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Pollutants Emitted by Transport Systems
Carbon Emissions by Main Freight Transport Mode

- Coastal Vessel: 13 g / ton-km
- Barge: 40 g / ton-km
- Electric Train: 38 g / ton-km
- Diesel Train: 69 g / ton-km
- Truck (35 tons): 100 g / ton-km
- Truck (20 tons): 200 g / ton-km
- Aircraft (1500 km): 800 g / ton-km
- Aircraft (550 km): 1420 g / ton-km

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Annual Emissions of Air Pollutants for a Passenger Car in the United States, 1997

- Carbon Dioxide
- Nitrogen Oxides
- Carbon Monoxide
- Hydrocarbons

- kg / veh / year
- grams per mile
Annual Emissions of Air Pollutants for a Light Truck in the United States, 1997

- Carbon Dioxide
- Nitrogen Oxides
- Carbon Monoxide
- Hydrocarbons

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Atmospheric Pollution Caused by Different Stages in the Driving Cycle of Gasoline Engine

- **Carbon Monoxide**
  - Decelerating
  - Cruising
  - Accelerating
  - Idling

- **Hydrocarbons**
  - Decelerating

- **Nitrogen Oxydes**
  - Decelerating

- **Aldehydes**
Air Pollutant Concentrations in some Cities, 1999 (in mg per m³)
Emissions by Urban Transport Modes

- CO
- VOC
- NOx
- Particulates

Legend:
- Passenger Cars
- Vans
- Motorcycles
- Urban Transit
- Car Freight Transport
- Vans (Household purchases)
- Van (Deliveries)
- Heavy Trucks
~ 70 db(A)
~ 85 db(A)
~ 55 db(A)

500 m
People Exposed to Aircraft Noise of more than 65 dbA, United States, 1975-2003
<table>
<thead>
<tr>
<th>Greenhouse gas</th>
<th>Concentration change, 1800s - 2016</th>
<th>Anthropogenic sources</th>
<th>100-yr GWP*</th>
<th>Proportion of total effect apart from water vapor (approximate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>280 - 403 ppm</td>
<td>fossil fuel burning, deforestation</td>
<td>1</td>
<td>60%</td>
</tr>
<tr>
<td>Methane</td>
<td>0.75 - 1.85 ppm</td>
<td>agriculture, fuel leakage</td>
<td>25</td>
<td>20%</td>
</tr>
<tr>
<td>Halocarbons</td>
<td>0 - 0.7 ppb</td>
<td>refrigerants</td>
<td>1100-11,000</td>
<td>14%</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>275 - 329 ppb</td>
<td>agriculture, combustion</td>
<td>298</td>
<td>6%</td>
</tr>
<tr>
<td>Ozone</td>
<td>15? - 20-30 ppb</td>
<td>urban pollution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Contribution of Different Gases to the Greenhouse Effect, 1995

- CO2: 64%
- Methane: 19%
- CFC (R12): 6%
- CFC (R11): 4%
- NO2: 1%
- Other: 6%
Carbon Dioxide Emissions From Energy Consumption by Sector, 1980-2001 (in million metric tons)
CO2 Emissions by Type of Fuel for the Transportation Sector in the United States, 1998

- Gasoline: 66%
- Diesel: 16%
- Jet fuel: 15%
- Other: 3%

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Greenhouse Gas Emissions for the Transportation Section, United States, 1990-2005

- CO2: 95.1%
- HFC: 3%
- N2O: 1.0%
- CH4: 0.1%
Climate Change and the Adaptation of Transport Infrastructure
Climate Change and its Potential Impacts on Transportation

### Operations

- Impacts of lift-off load limits on shorter runways.
- Limits on periods of construction activity.
- Frequent interruptions of coastal low lying road, rail and air traffic due to storm surges.
- Increase in weather related delays and disruptions, particularly road and air transport.

### Infrastructures

- Thermal expansion of bridges.
- Pavement integrity and softening.
- Deformation of rail tracks.
- More frequent flooding of infrastructure (and potential damage) in low lying areas.
- Erosion of infrastructure support.
- Changes in harbor facilities to accommodate higher tides and surges.
- Greater probability of infrastructure failure.
- Greater damage to port infrastructures.
- Damage to infrastructure because of the thawing of the permafrost.
- Shorter season for ice-roads.
Green Logistics
Logistics-Related Greenhouse Gas Emissions by Activity

- Road Freight: 11
- Ocean Freight: 6
- Air Freight: 9
- Rail Freight: 17
- Buildings: 57

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Logistic Activities and their Green Dimensions

**Materials Management**
- Product design
- Near sourcing
- Sustainable sourcing
- Packaging and packing
- Circular material use

**Physical Distribution**
- Demand responsive systems
- Load consolidation
- Alternative modes and fuels
- Certification of carriers and distribution facilities
- Shipping scheduling and routing

**Forward and Reverse Supply Chains**
- Suppliers
- Manufacturers
- Distributors
- Recyclers
- Collectors
- Consumers
- Disposal
## Logistical Strategies to Cope with Energy and Environmental Constraints

<table>
<thead>
<tr>
<th>Objective</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping less</td>
<td>Demand responsive systems. Reduce returns.</td>
</tr>
<tr>
<td>Changing sourcing</td>
<td>Reassessing sourcing both at the global and domestic levels.</td>
</tr>
<tr>
<td>Shipping scheduling</td>
<td>Allow greater shipping time and outside rush periods.</td>
</tr>
<tr>
<td>Efficient packaging</td>
<td>Reduce the shipment size (volume) of the same load.</td>
</tr>
<tr>
<td>Modal shift</td>
<td>For each segment, use a mode or a route that is more energy and environmentally efficient.</td>
</tr>
</tbody>
</table>
Hub-and-Spoke Network and Externalities

[Diagram of a hub-and-spoke network]

- Feeder
- Hub

Number of nodes:
- A
- B

Externalities:
- $E(A)$
- $E(B)$

Number of nodes:
- A
- B
Environmental Vicious Circle of Logistics

Paradigm

Added value
Efficiency
Control

More ton-km transported

Less spatial constraints

Energy consumption
Pollutant emissions

Network changes
Space consumption

Externalities

Network changes
Less spatial constraints
More ton-km transported
Added value
Efficiency
Control
Main Dimensions of Green Logistics (under construction)
## The Paradoxes of Green Logistics

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Outcome</th>
<th>Paradox</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Costs</strong></td>
<td>Reduction of costs through improvement in packaging and reduction of wastes. Benefits are derived by the distributors.</td>
<td>Environmental costs are often externalized.</td>
</tr>
<tr>
<td><strong>Time / Flexibility</strong></td>
<td>Integrated supply chains. JIT and DTD provide flexible and efficient physical distribution systems.</td>
<td>Extended production, distribution and retailing structures consuming more space, more energy and producing more emissions (CO2, particulates, NOx, etc.).</td>
</tr>
<tr>
<td><strong>Network</strong></td>
<td>Increasing system-wide efficiency of the distribution system through network changes (Hub-and-spoke structure).</td>
<td>Concentration of environmental impacts next to major hubs and along corridors. Pressure on local communities.</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td>Reliable and on-time distribution of freight and passengers.</td>
<td>Modes used, trucking and air transportation, are the least environmentally efficient.</td>
</tr>
<tr>
<td><strong>Warehousing</strong></td>
<td>Less warehousing per unit of freight. Inventory in circulation.</td>
<td>Inventory shifted in part to public roads (or in containers), contributing to congestion and space consumption.</td>
</tr>
<tr>
<td><strong>E-commerce</strong></td>
<td>Increased business opportunities and diversification of the supply chains.</td>
<td>Changes in physical distribution systems towards higher levels of energy consumption.</td>
</tr>
</tbody>
</table>
Weight and Packaging Improvements: iPad 1 versus iPad 2

iPad 1 (2010)

- Weight: 3.1 lbs.
- Dimensions: 25.4 cm x 20.3 cm x 4.3 cm

iPad 2 (2011)

- Weight: 2.8 lbs.
- Dimensions: 25.4 cm x 19.8 cm x 5.1 cm
Rail Deregulation in the United States
<table>
<thead>
<tr>
<th>Year</th>
<th>Merger -→ (Resulting Firm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>Burlington Northern and St. Louis - San Francisco (Burlington Northern)</td>
</tr>
<tr>
<td>1980</td>
<td>Seaboard Coast Line, Chesapeake and Ohio, and Baltimore and Ohio (CSX)</td>
</tr>
<tr>
<td>1982</td>
<td>Louisville and Nashville and CSX (CSX)</td>
</tr>
<tr>
<td>1982</td>
<td>Union Pacific, Western Pacific, Missouri Pacific (Union Pacific)</td>
</tr>
<tr>
<td>1982</td>
<td>Southern Railway and Norfolk and Western (Norfolk Southern)</td>
</tr>
<tr>
<td>1985</td>
<td>Southern Pacific and St. Louis South-Western (Southern Pacific)</td>
</tr>
<tr>
<td>1985</td>
<td>Union Pacific and Missouri-Kansas and Texas (Union Pacific)</td>
</tr>
<tr>
<td>1991</td>
<td>Southern Pacific and Denver &amp; Rio Grande (Southern Pacific)</td>
</tr>
<tr>
<td>1991</td>
<td>Canadian Pacific and Delaware and Hudson Railway (Canadian Pacific)</td>
</tr>
<tr>
<td>1995</td>
<td>Burlington Northern and Santa Fe (Burlington Northern Santa Fe)</td>
</tr>
<tr>
<td>1995</td>
<td>Union Pacific and Chicago and North-Western (Union Pacific)</td>
</tr>
<tr>
<td>1996</td>
<td>Southern Pacific and Union Pacific (Union Pacific)</td>
</tr>
<tr>
<td>1998</td>
<td>Norfolk Southern, 58% of CONRAIL (Norfolk Southern)</td>
</tr>
<tr>
<td>1998</td>
<td>CSX and 42% of CONRAIL (CSX Transportation)</td>
</tr>
<tr>
<td>1998</td>
<td>Canadian National and Illinois Central Railroad (Canadian National)</td>
</tr>
<tr>
<td>2001</td>
<td>Canadian National and Wisconsin Central (Canadian National)</td>
</tr>
<tr>
<td>2005</td>
<td>Kansas City Southern, Transportacion Ferrovia Mexicana (Kansas City Southern de Mexico)</td>
</tr>
<tr>
<td>2007</td>
<td>Canadian Pacific and Dakota, Minnesota and Eastern Railroad (Canadian Pacific)</td>
</tr>
</tbody>
</table>
MAKING THE BIG FOUR

A series of mergers over the past 50 years has led to the creation of four freight rail behemoths that now control 90% of all business. Below, some of the notable deals along the way.

Norfolk Southern Railway

Norfolk Southern

Southern

Dental of Georgia

Wabash Nickel Plate Pittsburgh & Waba

Norfolk & Western

Atlantic & Danville

Alton & Cincinnati & Youngstown

Illinois Terminal

Pennsylvania

New York Central

Chicago & South Shore & South Bend

Cheasapeake & Ohio

Baltimore & Ohio

Western & Maryland

Atlantic Coast Line

Seaboard Air Line

Louisville & Nashville

Minneapolis & St. Louis

Chicago & North Western

Chicago Great Western

Missouri-Kansas-Texas

Union Pacific

Western Pacific

Missouri Pacific

Chicago & Eastern Illinois

Texas & New Orleans

Southern Pacific

Pacific Electric

Denver & Rio Grande Western

Atchison Topeka & Santa Fe

Chicago Burlington & Quincy

Great Northern

Northern Pacific

Spokane Portland & Seattle

St. Louis - San Francisco


"The board works actively to help try to solve problems."

The rate relief process is expensive and notoriously complex. Some companies, such as those shipping iron, lumber, or cheese, aren't even allowed to appeal. The STB has worked to reduce the cost of these industries from the relief

But the STB is essentially the only option for shippers, since other government agencies are mostly shut out. The Federal Trade Commission has no ability to intervene; neither does the Justice Department, which can only offer advice or intervene. The STB faced a stern inquiry against

Sources:

CONRAIL COUNTERATTACK

EMERGING MAGAZINE

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Performance of Class I Railroads, 1964-2005

Index 1981 = 100

- Productivity
- Volume
- Revenue
- Price
Transportation and Pandemics
Main Factors behind the Global Spread of Diseases

Global Travel
- Air connectivity.
- People as vectors (e.g. Flu, West Nile Virus, SARS, COVID-19).

Global Trade
- Animals and insects.
- Cargo as the vector (e.g. Mad Cow Disease).

Poverty
- Overcrowding and malnutrition.
- Lack of healthcare and unsanitary conditions.

Wars and conflicts
- Destruction / damaging of healthcare systems and public utilities (aqueduct / sewage).
- Displacement of populations (refugees).

Migration
- Migrants bring endemic diseases in developed countries (e.g. tuberculosis).
- Creation of disease clusters.

Medical practices
- Pathogenic natural selection.
- More virulent and resistant diseases.
Diffusion of a Pandemic through a Global Transportation Network

Emergence

Translocation

Diffusion

Pandemic

Number of infections
Impacts of Pandemics on Supply Chains

Supply Chain

- Commodities
  - Raw Materials
  - Storage
  - Manufacturing and Assembly
  - Warehouse

Intermediate Goods

Final Goods

Transport Chain

- Bulk shipping
- Unit shipping
- LTL shipping
- Urban deliveries

Disruptions

Supply Shocks
- Lack of raw materials
- Lack of parts
- Lack of workforce

Distribution Constraints
- Trade restrictions
- Lack of workforce
- Closing of facilities

Demand Shocks
- Hoarding
- Drop in demand
- Substitution

Propagation
Backpropagation
The Logistics Stronghold Concept

1. **Strategic Asset**
   - Port, airport, inland terminal, distribution cluster, energy generation facility.
   - Access to global/national resources and markets.

2. **Secure Facility Area**
   - Secure area (fences).
   - Access restriction (checkpoints).
   - Maintenance of basic operations.
   - Key personnel on site continuously.

3. **Inventory Management**
   - Procurement, storage and distribution of key resources.
   - Energy, goods and parts, food, medical supplies.
   - Support facilities (maintenance).

4. **Secure Corridors**
   - Access to local/regional distribution.
   - Setting of secure convoys.
The Port Authority of New York and New Jersey
## Major Planning Agencies Involved in the New York Metropolitan Area

<table>
<thead>
<tr>
<th>Agency</th>
<th>Jurisdiction</th>
<th>Modes</th>
<th>Type</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York Metropolitan Transportation Council</td>
<td>New York City and 5 counties in NY</td>
<td></td>
<td>MPO</td>
<td>Plan, coordinate</td>
</tr>
<tr>
<td>North Jersey Transportation Planning Authority</td>
<td>13 counties in New Jersey</td>
<td></td>
<td>MPO</td>
<td>Plan, coordinate</td>
</tr>
<tr>
<td>New York State Department of Transportation</td>
<td>State of New York</td>
<td>State highways and traffic control systems</td>
<td>DOT</td>
<td>Plan, build, maintain</td>
</tr>
<tr>
<td>New Jersey Department of Transportation</td>
<td>State of New Jersey</td>
<td>State highways and traffic control systems</td>
<td>DOT</td>
<td>Plan, build, maintain</td>
</tr>
<tr>
<td>New York City Department of Transportation</td>
<td>City of New York</td>
<td>Local streets, arterials, traffic control systems</td>
<td>DOT</td>
<td>Plan, build, maintain</td>
</tr>
<tr>
<td>Port Authority of New York and New Jersey</td>
<td>Port district in NY and NJ</td>
<td>Marine terminals, bridges, tunnels, airports, transit system</td>
<td>Special purpose</td>
<td>Plan, build, operate, maintain, issue debt, toll, collect rent</td>
</tr>
<tr>
<td>Metropolitan Transportation Authority</td>
<td>New York City and 7 counties in NY</td>
<td>Buses, subways, commuter lines, bridges, tunnels</td>
<td>Special purpose</td>
<td>Plan, build, operate, maintain, issue debt, toll, collect rent</td>
</tr>
<tr>
<td>New York City Economic Development Corporation</td>
<td>New York City</td>
<td>Marine terminals</td>
<td>Special purpose</td>
<td>Plan, operate, maintain</td>
</tr>
<tr>
<td>Federal Agencies: USDOT, FHWA, FTA</td>
<td>United States</td>
<td></td>
<td></td>
<td>Oversight, regulate</td>
</tr>
</tbody>
</table>

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Financial Profile of the New York – New Jersey Port Authority, 2003

Gross Operating Revenues ($2.76 billion)

- Interstate Transportation Network: 58%
- Air Terminals: 29%
- Port Commerce: 3%
- World Trade Center: 5%
- Economic & Waterfront Development: 5%

Assets ($11.4 billion)

- Interstate Transportation Network: 32%
- Air Terminals: 51%
- Port Commerce: 12%
- World Trade Center: 3%
- Economic & Waterfront Development: 2%

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Gross Operating Revenues ($3.837 billion)
Main Container Ports of the American East Coast, 1985-2010 (TEUs)

- Boston
- Philadelphia
- Palm Beach
- Wilmington DE
- Baltimore
- Jacksonville
- Port Everglades
- Miami
- Savannah
- Hampton Roads
- Charleston
- New York/New Jersey

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Cargo Handled by the Port of New York, 1991-2016 (metric tons)

- Bulk Cargo Exports
- General Cargo Exports
- Bulk Cargo Imports
- General Cargo Imports

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The St. Lawrence Seaway and Regional Development
Great Lakes

- Duluth
- Sault St. Marie
- Welland Canal
- Kingston
- Montreal
- Quebec
- Les Escoumins
- Atlantic Ocean

St. Lawrence

- Kingston
- Montreal
- Quebec
- Les Escoumins
- Atlantic Ocean

Technical Characteristics:

- Distance: 1645 km, 300 km, 484 km, 1271 km
- Elevation: > 15 m, 10 m, > 15 m, 8.2 m, 32 m, 16 m, 0 m, 0 m
- Depth: > 15 m, > 15 m, > 15 m, 8.2 m, 10.5 m, 12.5 m, > 15 m
- Width: > 300 m, > 300 m, > 300 m, 60 m, 24.3 m, 60,000 m, > 300 m
- Capacity: 30,000 t, 25,000 t, 60,000 t, 150,000 t, 150,000 t and more

In meters

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## Transit Time on Sections of the St. Lawrence Seaway

<table>
<thead>
<tr>
<th></th>
<th>Average Transit (hours)</th>
<th>90% of Transits within (hours)</th>
<th>95% of Transits within (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welland Canal</td>
<td>11</td>
<td>9-13</td>
<td>7-15</td>
</tr>
<tr>
<td>Montreal / Lake Ontario</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inland Up</td>
<td>24</td>
<td>22-26</td>
<td>20-28</td>
</tr>
<tr>
<td>Inland Down</td>
<td>22</td>
<td>20-24</td>
<td>18-26</td>
</tr>
<tr>
<td>Ocean Up</td>
<td>23</td>
<td>21-25</td>
<td>19-27</td>
</tr>
<tr>
<td>Ocean Down</td>
<td>22</td>
<td>20-24</td>
<td>18-26</td>
</tr>
</tbody>
</table>
The St. Lawrence Seaway
The Financing of Transportation Infrastructure
A diagram illustrating the actors in transport finance. The providers include Private Investors, Governments, and Private Lenders. The recipients are the Public, Users, and Beneficiaries. The flow of capital is indicated by arrows, and the indirect relationship is shown by dotted lines. Copyright © 1998-2020, Dr. Jean-Paul Rodrigue, Dept. of Global Studies & Geography, Hofstra University.
Value Propositions behind the Interest of Equity Firms in Transport Terminals

Sectoral and geographical asset diversification.
Mitigate risks linked with a specific regional or national market.

Diversification
(Risk mitigation value)

Asset
(Intrinsic value)

Terminals occupy premium locations (waterfront).
Globalization made terminal assets more valuable.
Traffic growth linked with valuation.
Same amount of land generates a higher income.
Terminals as fairly liquid assets.

Source of income
(Operational value)

Income (rent) linked with the traffic volume.
Constant revenue stream with limited, or predictable, seasonality.
Traffic growth expectations result in income growth expectations.
### Examples of Highway Public / Private Partnerships in the United States

<table>
<thead>
<tr>
<th></th>
<th>Chicago Skyway</th>
<th>Indiana Toll Road</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
<td>2005</td>
<td>2006</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>7.8 miles (12.5 km) of toll urban highway with a bridge</td>
<td>156.9 mi (252.5 km) of toll intercity highway</td>
</tr>
<tr>
<td><strong>Lessee</strong></td>
<td>City of Chicago</td>
<td>State of Indiana</td>
</tr>
<tr>
<td><strong>Lease duration</strong></td>
<td>Skyway Concession Company</td>
<td>Cintra and Macquarie consortium</td>
</tr>
<tr>
<td><strong>Lease duration</strong></td>
<td>99 years</td>
<td>75 years</td>
</tr>
<tr>
<td><strong>Amount</strong></td>
<td>$1.85 billion</td>
<td>$3.85 billion</td>
</tr>
</tbody>
</table>
### Table 4: Top Ten Sovereign Wealth Funds (SWFs) by Assets

<table>
<thead>
<tr>
<th>Country</th>
<th>SWF Name</th>
<th>Assets (U.S. $ billions)</th>
<th>Inception</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Government Pension Fund - Global</td>
<td>1,035.2</td>
<td>1990</td>
<td>Oil</td>
</tr>
<tr>
<td>China</td>
<td>China Investment Corporation</td>
<td>800.0</td>
<td>2007</td>
<td>Non-commodity</td>
</tr>
<tr>
<td>UAE – Abu Dhabi</td>
<td>Abu Dhabi Investment Authority</td>
<td>828.0</td>
<td>1976</td>
<td>Oil</td>
</tr>
<tr>
<td>Kuwait</td>
<td>Kuwait Investment Authority</td>
<td>524.0</td>
<td>1953</td>
<td>Oil</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>SAMA Foreign Holdings</td>
<td>494.0</td>
<td>1952</td>
<td>Oil</td>
</tr>
<tr>
<td>China-Hong Kong</td>
<td>Hong Kong Monetary Authority Investment Portfolio</td>
<td>456.8</td>
<td>1993</td>
<td>Non-commodity</td>
</tr>
<tr>
<td>China</td>
<td>SAFE Investment Company</td>
<td>441.0</td>
<td>1997</td>
<td>Non-commodity</td>
</tr>
<tr>
<td>Singapore</td>
<td>Government of Singapore Investment Corporation</td>
<td>390.0</td>
<td>1981</td>
<td>Non-commodity</td>
</tr>
<tr>
<td>Singapore</td>
<td>Temasek Holdings</td>
<td>320.0</td>
<td>1974</td>
<td>Non-Commodity</td>
</tr>
<tr>
<td>Qatar</td>
<td>Qatar Investment Authority</td>
<td>320.0</td>
<td>2005</td>
<td>Oil &amp; gas</td>
</tr>
</tbody>
</table>

Total top ten SWFs: 5,709.6

Other SWFs: 2,131.8

Total All SWFs: 7,841.4

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1 Data compiled from Sovereign Wealth Fund Institute (April 2018). Of the more than $7.8 trillion held by SWFs, over $4.3 trillion was derived from oil and gas revenues and the rest ($3.5 trillion) from other sources.