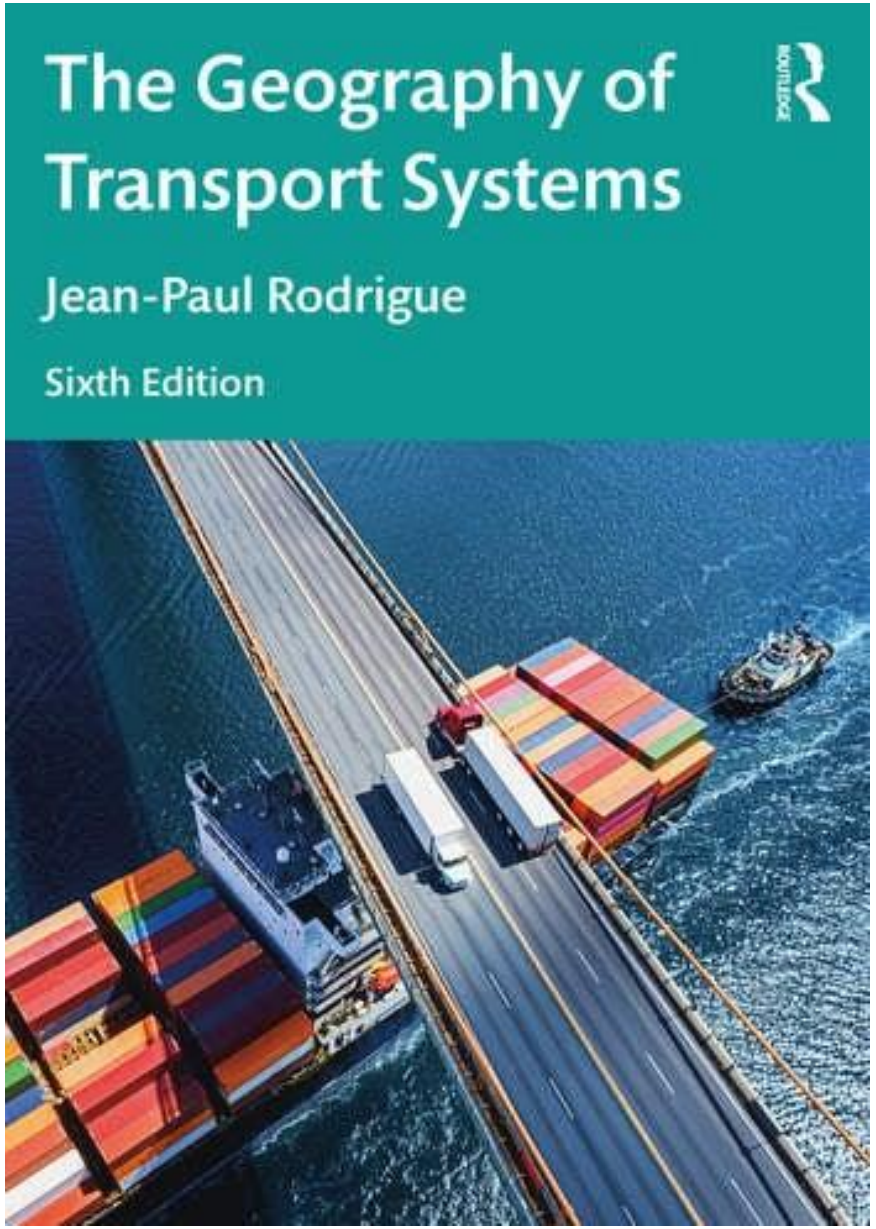

Transport, Economy and Society

CHAPTER 3

ecojpr@gmail.com

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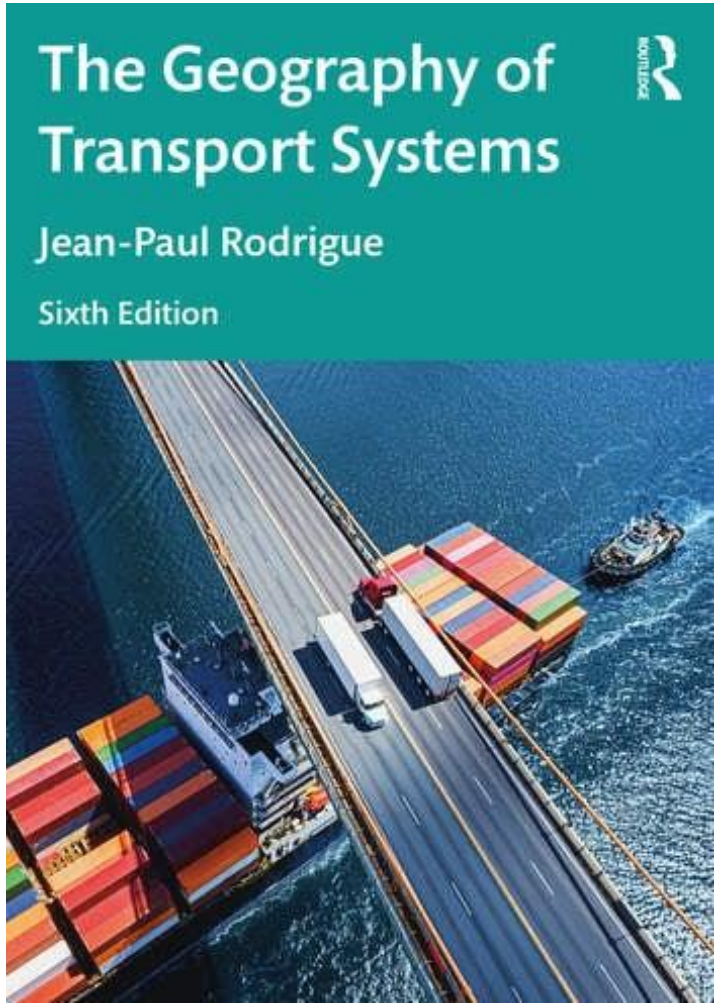


Transport and Economic Development

Chapter 3.1

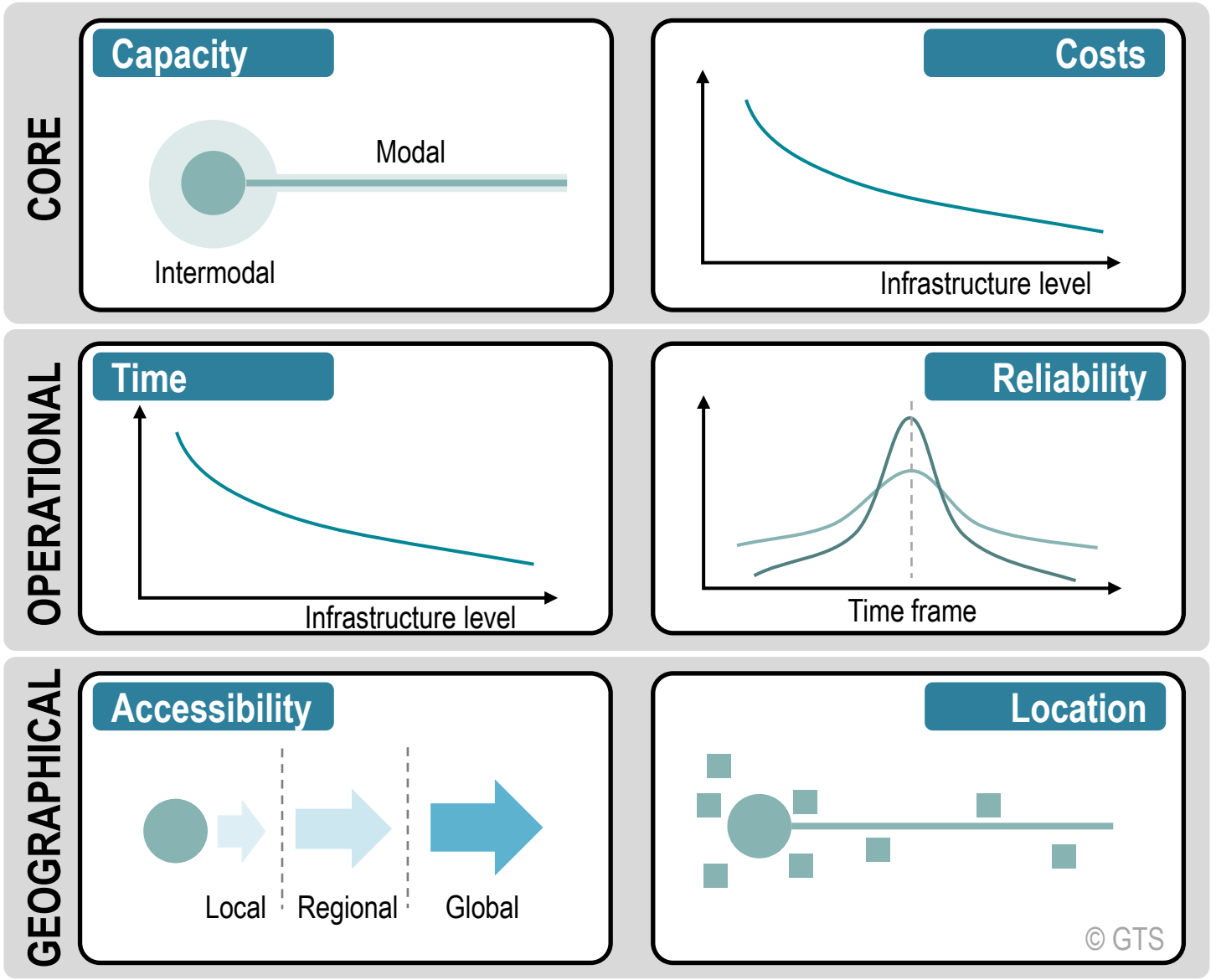
Factors behind the Development of Transport Systems

Scale	Environmental	Historical	Technological	Political	Economic
Local	Hydrography and geomorphology	Culture and settlement patterns	Roads	Zoning	Employment and distribution
Regional	Climate	Urban system	Railways and canals	Taxation and regulations	Modal competition and complementarity
National / Transnational	Distance	Nation state / Colonialism / Imperialism	Corridors and sea routes	Trade agreements	Markets
Global	Oceanic masses	Globalization	Air transport and tele-communications	Multilateral agreements (WTO)	Interdependency and comparative advantages

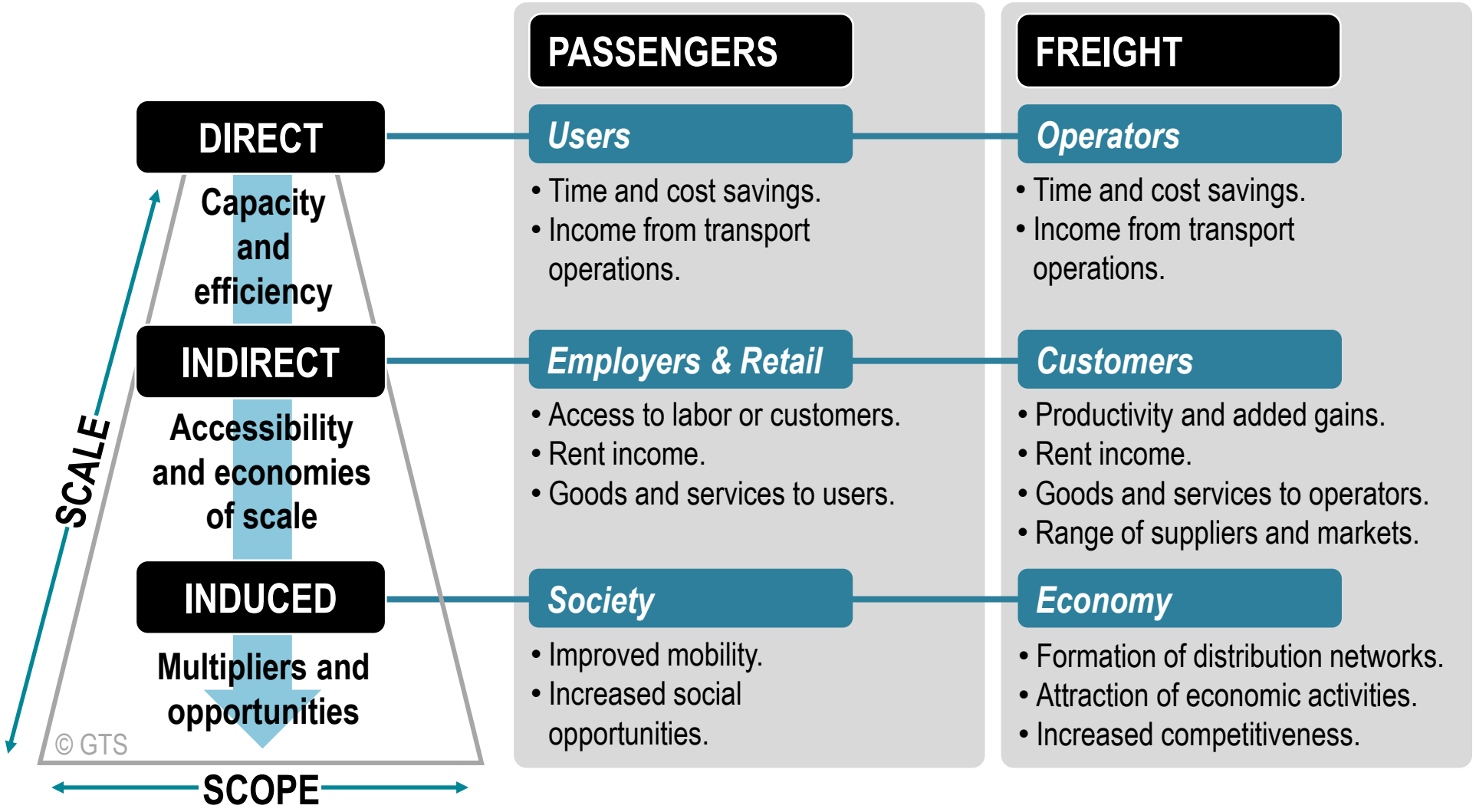
Services and their Associated Infrastructures

SERVICE	SUPPORTING INFRASTRUCTURES
Transportation	Roads, bridges, tunnels, rail tracks, ports, harbors, airports, distribution centers.
Water supply	Dams, reservoirs, pipes, treatment plants.
Water disposal	Sewers, used water treatment plants.
Irrigation	Dams, reservoirs, canals, sprinkling systems.
Waste disposal	Landfills, incinerators, recycling facilities, compost units.
Telecommunications	Telephone exchanges, telephone and cable lines, oceanic cables, cellular towers, fiber optic cables, web servers.
Power	Power plants, transmission & distribution lines, pipelines.

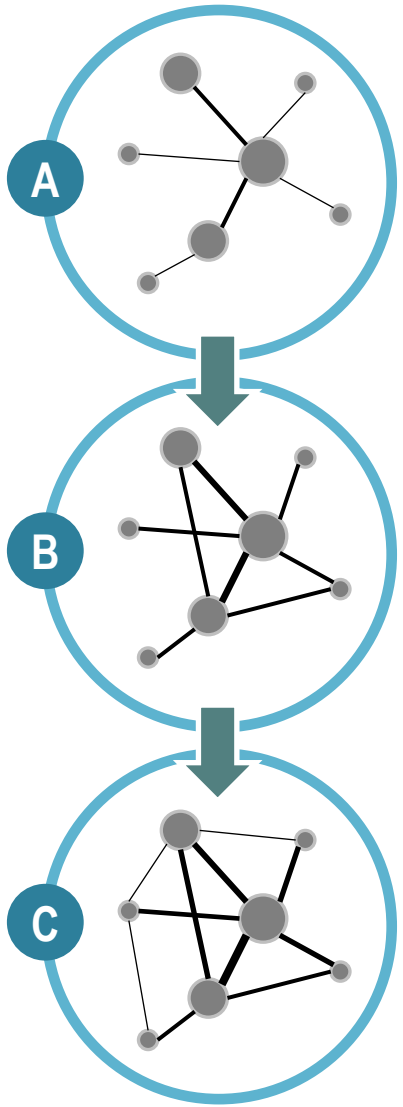
Economic Impacts of Transportation Infrastructure



Socioeconomic Benefits of Transportation



Diminishing Returns of Transport Investments



High Multiplying Effects

- New infrastructure built over limited existing infrastructure.
- Benefits from new connectivity and capacity.
- New economic opportunities (labor, resources, markets).

Average Multiplying Effects

- Expansion of existing infrastructure; emergence of corridors.
- Expanded connectivity, capacity and reliability.
- Productivity improvements.

Low Multiplying Effects

- High infrastructure maintenance and upgrade costs.
- Niche connectivity.
- Peak capacity and reliability.
- Limited productivity improvements.

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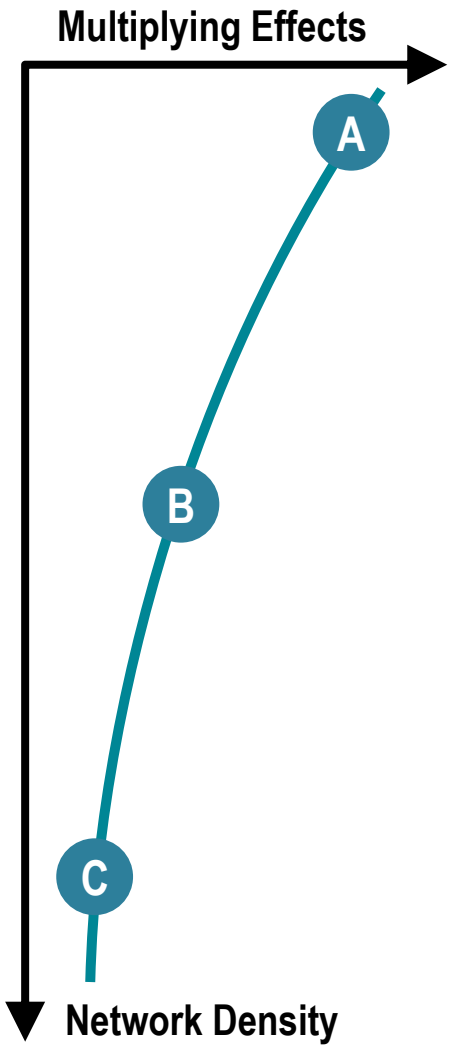
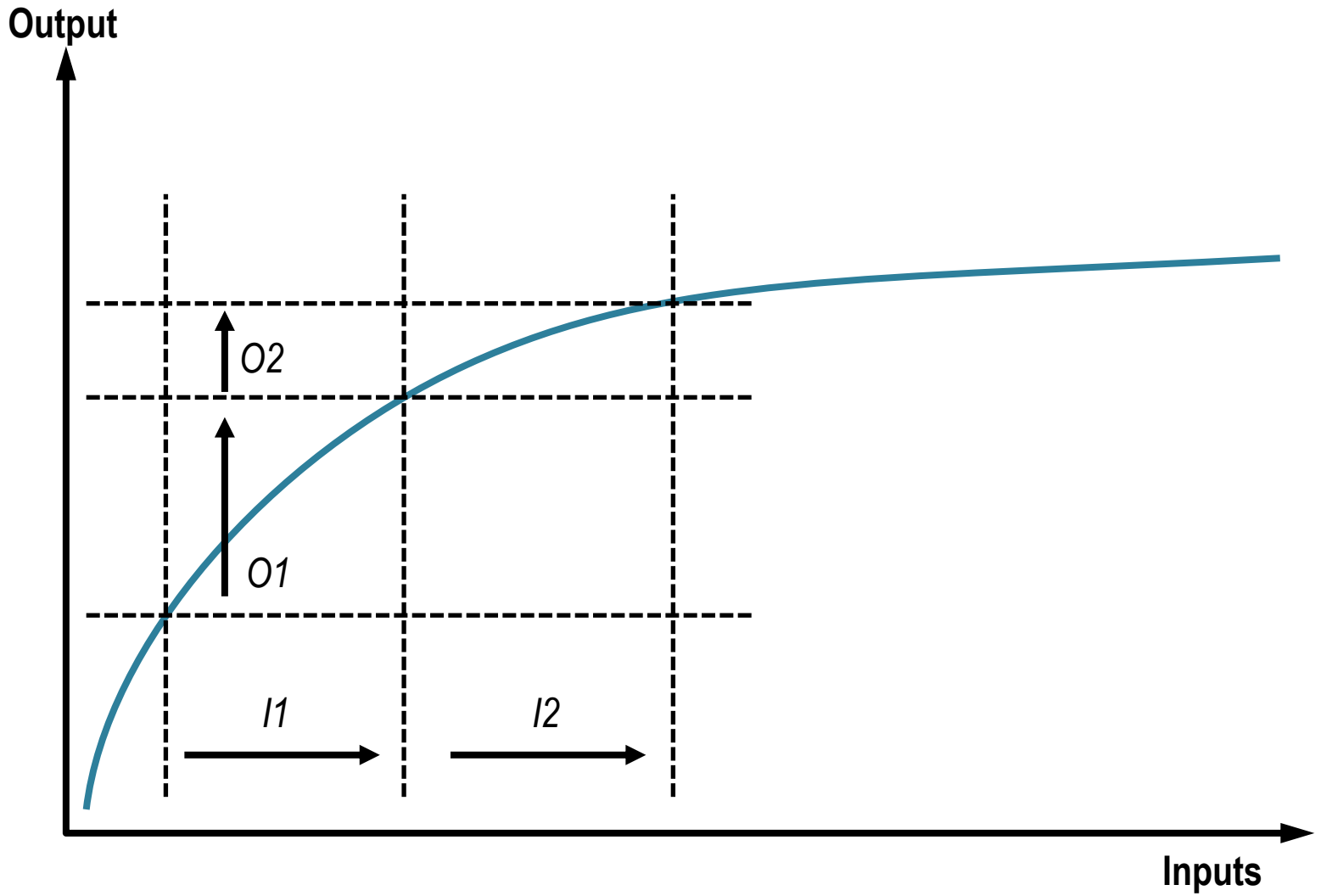


Diminishing Marginal Returns



Types of Transport Economic Improvements (under construction)

Factor Driven	
Efficiency Driven	
Innovation Driven	

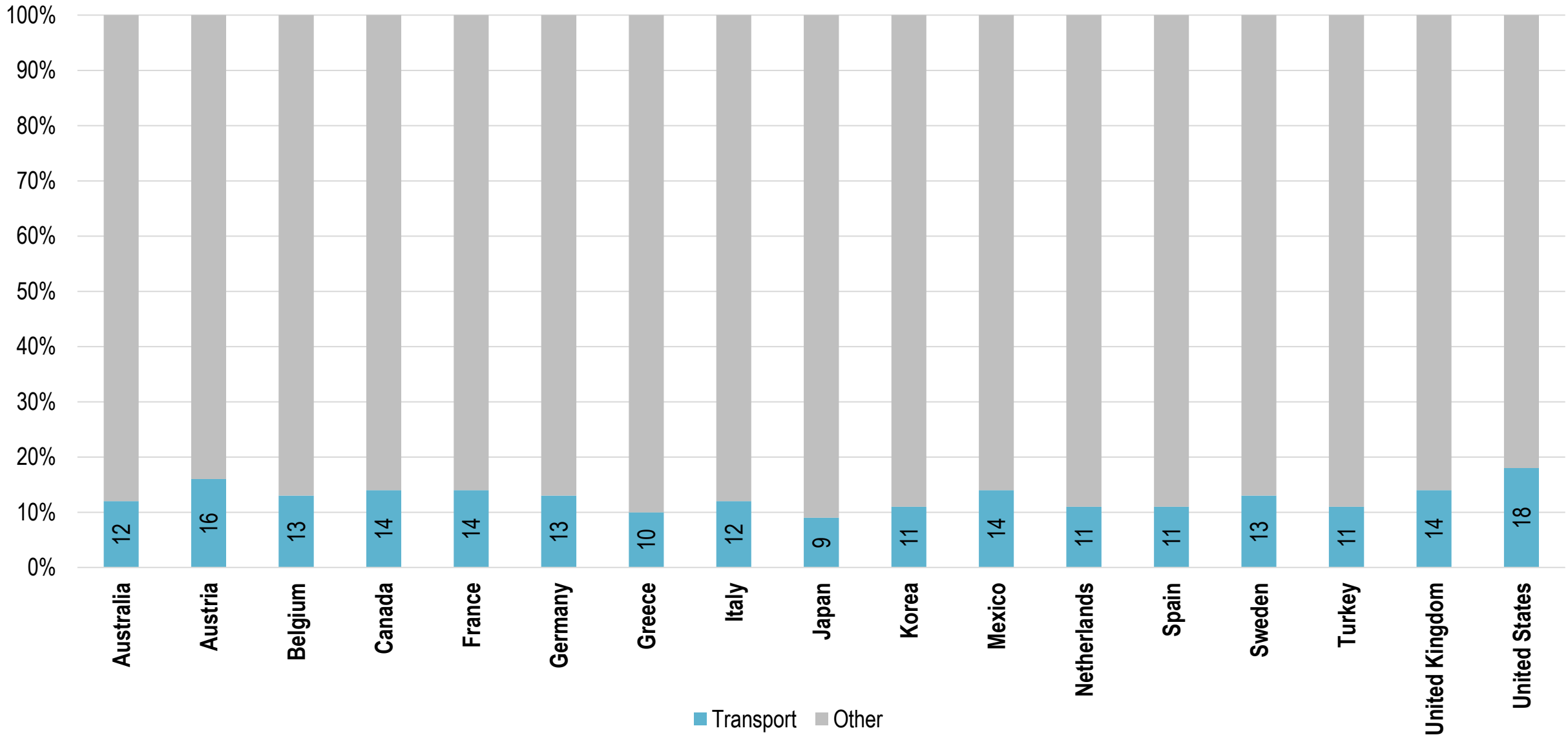
Transport Economic Indicators

TYPE	MEASURES	RELEVANCE
Transportation Prices	Aggregate price of transportation services by mode or commodity.	Input costs by economic sector. Market competitiveness.
Transportation Productivity	Labor productivity and total-factor productivity (labor and assets).	Level of return on investment. Economic impacts by sector.
Logistics Costs	Supply-chain distribution cost relative to GDP or total costs.	Efficiency by logistics function.
Transport Capacity Utilization	Share of modal (vehicles and links) and intermodal (terminals) capacity.	Assessment of investment needs for maintenance, upgrade and expansion.

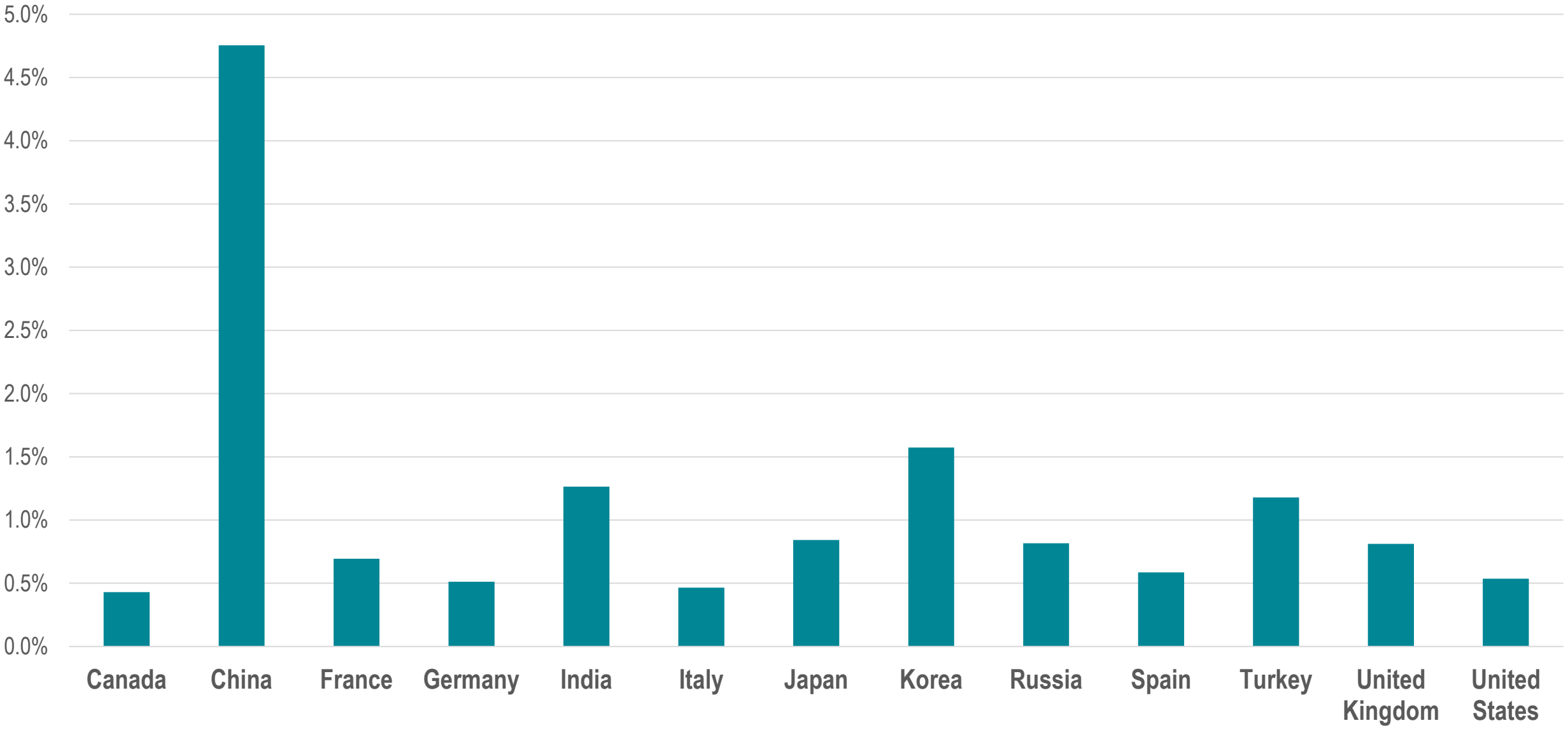
Economic Multiplier Effects of Transportation

Type	Effect	Context	Source
Transit time	One day in transit equivalent to a tariff of 0.6 to 2.1%	OECD	Hummels (2012)
Port	10% increase in port efficiency leads to 3.2% increase in real trade between a country pair	USA	Blonigen and Wilson (2006)
Port	1% increase in port efficiency leads to a 0.38% reduction in trade costs		World Bank (2017)

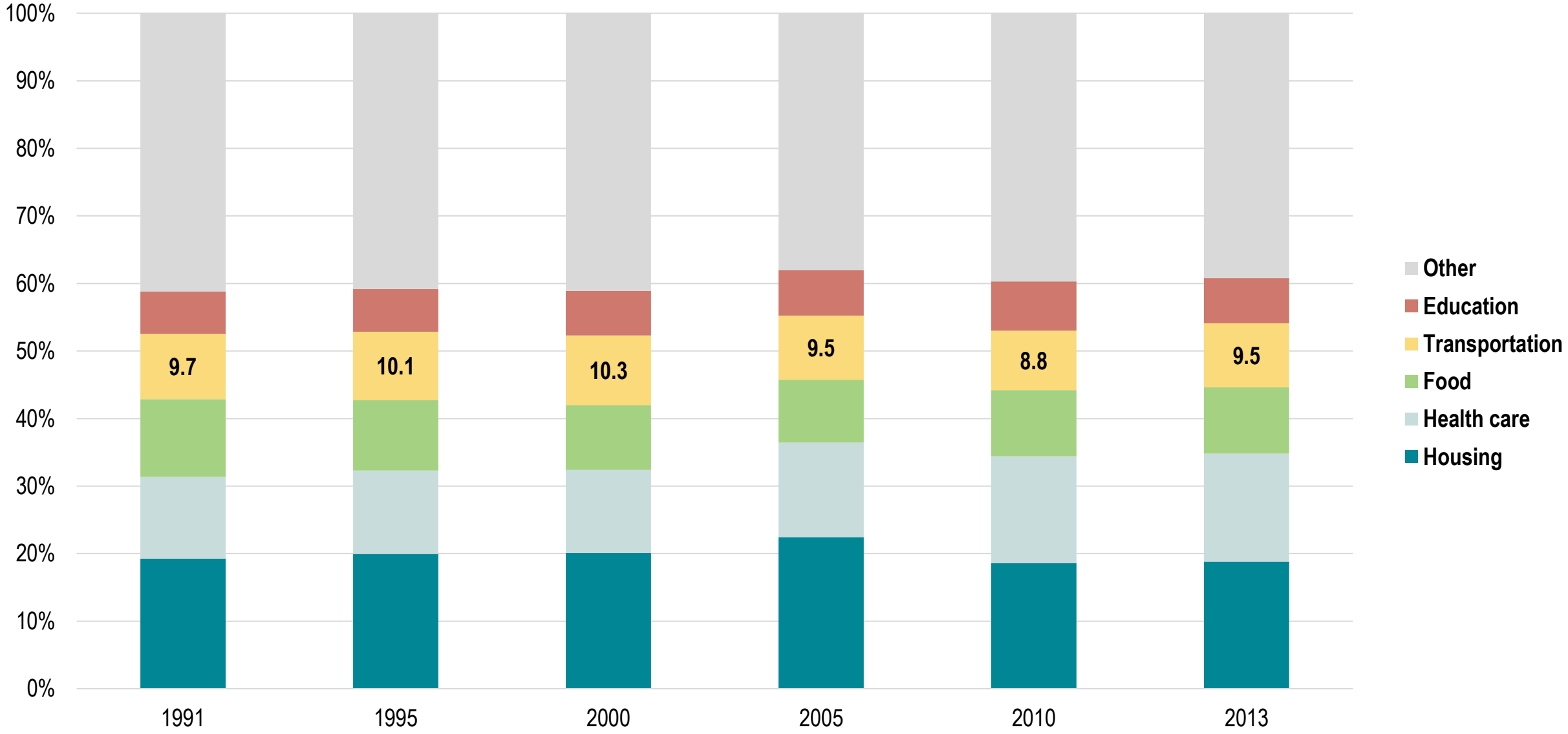
Transport Spending as Share of GDP, Selected Countries 2005



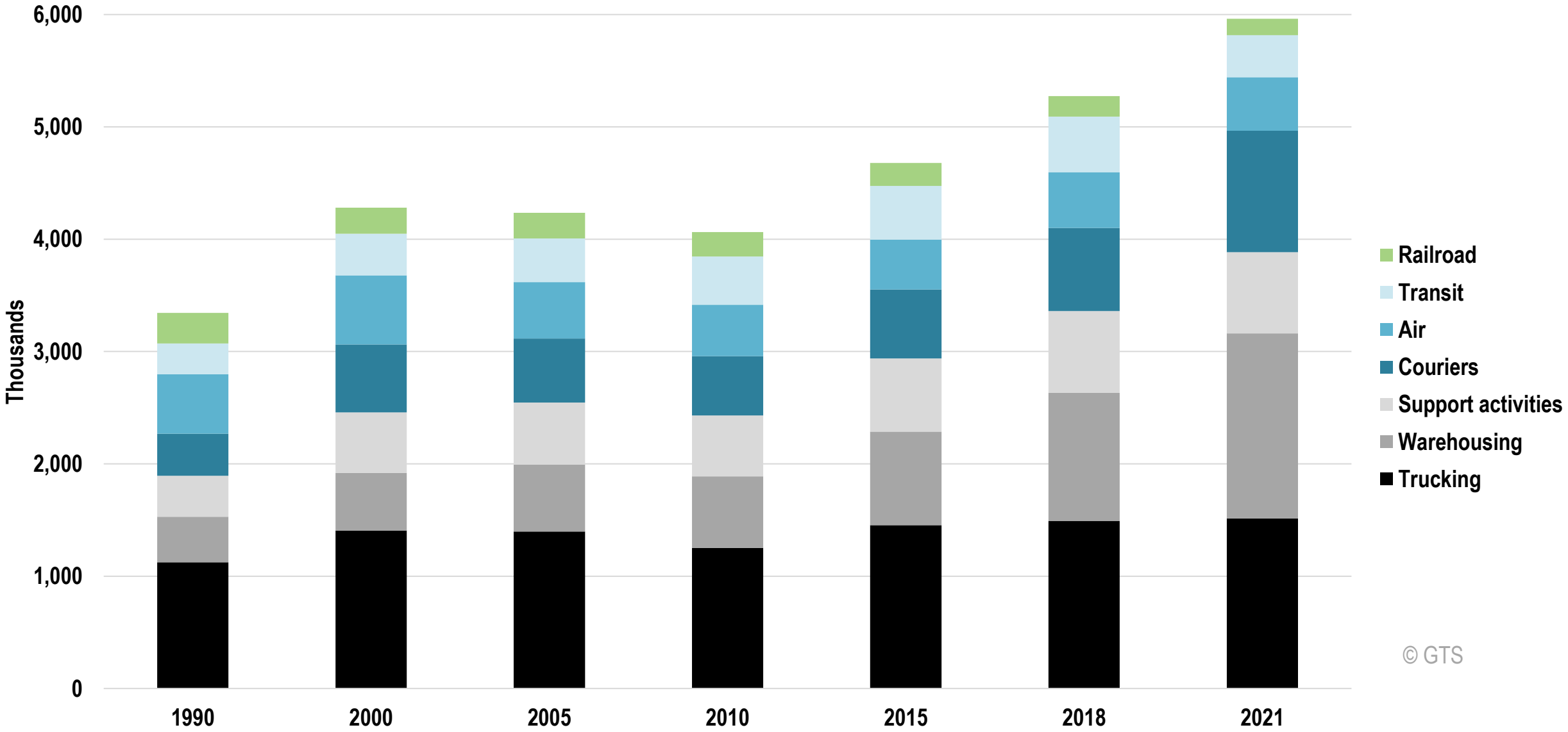
Transport Infrastructure Investment and Maintenance Spending as Share of GDP, 2015



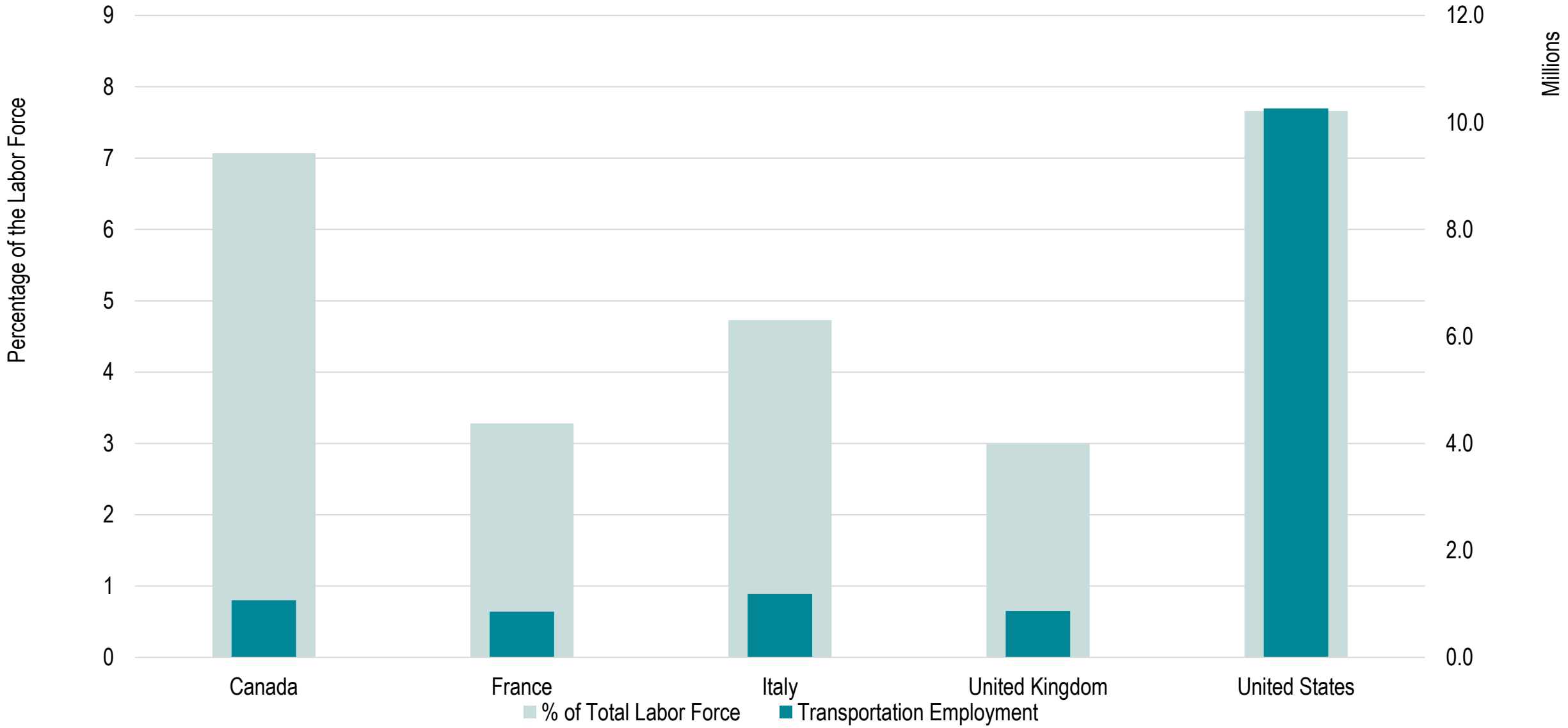
Composition of the GDP, United States, 1991-2013



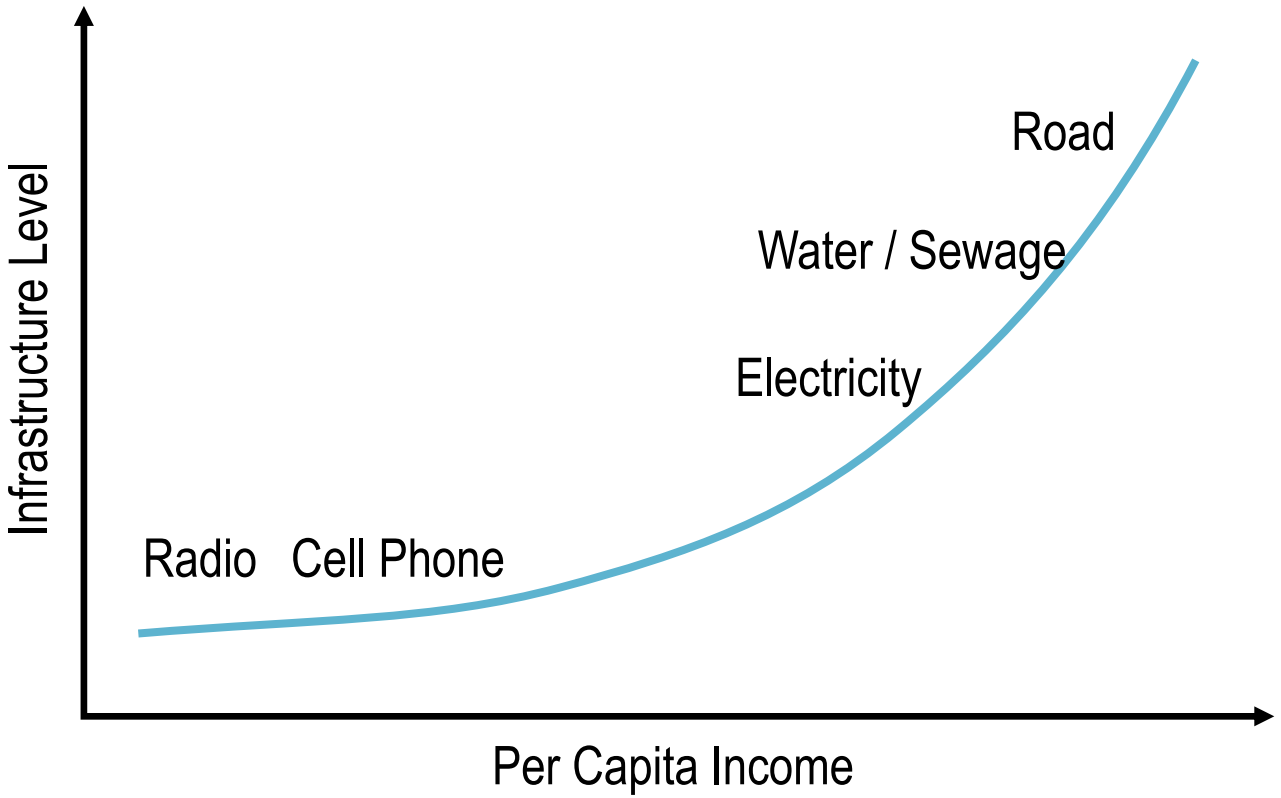
Employment in Transportation, United States, 1990-2021



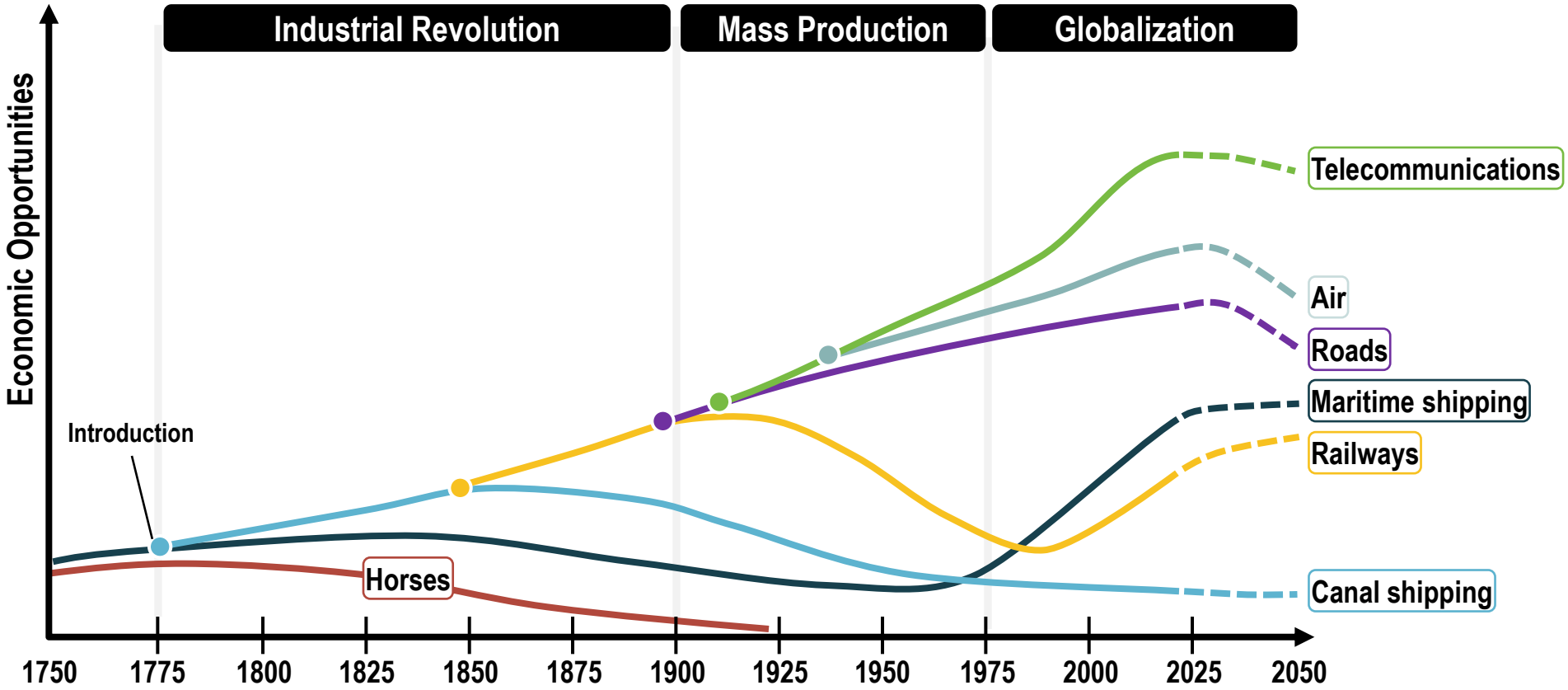
Employment in the Transport Sector, Selected Countries, 1996



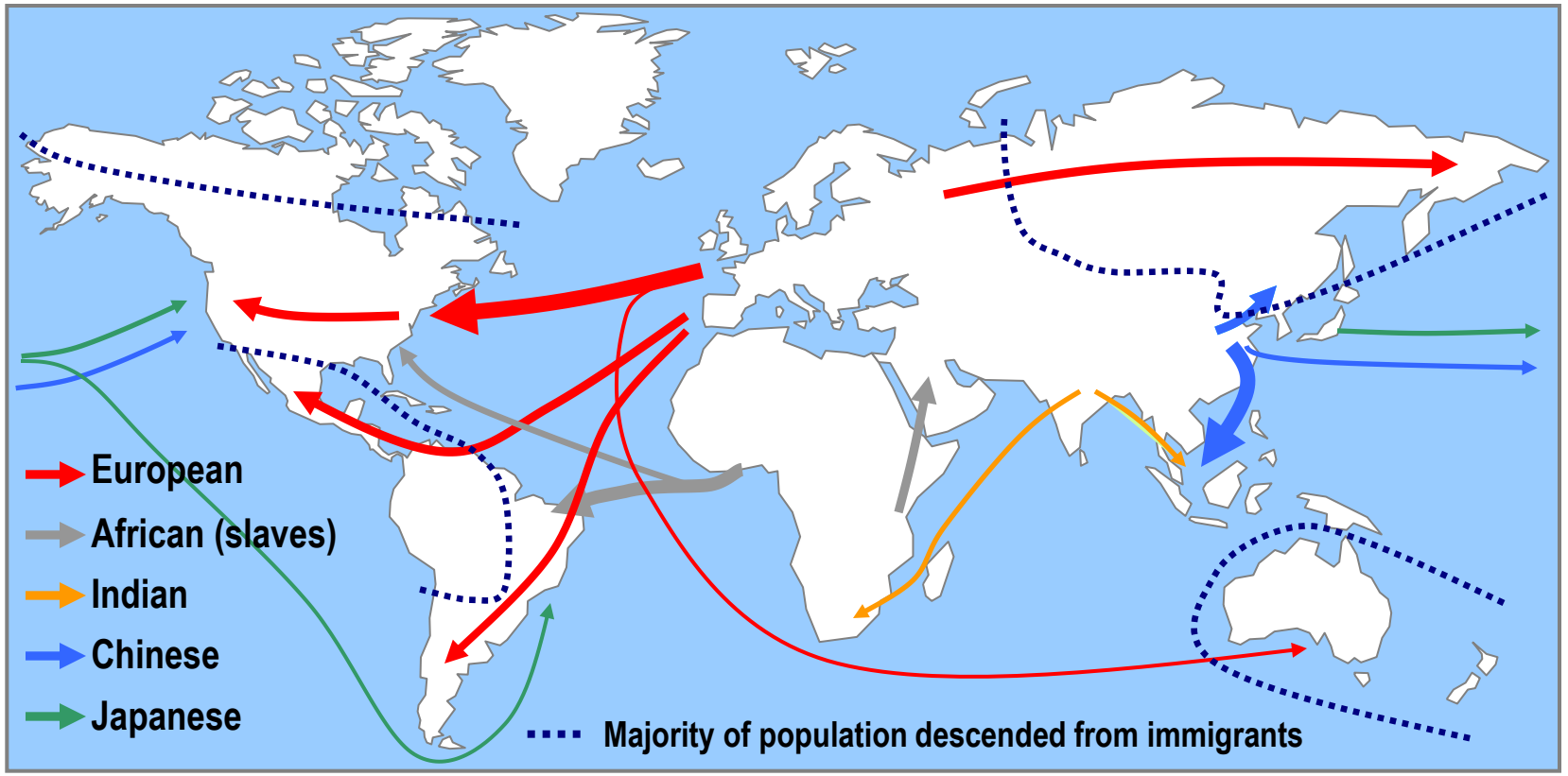
Infrastructure Level and Economic Development



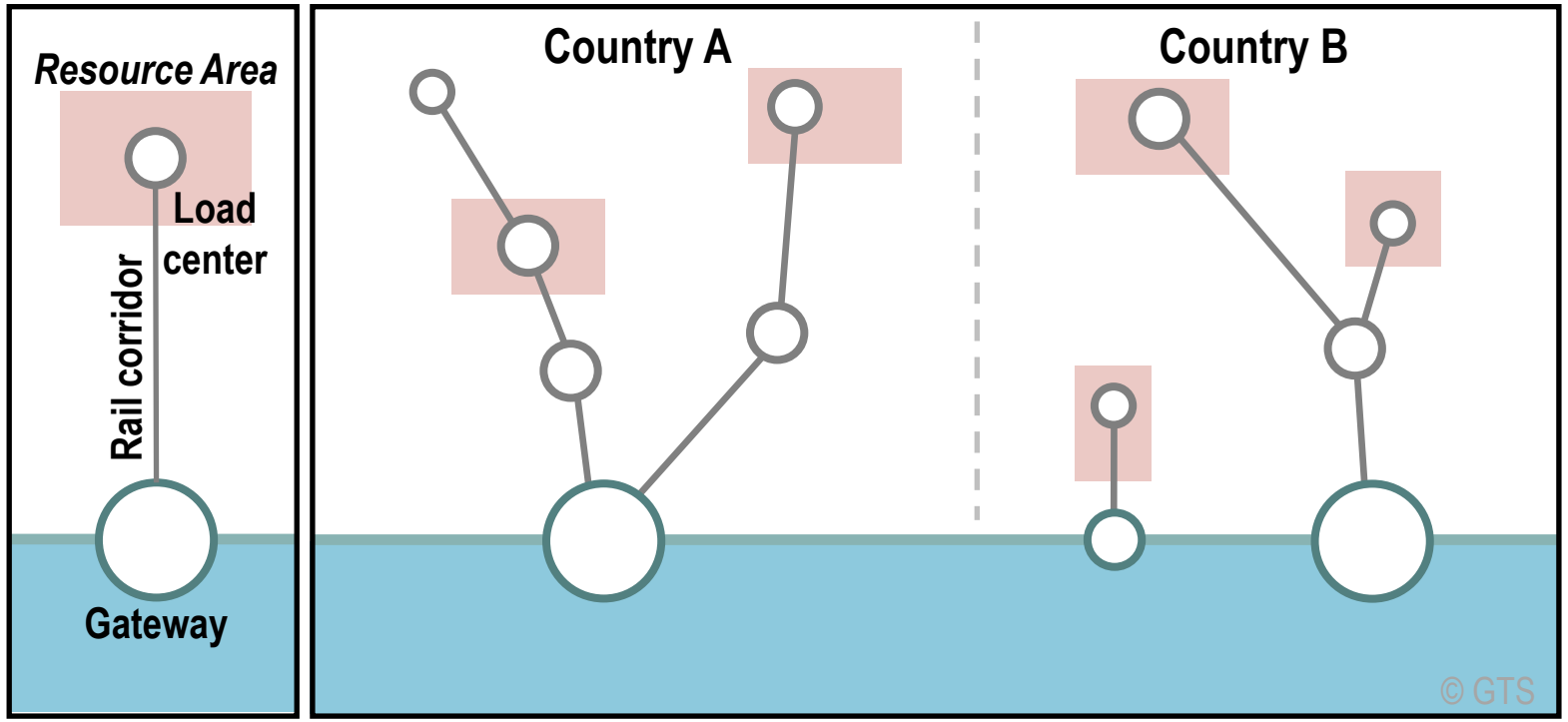
Cumulative Modal Contribution to Economic Opportunities



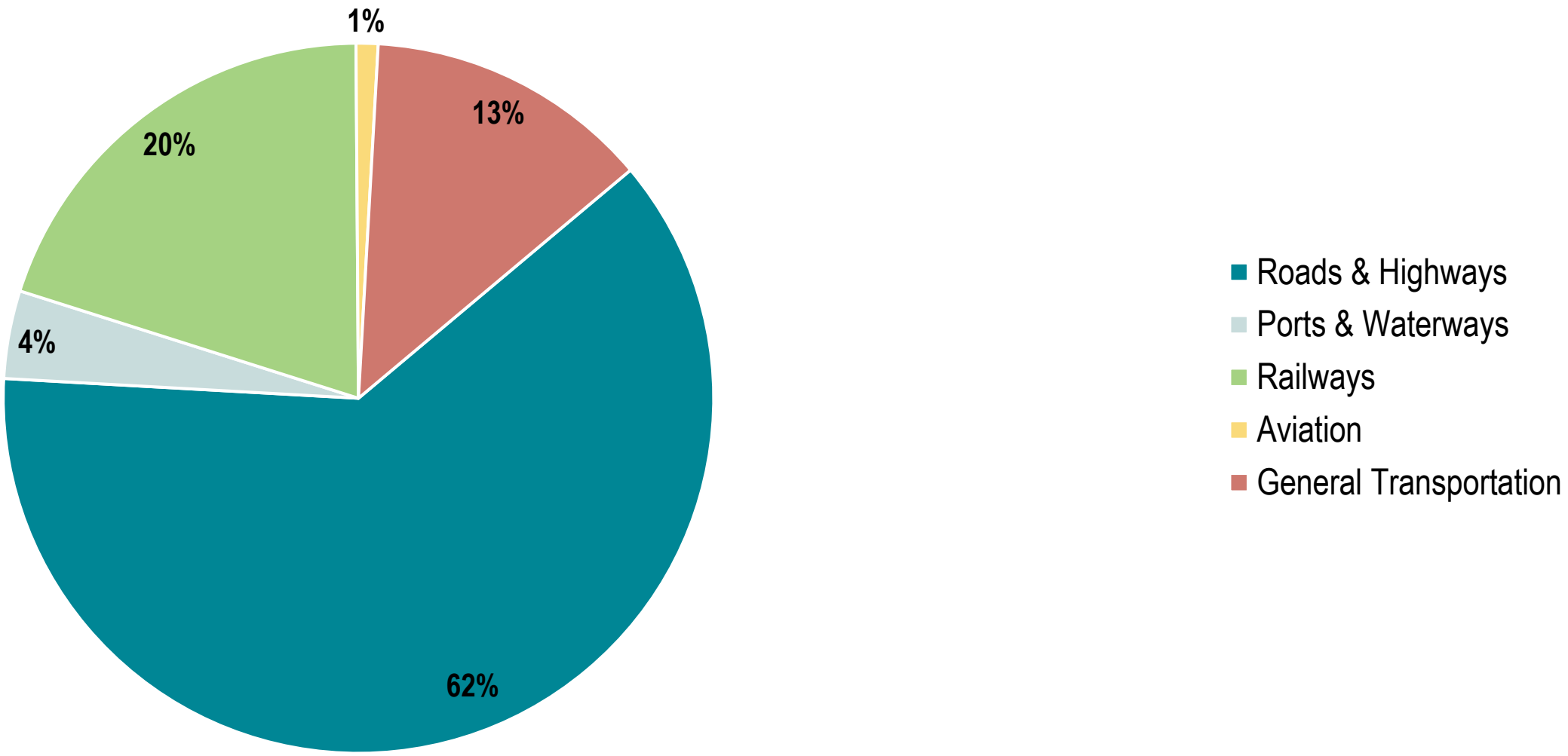
World Migration Routes Since 1700



Resource-Based Transport Systems

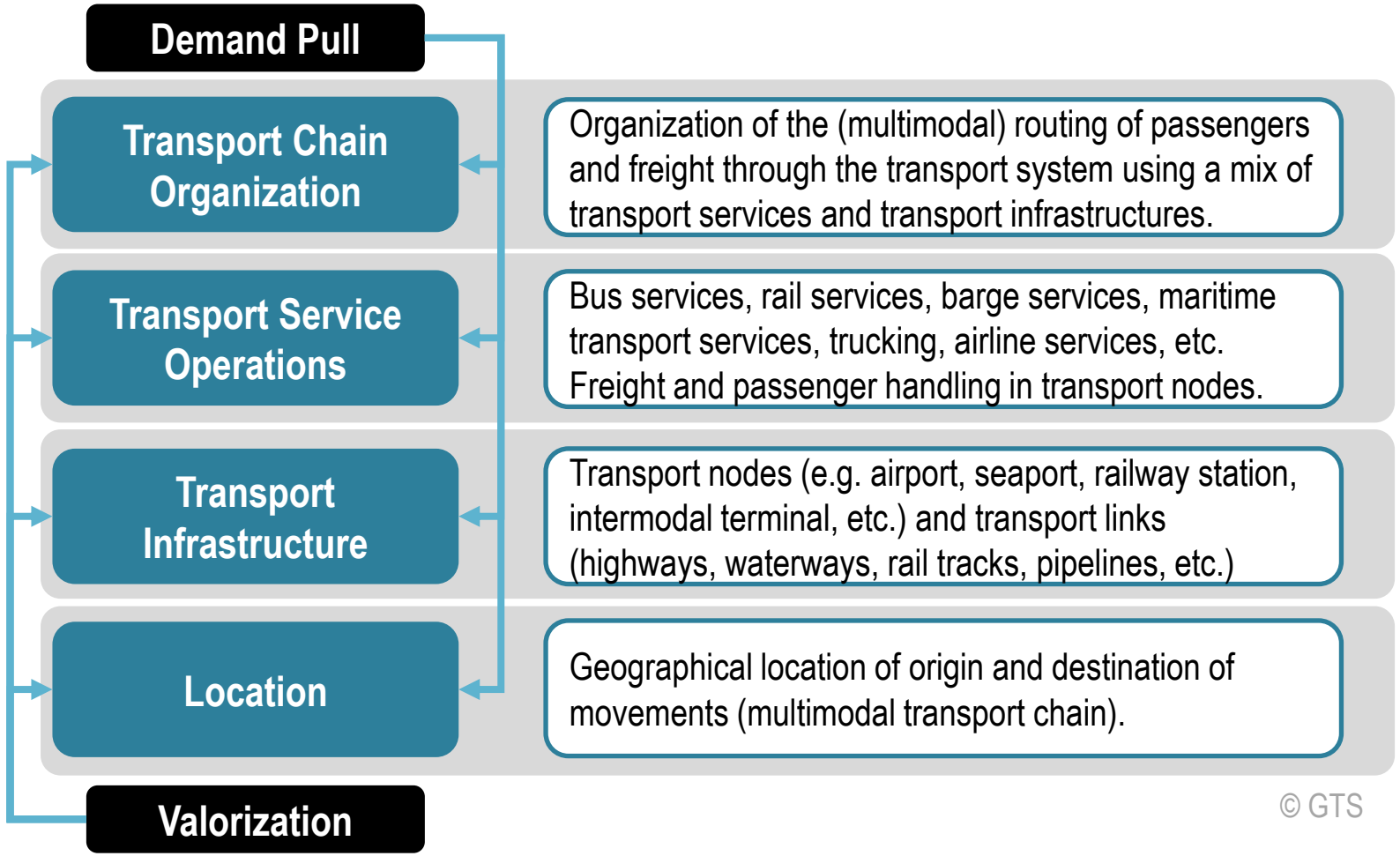


World Bank Average Annual Lending by Mode, 2007

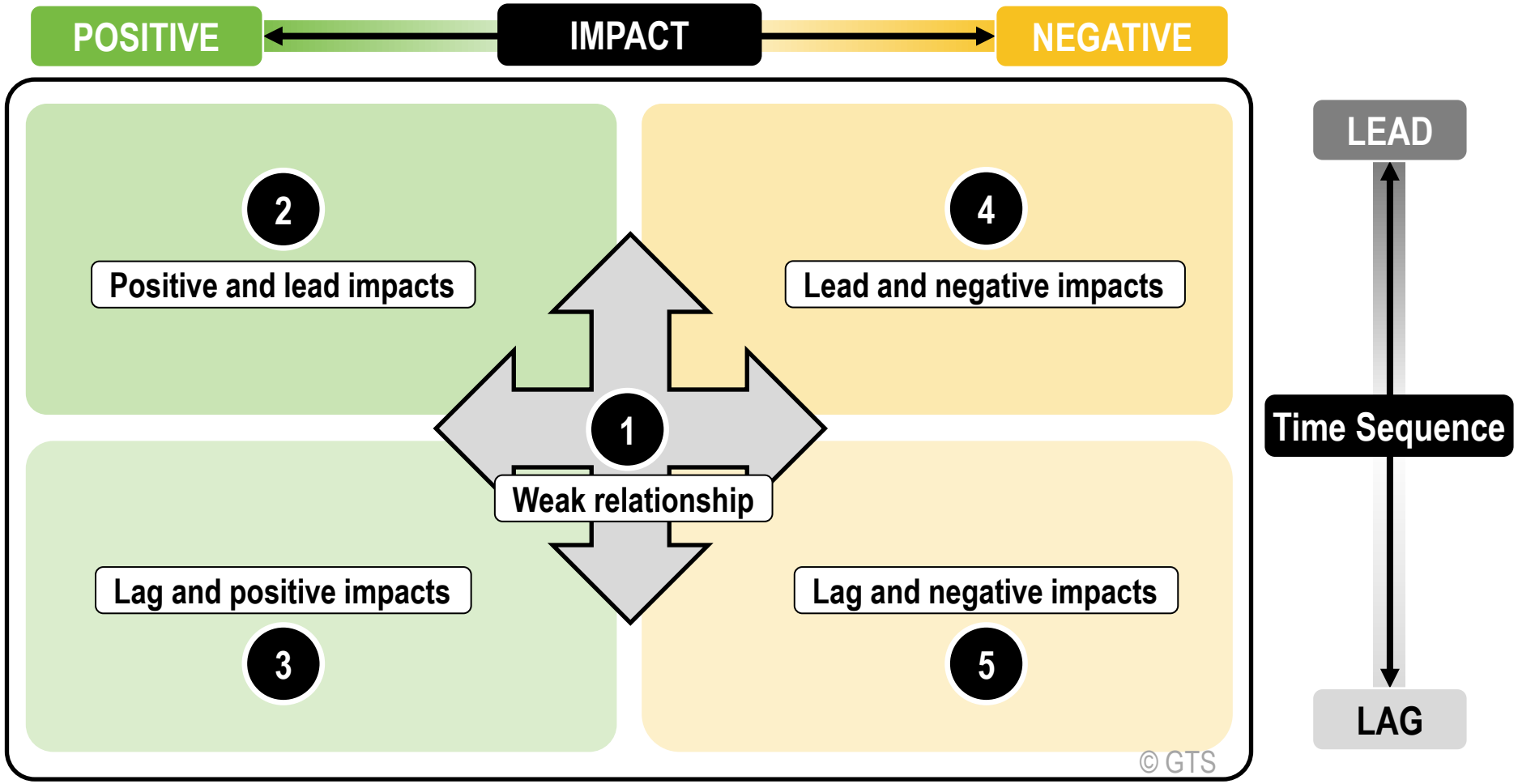


Wealth Consumption Investment in Transport Infrastructure: Repaving a Sidewalk

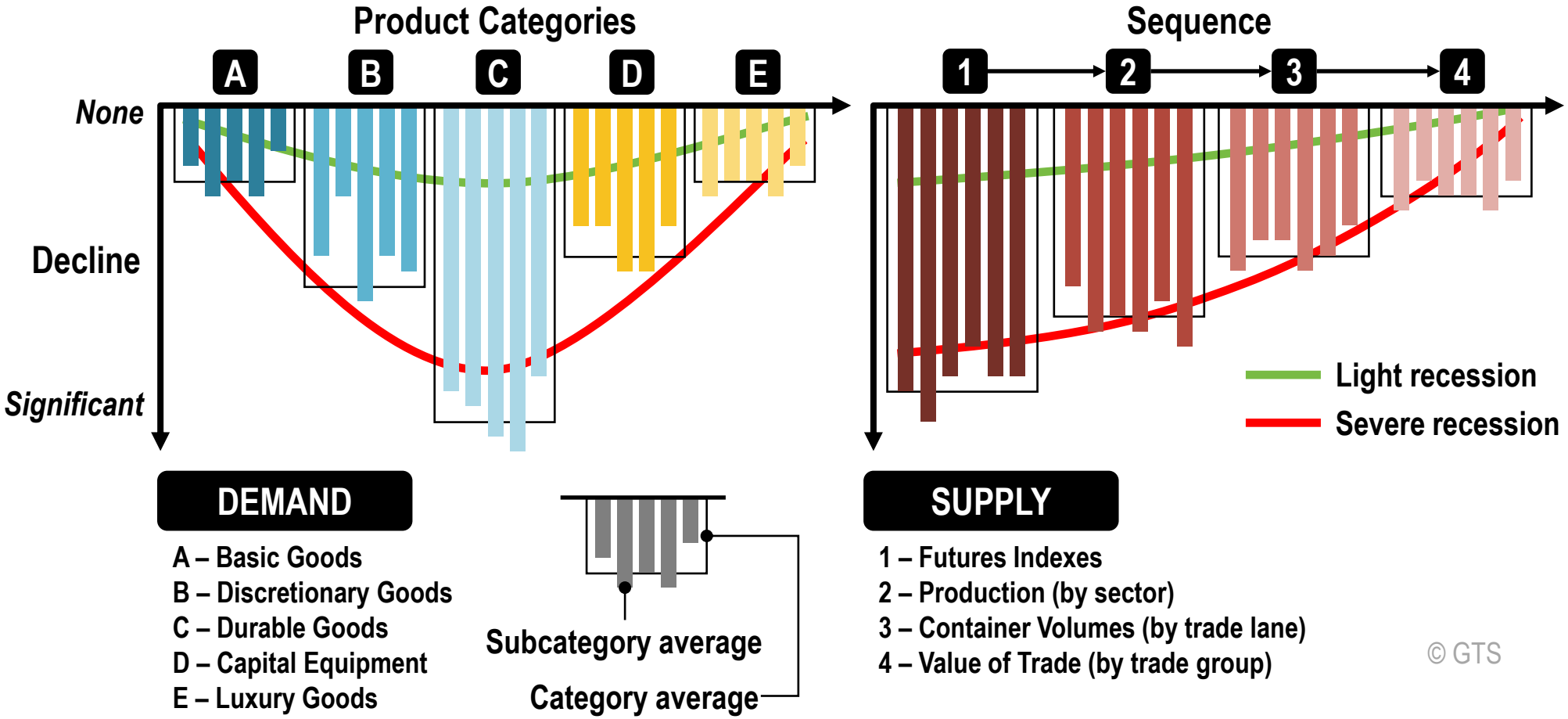
A Multi-Layer Perspective about Transport and Economic Development



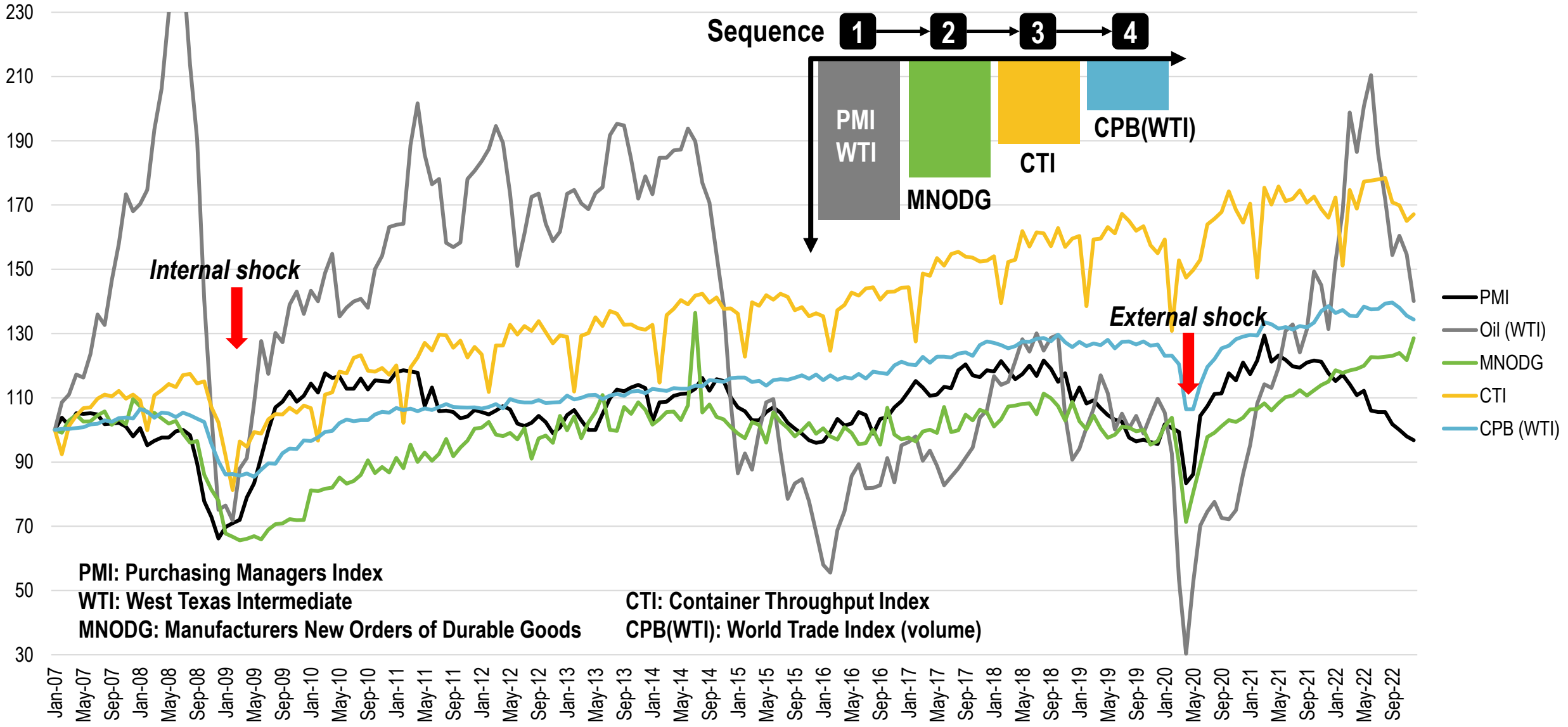
Time Sequence and Nature of Impacts of Transport Investments



Impact of Recessions on Consumption, Production and Trade

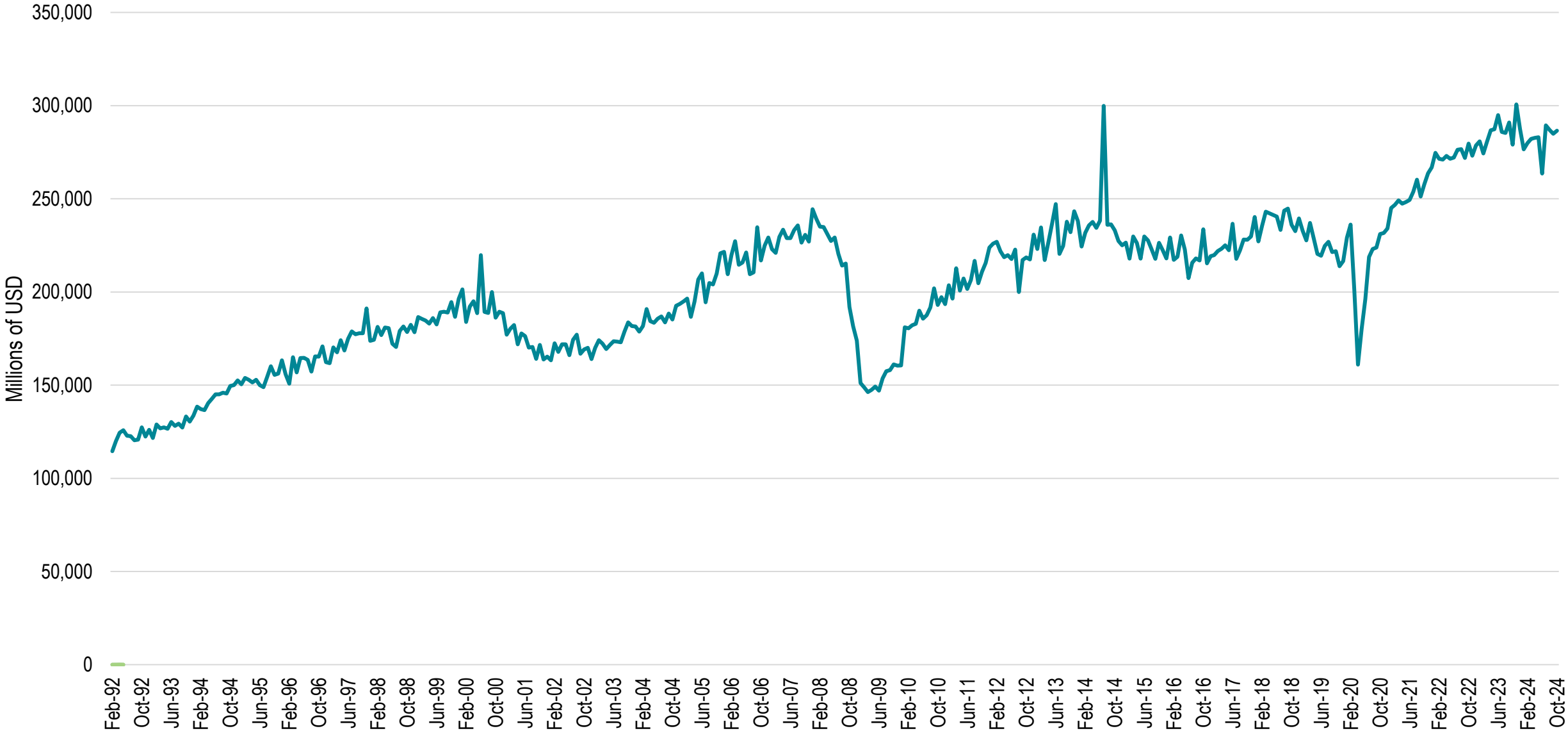


Selected Supply Chain and Trade Indicators, 2007-2022 (2007=100)

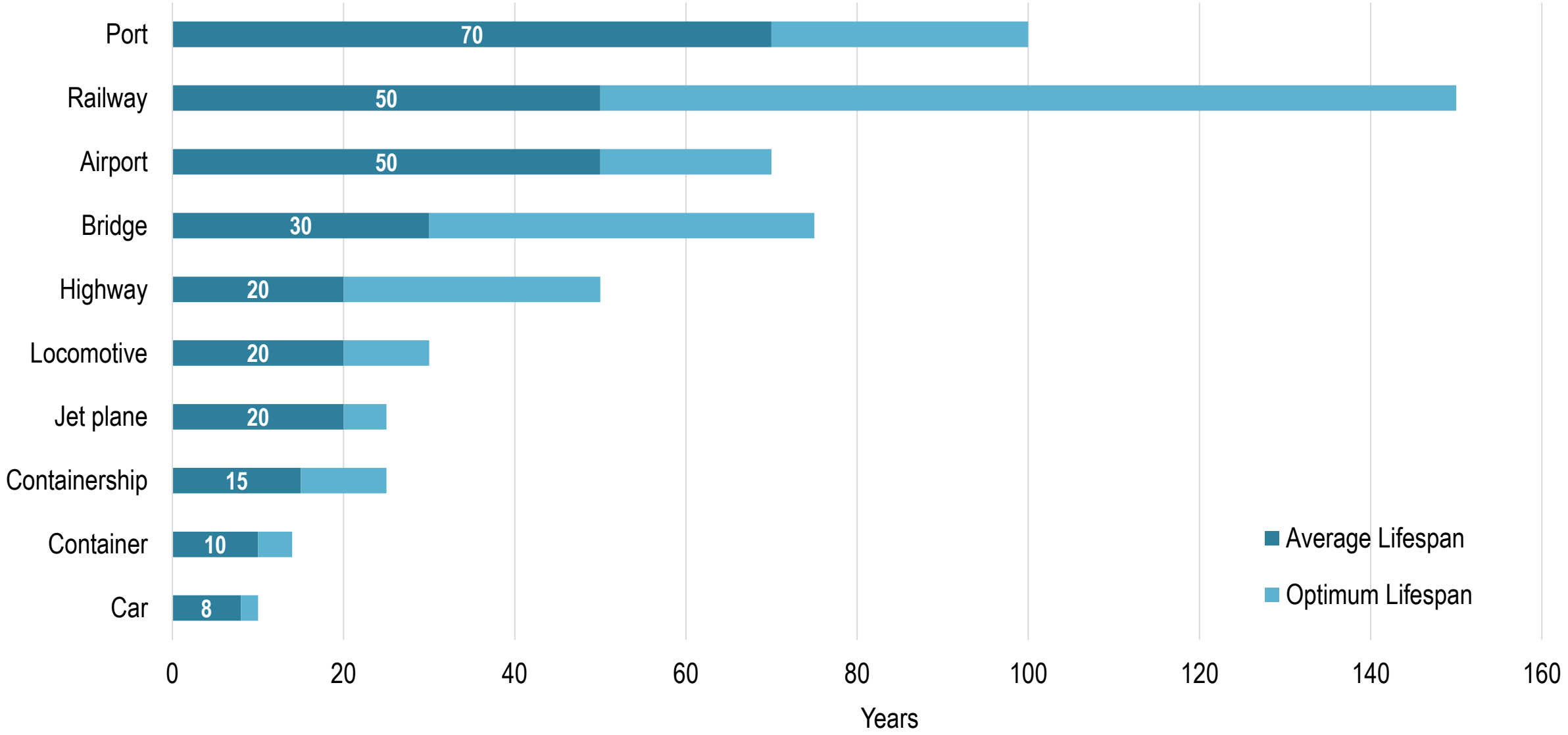


PMI: Purchasing Managers Index
WTI: West Texas Intermediate
MNODG: Manufacturers New Orders of Durable Goods
CTI: Container Throughput Index
CPB(WTI): World Trade Index (volume)

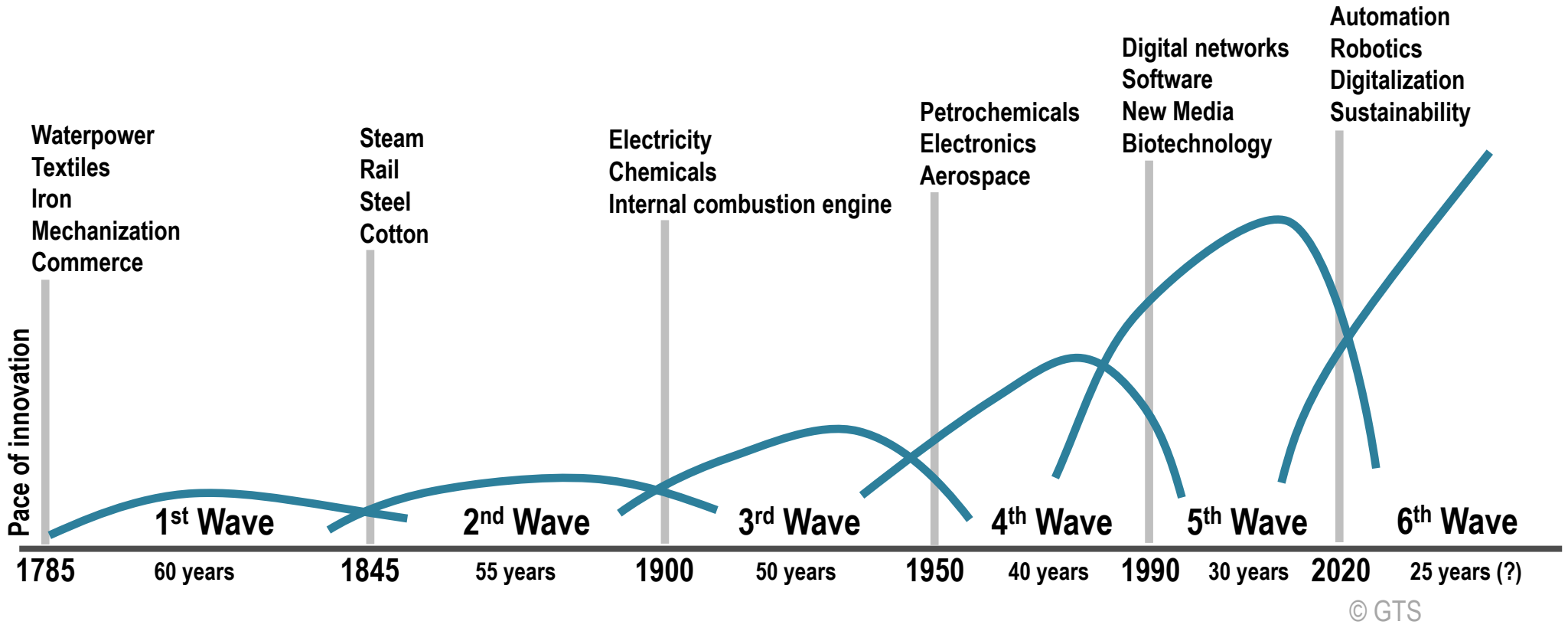
Manufacturers' New Orders of Durable Goods



Lifespan of Main Transport Assets



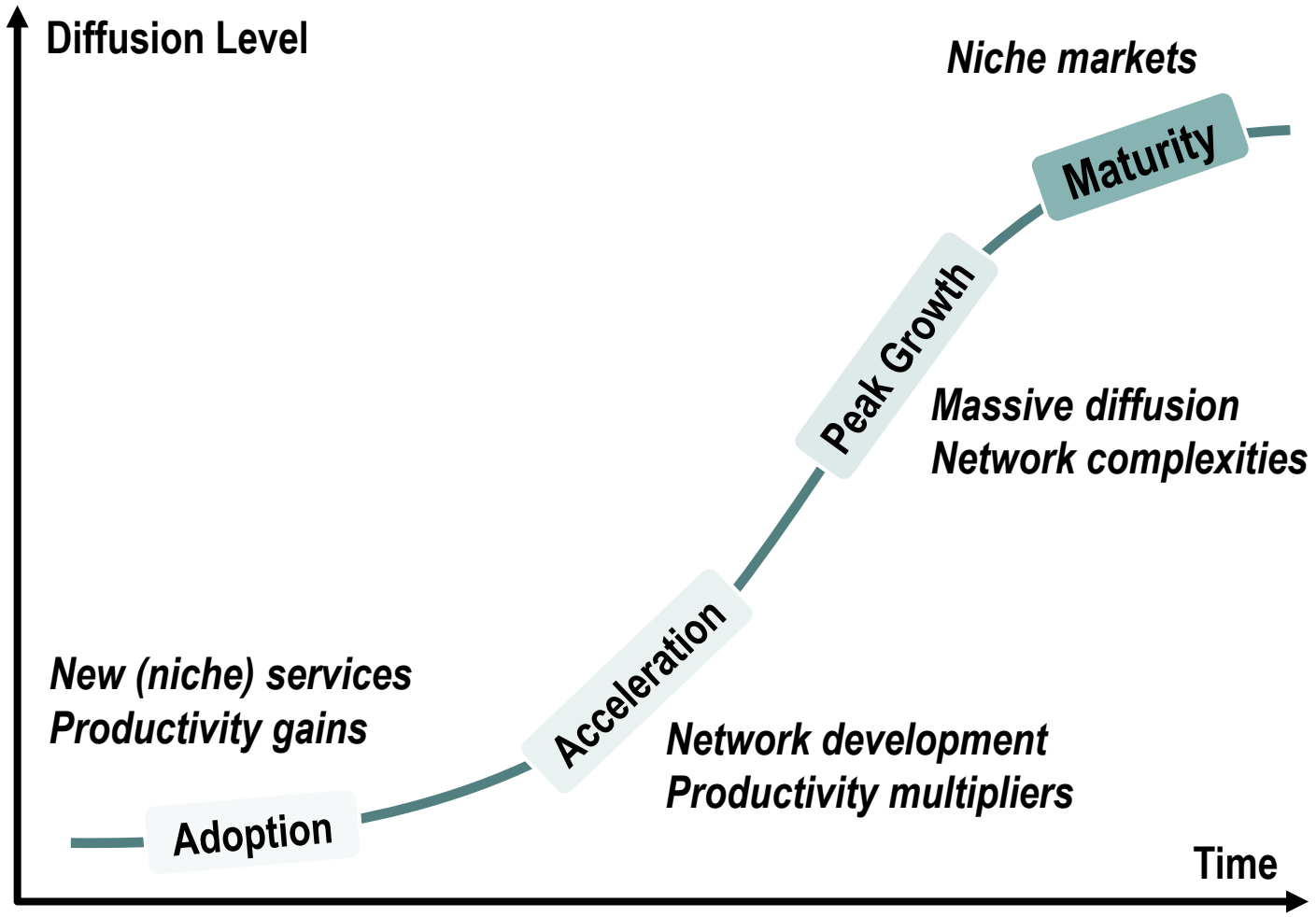
Long Wave Cycles of Innovation



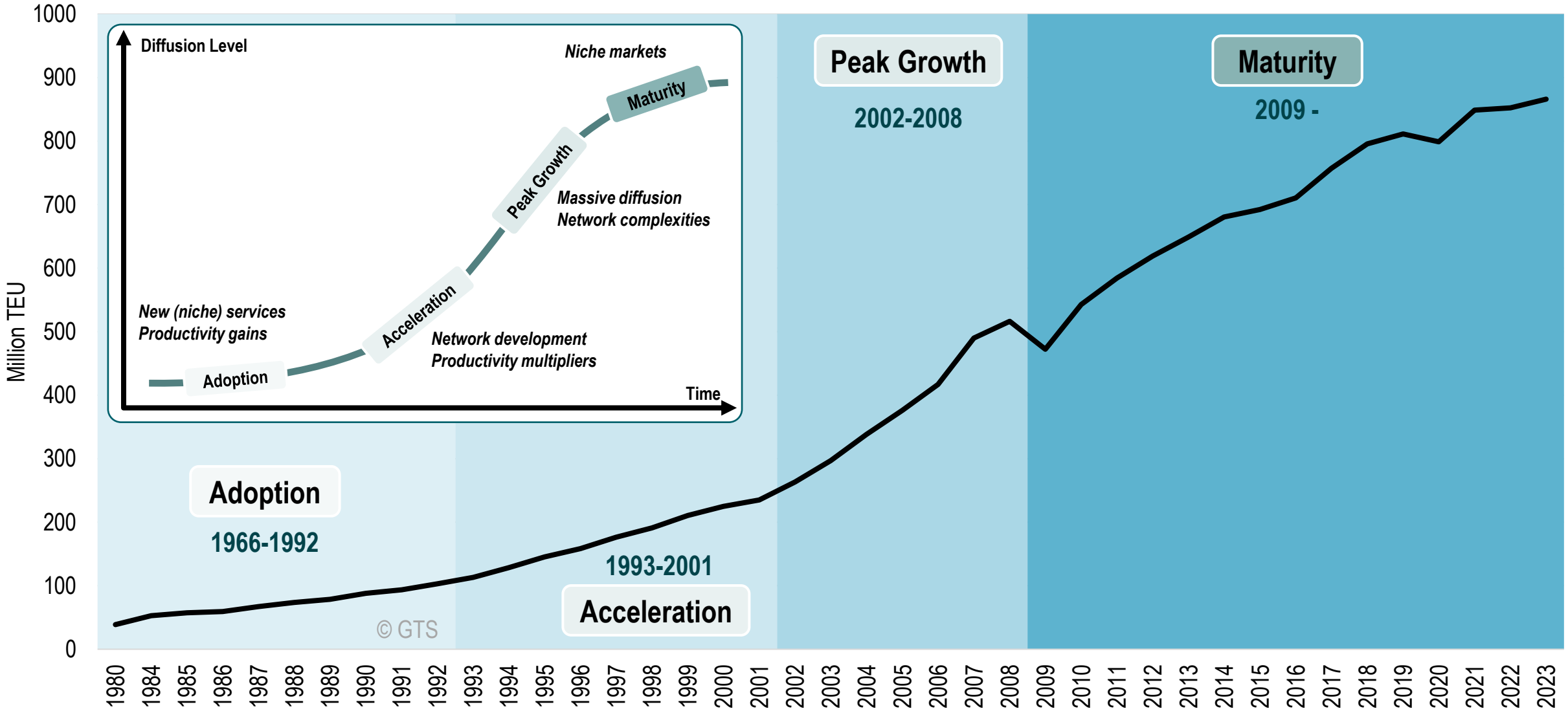
The Five Waves of Development

First wave (1785-1845)	Beginning of the industrial revolution (England). Agricultural surpluses, savings and investment. Productivity growth in agriculture and in new industrial activities. Textiles, iron and water power.
Second wave (1845-1900)	Acceleration in the generation of surpluses. Growth in the investment level (5 to 10% of the national income). Coal, steam engine and railways.
Third wave (1900-1950)	Phase of maturity (investment levels at 20% of national income). Electricity, chemicals and internal combustion engine.
Fourth wave (1950-1990)	Mass consumption society (surpluses, savings and investment). Tertiary sector taking a growing share of the economy. Petrochemicals, electronics and aviation.
Fifth wave (1990-2020?)	Technology and information are the driving forces. De-industrialization of several developed countries.

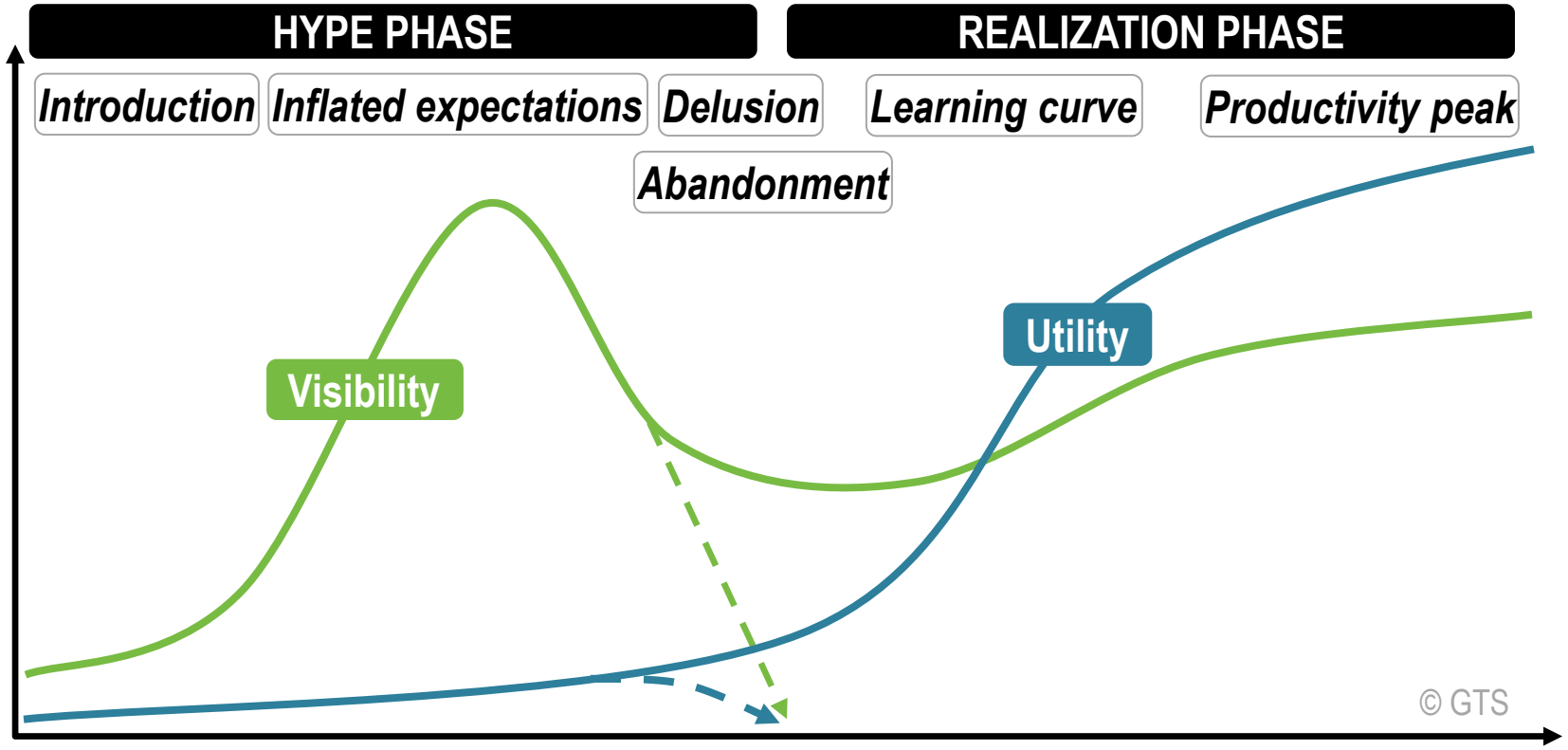
Diffusion Cycle of Containerization



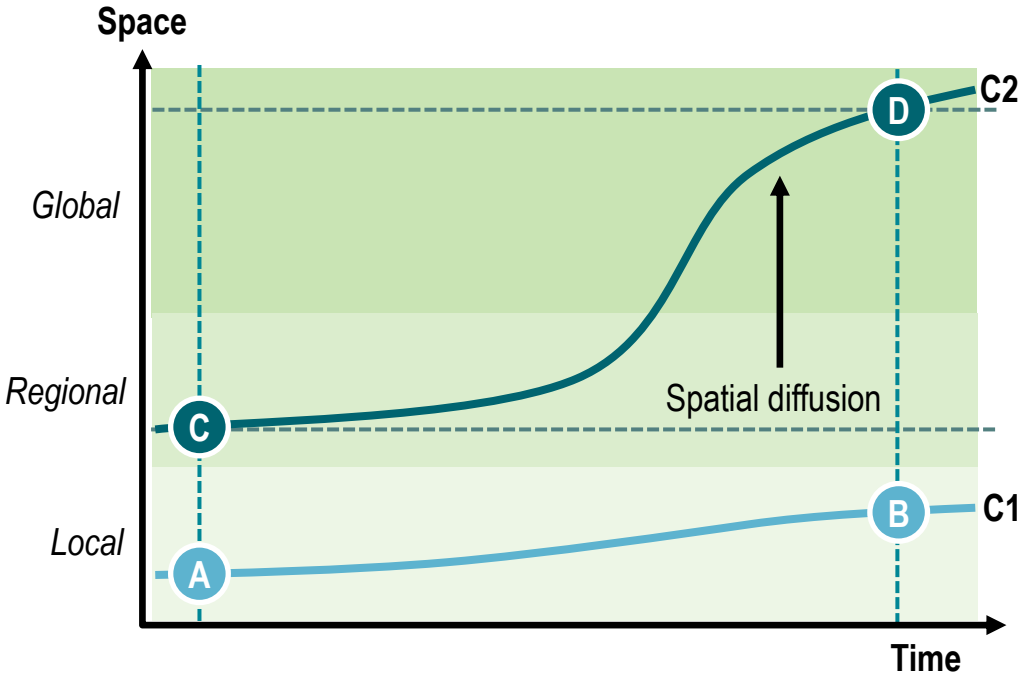
Containerization as a Diffusion Cycle: World Container Traffic (1980-2023)

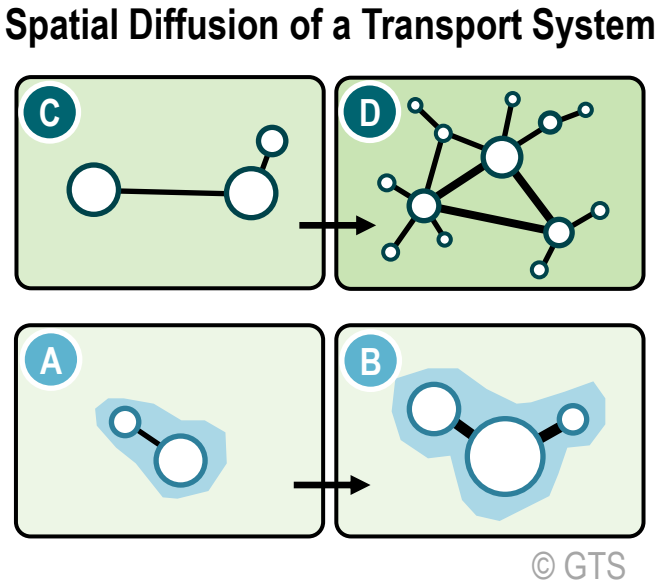


Technology “Hype” Cycle

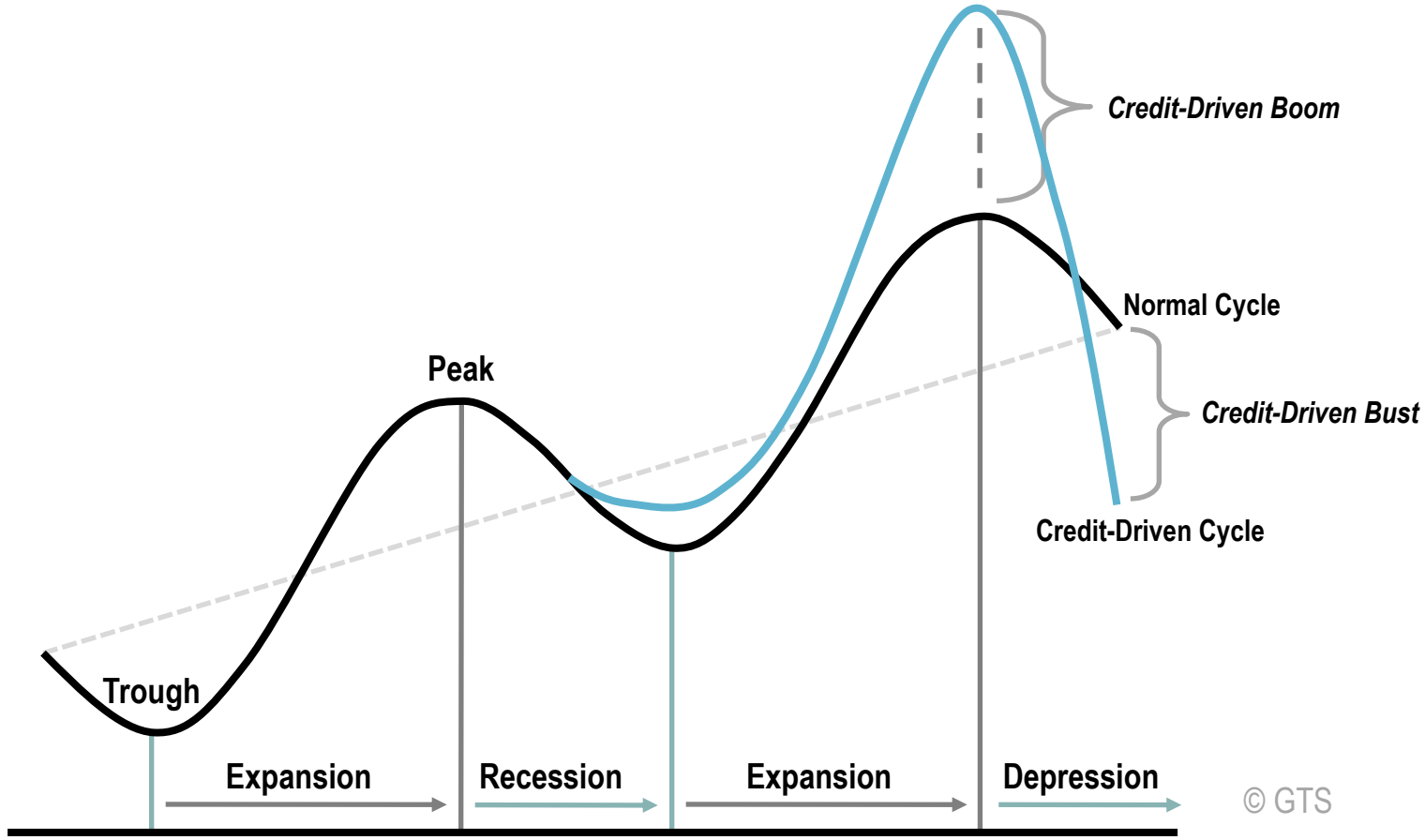


Cycles, Space and Transportation

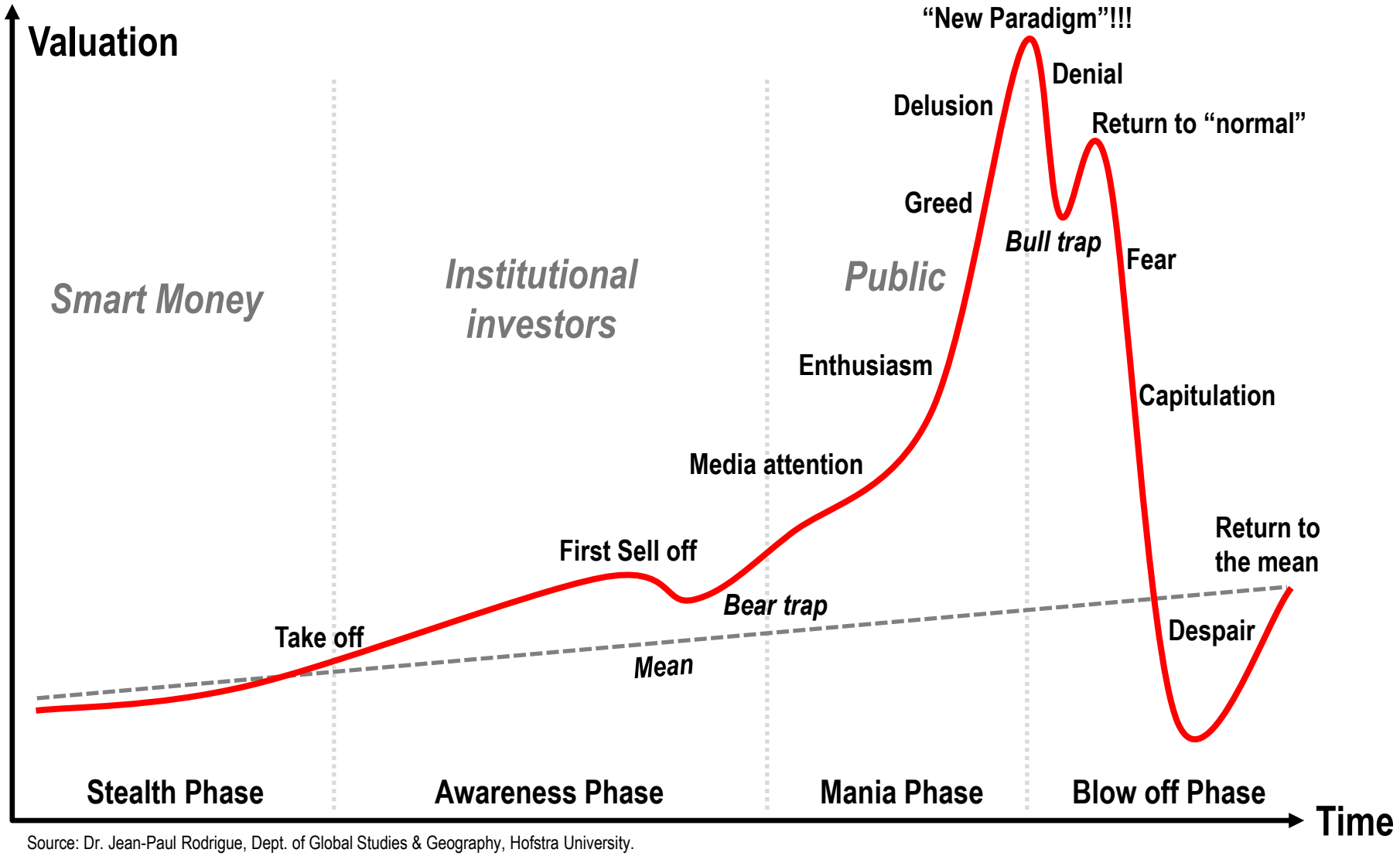




Business Cycles and Misallocations

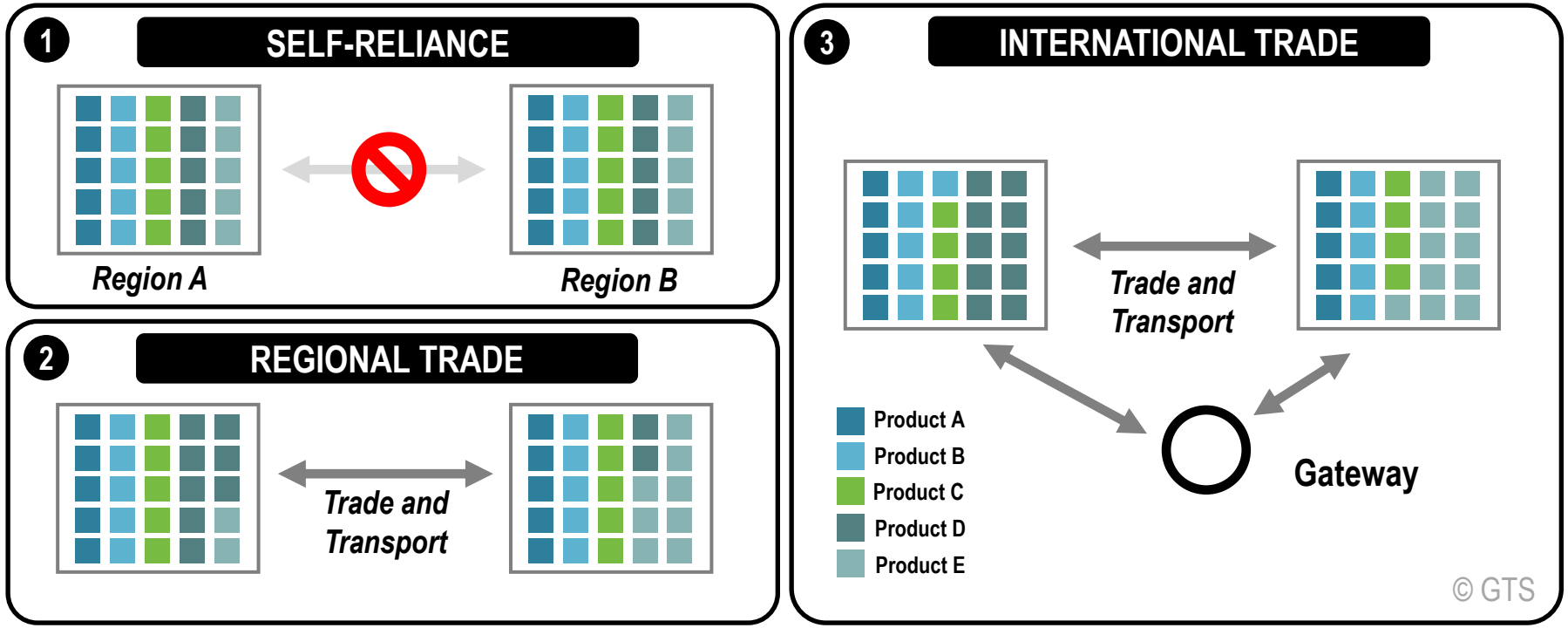


Main Stages in a Bubble

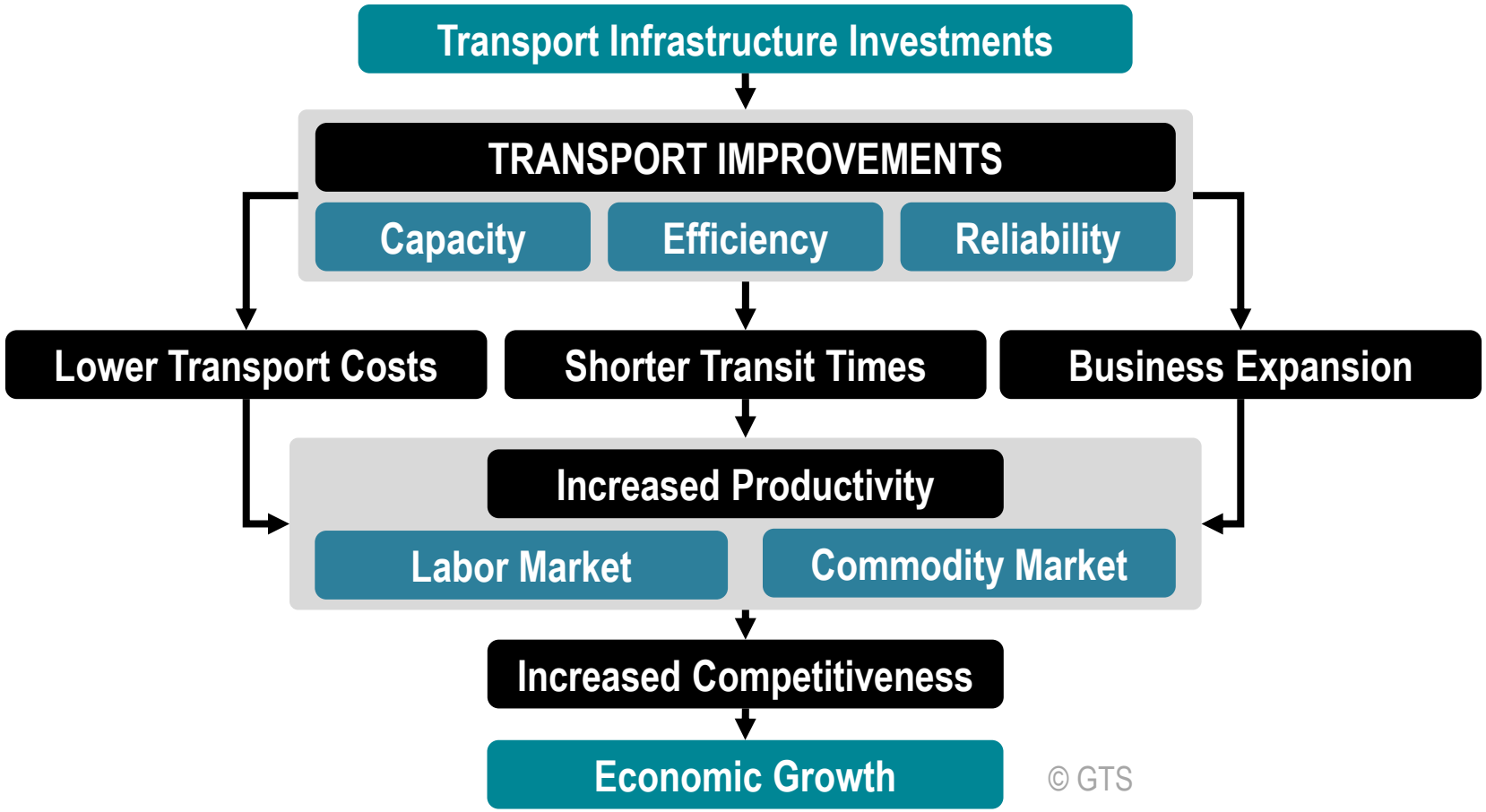


Source: Dr. Jean-Paul Rodrigue, Dept. of Global Studies & Geography, Hofstra University.

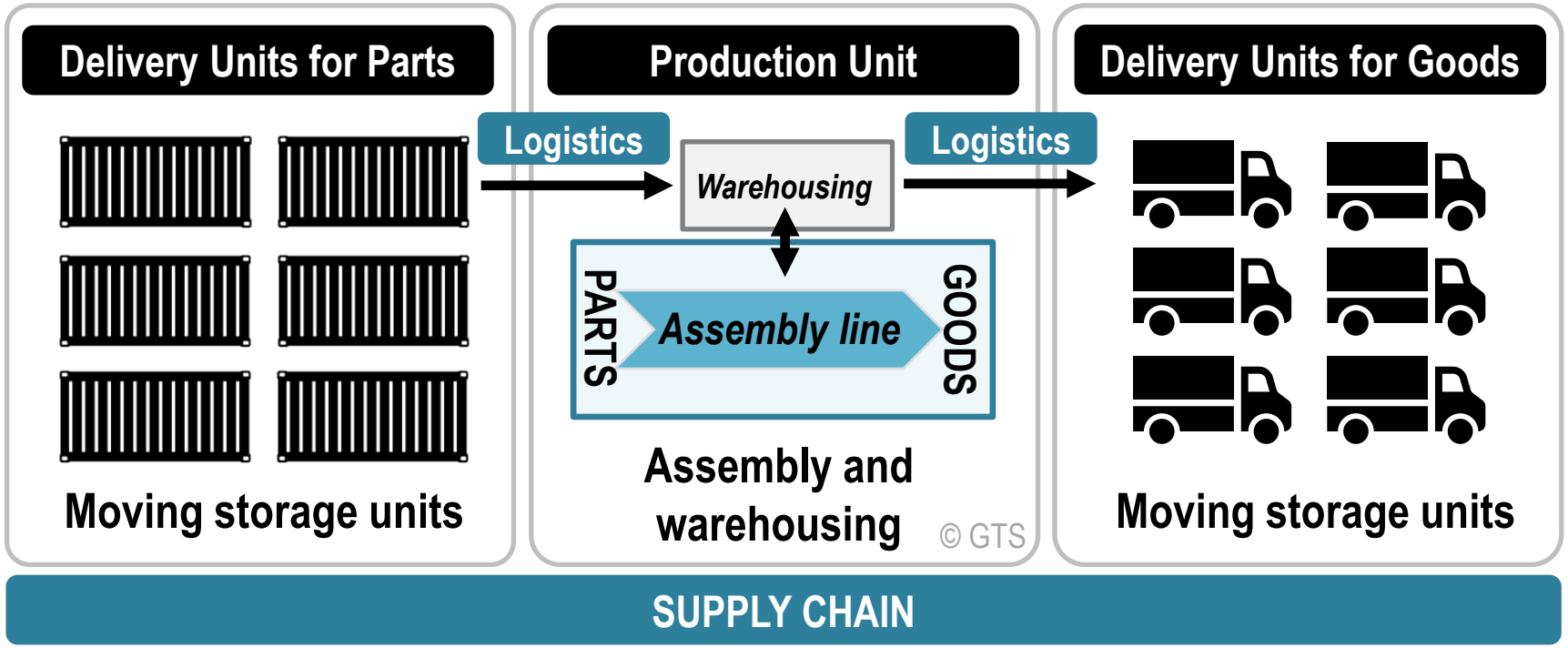
Economic Production and Specialization

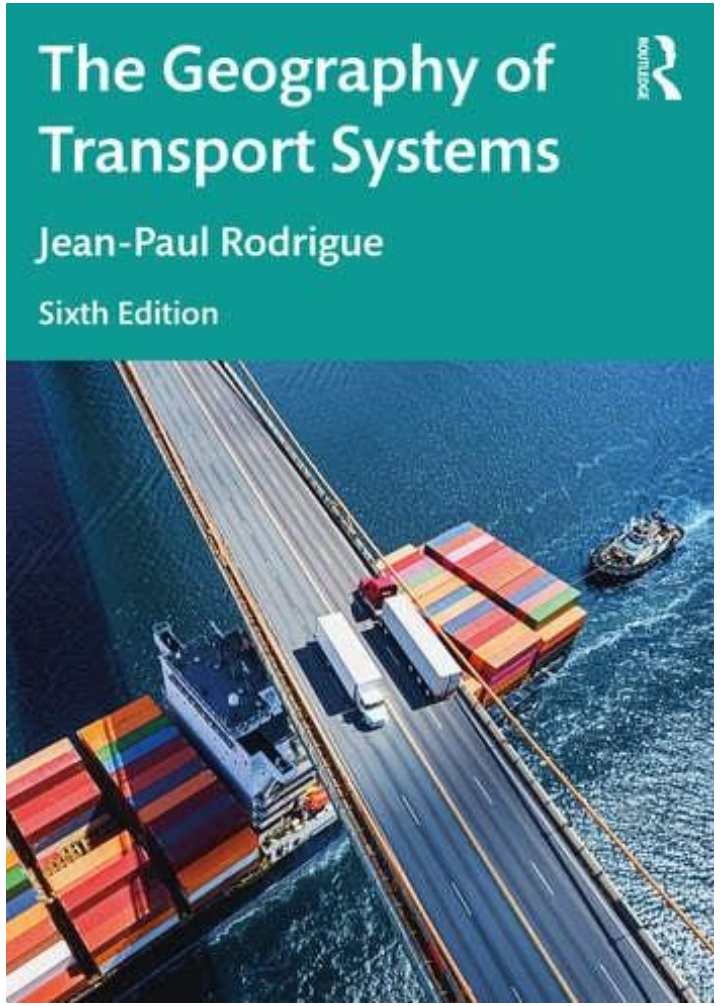


Transport Impacts on Economic Opportunities



Just in Time and its Logistics

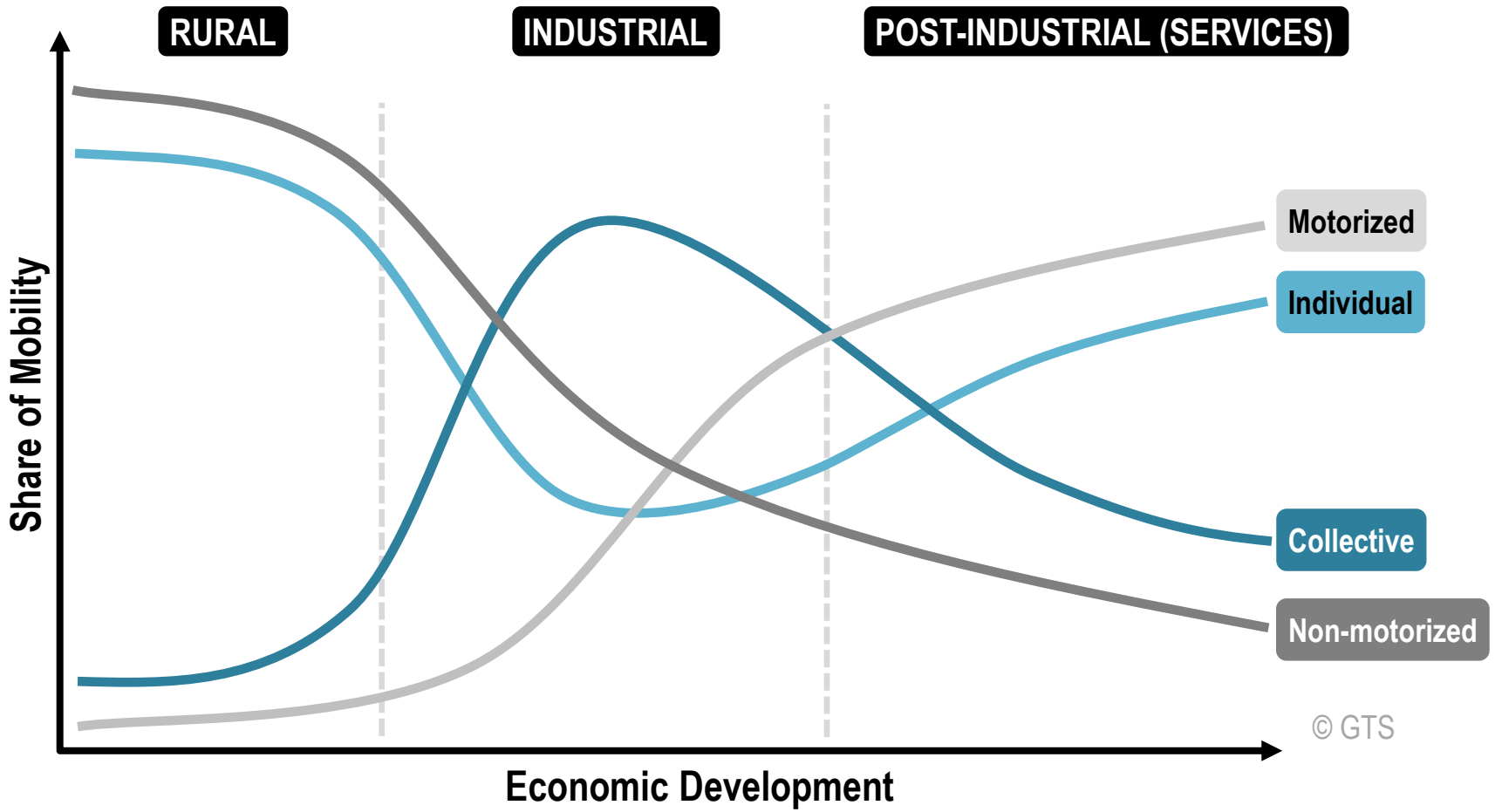




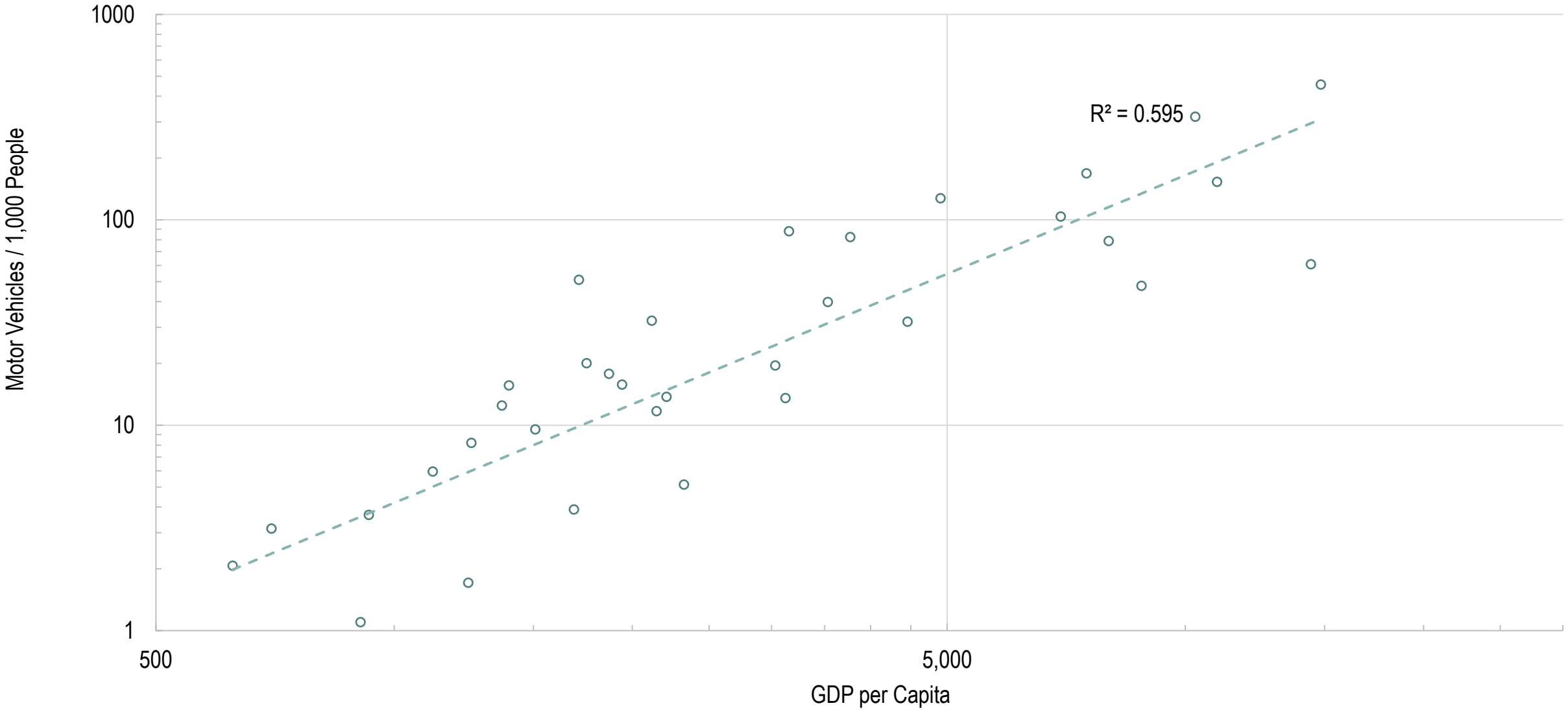
Transportation and Society

Chapter 3.2

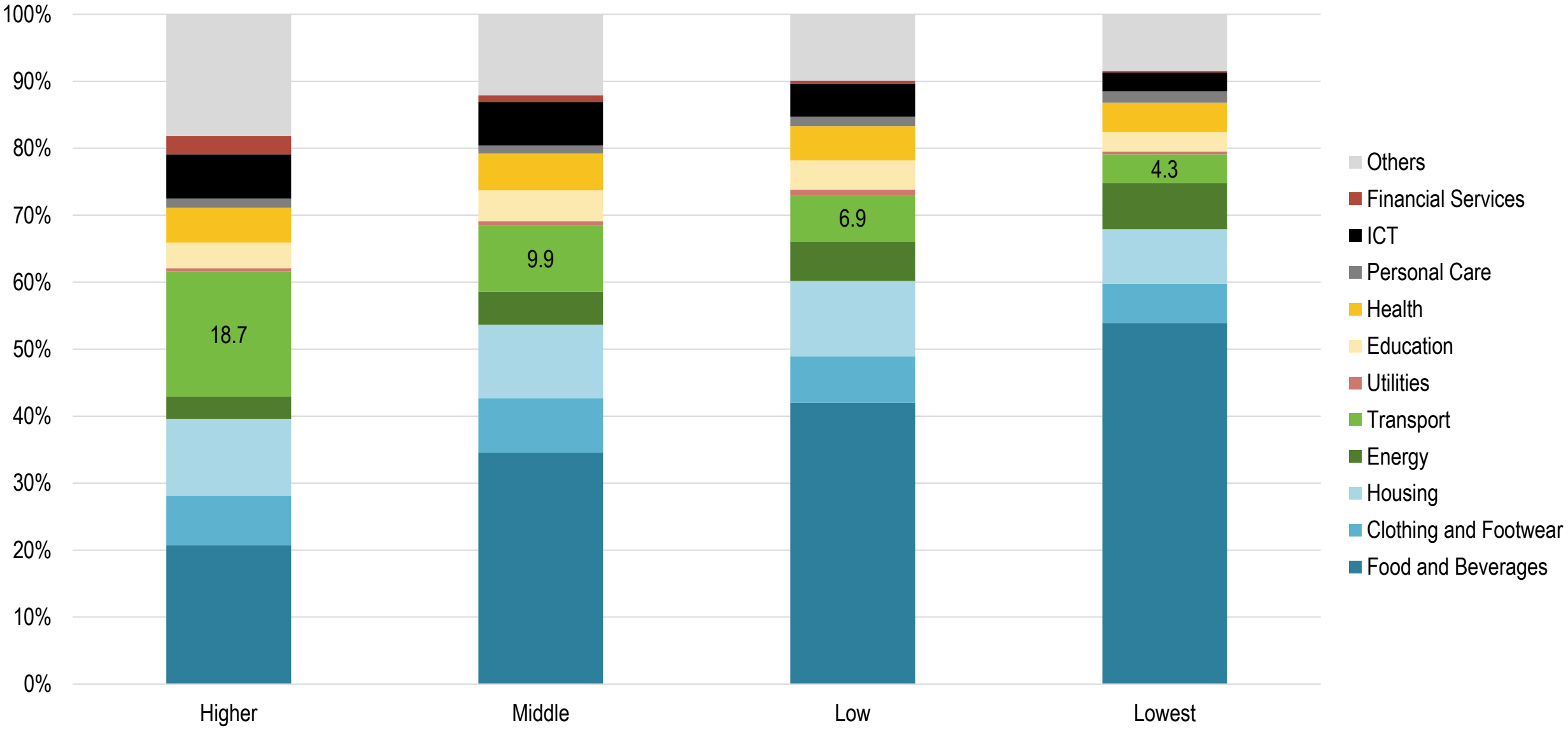
Passengers Mobility Transition



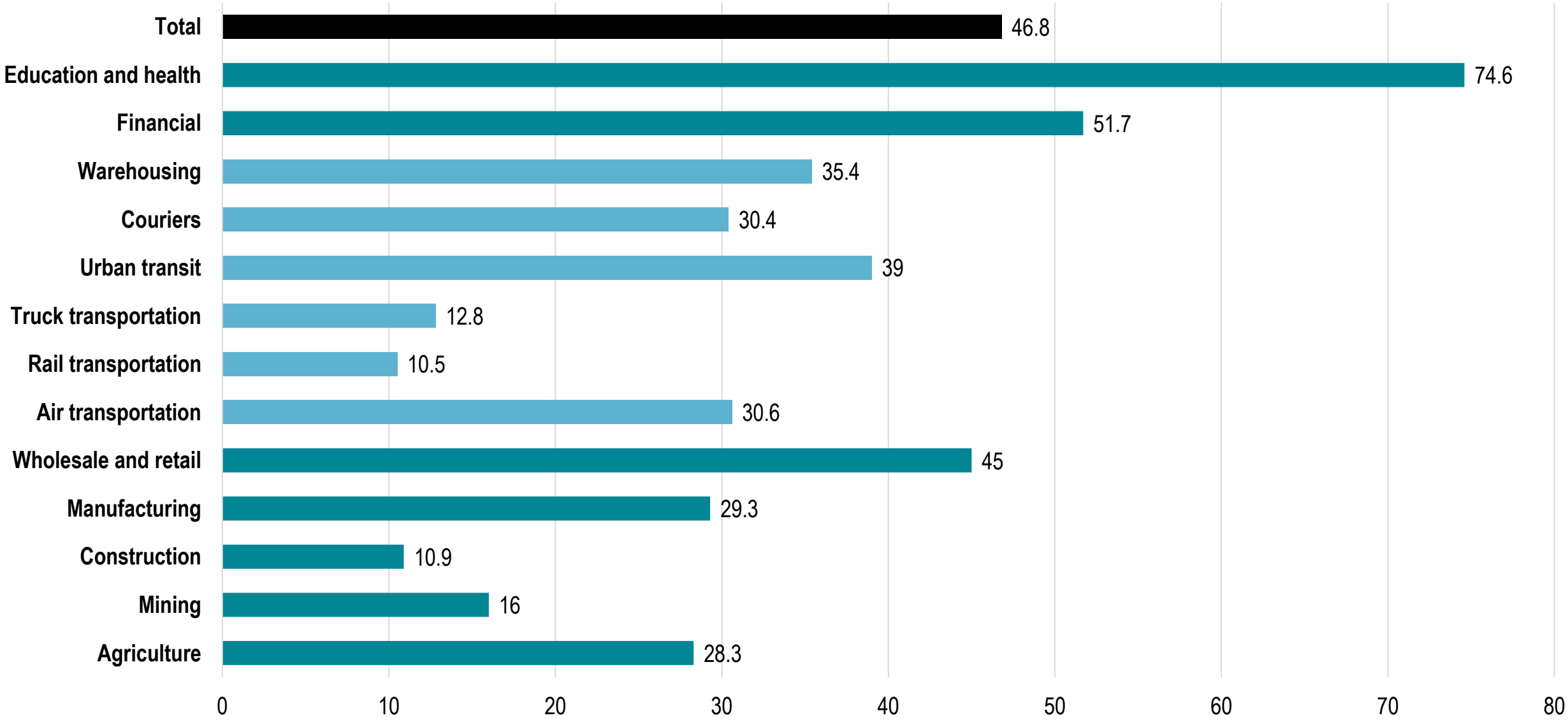
Relationship between GDP and Motorization, Selected Asian Countries, 1960-1990



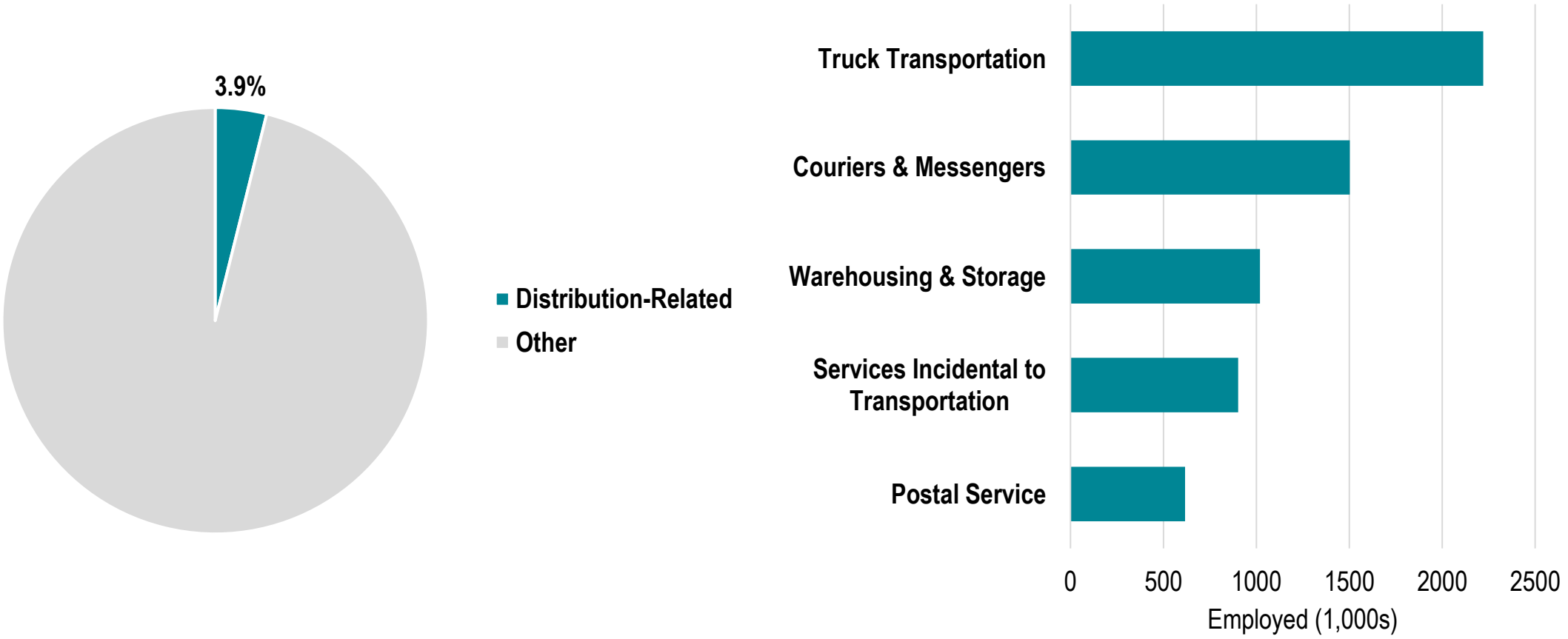
Share of Consumption by Sector and Income, Developing Countries, 2010



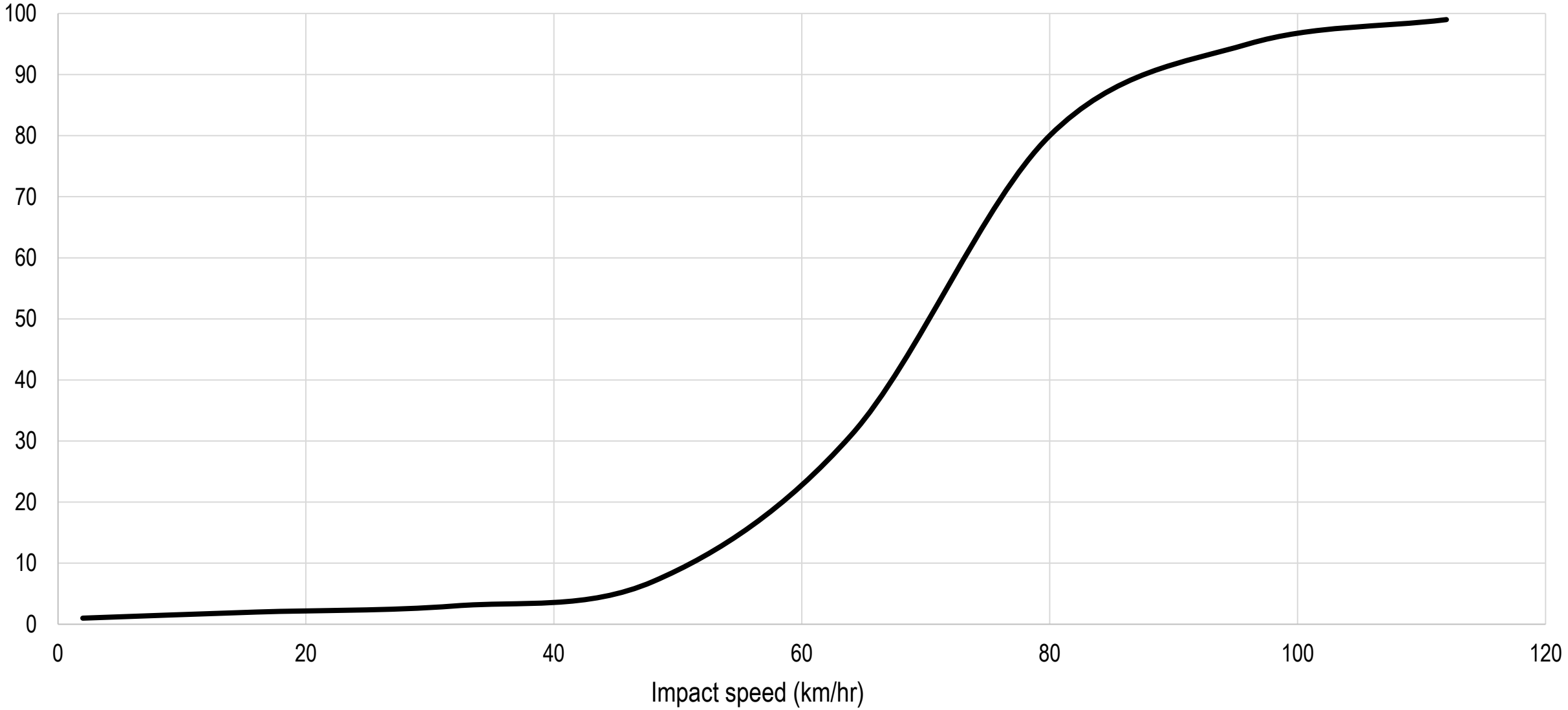
Share of Employed Females by Profession, United States, 2022



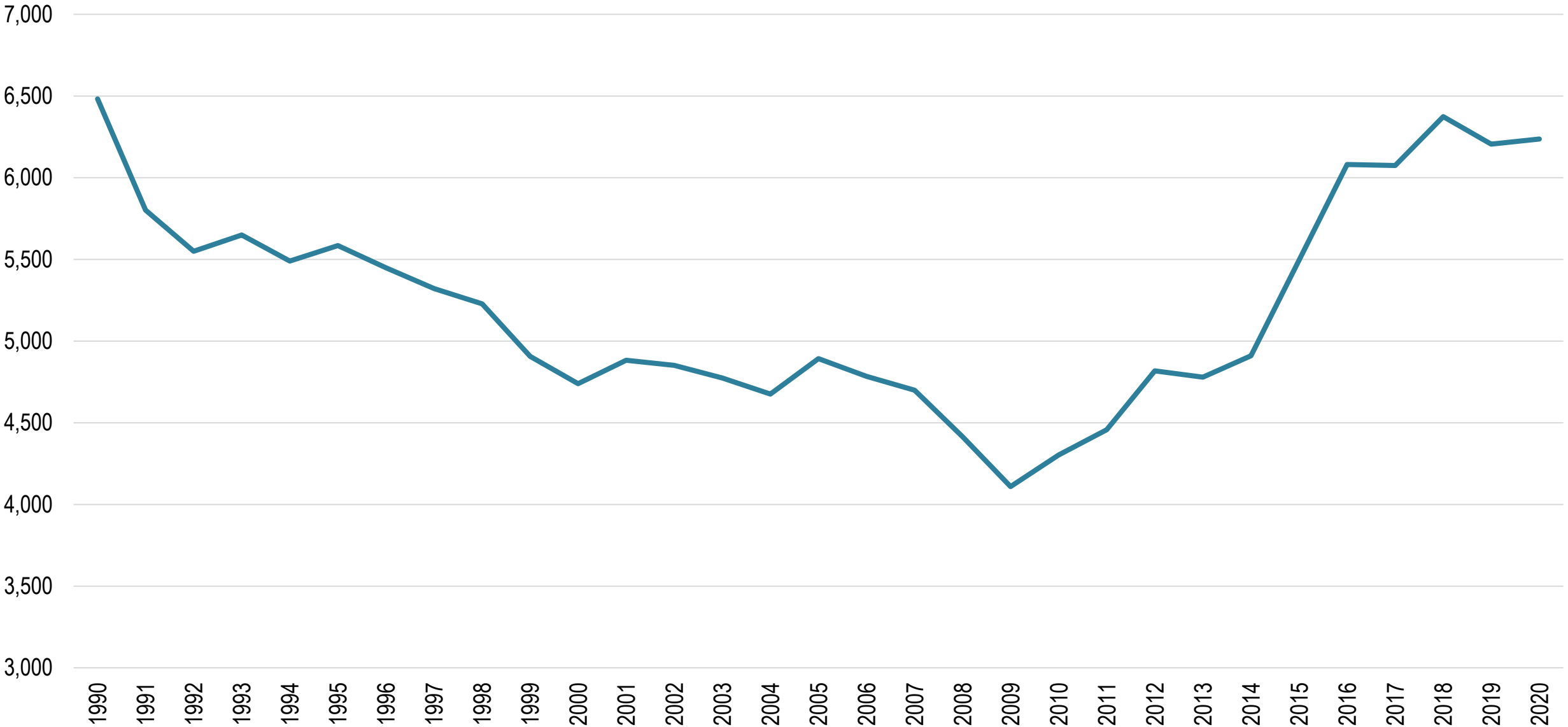
Employment in Distribution-Related Activities, United States, 2023



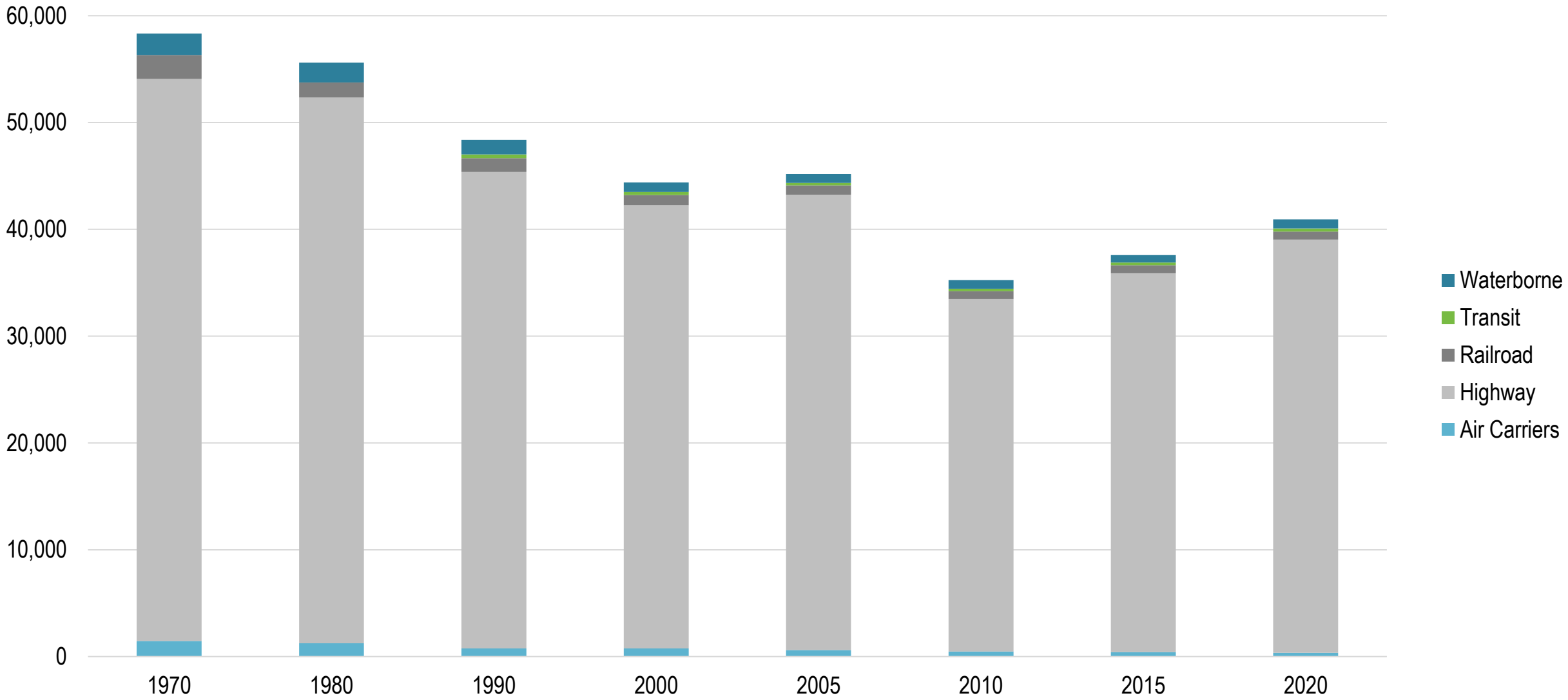
Probability of Pedestrian Fatality by Impact Speed



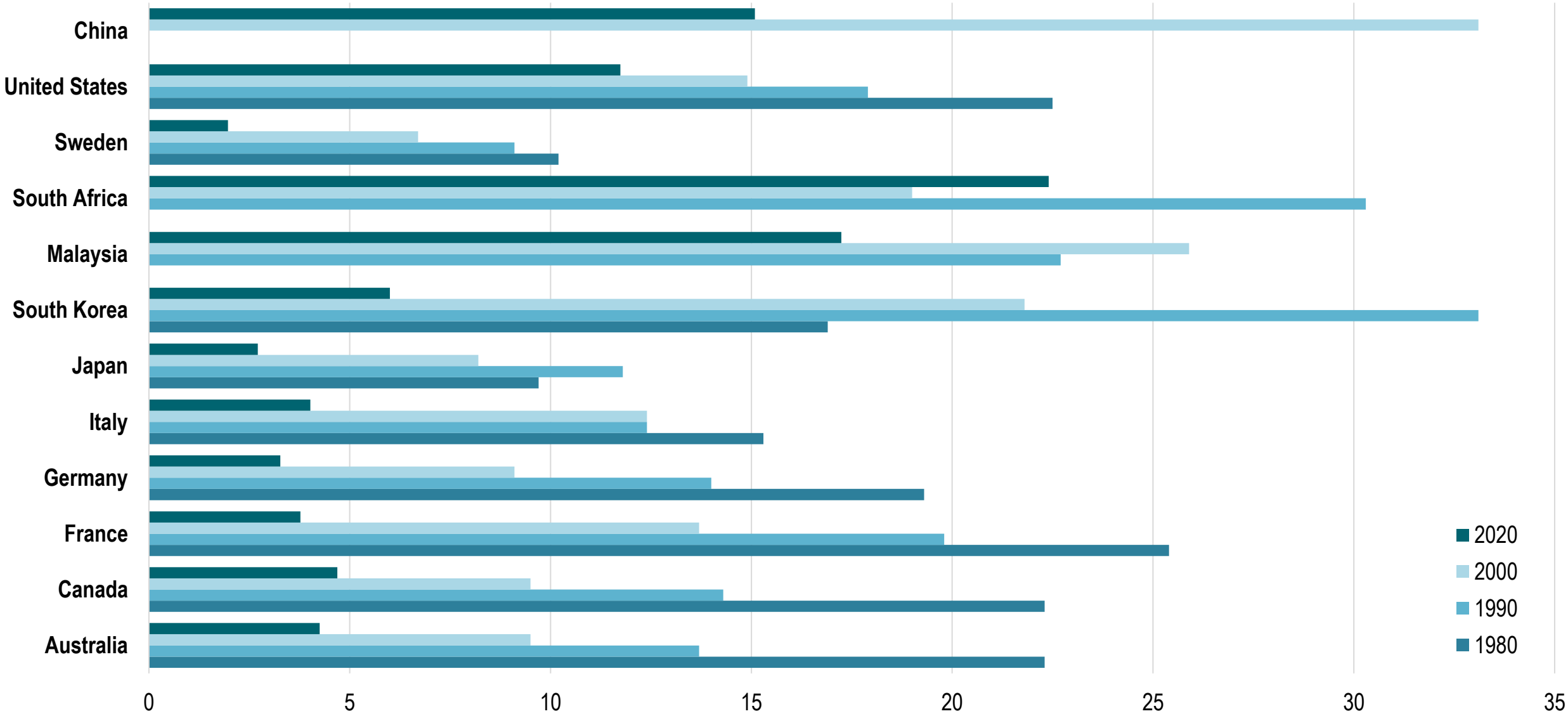
Pedestrian Fatalities, United States, 1990-2020



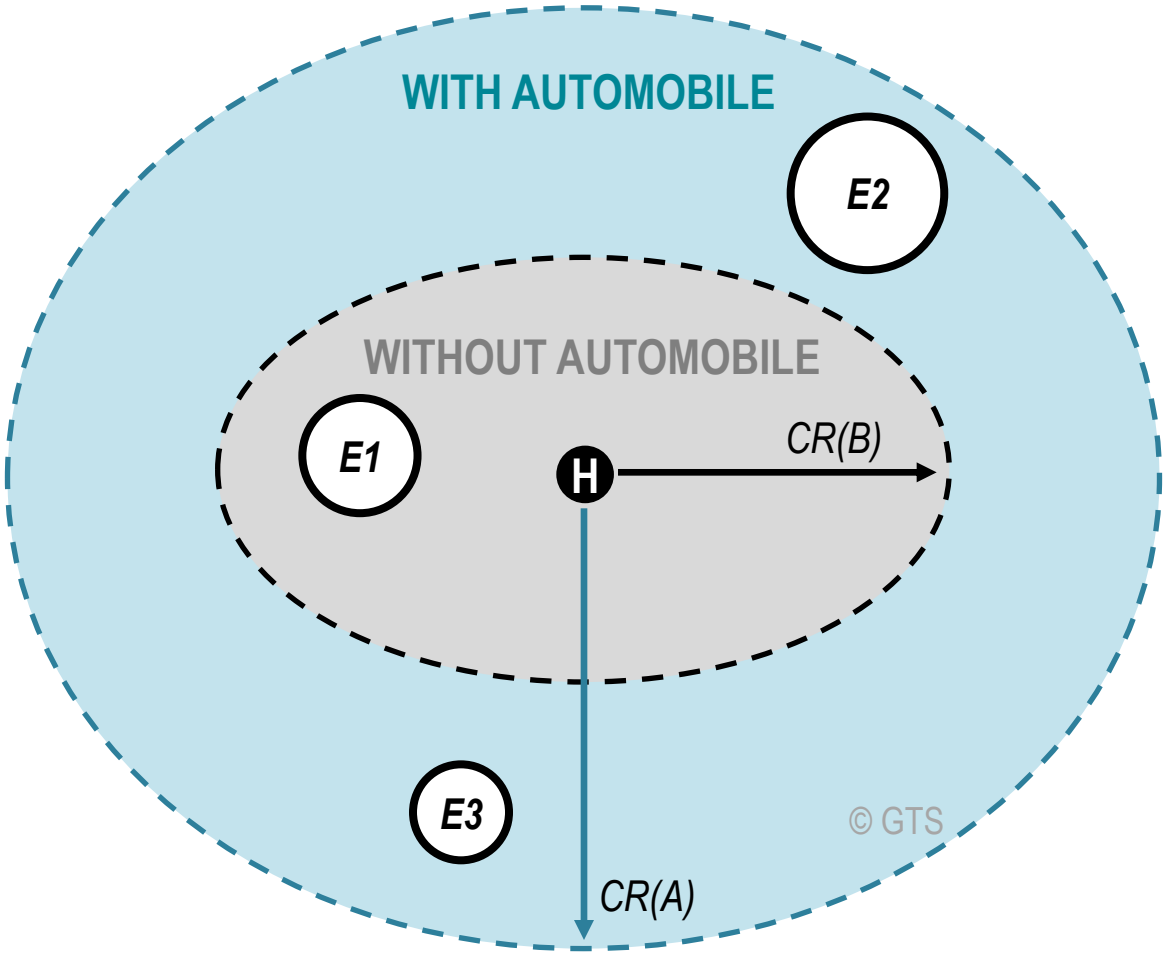
Transport Fatalities by Mode, United States, 1970-2020



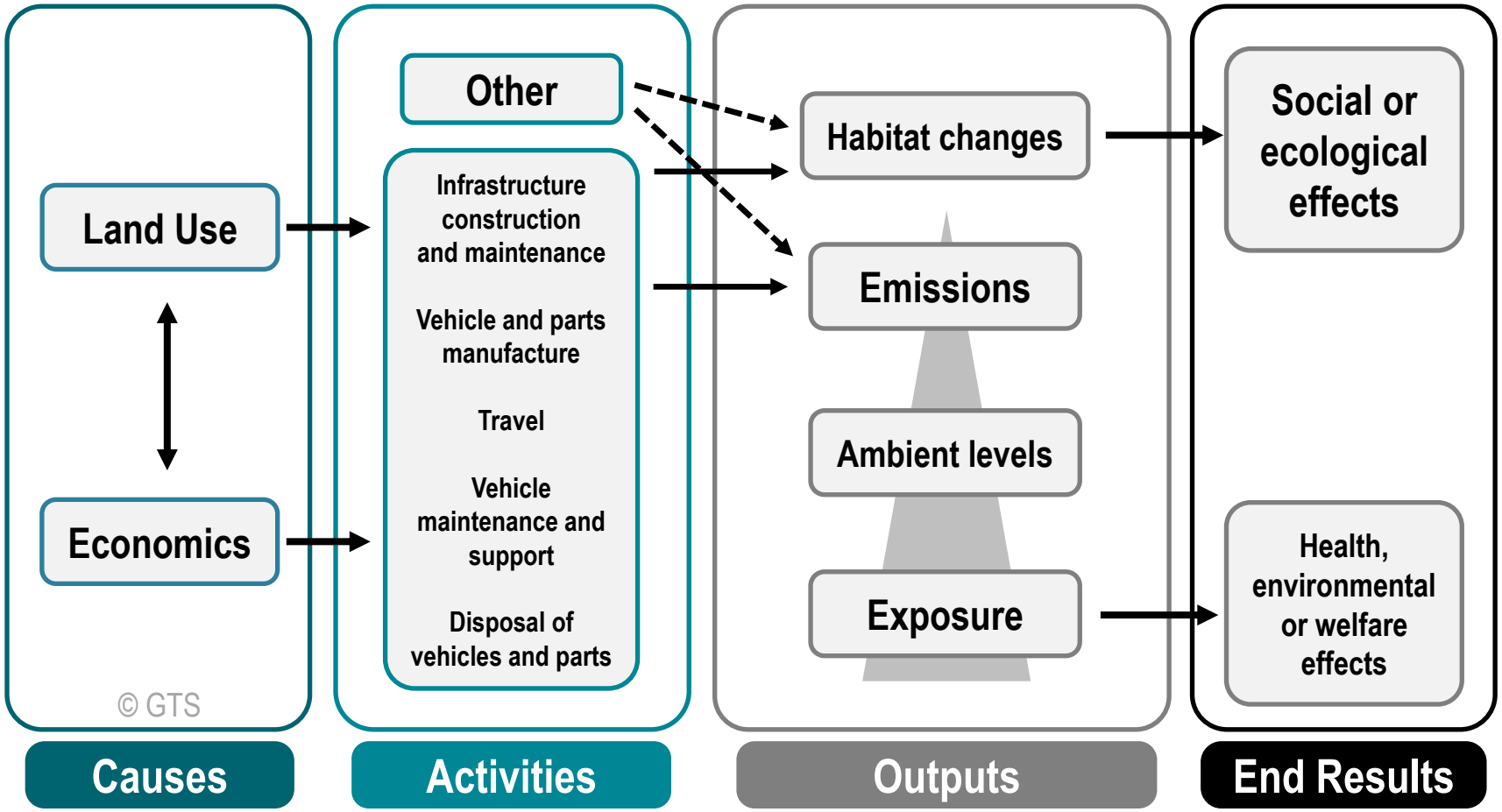
Road Fatalities per 100,000 People, Selected Countries

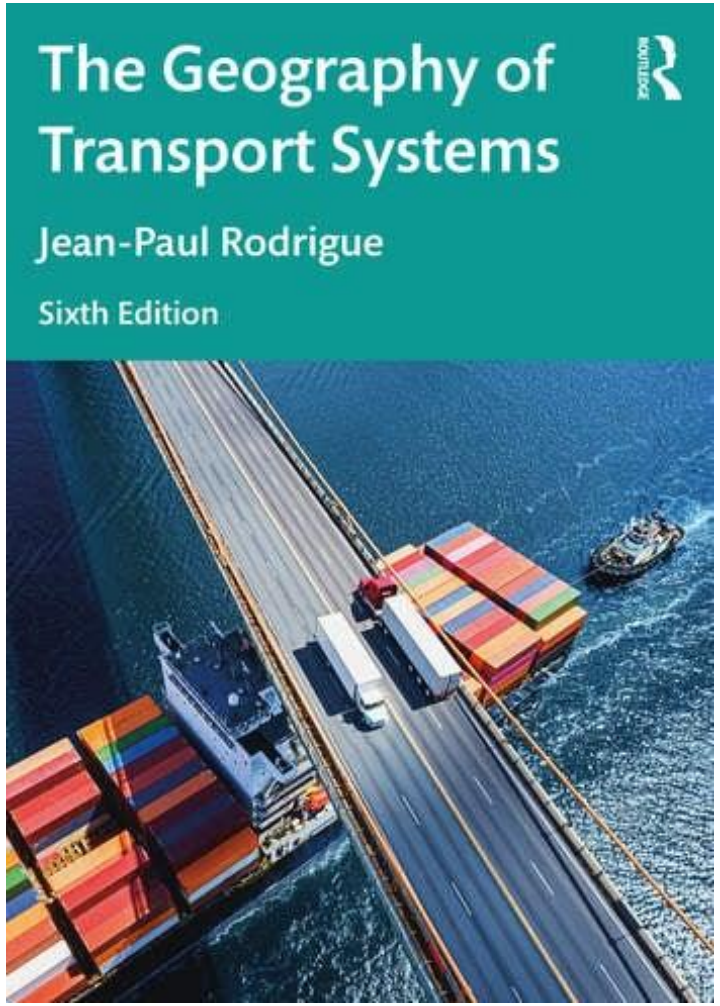


Economic Opportunities According to Automobile Ownership



Environmental Dimensions of Transportation

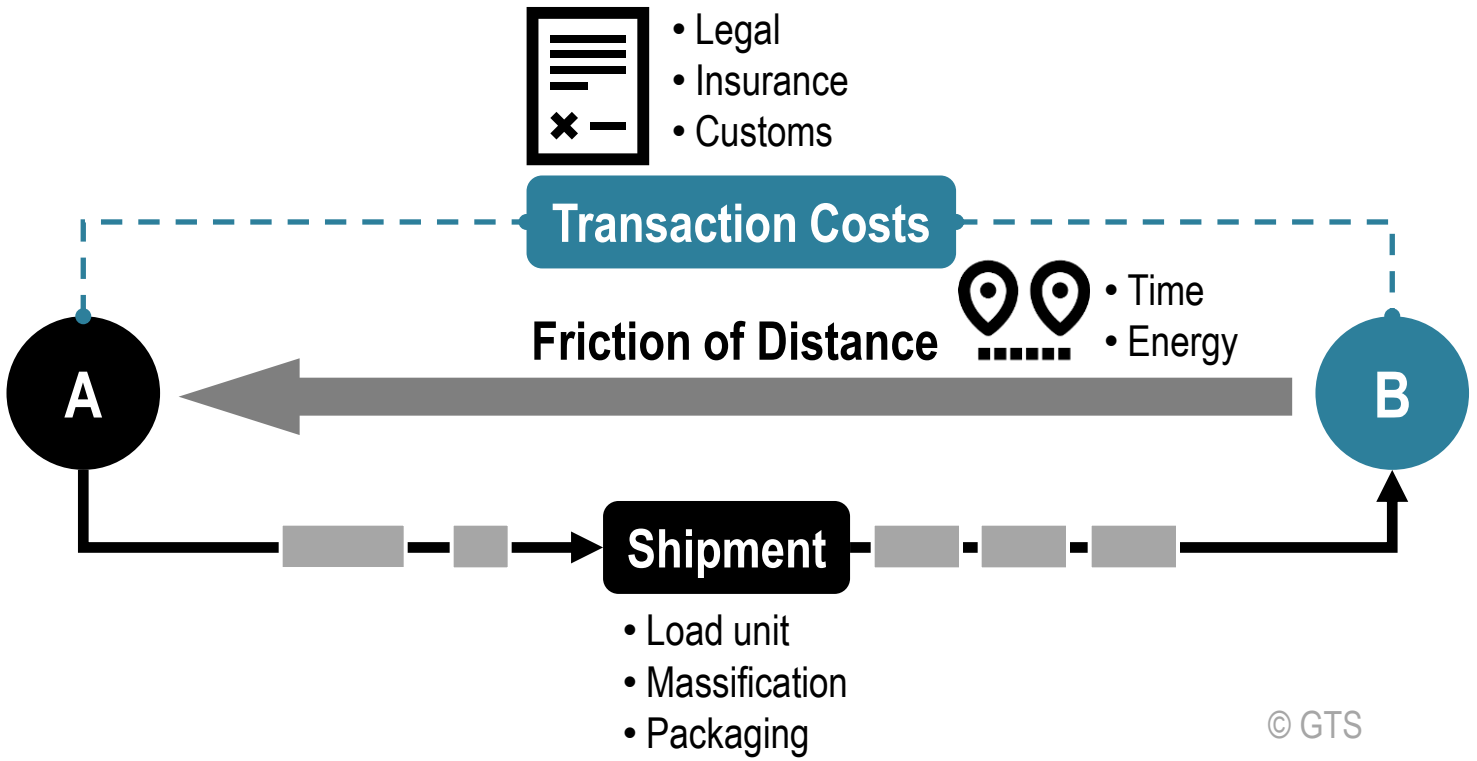




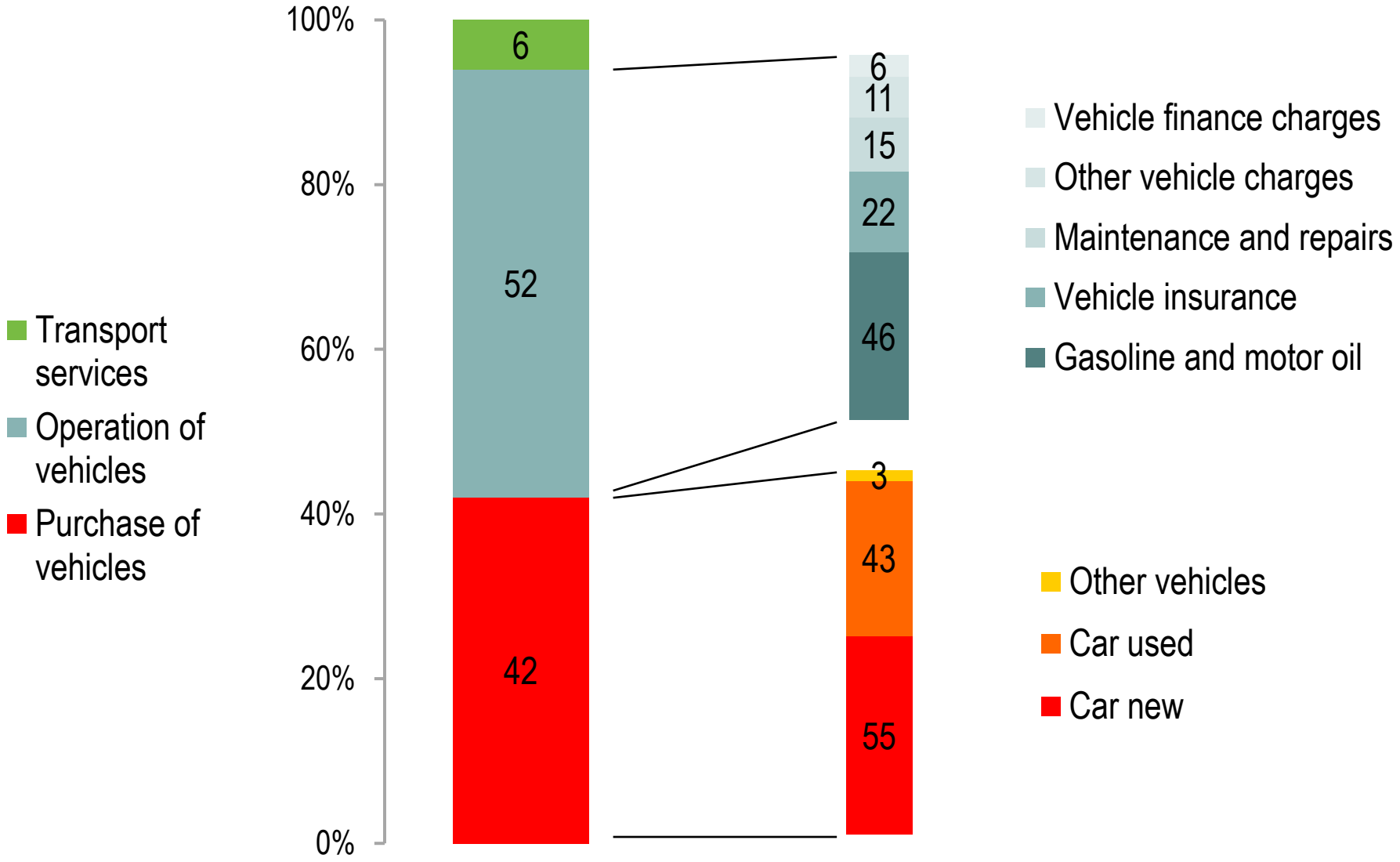
Transport Costs

Chapter 3.3

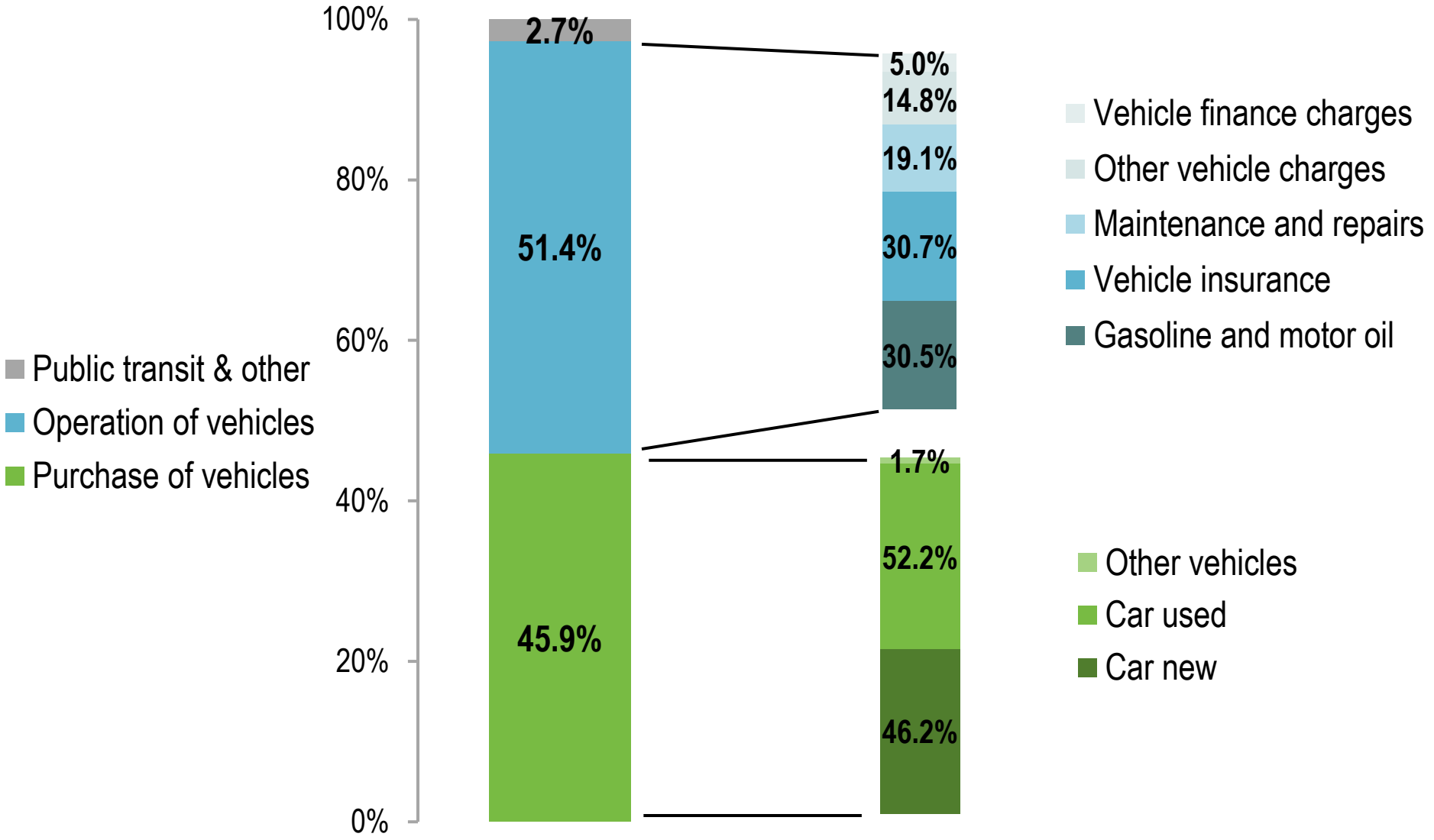
Components of Transport Cost



Household Expenditures on Transport, United States, 2005



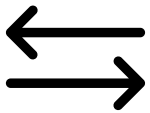
Household Expenditures on Transport, United States, 2020



Fixed and Operating Transport Costs

MODE	FIXED & CAPITAL COSTS	OPERATING COSTS
Road	• Land, Roads, Parking, Ramps, Bridges, Tunnels, Signalization • Vehicles and trailers	• Maintenance, Labor, Fuel/Energy
Rail	• Land, Tracks, Bridges, Tunnels, Signalization • Locomotives and Wagons • Rail yards and Terminals	• Maintenance, Labor, Fuel
Pipeline	• Land, Pipes • Pumping stations and Tanks	• Maintenance, Energy
Air	• Land, Field, Terminal • Aircraft	• Maintenance, Fuel, Labor, Airport charges
Maritime	• Land for port terminals • Cargo handling equipment • Ships	• Maintenance, Fuel, Labor, Port Charges
Telecommunications	• Towers, Hubs, Poles, Cables • Exchanges, Servers	• Maintenance, Energy

Conditions Affecting Transport Costs

	CONDITIONS	FACTORS	EXAMPLES
	Geography	• Distance, physiography, accessibility	• Shipping between France and England vs. shipping between France and the Netherlands
	Type of Product	• Amenities, packaging, density, weight, perishability	• Business vs economy class • Shipping coal, flowers or wine
	Economies of Scale	• Shipment size	• Narrow-body vs. a wide-body flight (passengers) • Post-Panamax vs. to Panamax (freight)
	Imbalances	• Empty travel	• Commuting • Trade between China and the United States
	Infrastructure	• Capacity, operational conditions	• The Interstate
	Mode	• Capacity, operational conditions	• A bus vs. a car • A bulk ship vs. a containership
	Regulations	• Tariffs, operational restrictions, safety, ownership	• Anti-trust regulations • The Jones Act

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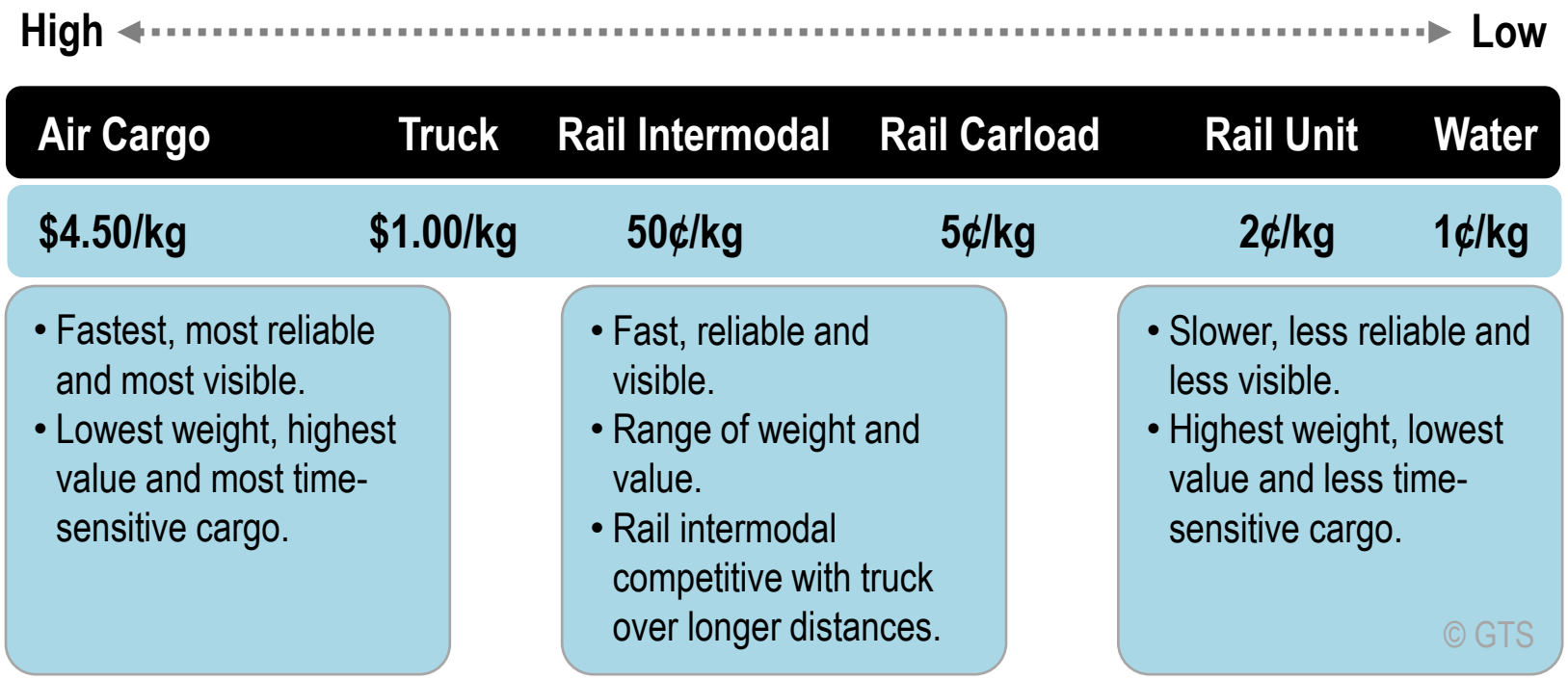
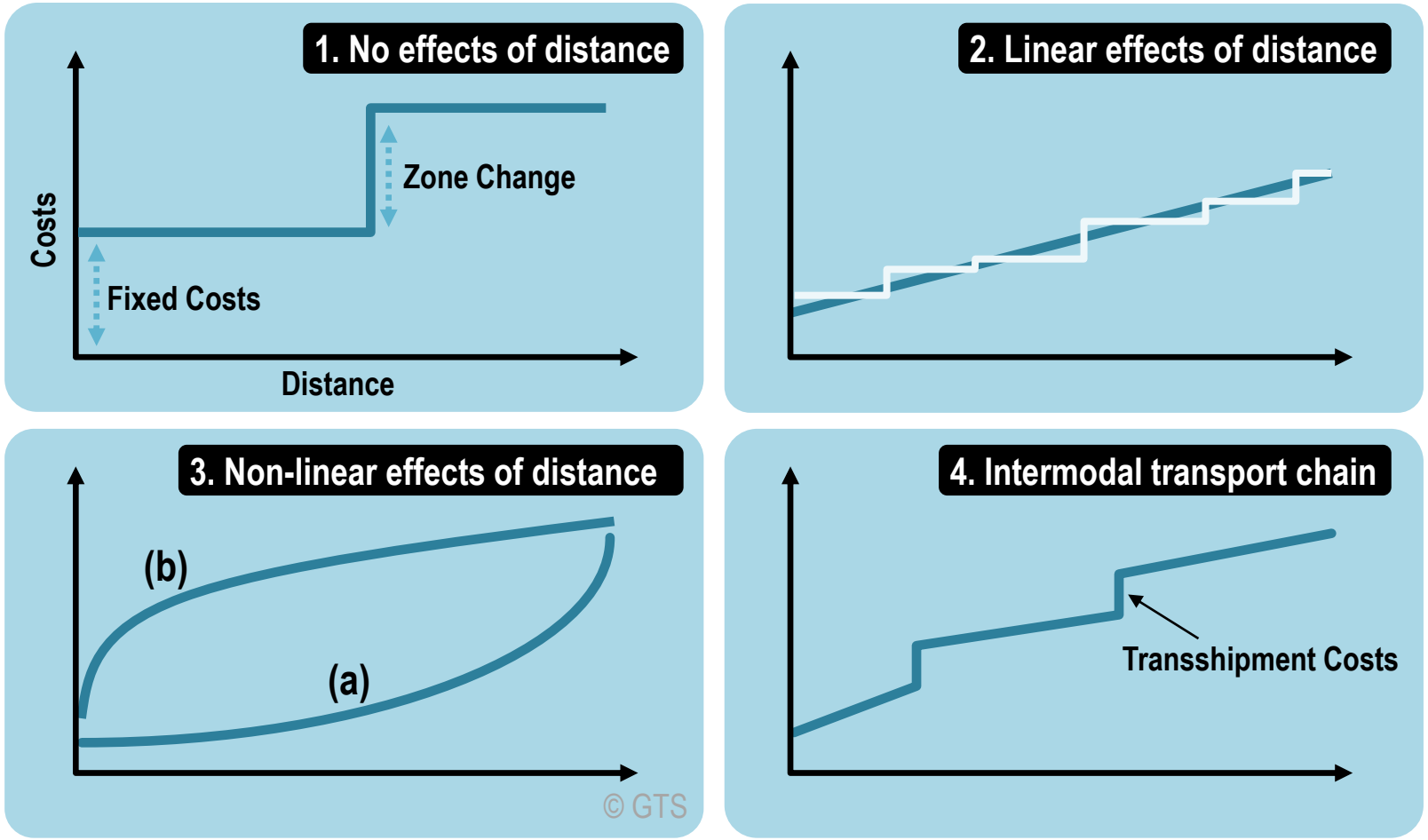
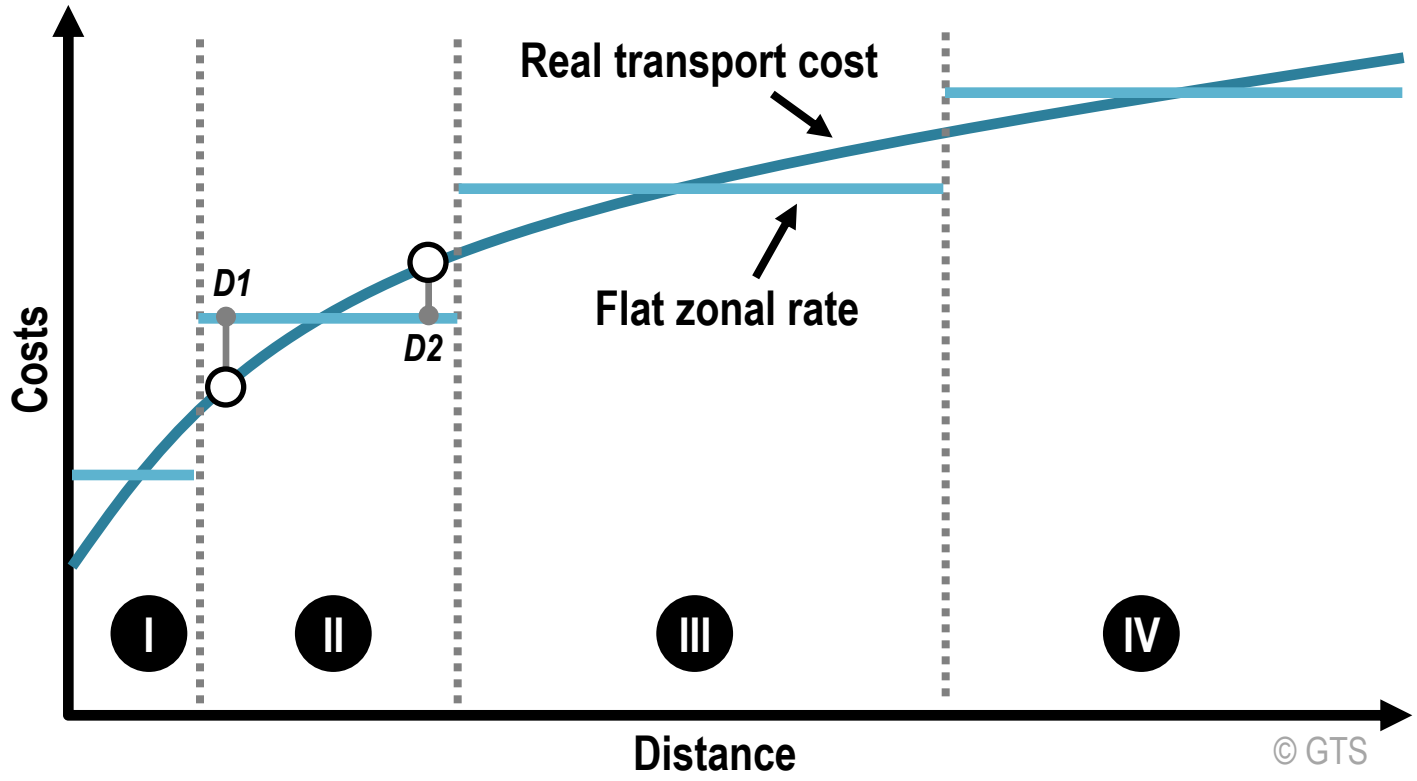
Freight Transportation Service Spectrum



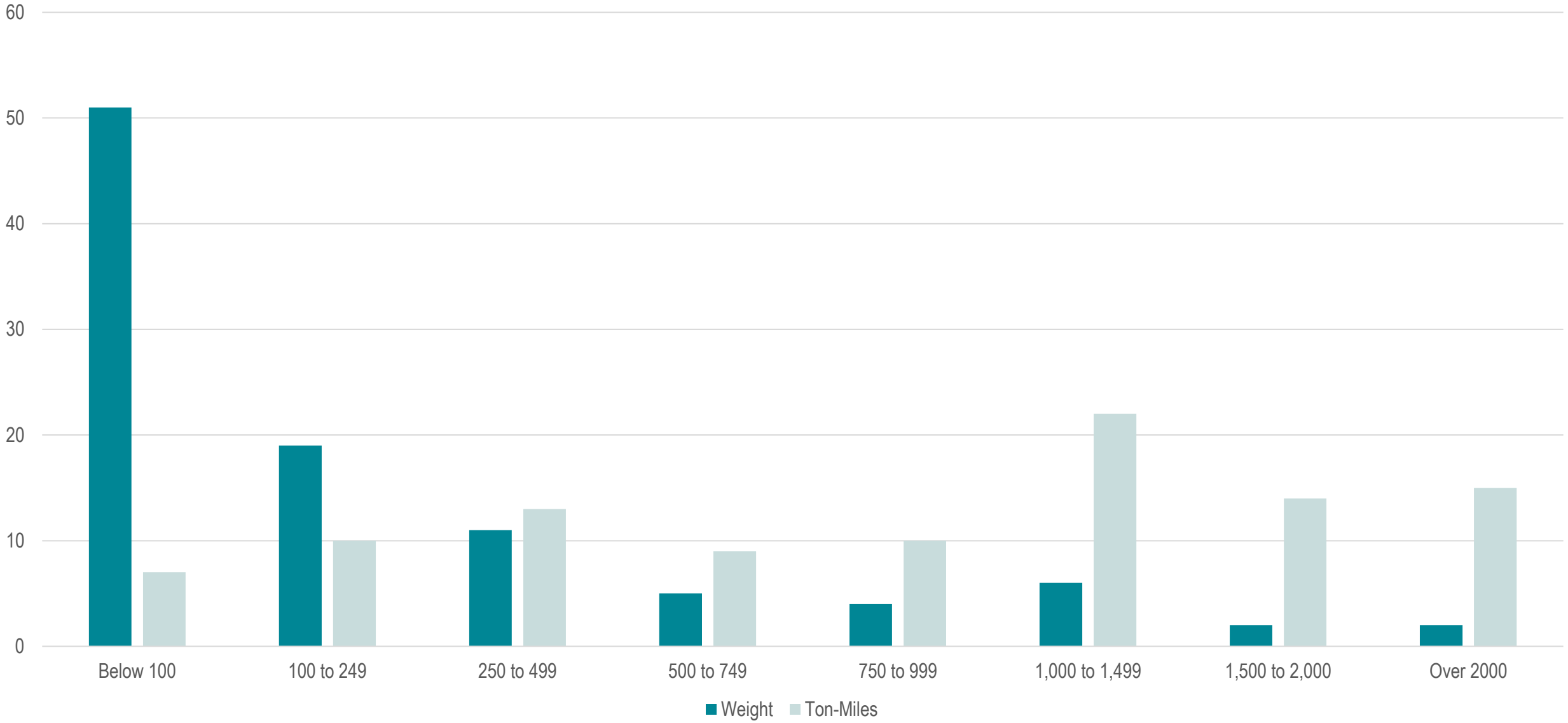
Friction of Distance Functions



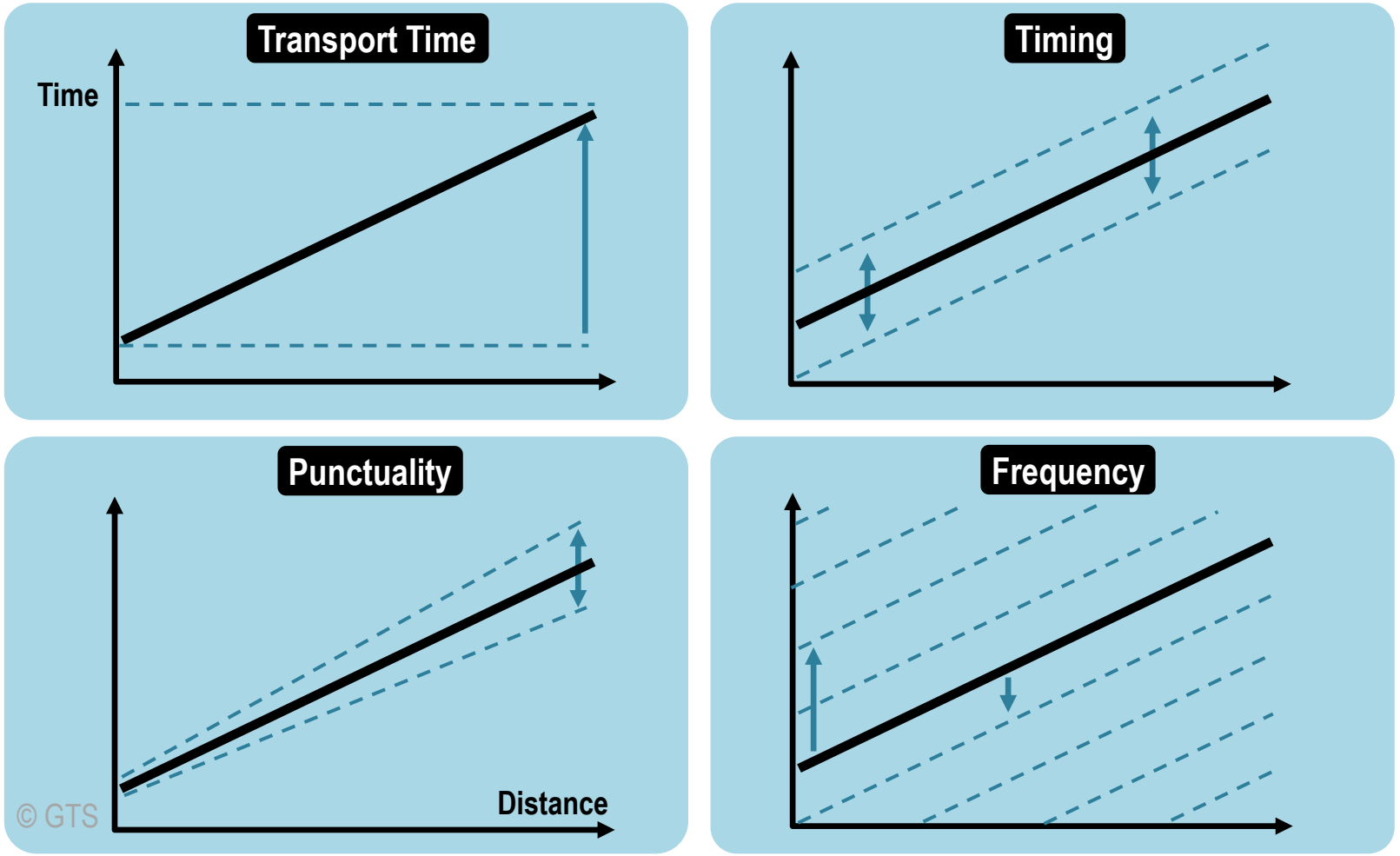
Zonal Freight Rates



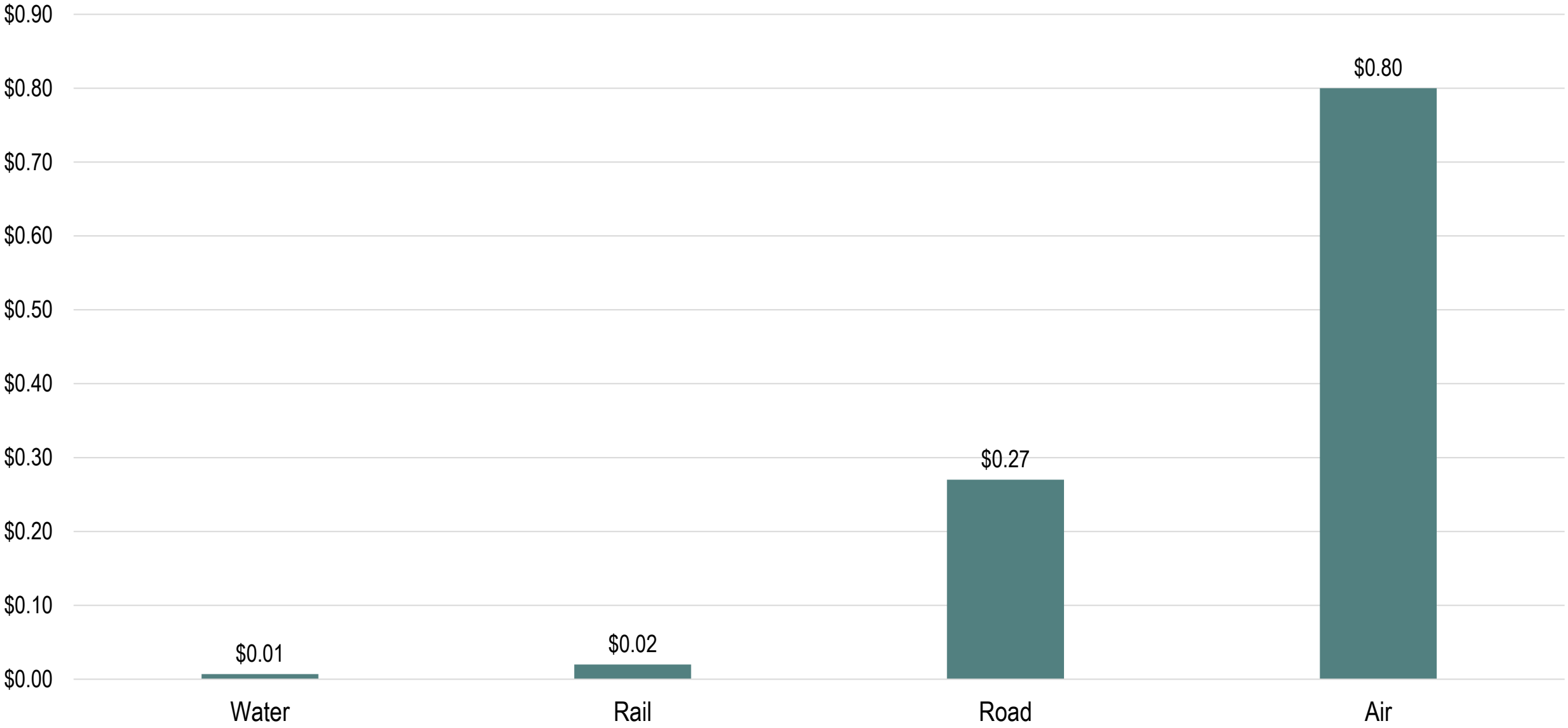
Total Freight Moved by Distance, United States, 2007



Different Components of Transport Time



Freight Transport Revenue per Ton-Mile (in 2006 dollars)



Breakeven Cost Per Mile

Moving product on a newer commercial truck in the United States costs $2.167 per mile, on average, just to cover expenses.

36%
Driver Wages
$0.797 per mile

24%
Fuel
$0.515 per mile

3%
Insurance
$0.068 per mile

15%
Truck/Trailer Lease/Purchase
$0.317 per mile

3%
Permits/ Licenses & Tolls
$0.057 per mile

7%
Repairs & Maintenance
$0.157 per mile

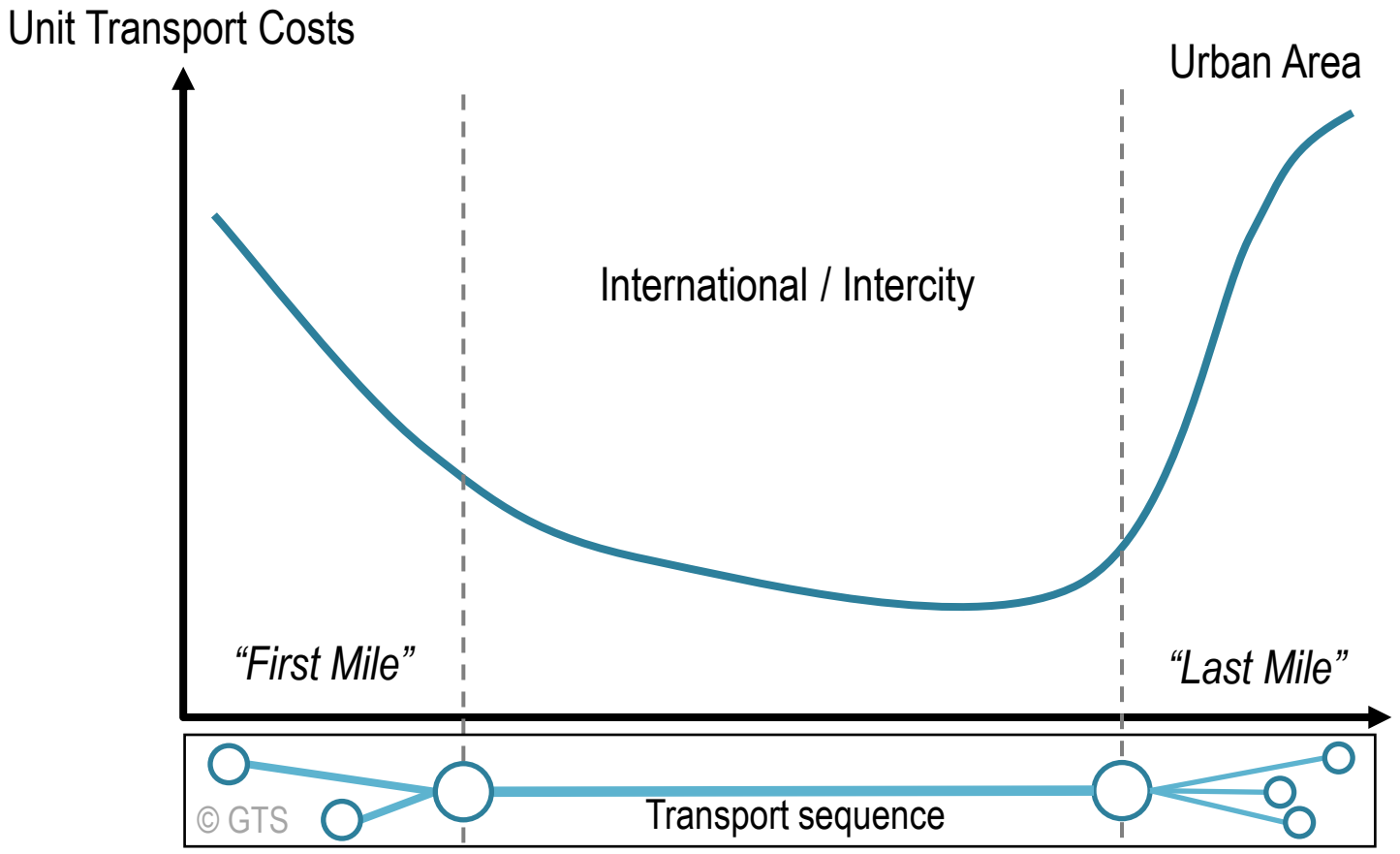
12%
Empty Miles Cost
$0.256 per mile

$2.167

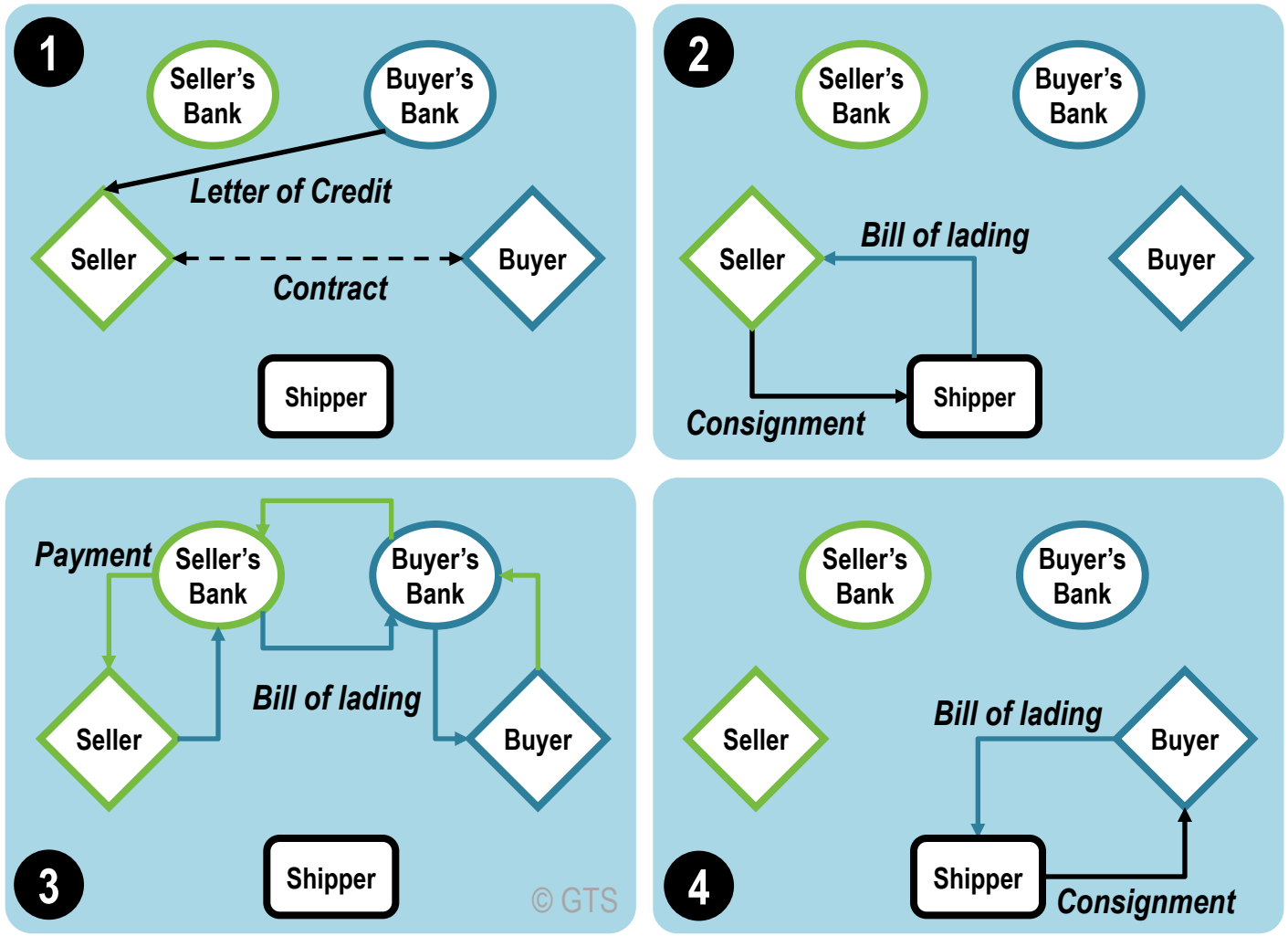
Breakeven Price Per Mile: $2.167

Data as of October 2021 – SOURCES: eia.gov, ATRI, stlouisfed.org, truckingresearch.org

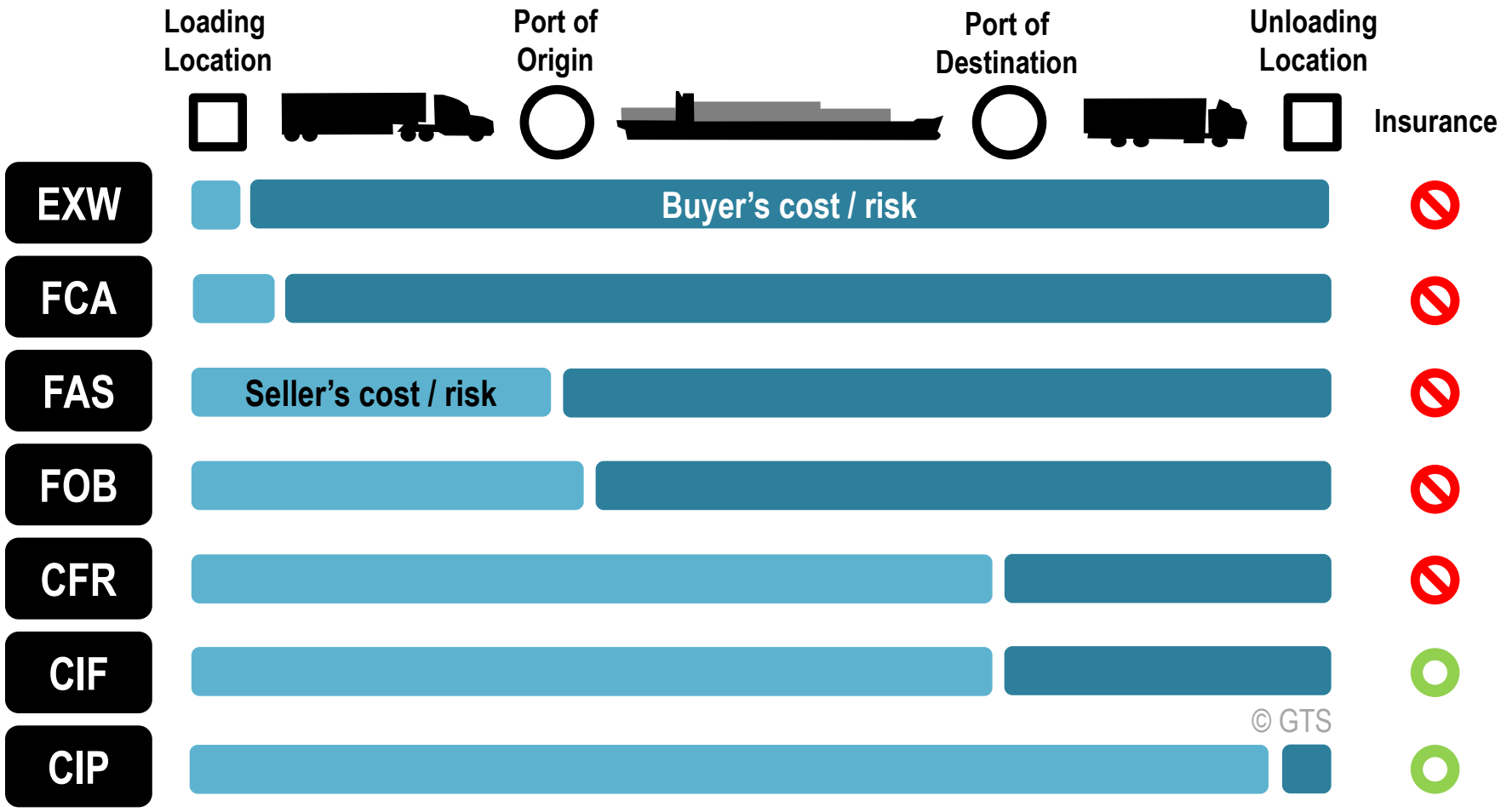
First and Last Mile Unit Cost Structure



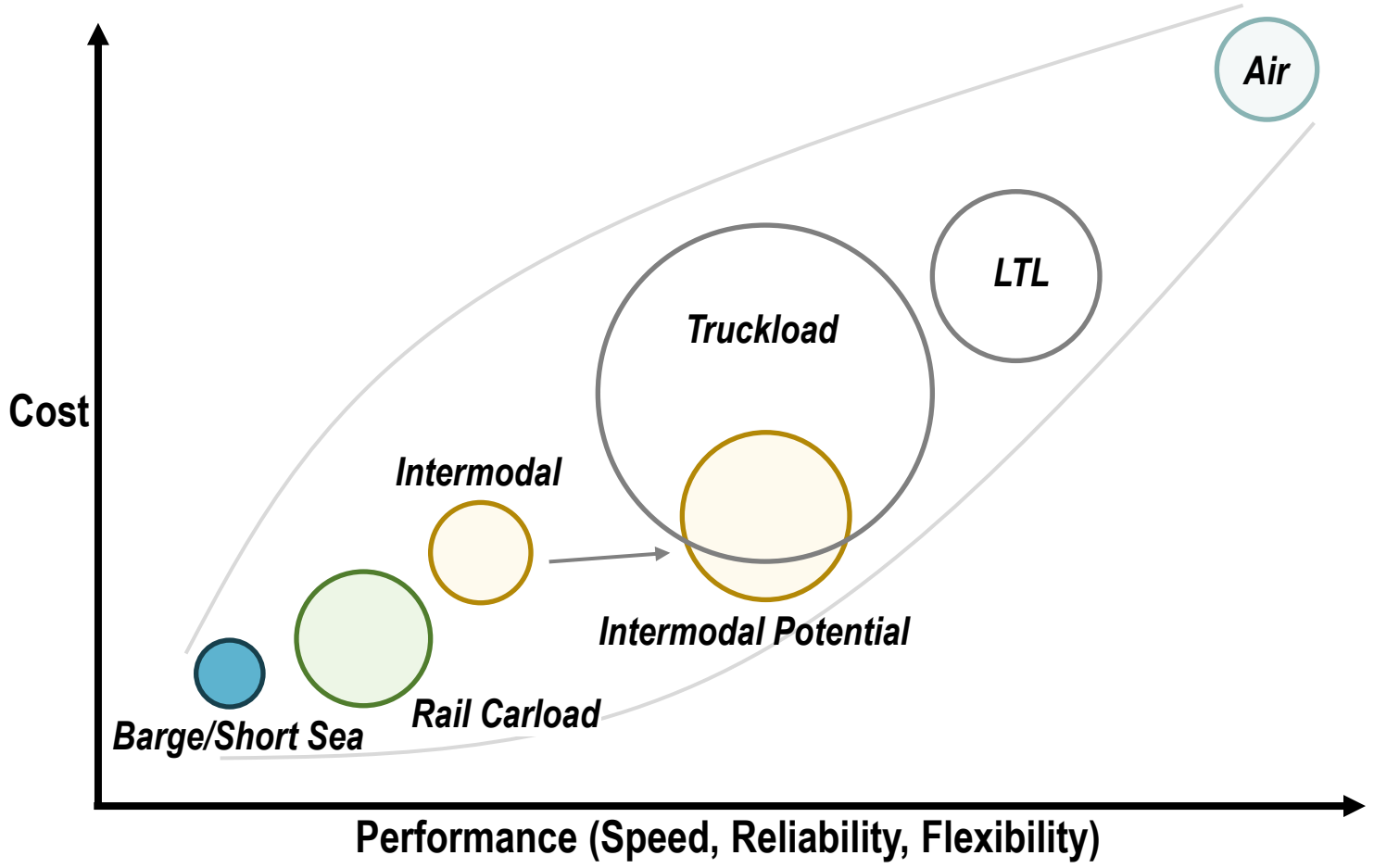
Letters of Credit and Bills of Lading in Commercial Transactions



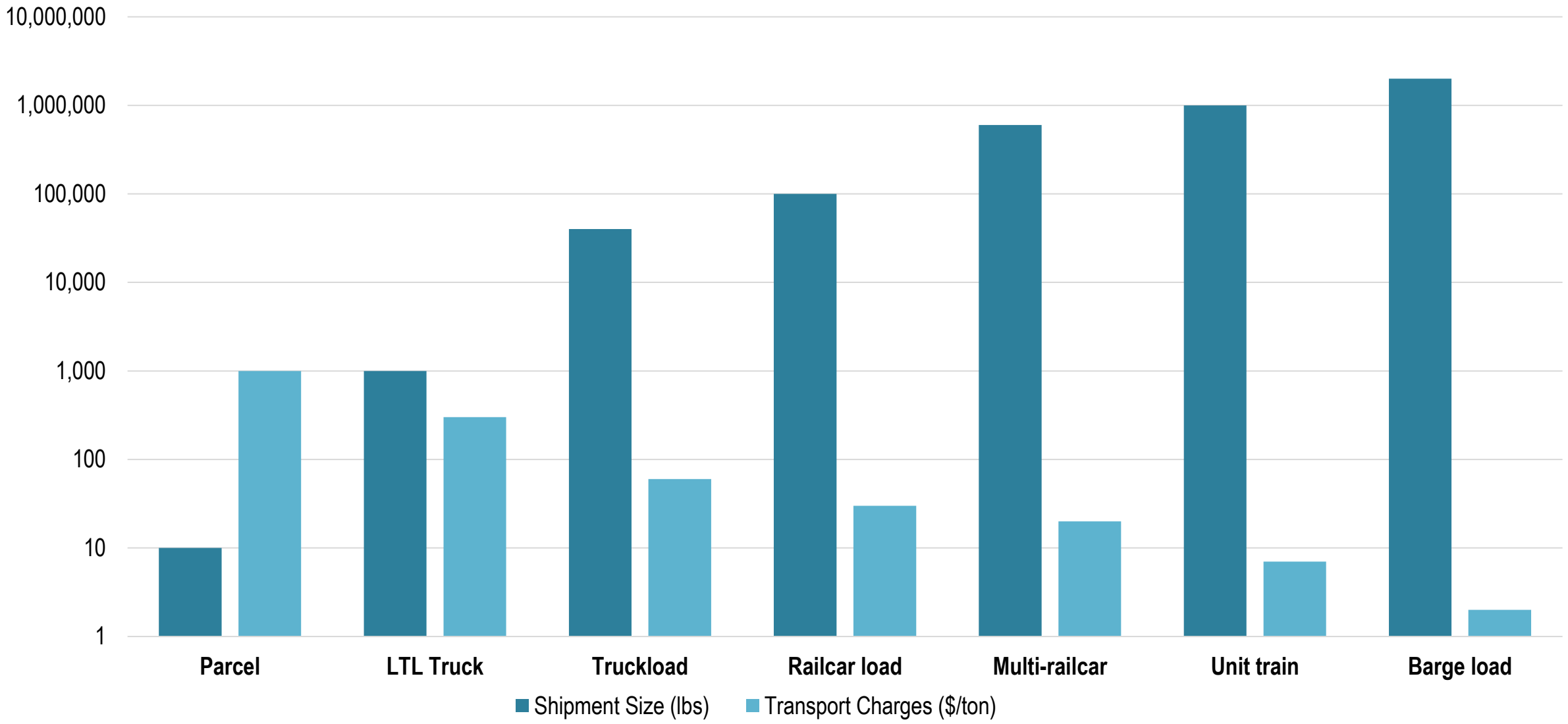
Selected International Commercial Terms (Incoterms)



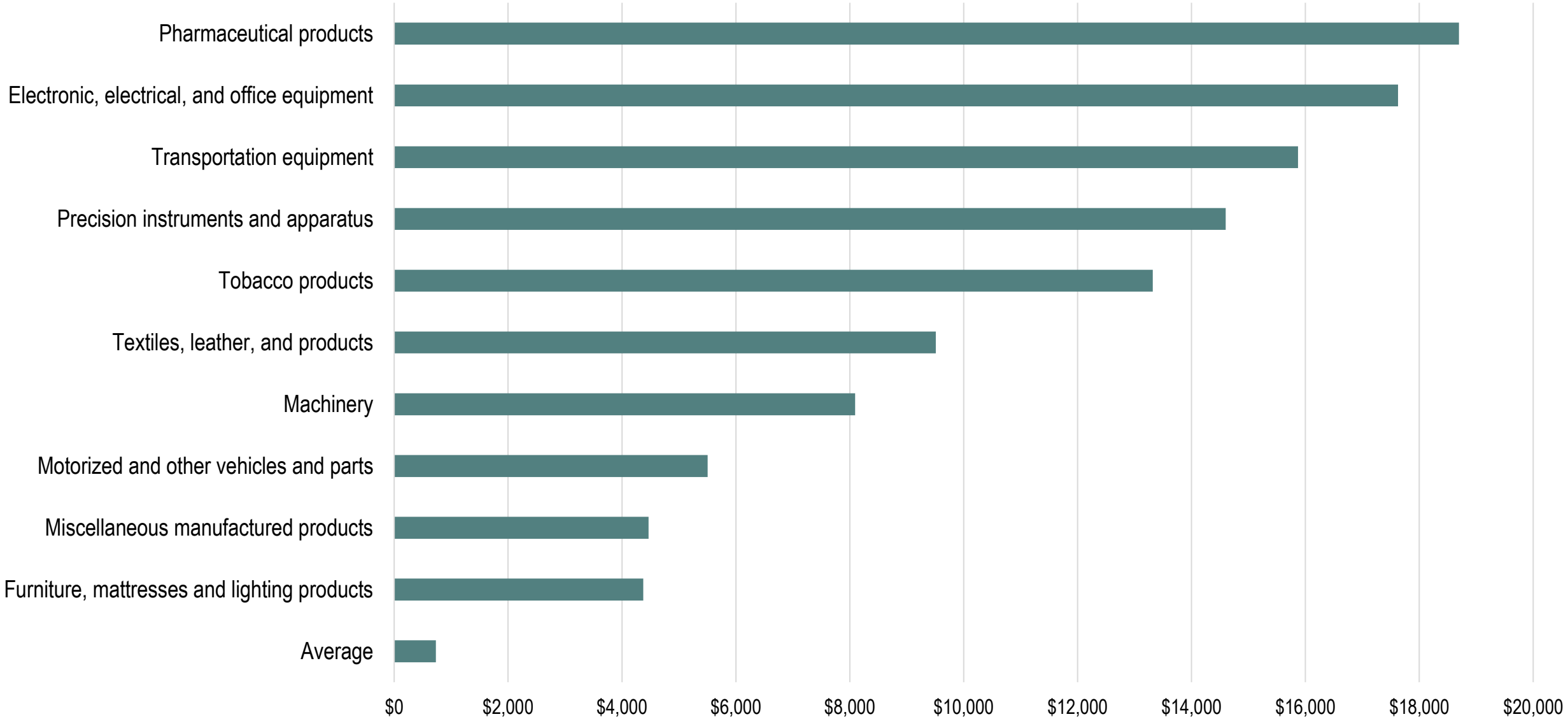
Cost / Performance Relationships for Inland Freight Transportation Modes



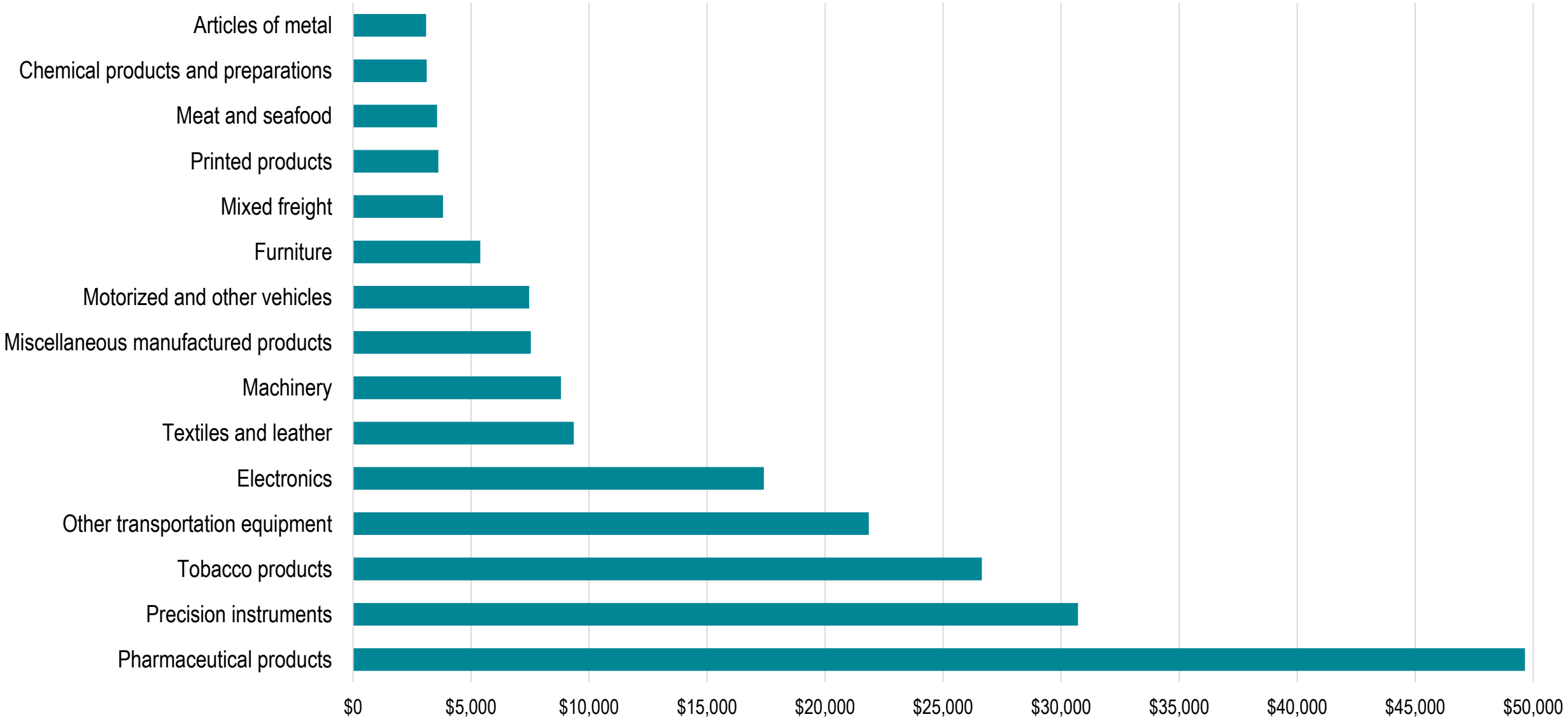
Shipment Size and Inland Transport Costs



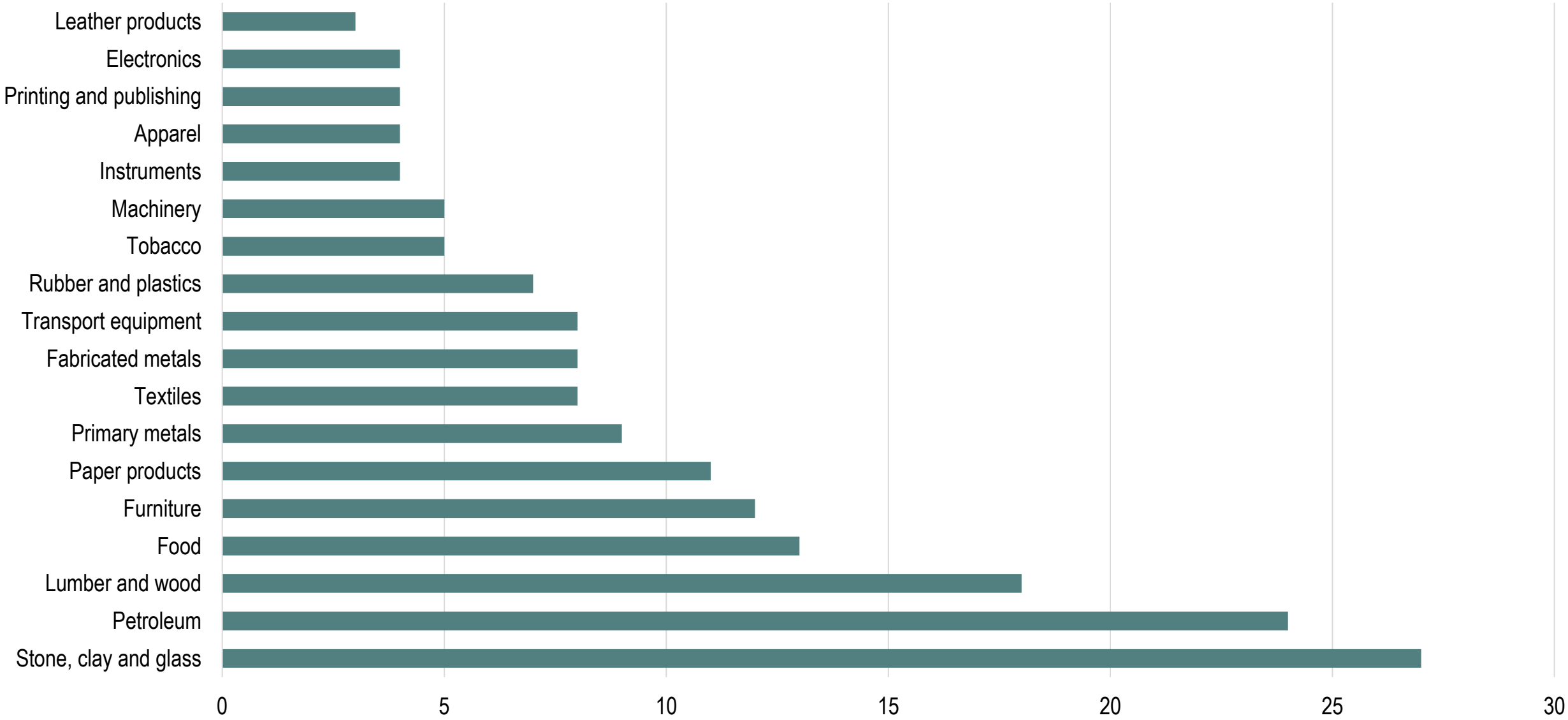
Top 10 Commodity Groups Ranked by Value Per Ton, United States, 2002



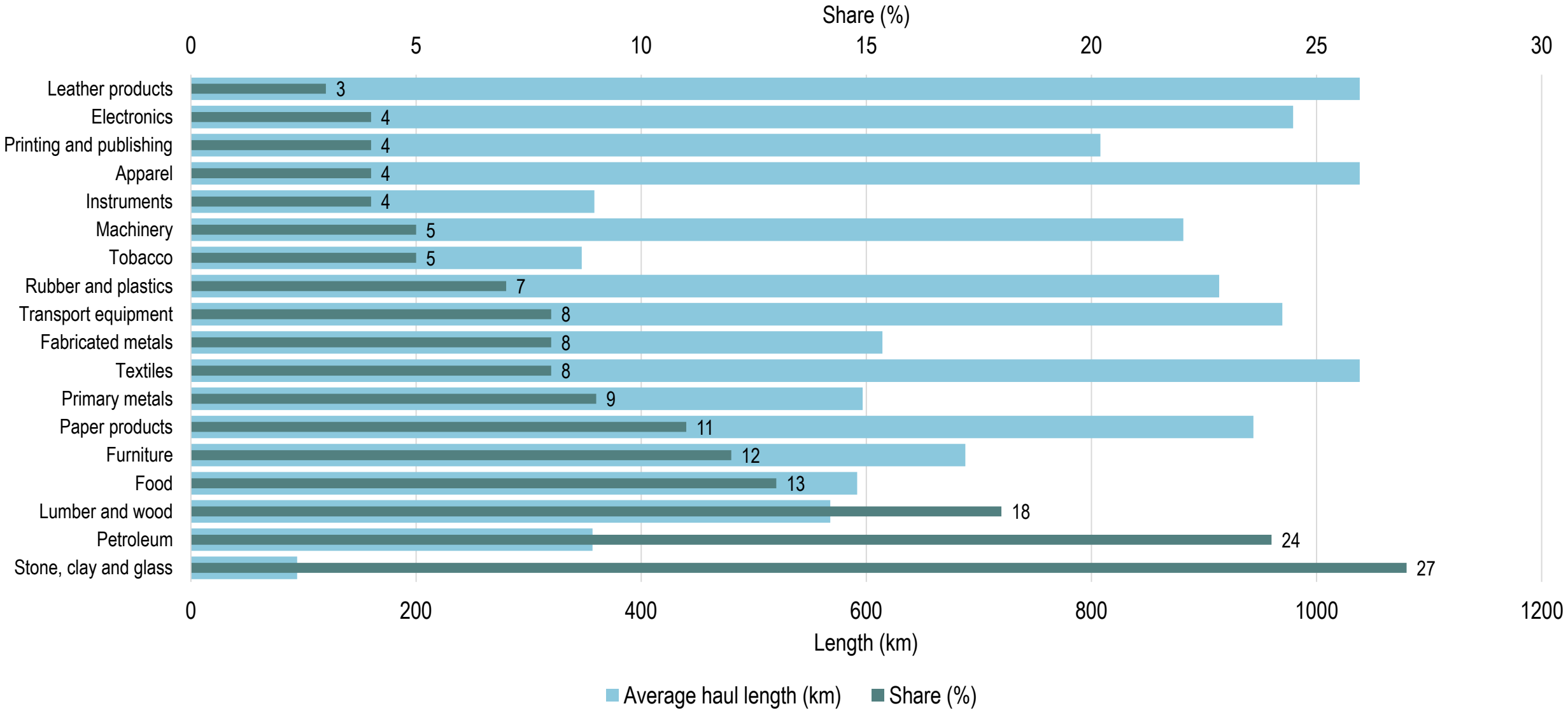
Top 15 Commodity Groups Ranked by Value Per Ton, United States, 2017



Share of Transport Costs in Product Prices



Share of Transport Costs in Product Prices and Average Haul Length



Share of Transport Costs in Product Prices and Average Domestic Haul Length

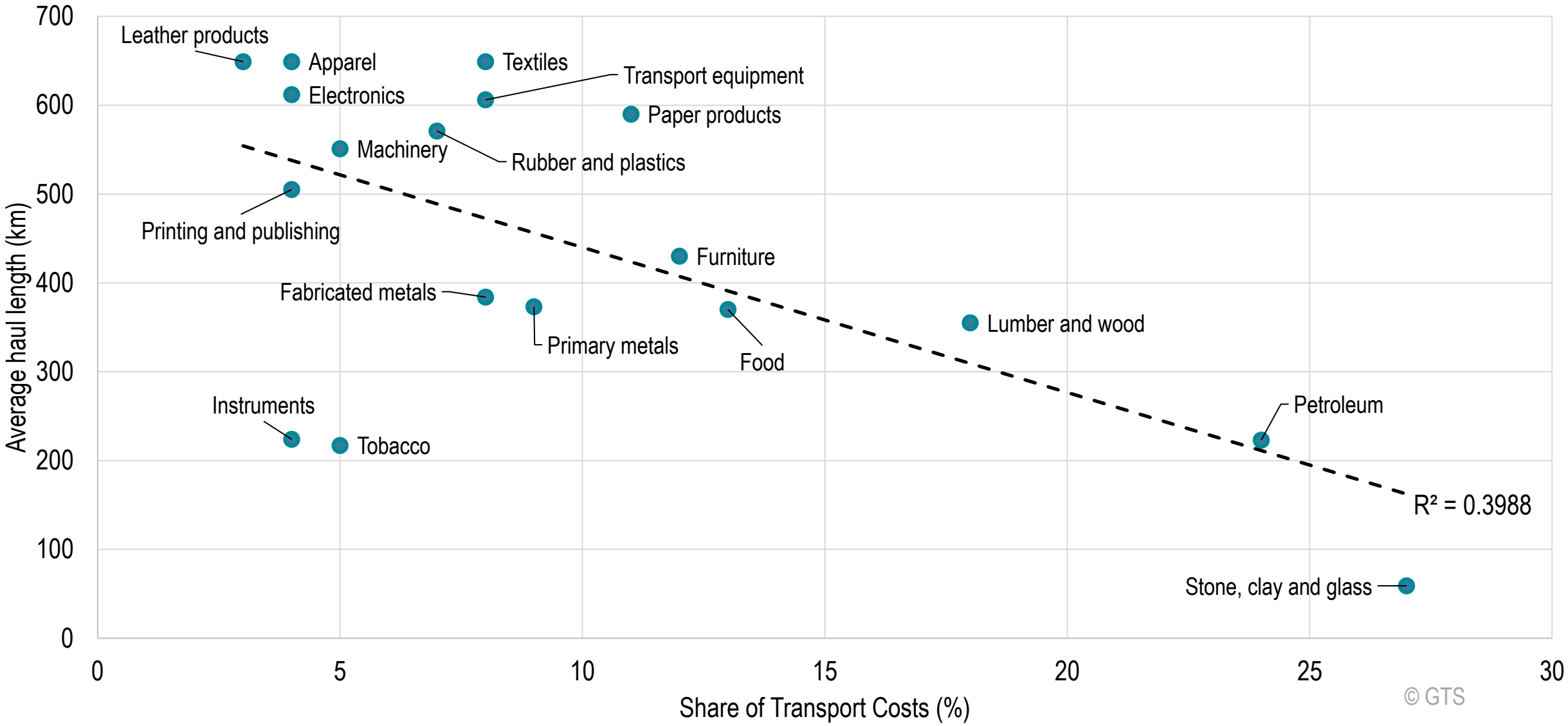
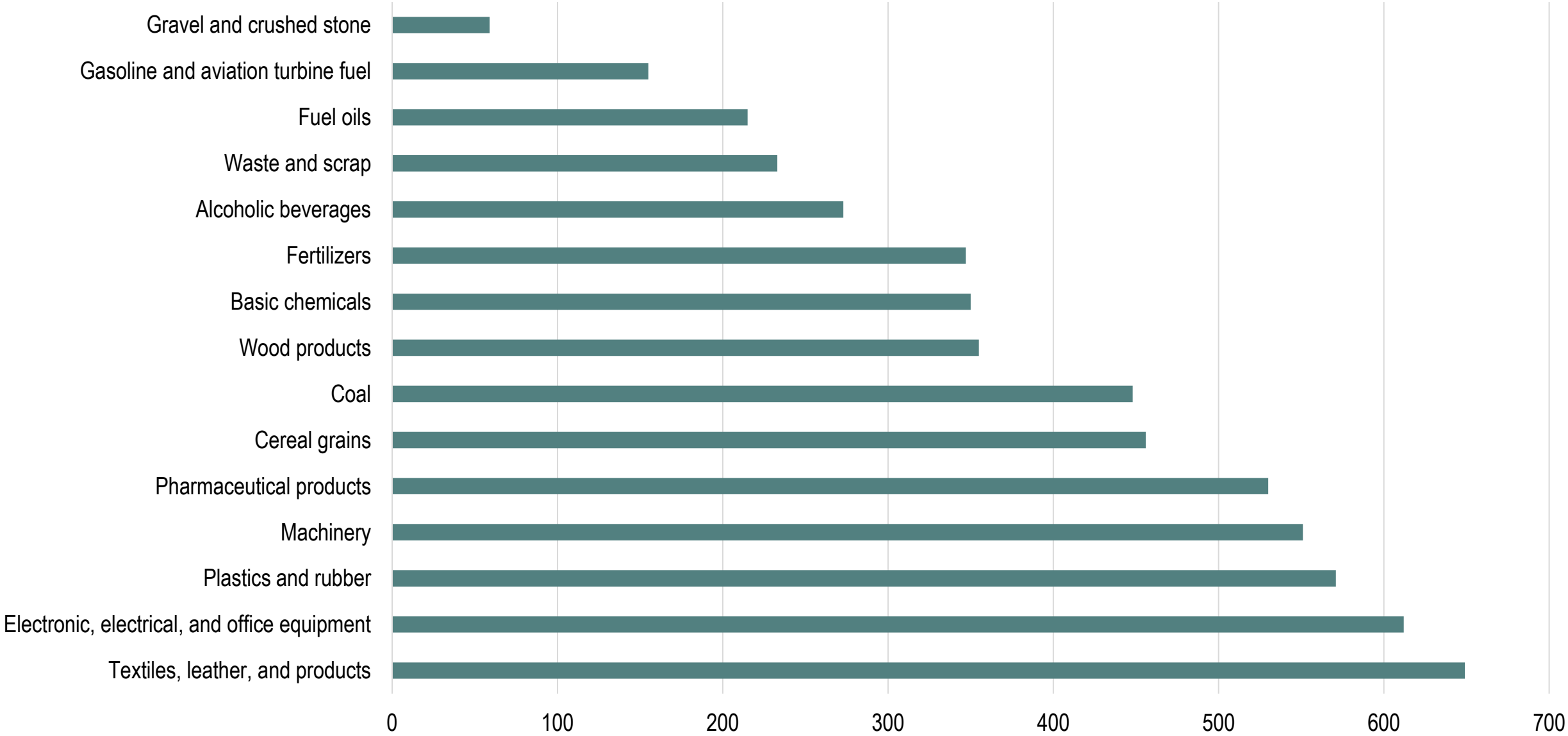


Table 4. HMT Average Payment for Containerized Cargo

Commodity	$ Value/ton	$ Value/40' container	HMT/40' container
Electronics	12,104	117,606	$147.01
Apparel	14,517	114,274	$142.84
Hardware	7,096	107,916	$134.90
Autos and Auto Parts	6,452	90,248	$112.81
Footwear	11,745	84,310	$105.39
Toys and Sport Equipment	7,964	68,032	$85.04
Beverages, Spirits, Vinegar	2,128	49,546	$61.93
Plastic Products	3,421	37,168	$46.46
Furniture	3,268	27,210	$34.01
Woodenware	1,315	21,860	$27.32

Source: FMC, *Study of U.S. Inland Containerized Cargo Moving Through Canadian and Mexican Seaports*, July 2012, p. 42.

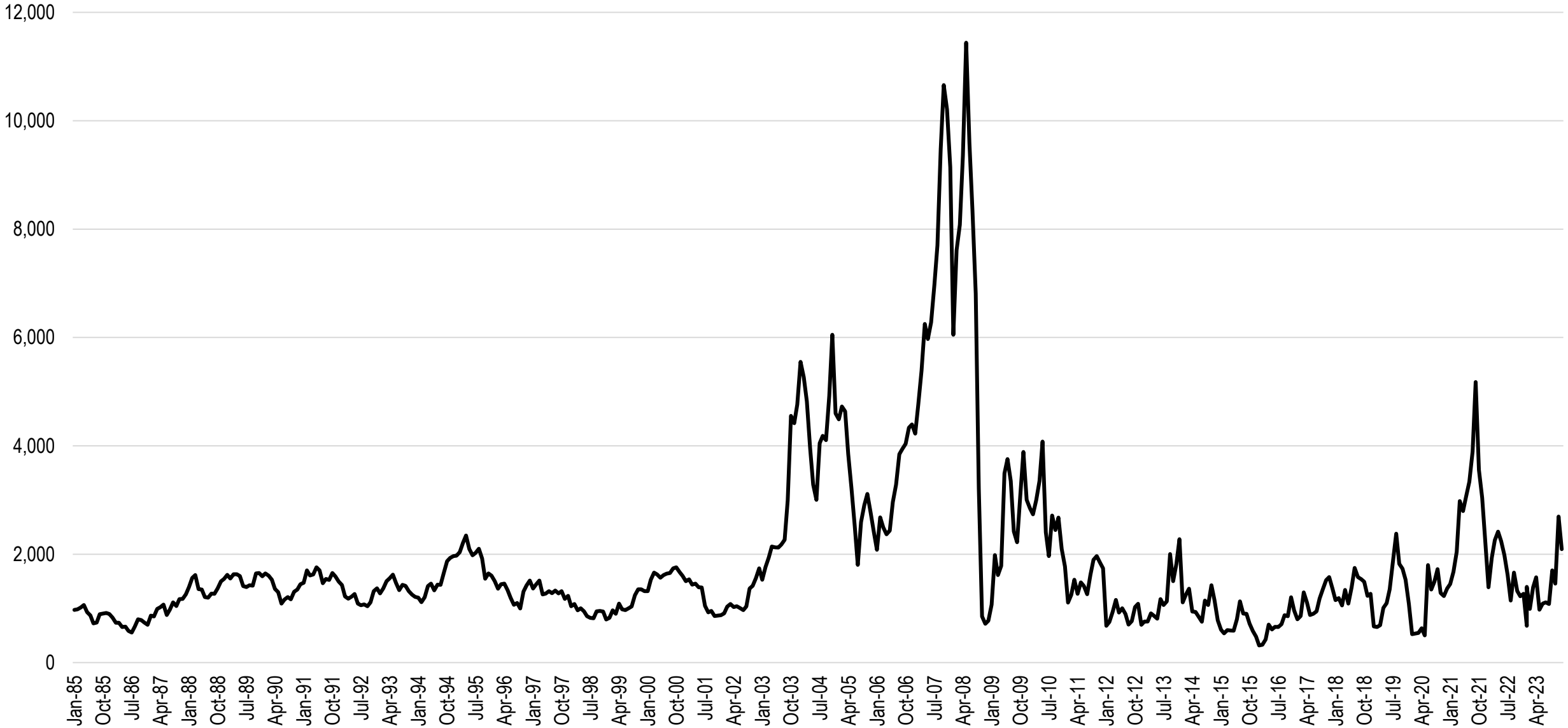
Average Length of Haul by Major Commodity Group, 2002 (in miles)



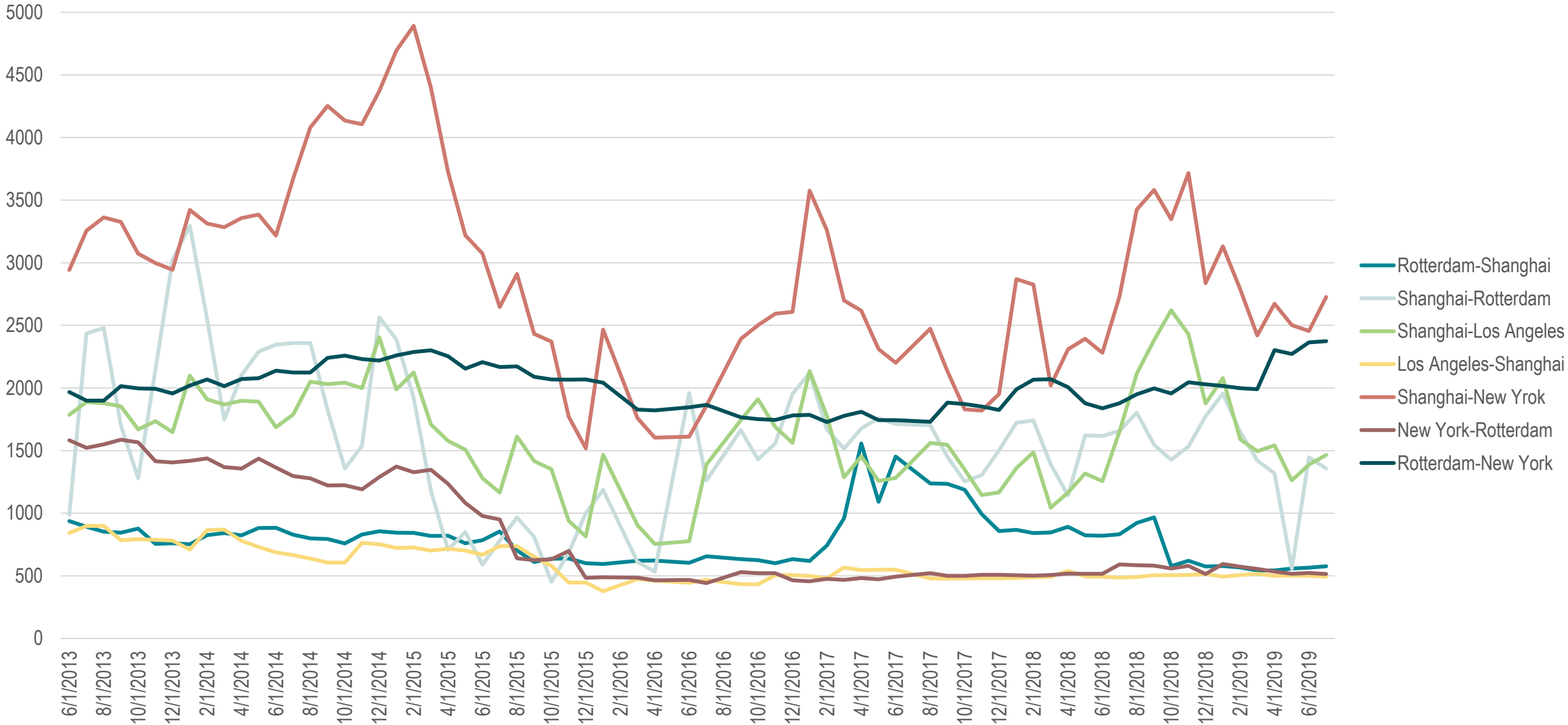
Typical Ocean Freight Costs for some Products (Asia – United States or Asia – Europe)

	Typical Shelf Price	Shipping Costs	Shipping Costs Share
LCD TV Set	$700	$4.00	0.5%
Digital Camera (high range)	$450	$0.15	0.03%
Vacuum Cleaner	$150	$1.00	0.6%
Scotch Whisky (bottle)	$50	$0.15	0.3%
Coffee (1 kg)	$15	$0.15	3.3%
Biscuits (Tin)	$3	$0.05	1.7%
Beer (Can)	$1	$0.01	1.0%
Apple	$0.75	$0.04	5.3%

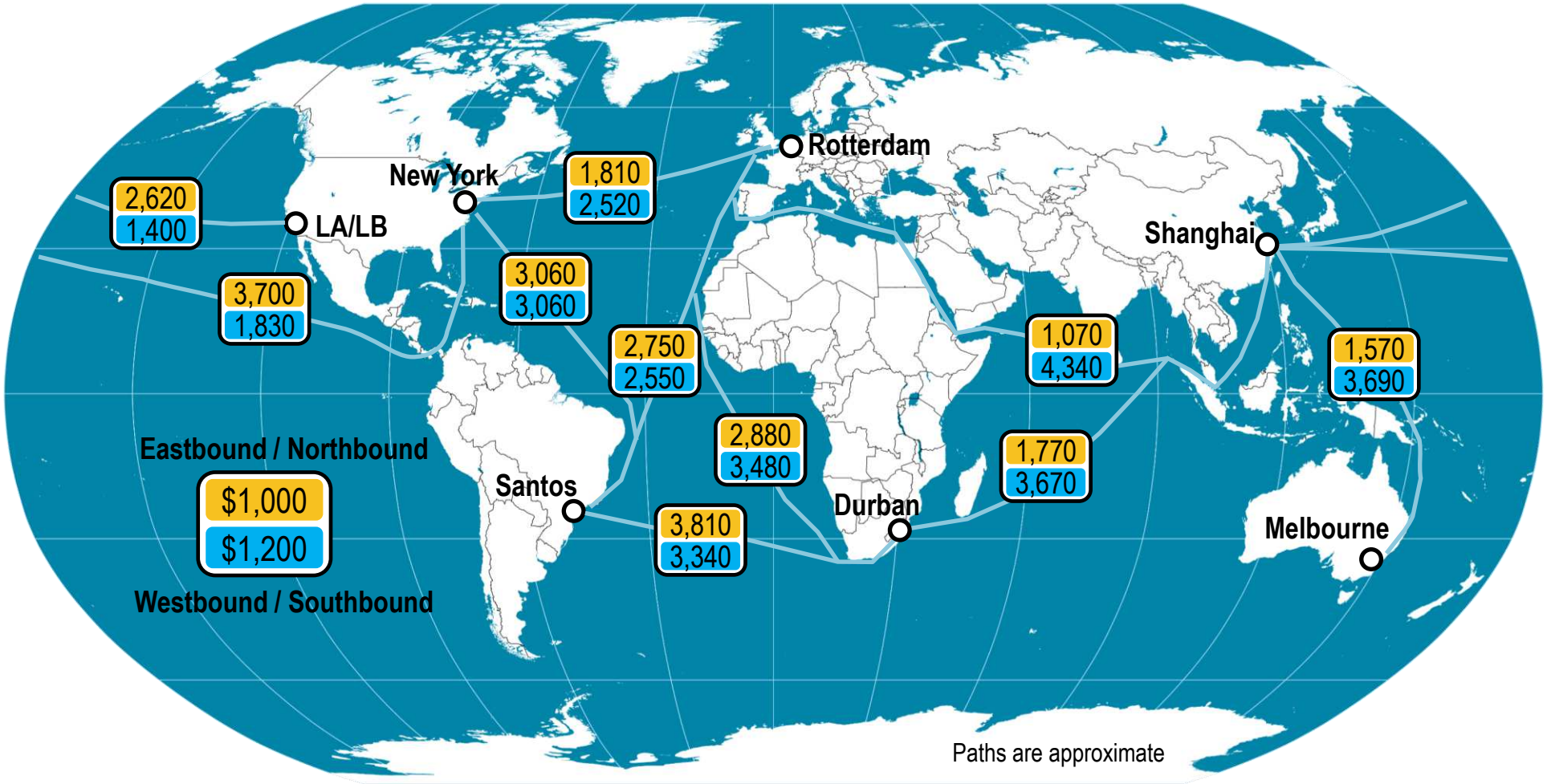
Baltic Dry Index, Monthly Value, 1985-2023



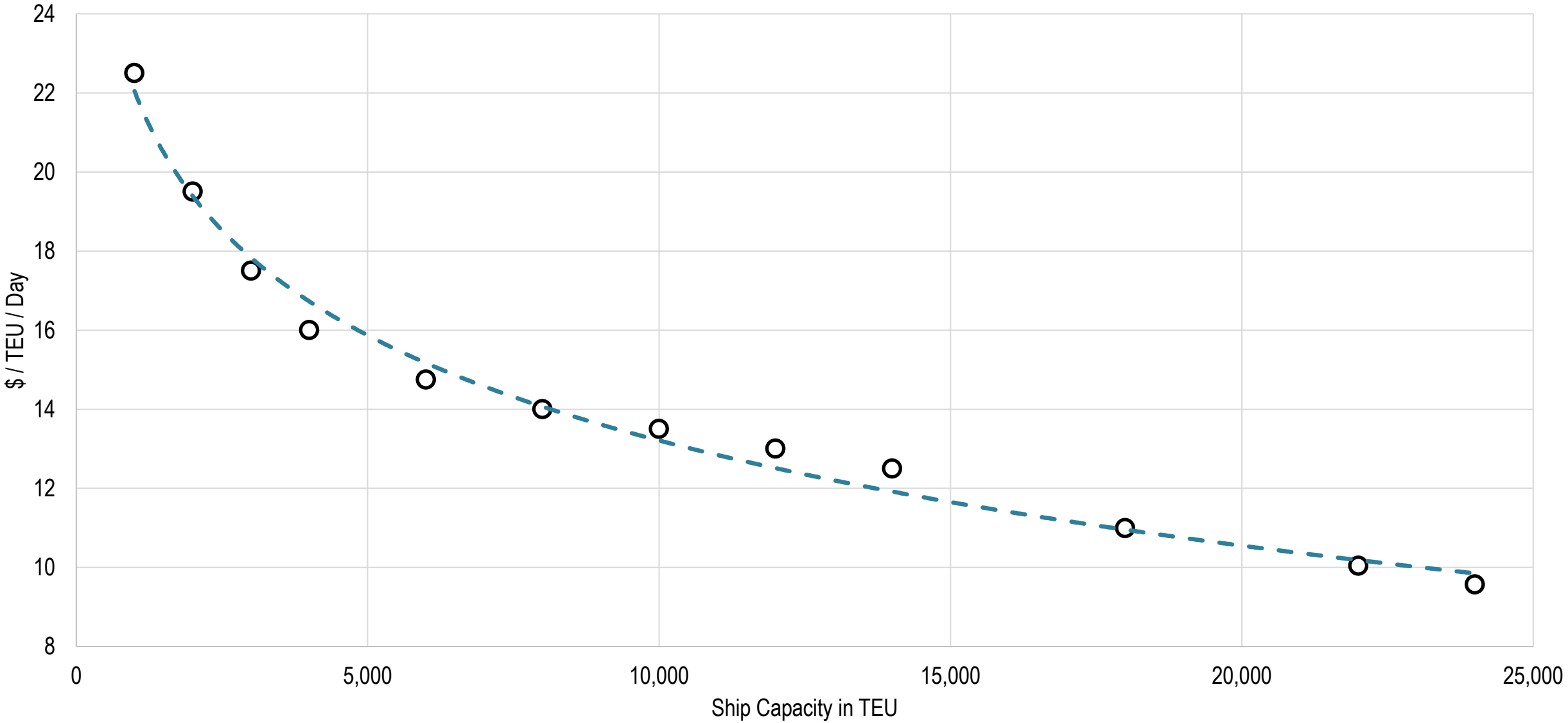
World Container Route Index, Monthly (To be updated)



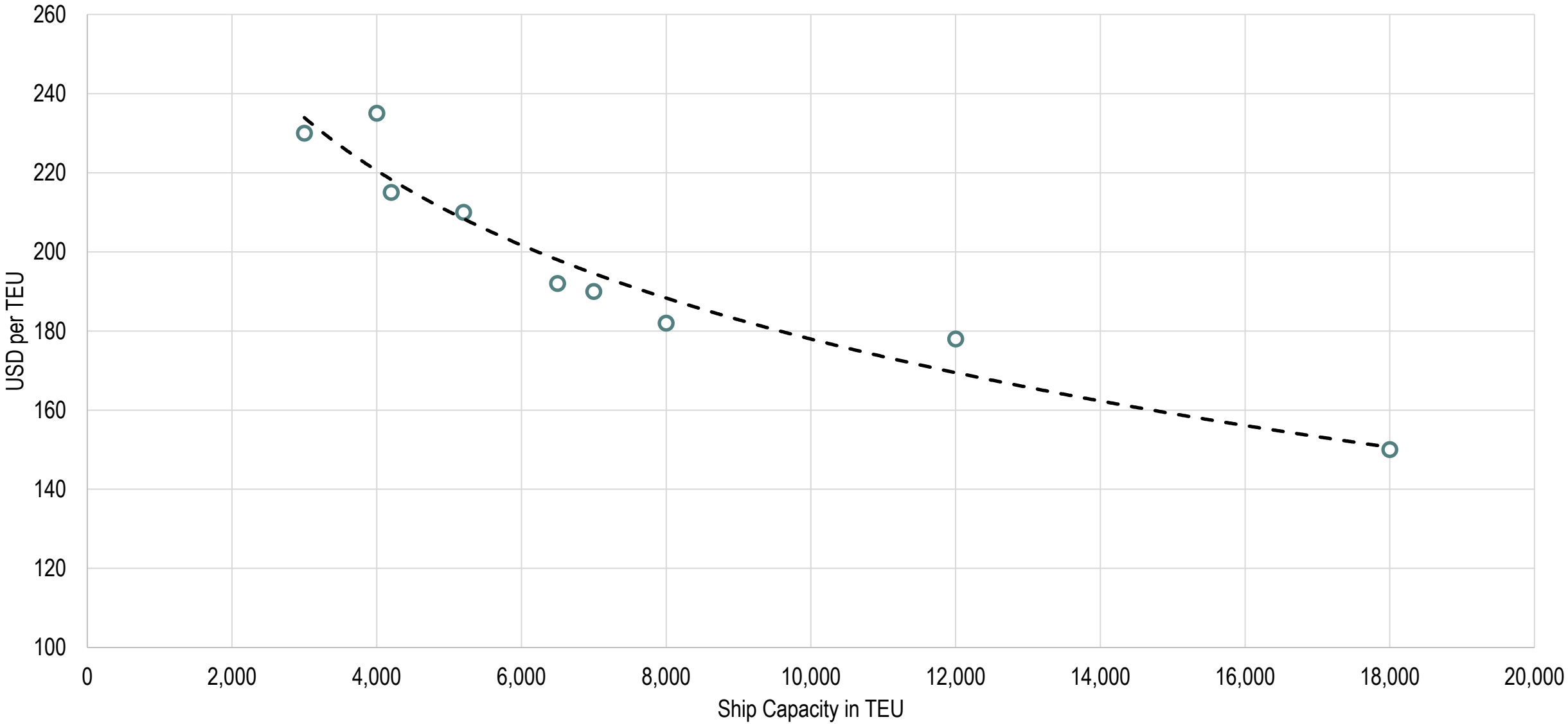
Maritime Transportation Rates for a 40 Foot Container between Selected Ports, 2010



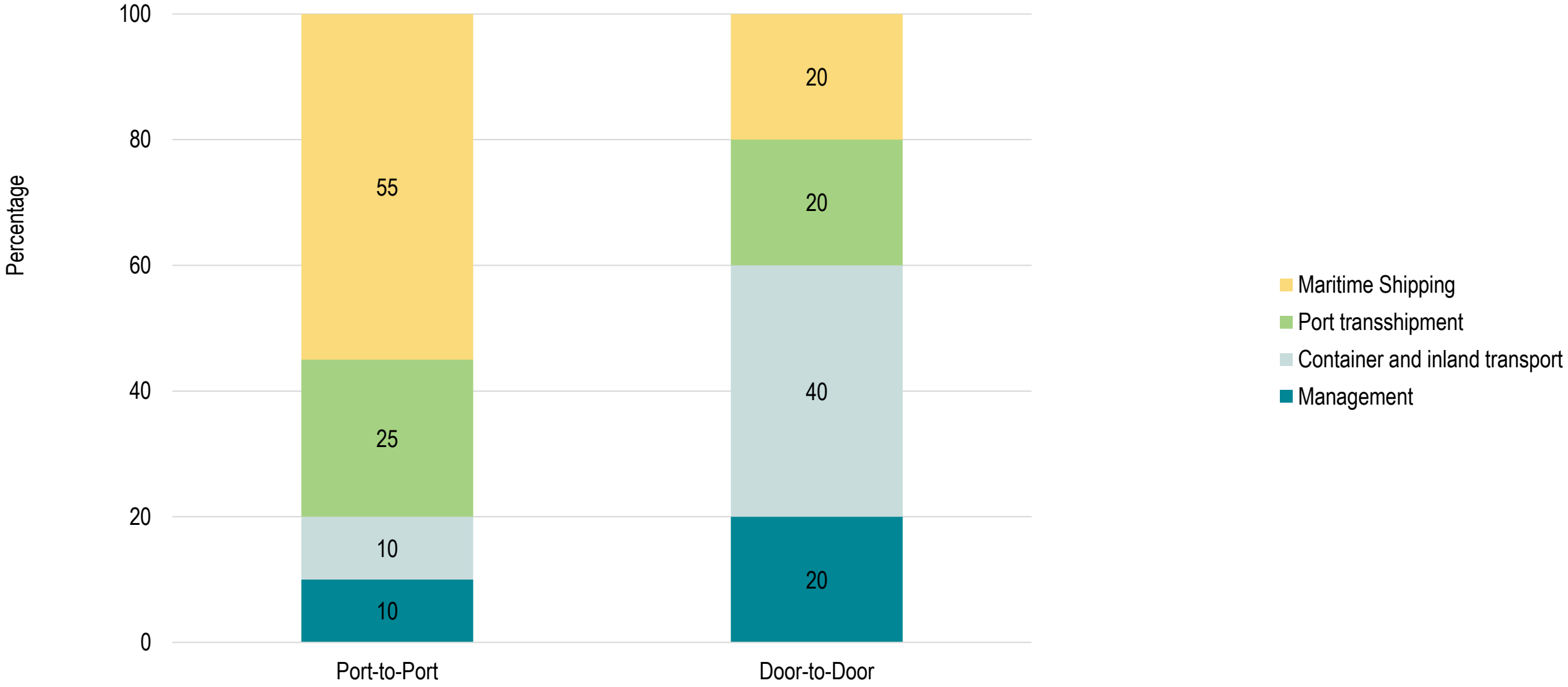
Daily Operating Expenses for Containerships per TEU



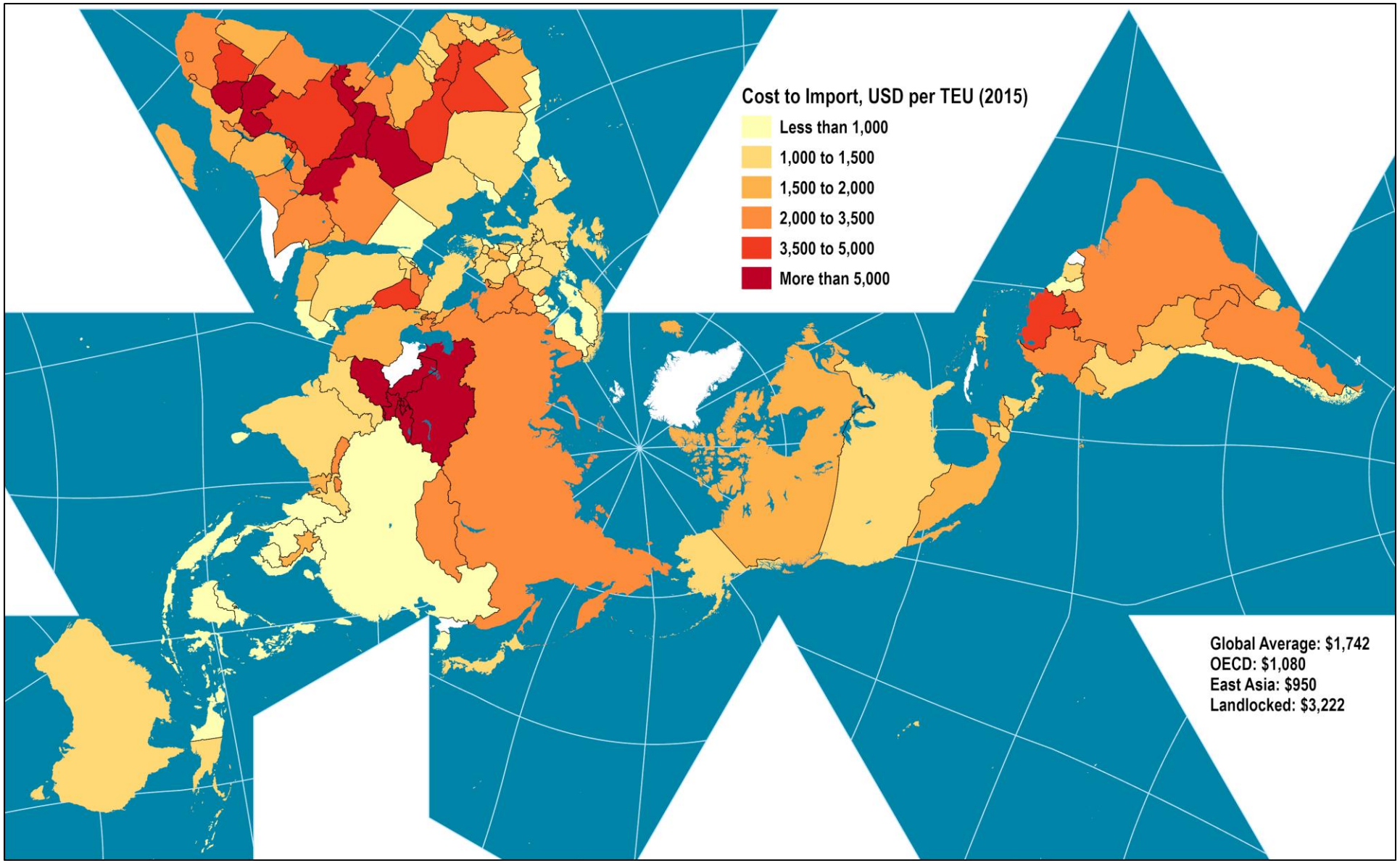
Freight Rates in TEU Between Singapore and Rotterdam



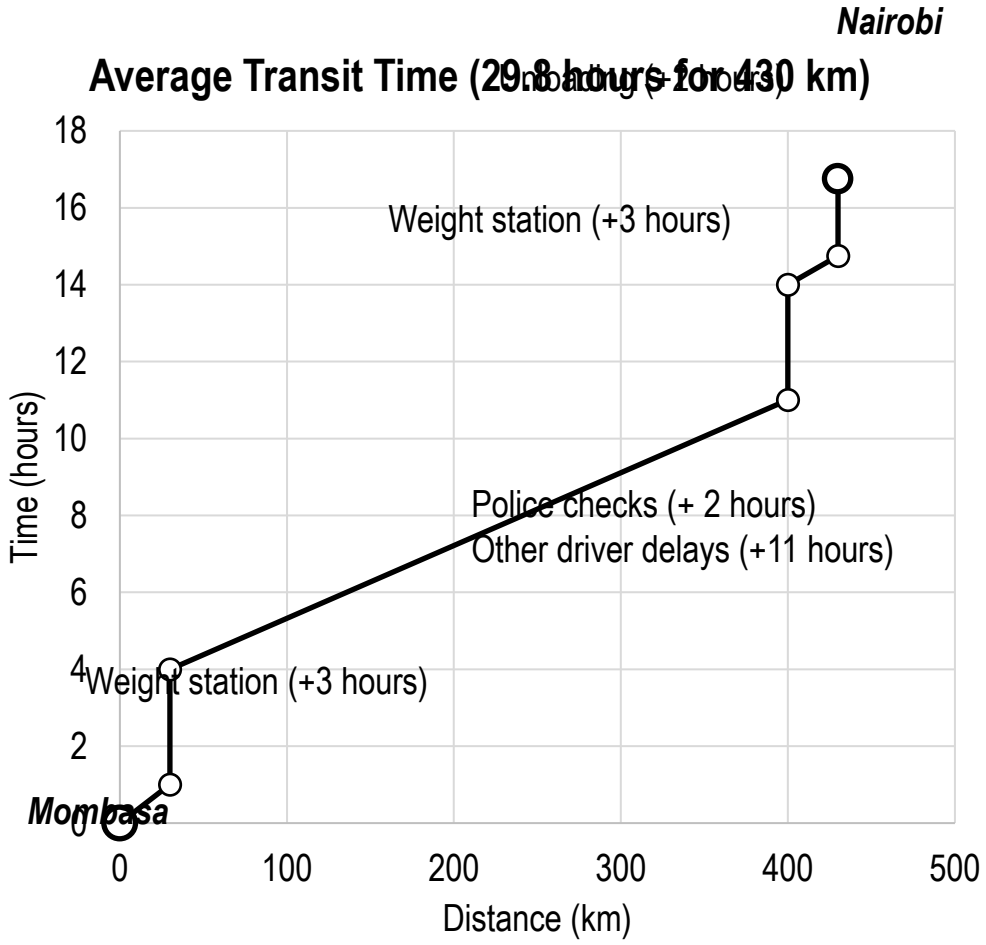
Container Shipping Costs

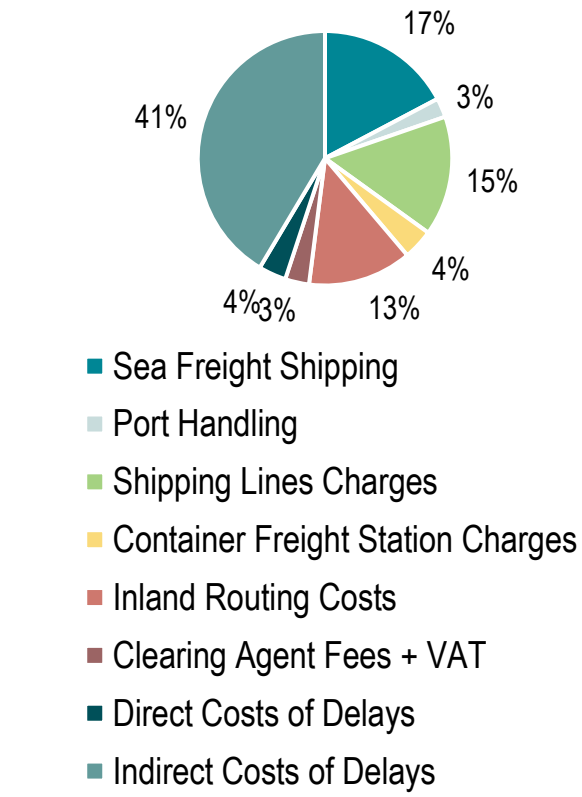


Cost to Import a 20 Foot Container, 2015



Logistics Costs and Average Transit Time of a 20 Foot Container, Mombasa – Nairobi (Kenya)

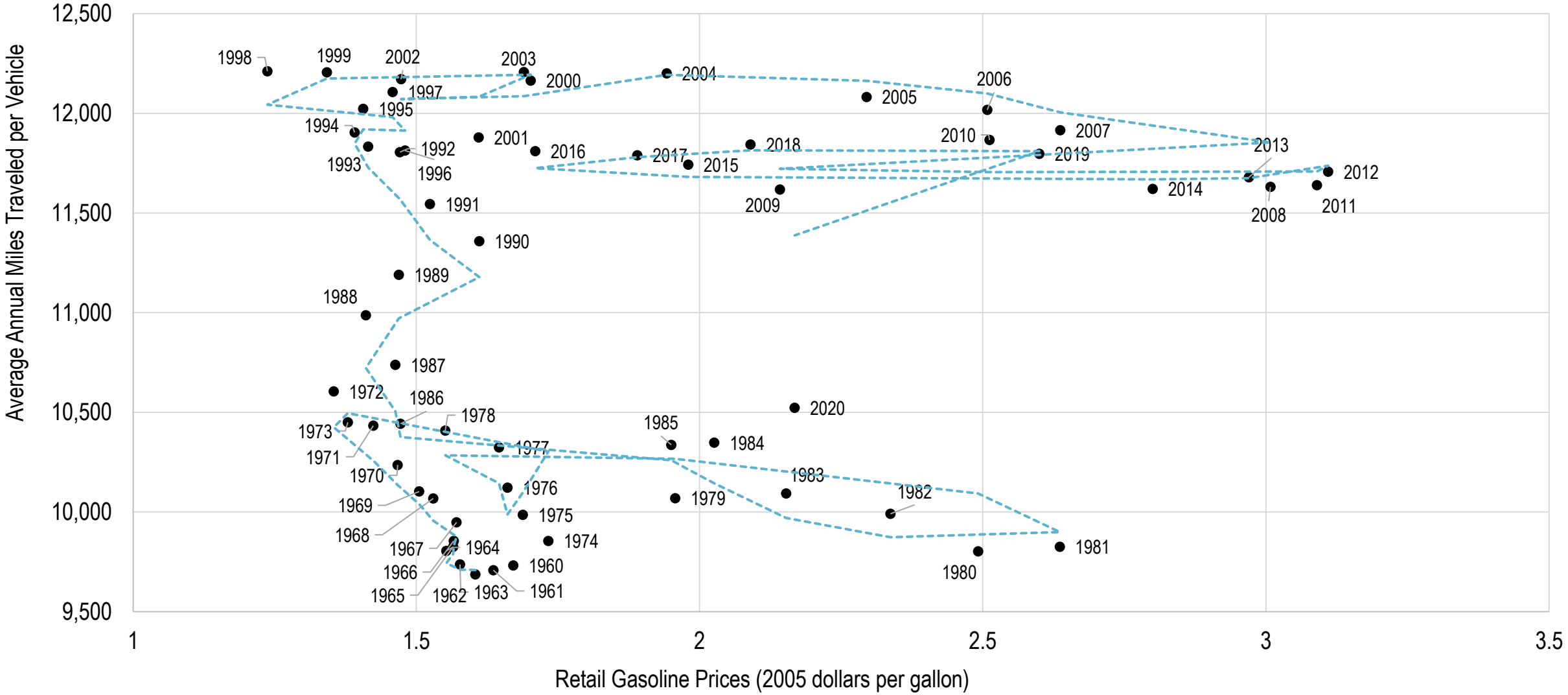


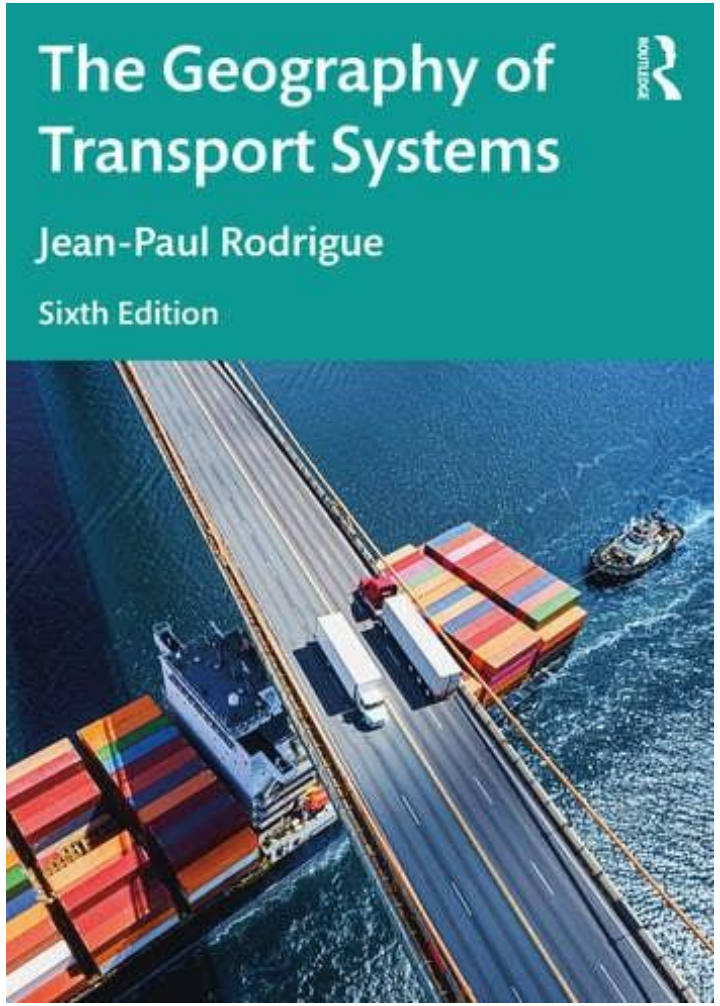


Fixed and Variable Costs and Service in the Transportation System

Characteristic	Fixed Infrastructure	Variable Costs
Examples	Highways, rail tracks, airports, ports	Trucks, railcars, planes, ships
Ownership	Mostly public	Mostly private
Lifespan	Very long (decades)	Short to average (5 to 20 years)
Rate of change	Slow	Rapid redeployment
Impact on service	Shapes accessibility	Shapes level of service
Competition	Level the playing field	Source of comparative advantages

Retail Gasoline Prices and Annual Vehicle Mileage, United States, 1960-2020

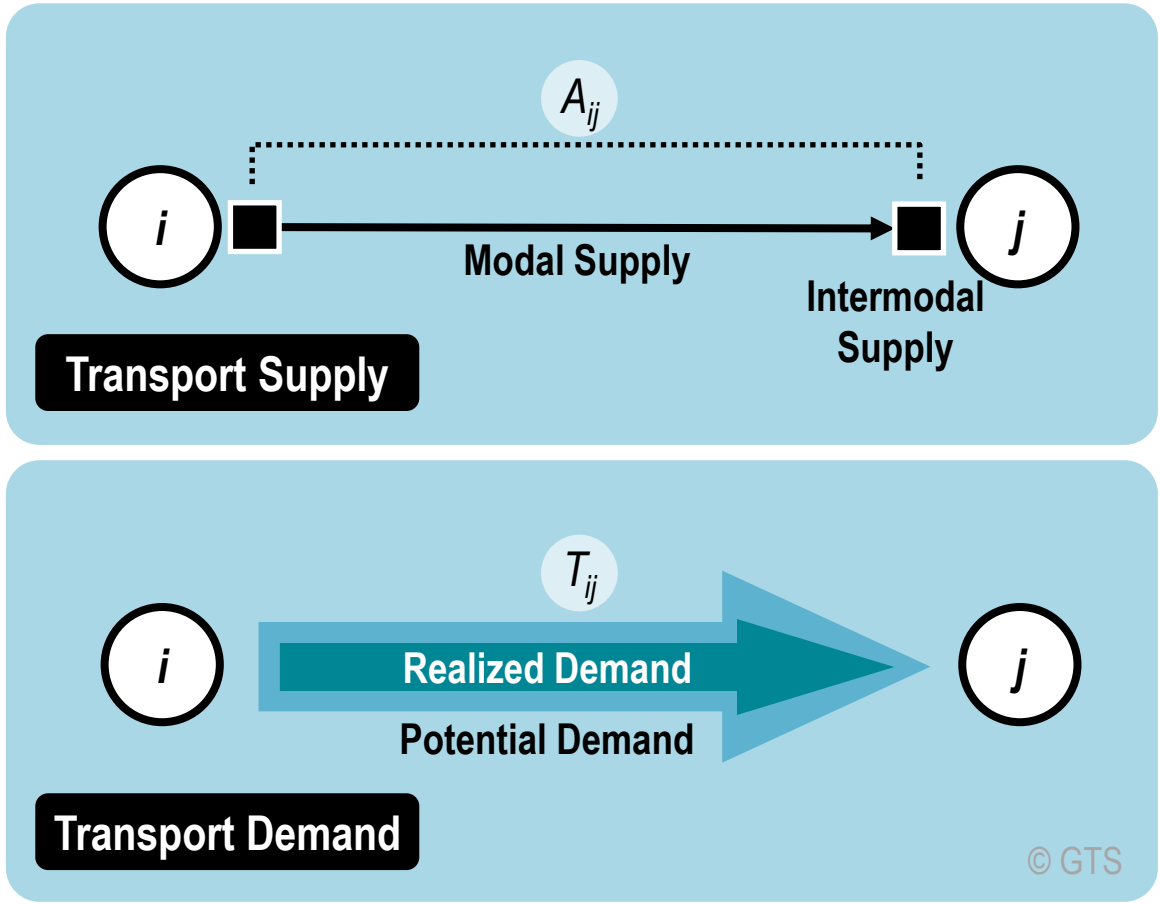




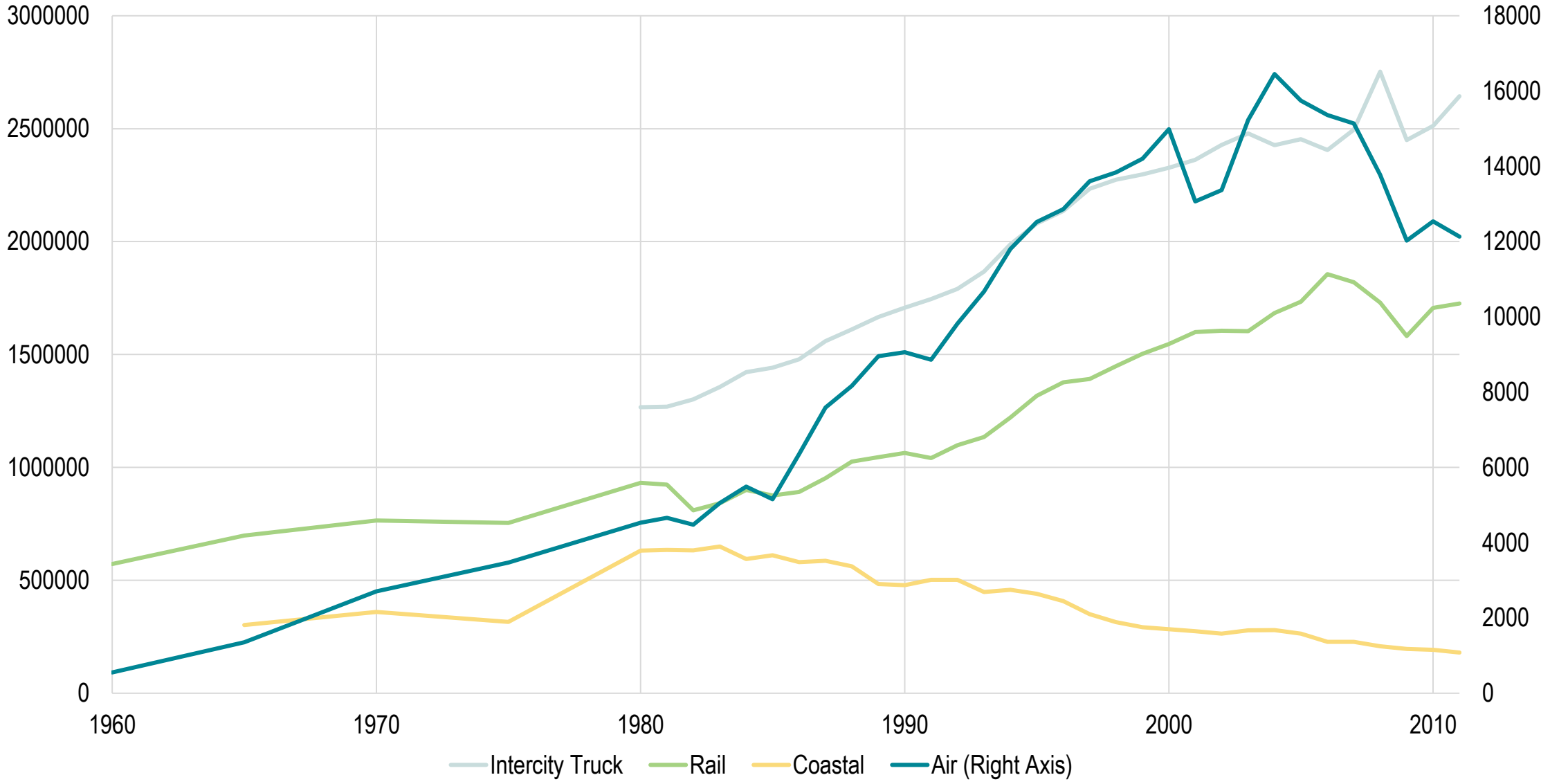
The Provision and Demand of Transport Services

Chapter 3.4

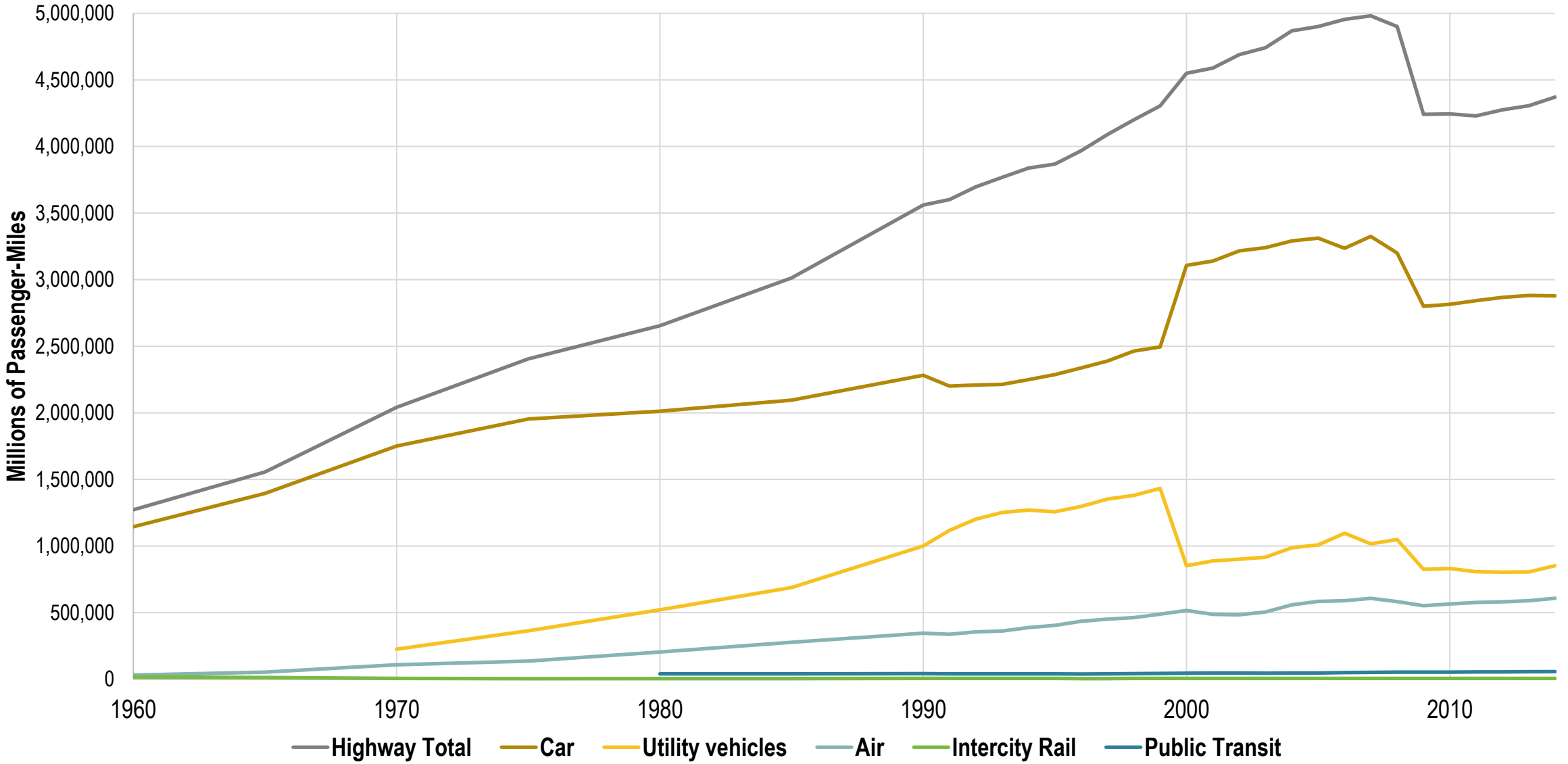
Transport Supply and Demand



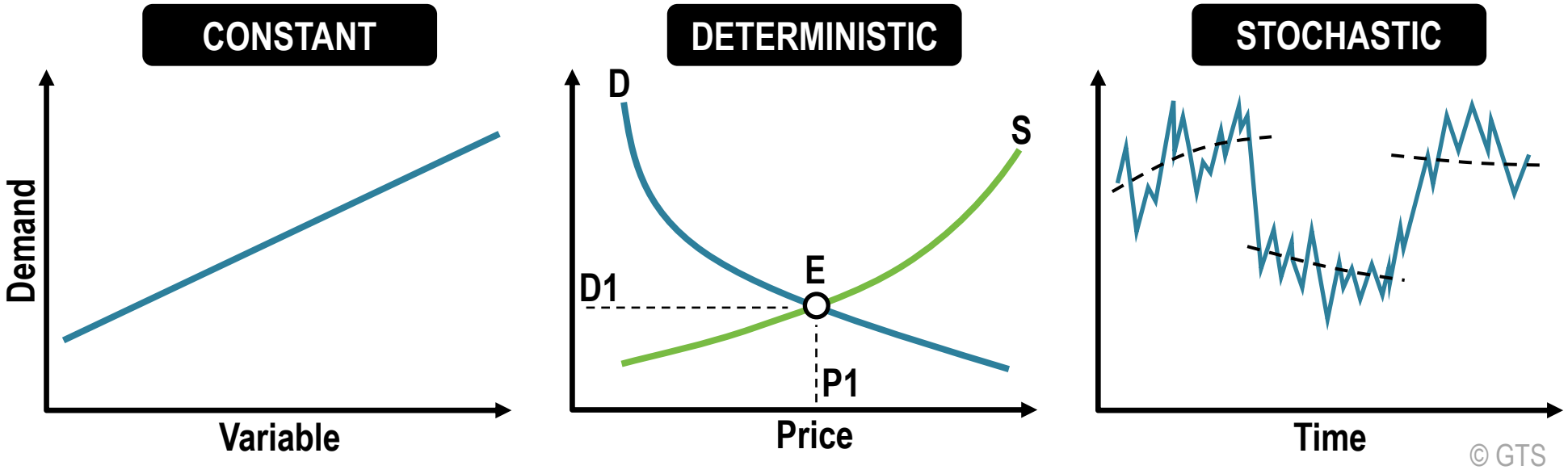
Ton-Miles of Transported Freight, United States, 1960-2011 (millions)



Passenger-Miles Transported within the United States, 1960-2014



Types of Transportation Demand

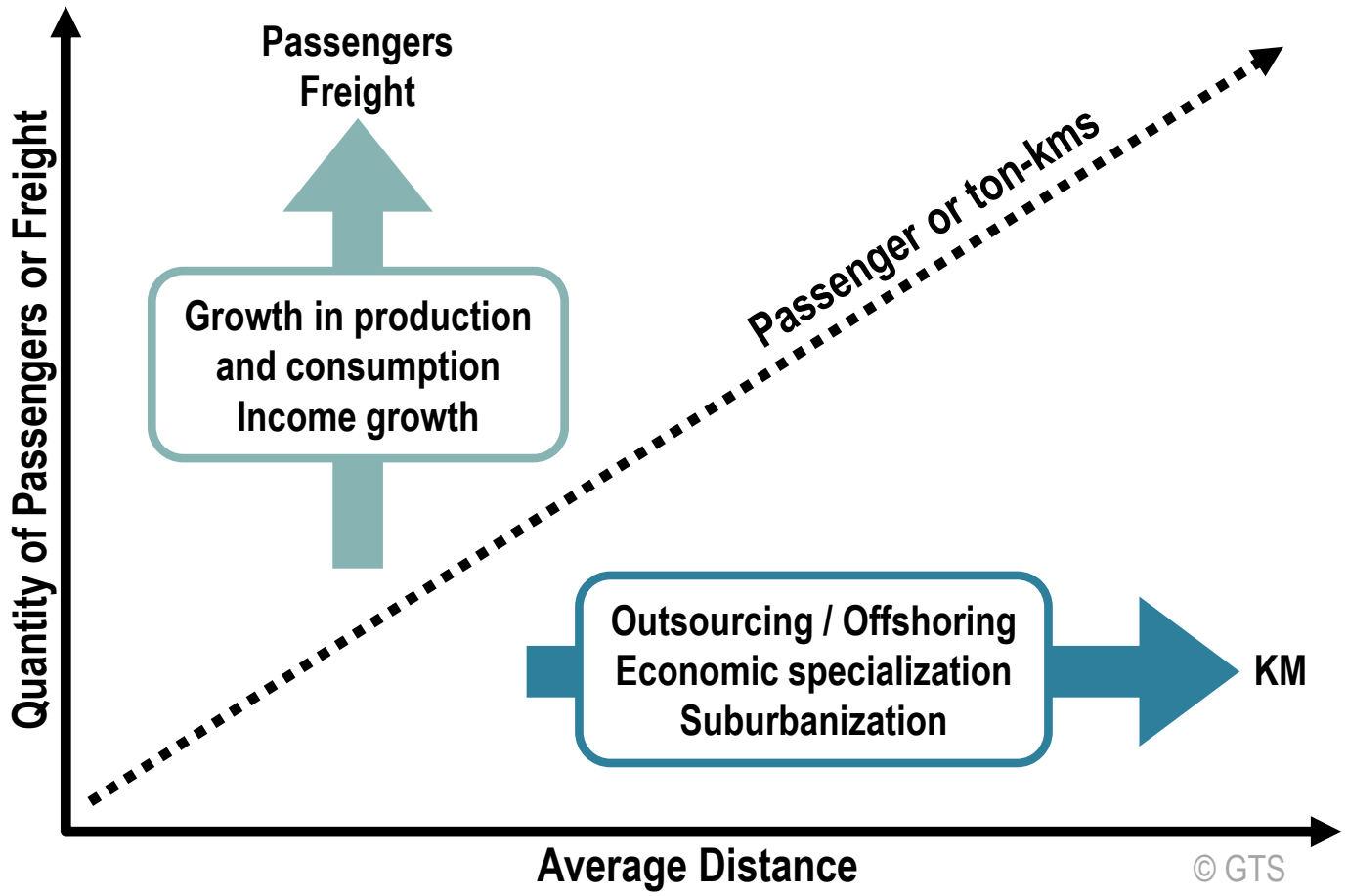


- Proportional to a variable
- Usually linear function
- Multiplier effect

- Direct function of parameters
- All parameters known
- No uncertainty

- Multiple parameters
- Some unknown effects
- Probability of demand

Growth Factors in Transport Demand



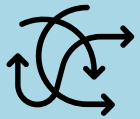
Factors behind Freight Transport Demand

Economy

General derived demand impact. Linked with the GDP. Function of the structure of the economy in terms of resources, goods, and services.

Industrial location

Effect on ton-kms and modal choice. Outsourcing and offshoring.



Spatial structure

Effect on ton-kms. Function of international trade structure. Major hubs, gateways and corridors.

International agreements

Concerning trade and transportation. Economic specialization. Increased transborder traffic. Trade facilitation. Simplified custom procedures.

JIT practices

Low inventory levels. More shipments. Smaller line hauls. Shift to faster and more reliable modes. Use of 3rd party logistics providers.

Strategic alliances

Between carriers, shippers and often producers and retailers. Lower distribution costs.

Packaging and recycling

Increased transportability of products. Lower freight density. Reverse distribution.

Deregulation

Increased competition, level of service and lower costs. Growth of intermodal transportation.

Fuel costs and subsidies

Large and volatile cost components, specifically for energy intensive modes. Preferred mode or carrier.

Infrastructure

Efficiency, operating costs and reliability.

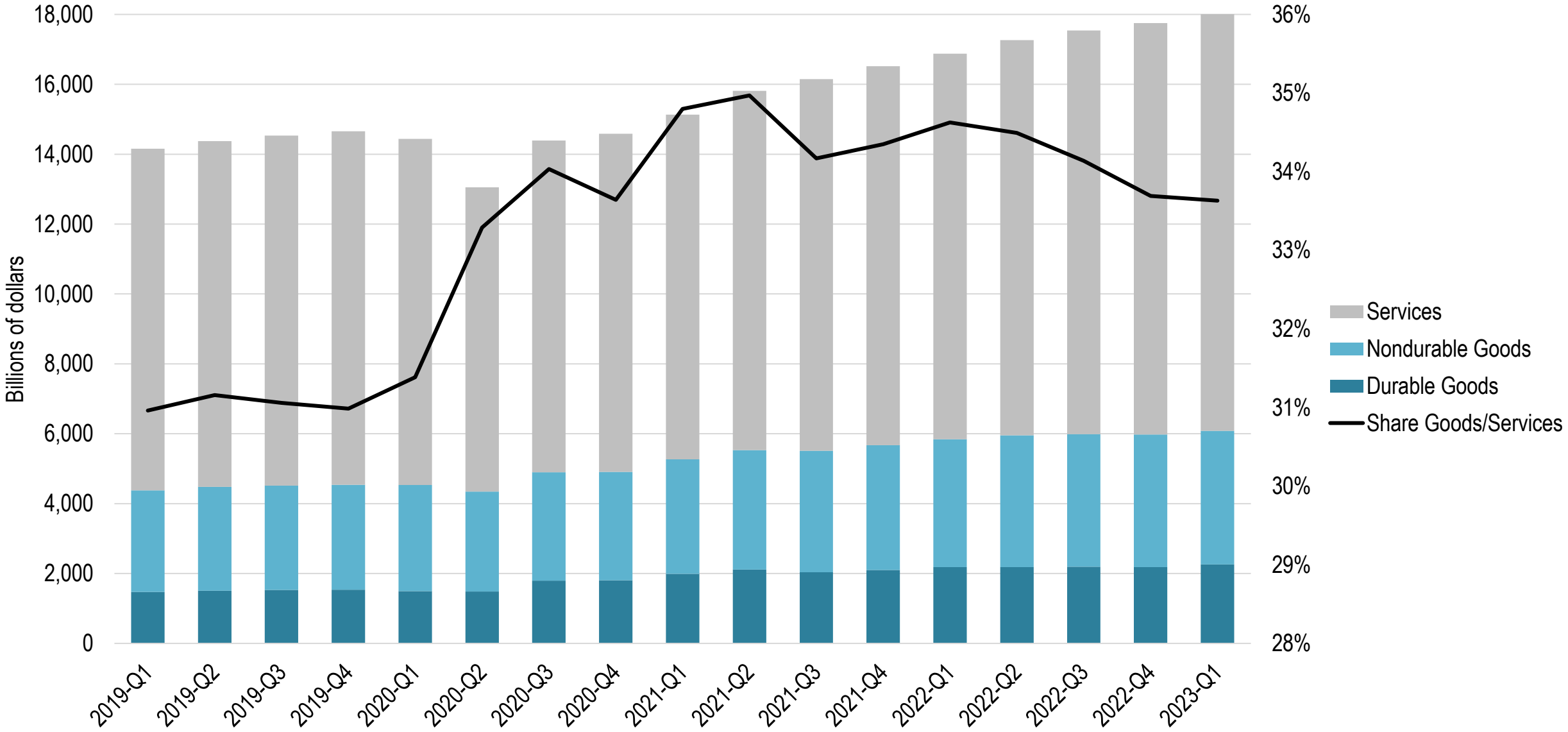
Safety

Operating speed, conditions and costs. Capacity and weight limits.

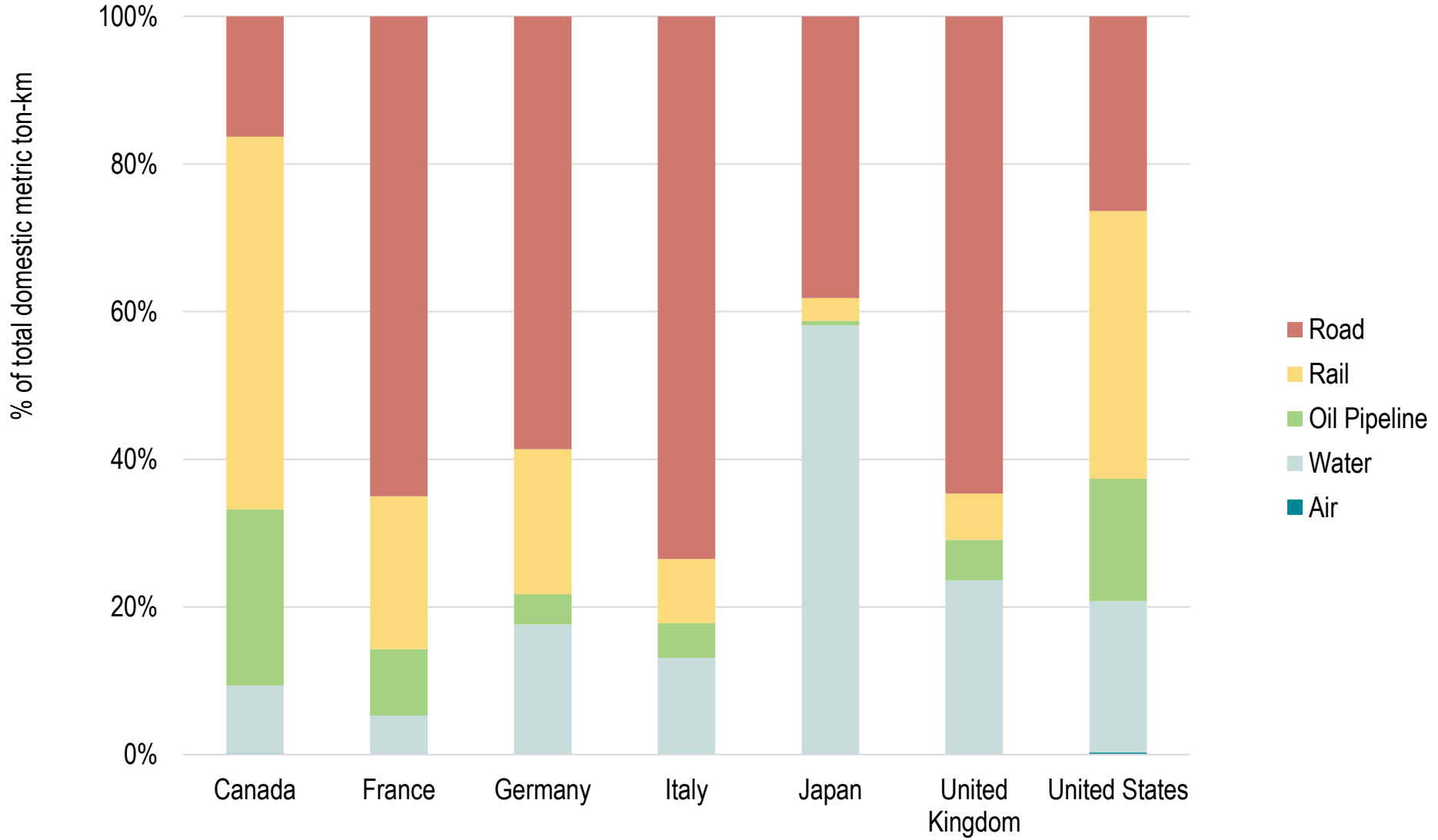
Technology

Containerization, automation and robotics. Information systems. Lower costs, increased efficiency and reliability and new opportunities.

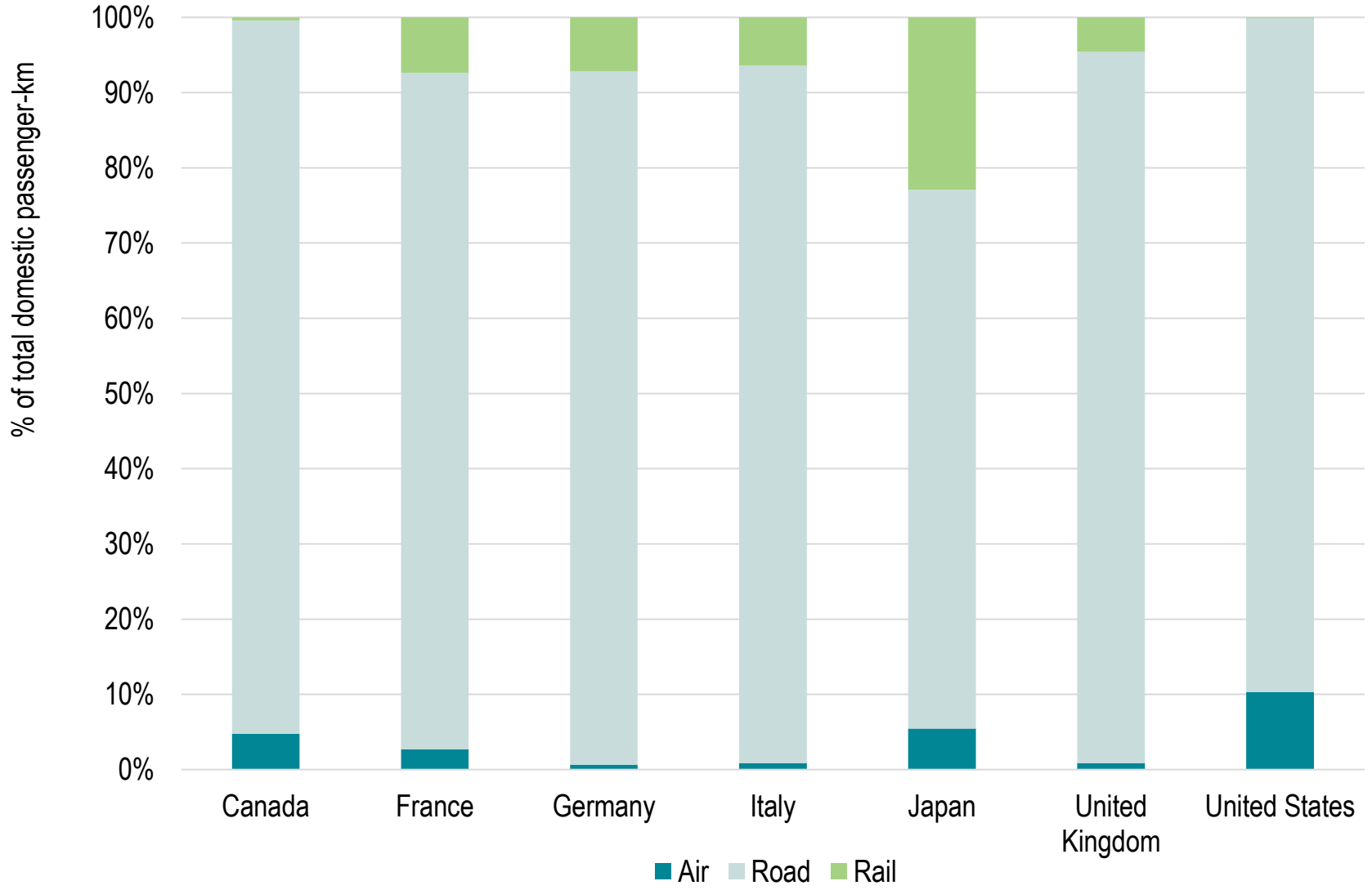
Personal Consumption Expenditures by Major Type of Product, United States



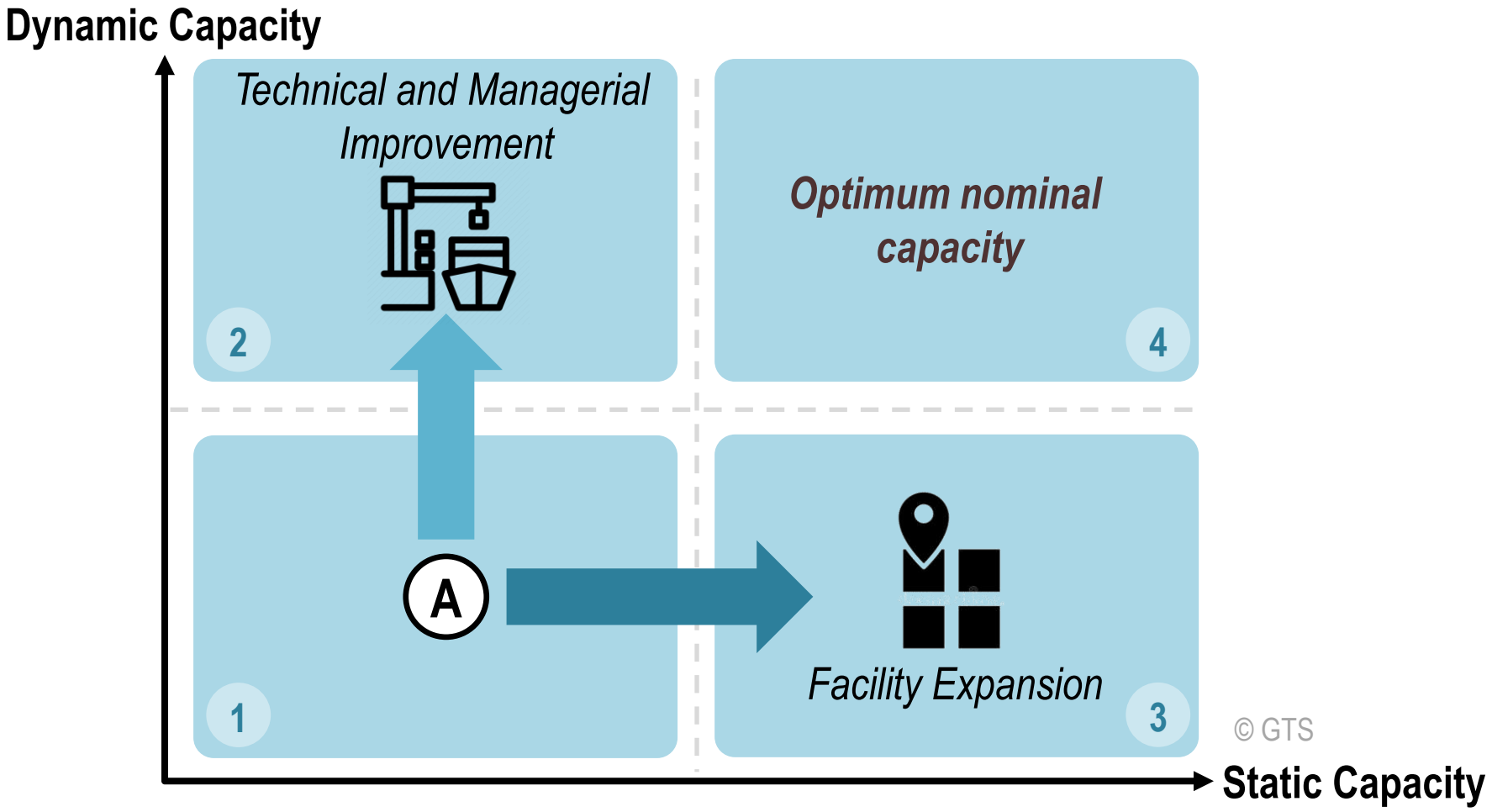
Share of Total Domestic Freight Activity by Mode, Selected Countries, 1996



Share of Total Domestic Passenger Activity by Mode, G7 Countries, 1996



Static and Dynamic Capacity of Transport Infrastructure



Major Supply Variables for Transportation Modes

	ROAD	RAIL	AIR	MARITIME
ROUTES	•Lanes •Width •Speed limit	•Tracks •Grade	•Corridors •Air control	•Canals •Locks
TERMINALS	•Parking	•Yards •Transshipment	•Runways •Gates	•Docks •Transshipment
VEHICLES	•Speed •Capacity	•Speed •Capacity	•Speed •Capacity	•Speed •Capacity

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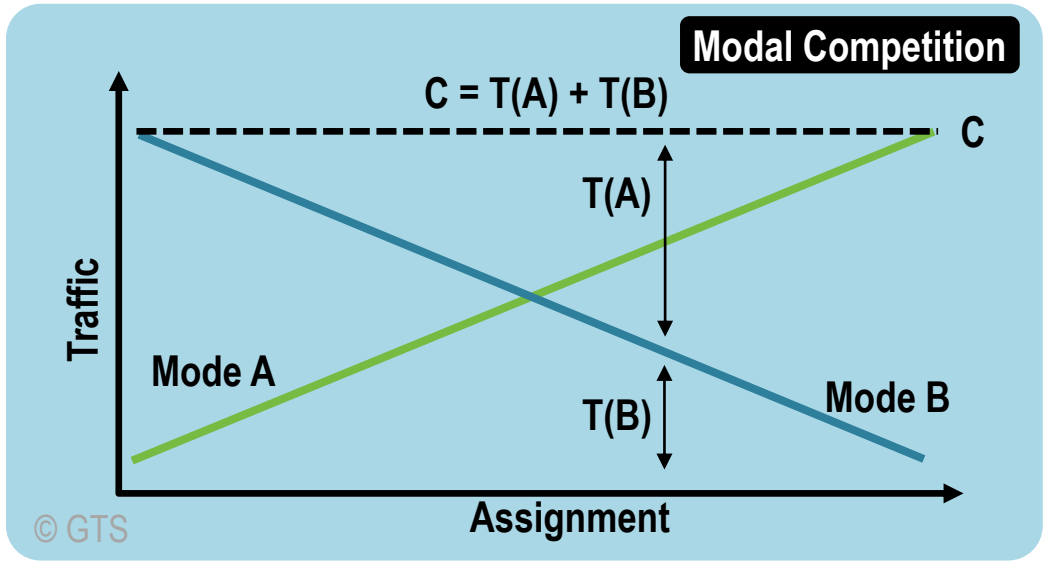
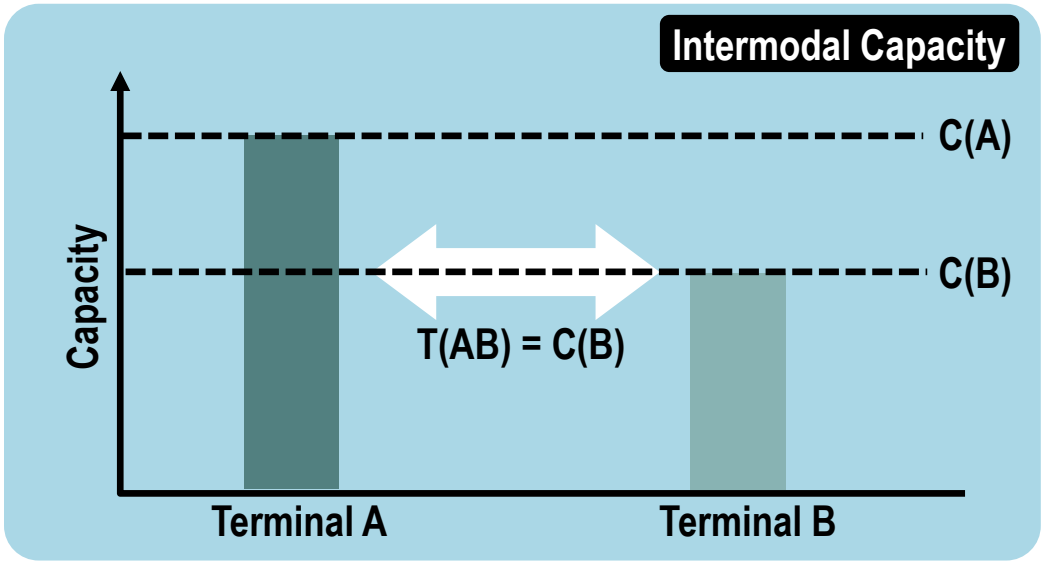
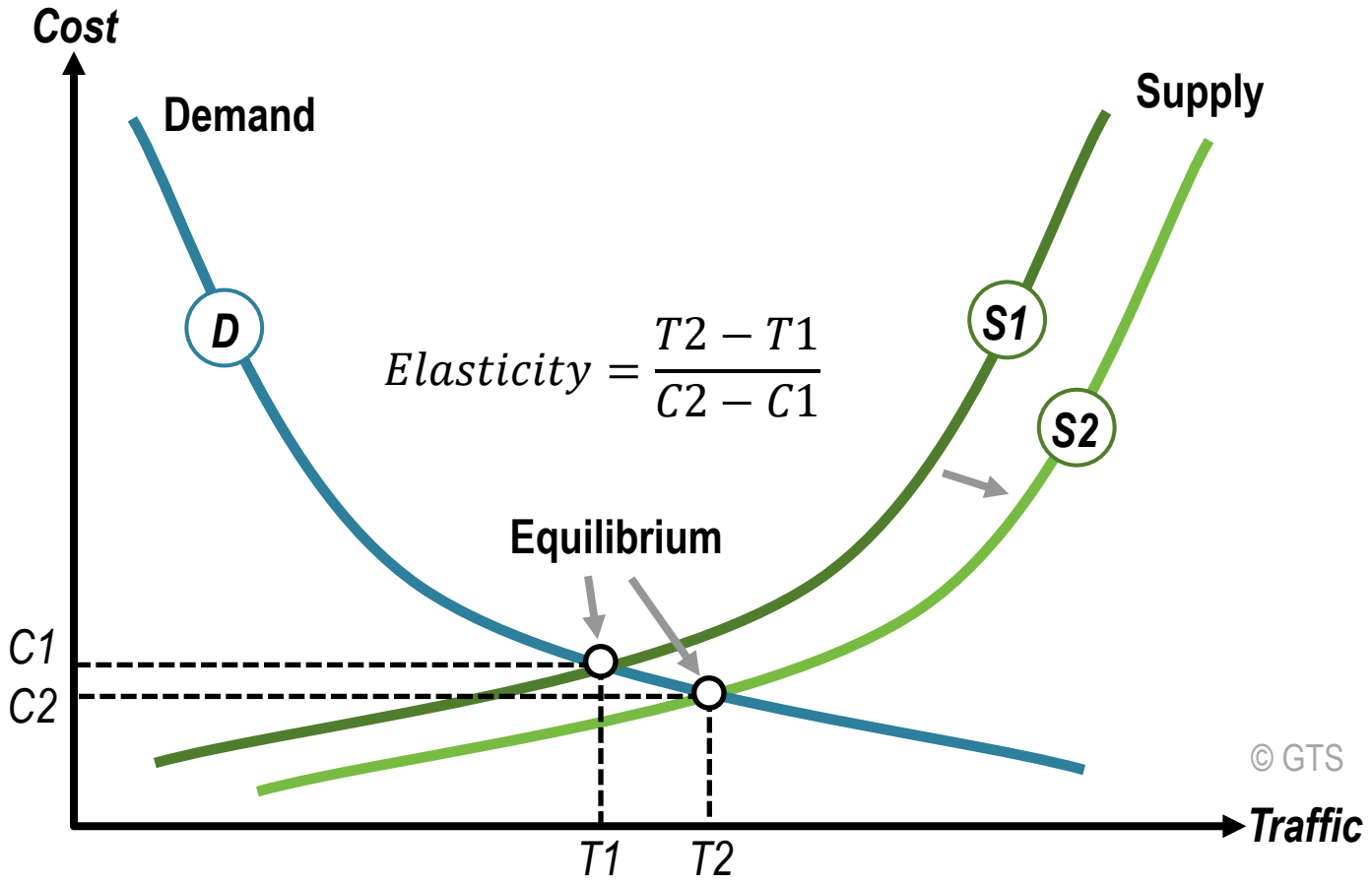
Impacts of Modal Competition and Intermodal Capacity on Transport Supply

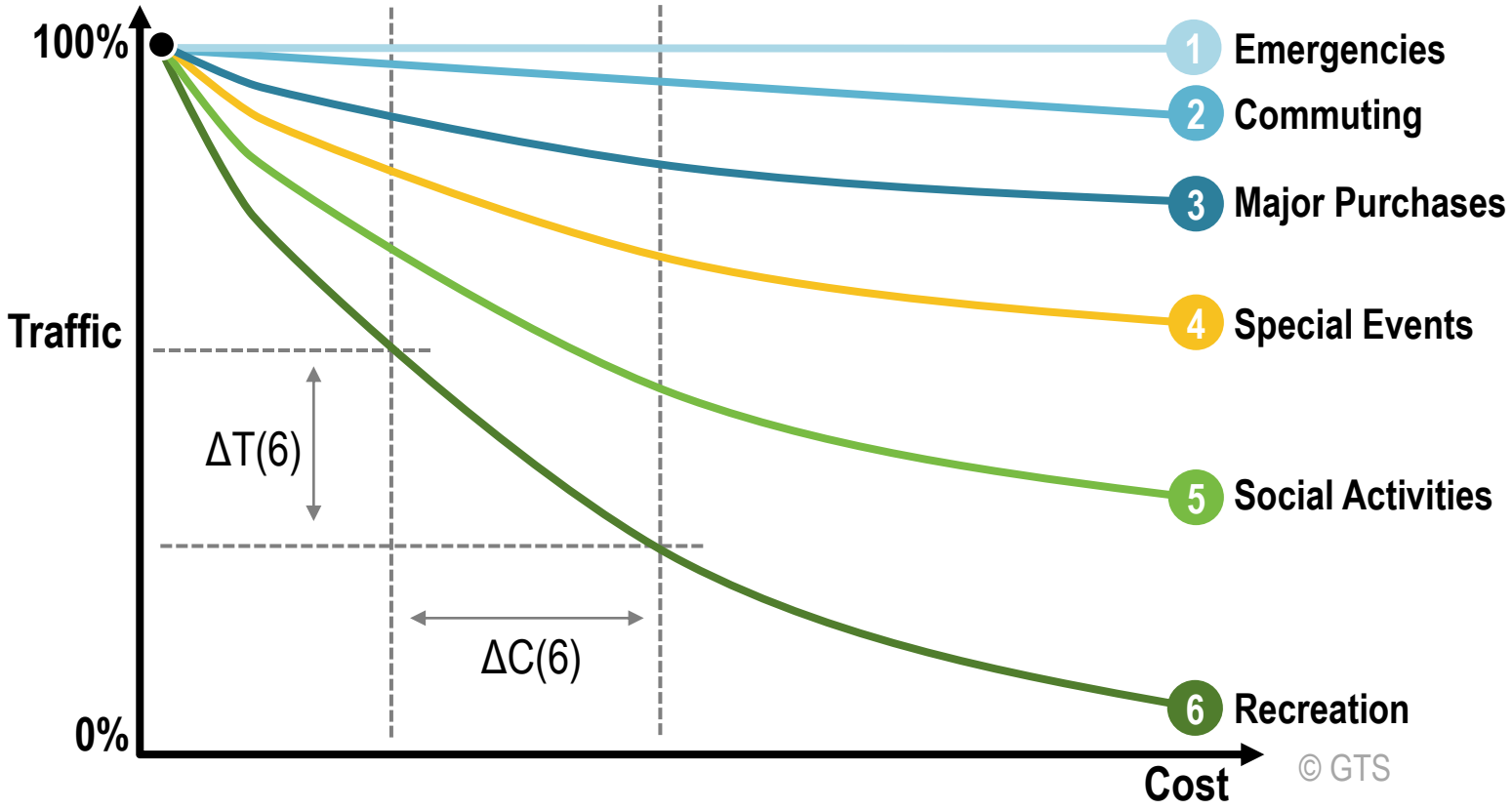




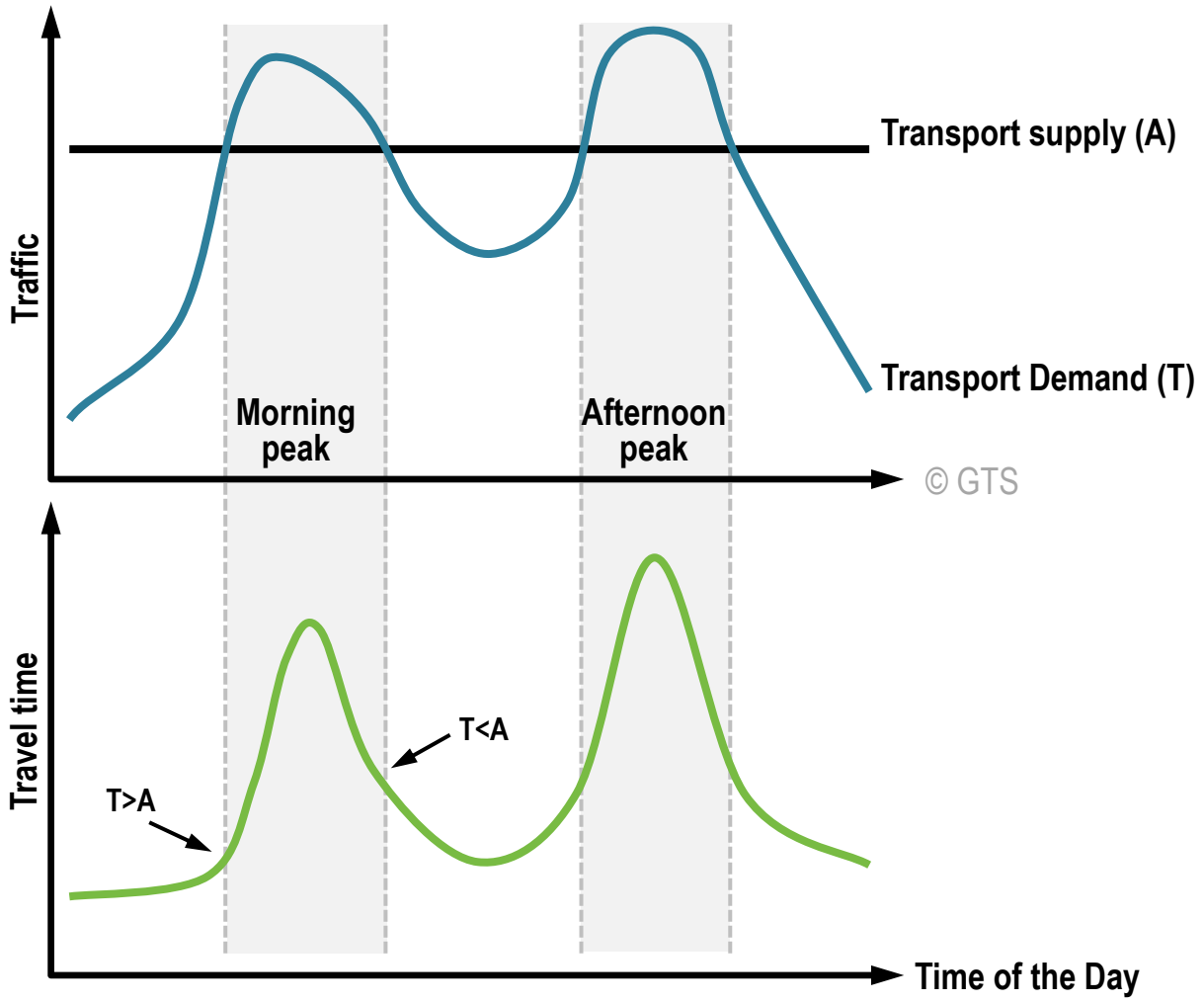
Classic Transport Demand / Supply Function



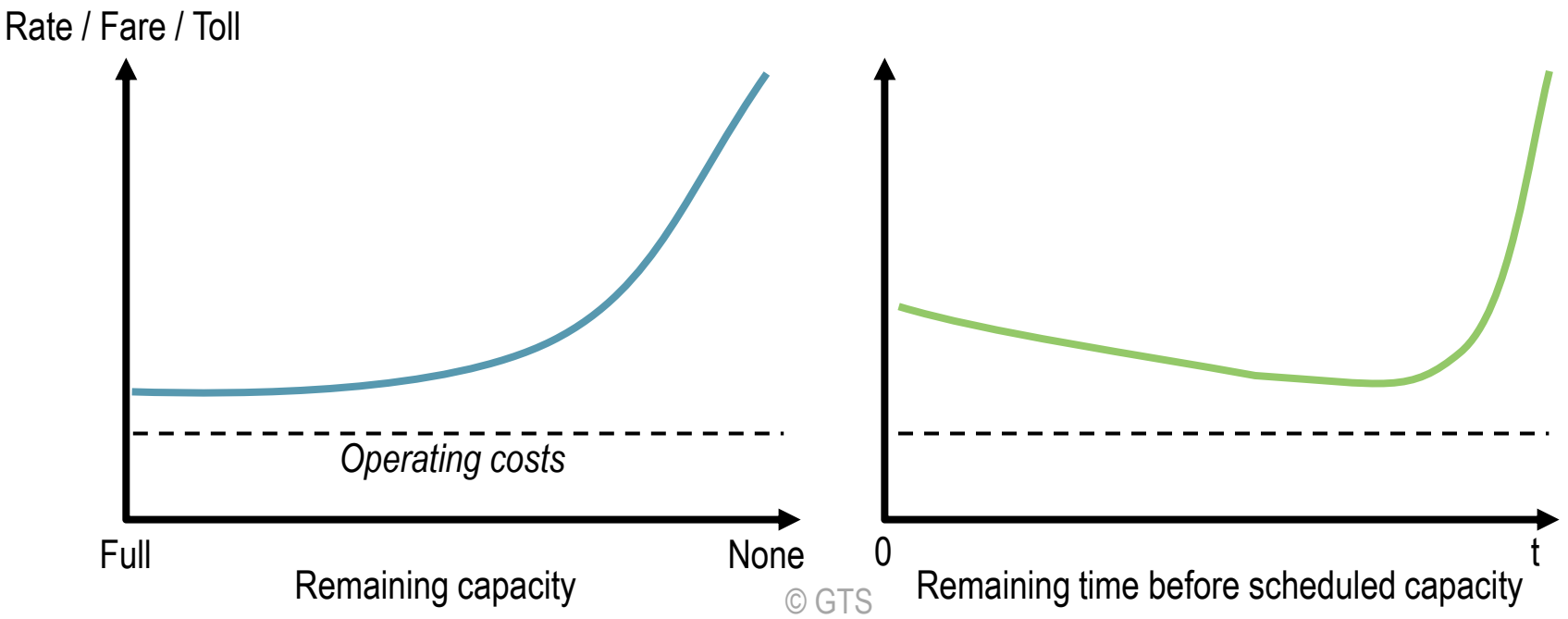
Road Transport Elasticity by Activity



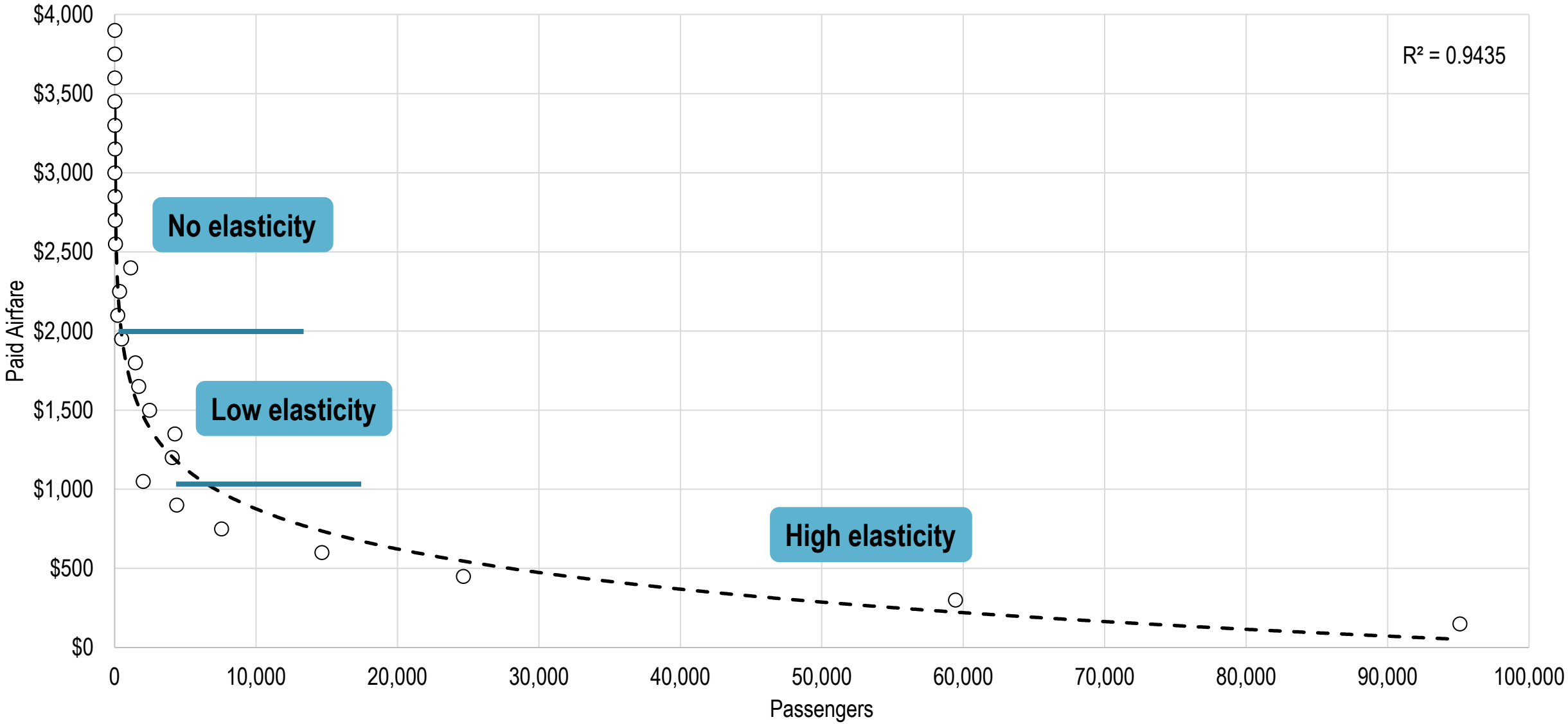
Transport Supply, Demand and Travel Time



Transportation Yield Management



Average Fares Disbursed for JFK–LAX Route, 2009 (April to July)



Average Price of a Domestic Airfare Based on Advance Purchase, United States, 2013