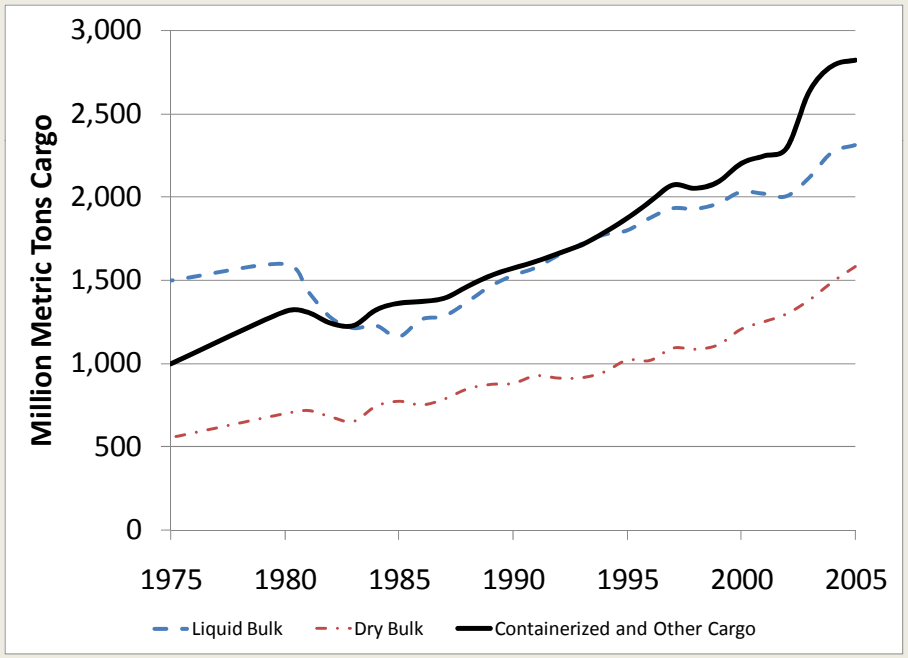
- Trucking is 40-45% of total work (ton-kilometers)



Source : Bureau of Transportation Statistics (2007); Energy Information Administration (2007).
Note that units are on log scale

Unitized cargoes grow faster than bulk cargoes

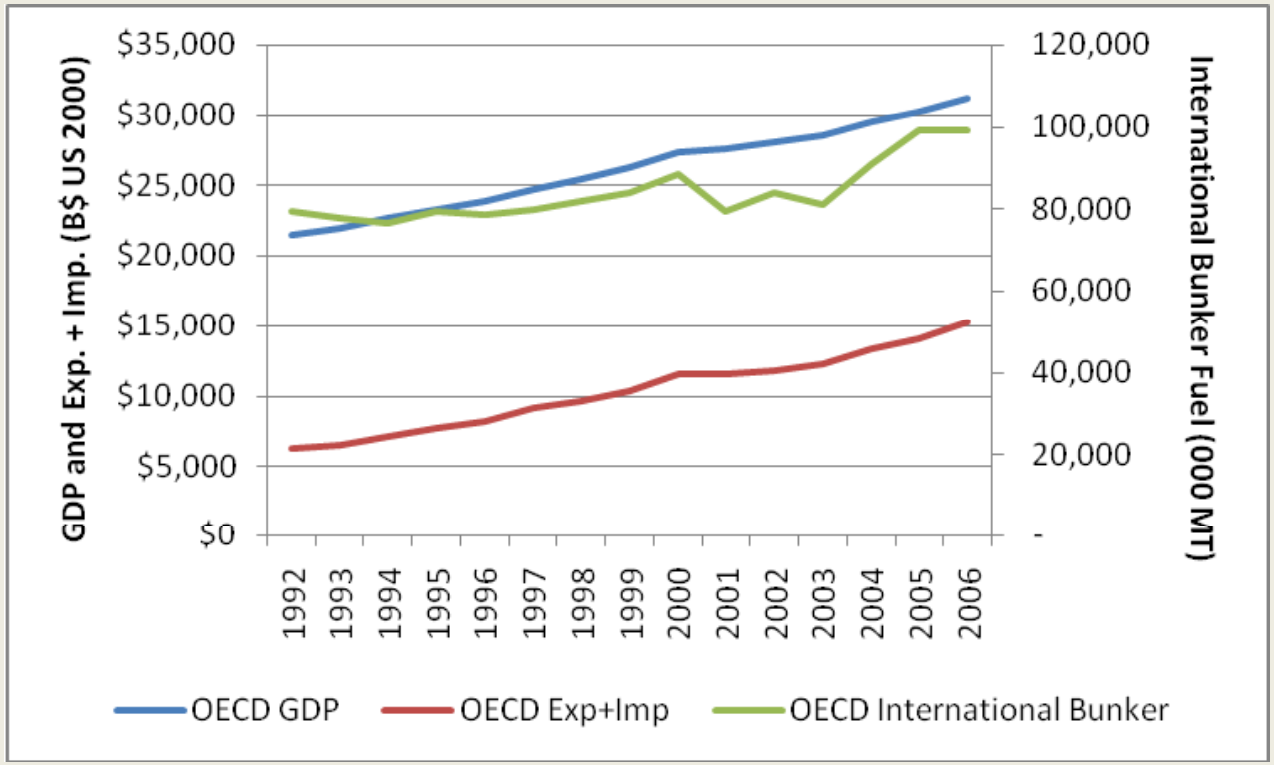
- Globalization has encouraged transactions of goods and services in smaller packets delivered "just-in-time"



- Labor advantages and inexpensive transport allow materials on one continent to be shipped to another for intermediate processing, moved to a third continent for assembly, and then delivered to market

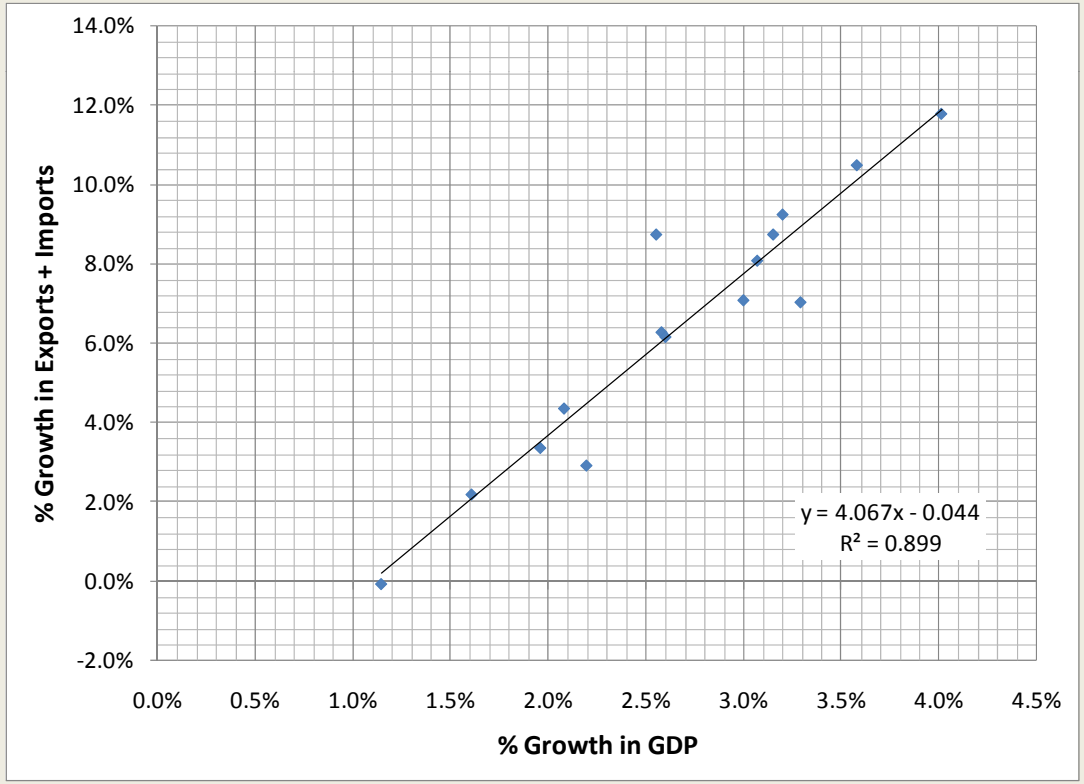
Economy, Transport, Energy are Coupled

- For every percentage increase in GDP for OECD, there has been ~4% rise in trade over this period



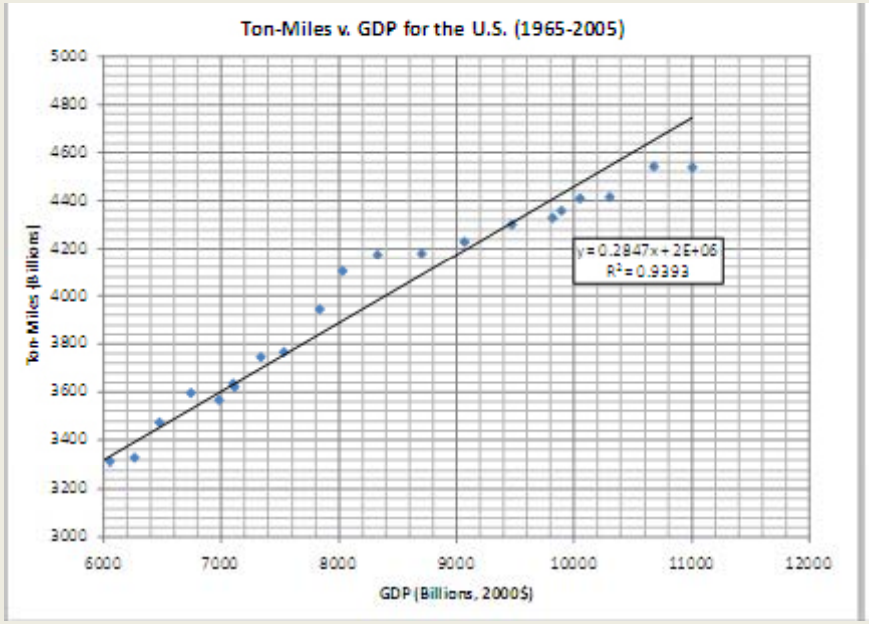
Relationship between OECD economic growth and growth in exports and imports

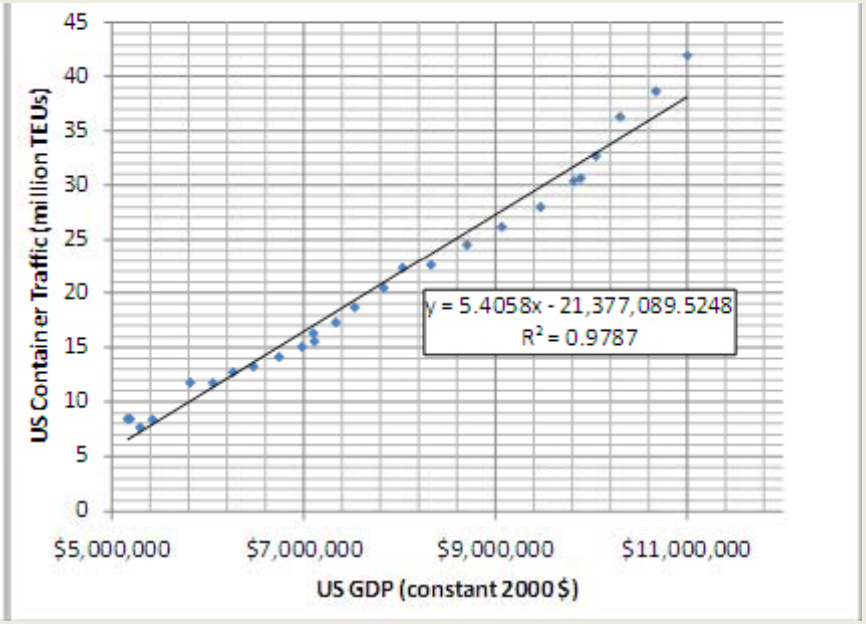
- For every one percentage increase in GDP for OECD, there has been ~4% rise in trade over 1992-2006



Economic coupling with goods movement can be directly measured

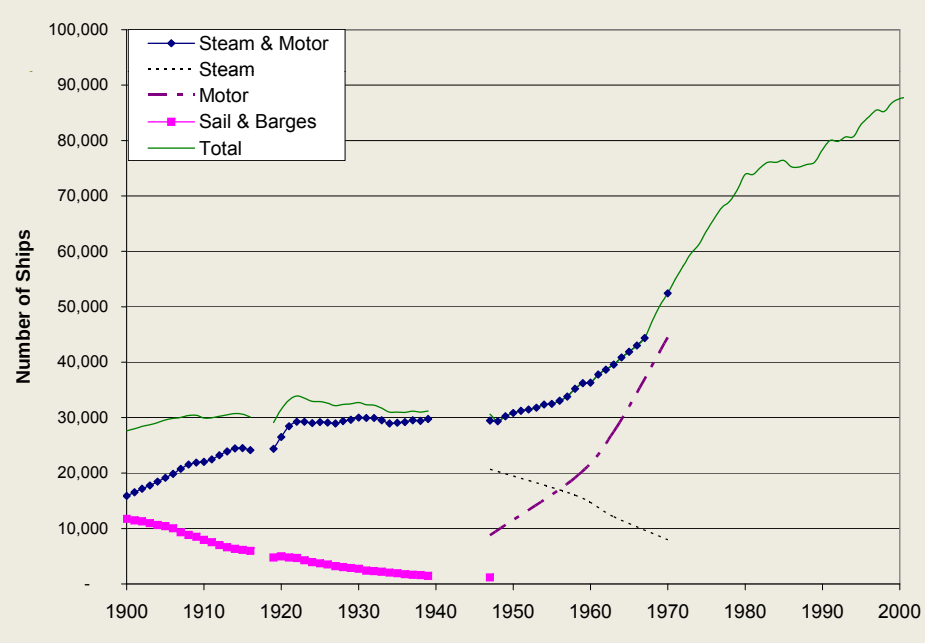
- Relationship between cargo shipments and container traffic (TEUs) and GDP as measured in ton-miles for the U.S



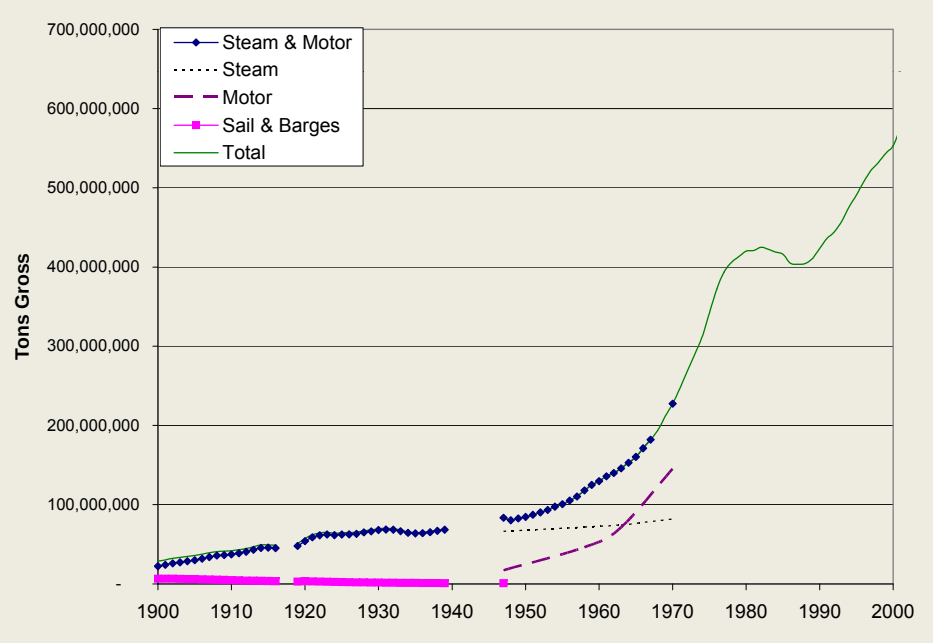


Technology shift during last century

Transition by number of ships slower than by tonnage



Number of ships in fleet
by vessel technology

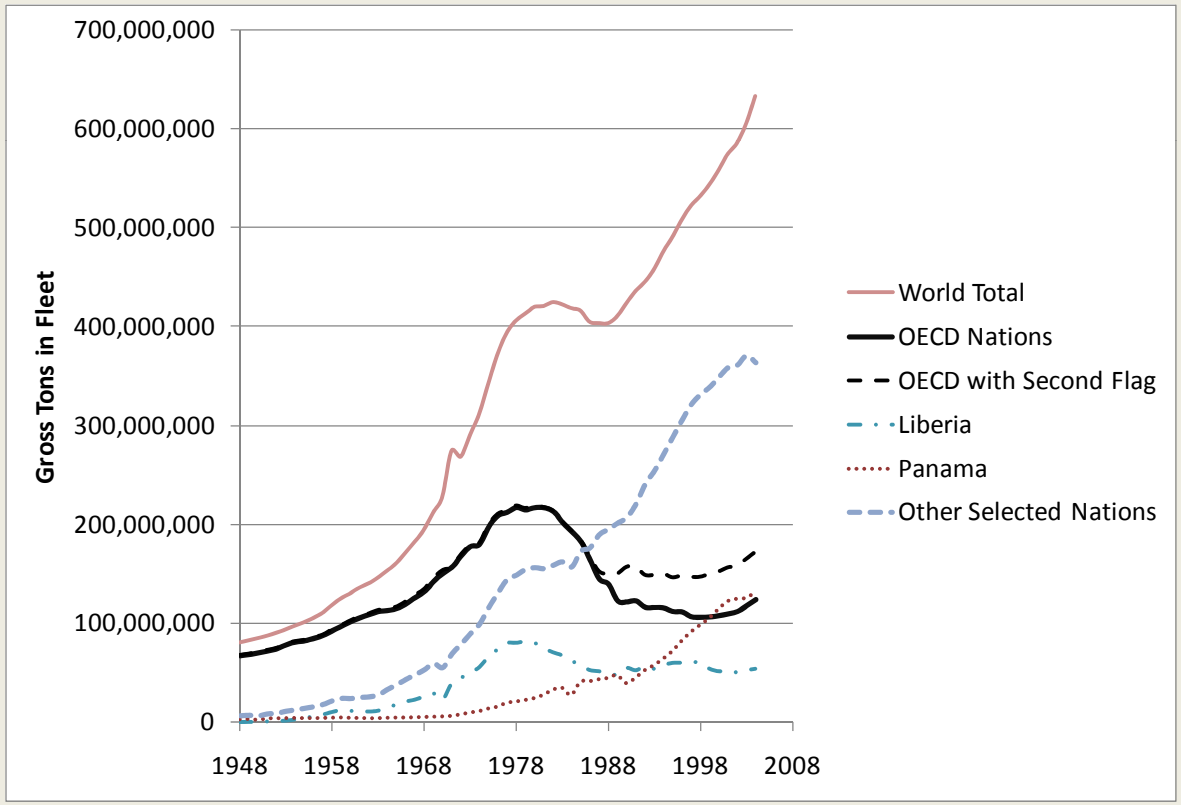


Gross maritime shipping tonnage
by vessel technology

Corbett, J.J., Marine Transportation and Energy Use, in *Encyclopedia of Energy*, edited by C.J. Cleveland, pp. 745-748, Elesvier Science, San Diego, CA, 2004

Trends in global fleet cargo capacity

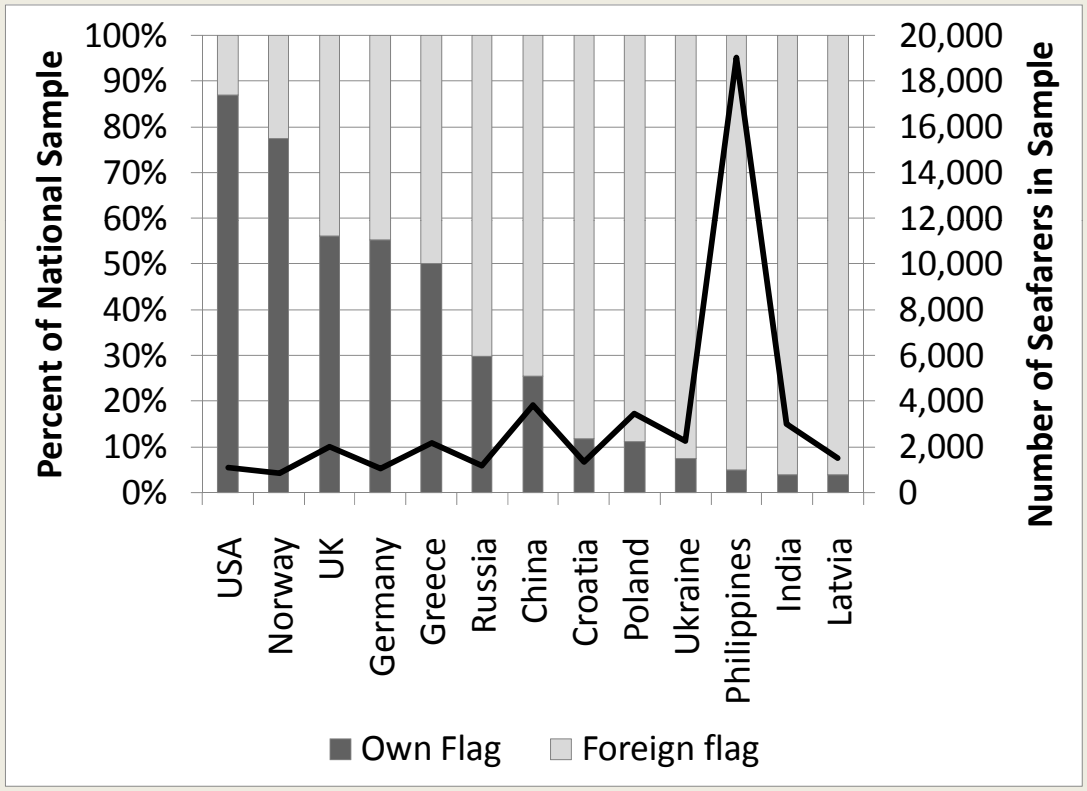
- Fleet capacity (gross tonnage) increased significantly with globalization
- Vessel flags have largely transitioned from OECD nations to others



- This is associated with a shift to more international seafaring labor …

Seafaring professions use international labor

- Qualified seafarers hired according to economic (not residency) criteria



- Professionally skilled seafarers across ranks and nationalities remains an issue of international importance to safety and environment

Source: Obando-Rojas, B. (2001), The Global Labour Market Study, Cardiff University

International marine fuel sales by nation as percent of world bunkers, 2003 - 2005

- Nations selling most fuel to ships are typically nations with strong interests in cargoes or services those ships provide

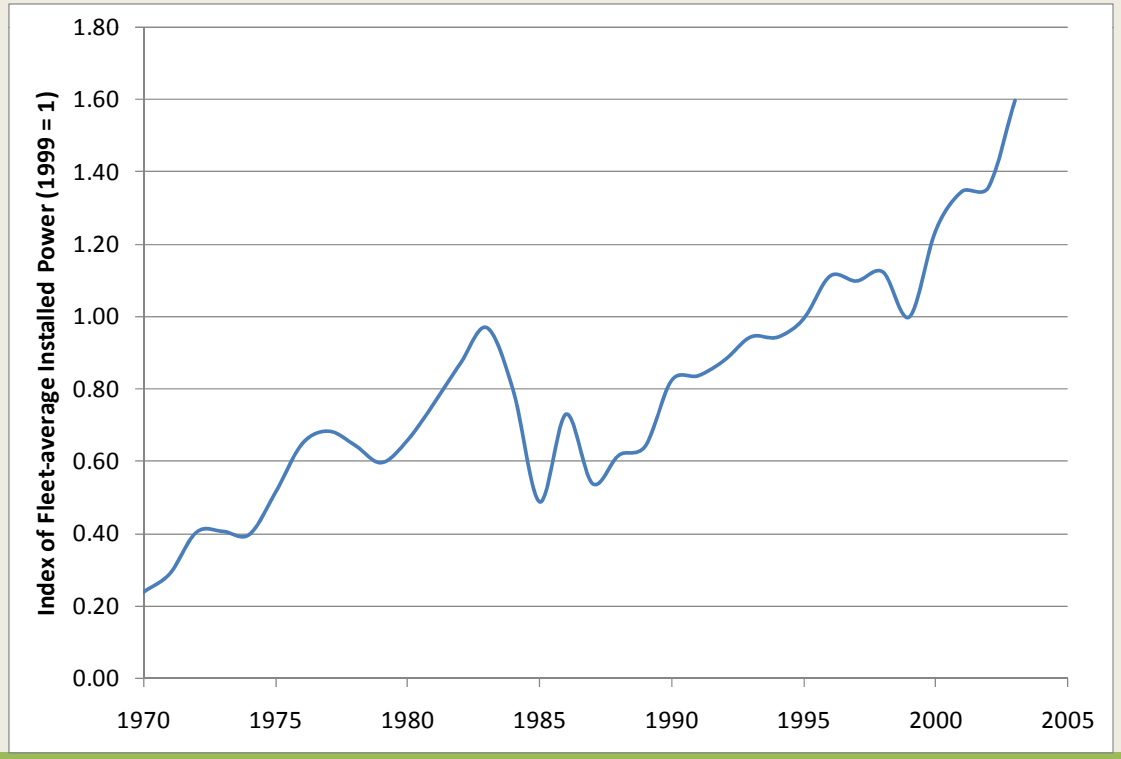
Million tonnes fuel	2003		2004		2005	
World	150,568	100%	167,734	100%	175,330	100%
OECD	81,425	54%	91,326	54%	99,140	57%
OECD North America	20,873	14%	26,213	16%	27,930	16%
United States	*19,559*	*13%*	*24,828*	*15%*	*26,455*	*15%*
OECD Europe	47,860	32%	51,442	31%	53,787	31%
OECD Pacific	12,692	8%	13,671	8%	17,419	10%
Non OECD	69,143	46%	76,408	46%	76,190	43%
Singapore	*20,809*	*14%*	*19,567*	*12%*	*25,479*	*15%*

- (OECD) nations account for roughly half of these fuel sales

Source: International Energy Agency and OECD (2007a) and (2007b)

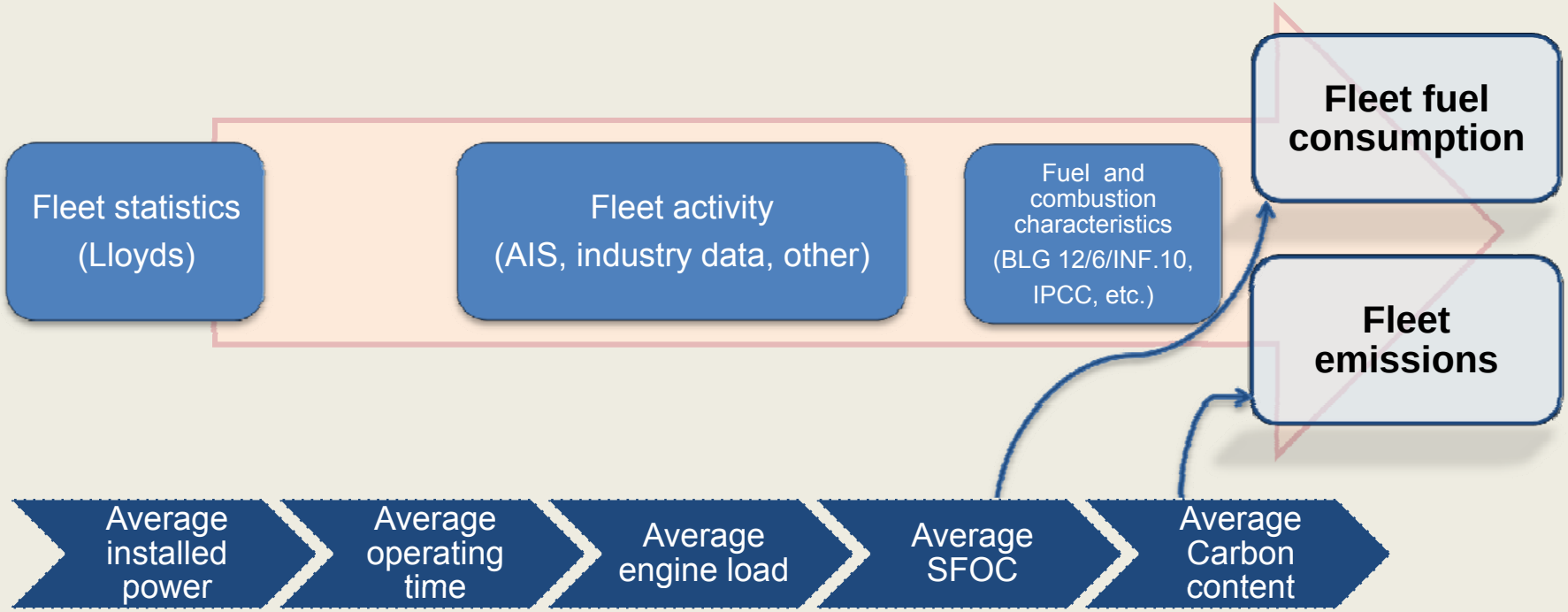
Trend in average installed power (kW) for world-wide vessel fleet

- Switch to more fuel-efficient engines was more than offset by increased engine power requirements to meet rapidly expanding demand for more and faster global trade



Activity-based methodology

Data confidence higher than fuel sales data only



- **Confidence High**

- **Confidence moderate**
- Known variability high
- Dominates output range

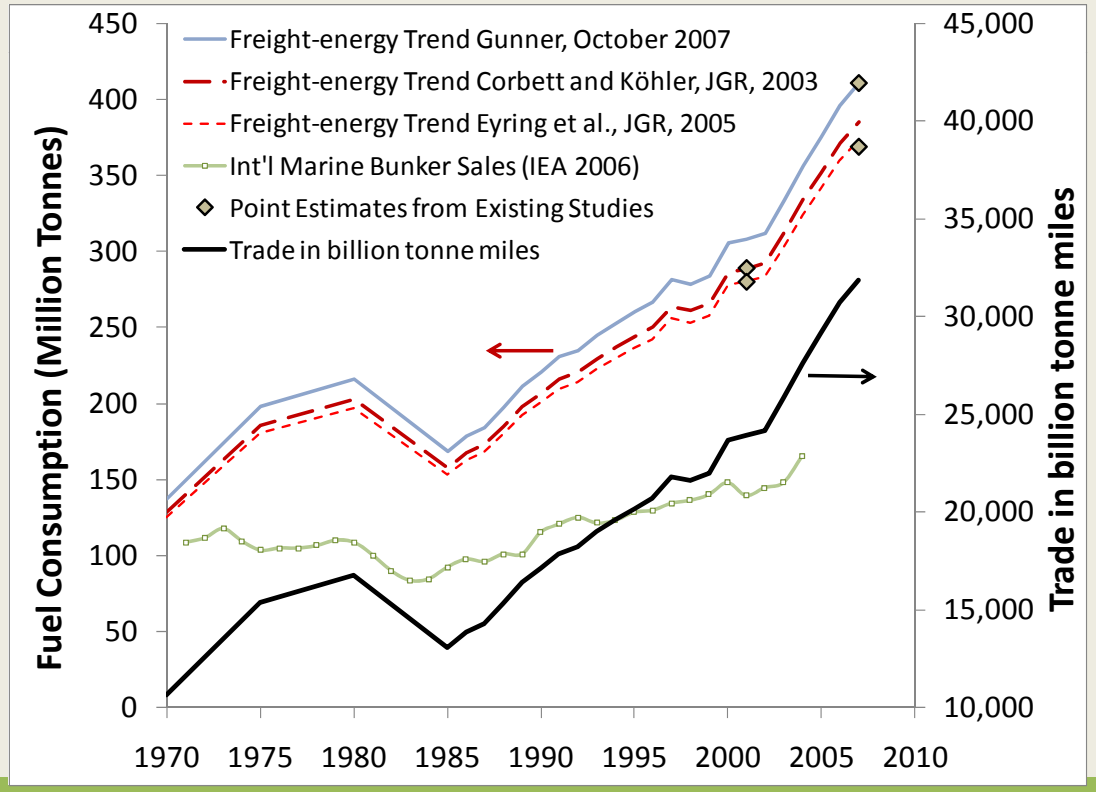
- **Confidence moderate**
- Known variability moderate
- Second most influential to output range

- **Confidence high**

- **Confidence high**
- Some variability due to fuel characteristics

Fuel consumption growing with global trade

- 2002 World fleet (including cargo, noncargo, and military vessels) consumed ~280 million tonnes fuel, ~200 million tonnes for cargo ships
  - IMO Informal Cross Government/Industry Scientific Group of Experts estimated 2007 global ship fuel consumption at ~369 million tonnes, increasin to ~486 million tonnes by 2020

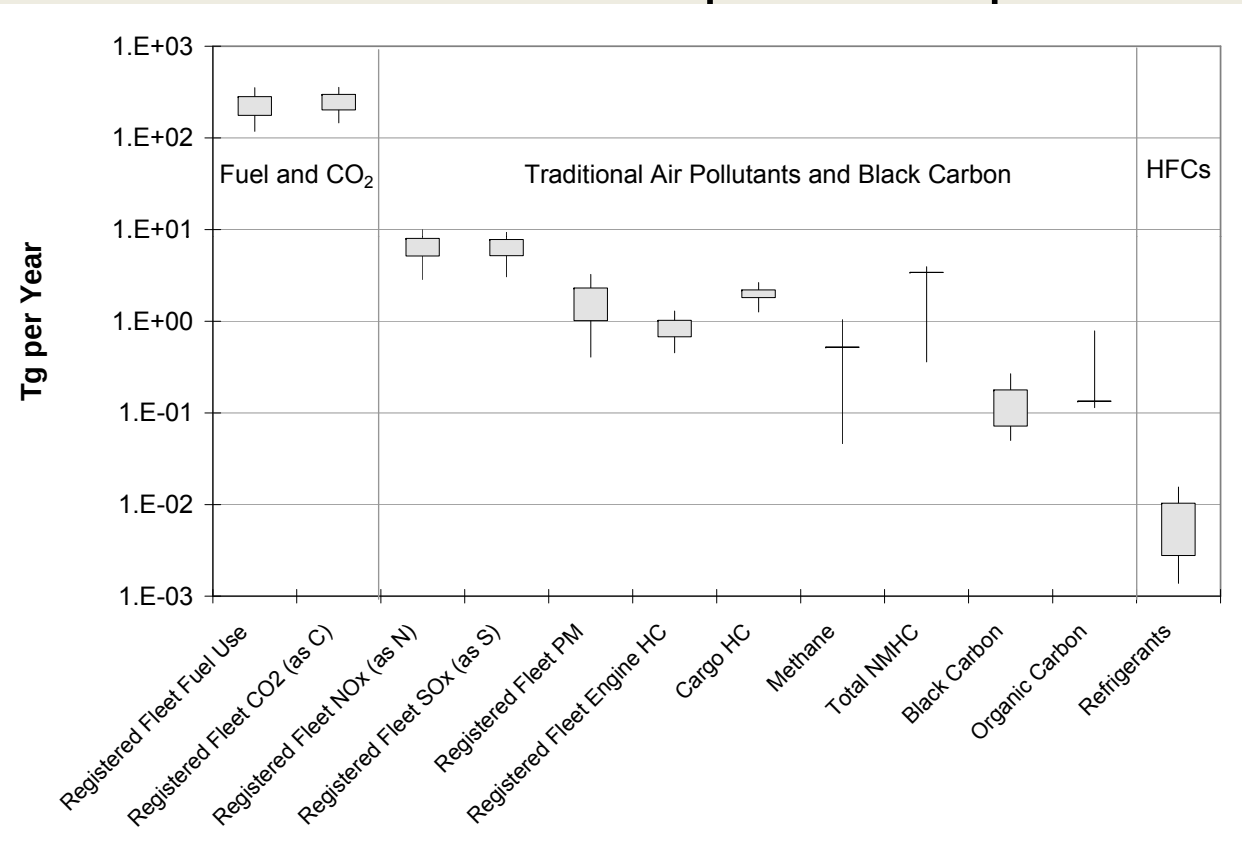


Taxonomy of Environmental Impacts

Episodic environmental events	Routine environmental events
Vessel-based	
Oil spills	Engine air emissions
Ocean dumping	Invasive species introductions (ballast water/hull fouling)
Sewage discharges	Hull coating toxics releases
Oily wastewater	Underwater noise
Vessel collisions	
Ship-strikes with marine life	
Port-based	
Dredging	Storm water runoff
Port expansion	Vessel wake erosion
Ship construction, breaking	Cargo-handling air emissions

Efforts are now underway to evaluate and reduce air pollution from ships

- Emissions → Pollution fate/transport → Exposure → Impact



- Summary of global emissions from maritime shipping, 2002

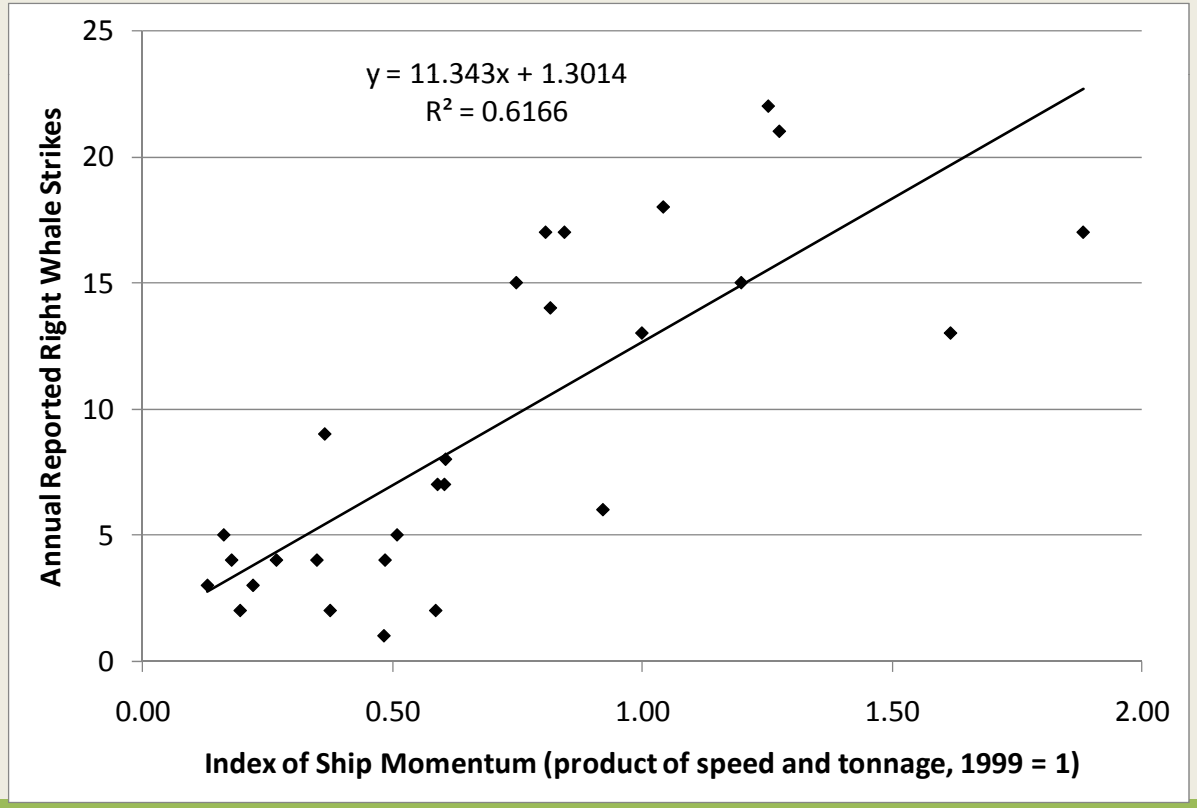
List of example air pollution control technologies for maritime shipping

- Emissions → Pollution fate/transport → Exposure → Impact → Mitigation
- Example technologies (not complete list)
  - Likely to include operations, logistics to fully address GHGs

Stage	Control technology	Target Pollutant
Pre-combustion	Fuel water emulsification	NO_x
	Humid air motor	NO_x
	Combustion air saturation system	NO_x
In-engine	Aftercooler upgrades	NO_x
	Engine derating	NO_x
	Injection timing delay	NO_x
	Engine efficiency improvements	NO_x, SO_x, PM, CO_2
Post-engine	Selective catalytic reduction	NO_x
	Seawater scrubbing	SO_x
	Diesel particulate filters	PM
	Diesel oxidation catalysts	PM
Vessel designs	Hull form	CO_2, energy ratio pollutants
	Propeller	CO_2, energy ratio pollutants

Mitigation focus not only emissions, GHGs
Globalization addresses entire ship impact taxonomy

- Globalization trends increase other impacts, global focus on environment motivate mitigating action for these too
  - Example: Right whale strikes and global average ship momentum



Creating a Sustainable Intermodal Freight System Summary

- Intrinsic connection between maritime transport, trade, globalization continue to be coupled (e.g., IPCC SRES)
- Industry responds to ***regulatory***, ***market-driven***, & ***advocacy*** pressure to improve environmental performance
- Environmental and security policy shifting to international agreements and global frameworks for regional policy
- A sustainable intermodal freight system is preferred to a mode-by-mode approach for at least two reasons:
  - It can show where shipping modes offer least-cost mitigation
  - It can identify where shipping offers the least polluting transport service

Discussion Welcome

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