

# The Geography of Transport Systems

FIFTH EDITION

Jean-Paul Rodrigue

# Transportation and Geography

## CHAPTER 1

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Jean-Paul.Rodrigue@hofstra.edu

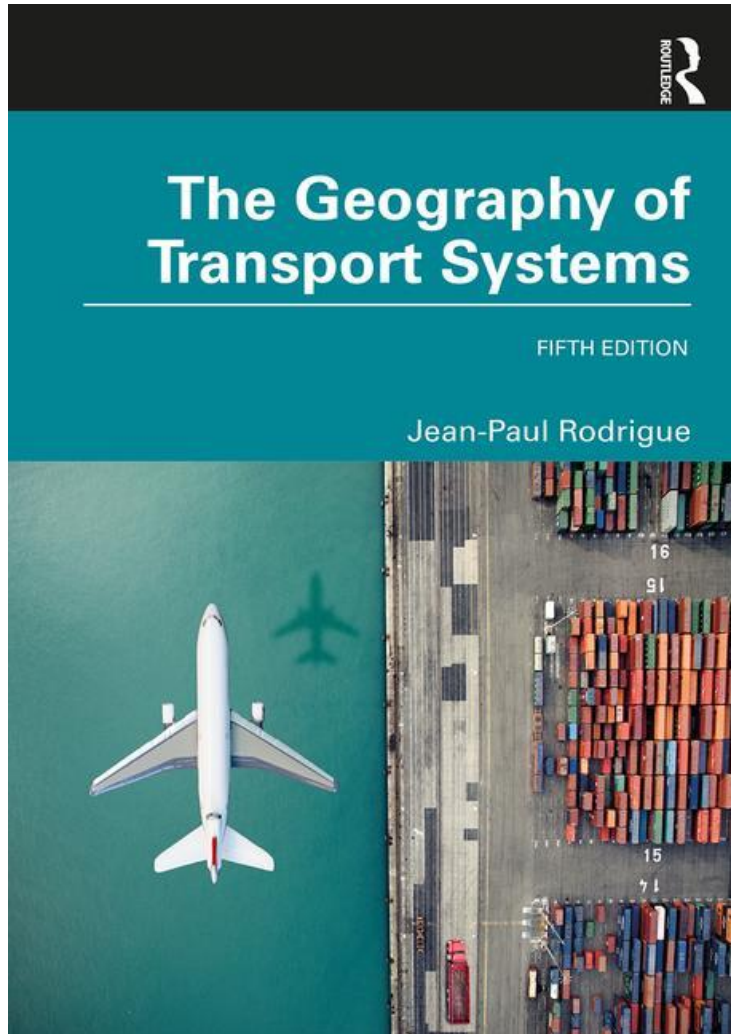
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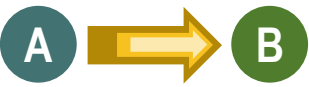

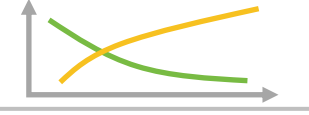




- 1.1 - What is Transport Geography?
- 1.2 - Transportation and the Physical Environment
- 1.3 - The Emergence of Mechanized Transportation Systems
- 1.4 - The Setting of Global Transportation Systems
- 1.5 - Transport and Commercial Geography



# What is Transport Geography?

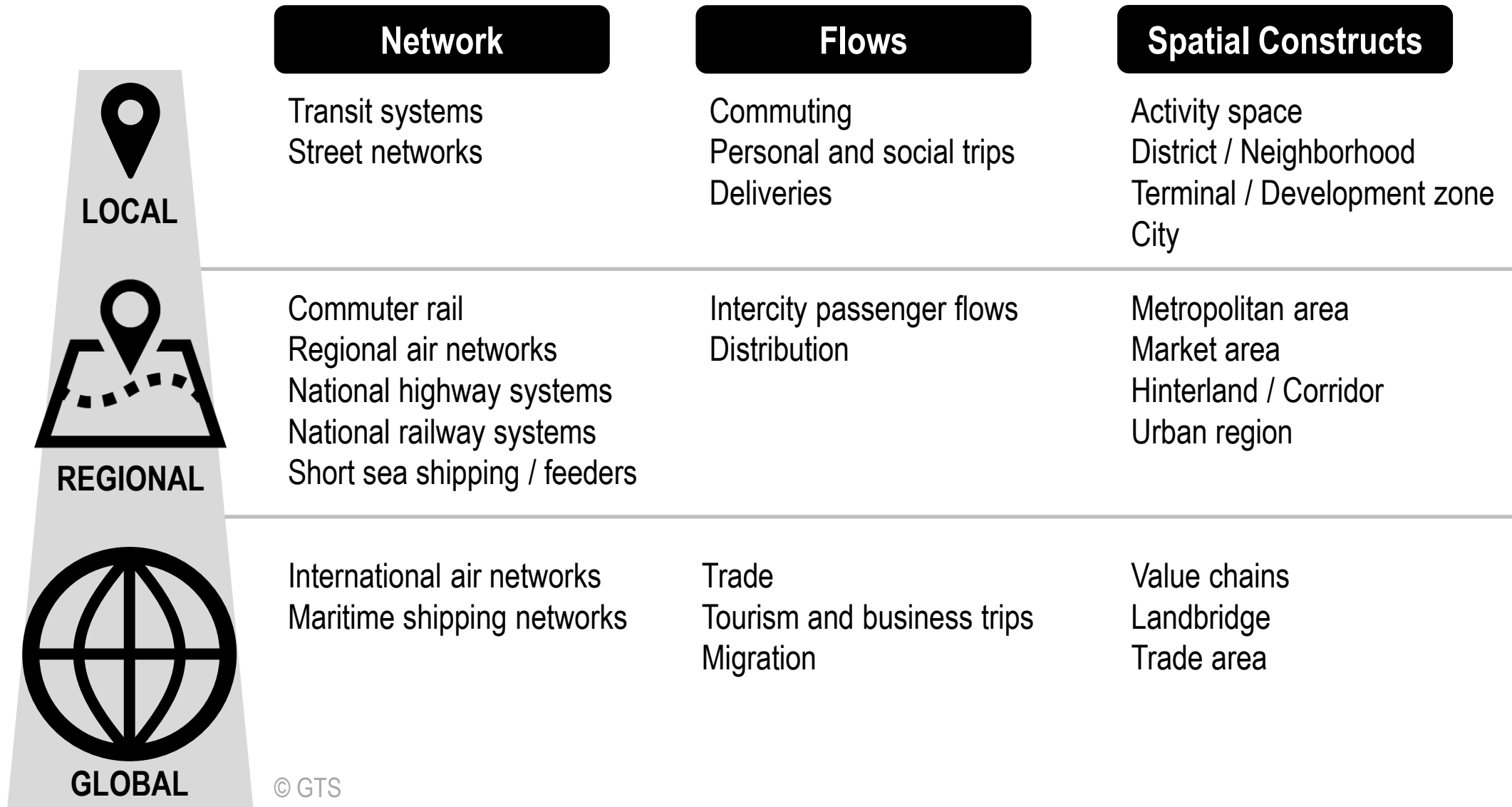
## Chapter 1.1

# The Core Principles of Transport Geography

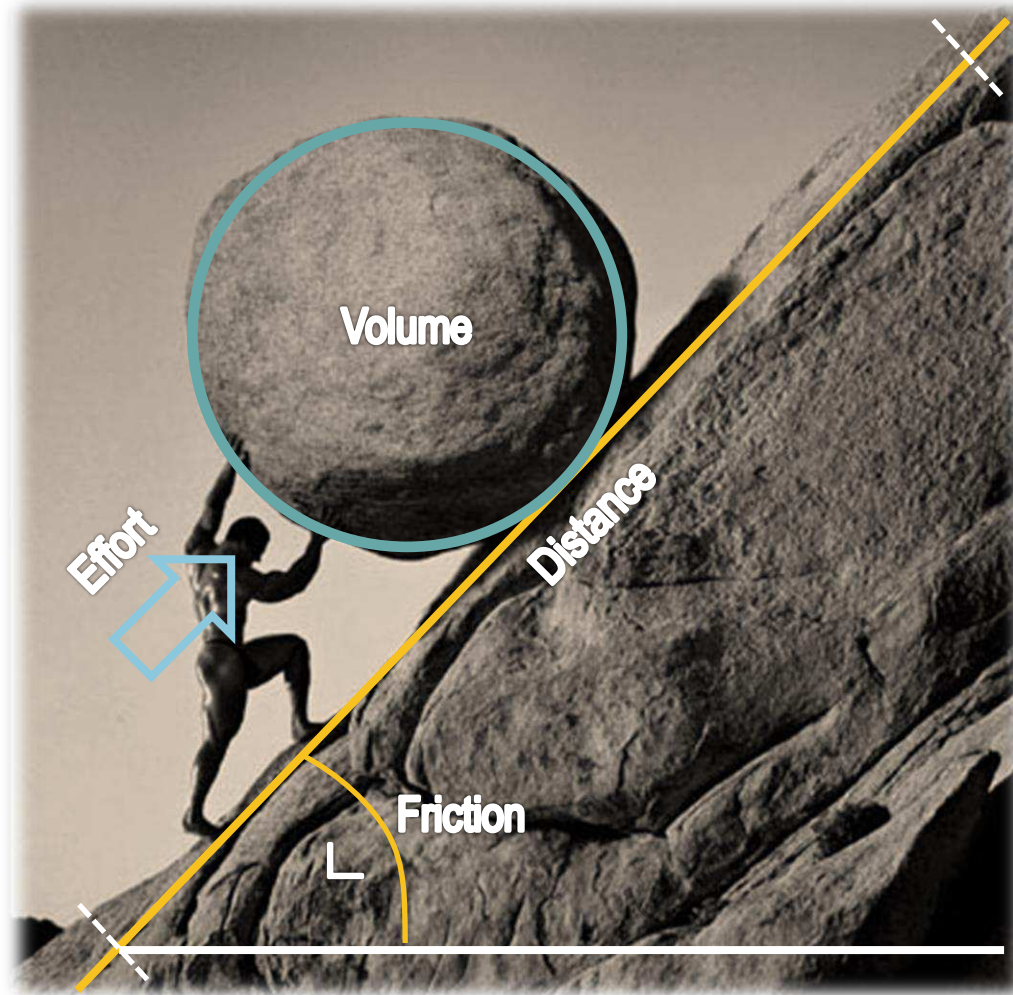
-  Transportation is the spatial linking of a **derived demand**
-  **Distance** is a relative concept involving space, time and effort (cost)
-  **Space** can be a generator, a support and a constraint for mobility
-  The relation between space and time can **converge** or **diverge**
-  A **location** can be a central or an intermediate element of mobility
-  To overcome **geography**, transportation requires a footprint
-  Transportation seeks **massification** but is constrained by **atomization**
-  **Velocity** is a modal, intermodal and managerial effort

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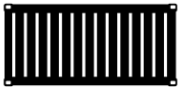
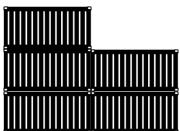
# The Scales of Transport Geography



# The Sisyphus Analogy in Transportation

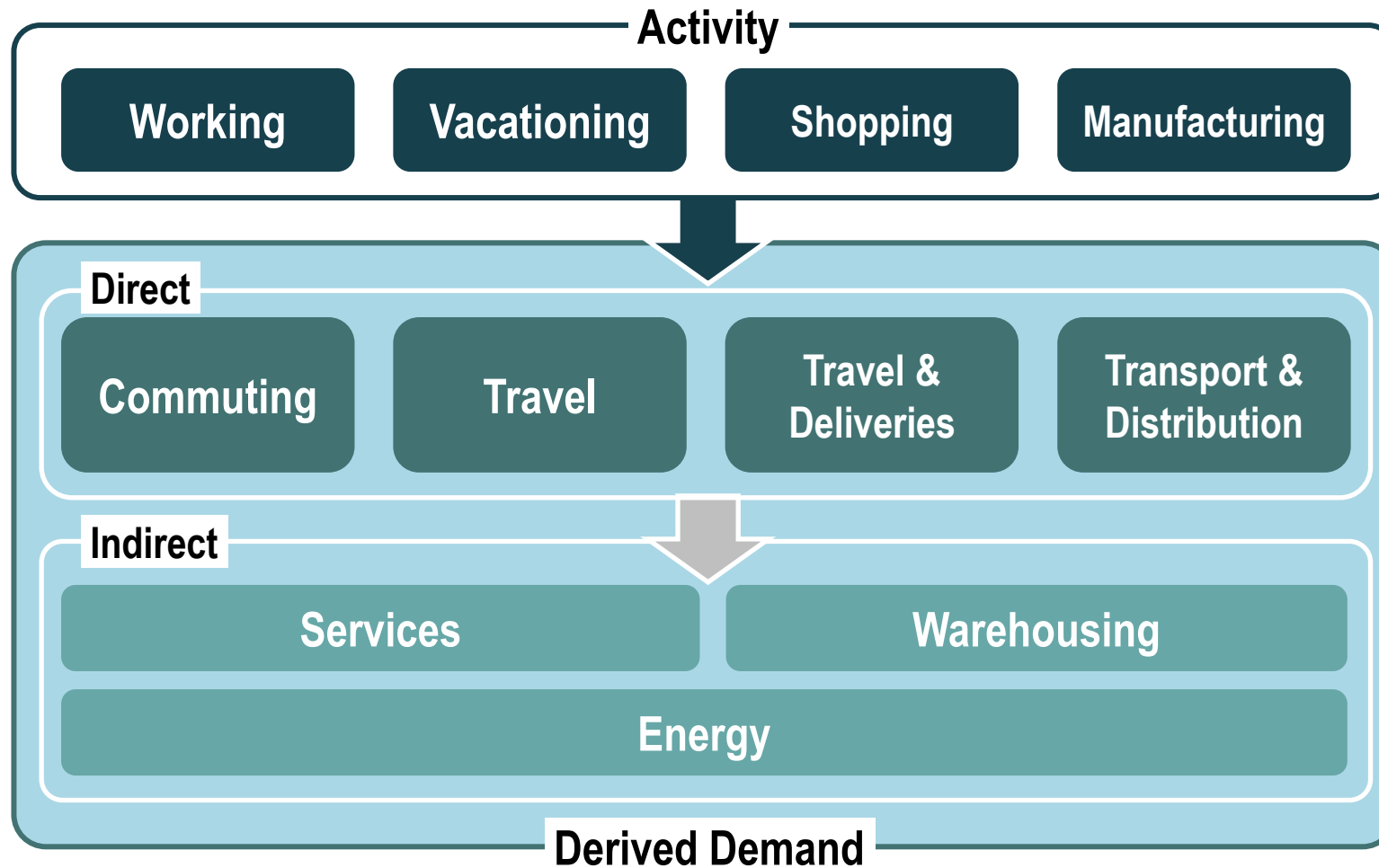


# Mobility of Freight

	Weight	Storage	Fragility	Perishability
	<b>Ores</b> Heavy (0.83 g/cc)	 Piling	None	None
	<b>Grain</b> Heavy (0.83 g/cc)	 Silos	Low	Low
	<b>Petroleum</b> Heavy (0.88 g/cc)	 Tanks	None	None
	<b>Apparel</b> Average	 Warehouse	Low	None
	<b>Fruits &amp; vegetables</b> Average	 Temperature controlled warehouse	High	High
	<b>Containers</b> Average (15-20 tons)	 Stacks	Cargo dependent	Cargo dependent



# Transportation as a Derived Demand

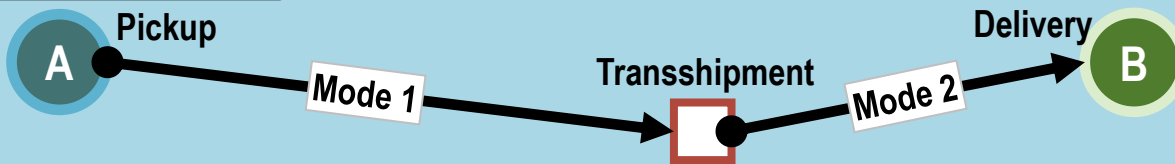


# Different Representations of Distance

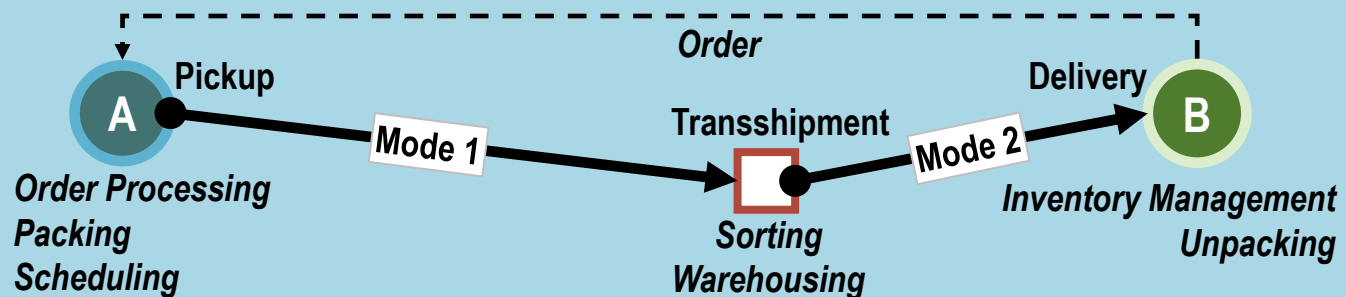
## Euclidean Distance



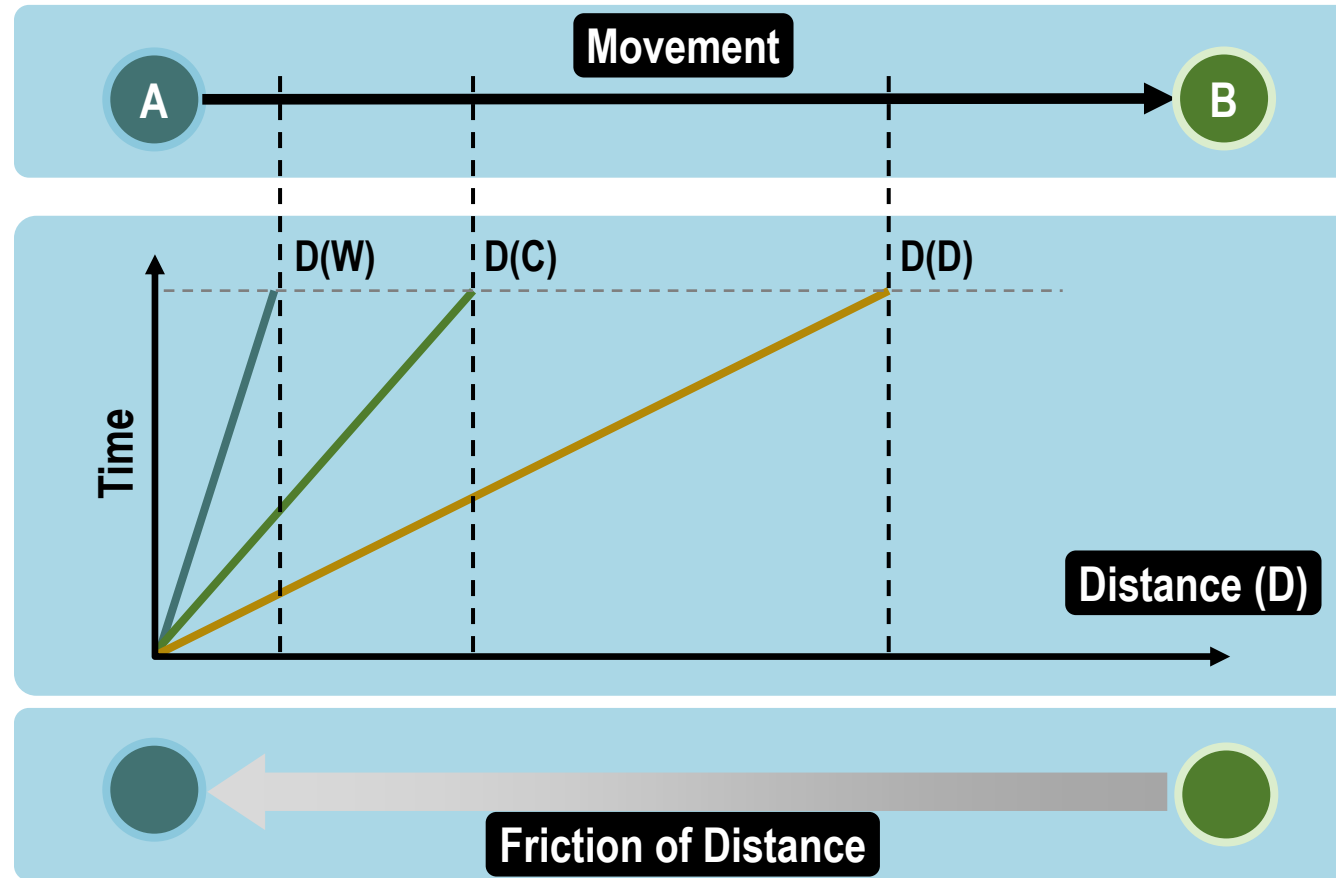
## Transport Distance



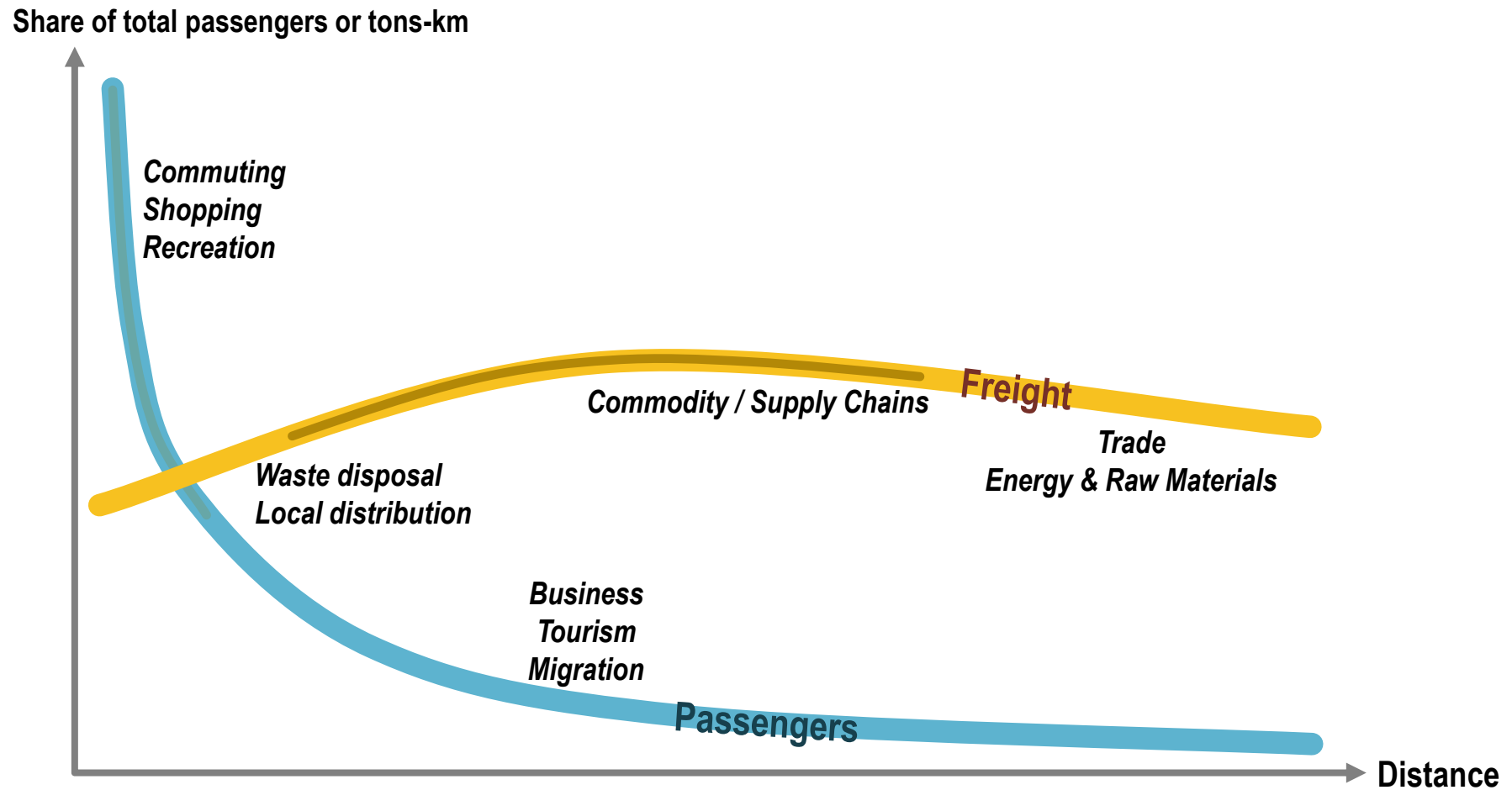
## Logistical Distance



# The Spatial Consideration of a Movement



# Transportation and the Mobility of Passengers and Freight



# Operational Differences between Passengers and Freight Transportation



## Passengers

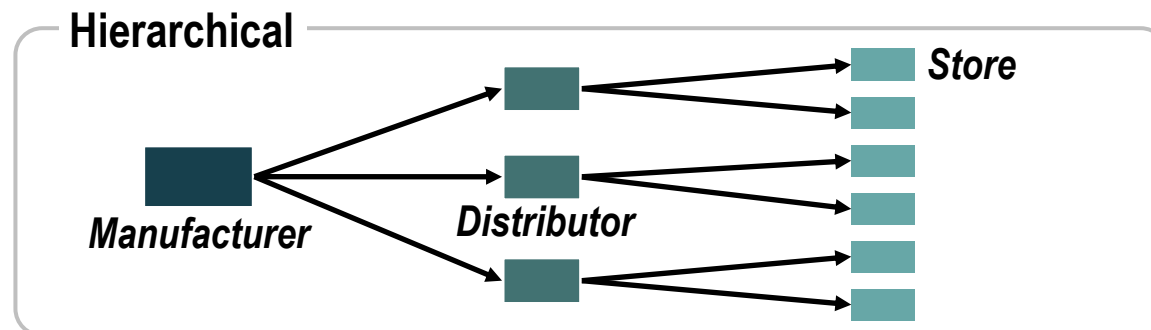
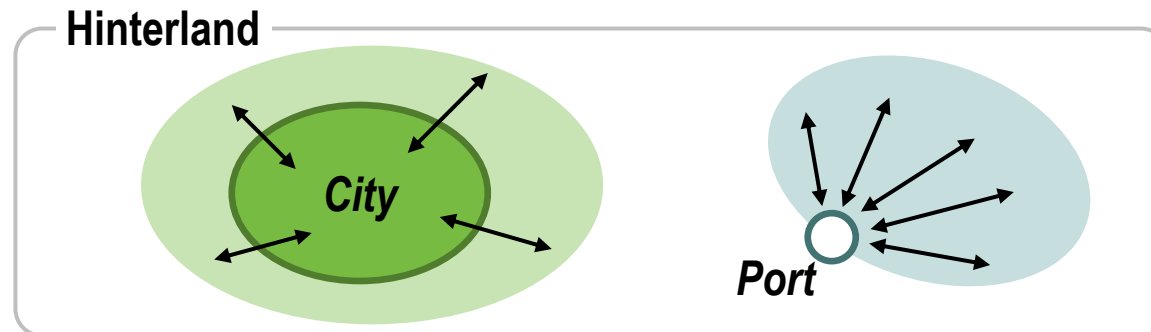
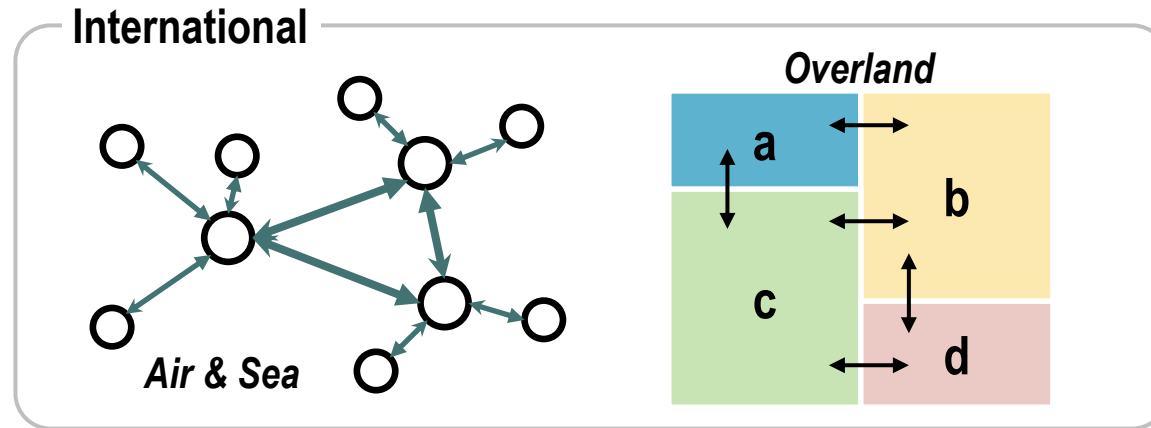
- Board, get off and transfer without assistance.
- Process information and act on it without assistance.
- Make choices between transport modes without assistance but often irrationally.
- Require travel accommodations related to comfort and safety.



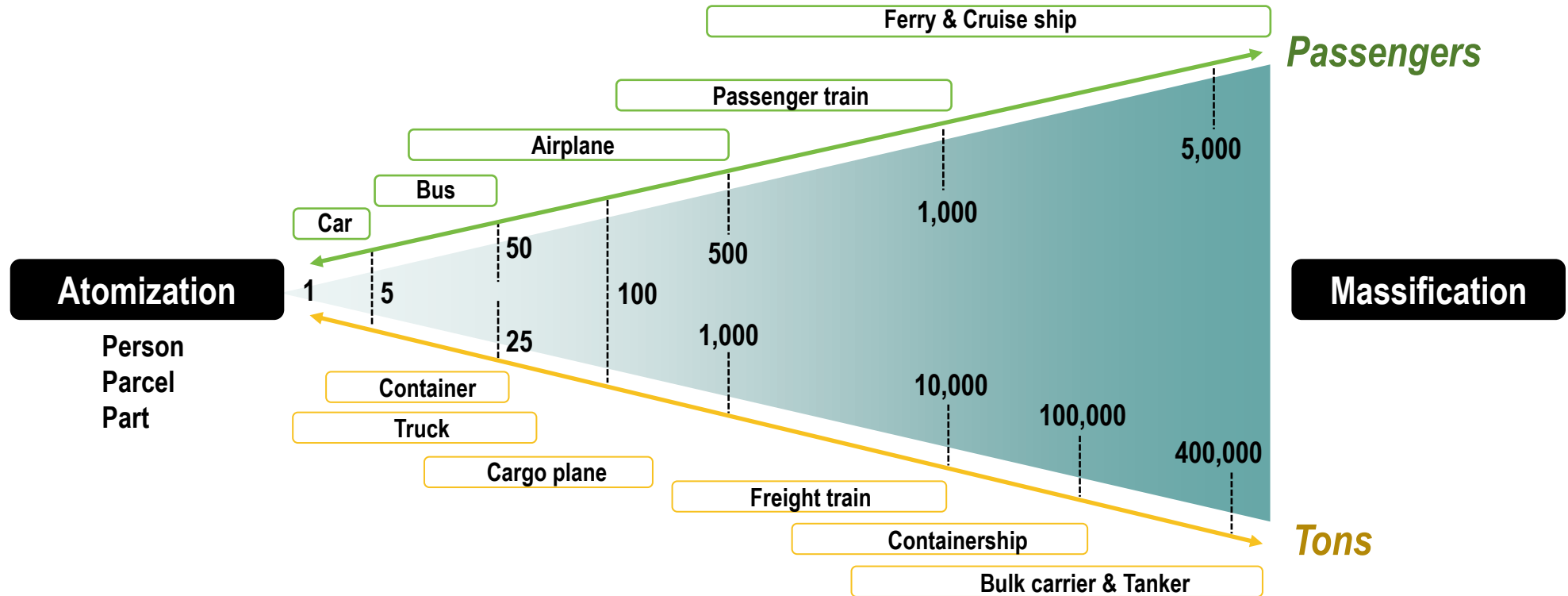
## Freight

- Must be loaded, unloaded and transferred.
- Information must be processed through logistics managers.
- Logistics managers meet choices between transport modes rationally.
- Require accommodations related to storage.

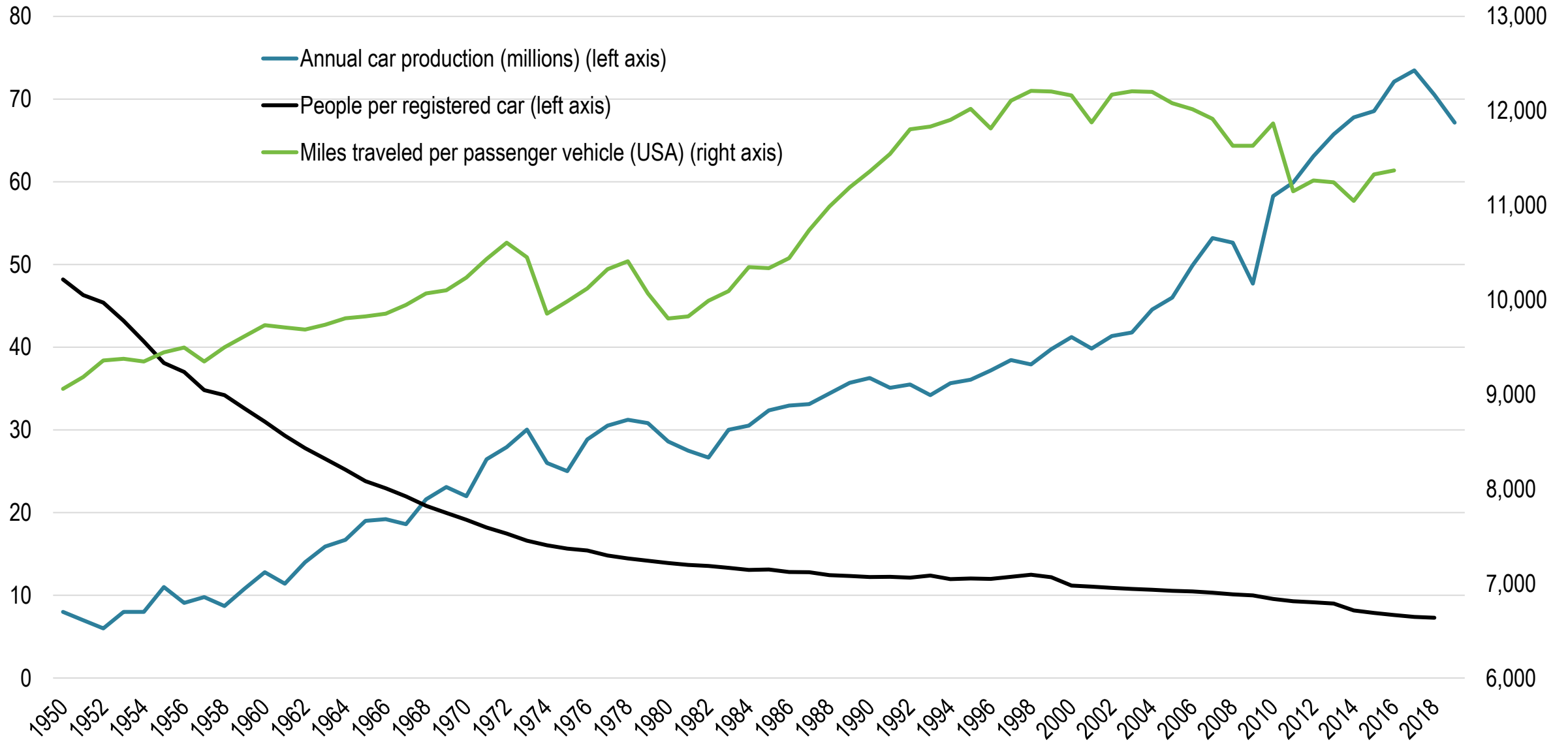
# Spatial Flow Patterns



# Atomization versus Massification in Transportation Modes

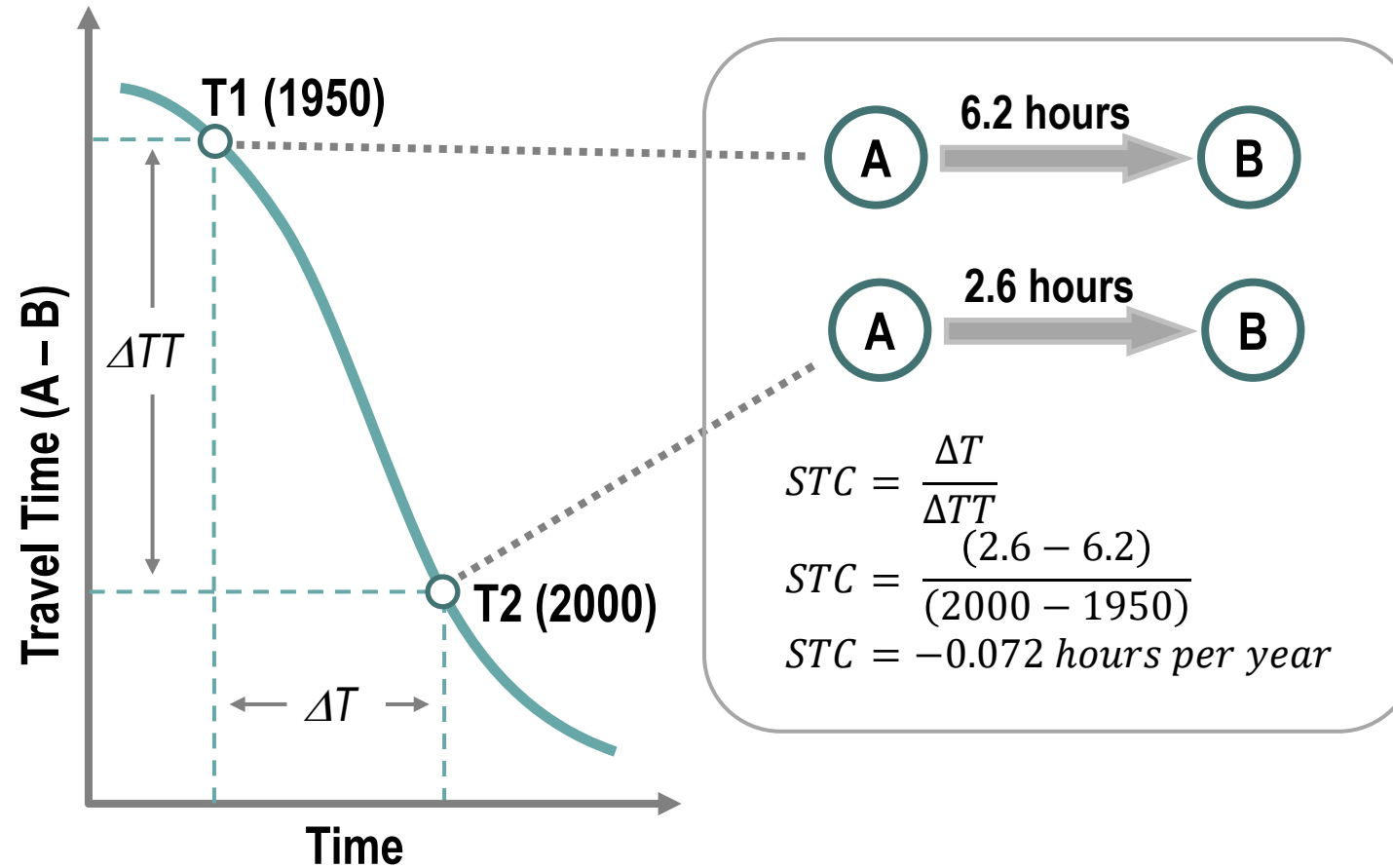


# Vehicle Use Indicators, World, 1950-2019

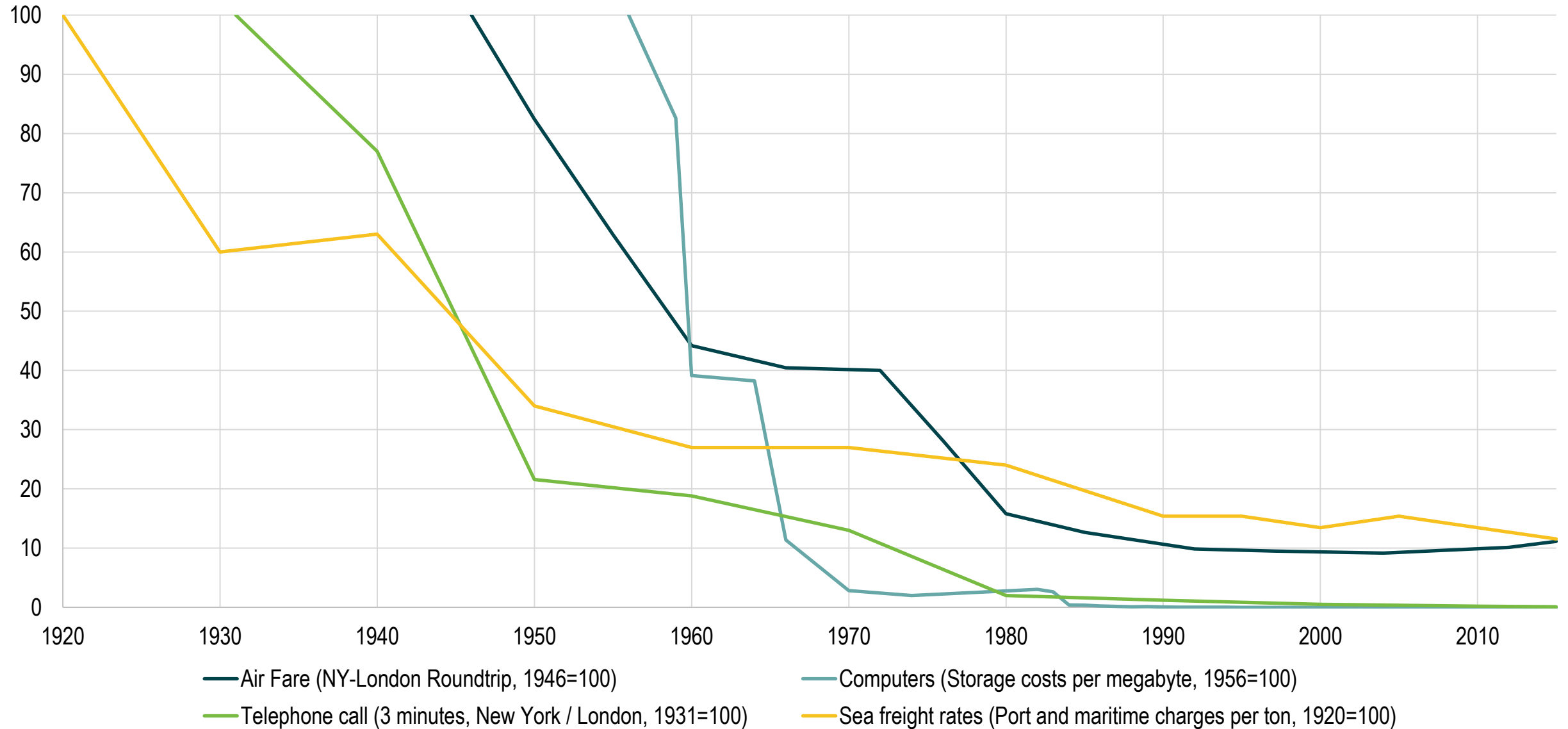




# Space / Time Convergence



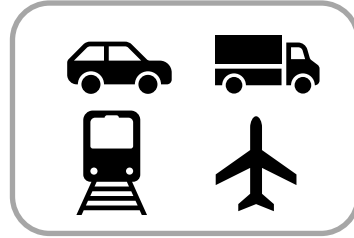
# Transport and Communication Costs Indexes, 1920-2015



# Key Dimensions of Transportation

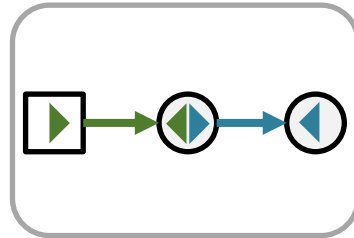
Dimension	
<b>Historical</b>	Changes brought by transport technologies. Rise of civilizations. Development of modern nation states. Globalization.
<b>Economic</b>	Transport and economic development (indirectly and directly). Factor in the production and added-value of goods and services. Facilitates economies of scale. Influences land (real estate) value. Contributes to the specialization of regions.
<b>Social</b>	Access to healthcare, welfare, and cultural events. Shape social interactions.
<b>Political</b>	Nation building and national unity. National defense. Rules and regulations. Subsidizing mobility (e.g. public transit or highways).
<b>Environmental</b>	Important environmental impacts. Pollution, exploitation of natural resources. Climate change.

# Core Components of Transportation



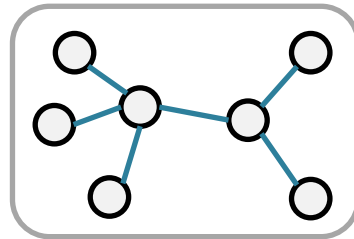
## Modes

- Conveyances used for the mobility of passengers and freight.
- Mobile elements of transportation.



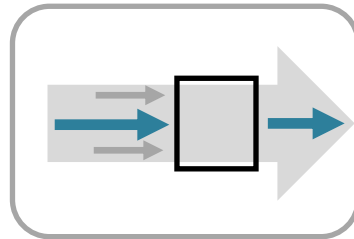
## Infrastructures

- Physical support of transport modes, such as routes and terminals.
- Fixed elements of transportation including superstructures.



## Networks

- System of linked locations (nodes).
- Functional and spatial organization of transportation.



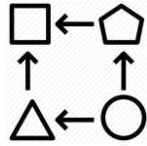
## Flows

- Movements of people, freight and information over their network.
- Flows have origins, intermediary locations and destinations.

# Complex Systems and Transportation

## Adaptability

*Competition*



Adaptation to the actions of other components.  
Adaptation to social, economic and technological changes.

## Self-Organization

*Routing*



Autonomous adaptation to changing conditions as a result of the adaptability of the individual components.

## Stability

*Land use*



A recognizable dynamic state of a system that may continuously reappear.

## Cumulative

*Congestion*



Changes in one property or component may have a disproportionately large effect on another property or component.

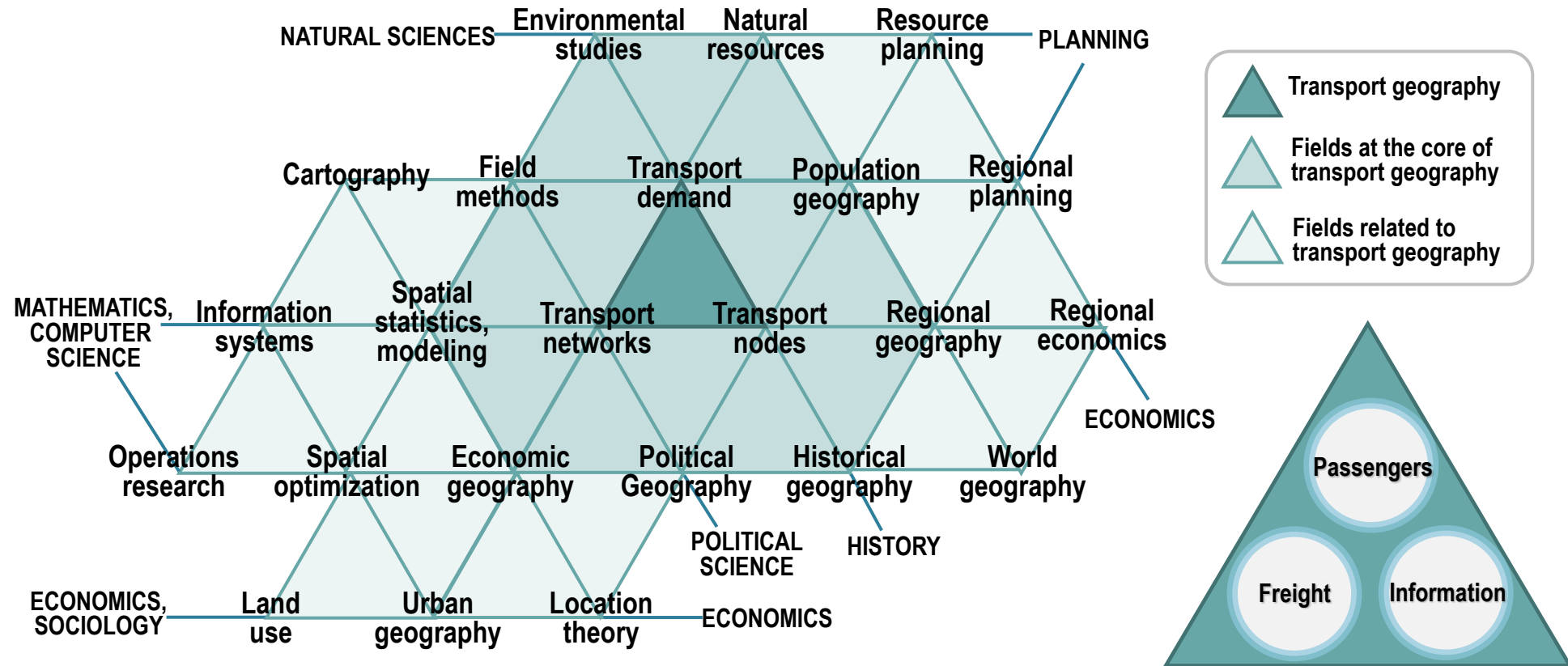
## Transition

*Containerization*

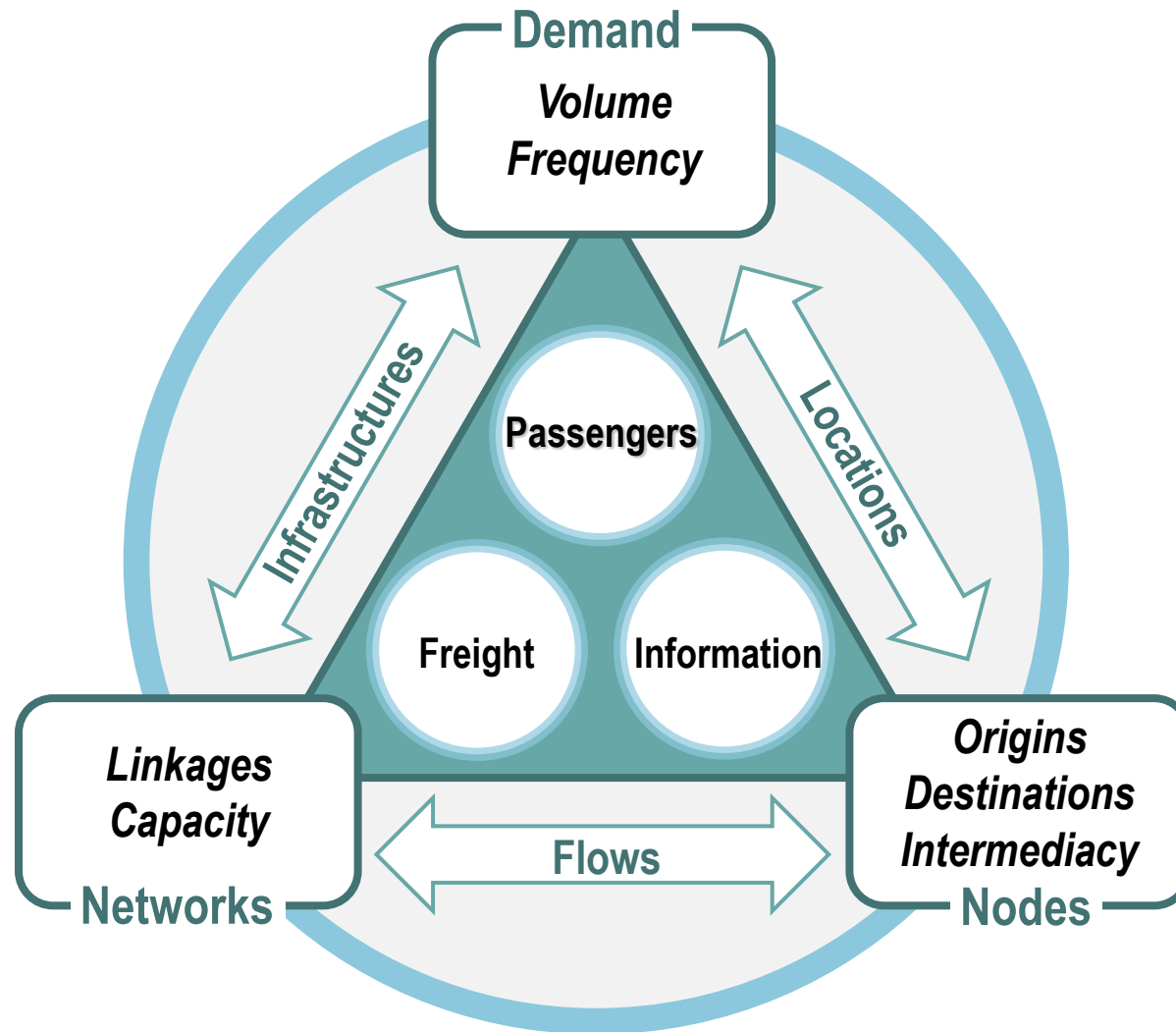


A system's behavior may change radically, and sometimes irreversibly, when a tipping point is reached.

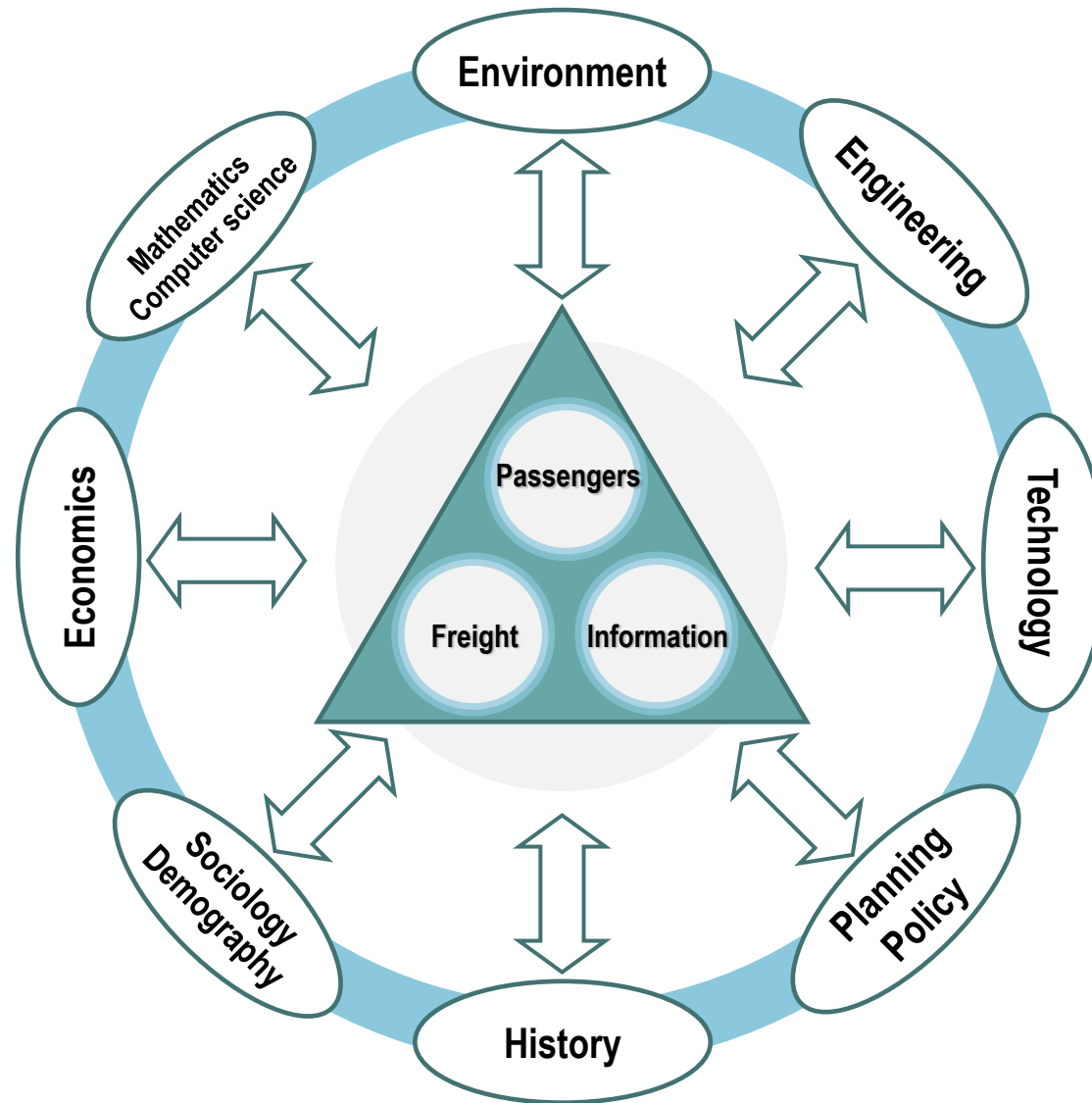
# Fields of Transport Geography



# The Transport System

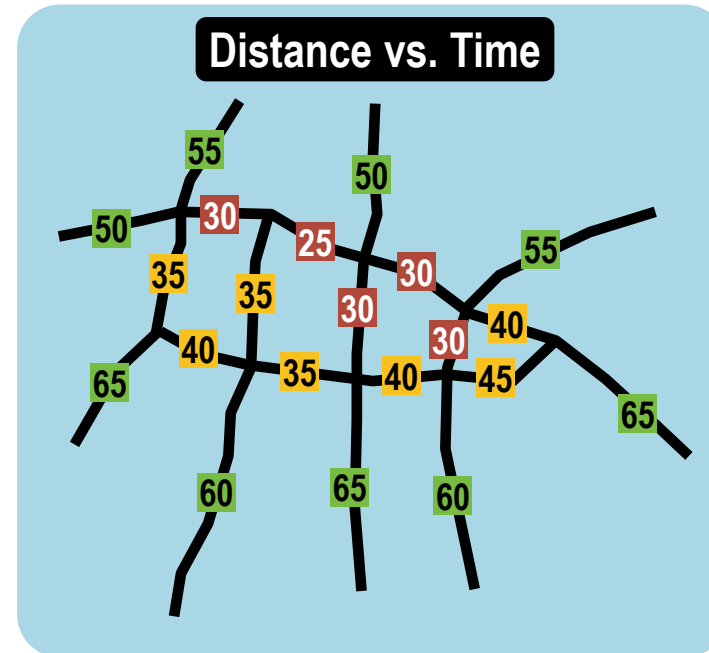
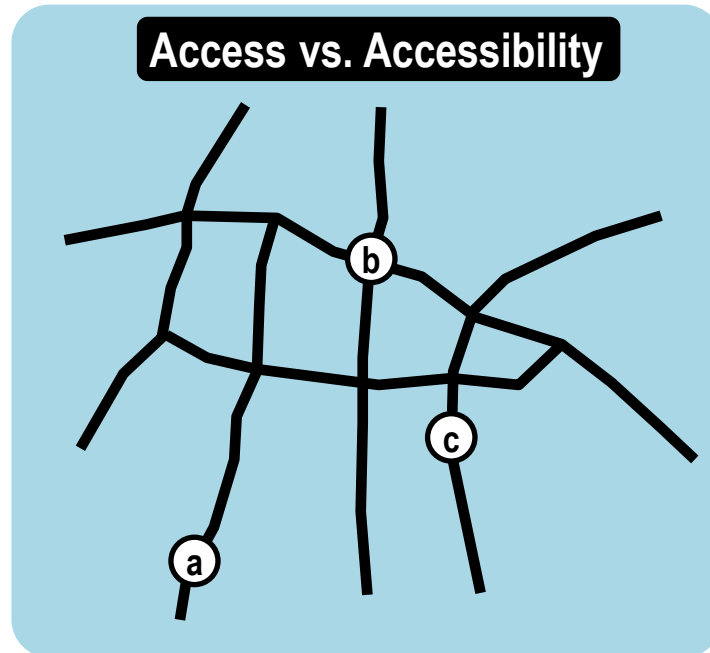


# Dimensions of Transport Geography

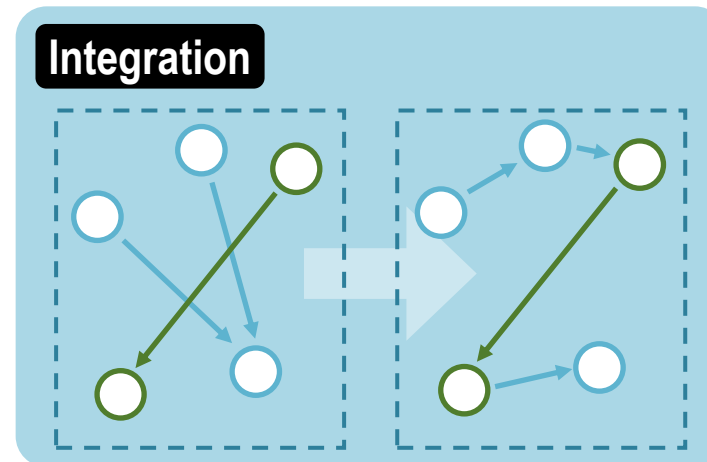
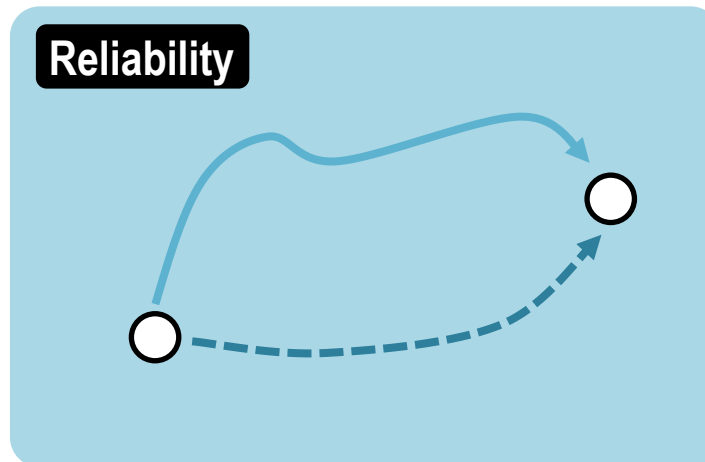
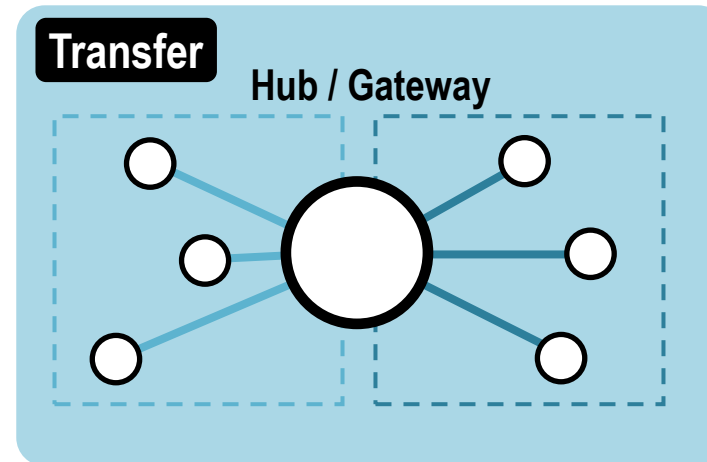
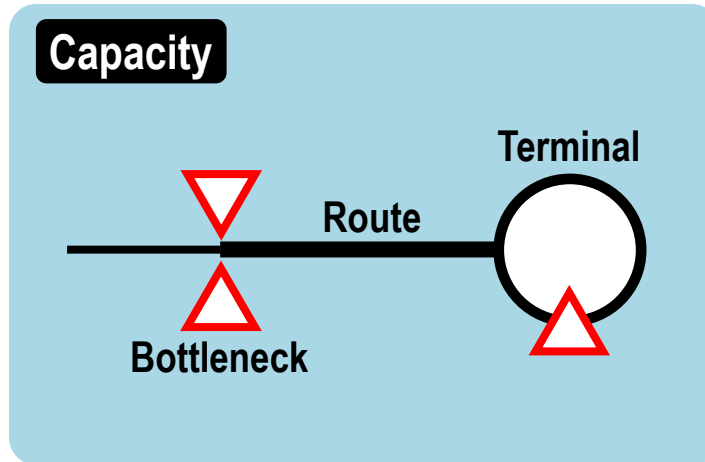


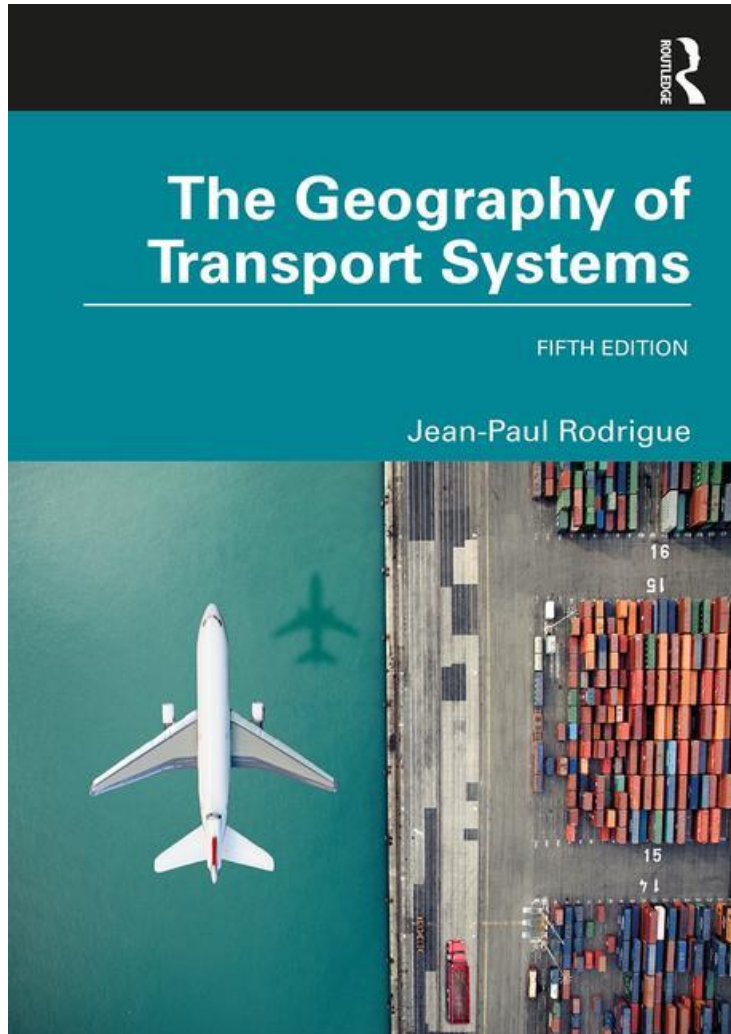


# Two Common Fallacies in Transport Geography



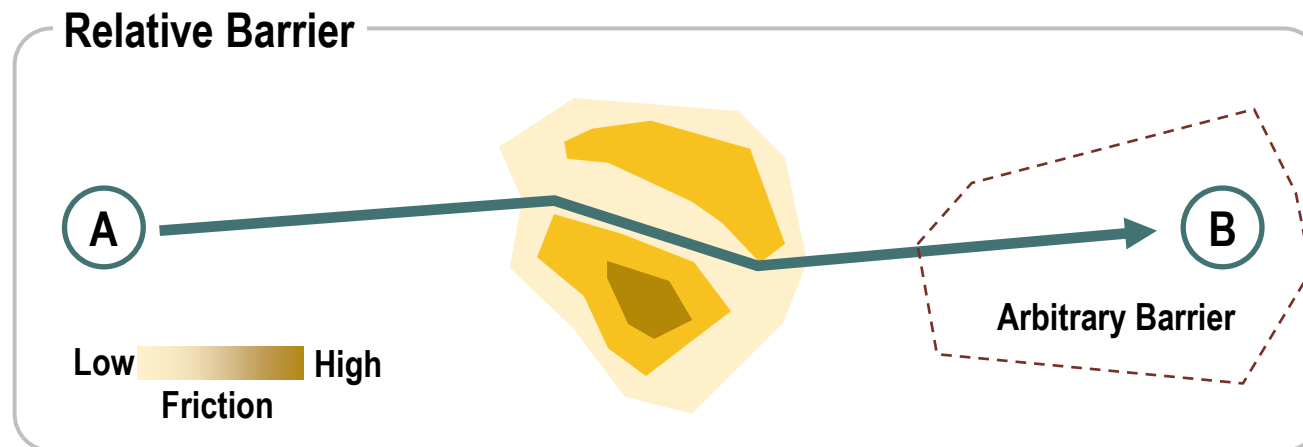
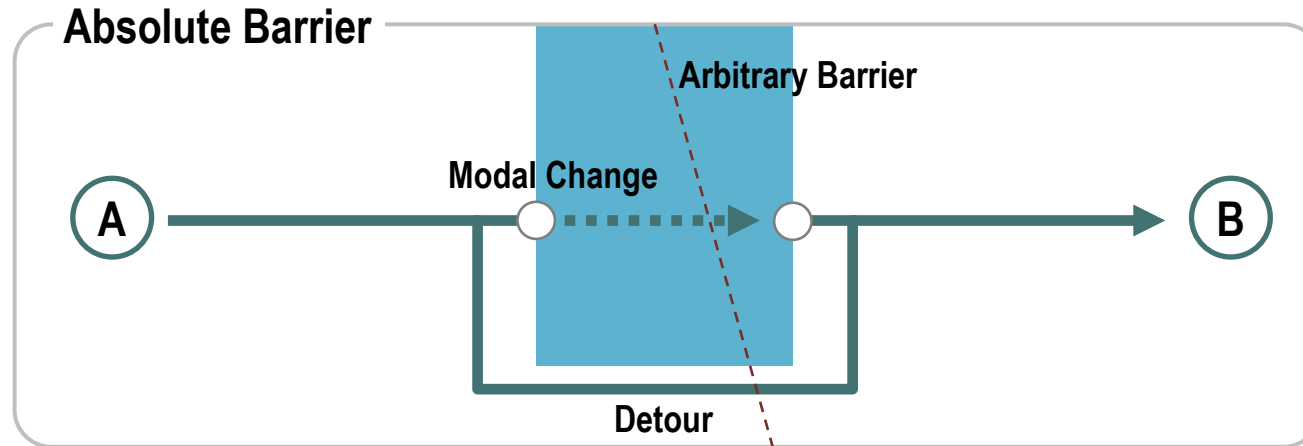
# Common Problems for Transport Systems





# Transportation and the Physical Environment

# Absolute, Relative and Arbitrary Barriers



# World's Longest Tunnels Used for Transportation

Name	Location	Traffic	Opening	Length
Gotthard Base Tunnel	Swiss Alps	Rail	2017	57.1 km
Seikan Tunnel	Strait of Tsugaru, Japan	Rail	1988	53.8 km
Channel Tunnel	English Channel (UK-France)	Rail (High speed)	1994	50.4 km
Lötschberg Base Tunnel	Swiss Alps	Rail	2007	34.6 km
Guadarrama Tunnel	Sierra de Guadarrama, Spain	Rail (High speed)	2007	28.4 km
Taihang Tunnel	Taihang Mountains, China	Rail (High speed)	2008	27.8 km
Iwate-Ichinohe Tunnel	Ōu Mountains, Japan	Rail (High speed)	2002	25.8 km
Lærdal Tunnel	Lærdal - Aurland, Norway	Road	2000	24.5 km
Daishimizu Tunnel	Mount Tanigawa, Japan	Rail (High speed)	1982	22.2 km
Wushaoling Tunnel	Wuwei, China	Rail	2006	21.0 km

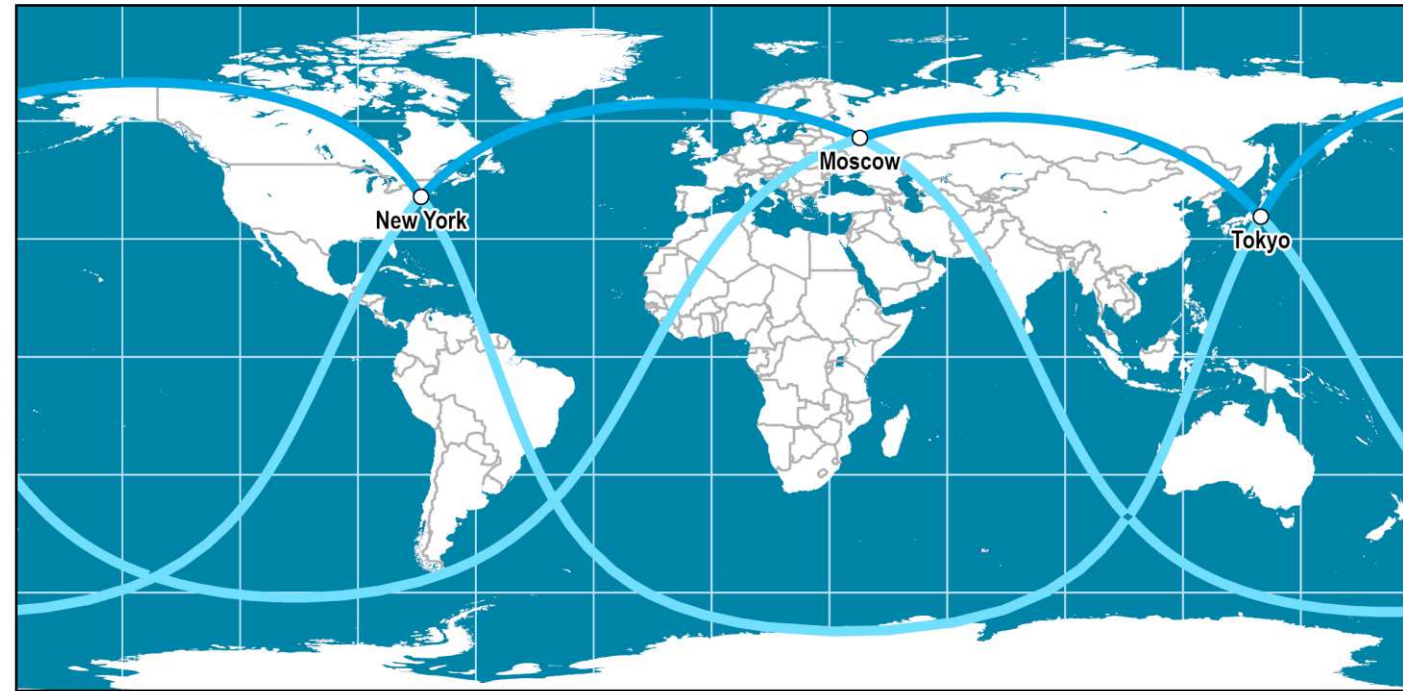
# The Geographical Space of Maritime Transportation



# Polar Shipping Routes

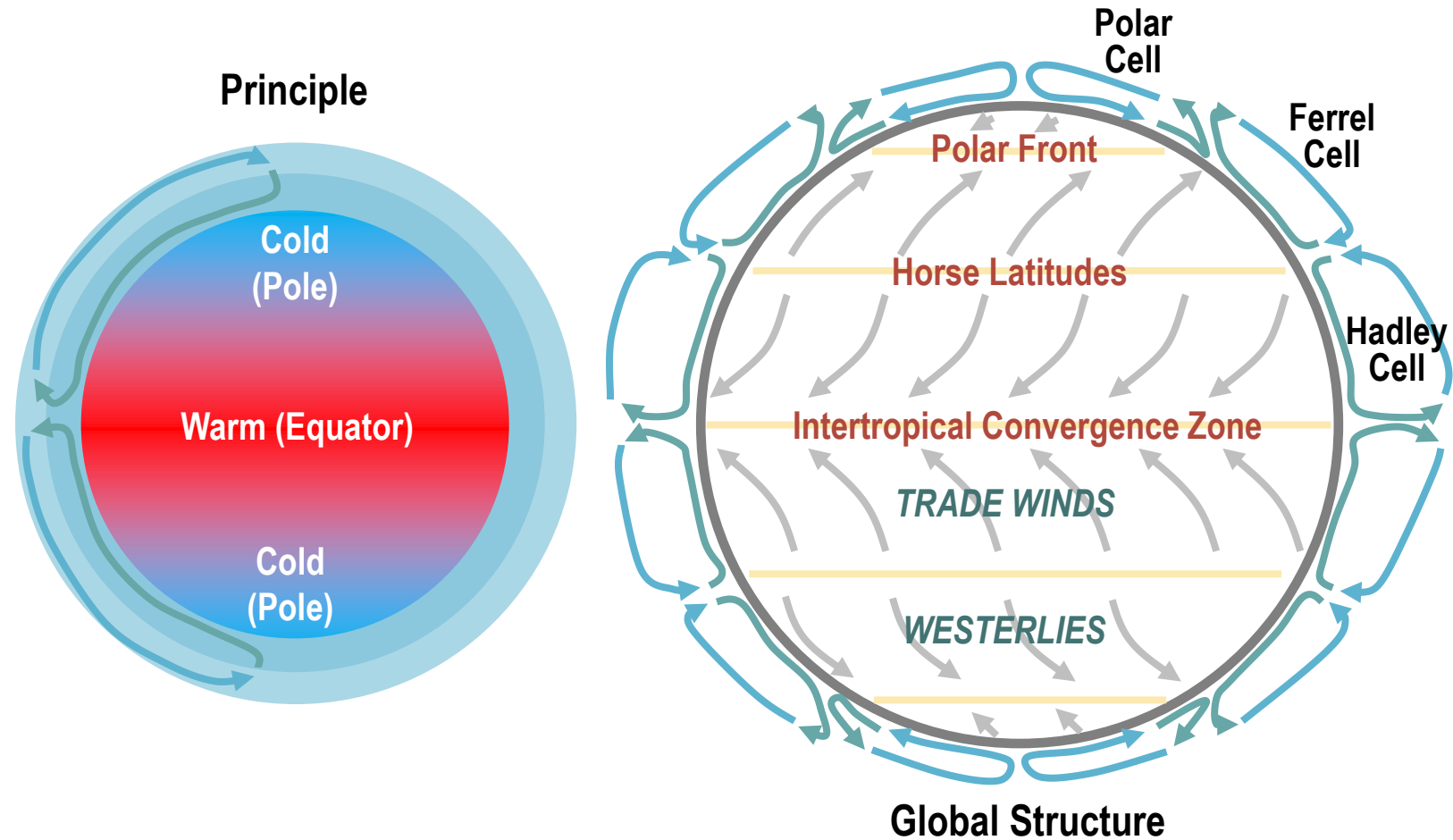


# Great Circle Distance between New York, Moscow and Tokyo

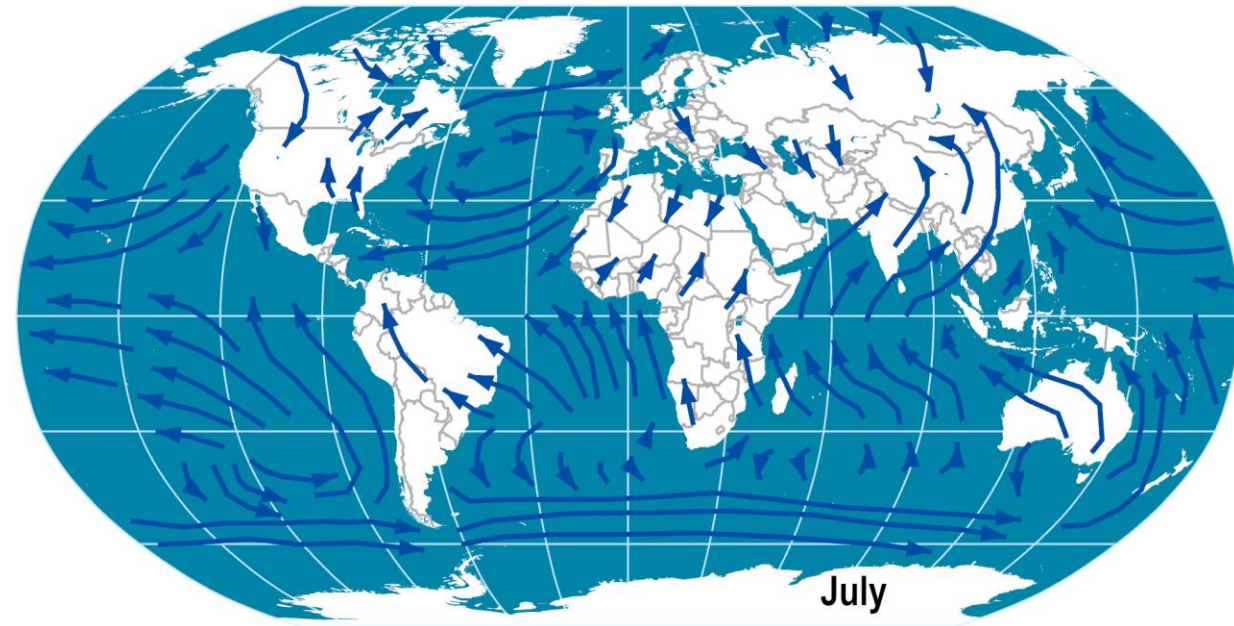
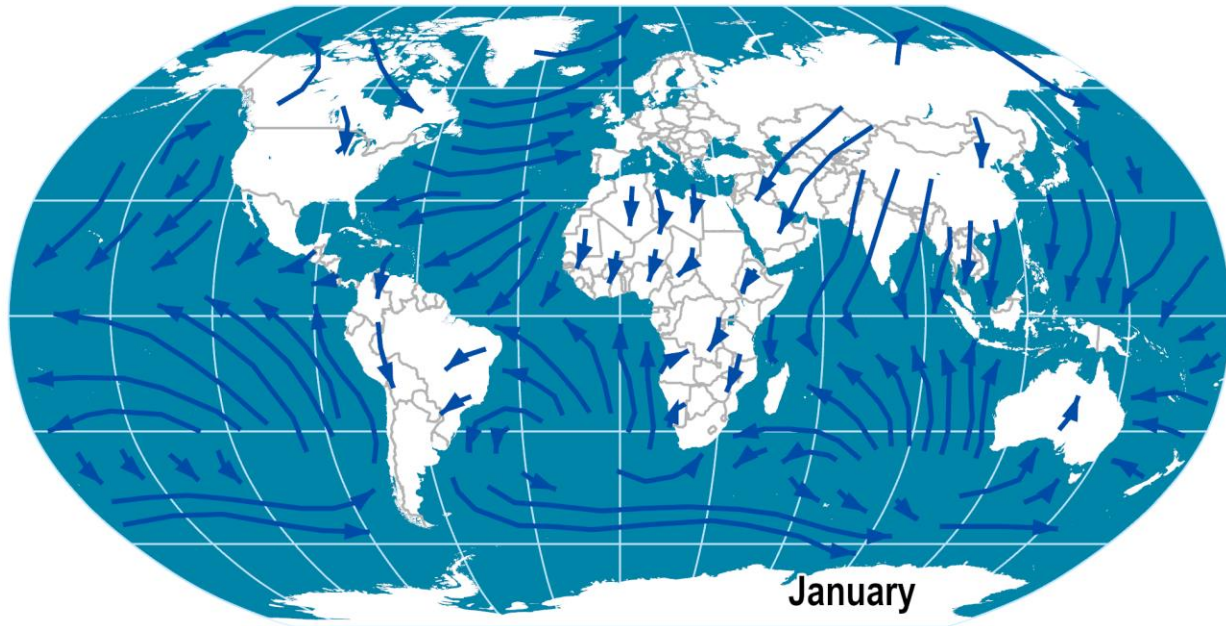




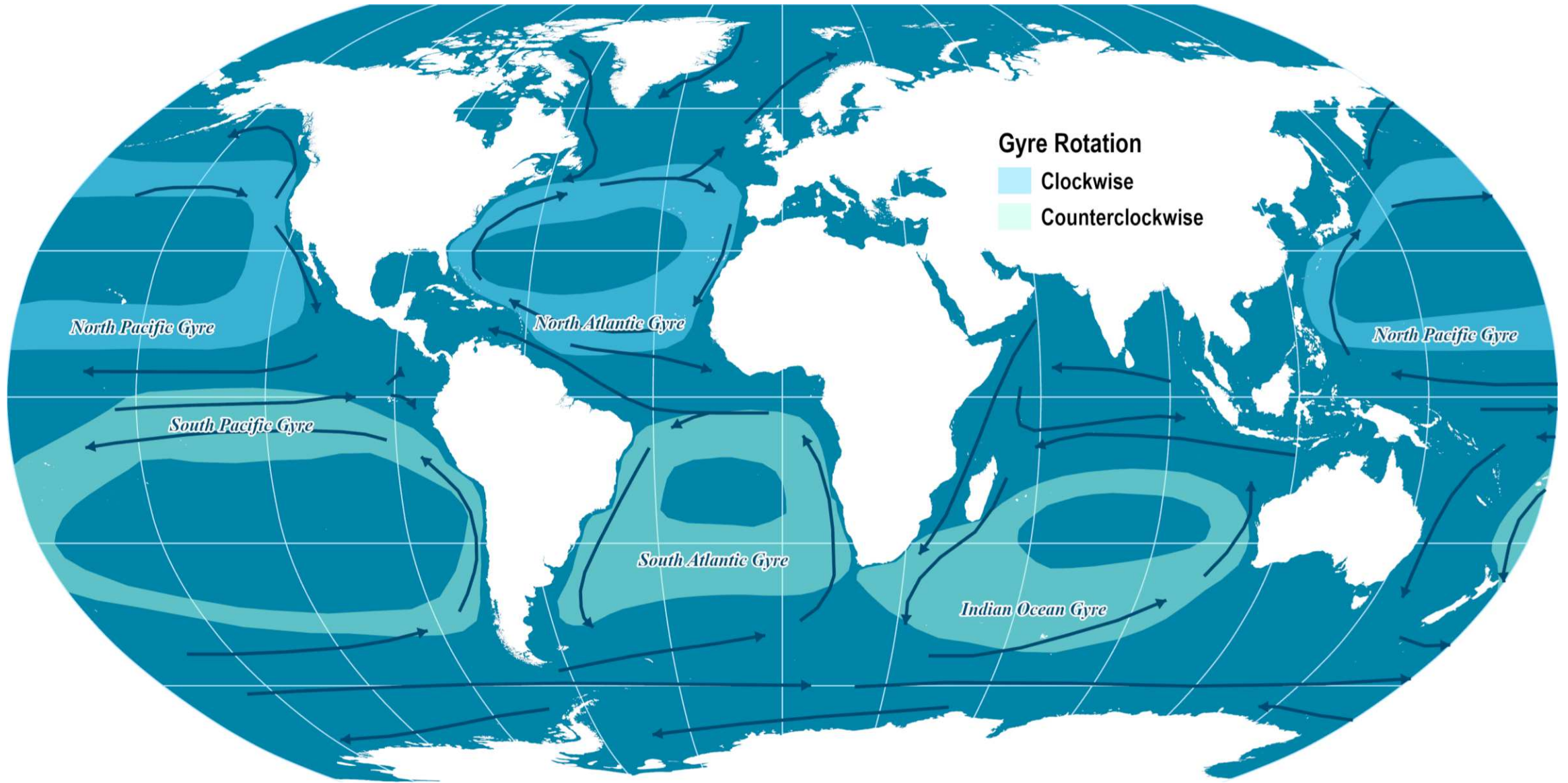
# Global Wind Patterns



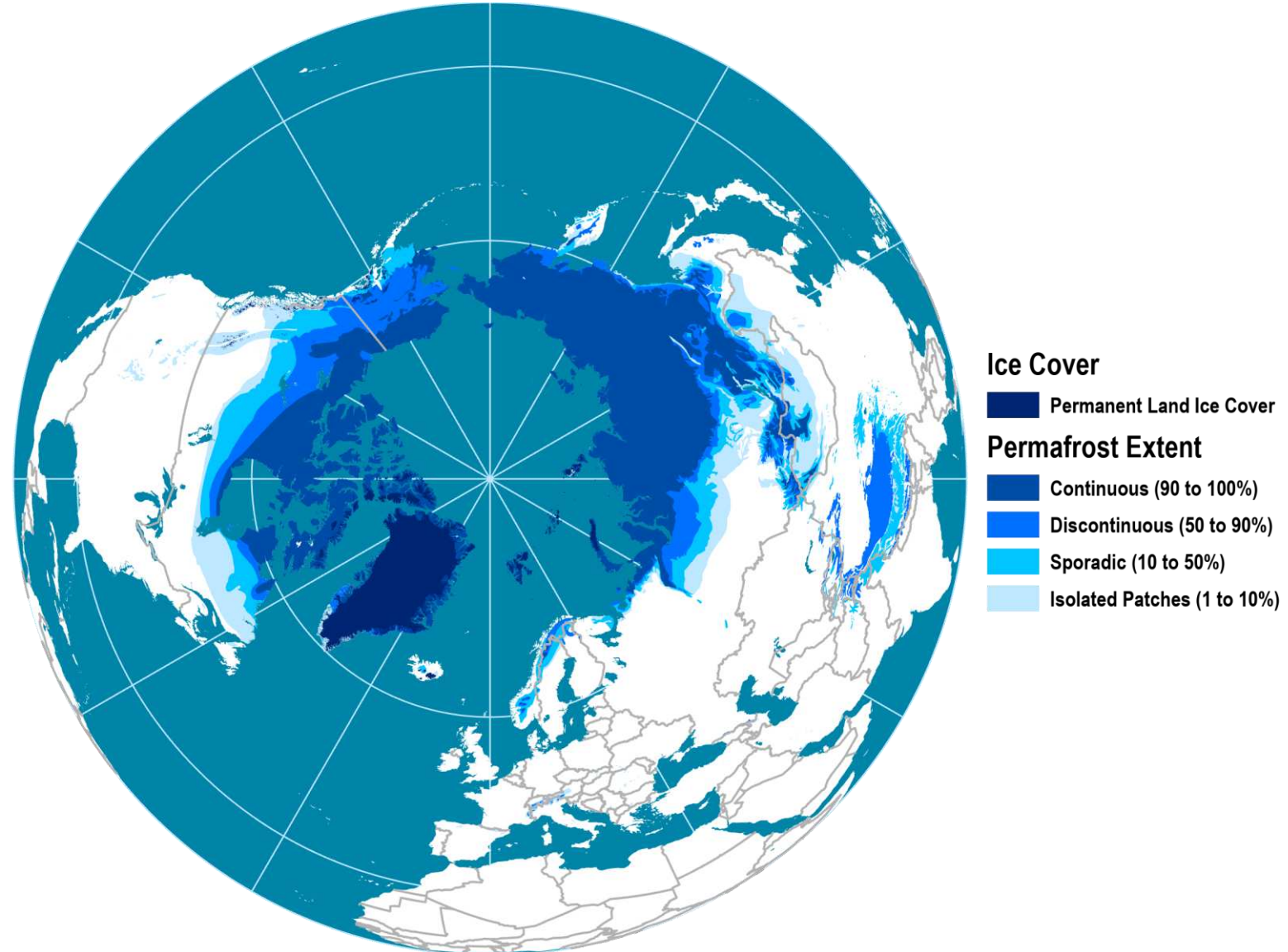
# Seasonal Variation of Global Wind Patterns



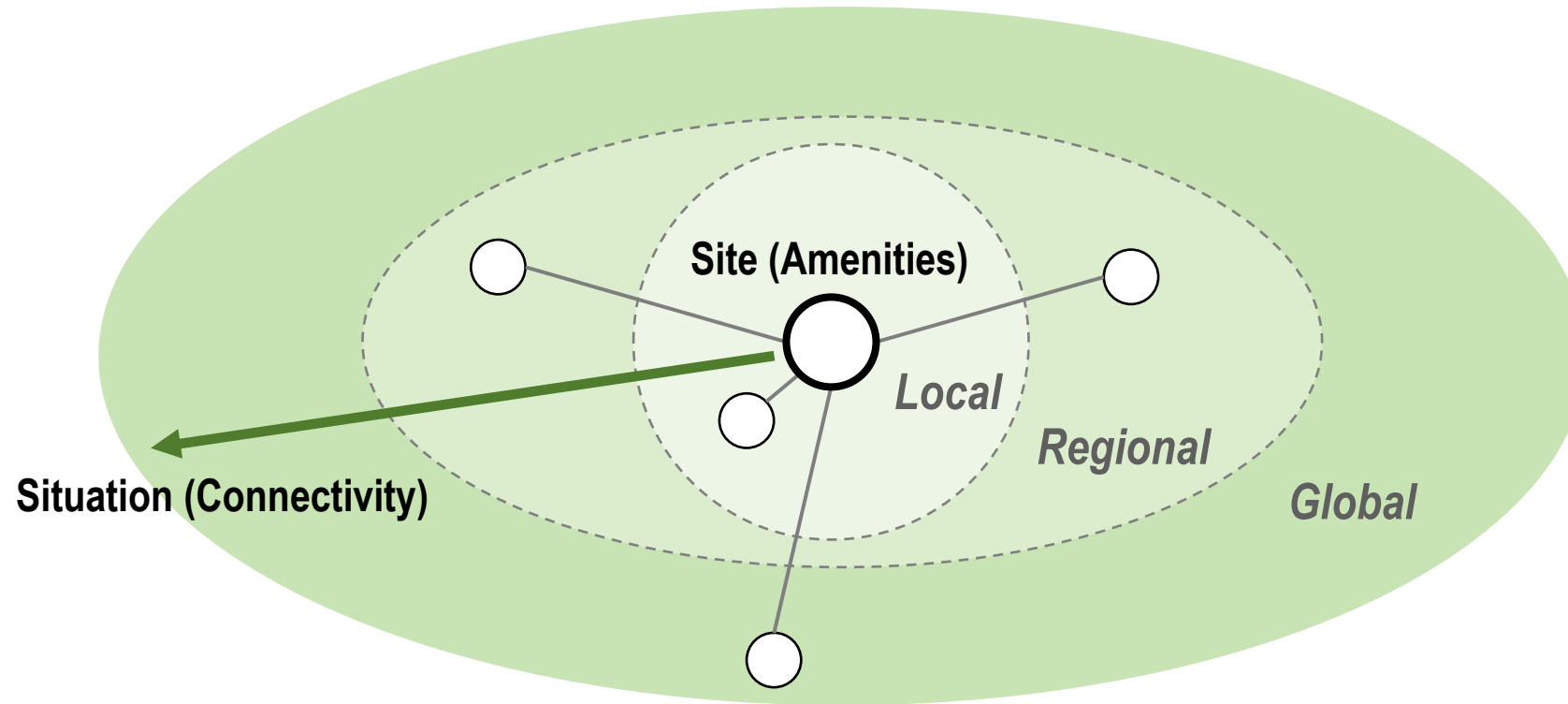
# Major Oceanic Gyres and Sea Currents



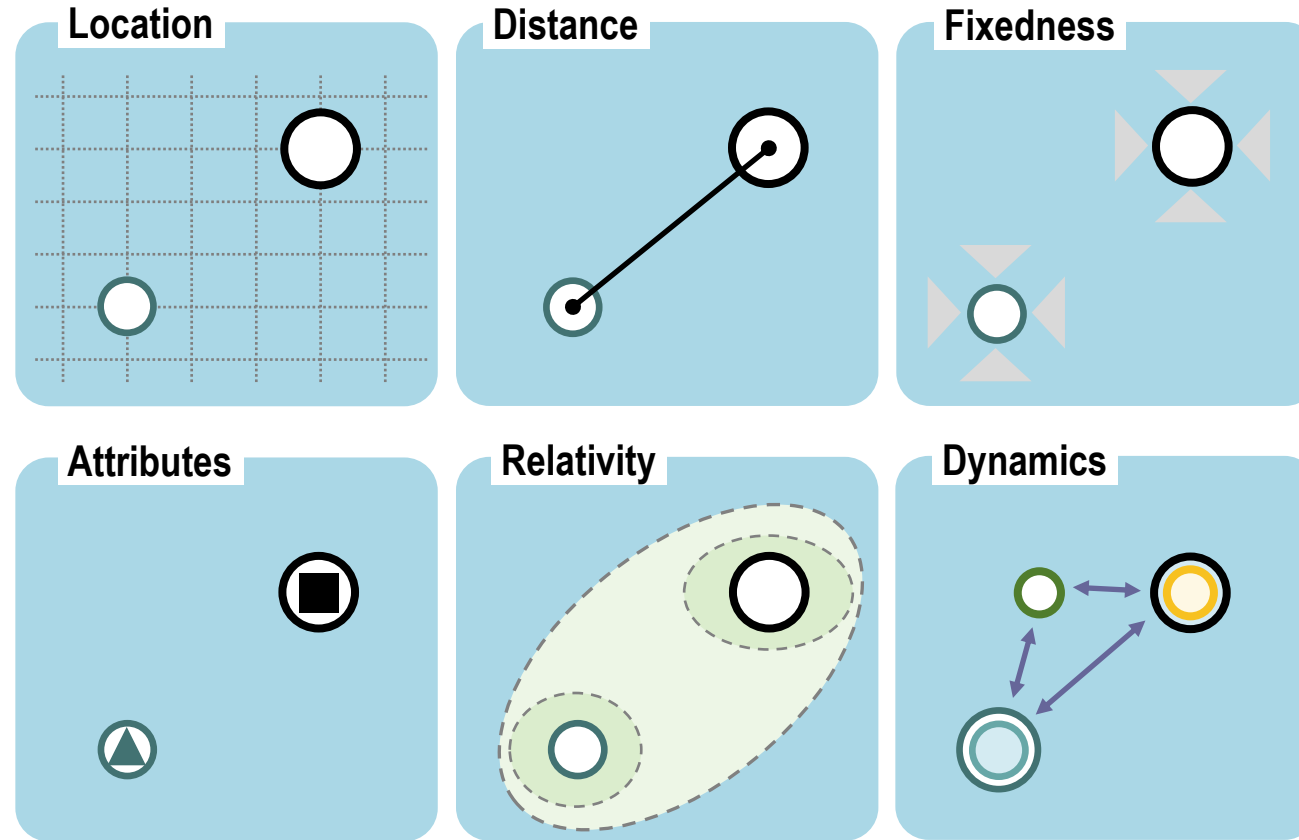
# Land Covered by Permafrost



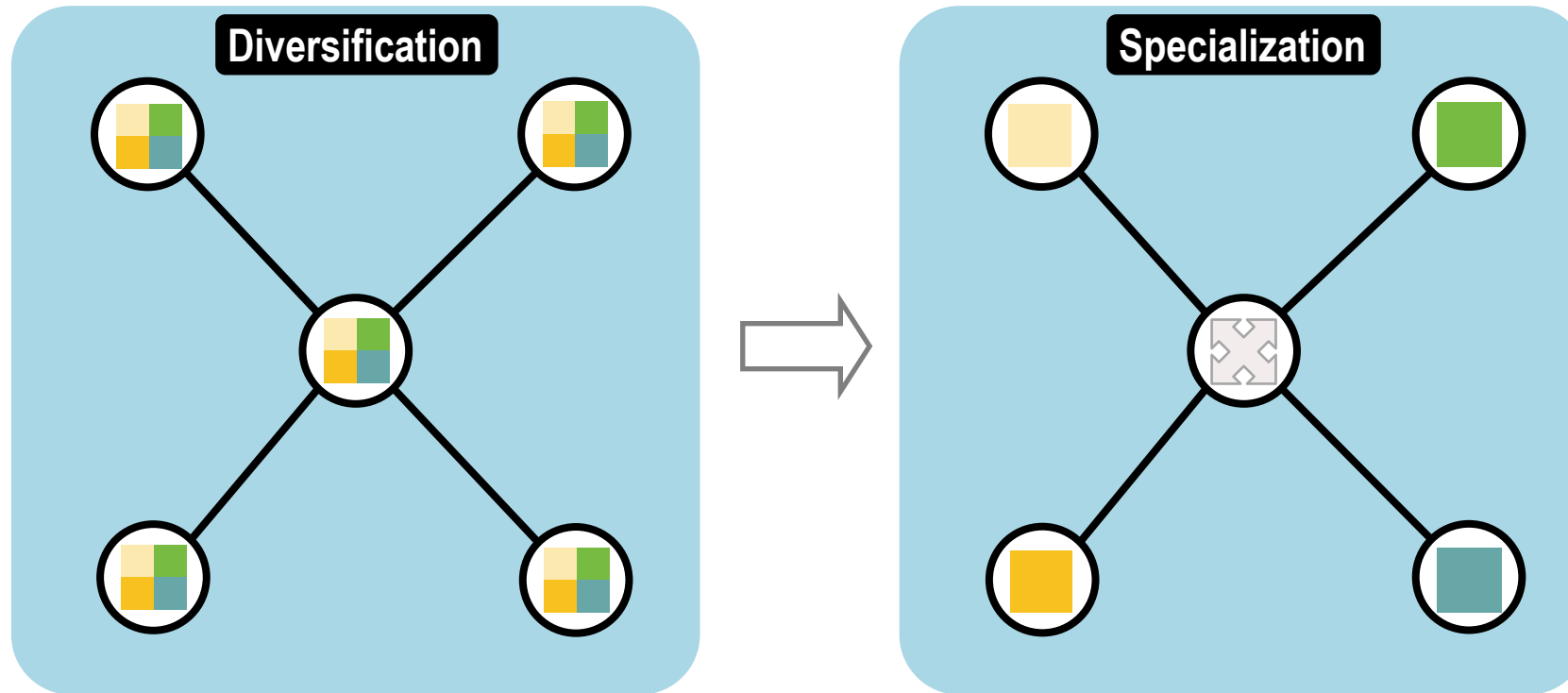
# Transport, Site and Situation



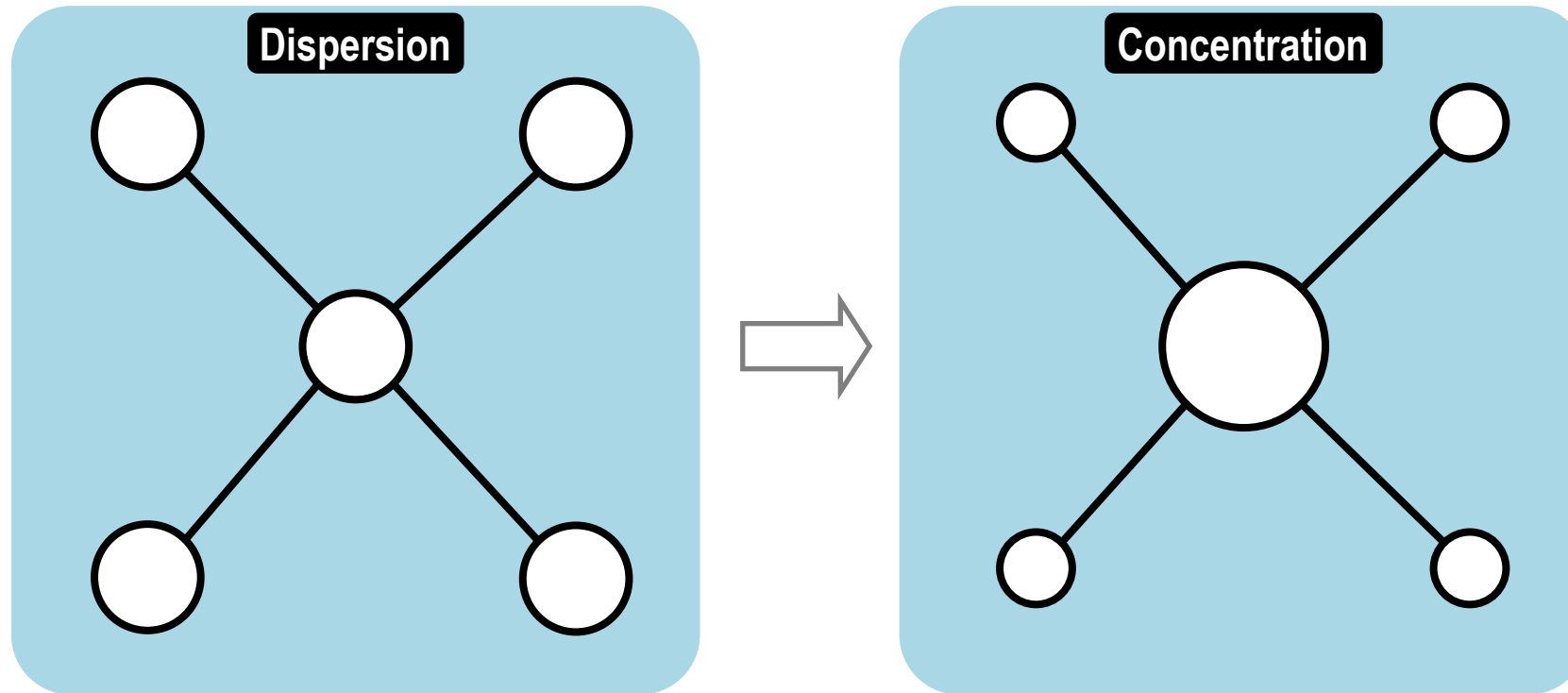
# The Spatial Structure and Transportation



# Transportation Networks and Geographical Specialization



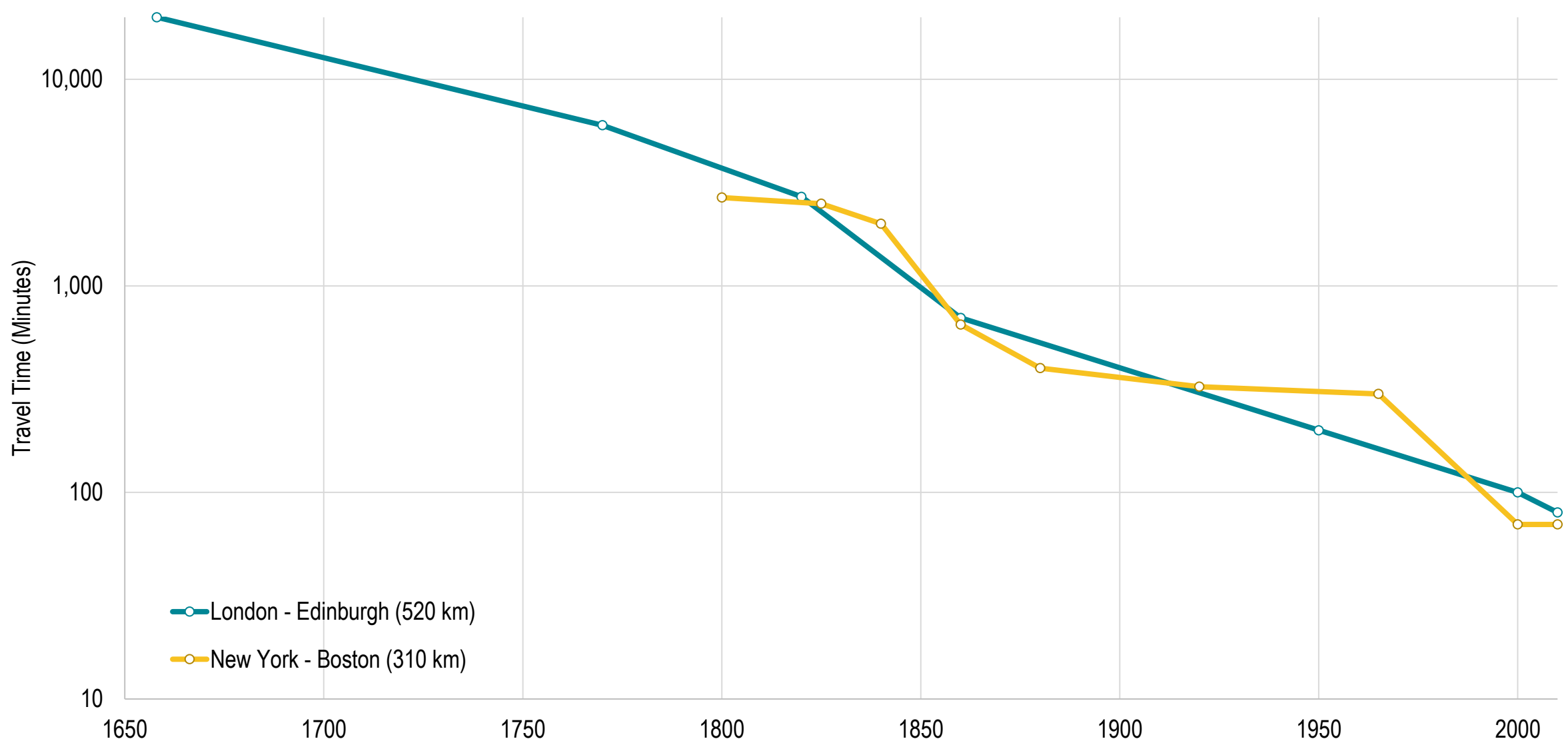
# Transportation Networks and Geographical Concentration



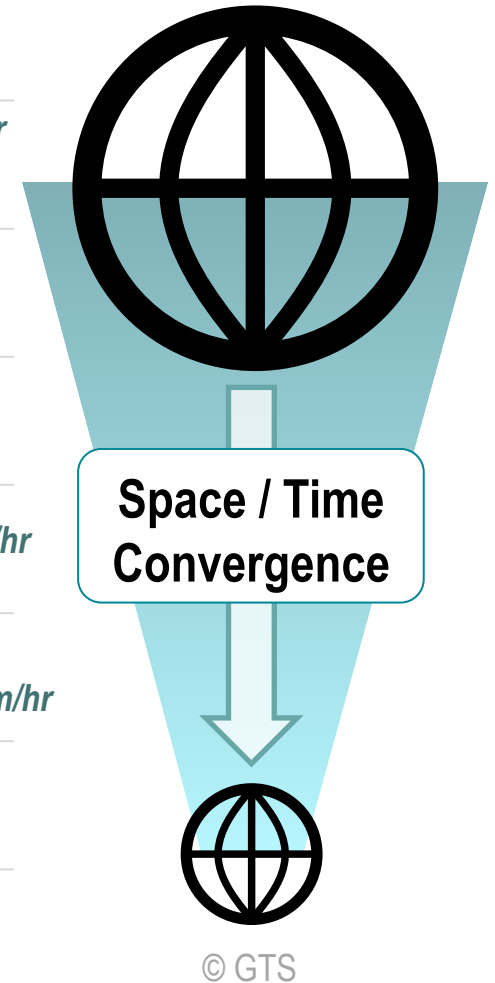
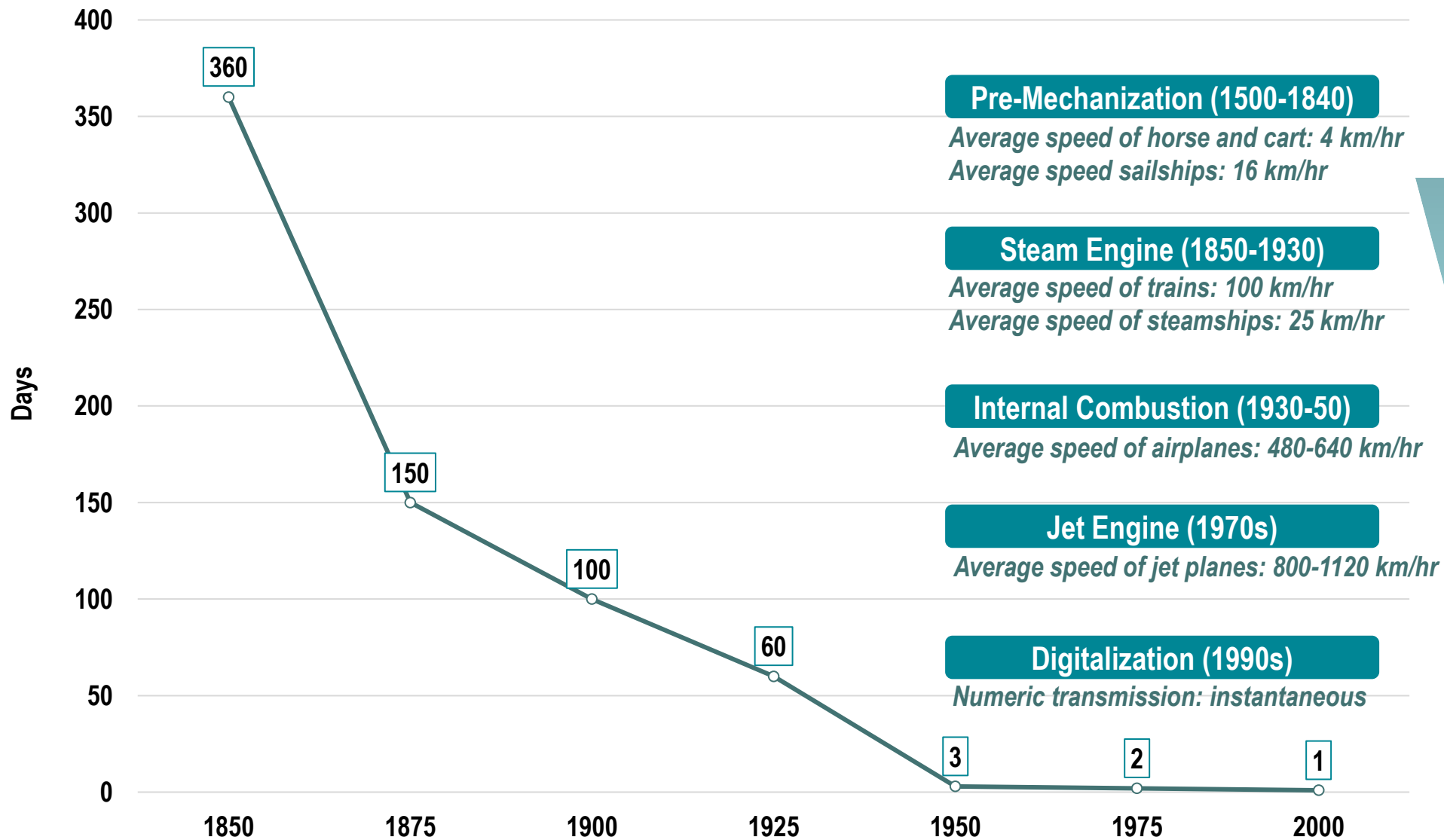


# Transport as a Centralizing and Decentralizing Force (under construction)

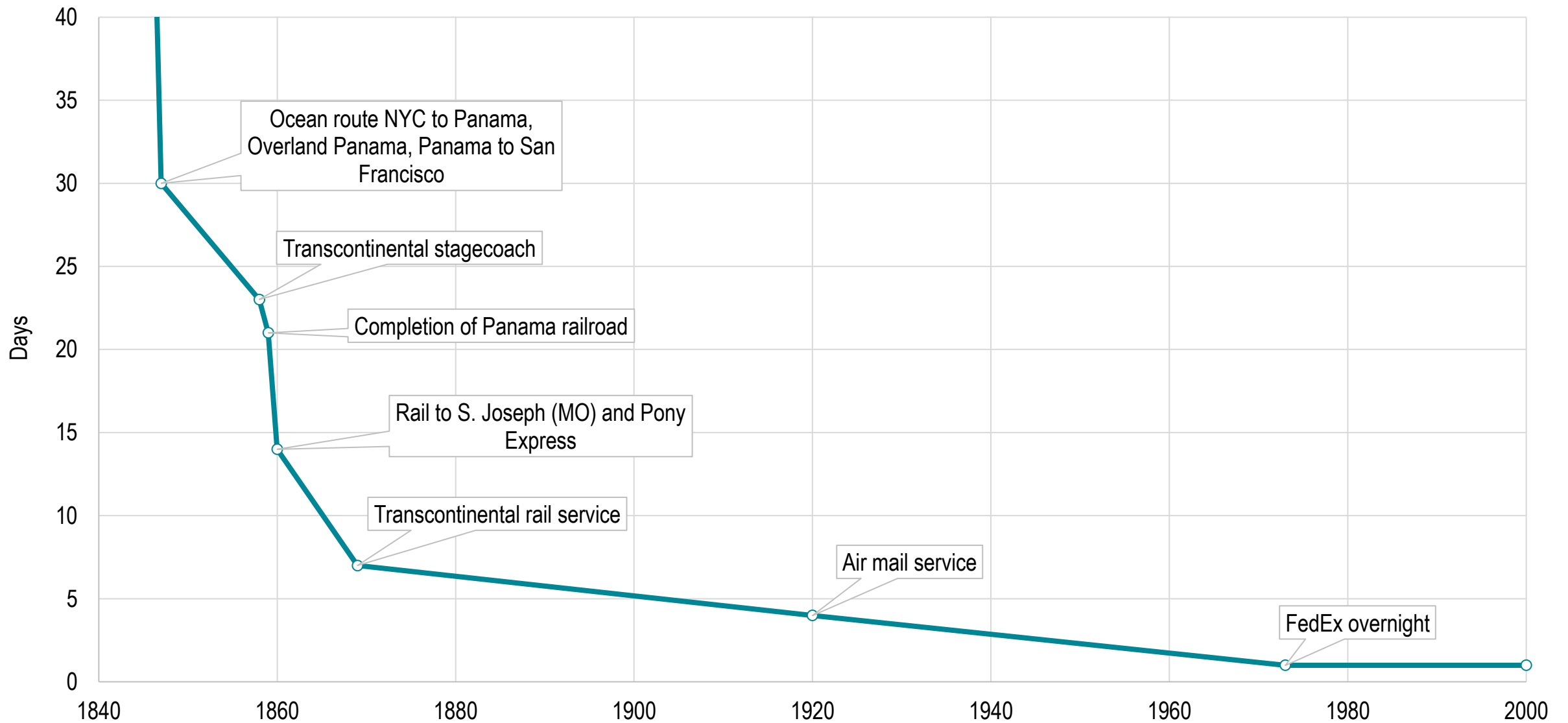
# Regional Space / Time Convergence, (London – Edinburgh, New York – Boston)



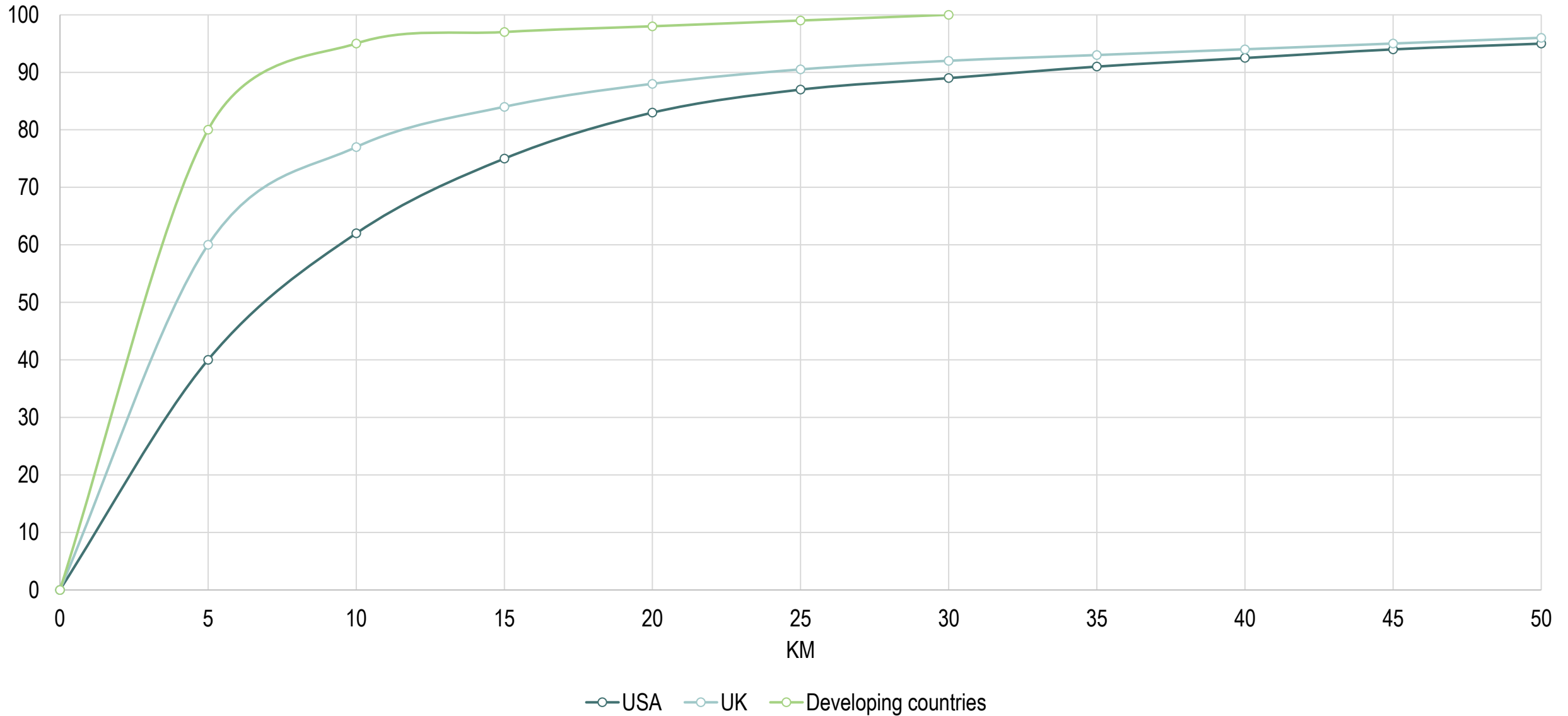
# Global Space / Time Convergence: Days Required to Circumnavigate the Globe



# Mail Delivery Times between New York and San Francisco, 1840-2000



# Cumulative Distribution of per Capita Trip Rate for all Modes by Trip Distance, 1995

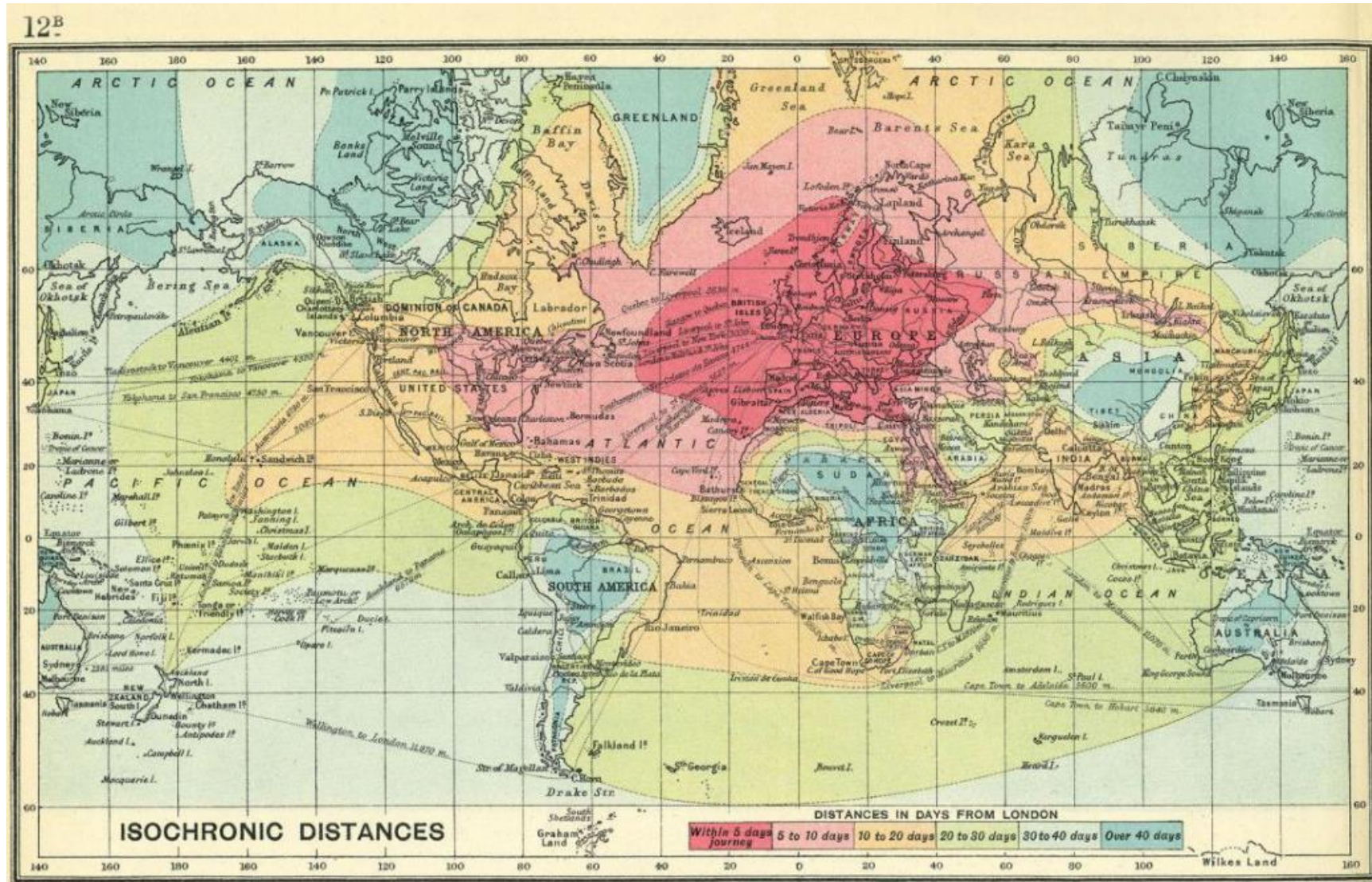


# Speed Improvement Potential by Transport Mode [TO BE UPDATED]

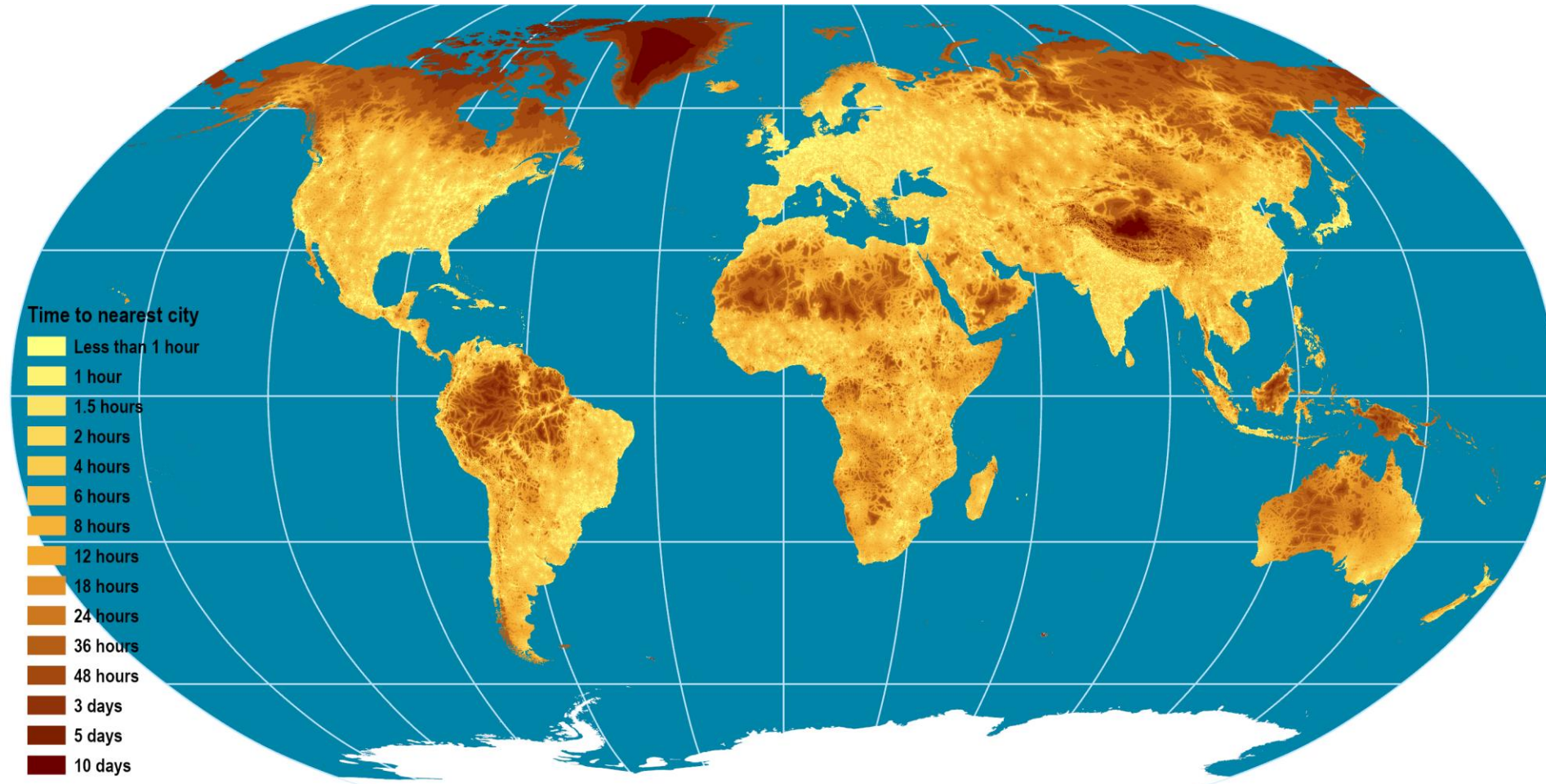
Mode	Potential	Main Issues
Road (automobiles, buses, trucks)	None to limited	Congestion. Operational safety (speed limits). Limited access highways.
Rail (Freight)	Limited	Operational safety (grade crossings). Availability of train slots. Terminal capacity.
Rail (Passengers)	Good to significant	Development of high speed rail systems. Long term potential of new technologies (e.g. Maglev).
Air	None to limited	Energy consumption. Congestion at airport terminals. Abandonment of supersonic services.
Maritime	None to limited	Energy consumption (slow steaming). Fast ferries.

[https://transportgeography.org/contents/chapter1/transportation-and-space/table\\_transport\\_speed/](https://transportgeography.org/contents/chapter1/transportation-and-space/table_transport_speed/)

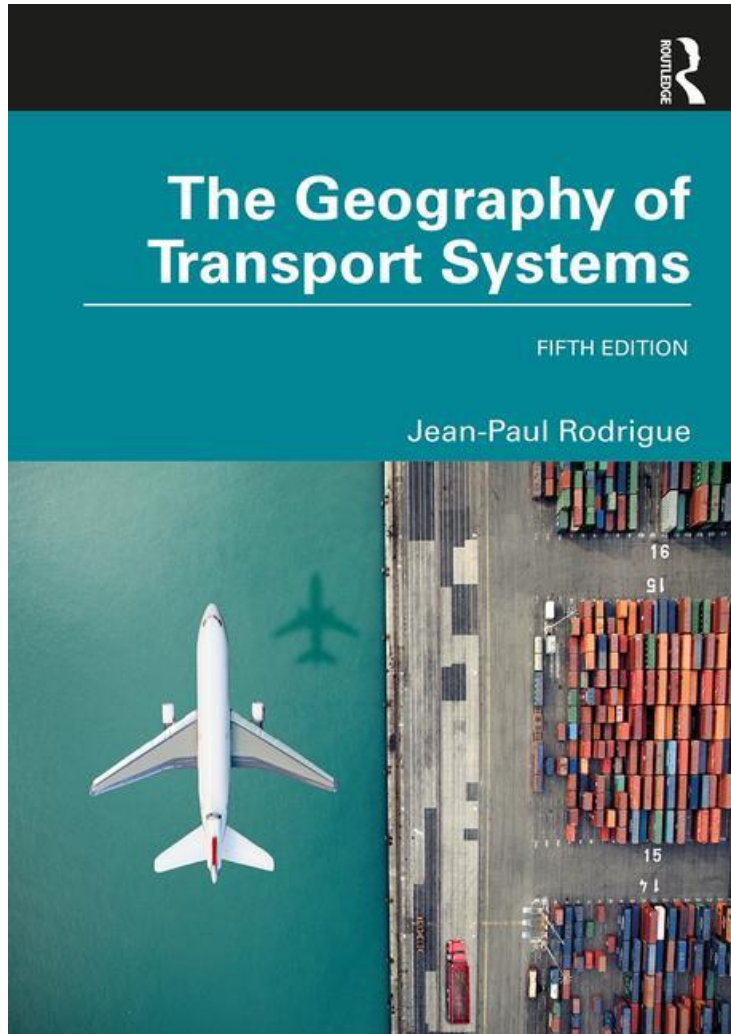
# Travel Time between London and the Rest of the World, 1914



# Global Accessibility: Time to the Nearest Large City







# The Emergence of Mechanized Transportation Systems

# The Genesis of Globalization

	Antiquity	Modern Era	Post-Modern
Time Frame	<ul style="list-style-type: none"><li>• Since the beginning of history</li></ul>	<ul style="list-style-type: none"><li>• Nineteenth century</li></ul>	<ul style="list-style-type: none"><li>• After World War II</li></ul>
Economic System	<ul style="list-style-type: none"><li>• Imperialism / Mercantilism</li></ul>	<ul style="list-style-type: none"><li>• Imperialism / Capitalism</li></ul>	<ul style="list-style-type: none"><li>• Capitalism / Corporatism</li></ul>
Foundation	<ul style="list-style-type: none"><li>• Exploration, war (expansion) and trade</li></ul>	<ul style="list-style-type: none"><li>• Mass production and consumption</li></ul>	<ul style="list-style-type: none"><li>• Trade liberalization</li></ul>
Acceleration	<ul style="list-style-type: none"><li>• Age of exploration of colonialism (15-16th century)</li></ul>	<ul style="list-style-type: none"><li>• Berlin Conference (1884)</li></ul>	<ul style="list-style-type: none"><li>• Fall of the Soviet Union</li><li>• Entry of China in world trade</li></ul>
Form	<ul style="list-style-type: none"><li>• Empires</li></ul>	<ul style="list-style-type: none"><li>• Nation-states</li></ul>	<ul style="list-style-type: none"><li>• Economic blocs</li></ul>
Mobility	<ul style="list-style-type: none"><li>• Trails and sailships</li></ul>	<ul style="list-style-type: none"><li>• Mechanized (steamship and rail)</li></ul>	<ul style="list-style-type: none"><li>• Air transport, containerization and telecommunications</li></ul>

# Transport Revolutions in Human History

Era	Date	Mobility
Paleolithic	c. 700,000 years ago c. 35,000 years ago c. 18,000 years ago	First migrations from Africa First migrations by sea to Australasia First migrations to the Americas
Agrarian	c. 4,000 BCE c. 3,500 BCE c. 1,000 BCE	Animal-powered transport Wheeled transport Long distance navigation in Polynesia
Modern	From 15th century From early 19th century From late 19th century From early 20th century From mid 20th century	Improvements in shipbuilding and navigation Railways and steamships Internal combustion engines Air travel Space travel

# Main Technological Advances in Transportation and Telecommunication

## Transportation

3000 BCE

Horses; Sailing ships; Wheeled carts; Aqueducts

300 BCE – 500 CE

Wheelbarrow; Paved roads; Stirrups; Canals

500 – 1000 CE

Horse collars; Compass

1000 – 1500 CE

Rudder, Locks; Three-mast ships

1500 – 1800 CE

Steam engine (1712); Steam car (1769); Balloons (1783)

1800 – 1850 CE

Steamboat (1807); Bicycles (1816); Surfaced roads (1816); Steam rail (1825); Electric streetcars (1834); Iron hulls (1843)

1850 – 1875 CE

Airships (1852); Compound steam engine (1854); Subway (1863); Pipelines (1864); Internal combustion engine (1866); Asphalt roads (1872)

1875 – 1900 CE

Steam turbine (1884); Gasoline engine (1885); Pneumatic tires (1888); Diesel engine (1895); Trucks (1886)

1900 – 1925 CE

Airplanes (1903); Helicopters (1907); Ford Model T (1908); Dirigibles (1910); Diesel locomotives (1917); Air passenger services (1919)

1925 – 1950 CE

Rockets (1926); Highways (1933); Jet engine (1940); Passenger jet (1949)

1950 – 1975 CE

Intermodal containers (1957); Space travel (1957); Jumbo jets (1966); Supersonic passenger jets (1969); Maglev (1969)

1975 – 2000 CE

Double-stacked rail services (1984); Drones (1991); Hybrid cars (1997)

2000 – 2025 CE

Ride-sharing (2011); Self driving vehicles (2014)

## Telecommunication

Writing systems; Mail services

Paper

Moveable type

Printing press (1456); Paper currency

Newspapers and magazines

Photographs (1830); Telegraph (1844)

Transoceanic telegraph cable (1858); Typewriters (1867)

Telephones (1876); Wireless radio (1895)

Transatlantic radio (1900); Commercial radio (1920); Facsimile (1925)

RADAR (1940); Commercial television (1940); Electronic computers (1946); Transistor (1947)

Integrated circuits (1958); Xerox copier (1959); Telecom satellites (1962); Internet (1970); Cell phones (1973)

Laser printer (1977); Fiberoptic cable (1978); GPS (1978); Personal computers (1981); WWW (1991); Search engine (1994); E-commerce (1997)

Smartphones (2002); Blockchain (2008)

# Ancient Trade Issues

## Nature of Trade



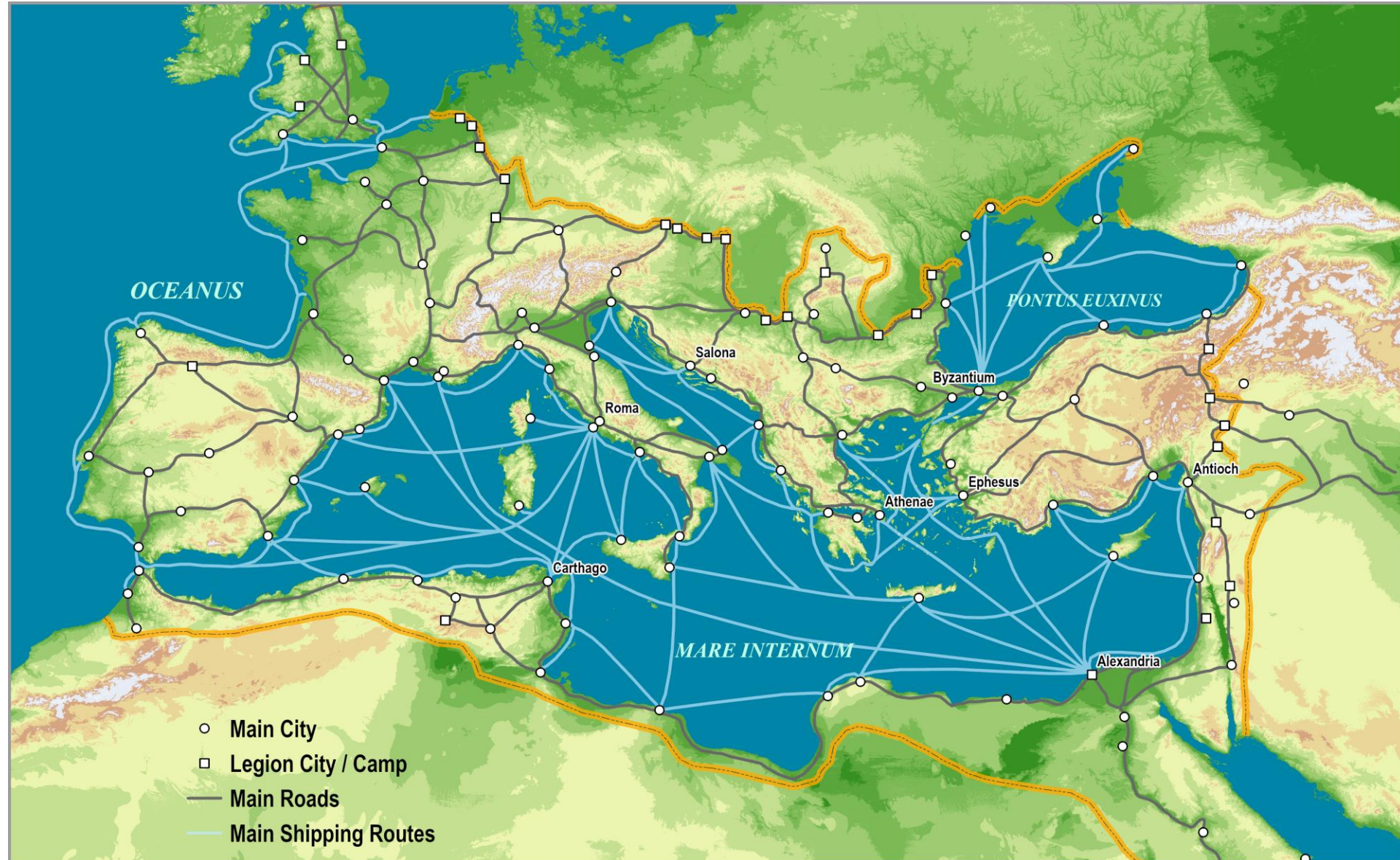
- Limited market size.
- High value commodities (silk, spices, perfumes, gems, gold / silver, ivory).
- Bulk commodities could be traded when maritime transport was available (grain, wine, olive oil).
- Many intermediaries.

## Limiting Factors

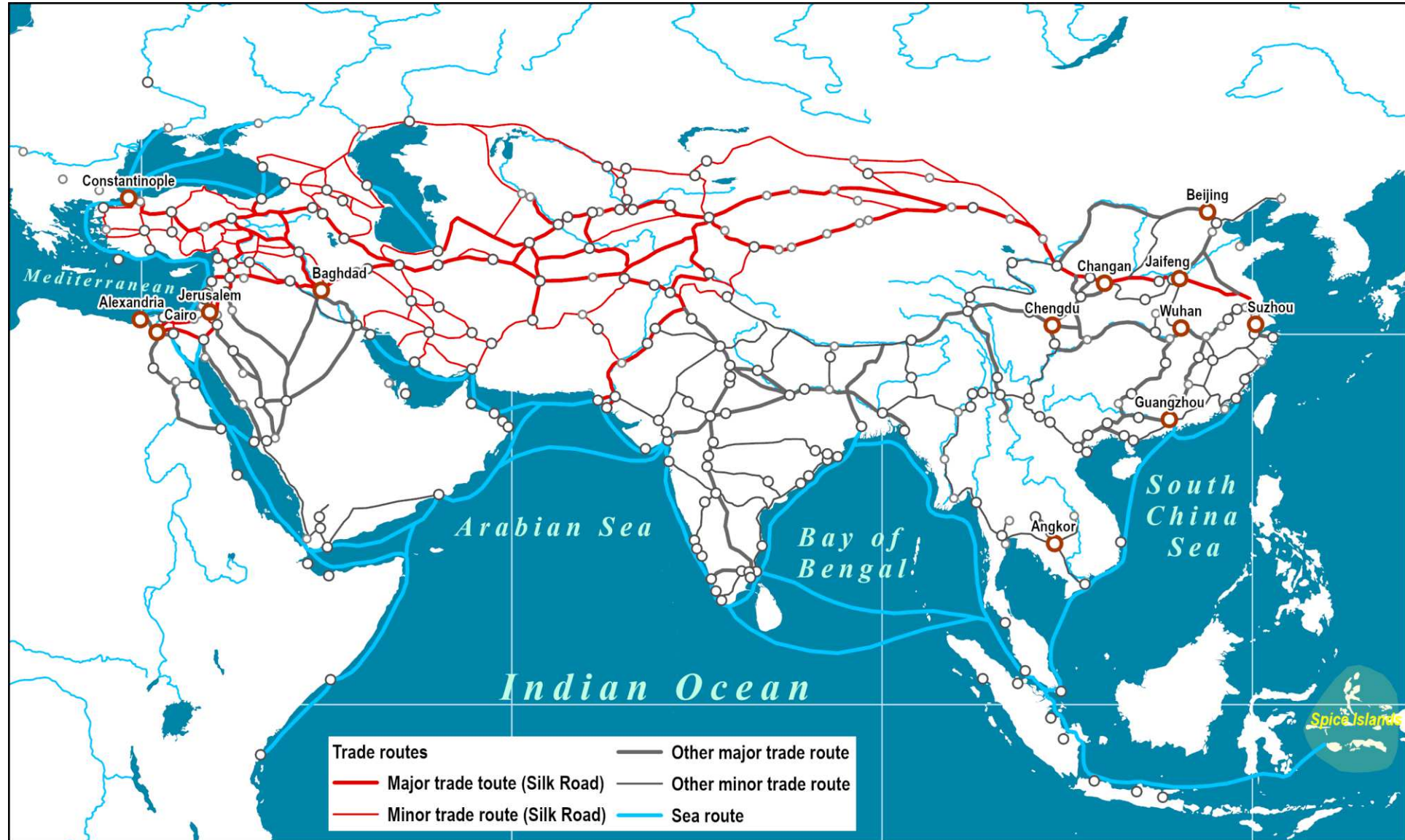


- Limited capacity and speed of inland transportation.
- Diversity of currencies and units of measure.
- High tariffs.
- Unreliable navigation.
- Insecurity / piracy.

# Roman Empire, c125AD



# The Silk Road and Arab Sea Routes (11th and 12th Centuries)

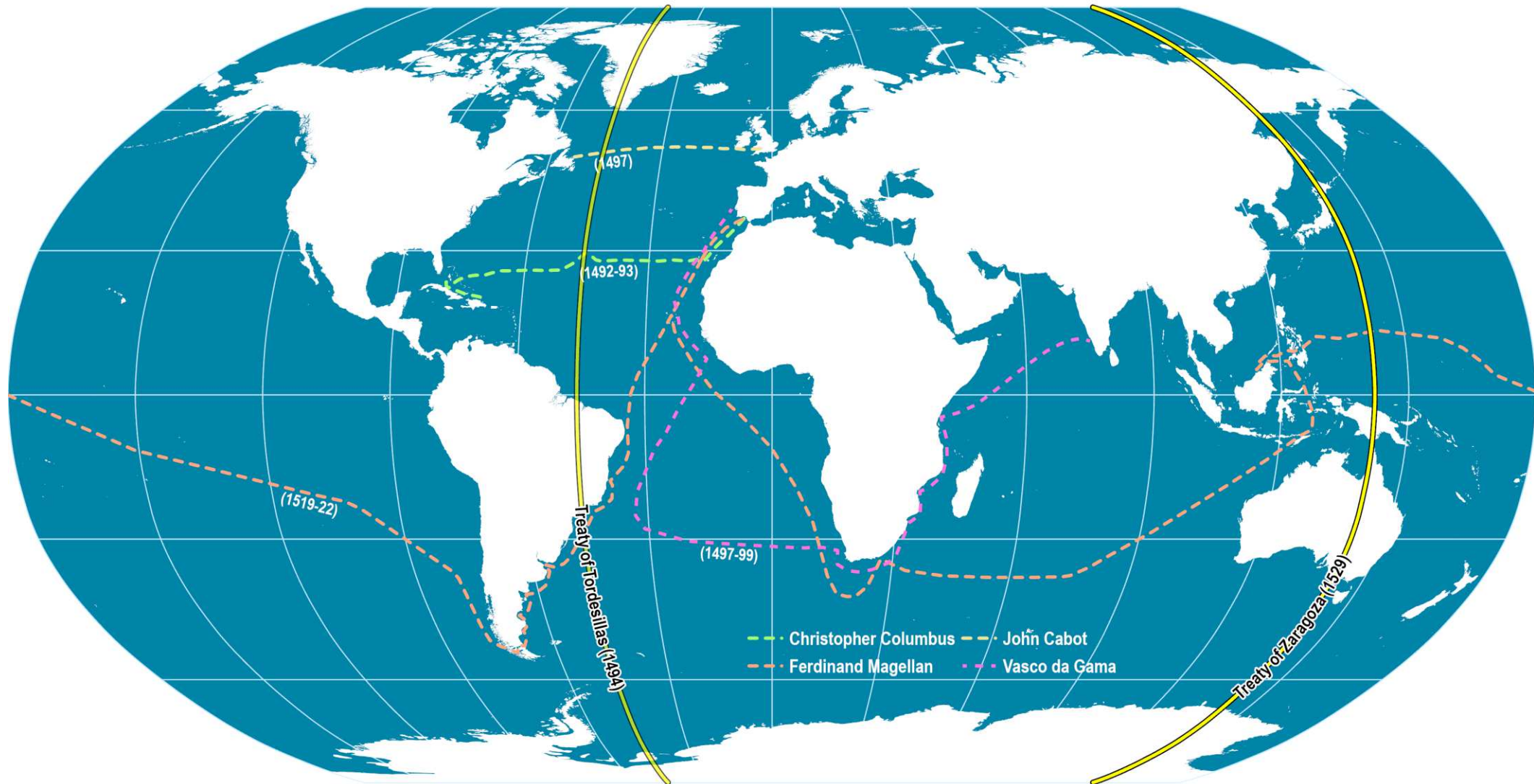


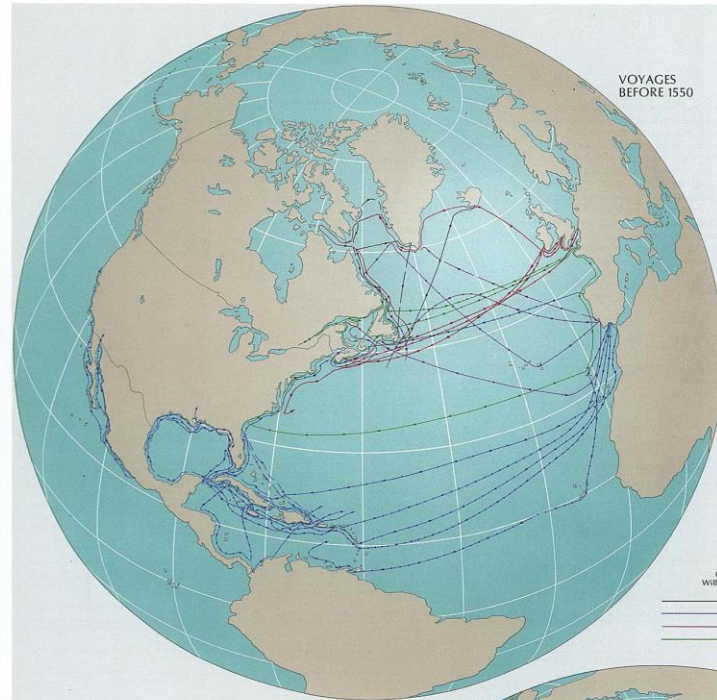
# Grand Canal System





# Early European Maritime Expeditions, 1492-1522





VOYAGES BEFORE 1550

PRINCIPAL VOYAGES

- 985-986 B. Herjulfsson
- 995-996 L. Ericsson
- 1003-1004 T. Karlsefni
- 1492 C. Columbus
- 1493 C. Columbus
- 1497 J. Cabot
- 1498 C. Columbus
- 1498 J. Cabot
- 1500 G. Corte-Real
- 1501 G. Corte-Real
- 1502 C. Columbus
- 1502 M. Corte-Real
- 1508-1509 S. Cabot
- 1513 V. de Balboa
- 1513 J. Ponce de León
- 1518 J. de Grijalva
- 1519 A. de Pineda
- 1520 J. Fagundes
- 1523 G. da Verrazano
- 1524 E. Gómez
- 1526 L. de Ayllón
- 1528 P. de Narváez
- 1534 J. Cartier
- 1535 J. Cartier
- 1539 H. de Soto
- 1542 L. Moscoso (after de Soto)
- 1539 F. de Ulloa
- 1540 H. de Marcon
- 1542 J. Cabrillo

Compiled from information provided by William H. Goetzmann, University of Texas, 1966

- NORSE
- SPANISH
- PORTUGUESE
- FRENCH
- BRITISH
- DUTCH
- RUSSIAN

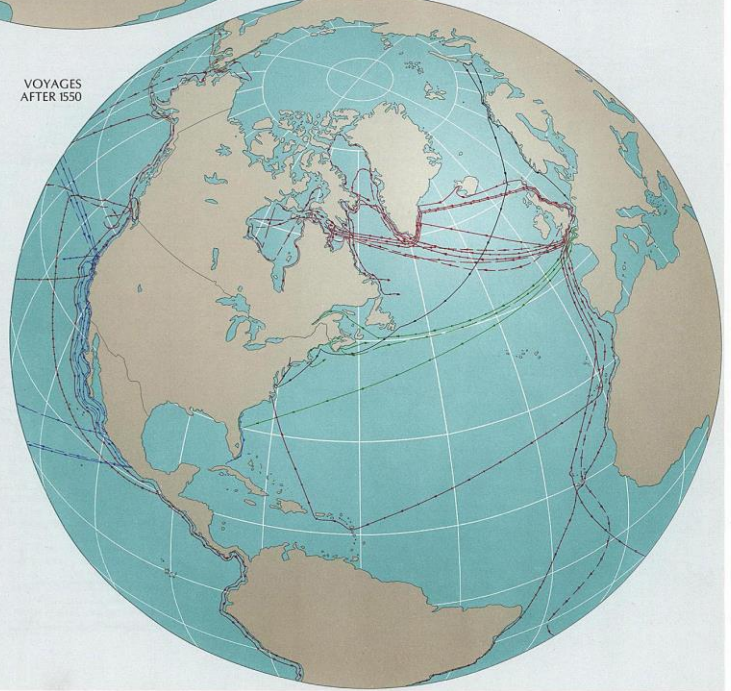
VOYAGES AFTER 1550

PRINCIPAL VOYAGES

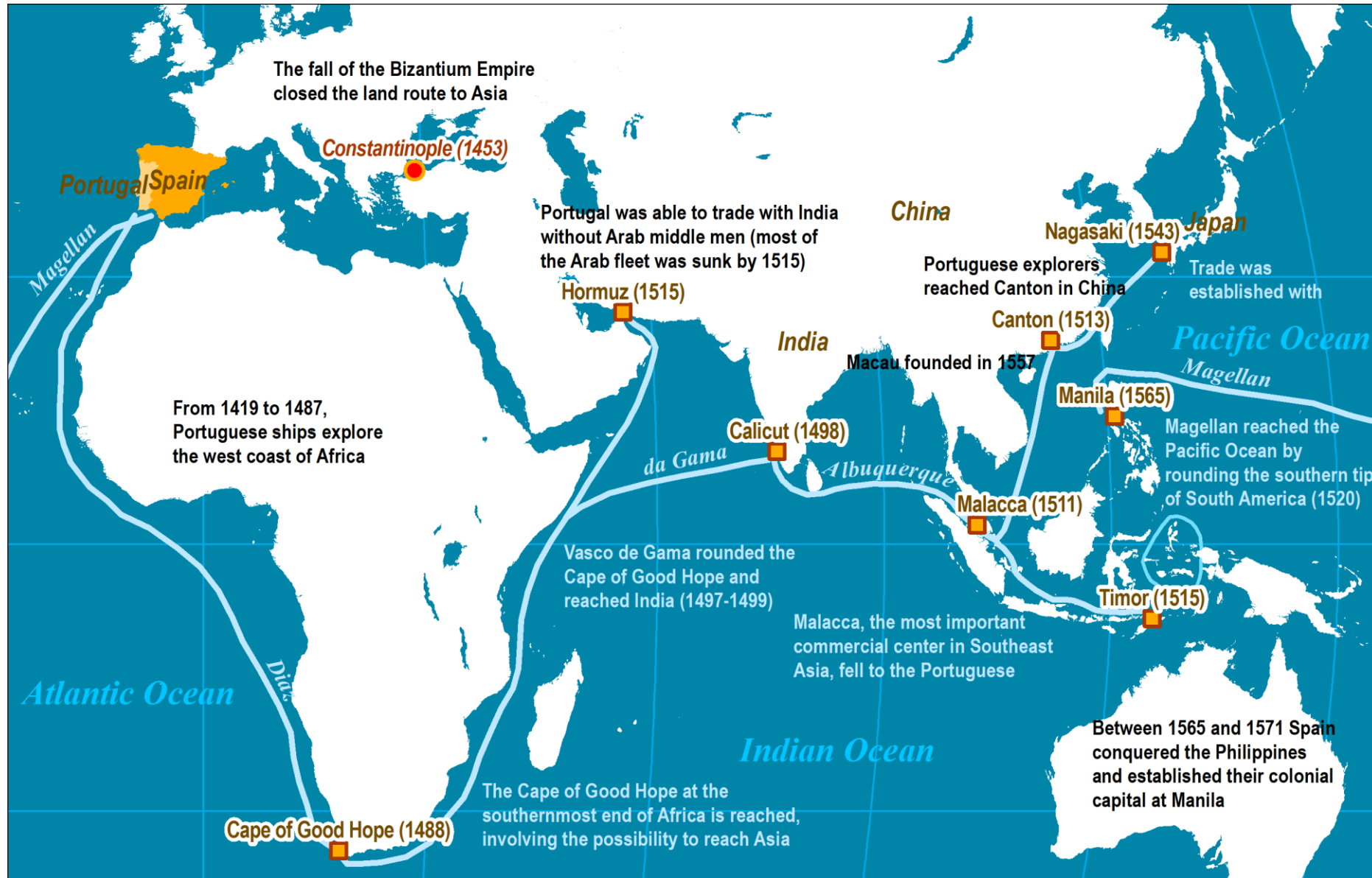
- 1562 J. Ribaut
- 1565 P. de Avilés
- 1565 A. de Arellano
- 1576-1577 M. Frobisher
- 1577 F. Drake
- 1578 M. Frobisher
- 1584 A. Barlow-P. Amadas (Roanoke Voyages)
- 1585 J. Davis
- 1586 J. Davis
- 1587 J. Davis
- 1587 P. de Unamuno
- 1595 S. Cermenho
- 1602 S. Viscaino
- 1603 S. de Champlain
- 1604-1607 S. de Champlain
- 1609 H. Hudson
- 1610 H. Hudson
- 1612 T. Button
- 1616 R. Bylot-W. Baffin
- 1631 L. Foxe
- 1648 S. Deshnev
- 1728 V. Bering
- 1741 V. Bering
- 1776-1780 J. Cook
- 1790 M. Quimper
- 1791-1794 C. Vancouver

EXPLORING PARTIES NOT SHOWN

BRITISH EXPLORING AND COLONIZING PARTIES 1631-1663  
 H. Gilbert, G. Waymouth, B. Gosnell, J. Smith, W. James, W. Hilton  
 RUSSIAN FUR TRADERS 1742-1795  
 E. Baov, Y. Chuprov, S. Gutor, G. Shelikhov, A. Baranov, J. Billings  
 SPANISH INDIAN TRADERS 1742-1795  
 E. J. Martínez, J. Pérez, J. Riquelme, J. López, L. de Borja y Cuadra, C. López de Haro, J. Martínez, J. Martínez y Zayas, J. de Ycaza, J. Cancho, F. Elías, J. Martínez y Zayas, J. de Ycaza  
 AMERICAN AND BRITISH SEA OTTIE TRADERS 1780-1795  
 C. Clark, J. Stragg, J. Harris, J. Neave, C. Dixon, N. Pothol, J. Collett, C. Duncan, C. Barkley, J. Kendrick, R. Gray



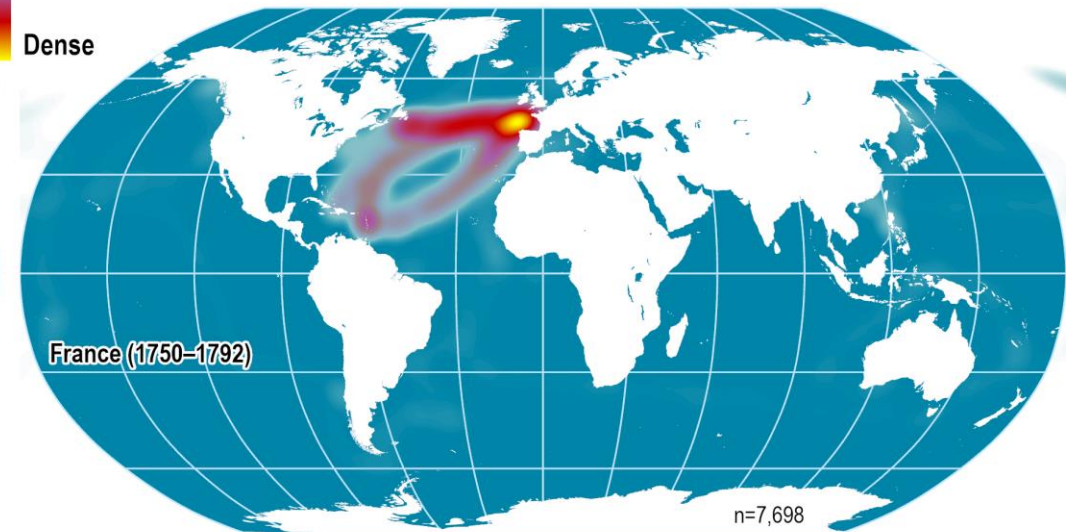
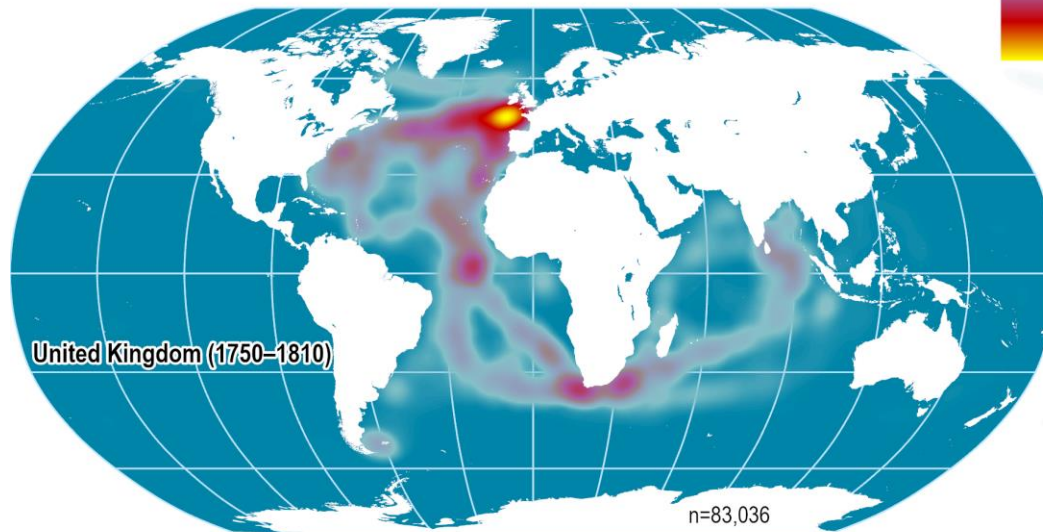
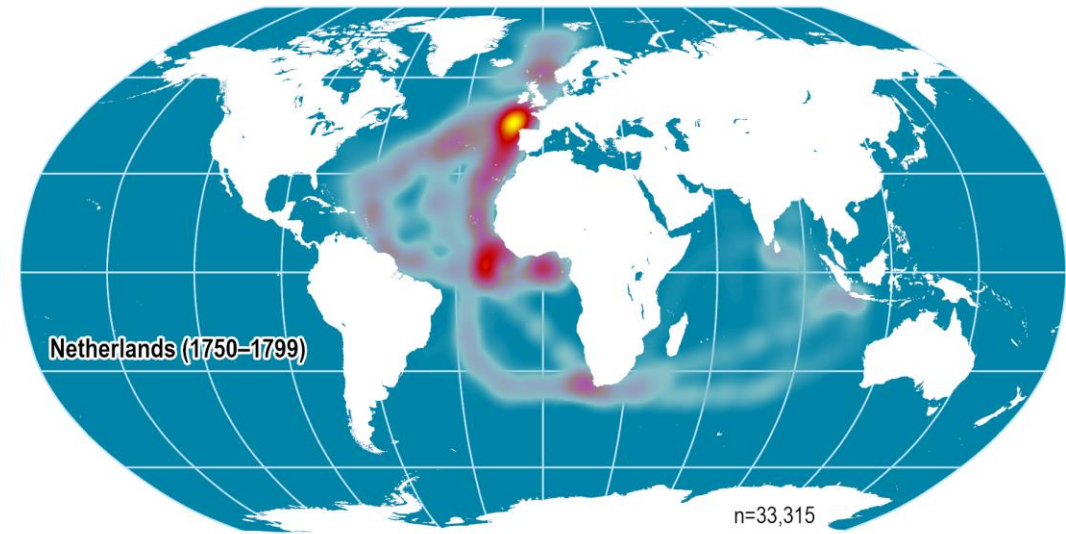
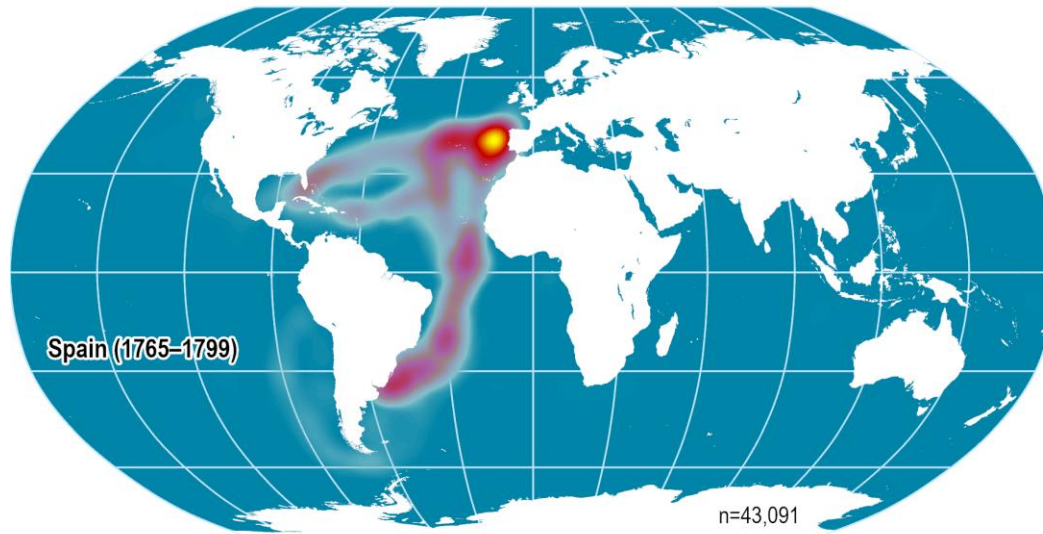
# The Eastern and Western Maritime Routes to Asia



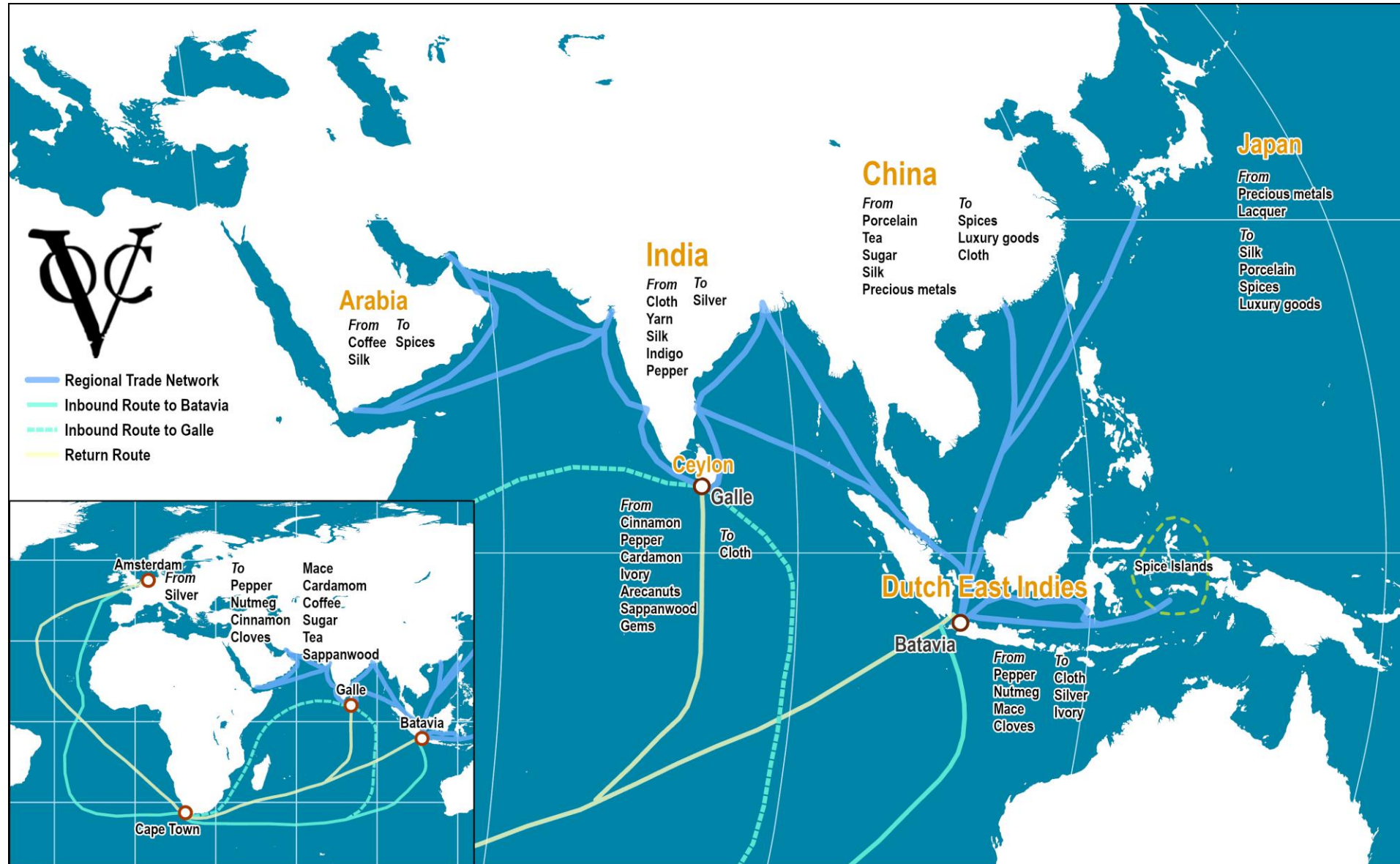
# Spanish and Portuguese Empires (1581–1640)



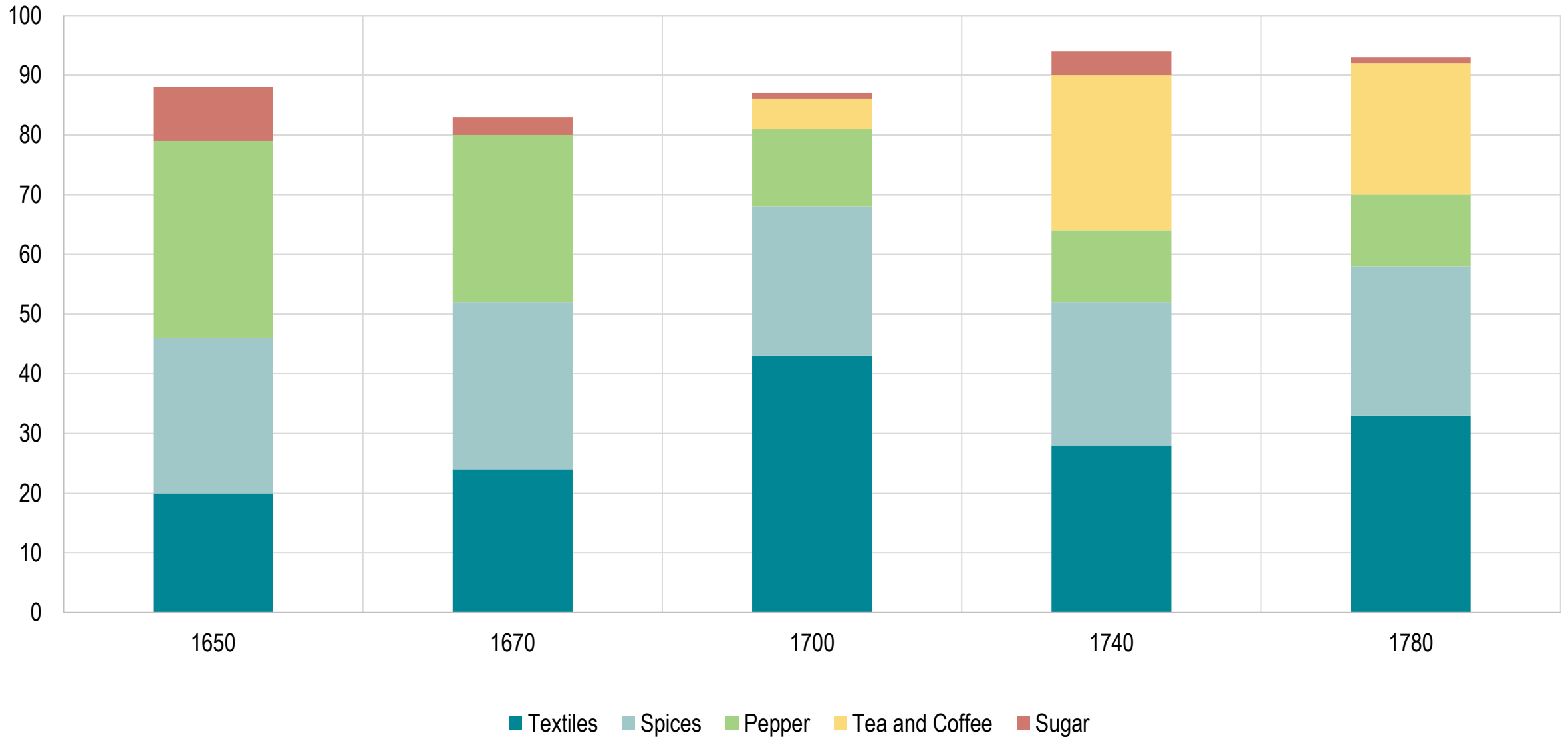
# Density of Ship Log Entries, 1750–1810



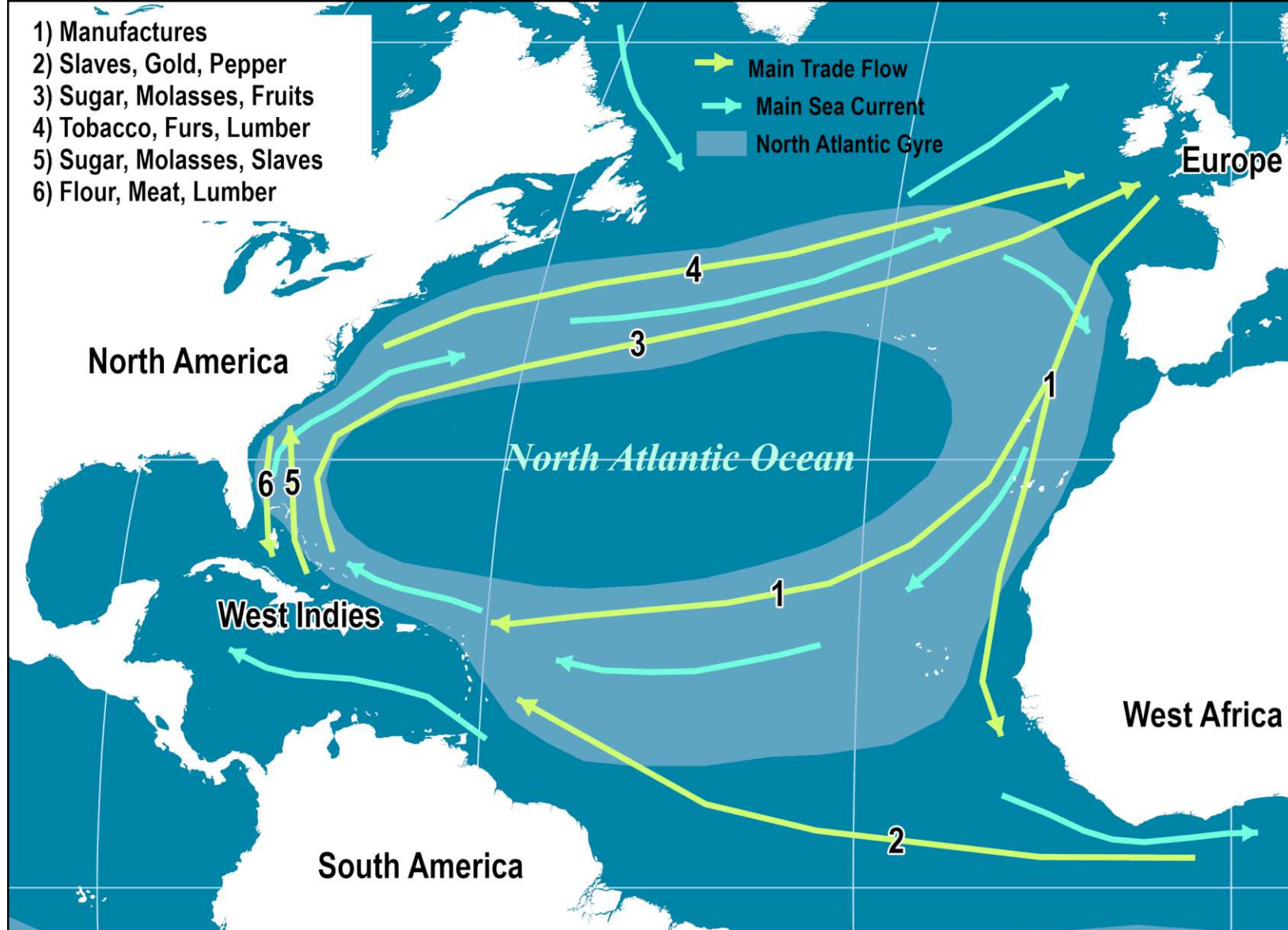
# Dutch East India Company, Trade Network, 17th Century



# Imports from the Dutch East India Company at Amsterdam, 17<sup>th</sup> and 18<sup>th</sup> Centuries



# Colonial Trade Pattern, North Atlantic, 18<sup>th</sup> Century





# North American Coastal Trade System, 18th Century



# The Performance of Pre-industrial Means of Transportation

## Walking



 40 lbs / 18 kg

 5 km/hr

 30 km/day

## Horse Riding



 275 lbs / 125 kg

 8 km/hr

 60 km/day

## Camel




 350 lbs / 160 kg

 5 km/hr


 40 km/day

## Horse & cart




 1 ton

 3 km/hr

 25 km/day

## Barge pulled by horse

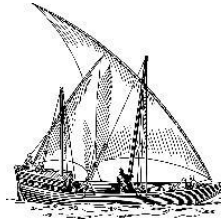



 50-100 tons


 4 km/hr


 35 km/day

## Dhow

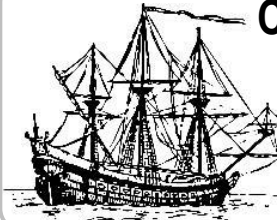



 15-300 tons

 13 km/hr


 150 km/day

## Carrack (15th century)




 500-1500 tons


 10 km/hr


 130 km/day

## Galleon (17th century)




 500-800 tons

 15 km/hr


 300 km/day

## Clipper (19th century)



 500-1500 tons

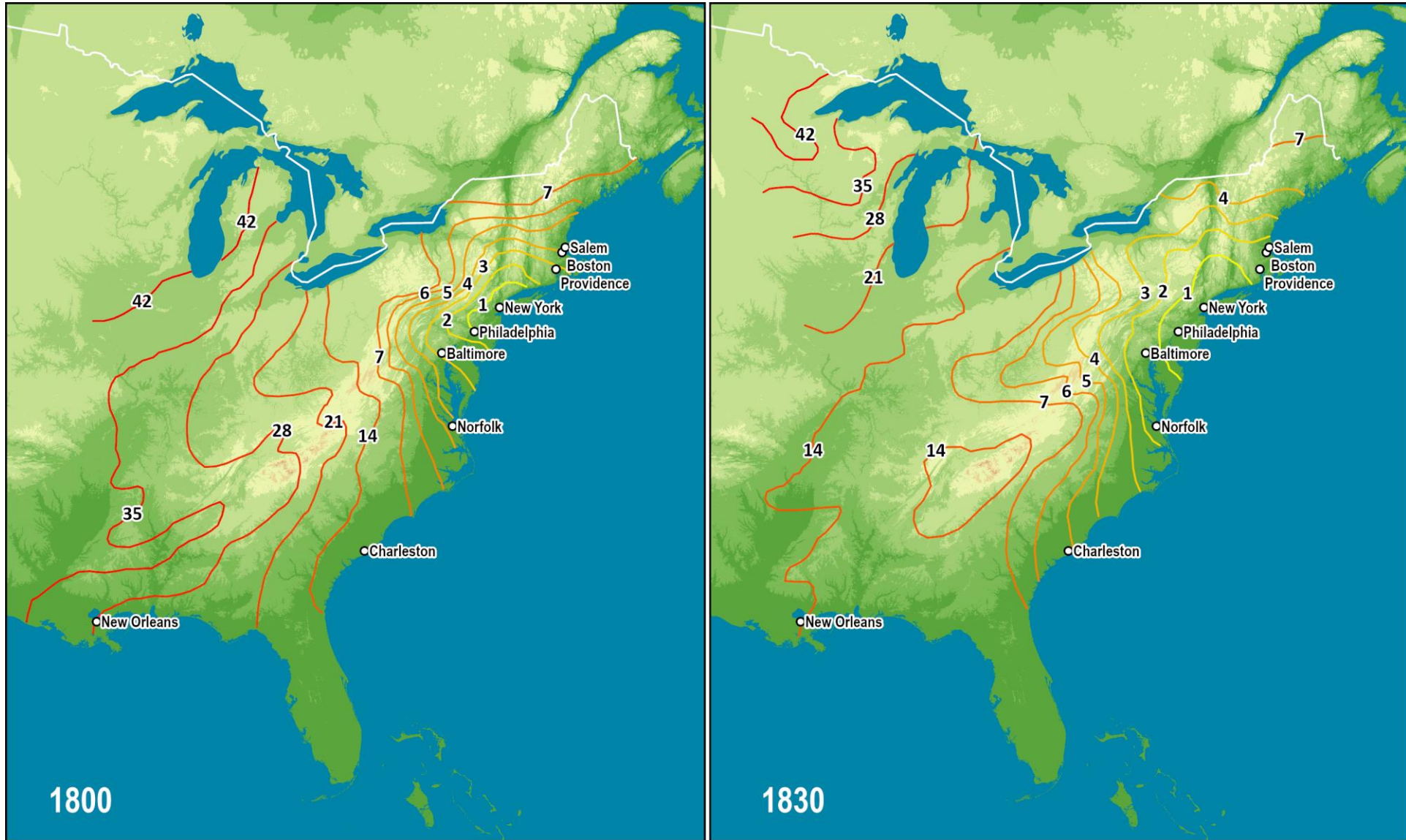
 30 km/hr

 700 km/day

# Major Technological Innovations of the Industrial Revolution

Power Generation	Textiles	Metallurgy	Transportation
Thermal energy used for mechanical energy	Mechanization of spinning and weaving	Mass production of steel (shipbuilding, rails, construction and machines)	Modern transport and telecommunication systems
<ul style="list-style-type: none"><li>• First water pump (1712) in mines.</li><li>• Watt (1769); significant improvements.</li><li>• Steam locomotive (1824).</li><li>• Electric generator (1831).</li><li>• Steam turbine (1884).</li></ul>	<ul style="list-style-type: none"><li>• “Flying shuttle” (1733) doubled weaving productivity.</li><li>• “Spinning jenny” (1765).</li><li>• “Water frame” (1768); hydraulic power.</li><li>• “Spinning Mule” (1779); steam power.</li><li>• Sewing machine (1846).</li></ul>	<ul style="list-style-type: none"><li>• Coke instead of coal for iron production (1709).</li><li>• Bessemer process (1855).</li></ul>	<ul style="list-style-type: none"><li>• Railroads (1825).</li><li>• Telegraph (1834).</li><li>• Steamship (1838).</li><li>• Telephone (1876).</li></ul>

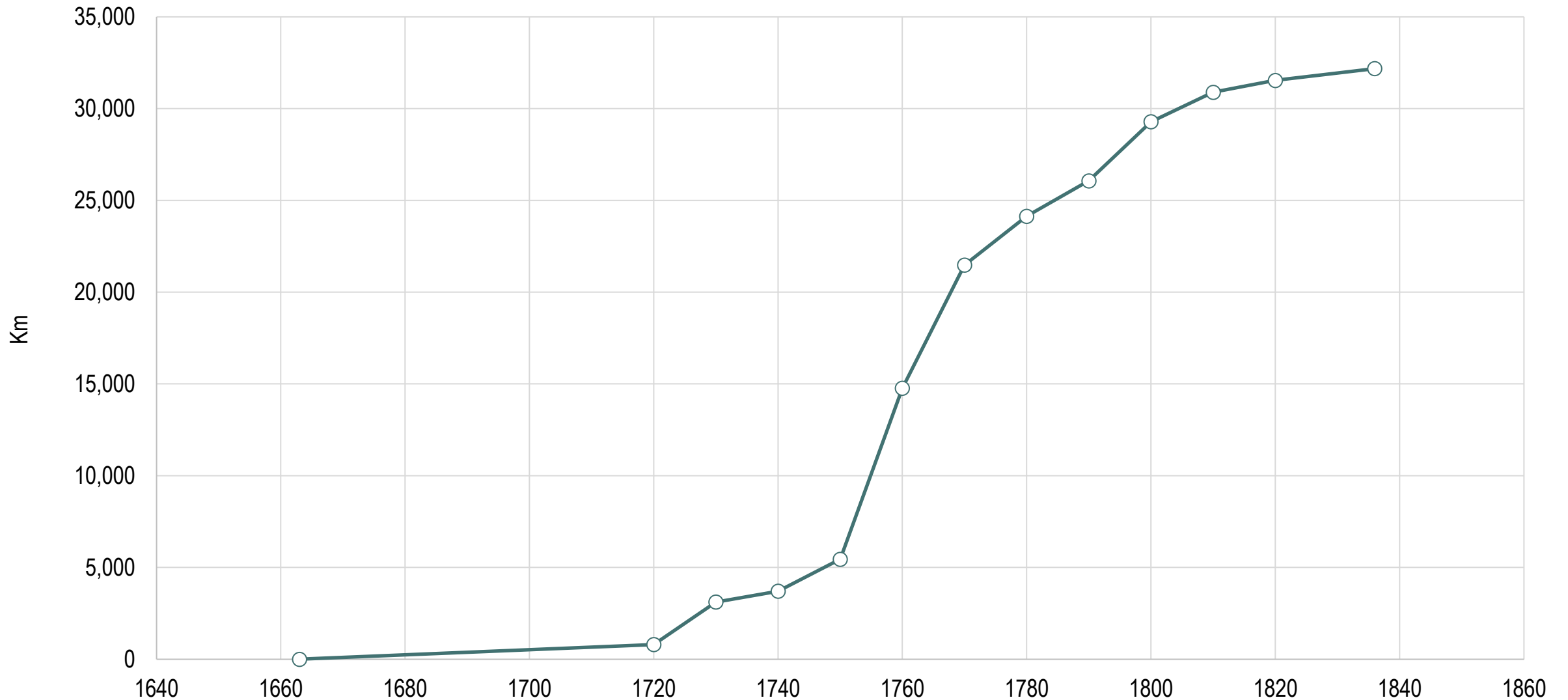
# Inland Travel Time from New York, 1800 – 1830 (in Days)



# American Rail Network, 1861



# Turnpikes in Great Britain, Late 18th and Early 19th Century



# Major Canals Built

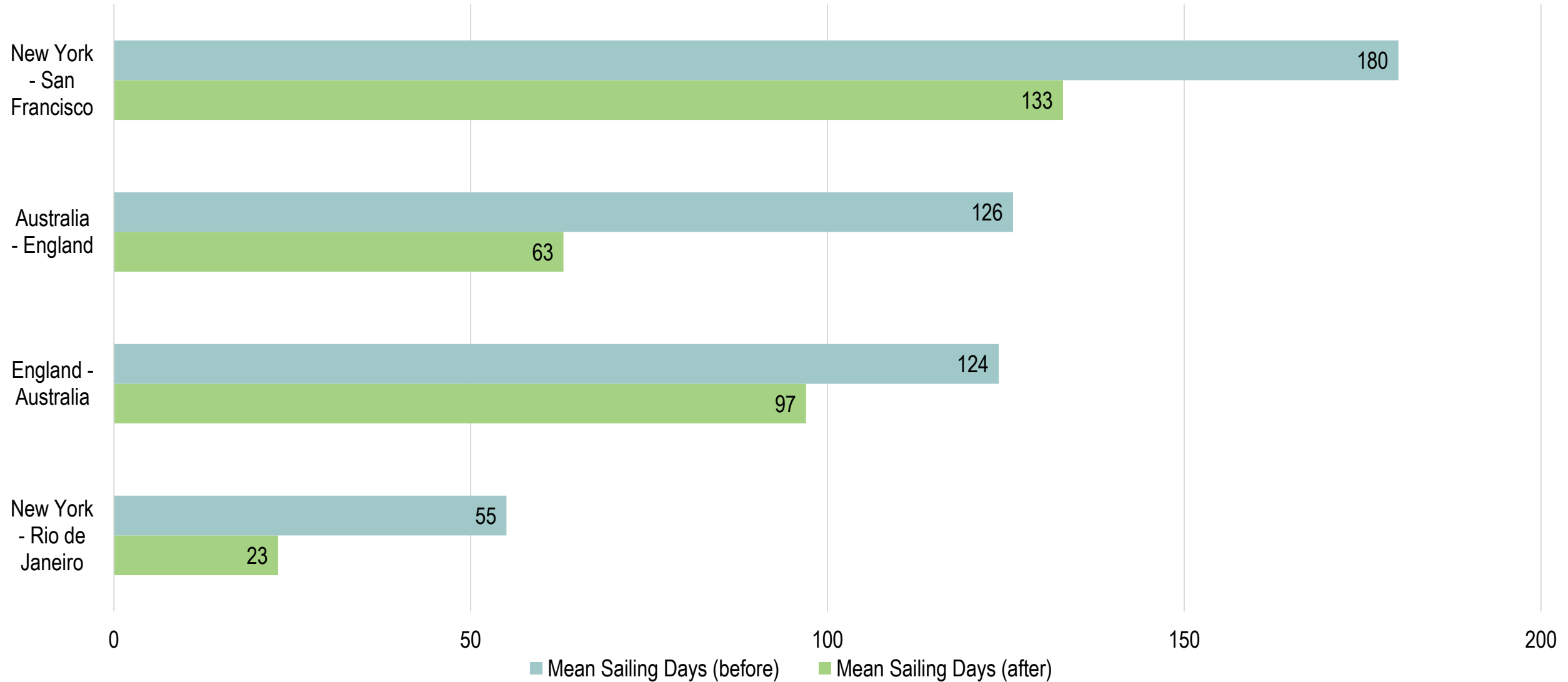
540-1320	Grand Canal	Beijing – Hangzhou (2,500 km)
11 <sup>th</sup> Century	Naviglio Grande	Milan – Adriatic (30 km)
1390-97	Stecknitz Canal	Elbe – Trave (11 km)
1604-42	Briare Canal	Seine – Loire (58 km)
1667-81	Canal du Midi	Garonne – Mediterranean (279 km)
1732	Ladoga canal	St. Petersburg – Volga (110 km)
1759-61	Bridgewater Canal	Worsley – Manchester (16 km)
1784-1833	Rhine-Rhone canal	Strasbourg-Mulhouse-Burgundy (319 km)
1810-24	North Sea canal	Amsterdam – North Sea (20 km)
1817-25	Erie canal	Buffalo – Albany (544 km)
1836-45	Ludwigskanal	Main – Danube (172 km)
1838-54	Rhine – Marne canal	Saverne gap (314 km)
1859-69	Suez canal	Mediterranean – Red Sea (112 km)
1894	Manchester Ship Canal	Manchester – Liverpool (64 km)
1887-95	Kiel canal	Baltic Sea – North Sea (99 km)
1906-14	Panama canal	Atlantic Ocean – Pacific Ocean (80 km)
1905-38	Mittellandkanal	Rhine – Elbe (320 km)

# Major Canals Built in the 19th Century, American Northeast

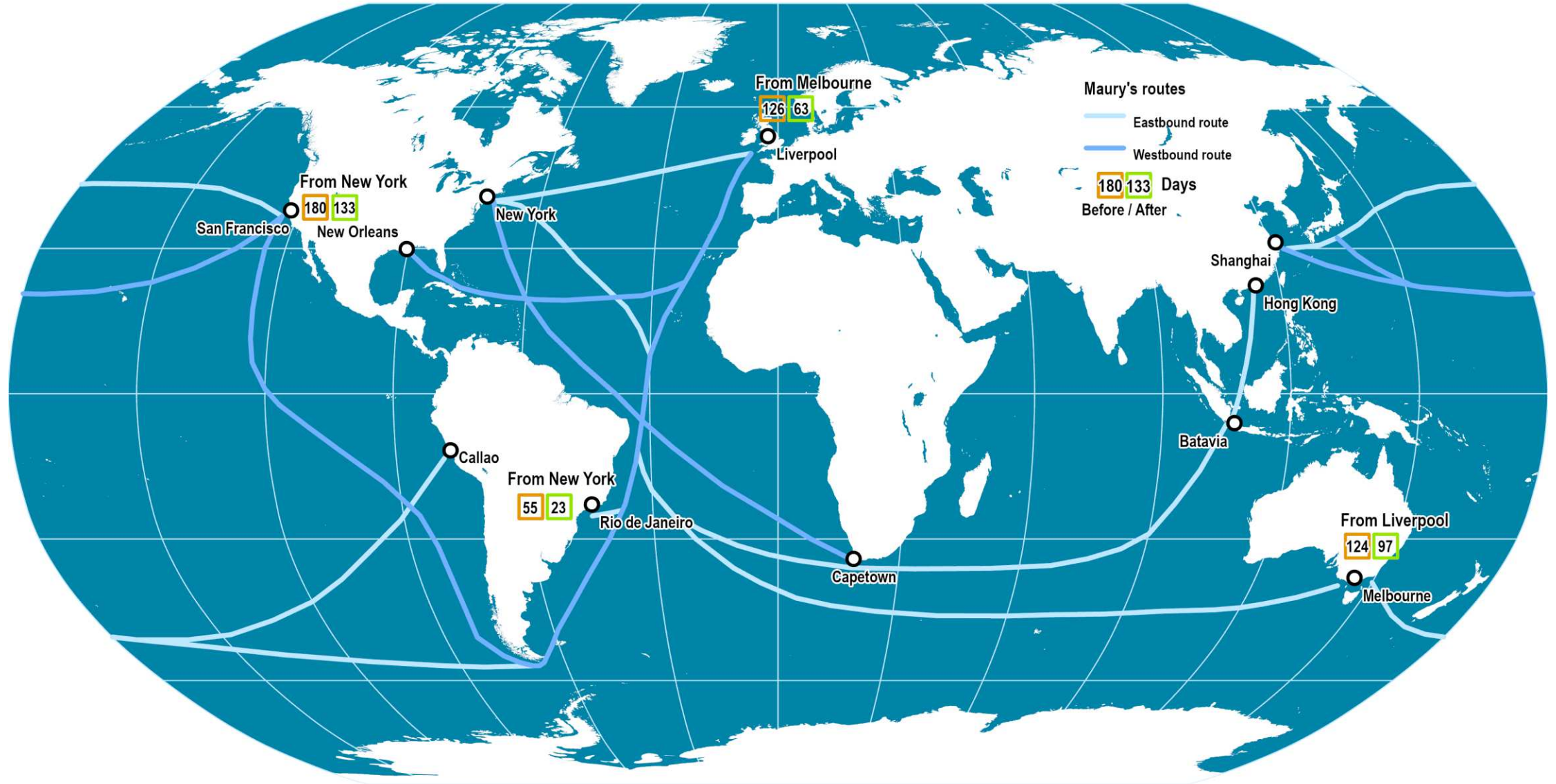




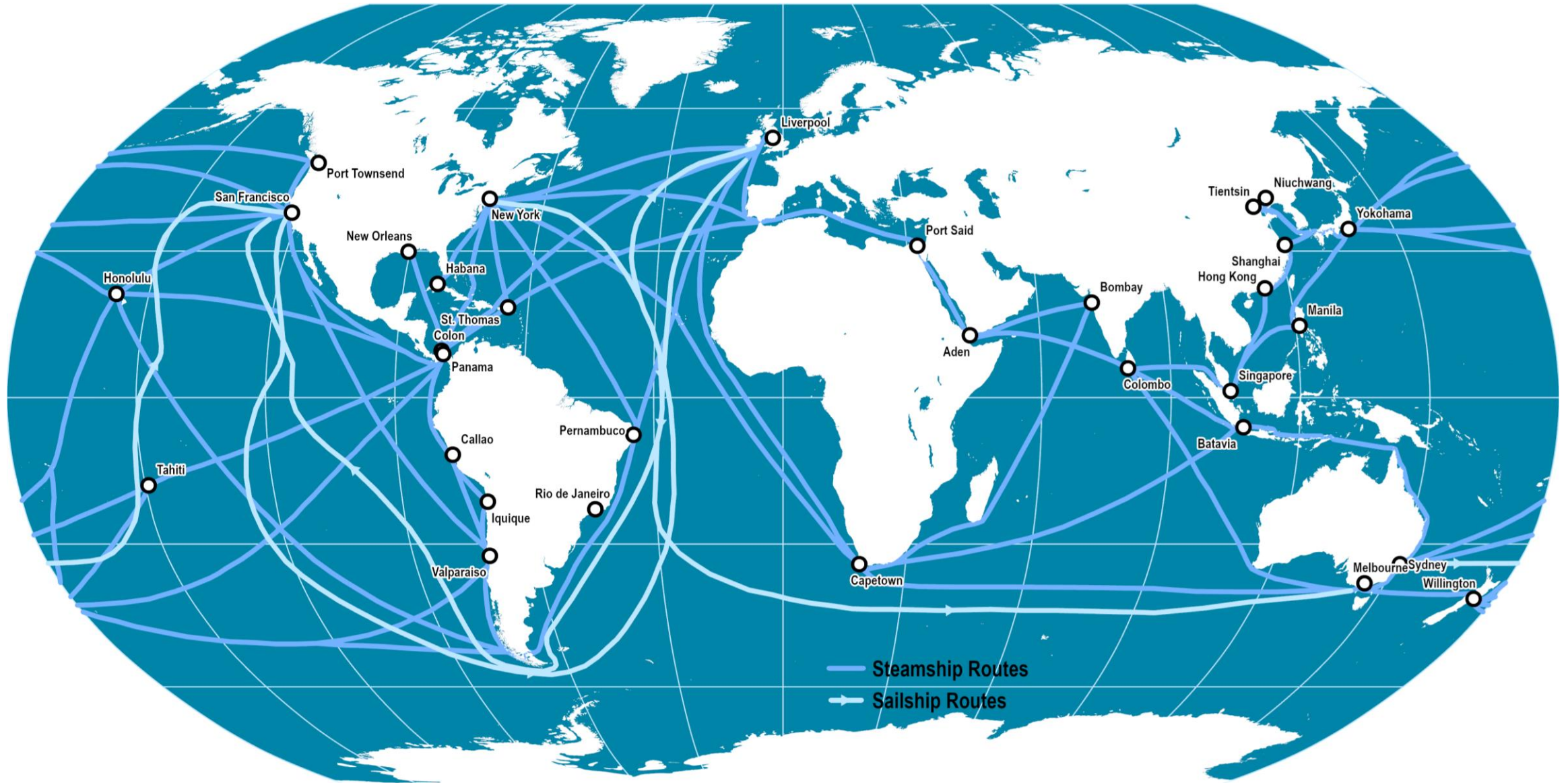
# Impacts of Maury's Navigation Charts on Sailing Time, 1850s



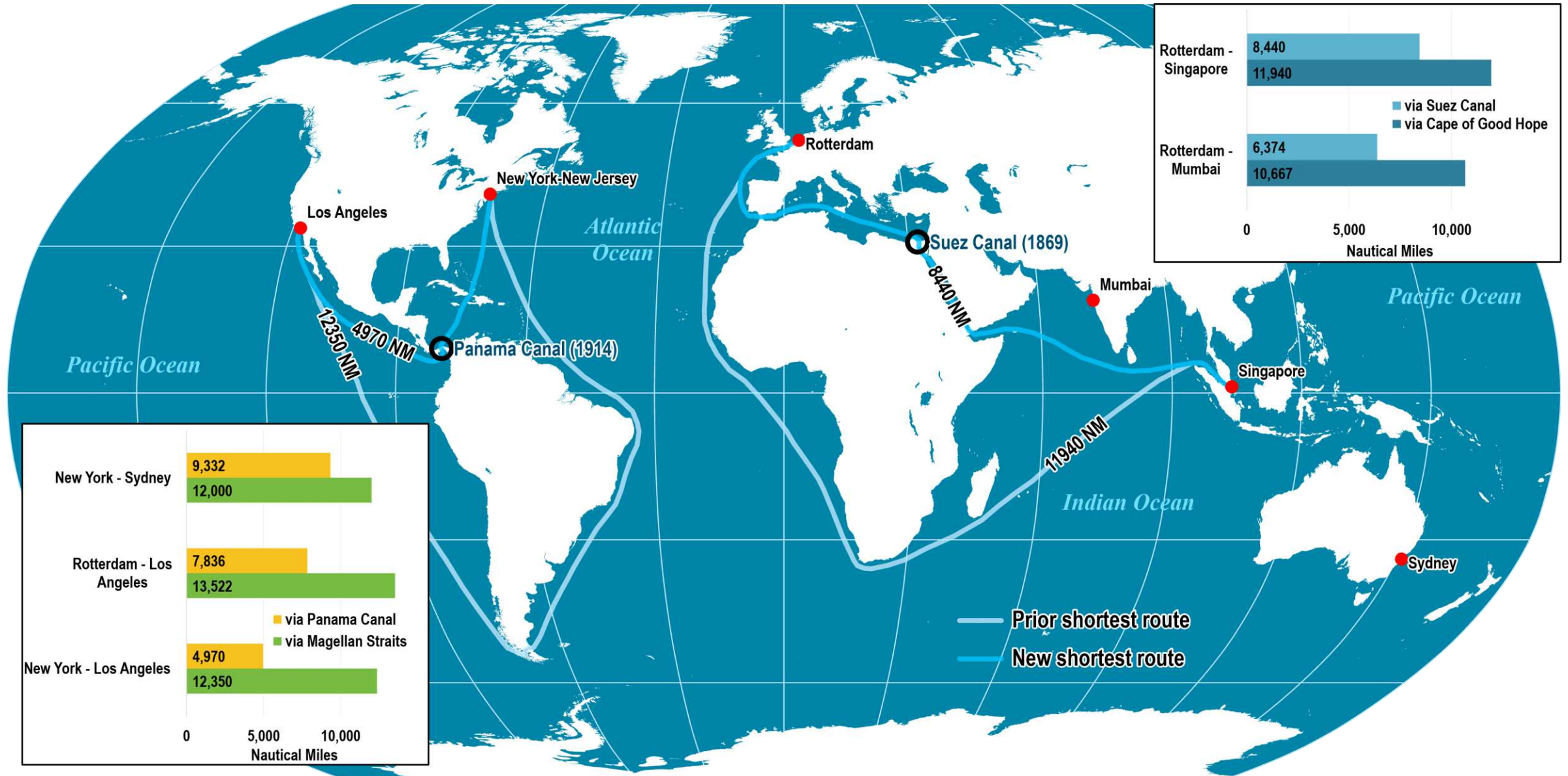
# Impacts of Maury's Navigation Charts on Sailing Time, 1850s



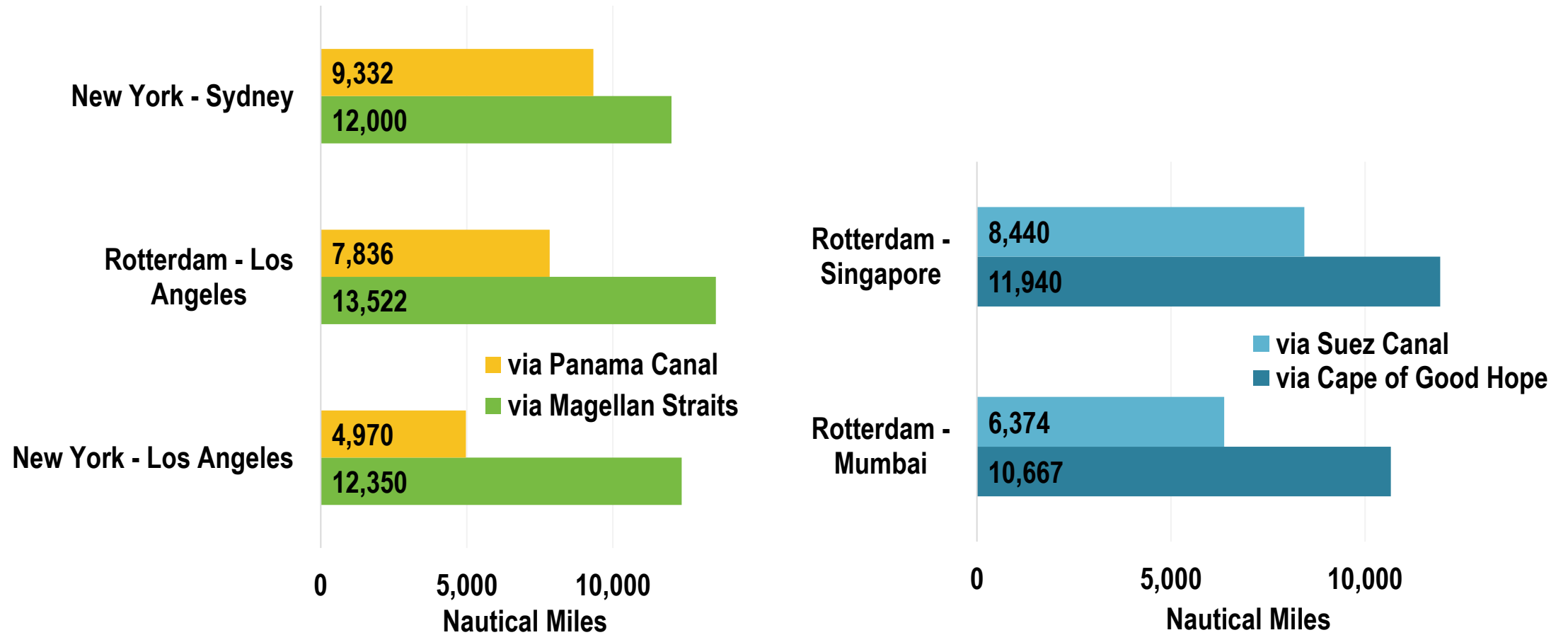
# World Maritime Trade Routes, 1912



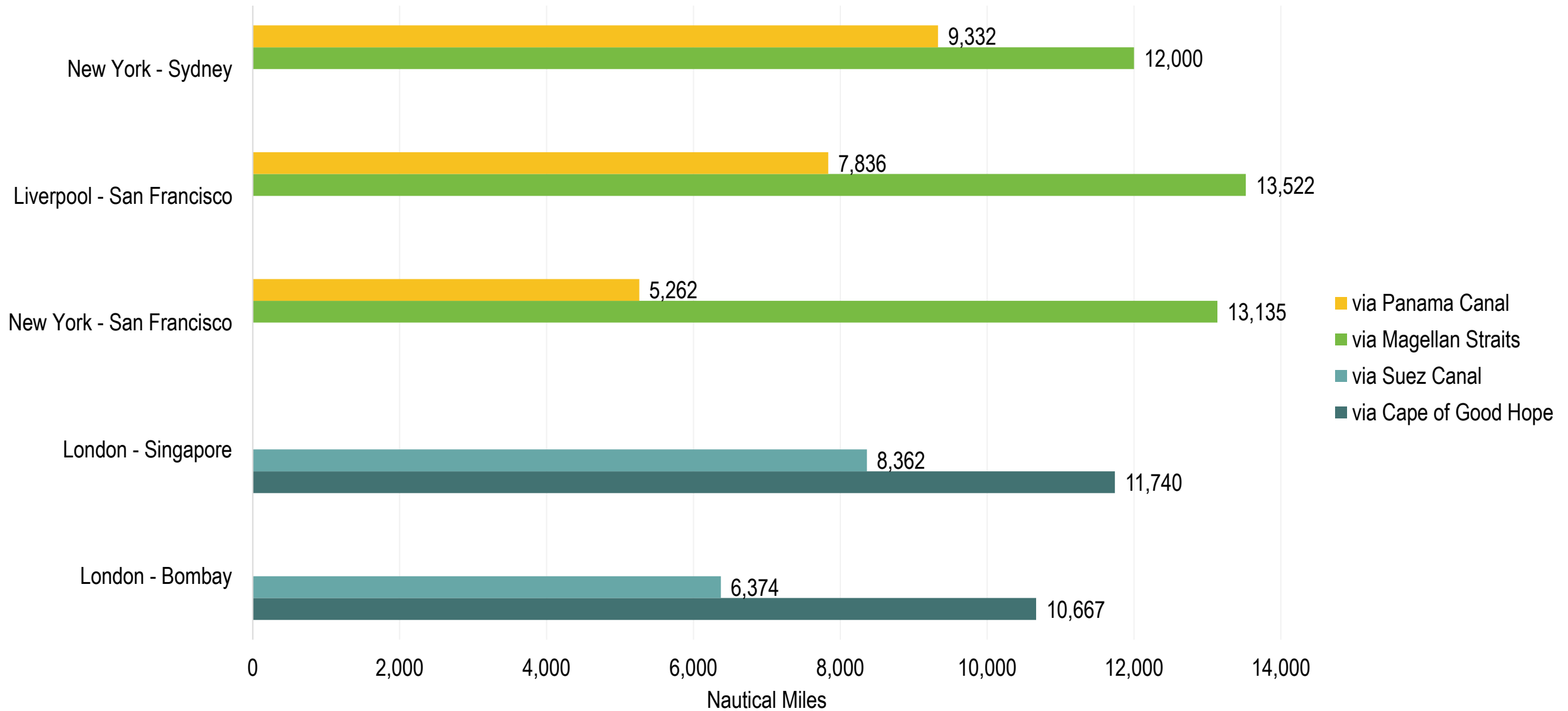
# Geographical Impacts of the Suez and Panama Canals



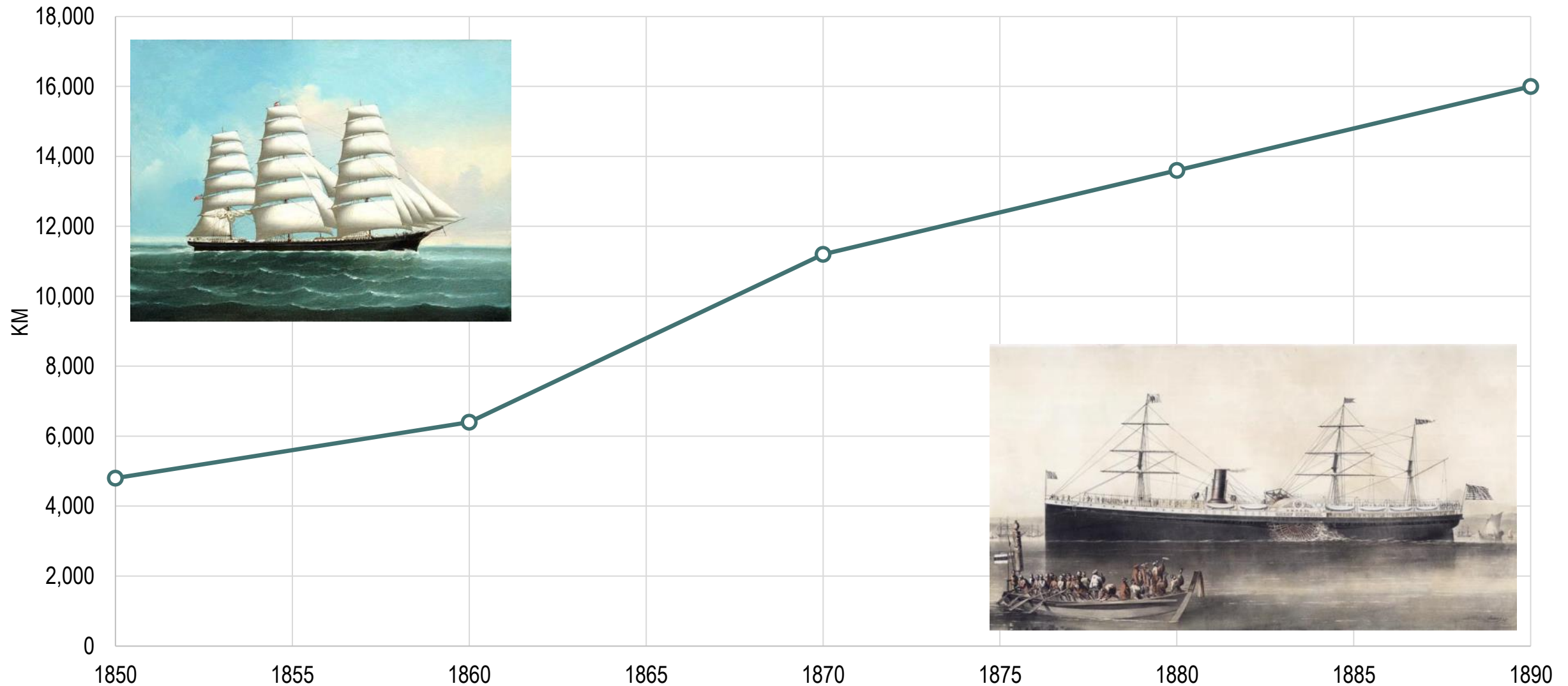
# Effects of the Suez and Panama Canals on Travel Distances



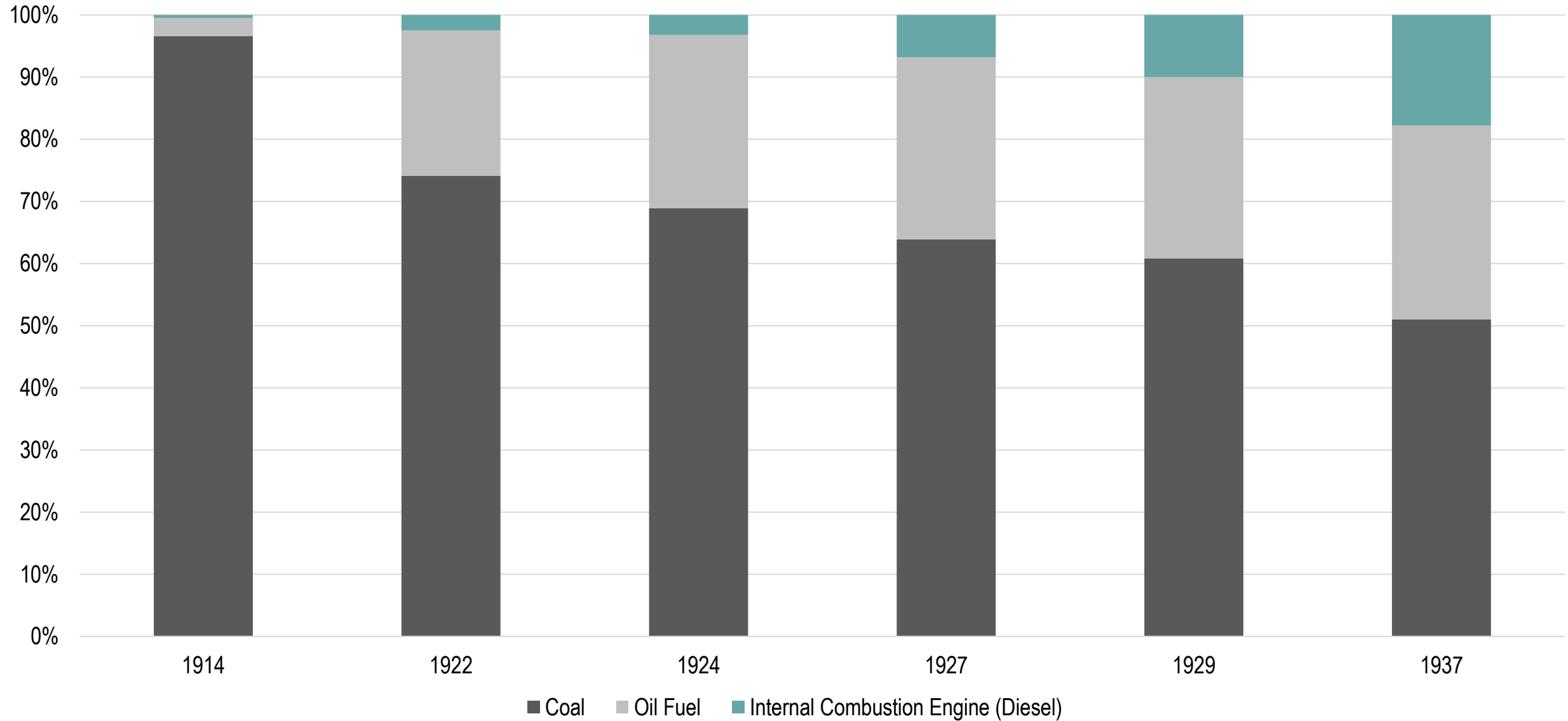
# Effects of the Suez and Panama Canals on Travel Distances



# Break-Even Distance between Sail and Steam, 1850-1890

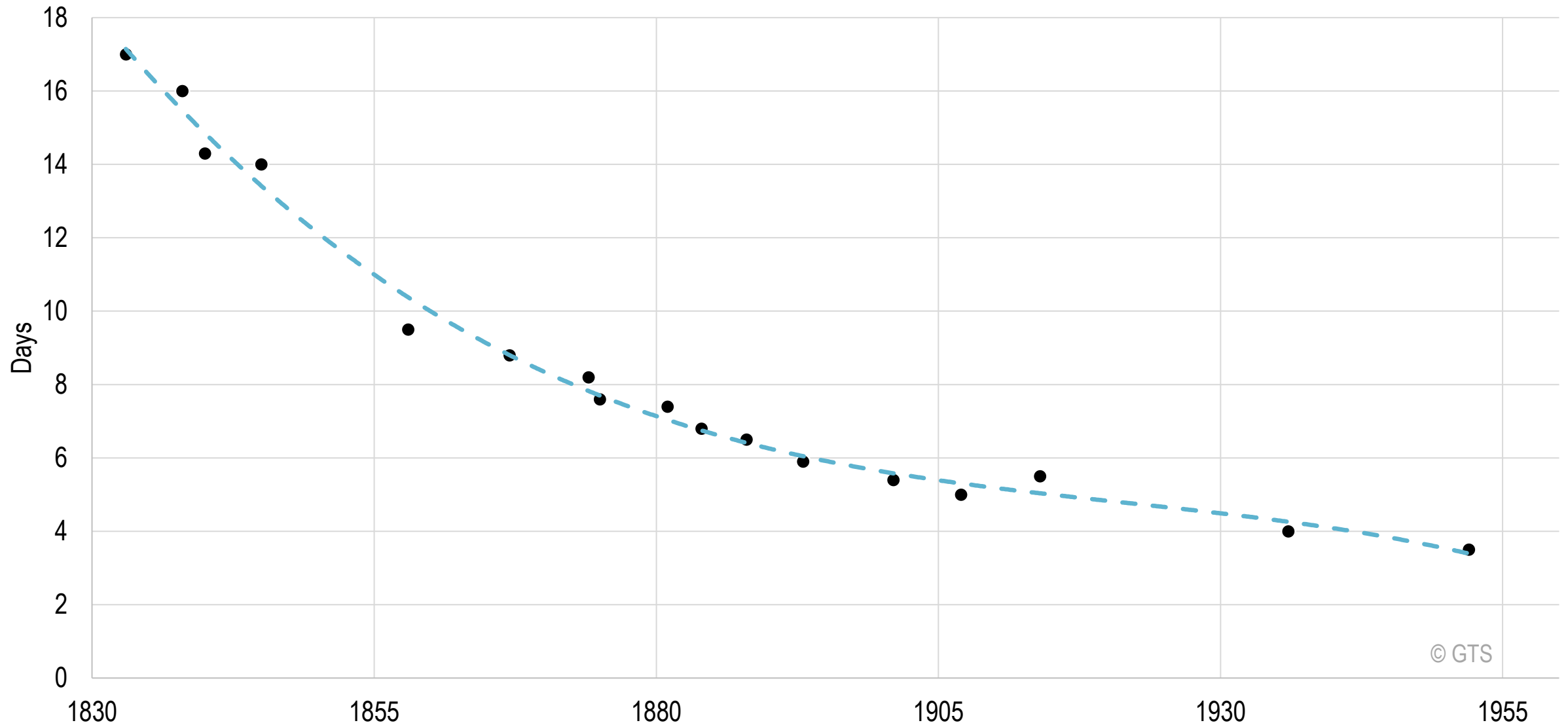


# World Merchant Fleet by Motive Power, 1914-1937



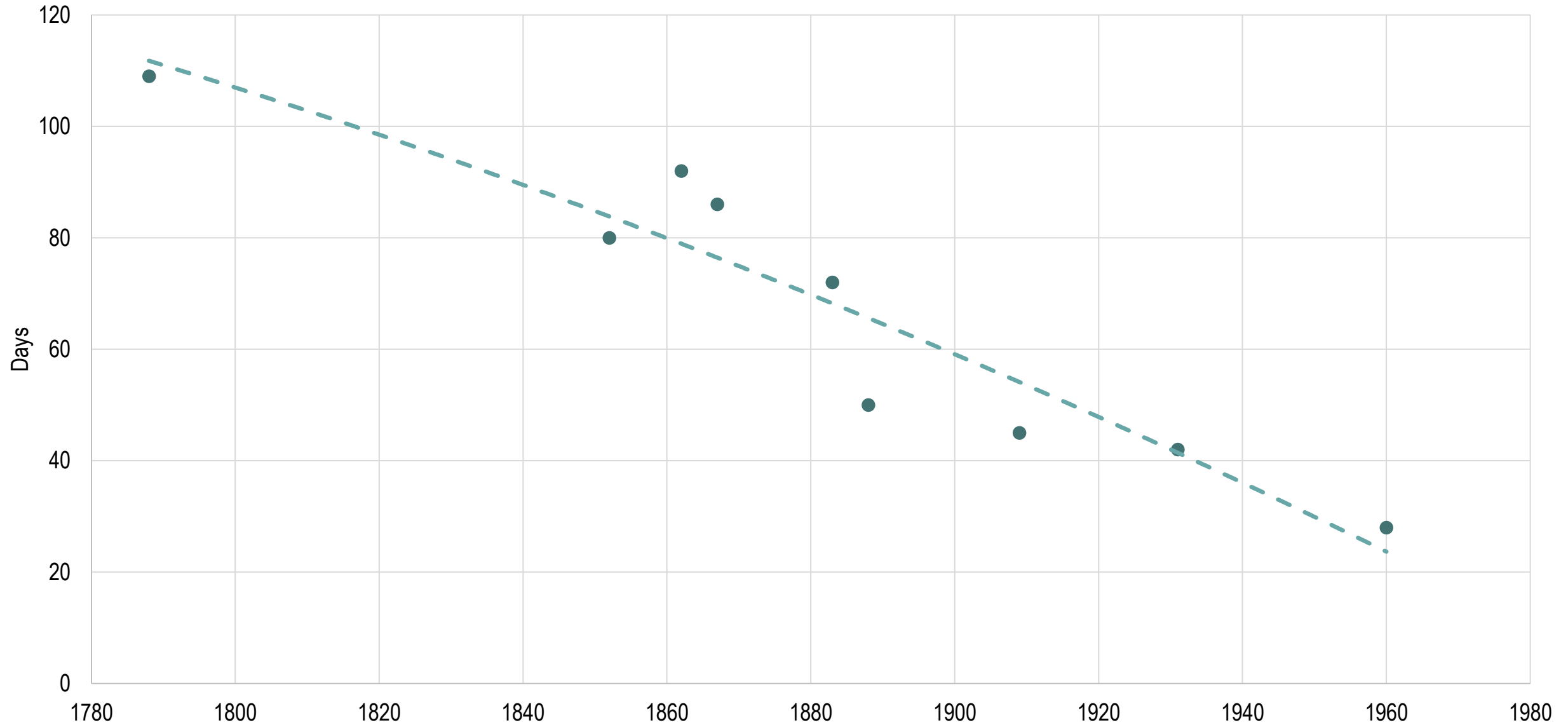


# Liner Transatlantic Crossing Times, 1833 – 1952 (in days)

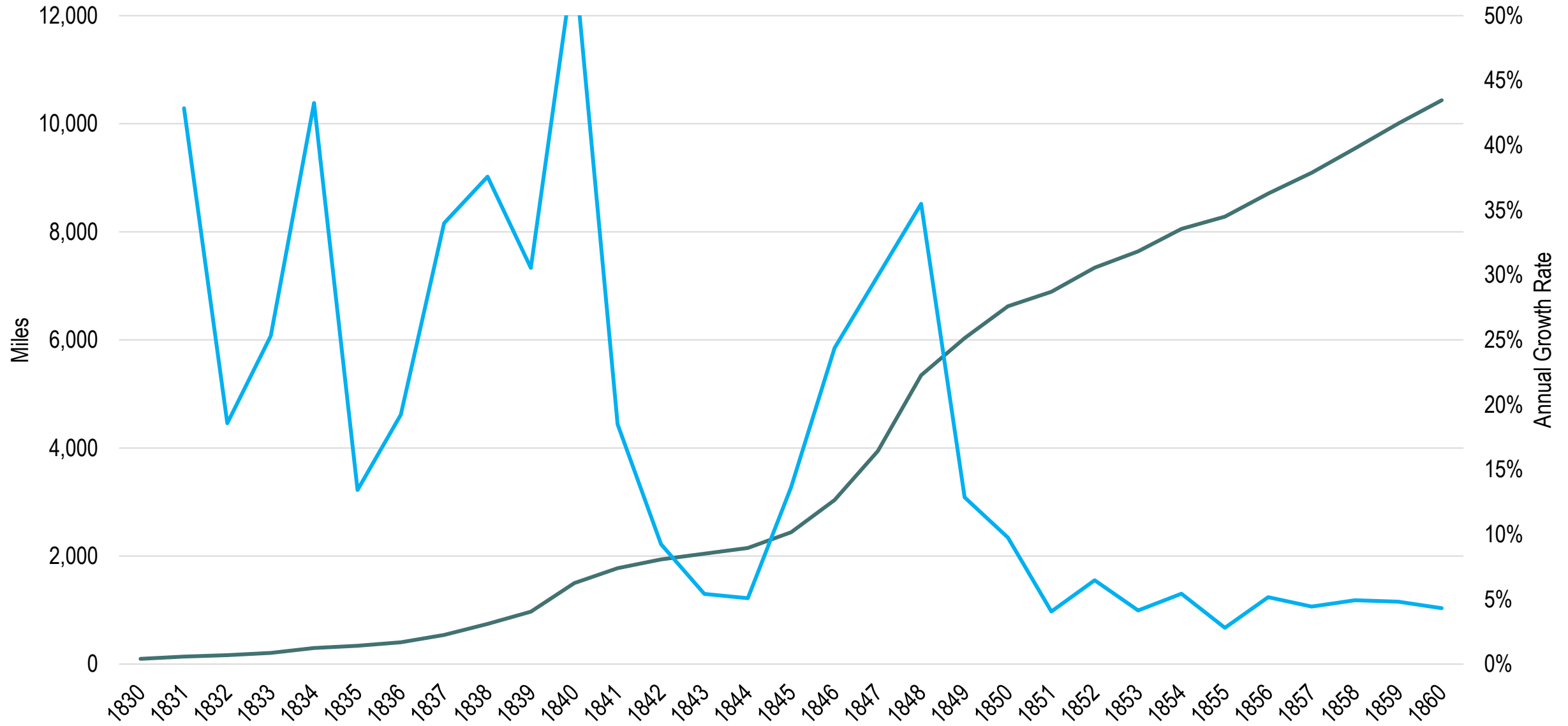


© GTS

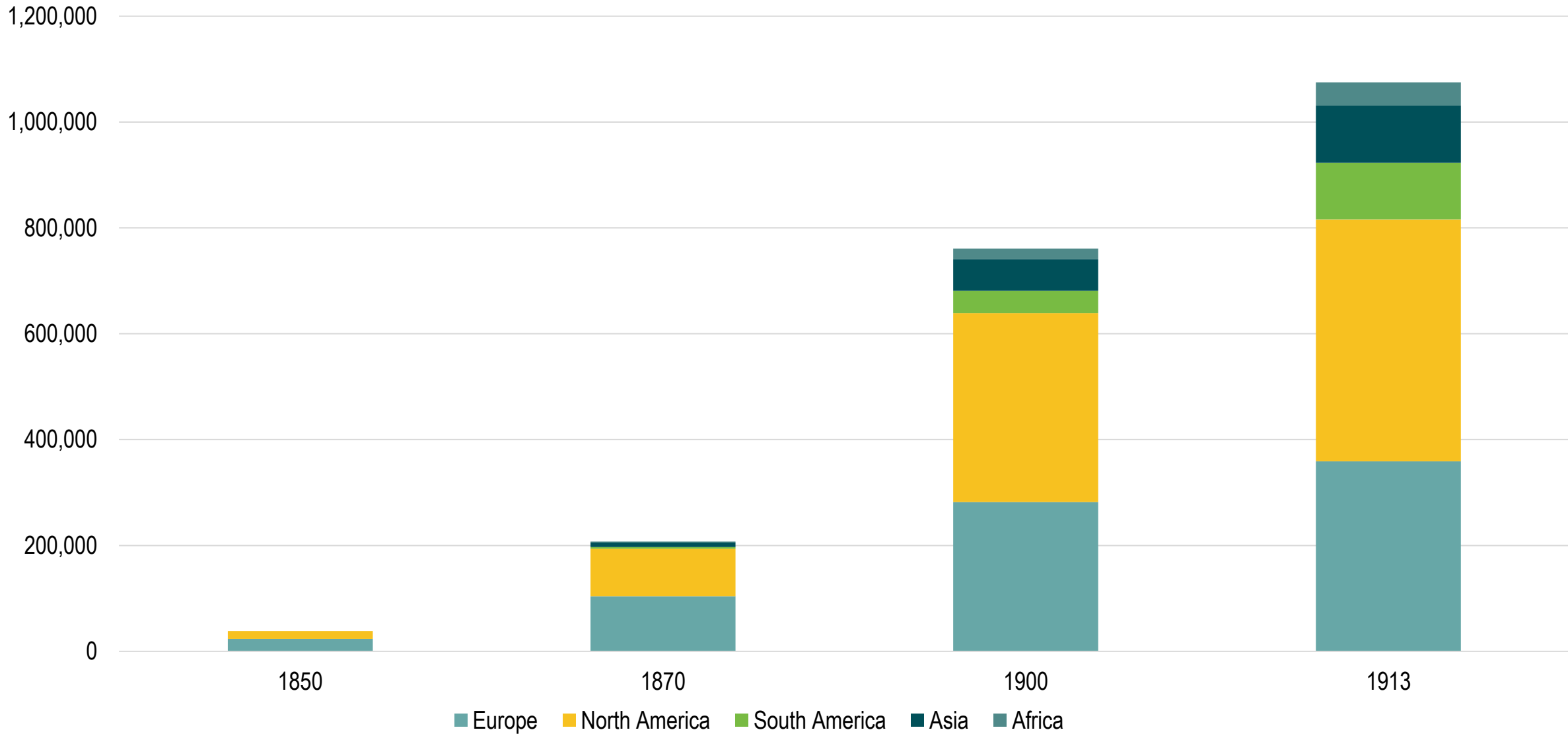
# Maritime Journey from Britain to Australia, 1788-1960



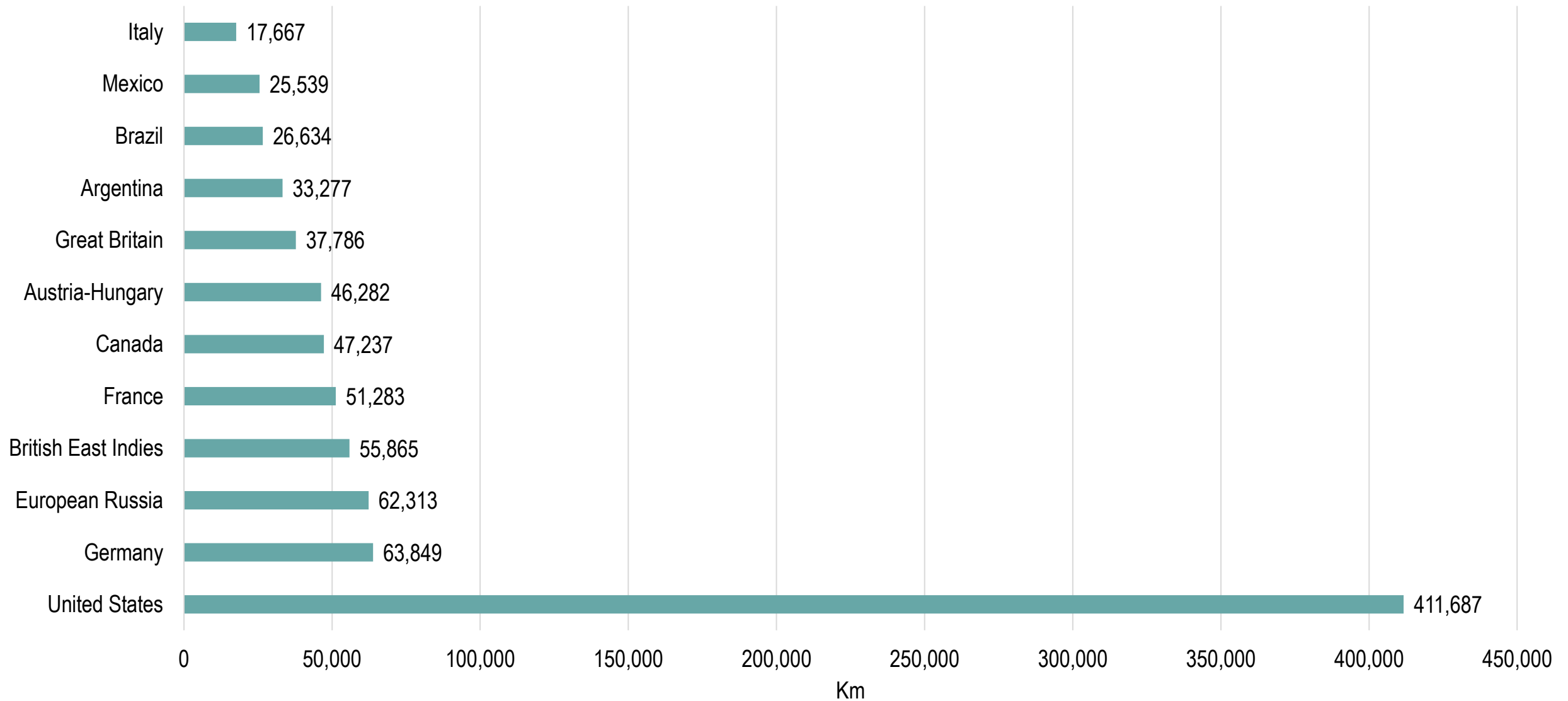
# Length of the British Railway System, 1830-1860



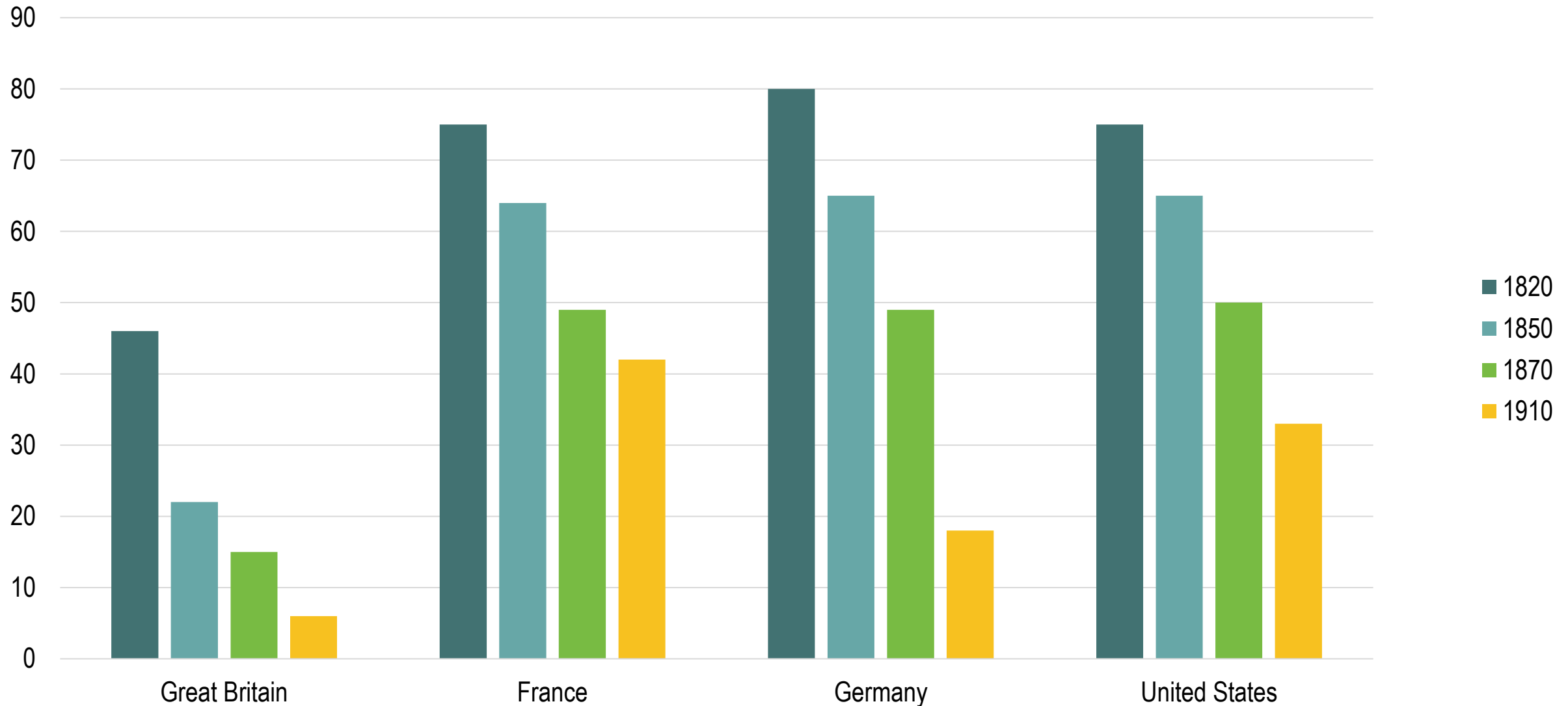
# Evolution of the Railway Network (in km), 1850-1913



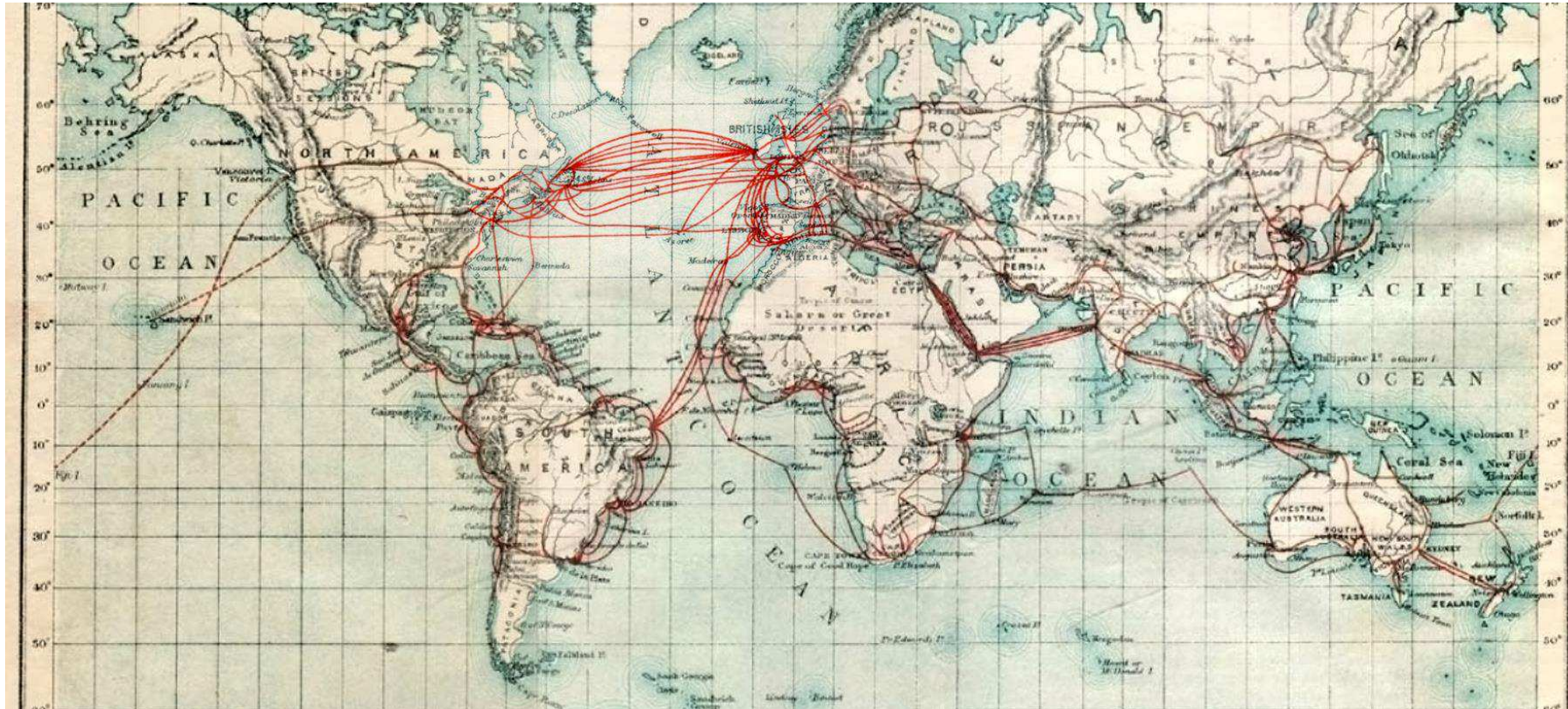
# Length of the World's Largest Railway Systems, 1913



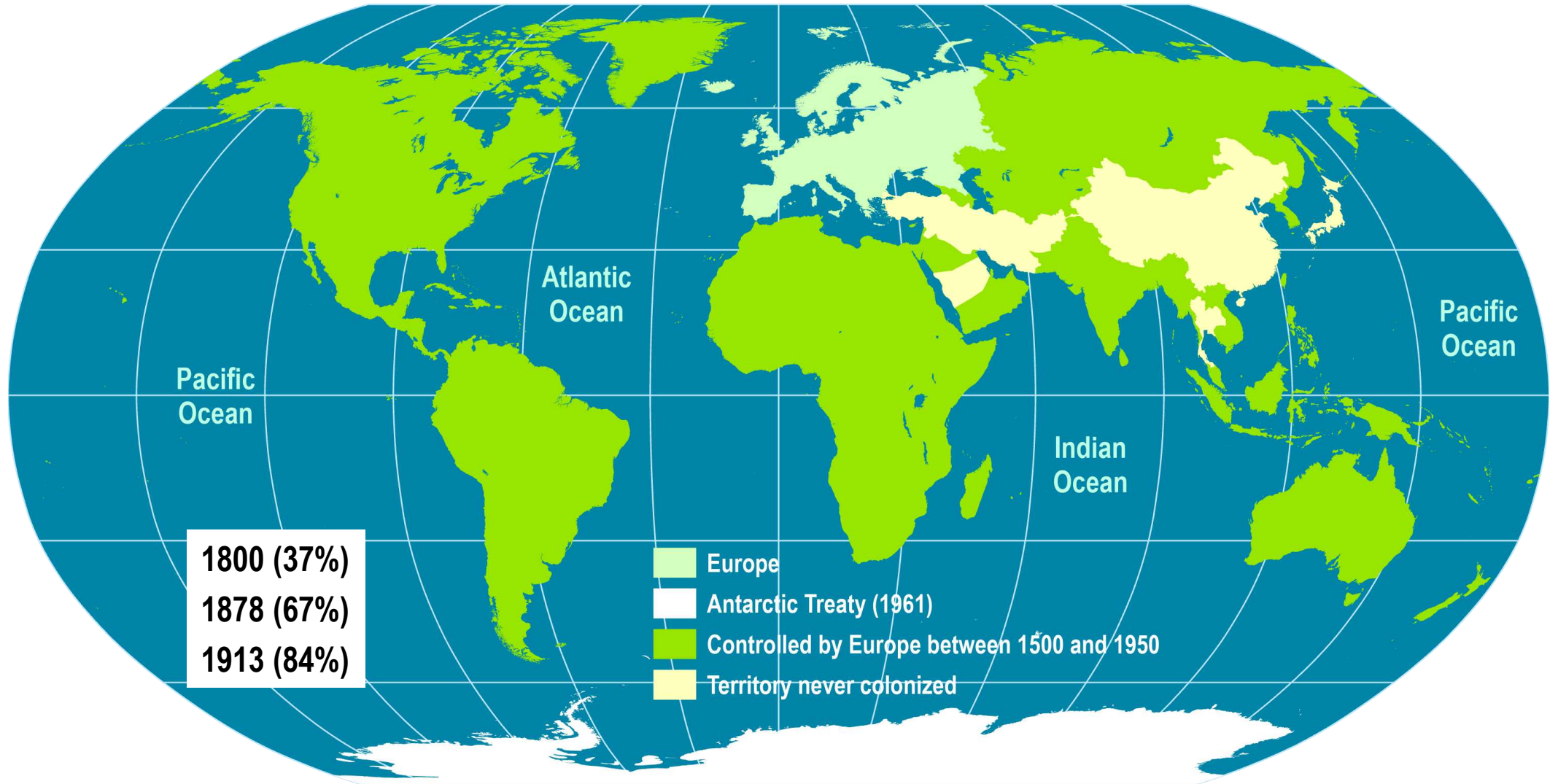
# Share of the Population in Agriculture, Early Industrial Countries, 1820-1910



# Global Telegraph System, c1901 (the Victorian Internet)

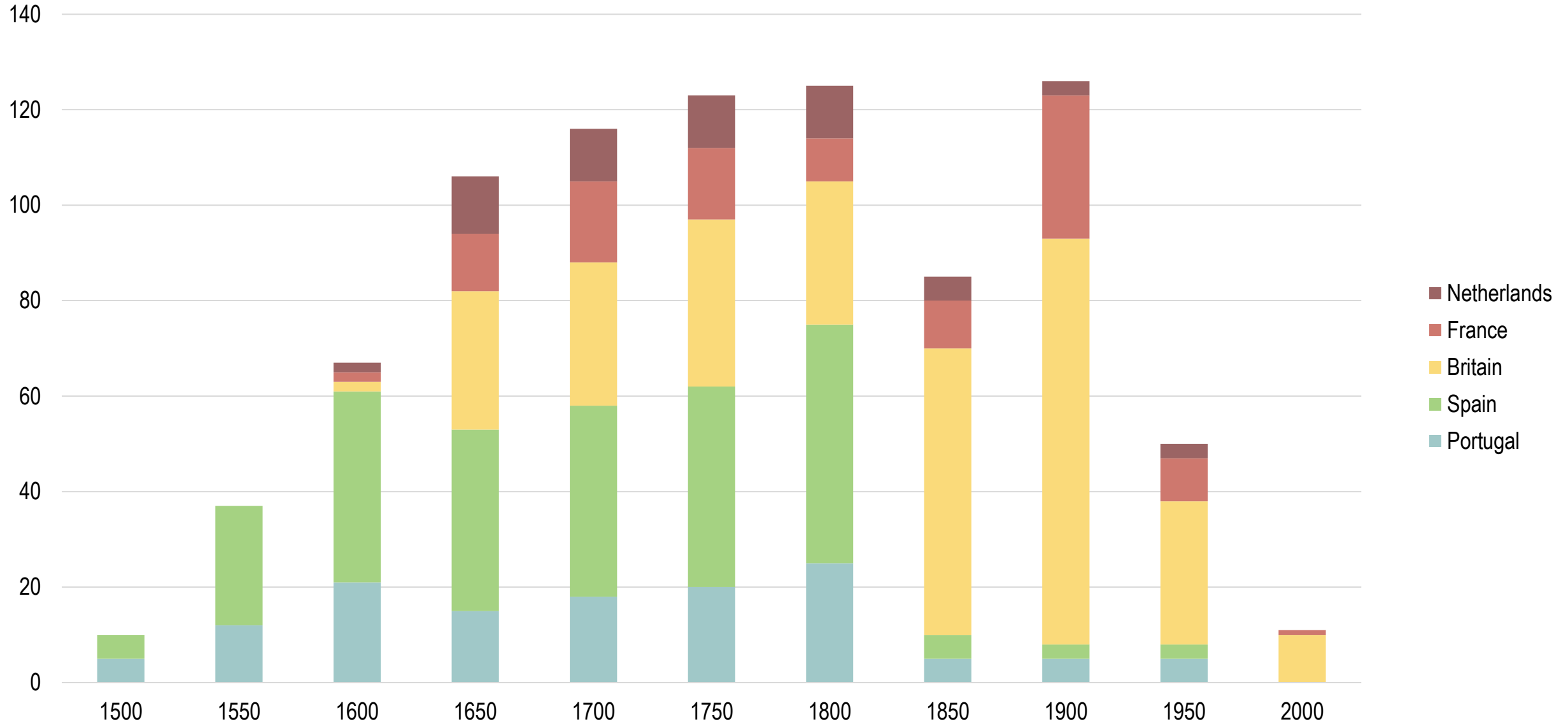


# European Control of the World, 1500-1950

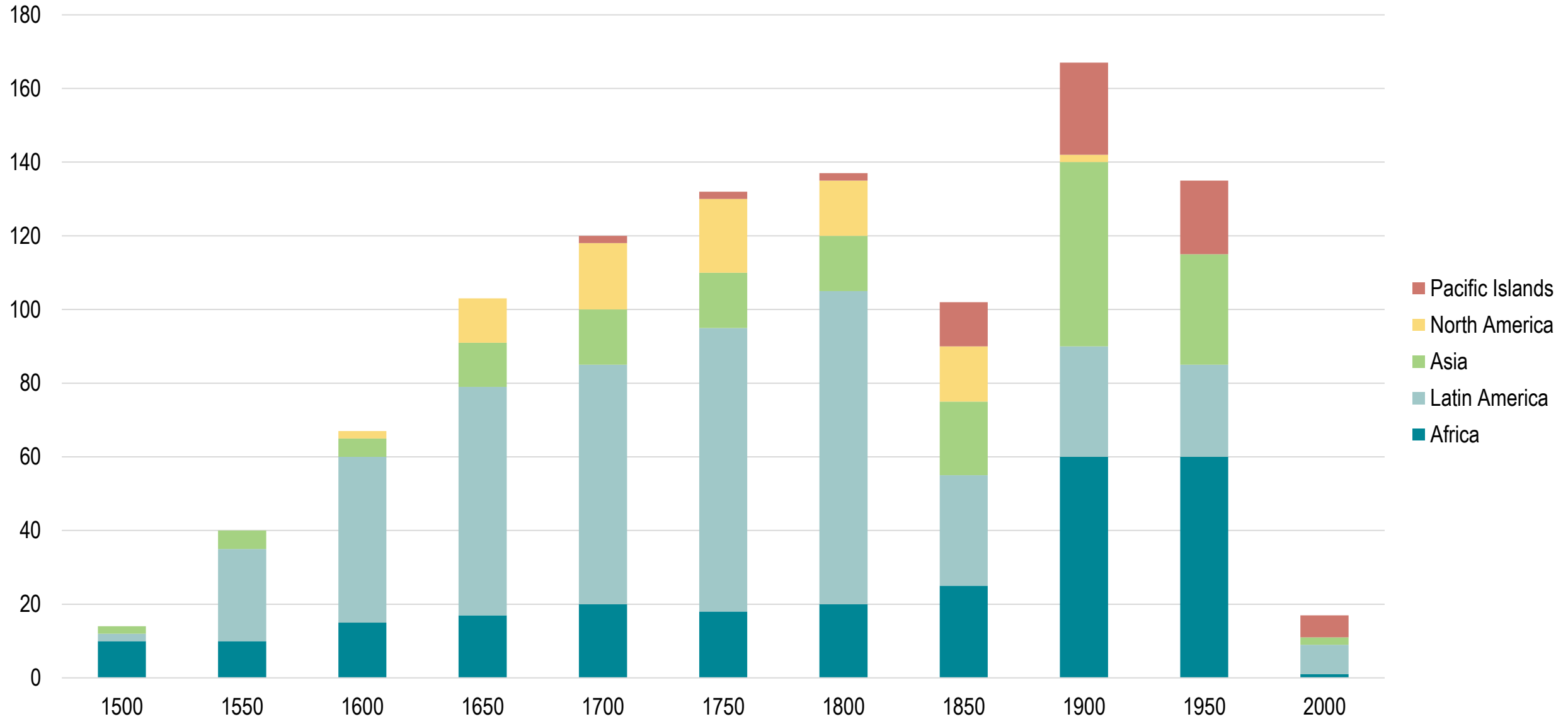


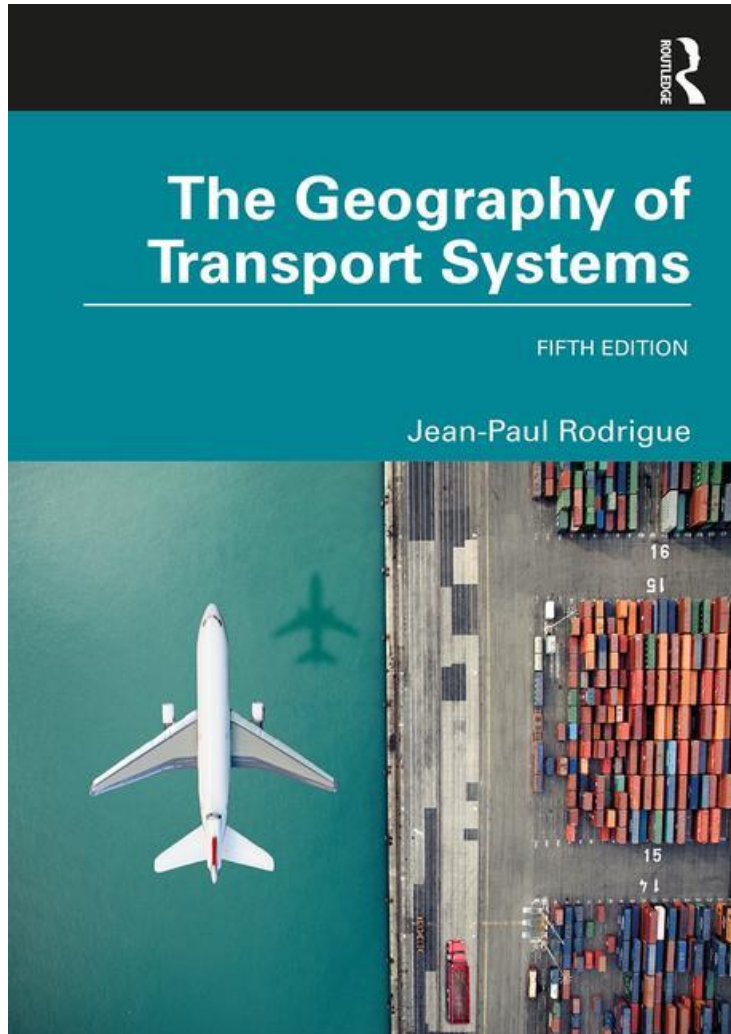


# Colonies Controlled by Main Colonial Powers, 1500-2000



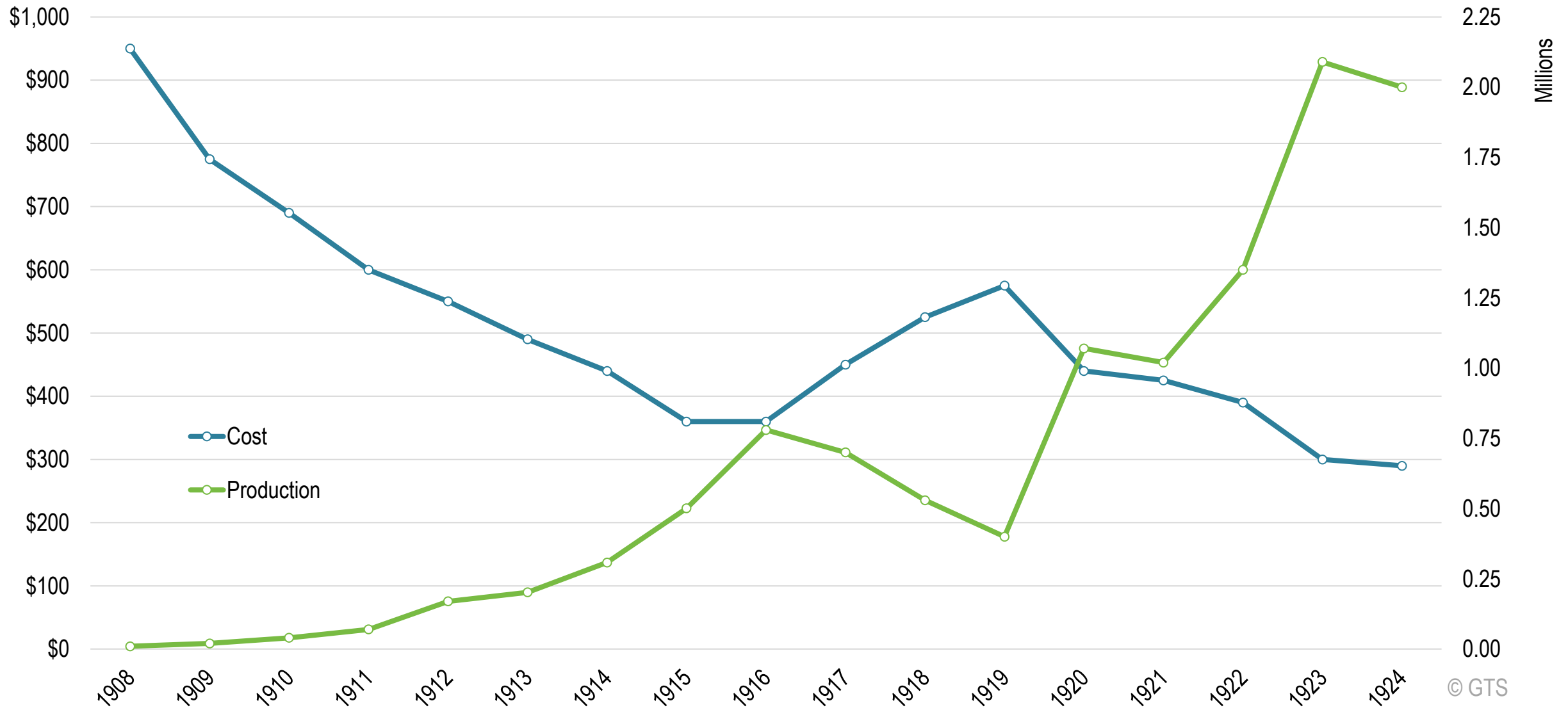
# Colonies by Main World Region, 1500-2000





# The Setting of Global Transportation Systems

# Cost and Production of Ford Vehicles, 1908-1924



# United States Maritime Commission Cargo Ships, 1938-1947

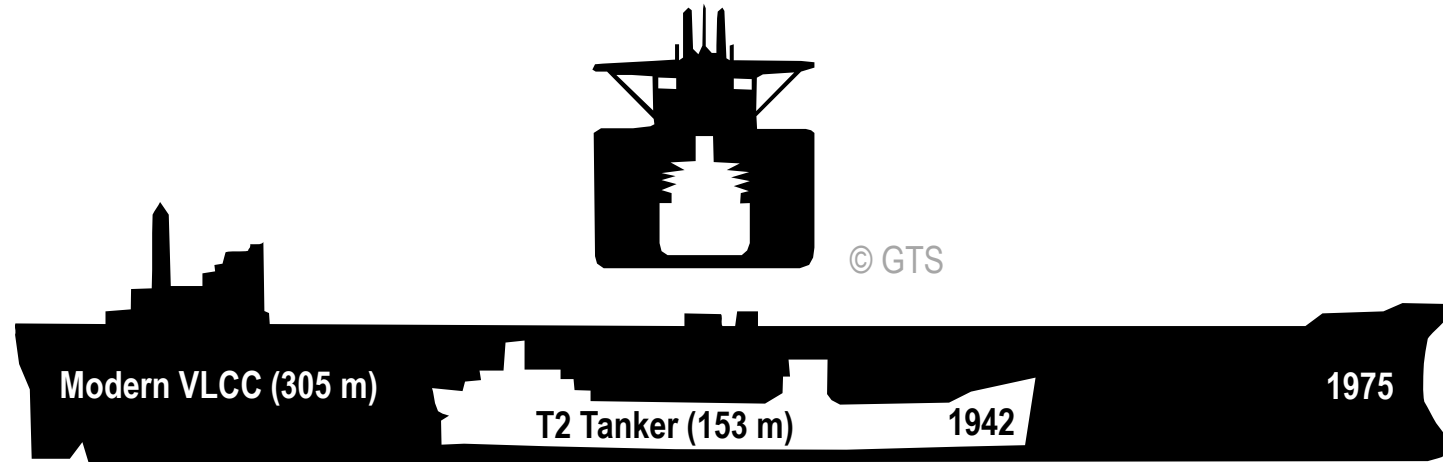
Type	Function	Period	Total constructed	Length (feet)	Beam (feet)	Deadweight tonnage
C-1	Small cargo	1940-1945	173	418	60	8,075
C-2	General cargo	1938-1945	173	460	63	8,794
C-3	General cargo	1940-1947	465	492	70	12,500
C-4	General cargo; Troop ship	1941-1946	75	523	72	6,100
EC-2	Emergency cargo; Liberty ship	1941-1945	2,710	442	57	10,419
VC-2	General cargo; Victory ship	1944-1946	534	455	62	10,734
T-2	Tanker	1940-1945	536	524	68	16,400
T-3	Tanker	1939-1946	63	553	75	18,400

# United States Maritime Commission Cargo Ships, 1938-1947

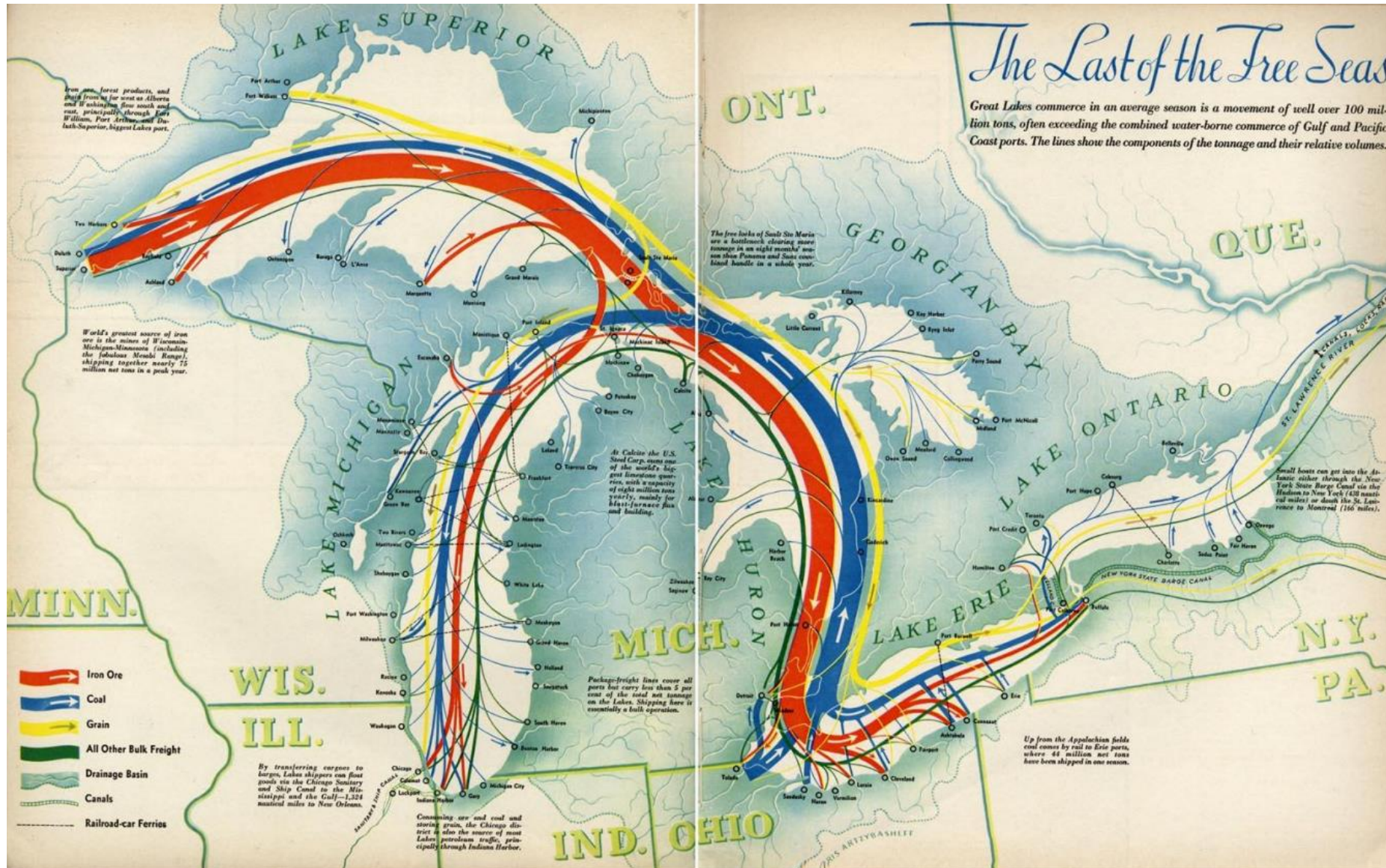
Type	Function	Period	# Constructed	Length (m)	Beam (m)	DWT
C-1	Small cargo	1940-45	173	127	18	8,075
C-2	General cargo	1938-45	173	140	19	8,794
C-3	General cargo	1940-47	465	150	21	12,500
C-4	General cargo; Troop ship	1941-46	75	159	22	6,100
EC-2	Emergency cargo; Liberty ship	1941-45	2,720	134	17	10,419
VC-2	General cargo; Victory ship	1944-46	534	138	19	10,734
T2	Tanker	1940-45	536	160	21	16,400
T3	Tanker	1939-46	63	159	23	18,400

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# Comparison between a Contemporary and Second World War Tanker

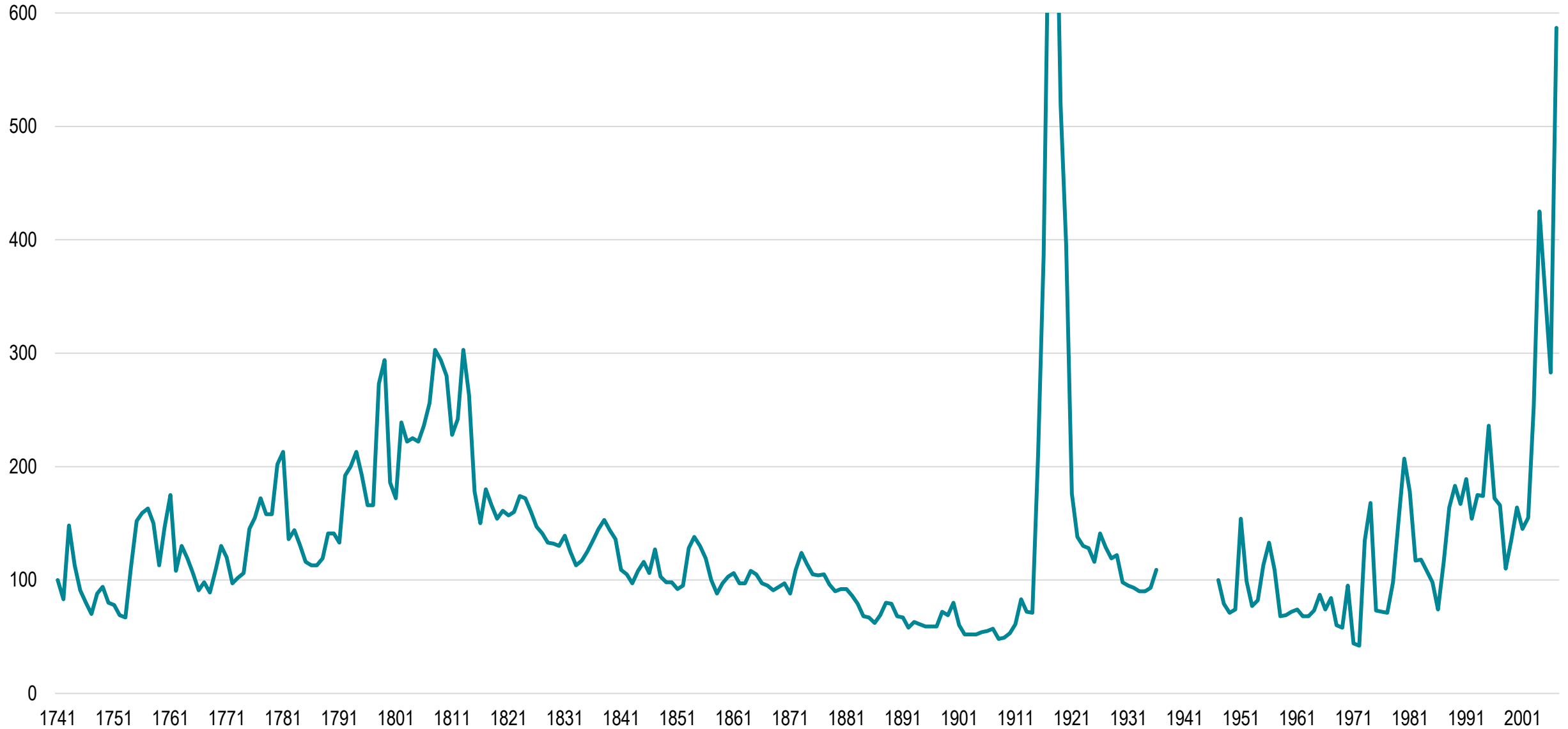


# Major Commodity Flows over the Great Lakes, 1940

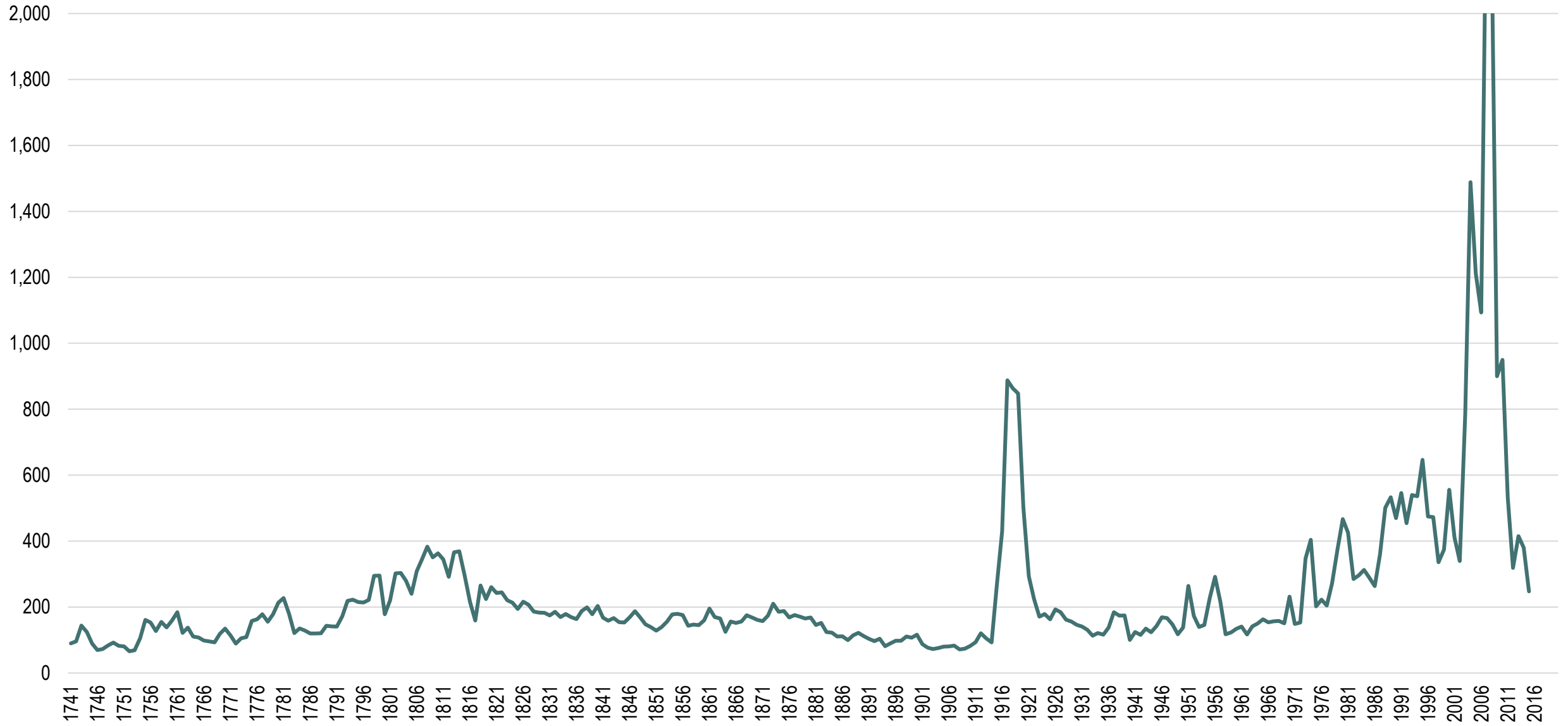




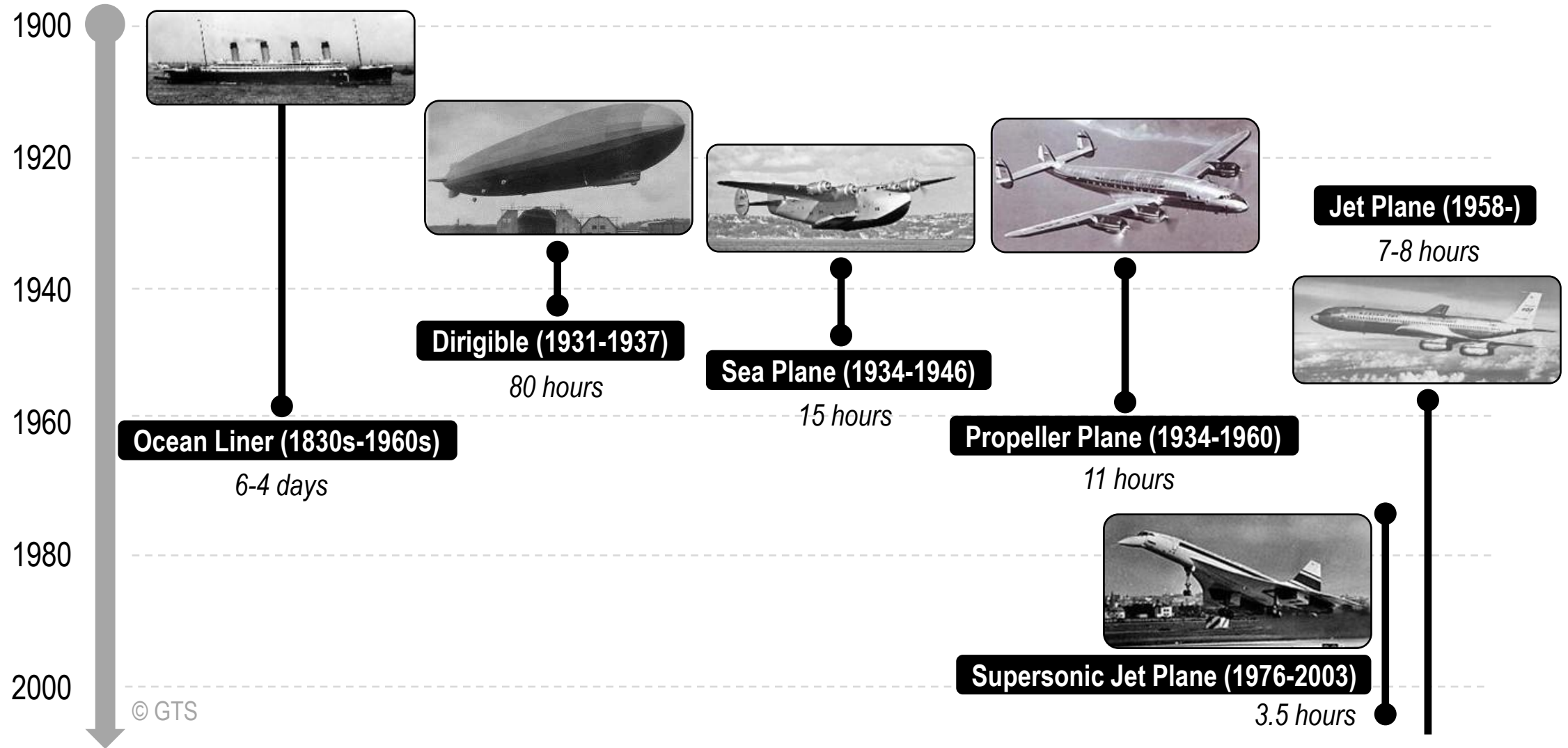
# Maritime Economics Freight Index, 1741-2007



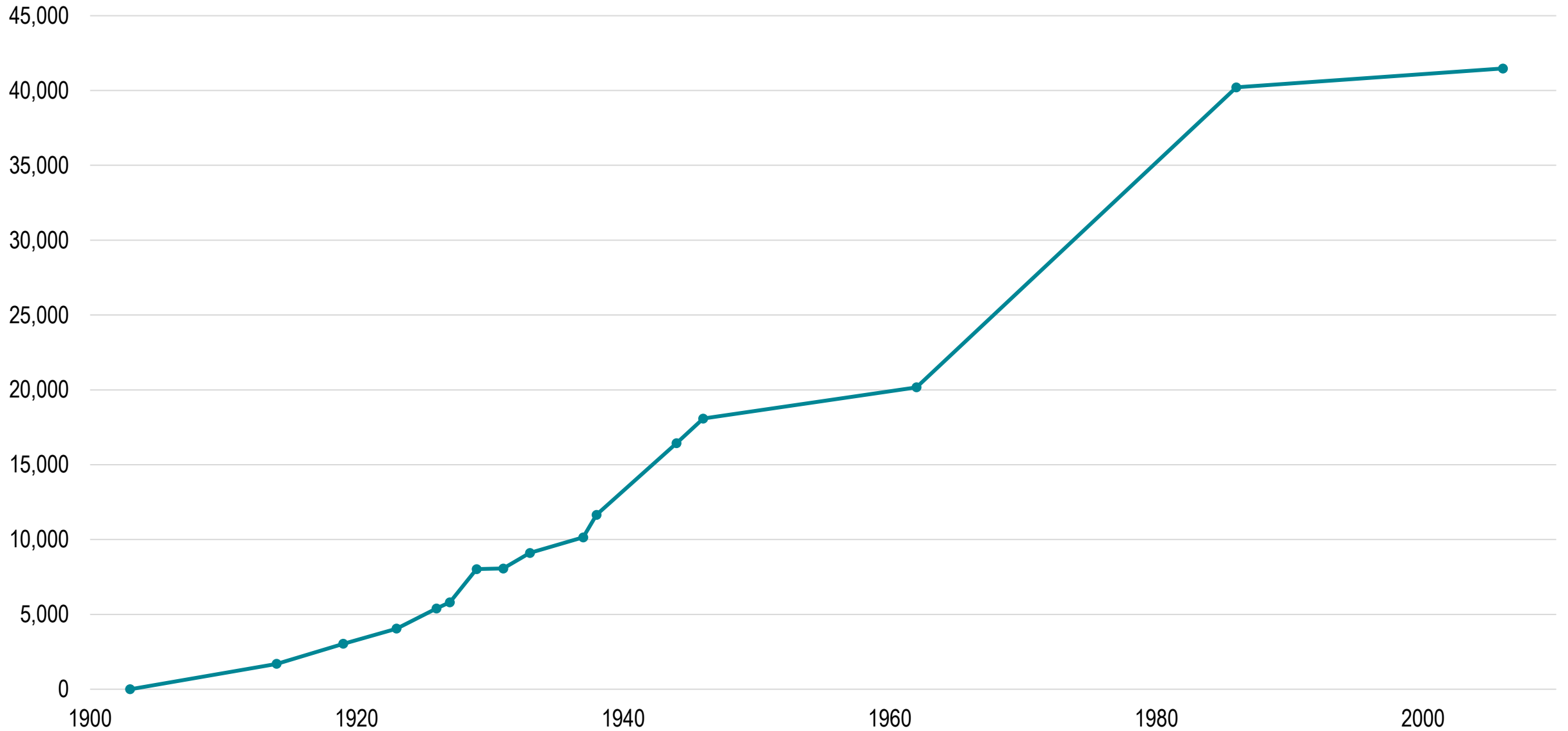
# Long Term Freight Market Index (LFI), 1741-2015



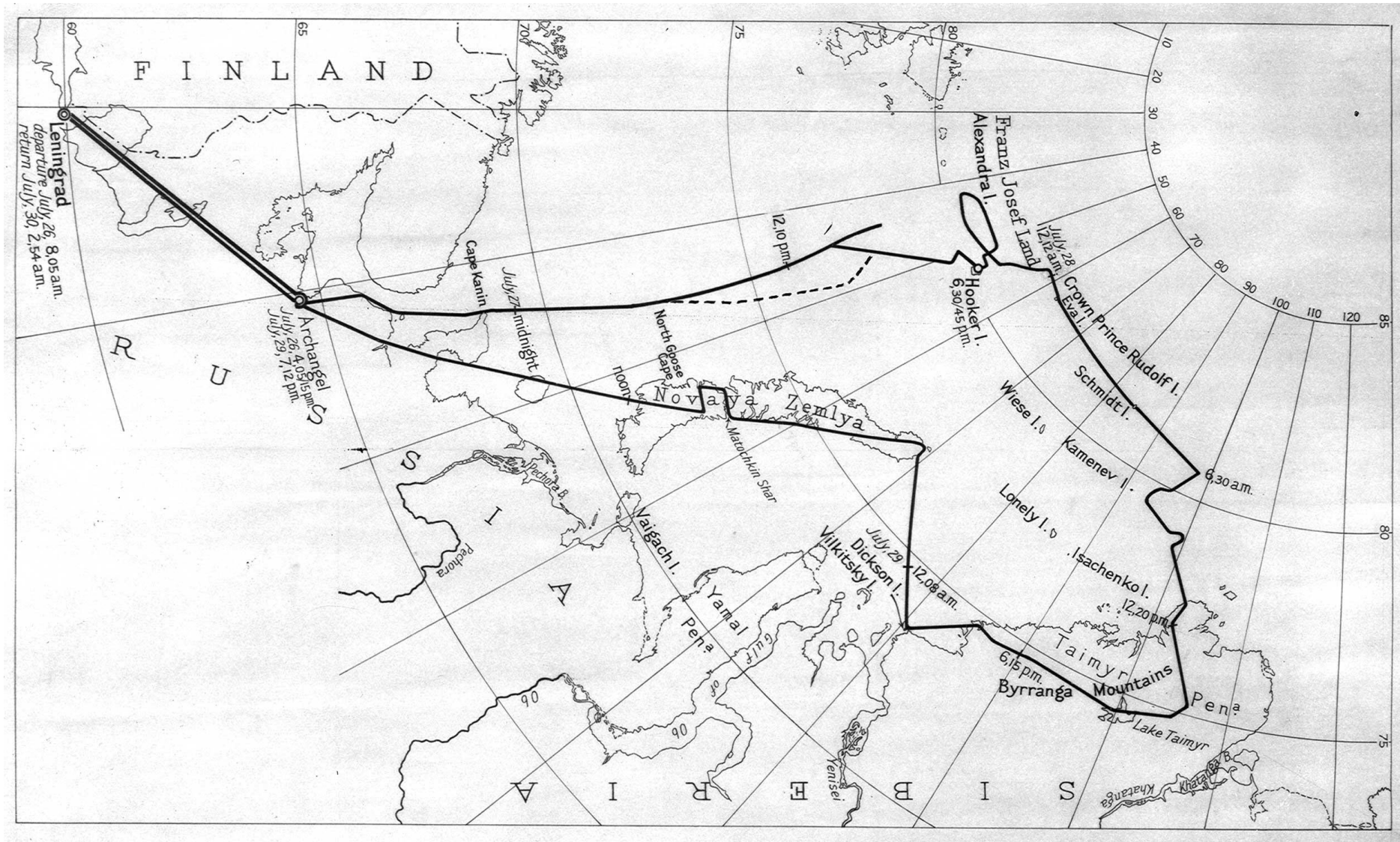
# Powered Transatlantic Passenger Modes



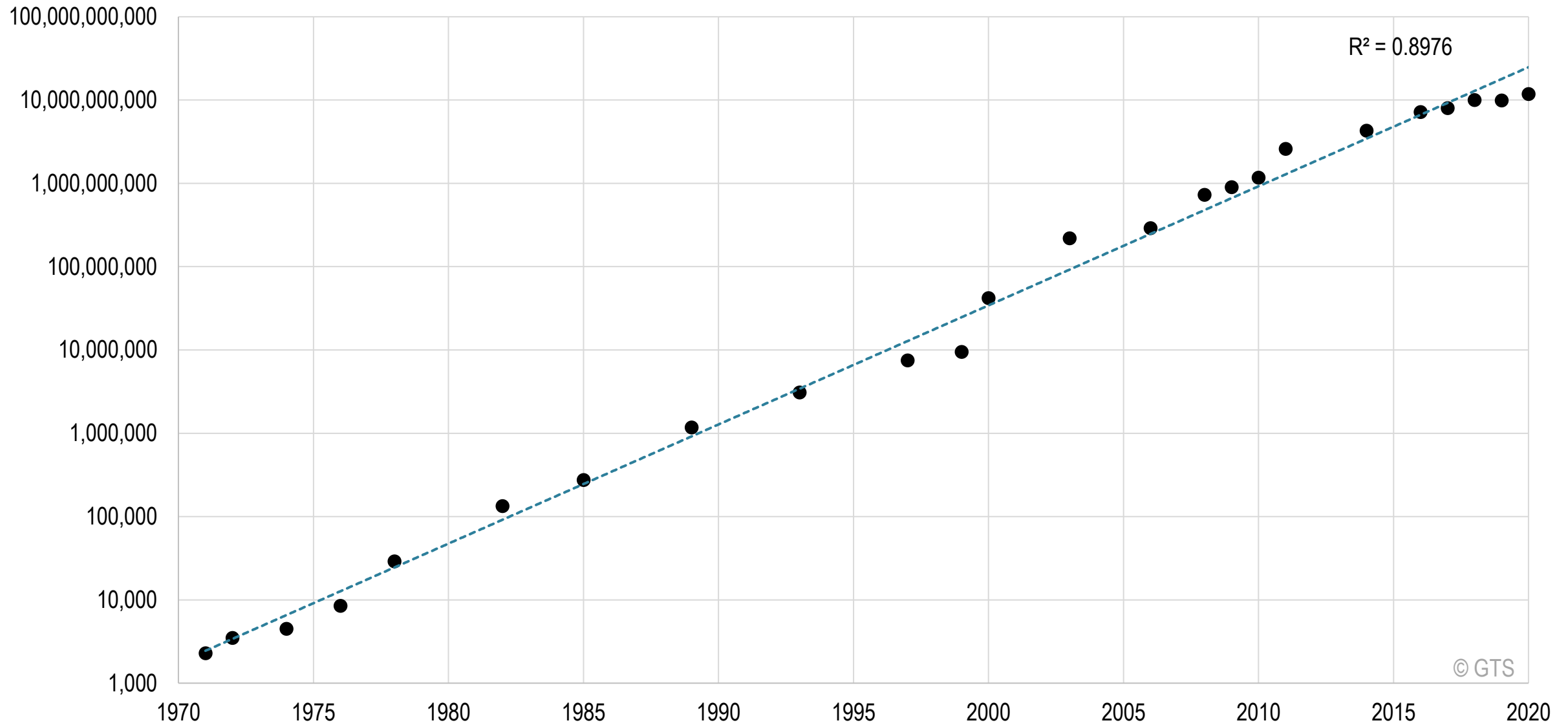
# Longest Non-Commercial Flight Distance (in km)



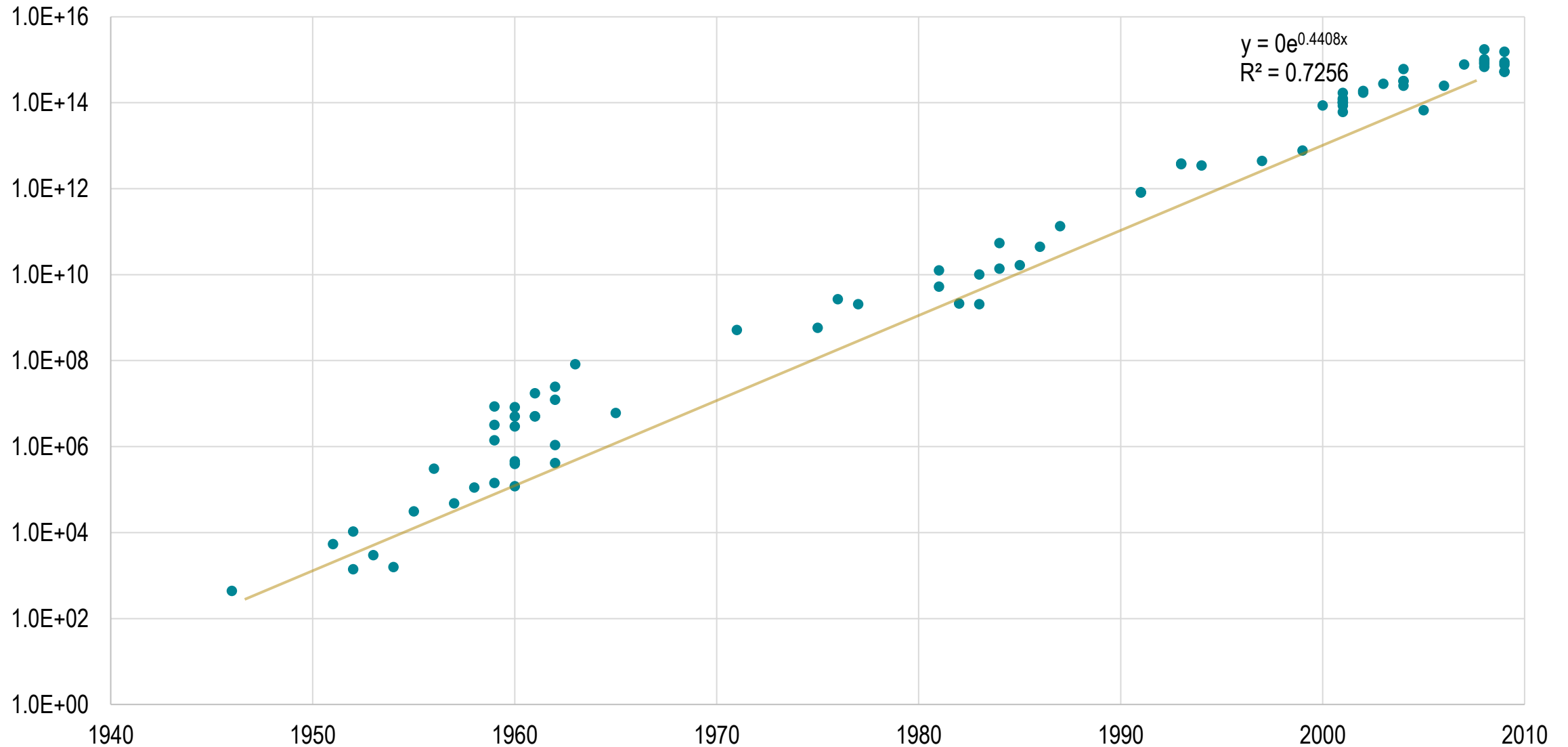
# Route of the Graf Zeppelin into the Arctic (1931)



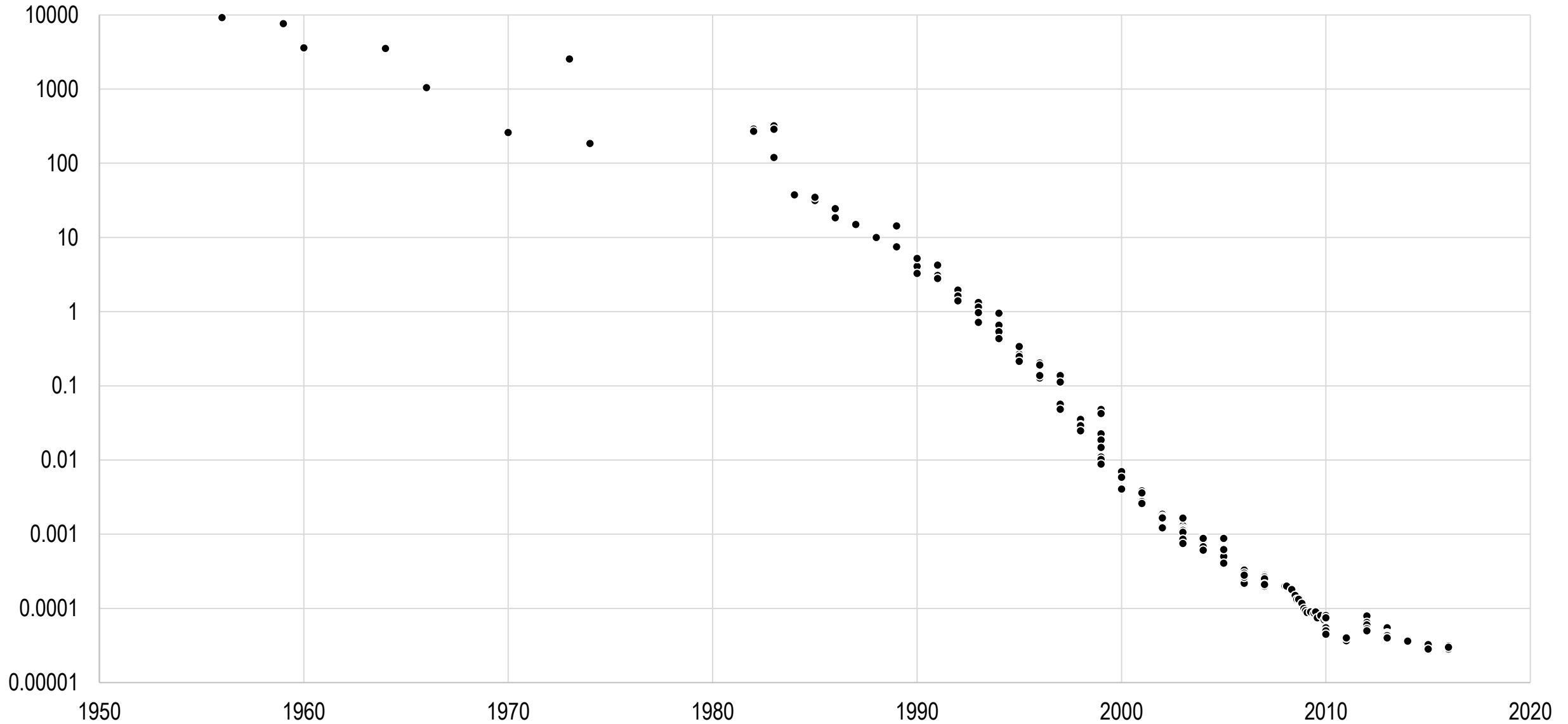
# Moore's Law: Transistors per Microprocessor, 1971-2020



# Computations per kWh, Selected Computers, 1946-2009

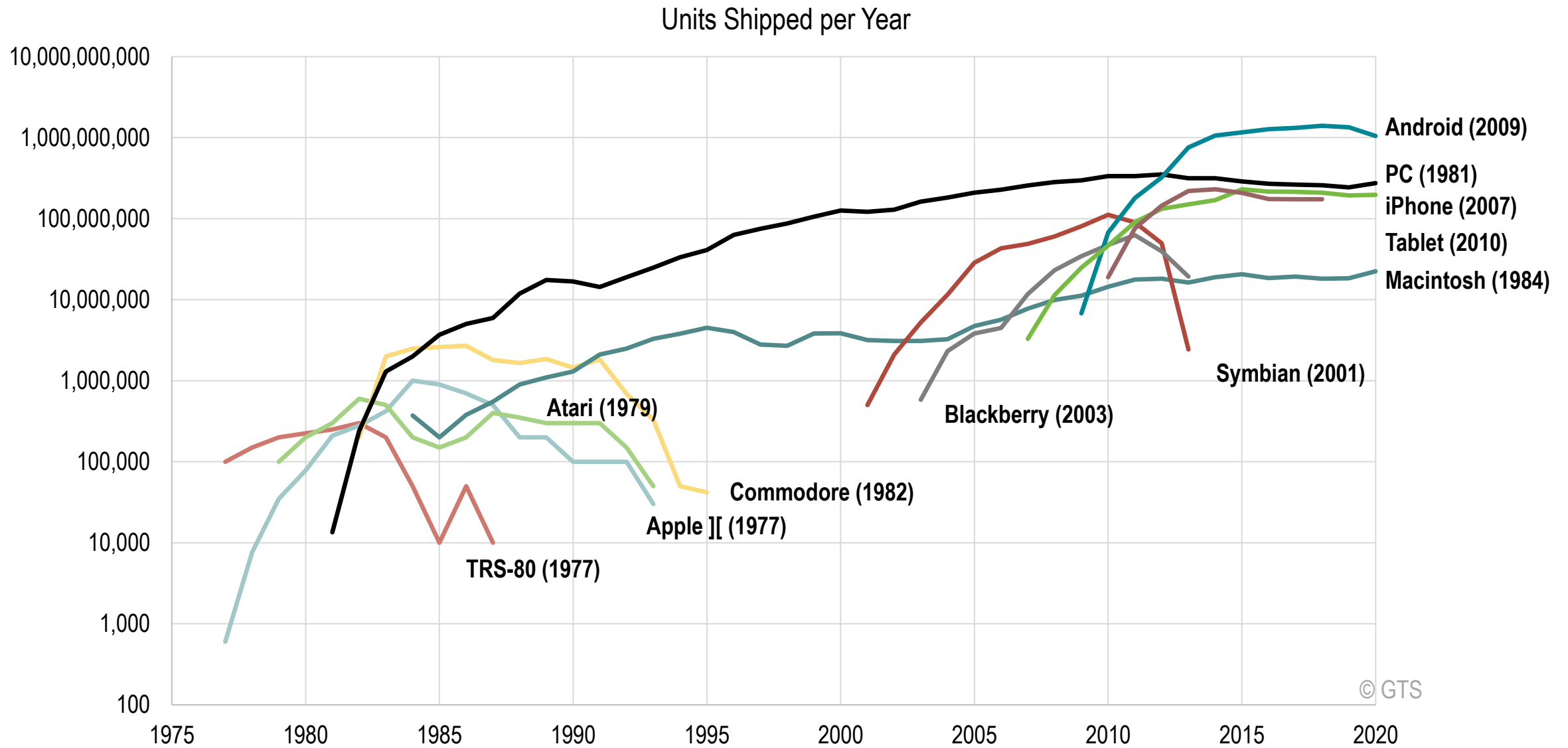


# Computer Storage Space, 1956-2016 (Dollars per Megabyte)

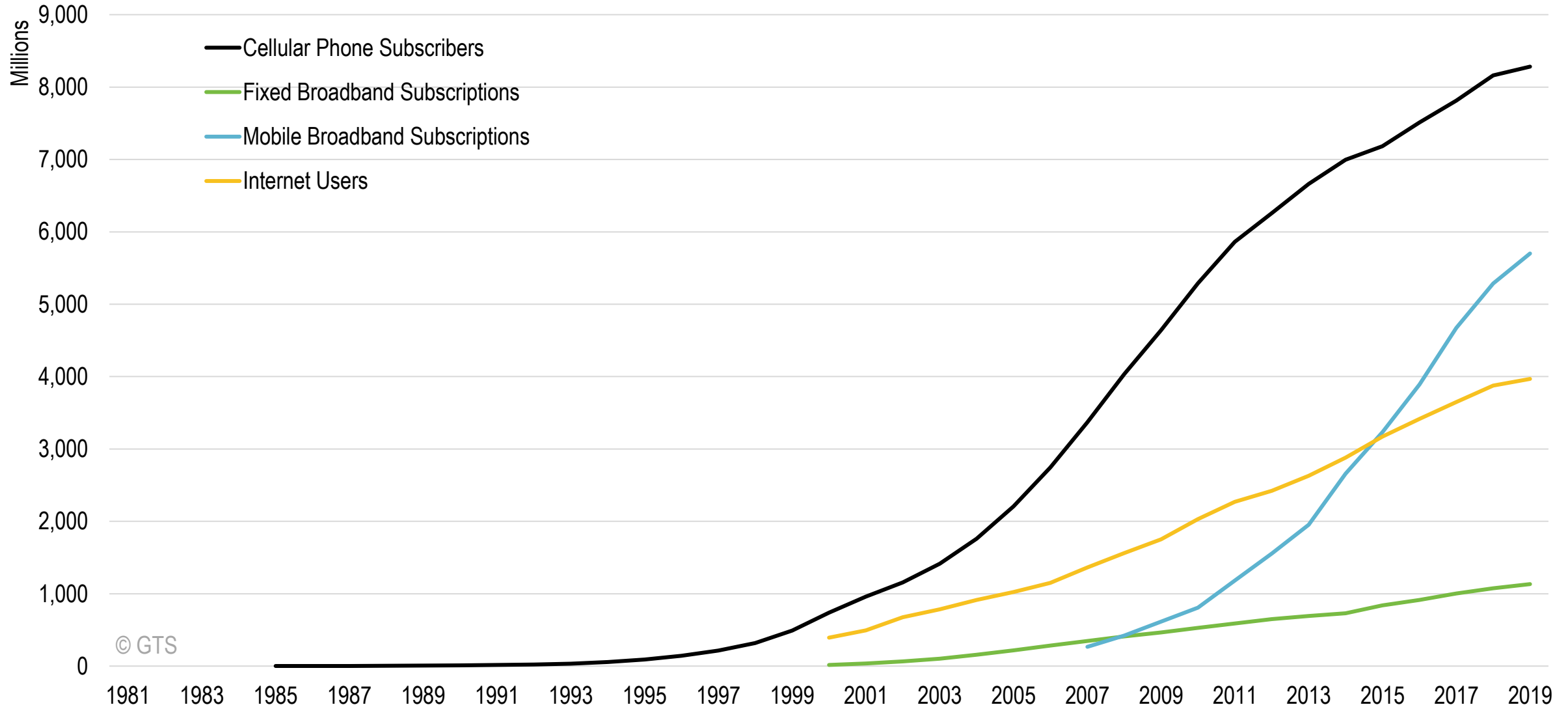




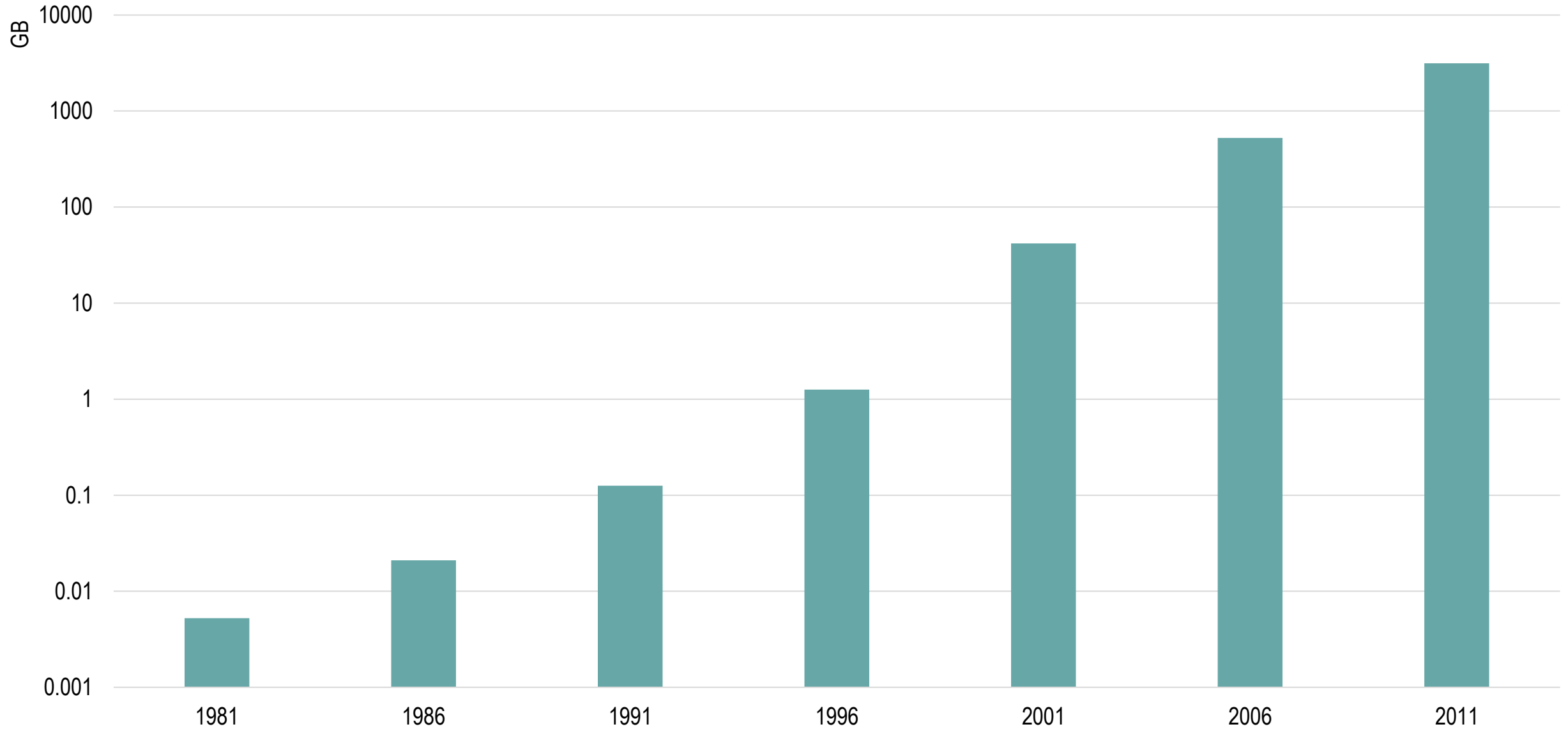
# Diffusion of Personal Computing Devices, 1977-2020



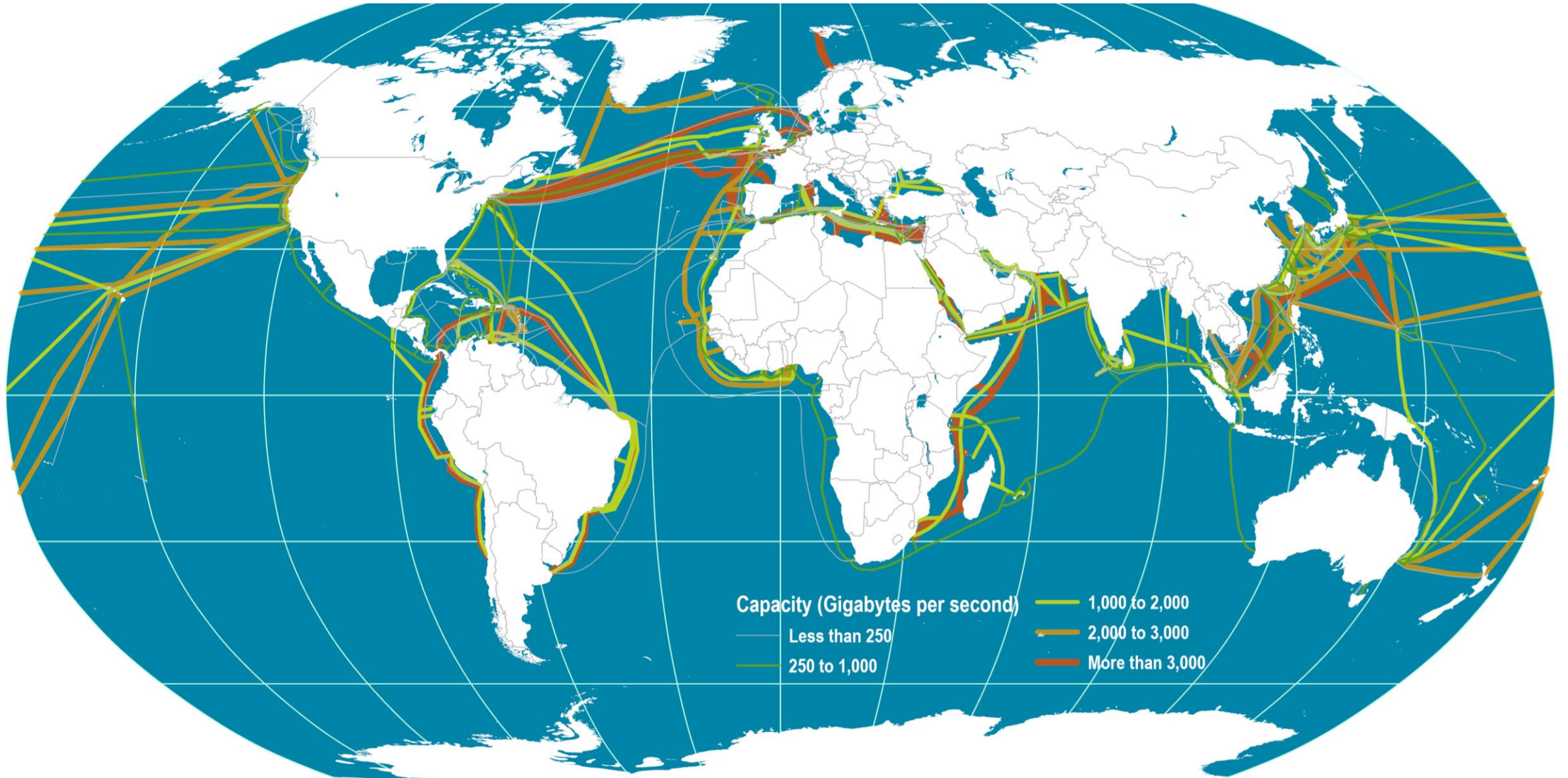
# Diffusion of Telecommunication Services, 1985-2019



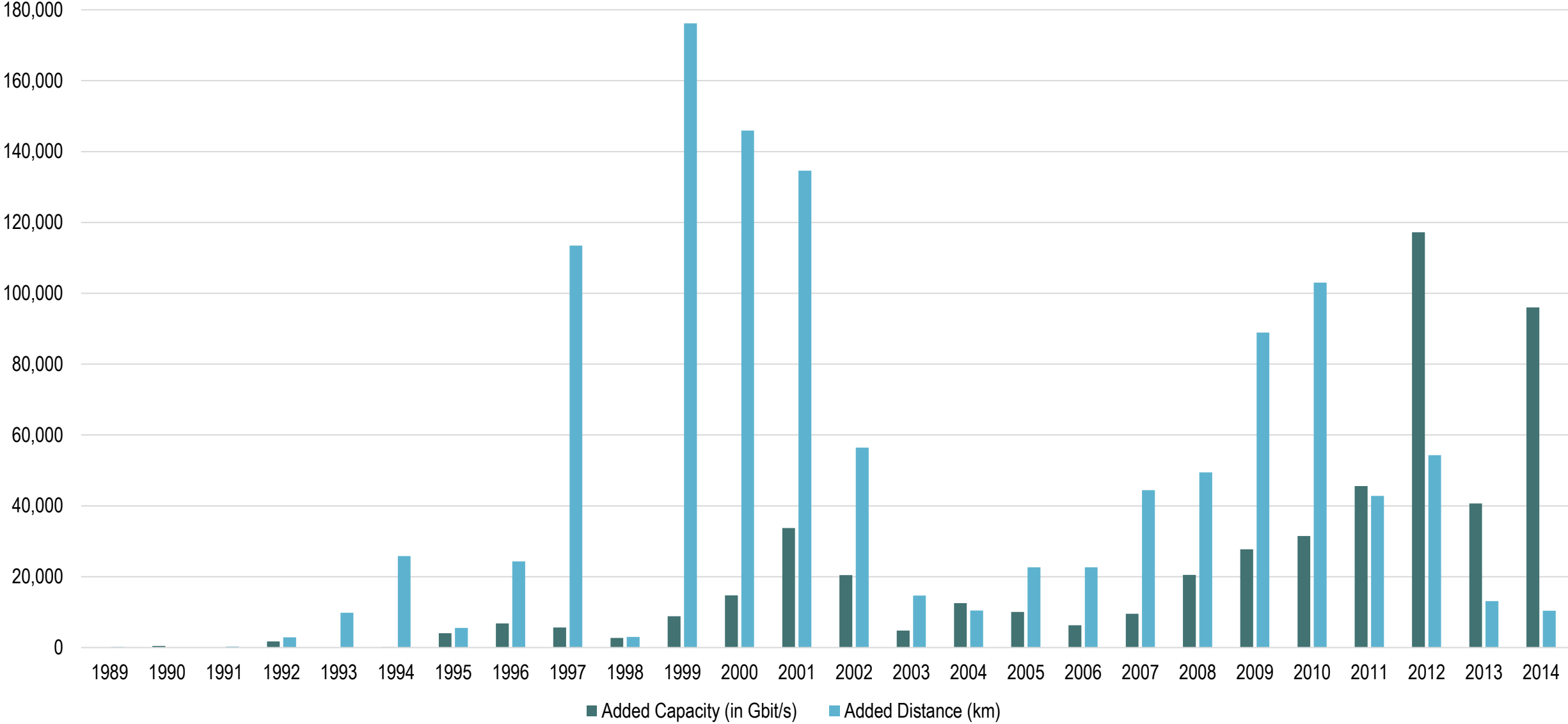
# Typical Hard Drive Capacity, New Computer, 1981-2011



# Global Submarine Cable Network



# Annual Oceanic Cable Capacity Increase, 1989-2014



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# Some Long Distance Travel Costs

Link	Cost in Dollars (Current 2005 Dollars)
Transatlantic steamship (1880s)	\$35 to \$100 (\$1,000 to \$3,000)
Transcontinental rail (1880s)	\$100 to \$200 (\$3,000 to \$6,000)
Transcontinental rail (1940s)	\$70 to \$100 (\$250 to \$350)
Transcontinental air (1940s)	\$300 (\$3,600)
Transcontinental air (1960s)	\$150 (\$1,200)
Transcontinental air (2000s)	\$600

# Evolution of Mobility, United States, 1800-2000

	<b>Average ground travel speed</b>	<b>Average mobility</b>	<b>Per capita GDP</b>
1800	3 mph	1,500 miles per year	\$1,200
1850	4 mph	1,600 miles per year	\$1,900
1900	8 mph	2,000 miles per year	\$5,000
1950	23 mph	6,900 miles per year	\$12,000
2000	34 mph	18,000 miles per year	\$35,000

# Some Impacts of Early Containerization

	<b>Pre-Containerization (1965)</b>	<b>Post-Containerization (1970-71)</b>
Dock labor productivity	1.7 tons per hour	30 tons per hour
Port concentration (loading ports servicing Europe/Australia trade)	11 ports	3 ports
Insurance costs (Australia / Europe imports)	£0.24 per ton	£0.04 per ton
Inventory holding costs (Hamburg/Sydney)	£2 per ton	£1 per ton



# Corporate Adaptation to Transport Innovations: American Express and Wells Fargo

American Express

## Interstate Wagon Services



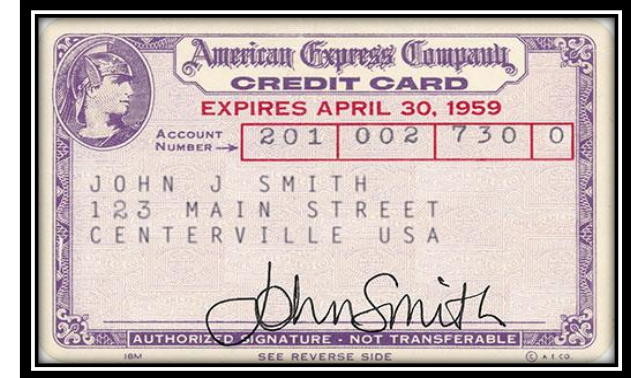
1850: Established in Buffalo, NY

## Rail Services



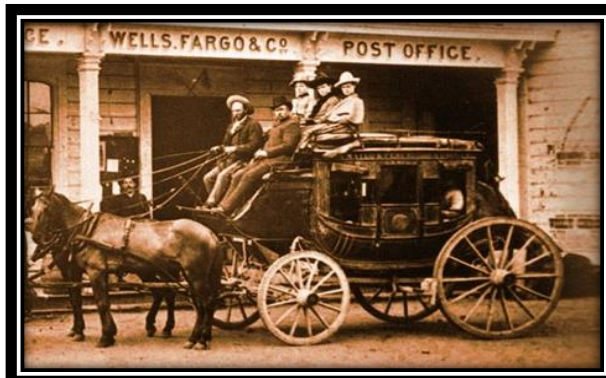
1883: Express trains  
1918: Exiting the express business

## Financial Services



1857: Money orders  
1891: Traveler's cheques  
1958: Credit cards

Wells Fargo



1852: Established in San Francisco, CA  
1866: Stagecoach services

## Wells Fargo & Co's Express

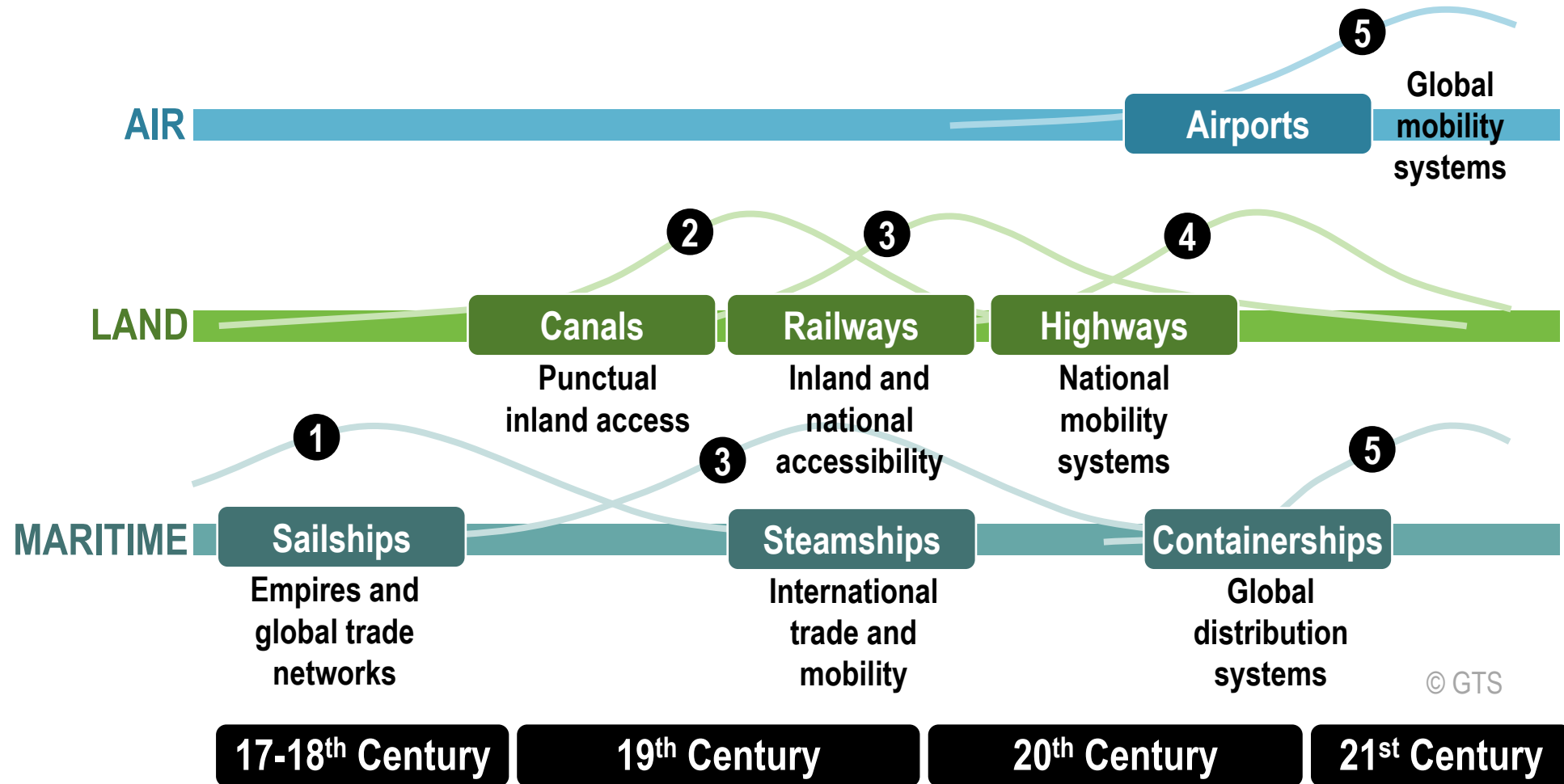


1888: Express trains

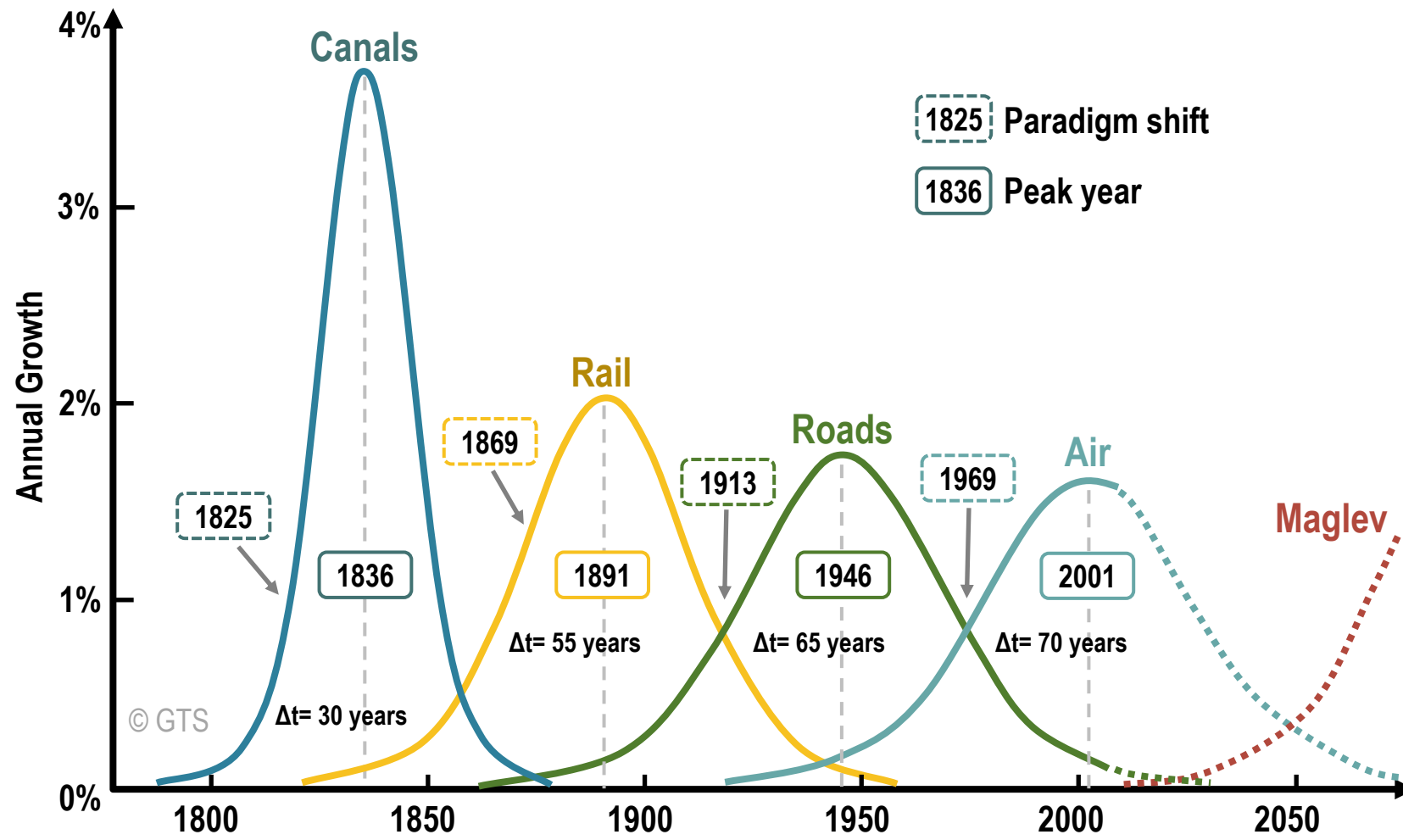


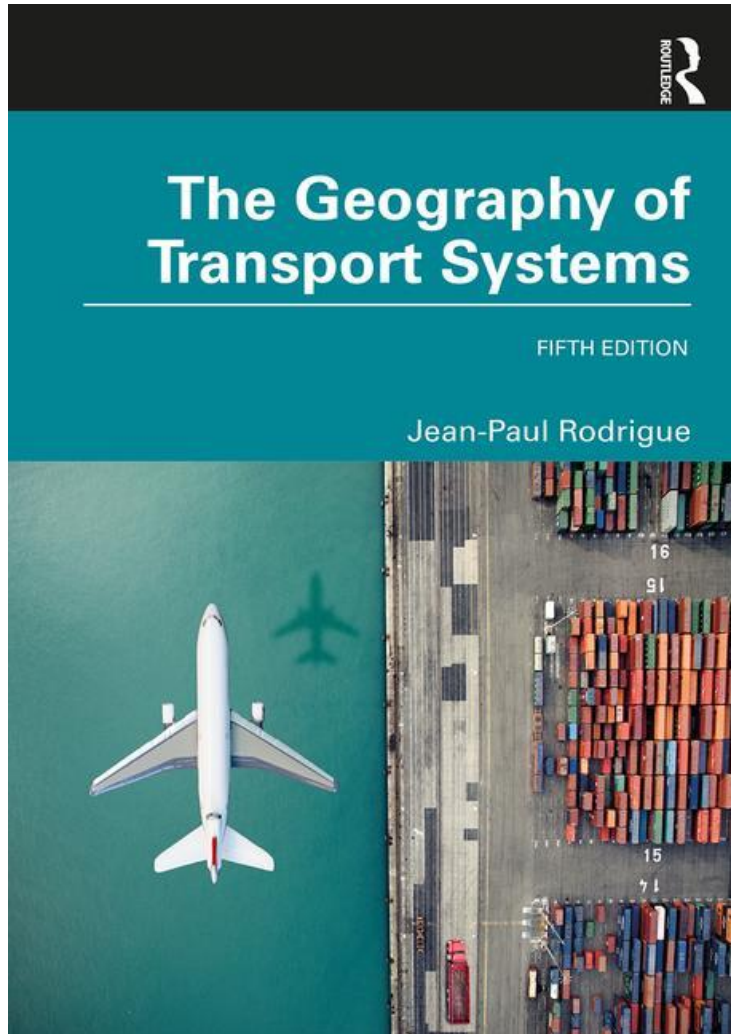
1905: Wells Fargo Bank  
1967: Credit cards  
1995: Web banking accounts

# Cumulative Waves of Transport Development



# Growth of the US Transport System, 19<sup>th</sup> - 21<sup>st</sup> Century

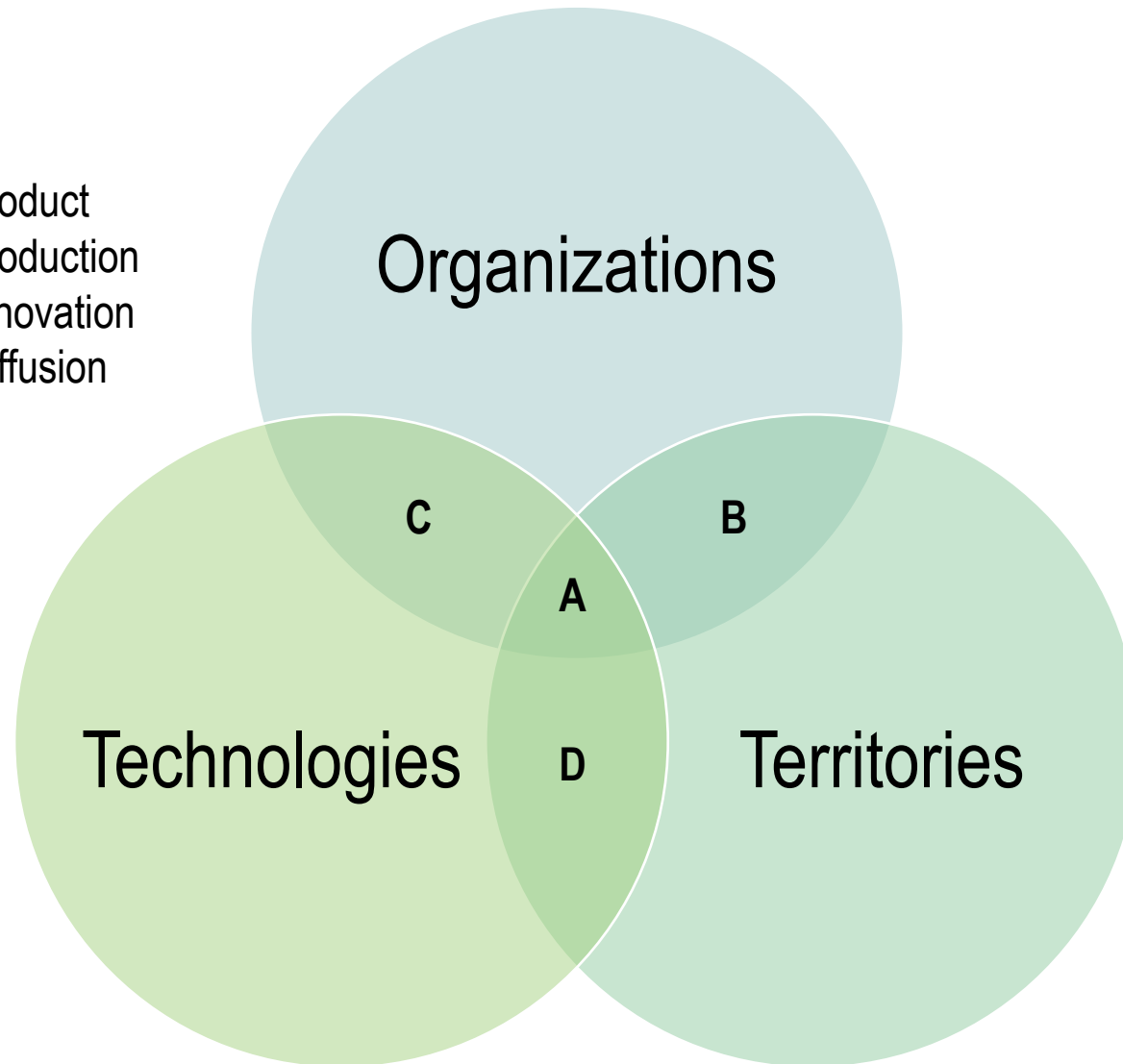




# Transportation and Commercial Geography

# Dimensions of Economic Geography

A: Product  
B: Production  
C: Innovation  
D: Diffusion



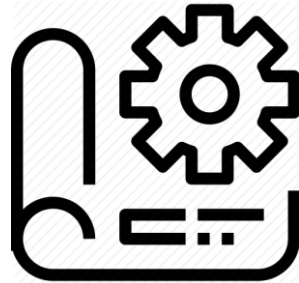
# The Drivers of Trade and Globalization

## Integration



- Regulatory chains.
- Harmonization of regulatory regimes.
- Trade agreements.

## Production



- Supply / value chains.
- Offshoring.
- Global production networks.

## Transportation



- Transport chains.
- Containerization.
- Transborder transportation.

## Transactions

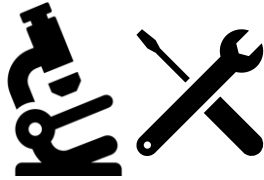


- Information chains (ICT).
- Investment capital.
- Credit for transactions.

## Standards

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# Globalization as a Driver of Added Value



## Research and Development

Finding better products and processes.



## Input Costs

Using the labor and resources advantages of locations.



## Transportation

Effectively transporting and distributing resources, parts and finished goods.

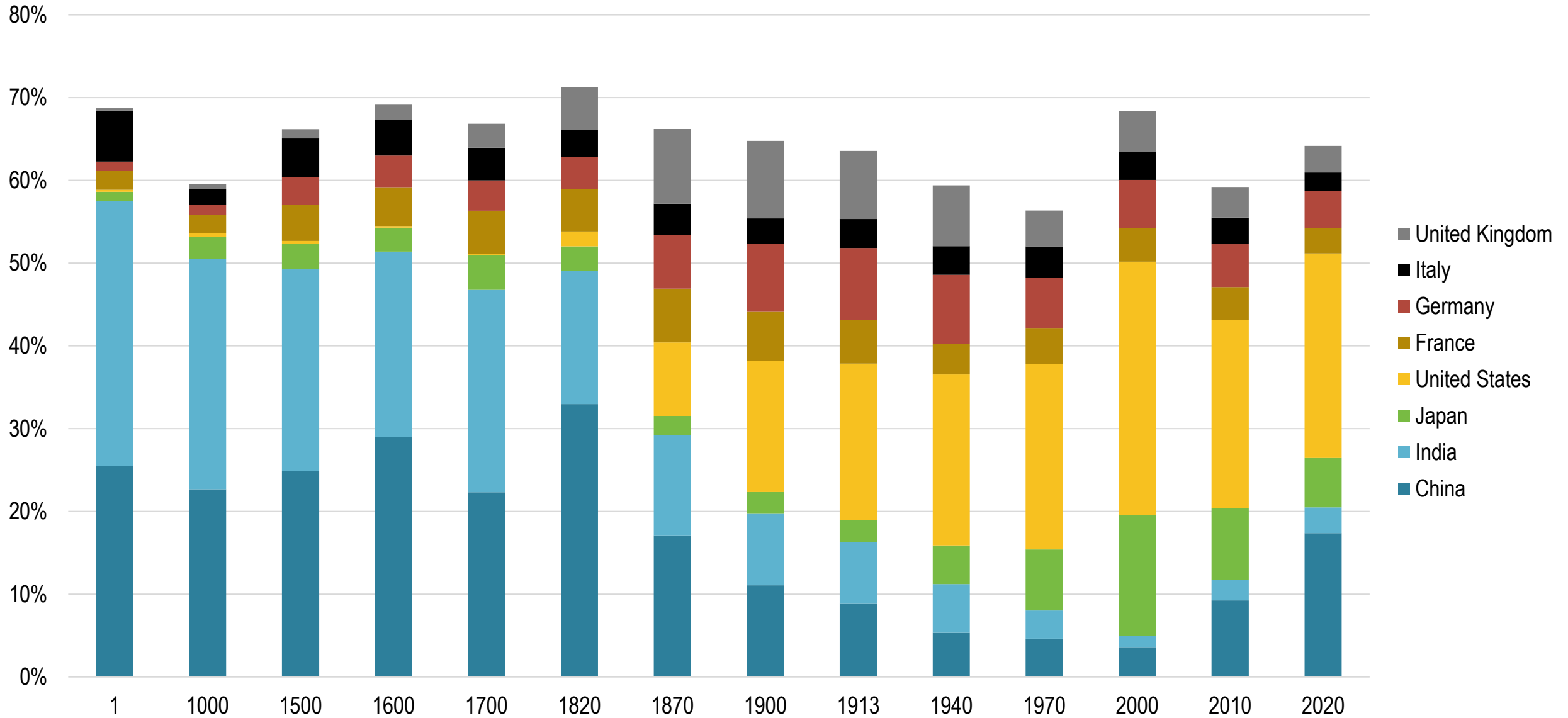


## Sustainability

Improving resource, environmental and energy efficiency.

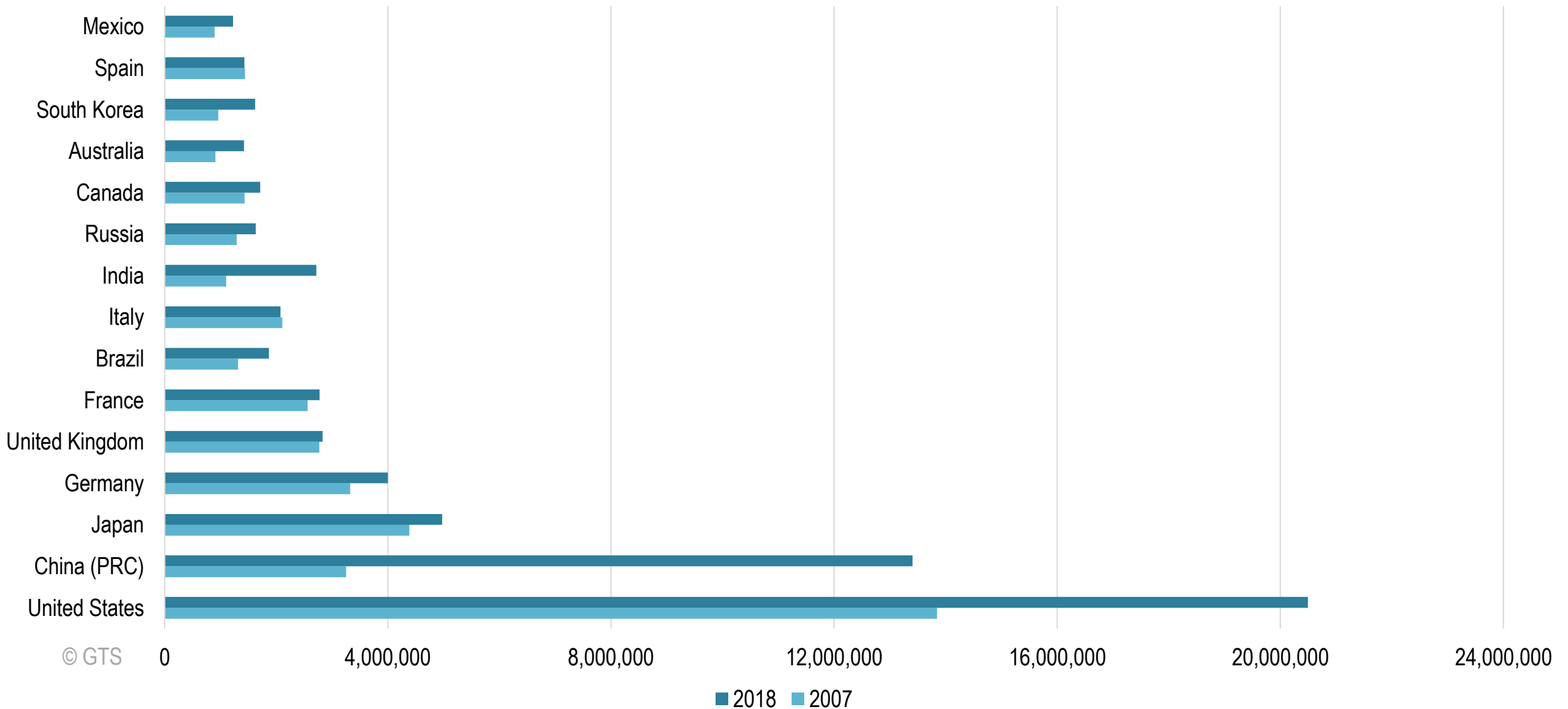
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# World GDP, 1CE - 2020

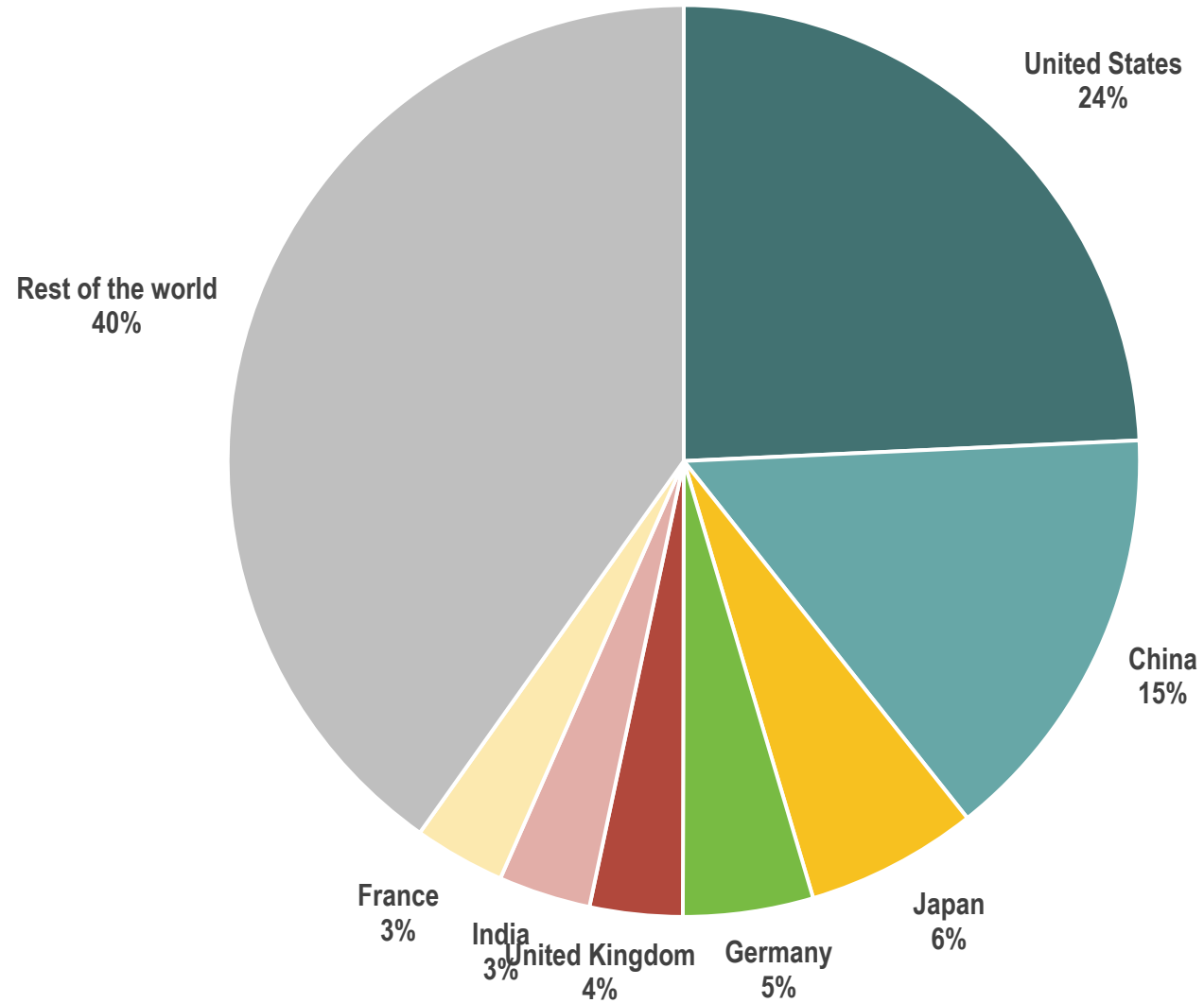




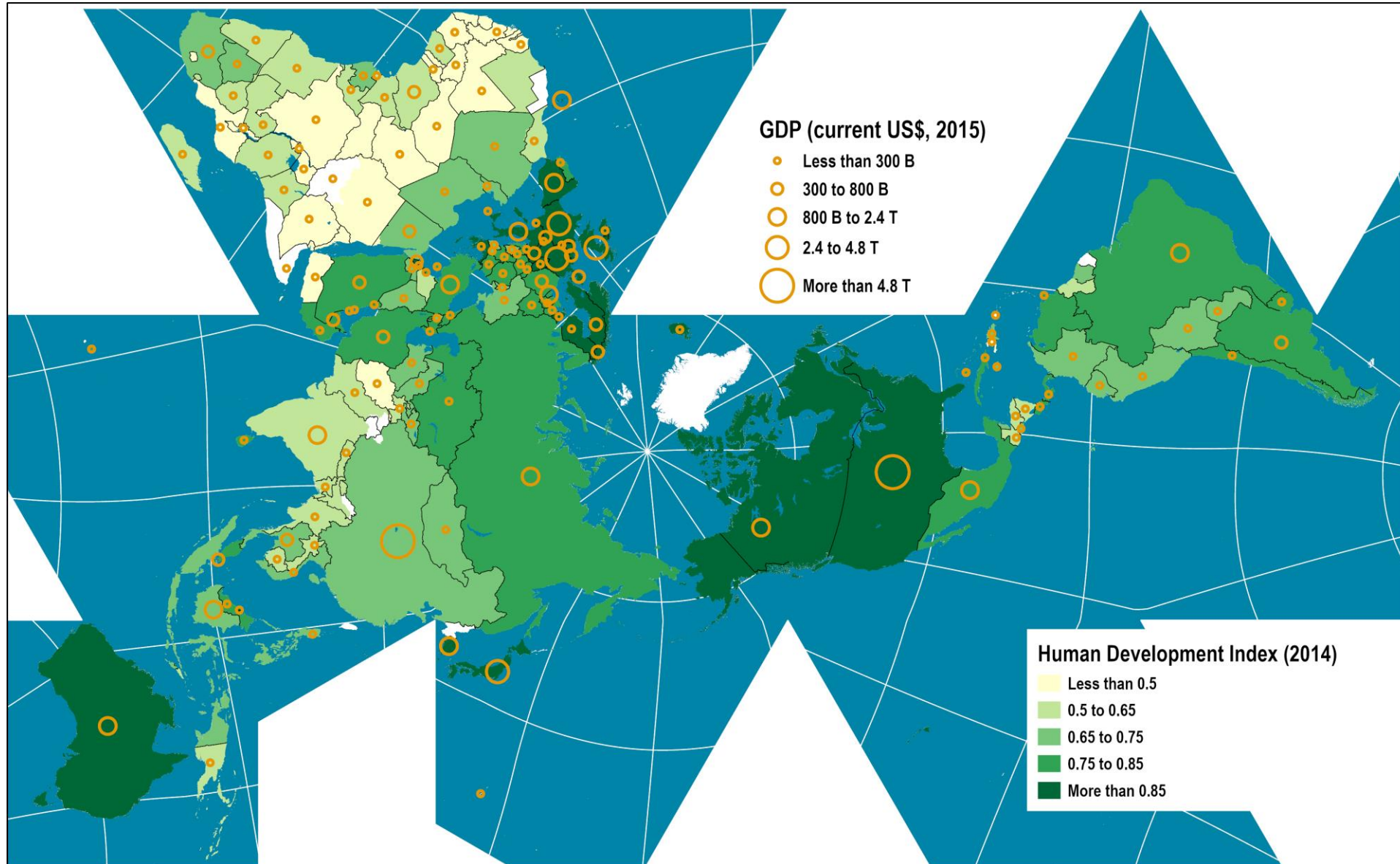
# World Nominal GDP, 2007, 2018 (in billion USD)



# Share of the World GDP, 2016 (Current USD)



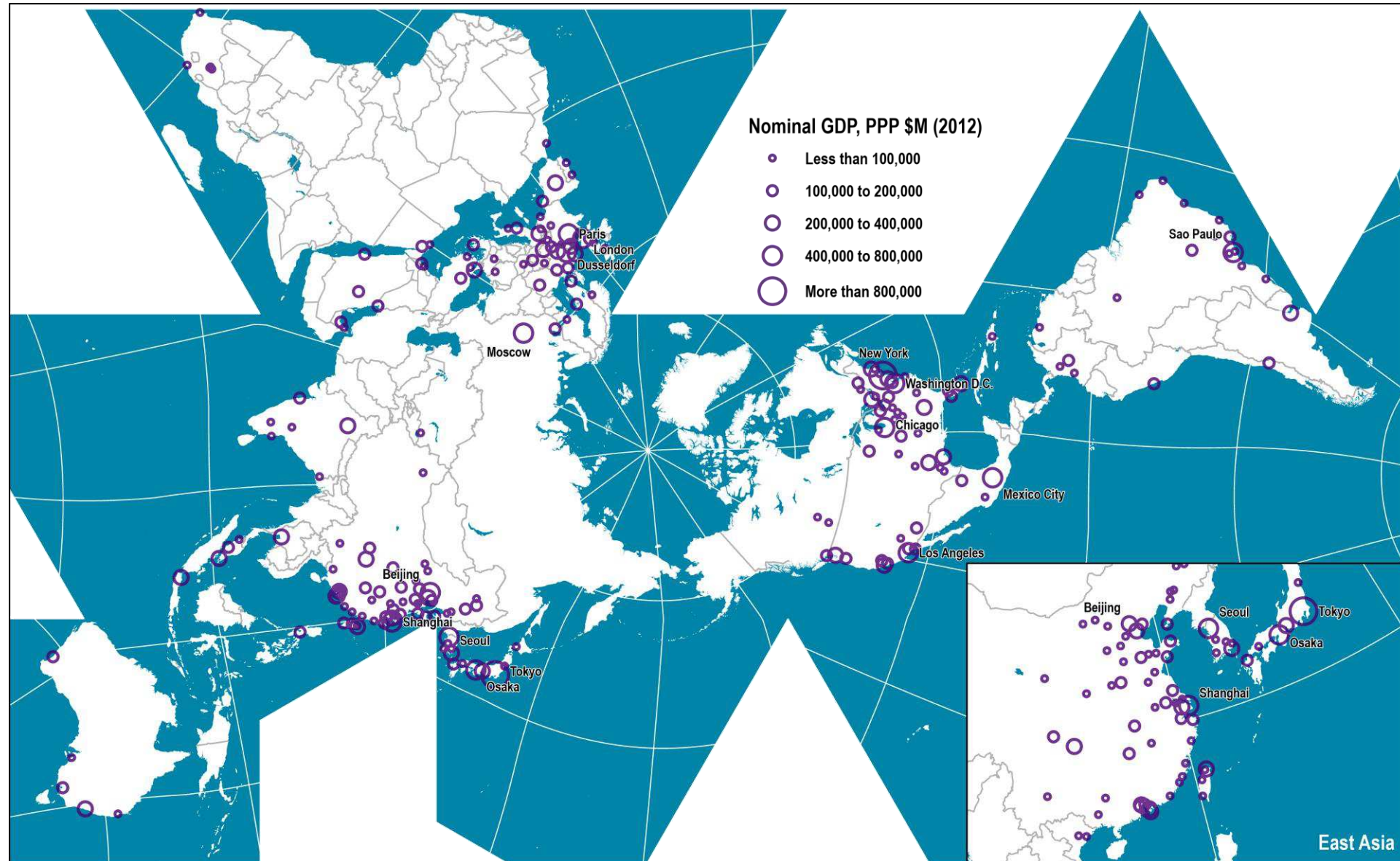
# Global Gross Domestic Product and Human Development Index, 2015



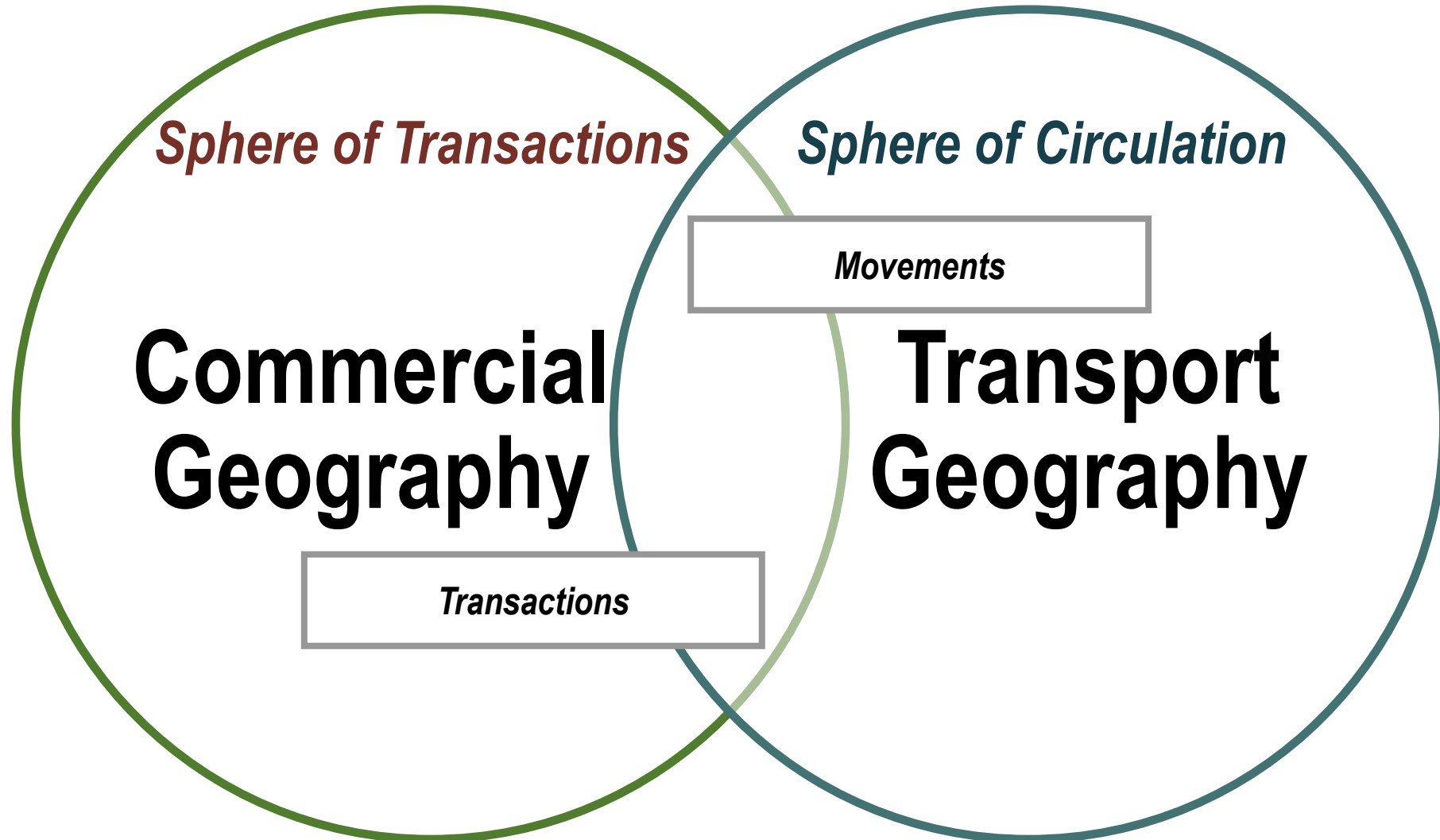
# Global Competitiveness Index, 2018



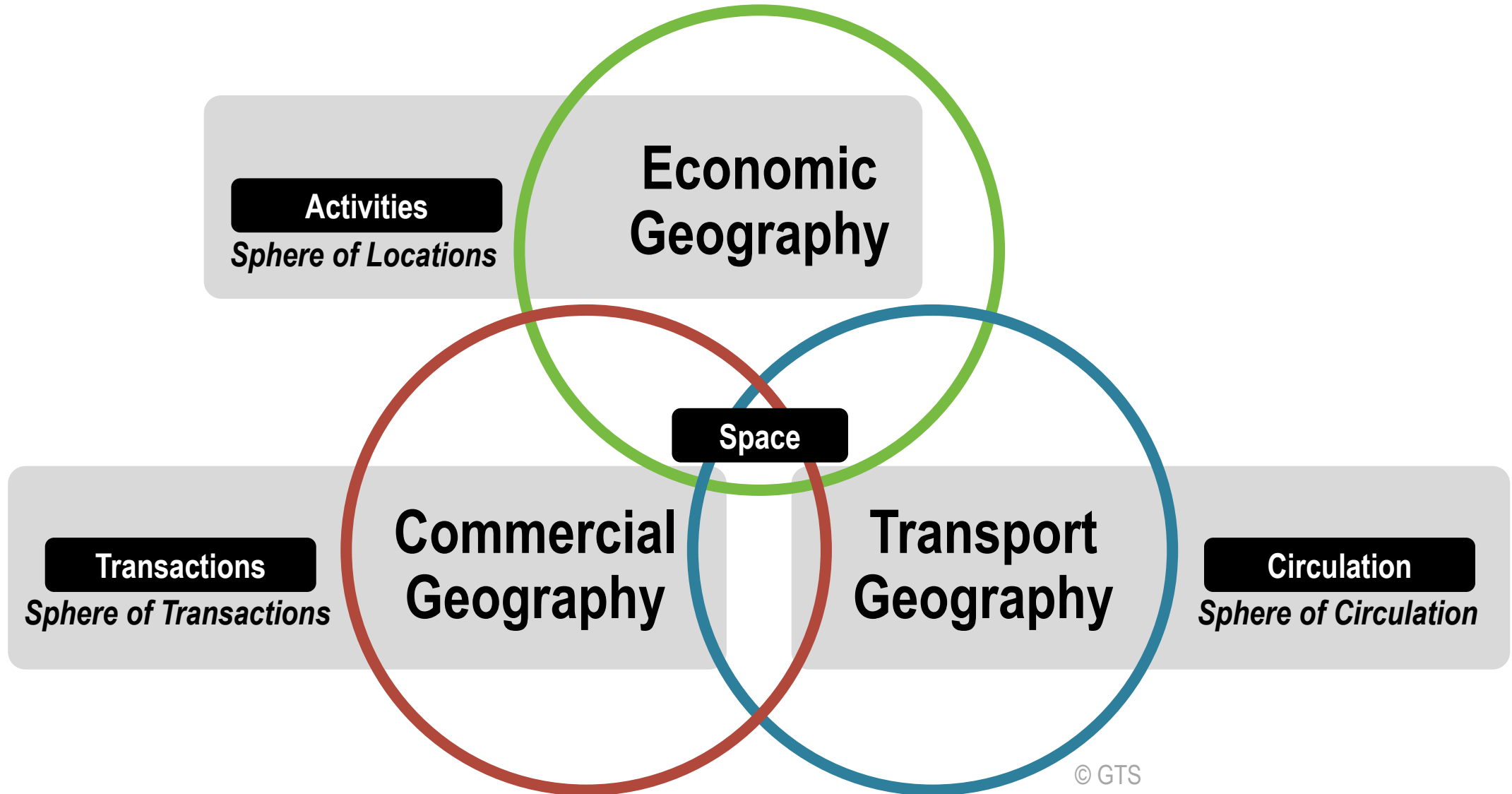
# The Economic Output of the World's Major Metropolitan Areas, 2012



# Economic, Transport and Commercial Geography



# Economic, Transport and Commercial Geography



# Main Forms of Competitiveness in Transportation (under construction)

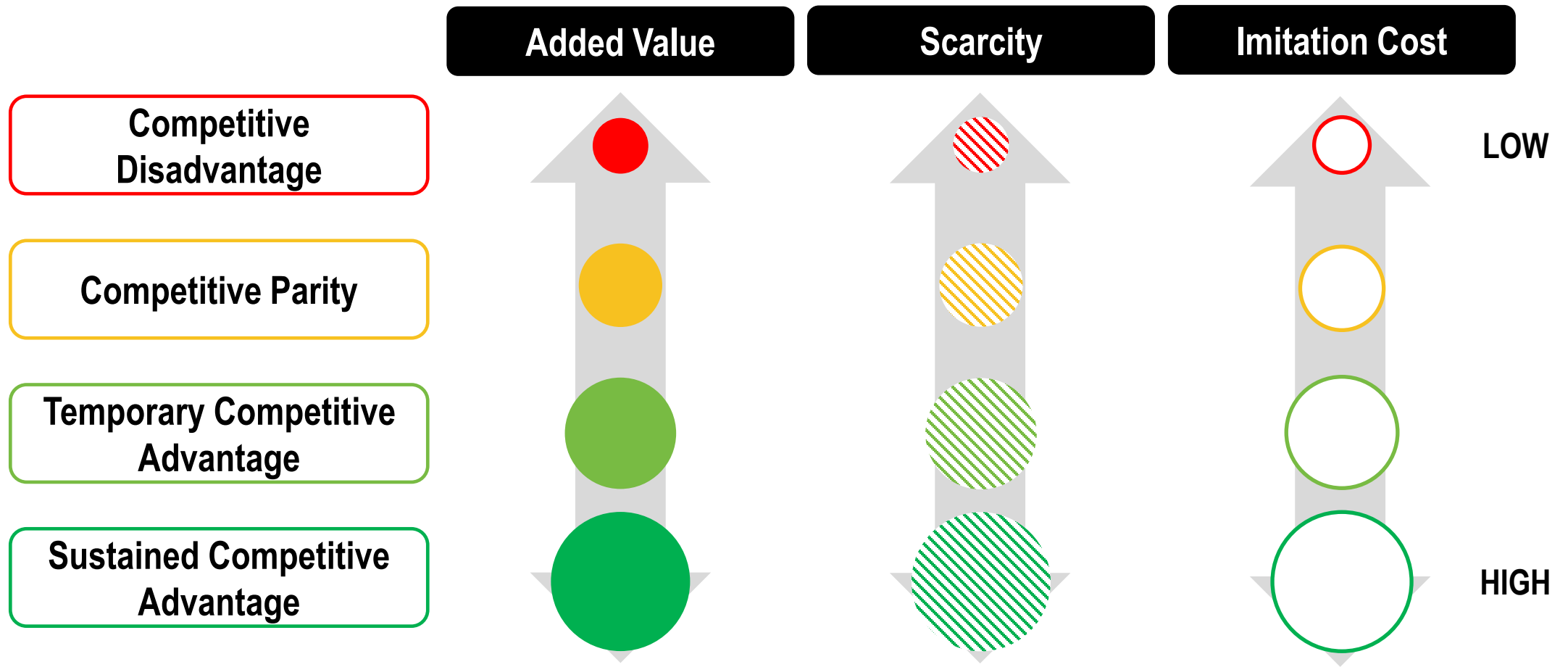
**Costs**

**Differentiation**

**Focus**



# Types of Competitive Advantages



# Types of Innovation

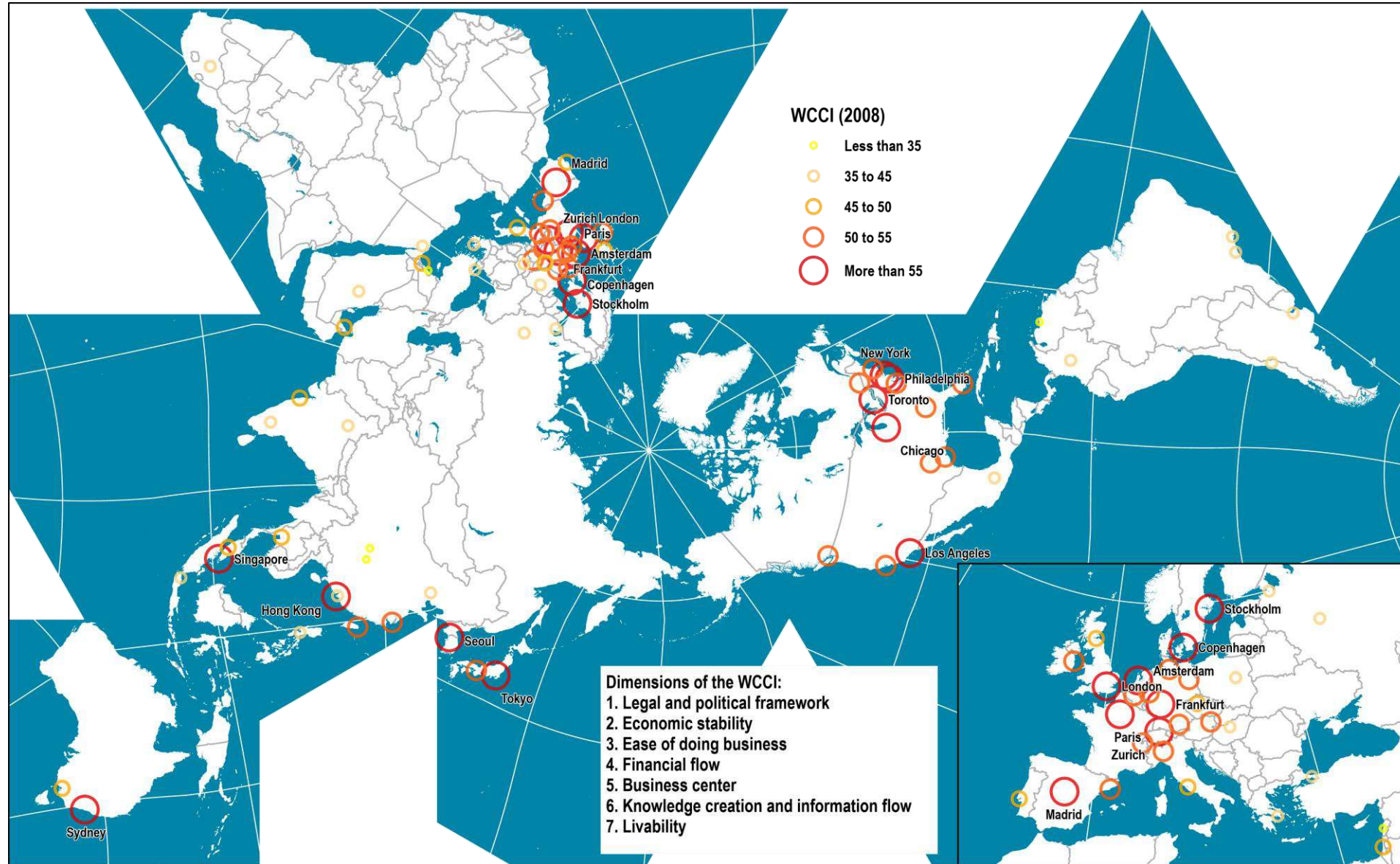
Organization

Process

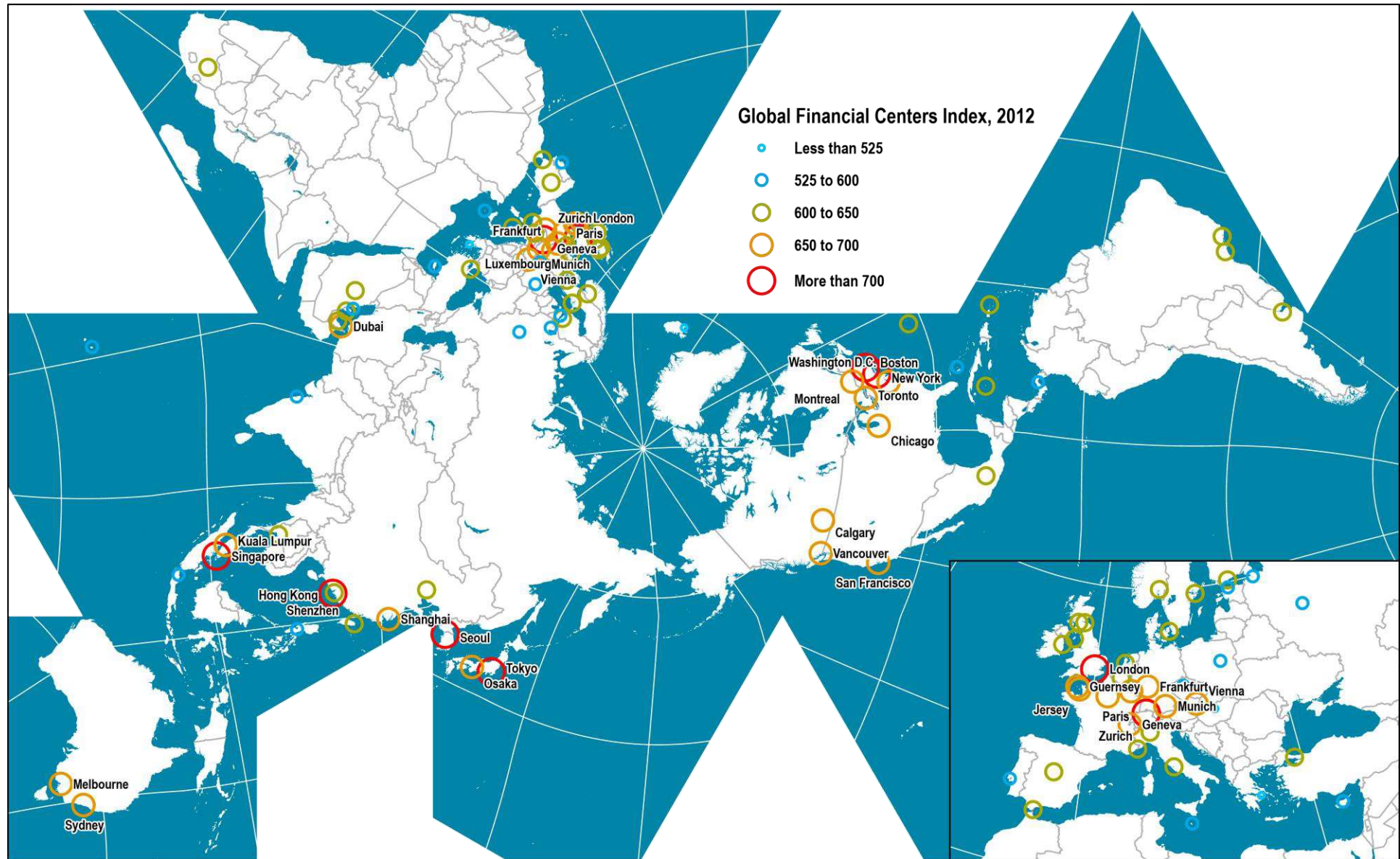
Product

Distribution

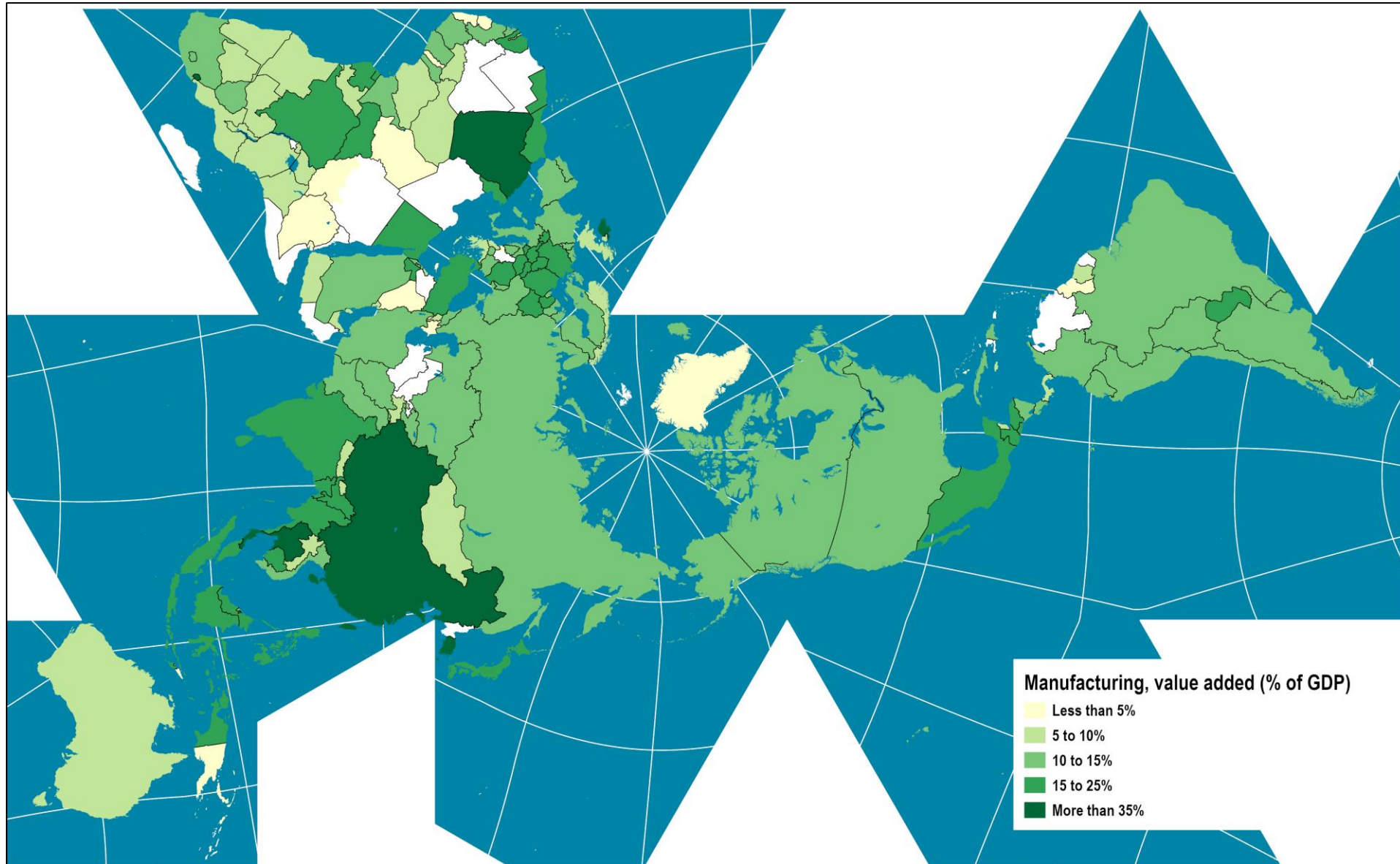
# Worldwide Centers of Commerce Index, 2008



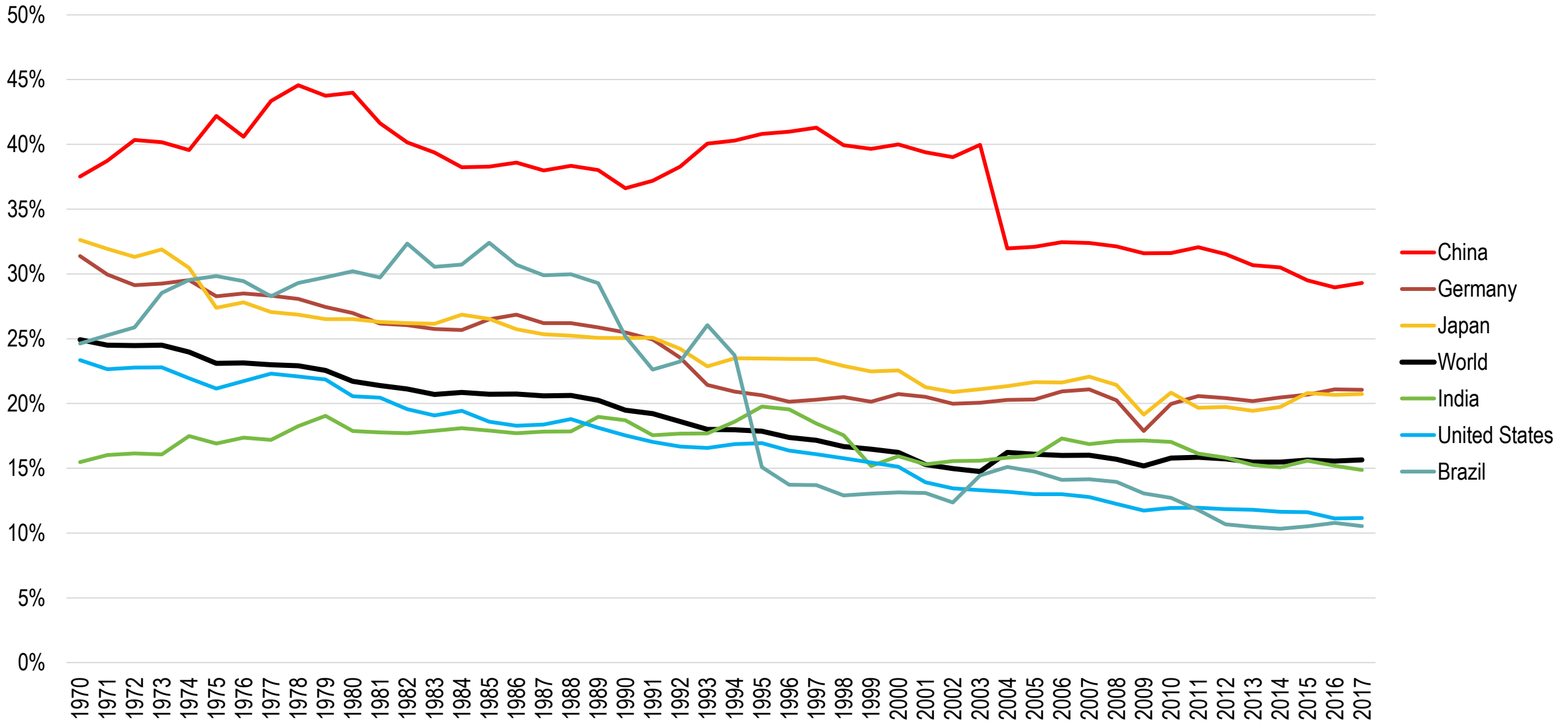
# Global Financial Centers, 2012



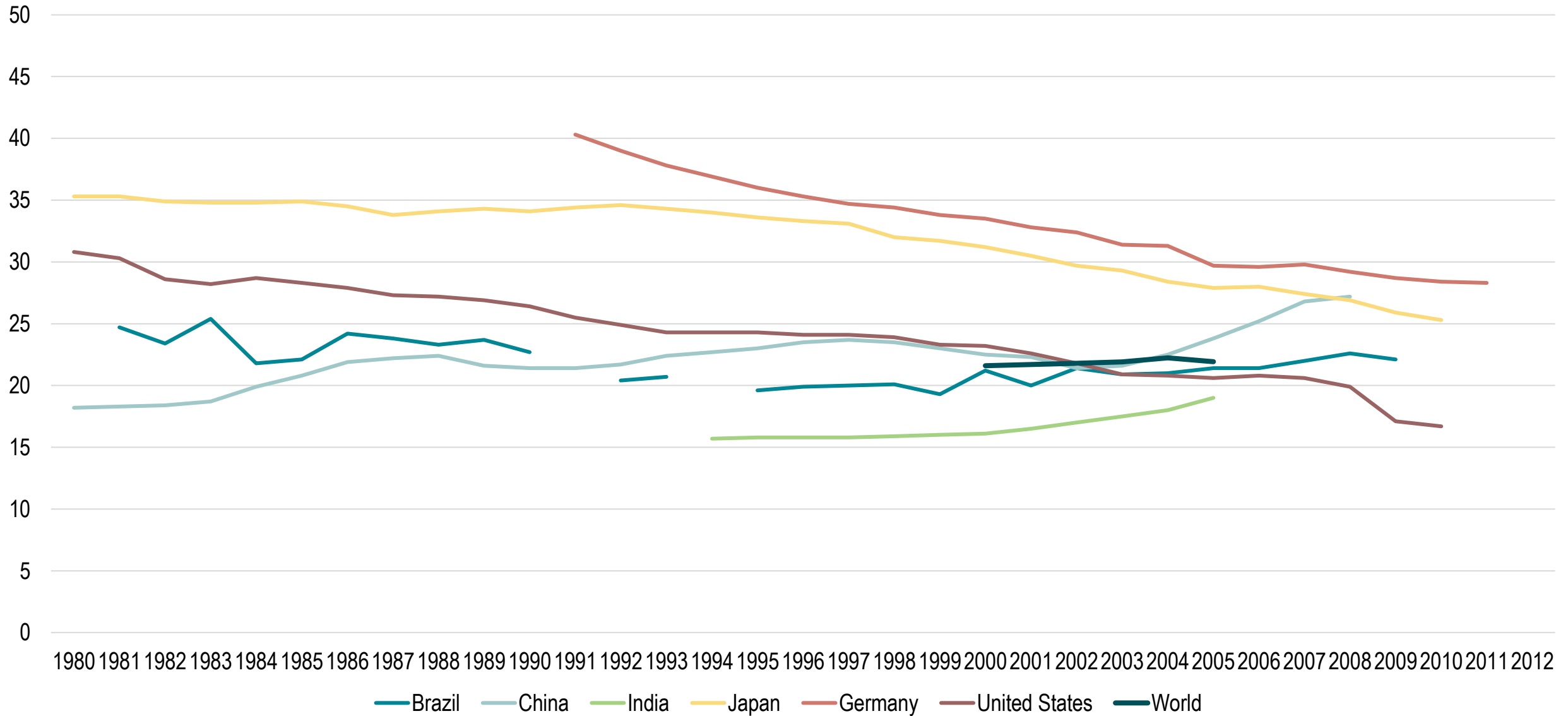
# Global Manufacturing, 2015



# GDP Share of Manufacturing, Selected Countries, 1970-2020



# Employment in Industry (in % of total Employment), 1980-2011



# Drivers of Change in Manufacturing and the Transition Towards Added-Value

## Market Forces

- Growth in emerging markets
- Demographic shifts

## Technologies

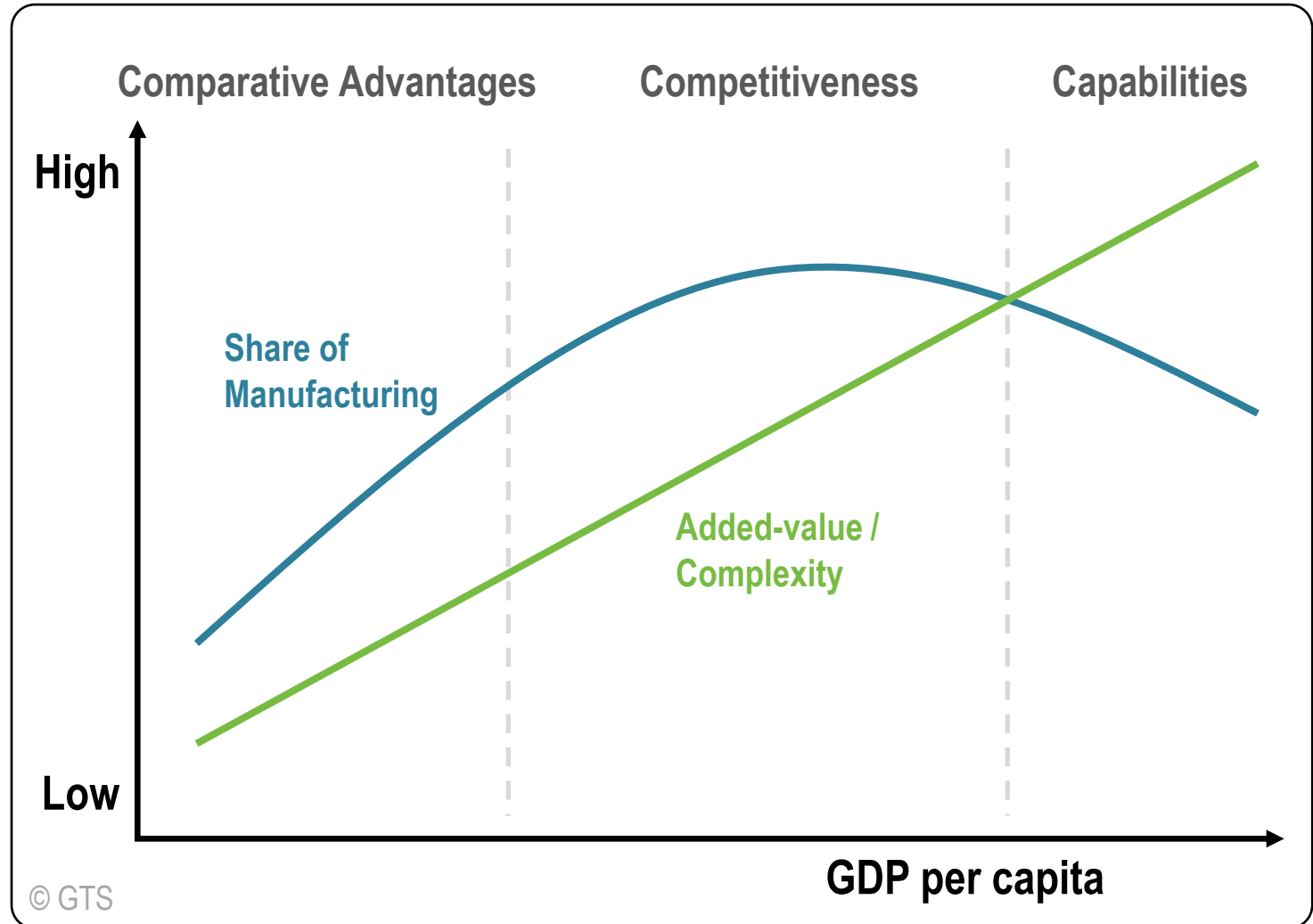
- Digitalization and automation
- Production costs
- Improved logistics

## Resources

- Energy costs
- Natural resources

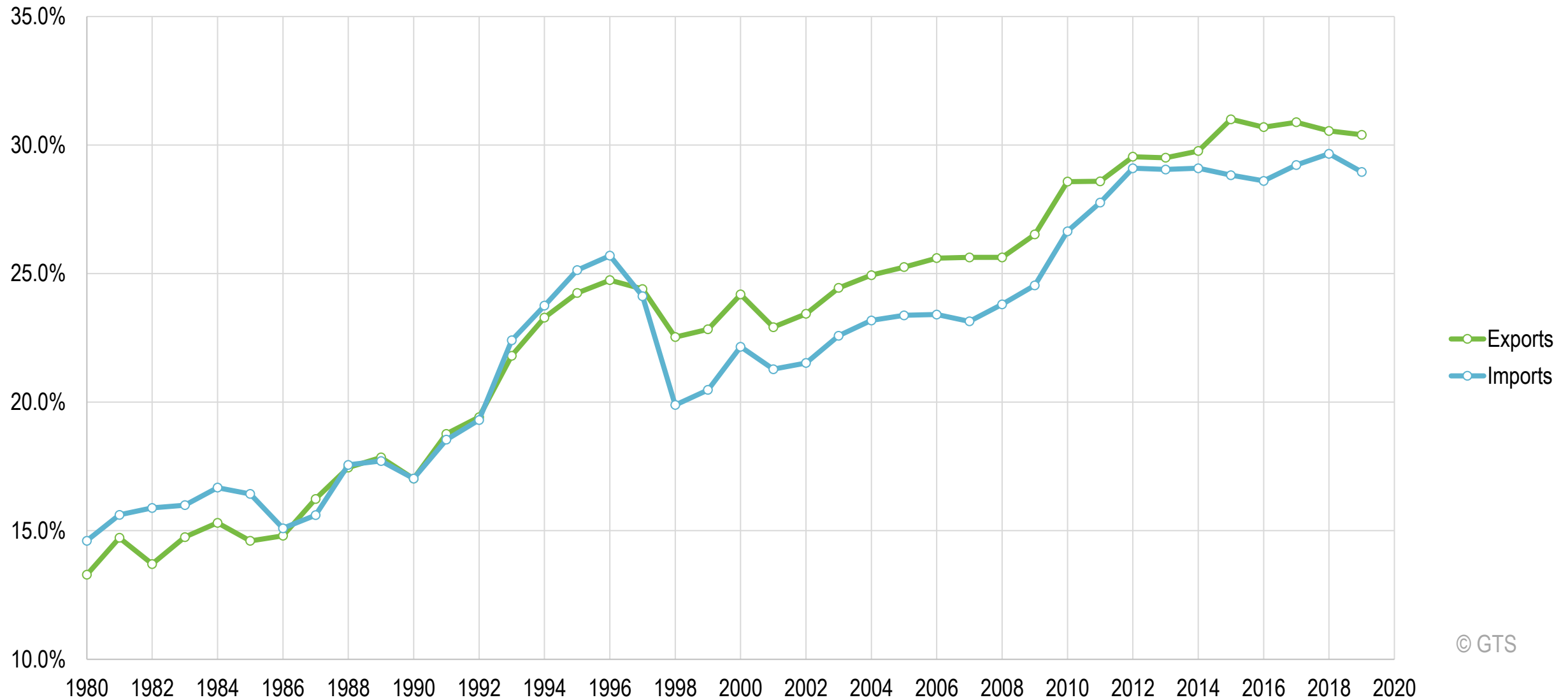
## Policy

- Environmental regulation
- Trade agreements
- Industrial policy



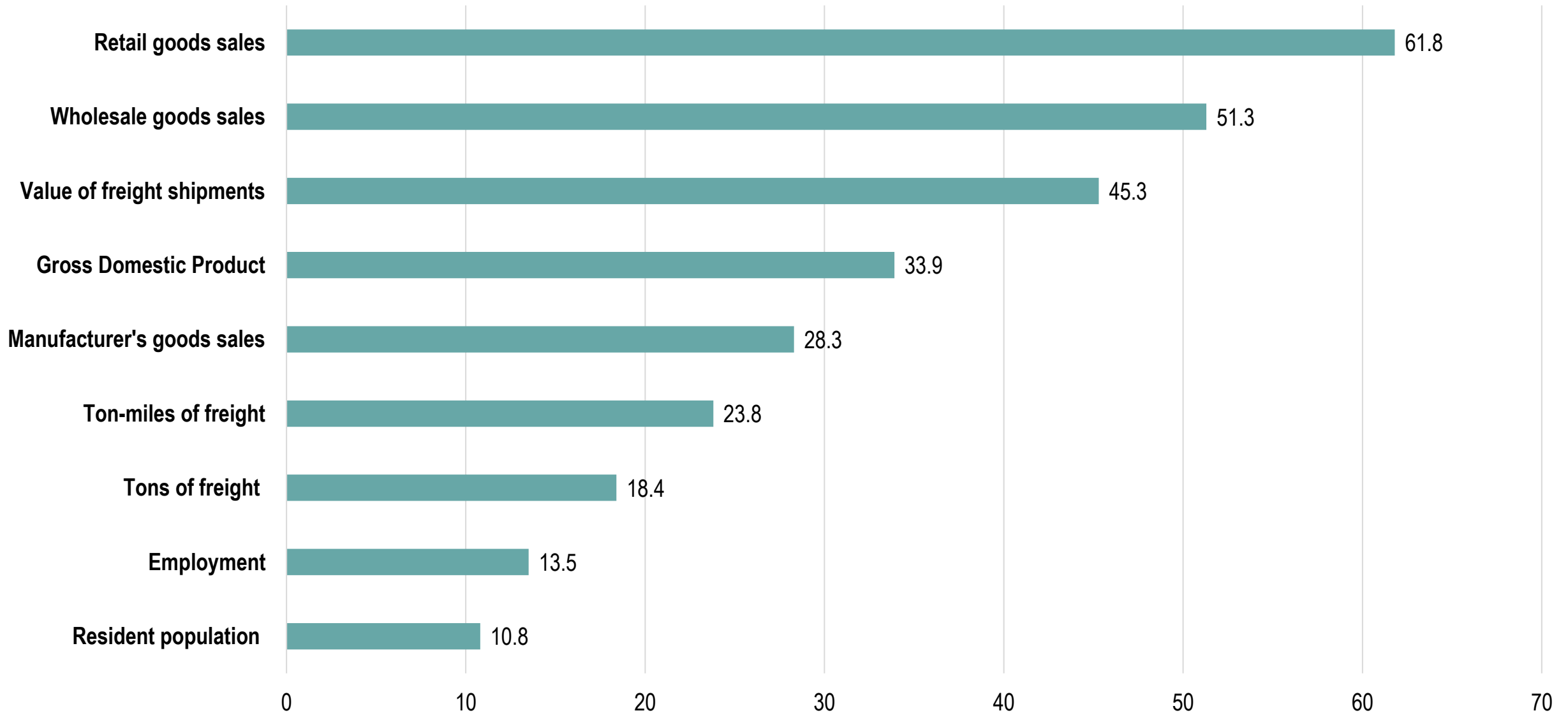


# Share of East Asia in the Value of World Trade, 1980-2019

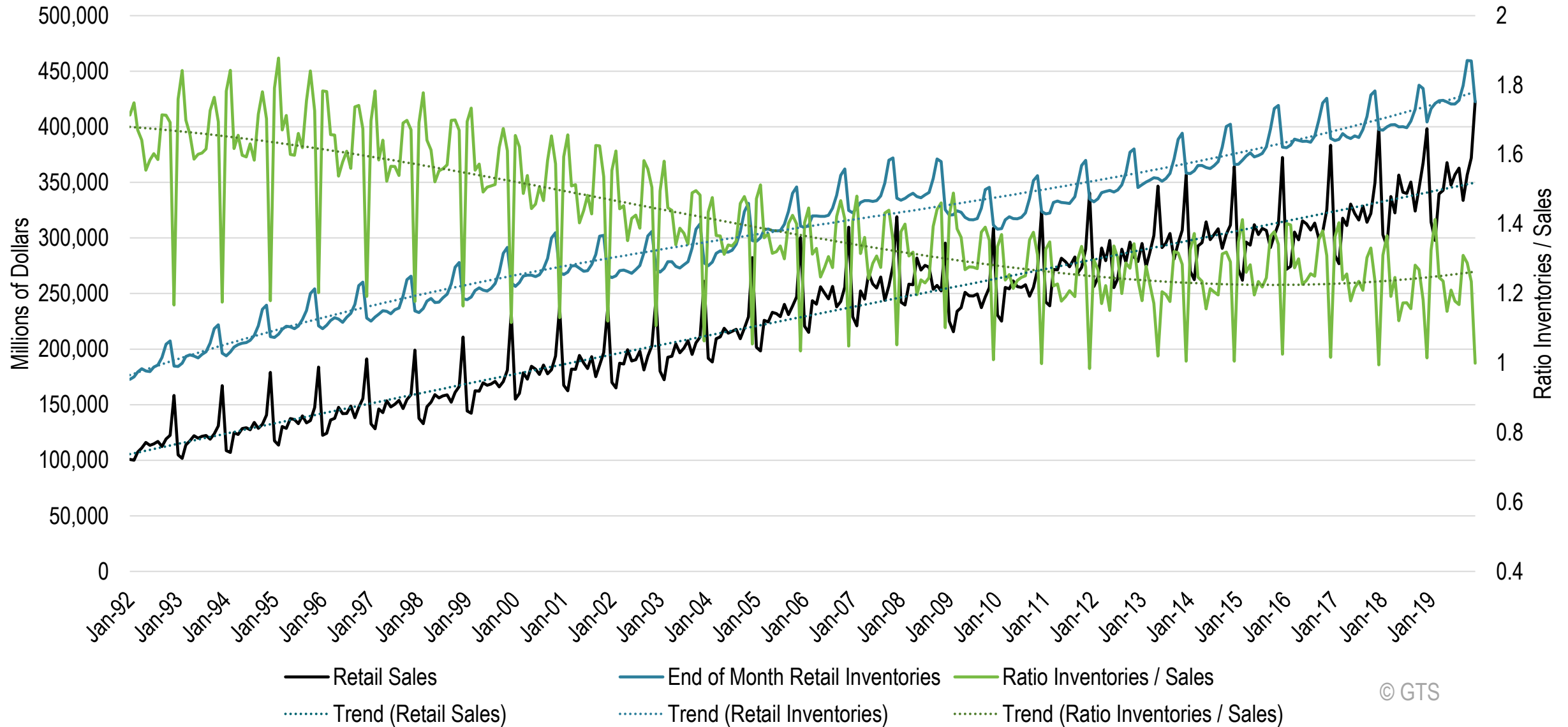


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# Increases in U.S. Commercial Freight Shipments and Related Growth Factors, 1993–2002

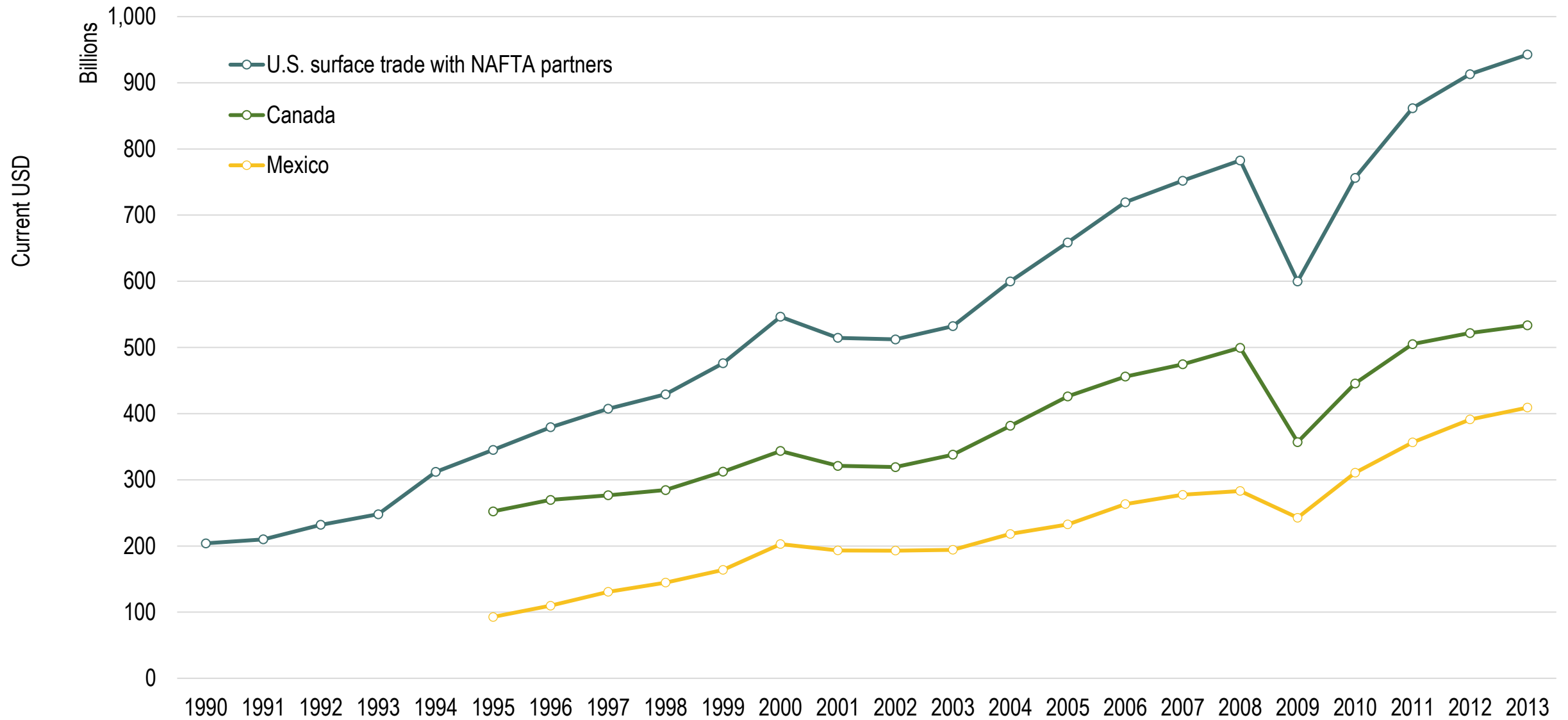


# Monthly Retail Sales and Inventories, United States, 1992-2019

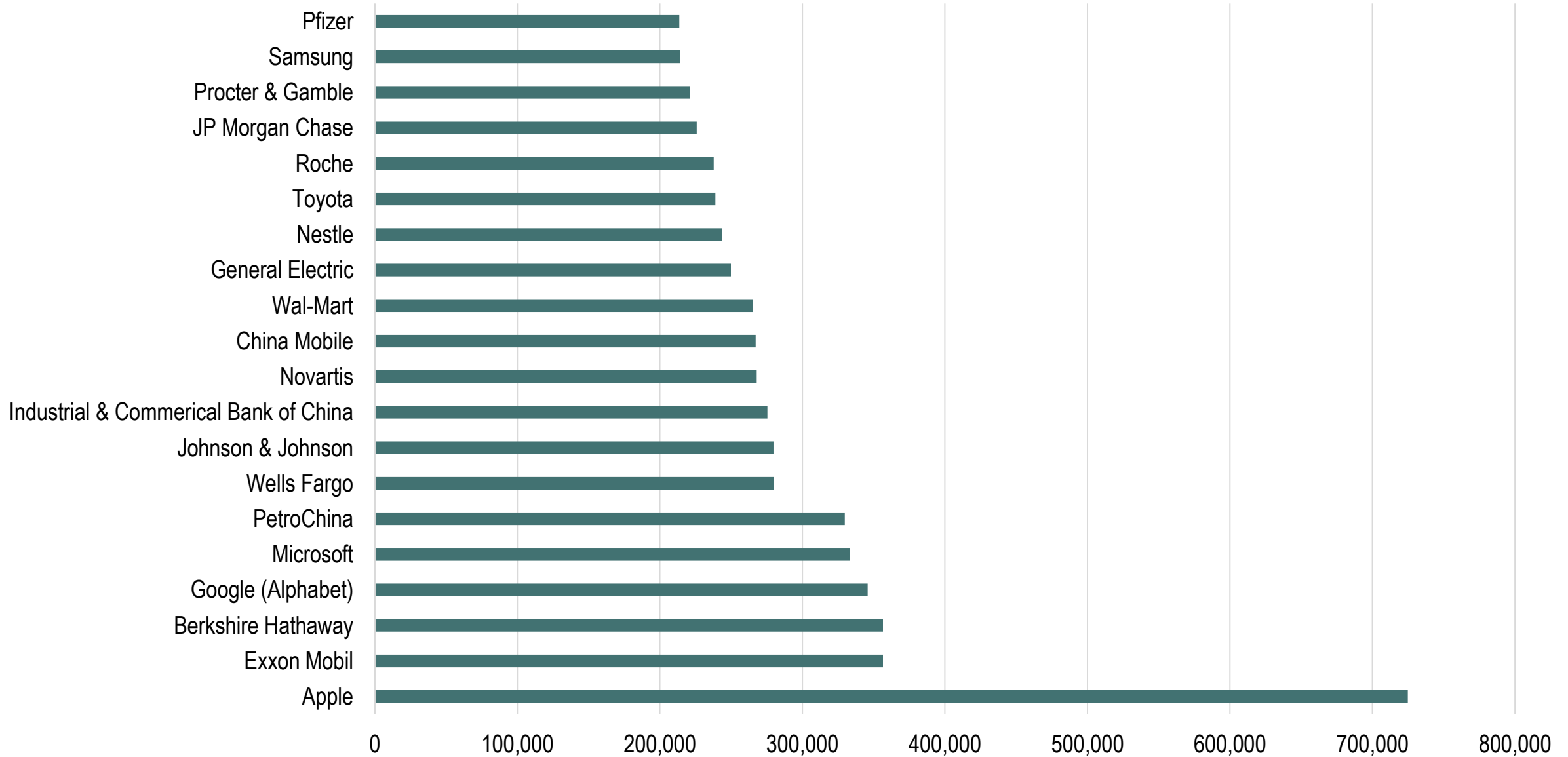


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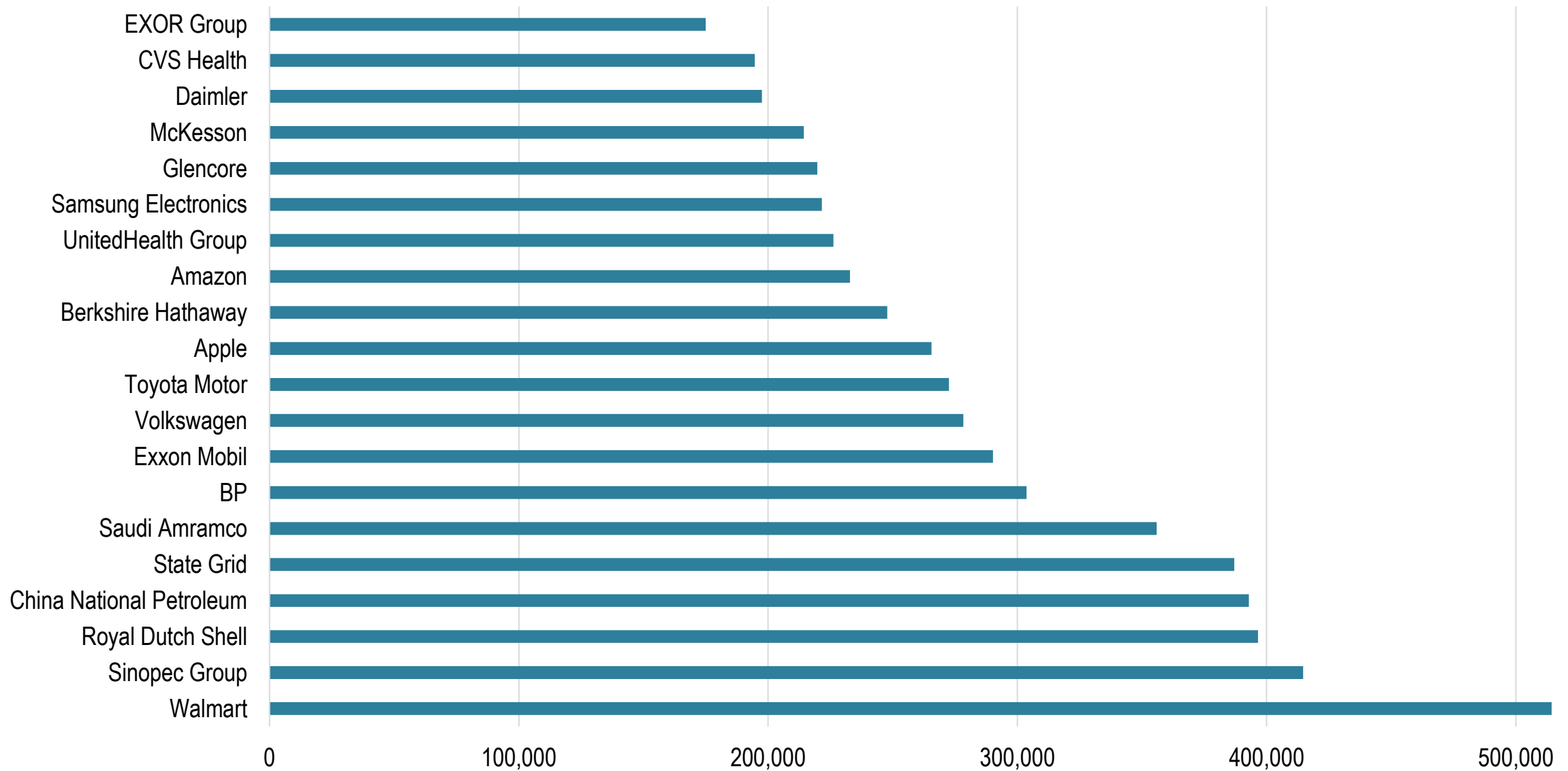
# Value of U.S. Merchandise Trade with Canada and Mexico, 1990-2013



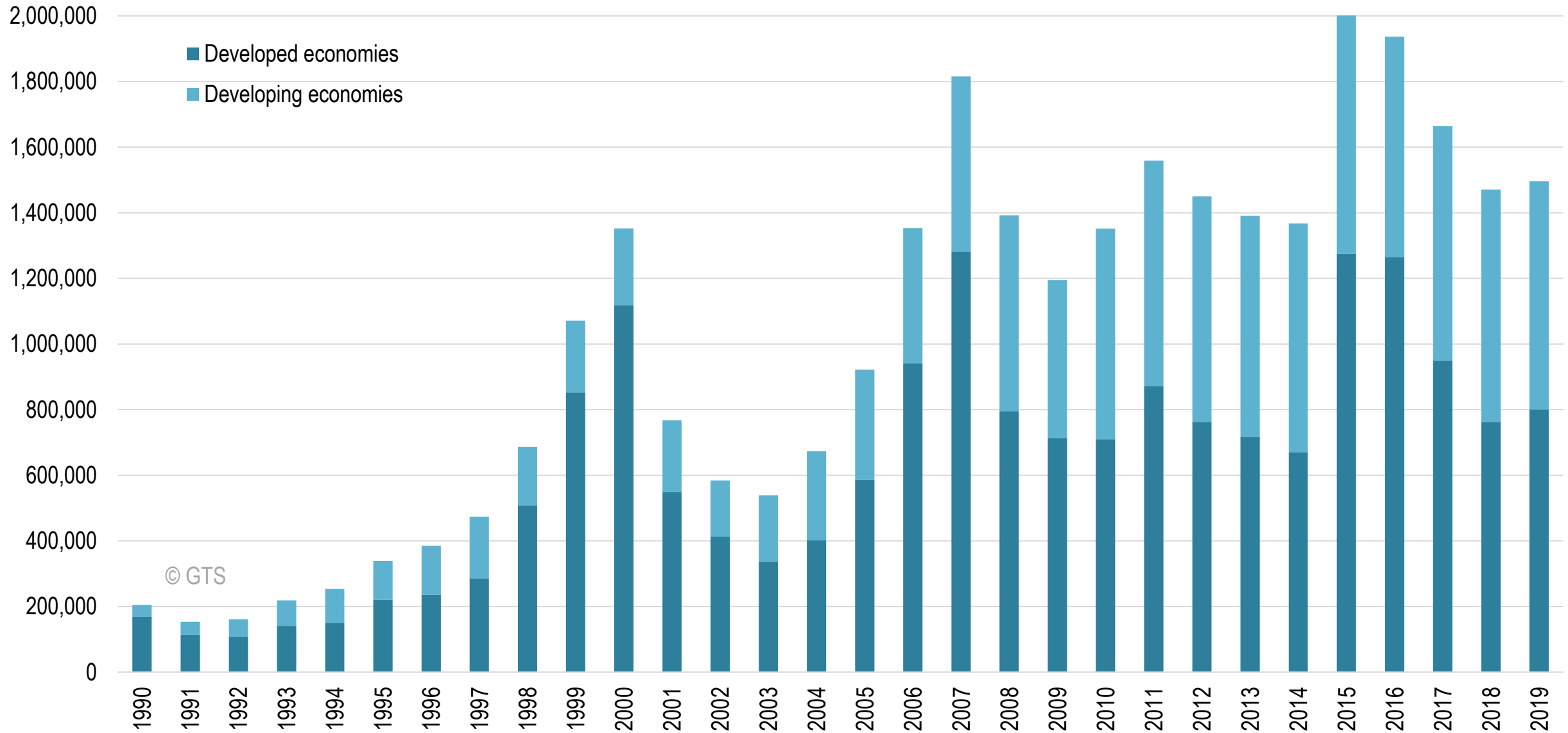
# The World's 20 Largest Corporations by Market Value, 2015 (\$US millions)



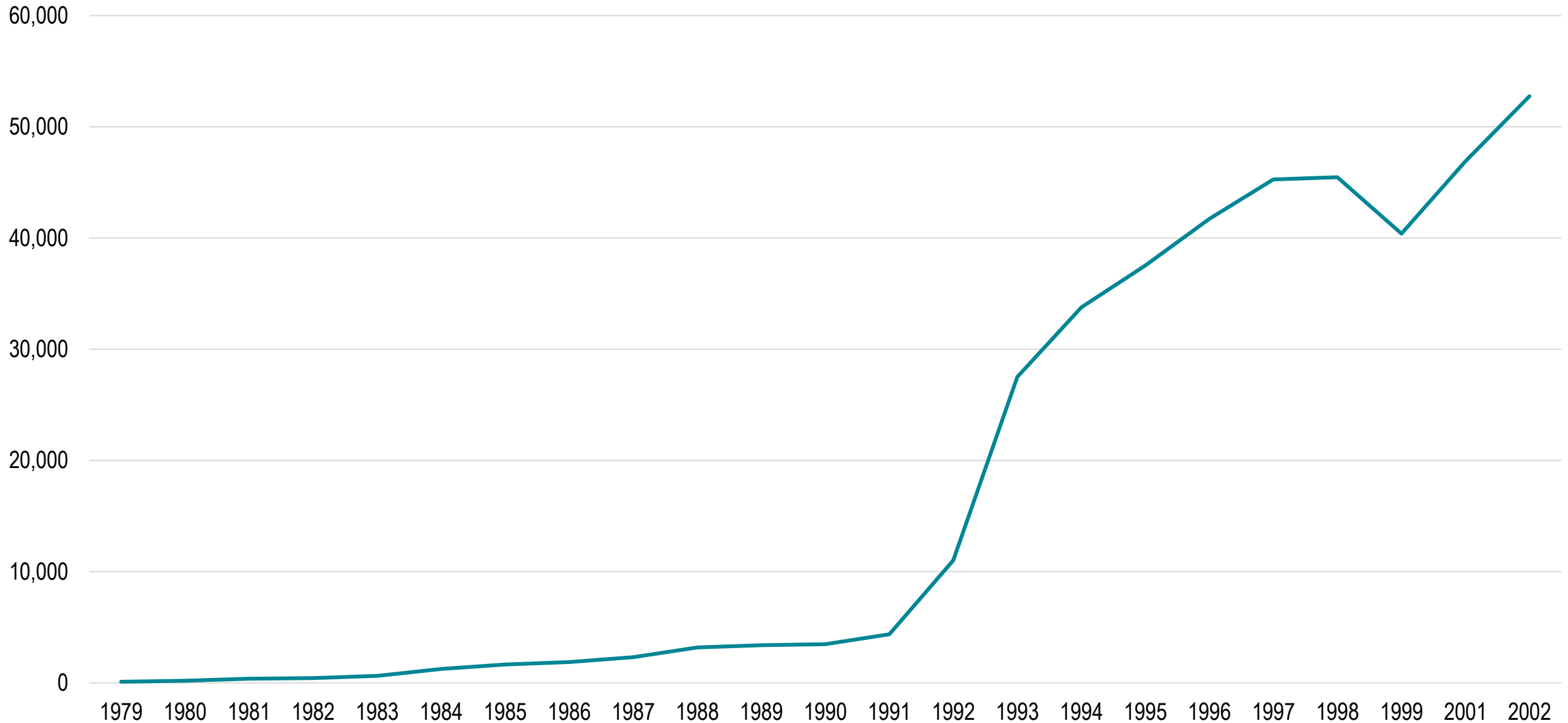
# The World's 20 Largest Corporations by Revenue, 2019 (\$US millions)



# Global Inflows of Foreign Direct Investments, 1990-2019 (in Millions of Current \$US)

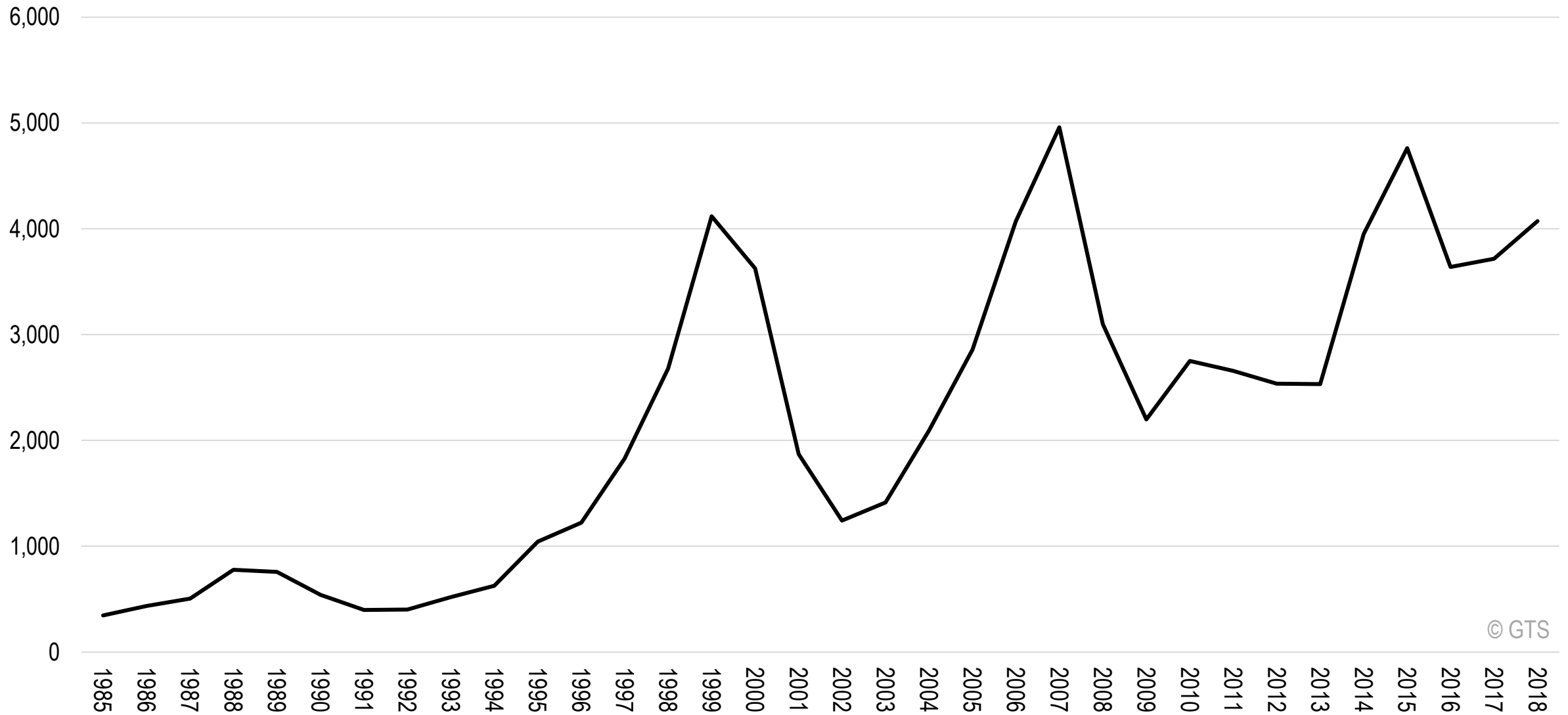


# Foreign Direct Investments (FDI) Inflows in China, 1979-2002 (in M USD)



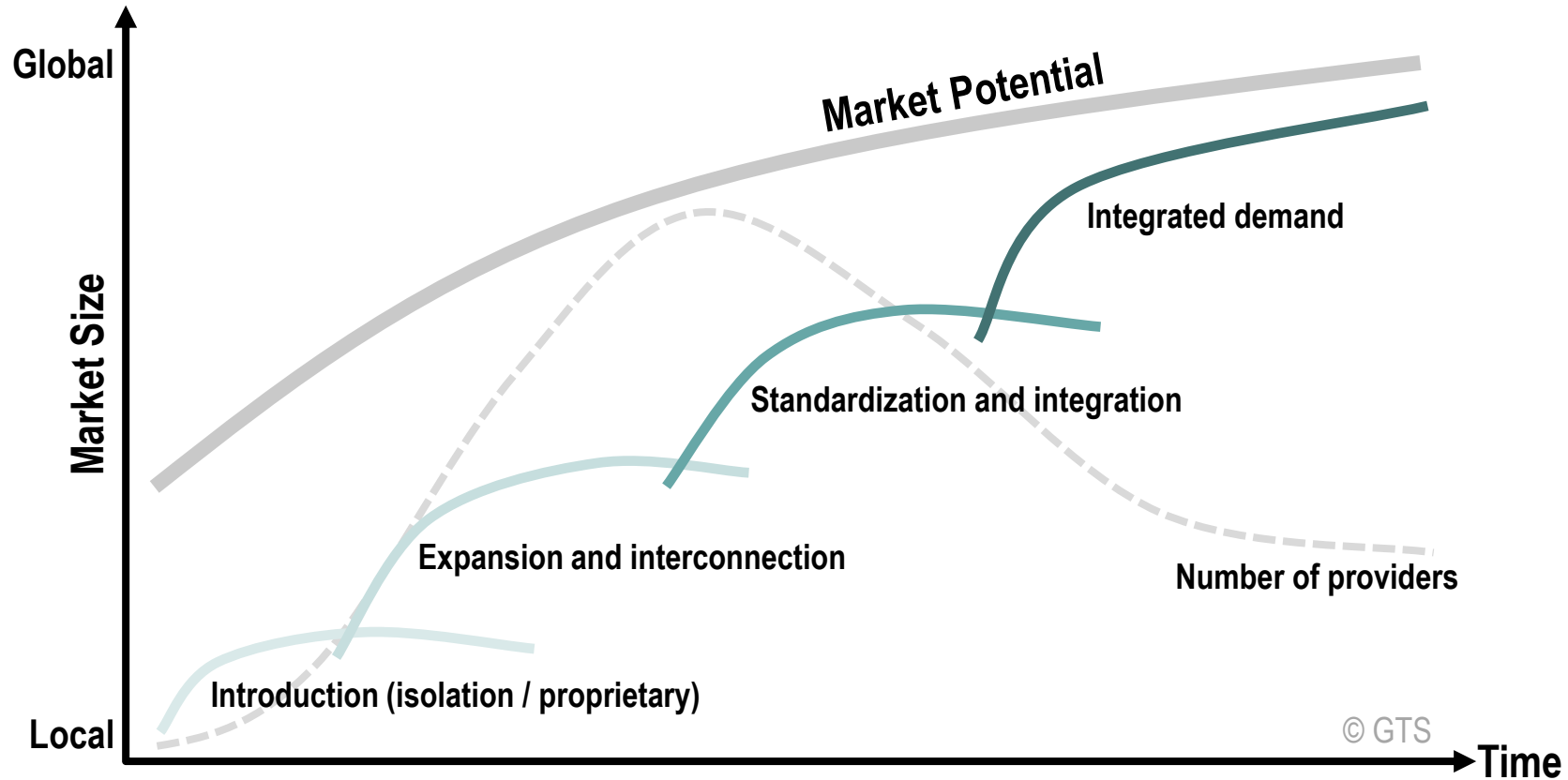


# Worldwide Mergers and Acquisitions, 1987-2018 (in millions current USD)



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# The Commercialization of Transportation



# Selection of Transport Route

	Passengers	Freight
Type I	Individual selects route (private transport)	Shipper or consignee selects route (own account)
Type II	Charterer selects route	Freight forwarder selects route
Type III	Transport company selects route	Transport company selects route

# Major Commercial Actors in Freight Distribution (to update)

Transport Sector	Function
Maritime shipping companies	Control long distance segments of the global freight distribution linking major markets. Highly capital intensive industry. Decide of their network configuration (ports of call and routing).
Global port terminal operators	Control important intermodal infrastructures (terminals) within the world's largest container ports. Have strong linkages with maritime shipping companies.
Port authorities	Manage and plan port infrastructures. Tend to lease terminal operations. Important intermediaries for regional distribution (hinterland).
Real estate promoters	Develop logistics zones (build to lease, build to suit), often in coordination with terminals (rail and port). Manage a real estate portfolio of distribution centers (leases).
Maritime lock and canal operators	Operate strategic passages in global and national distribution (e.g. the Panama Canal, the Suez Canal or the St. Lawrence Seaway).
Rail and rail terminal operators	Strategic inland freight carriers transporting a wide array of raw materials and commodities. Responsible for many of the transshipments between rail and road, particularly for containerized freight.
Trucking industry	Control vast and diverse assets that include critical segments of freight distribution in all economic sectors. Short and medium haul transport.
Third party logistics providers	Important managerial and organizational skills within supply chains. Often act as brokers between transport customers and service providers. Some own and operate transport assets.
Air freight transport companies and air freight terminals	Important assets for the rapid distribution of high value added freight. Decide of their network configuration (airports serviced).
Freight forwarders	Perform tasks such as packaging, labeling and the consolidation of shipments on behalf of their customers. Operate distribution centers. Define how markets are serviced. Can subcontract to third party providers.

<https://transportgeography.org/contents/chapter1/transportation-and-commercial-geography/commercial-actors-freight-distribution/>

# The Relevance of Logistics

## Costs



### Friction of distribution



- Efficient logistics has commercial benefits (costs, time and reliability).
- Logistics cost 10-15% of national GDP.

## Growth



### Growing material demand

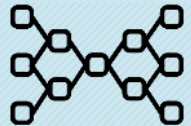


- Growth of global consumption and income.
- Diversity of consumption patterns.

## Complexity



### Complex value chains



- Goods are getting more complex (parts and processes).
- Embeddedness of design, manufacturing, distribution and marketing.

## Geography



### Spatial division of manufacturing



- Stages of production are spatially separated.
- Final production and markets are spatially separated.

## Environment

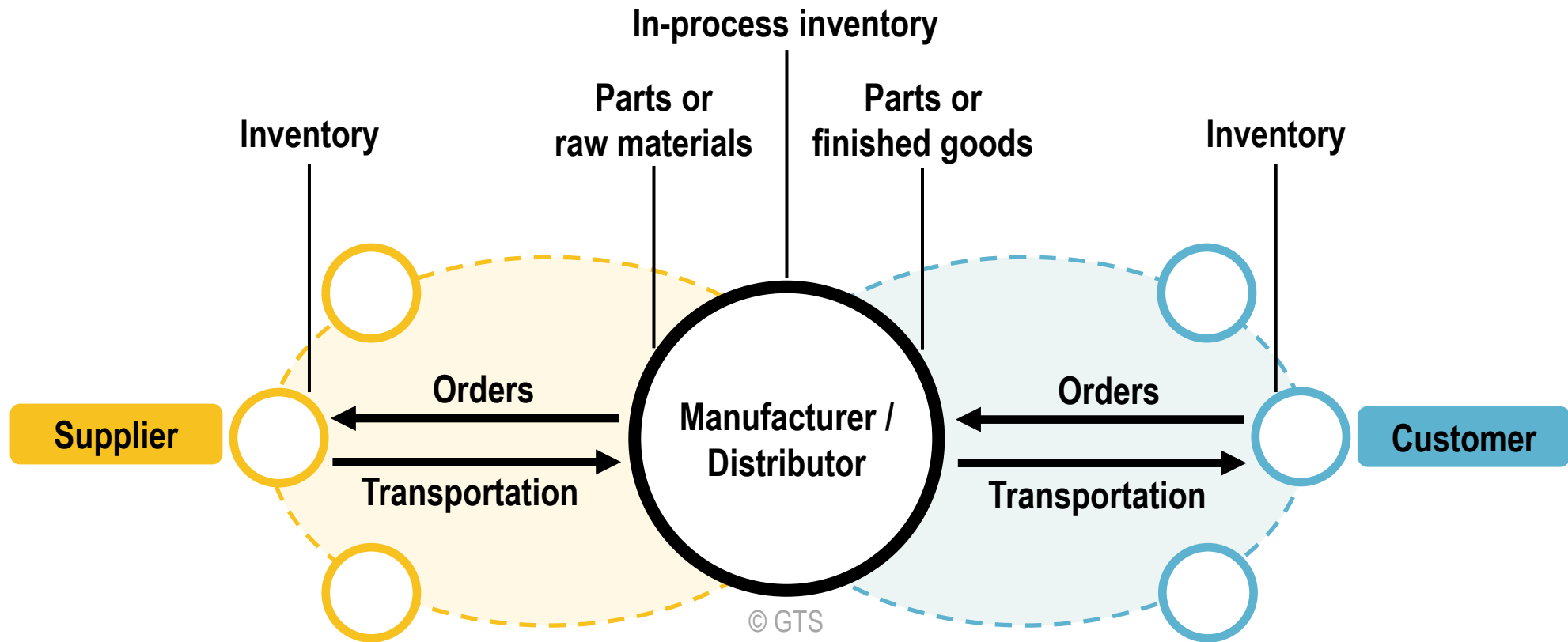


### Sustainability

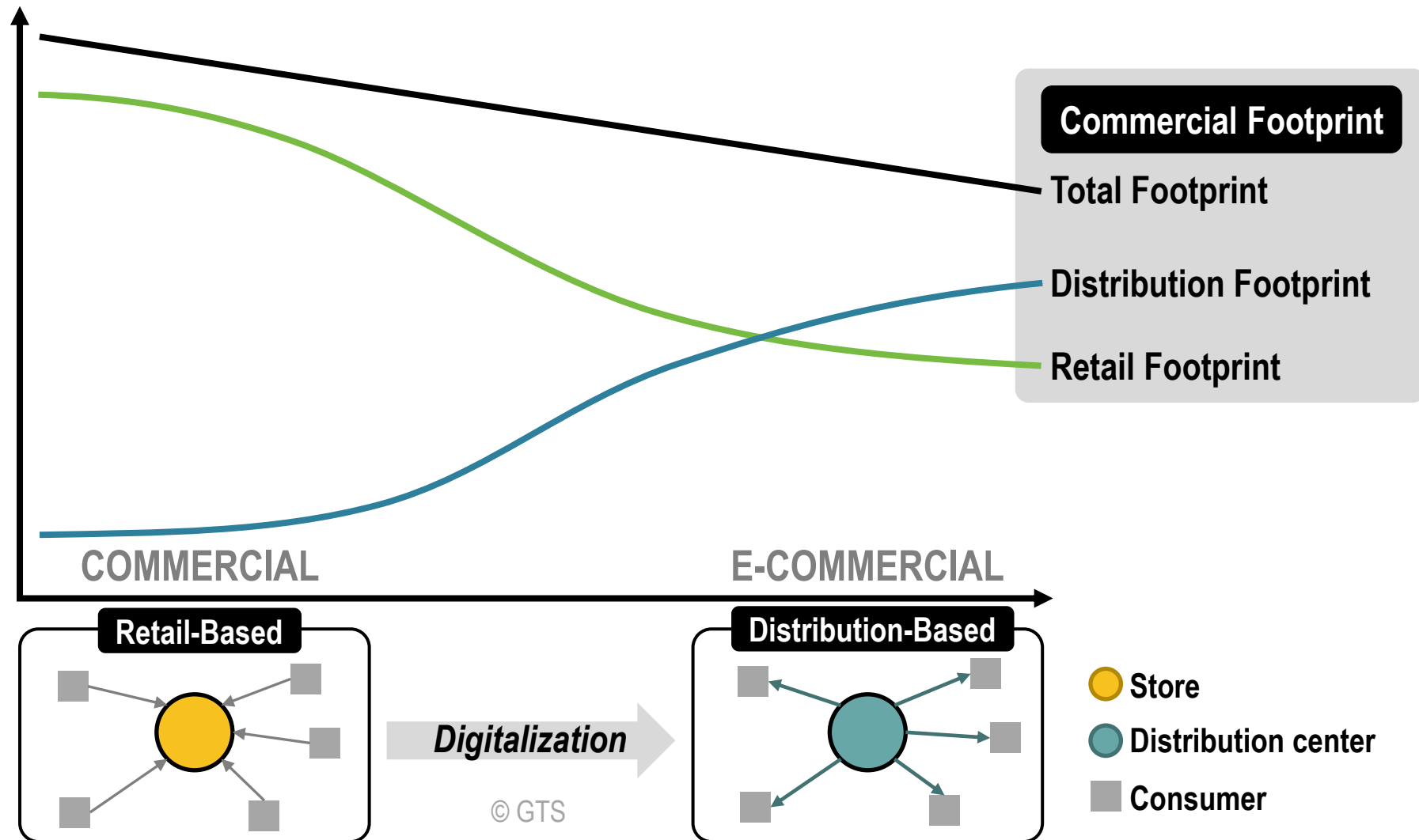


- Energy and material efficiency.
- Reverse logistics / recycling.

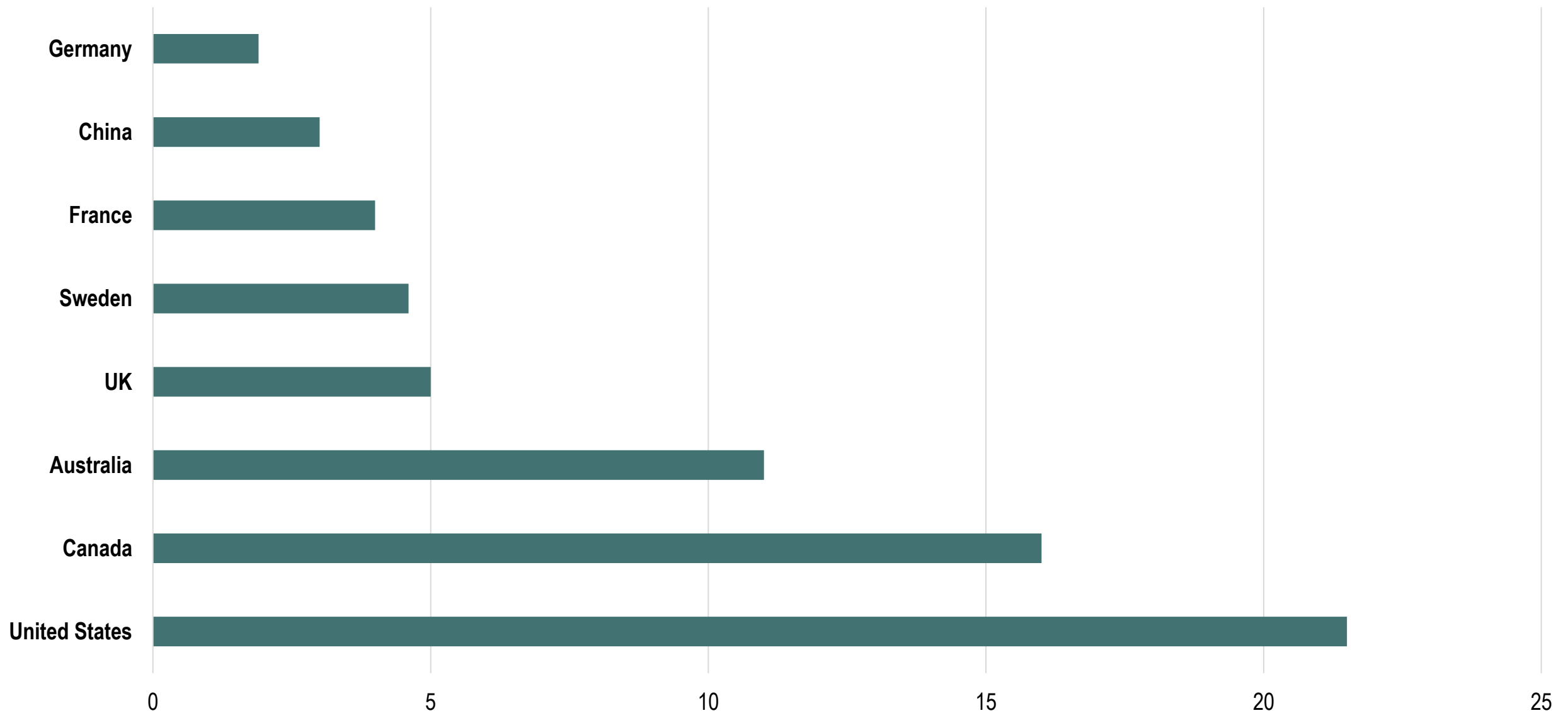
# The Nature of a Supply Chain



# Footprint of Retail-Based and Distribution-Based Commercial Activities



# Retail Space per Capita, 2017 (in square foot)





# Factors behind Empty Transport Flows

