APPENDIX B

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• High Speed Trains
• Mega Airport Projects
• International Tourism and Transport
• Petroleum: A Transportation Resource
Transportation and Mega-Urban Regions
# Globalization and Urbanization

<table>
<thead>
<tr>
<th>Technology and Processes</th>
<th>Supporting Principles</th>
<th>Spatial Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mercantile Era</strong></td>
<td><strong>Industrial Era</strong></td>
<td><strong>Contemporary Era</strong></td>
</tr>
<tr>
<td>New transport technology: long distance ships, sextant, etc.</td>
<td>Steam power; Railroad; Steamships; Machine fabrication</td>
<td>New transport and communication technologies; Information-rich production technologies</td>
</tr>
<tr>
<td>Cartography (navigation); New means of payment (credit): precious metals, financial Innovations (accounting &amp; banking).</td>
<td>Economies of scale; Vertical integration of production; Factory systems; Assembly line Labor unions; Property rights; Central banking; Currency; Monetary policies; Compulsory education.</td>
<td>Economies of scope; Trade liberalization; Logistical innovations to facilitate flows of goods, services, capital, and information.</td>
</tr>
<tr>
<td>Division of labor brings increasing urbanization; Size of major cities increases.</td>
<td>Massive urbanization; Average town size increases; Structural issues (housing, infrastructure, spatial organization); Social issues (unemployment, health, welfare, education).</td>
<td>Urban regions competing globally; Relatively fast economic changes causing local dislocations; Rise of large urban regions around major cities connected to the global economy.</td>
</tr>
</tbody>
</table>
Mega-Region Development

A – Single Cities

B – Interconnected Cities

C – Metropolitan Regions

D – Mega Region

- Urban Center
- Land Link (intensity)
- Maritime Link (intensity)
- Gateway
- Urban Region
“Center of power”

- Compact
- Transit-oriented
- Labor intensive industrial
- New industrial activities
- Development zones
- Administrative / commercial
- Commercial / Institutional
- High density agricultural
- Compact motorized
- Terminals / logistical

Main arterial
- Rail
- Freeway
- Mass transit

Land Use
Freight Distribution Centers along a Corridor

Emerging Situation
- Maritime Interface
- Sub-harborization
- Suburban distribution center

Conventional Situation
- Transport terminal
- Distribution / warehousing
- Agglomeration of distribution
- Transport Link
- 1 Sub-harborization
- 2 Suburban distribution center

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Articulation Node and Transport Chains

ORIGIN  TRANSPORT CHAIN  DESTINATION

Global
Regional
Local

Articulation Node

- Transport terminal
- Added value to mobility
- Cluster
Modal Corridors in an Urban Region

Maritime Corridor

Land Corridor

Fluvial Corridor

Air Corridor

- City
- Articulation node
- Maritime corridor
- Road and rail link
- Fluvial corridor
- Air corridor
The BostWash Mega Urban Region
Tokaido Megalopolis
Transcontinental Bridges
Types of Landbridges
The North American Landbridge
Transport Corridors in North America
Monthly Value of Surface Trade between the United States, Canada and Mexico, 1993-2016 (USD)
Main Container Ports, Trade Corridors and Distribution Hubs in North America
Some North American Trade Corridor Initiatives
Transit Times from Shanghai and North American Routing Options (in Days)
Factors Impacting North American Freight Distribution in View of the Panama Canal Expansion

<table>
<thead>
<tr>
<th>Factor</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Macroeconomic factors</strong></td>
<td></td>
</tr>
<tr>
<td>Aggregate demand changes</td>
<td>Level and composition of cargo.</td>
</tr>
<tr>
<td>Structure of production changes</td>
<td>Regionalization of production (NAFTA).</td>
</tr>
<tr>
<td></td>
<td>Production shifts within Asia (e.g. Vietnam and Indonesia).</td>
</tr>
<tr>
<td><strong>Operational factors</strong></td>
<td></td>
</tr>
<tr>
<td>Economies of scale in shipping</td>
<td>Changes in the frequency of services, port calls and network configuration.</td>
</tr>
<tr>
<td>Shipping costs structure (e.g. tolls and fuel)</td>
<td>Comparative advantages of respective routing options (landbridge, Suez, all-water).</td>
</tr>
<tr>
<td><strong>Competitive factors</strong></td>
<td></td>
</tr>
<tr>
<td>Response from East and West coast ports</td>
<td>Comparative advantages of port selection. New transshipment hubs.</td>
</tr>
<tr>
<td>Response from railways</td>
<td>Comparative advantages of inland routes.</td>
</tr>
<tr>
<td>Response from Suez Canal and transshipment hubs</td>
<td>Comparative advantages of routing options.</td>
</tr>
<tr>
<td>New gateways</td>
<td>Additional inland routing options (e.g. Prince Rupert and Lazaro Cardenas).</td>
</tr>
</tbody>
</table>
High Speed Trains
Travel Times before and after the Introduction of a High-Speed Rail Service (hours)

<table>
<thead>
<tr>
<th>City Pair</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wuhan - Guangzhou</td>
<td>3.0</td>
<td>10.5</td>
</tr>
<tr>
<td>Taipei - Kaohsiung</td>
<td>1.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Seoul - Busan</td>
<td>2.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Tokyo - Osaka</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Paris - Marseille</td>
<td>3.0</td>
<td>6.6</td>
</tr>
<tr>
<td>Madrid - Seville</td>
<td>2.2</td>
<td>6.0</td>
</tr>
<tr>
<td>London - Paris</td>
<td>3.0</td>
<td>5.3</td>
</tr>
<tr>
<td>Paris - Bruxelles</td>
<td>1.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Berlin - Hannover</td>
<td>1.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Hannover - Wurzburg</td>
<td>2.0</td>
<td>3.7</td>
</tr>
<tr>
<td>Firenze - Rome</td>
<td>1.6</td>
<td>3.0</td>
</tr>
</tbody>
</table>
# Evolution of the French TGV, 1981-2005

<table>
<thead>
<tr>
<th>Name</th>
<th>TGV Paris Sud-Est</th>
<th>TGV Atlantique</th>
<th>AVE</th>
<th>TGV Reseau</th>
<th>Eurostar</th>
<th>TGV Duplex</th>
<th>TGV Thalys</th>
<th>TGV NG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Speed</strong></td>
<td>168 mph (270 km/h)</td>
<td>186 mph (300 km/h)</td>
<td>186 mph (300 km/h)</td>
<td>186 mph 300km/h</td>
<td>186 mph (300 km/h)</td>
<td>186 mph (300 km/h)</td>
<td>186 mph (300 km/h)</td>
<td>225 mph (360 km/h)</td>
</tr>
<tr>
<td><strong>Design Speed</strong></td>
<td>168 mph (270 km/h)</td>
<td>186 mph (300 km/h)</td>
<td>186 mph (300 km/h)</td>
<td>200 mph (320 km/h)</td>
<td>200 mph (320 km/h)</td>
<td>200 mph (320 km/h)</td>
<td>200 mph (320 km/h)</td>
<td>225 mph (360 km/hr)</td>
</tr>
<tr>
<td><strong>Speed Record</strong></td>
<td>236 mph (380 km/h)</td>
<td>320 mph (515 km/h)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Maximum speed on normal railways</strong></td>
<td>138 mph (220 km/h)</td>
<td>138 mph (220 km/h)</td>
<td>No running</td>
<td>138 mph (220 km/h)</td>
<td>100 mph (160 km/h)</td>
<td>No running</td>
<td>unknown</td>
<td>156 mph (250 km/h)</td>
</tr>
<tr>
<td><strong>Comments</strong></td>
<td>Famous Orange TGV</td>
<td>Rail Speed Record</td>
<td>TGV for Spain</td>
<td>Pressure Sealed</td>
<td>Strictly not a TGV</td>
<td>Double decker</td>
<td>International TGV</td>
<td>Next Generation</td>
</tr>
</tbody>
</table>

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Breakeven Distances between Conventional Rail, High Speed Rail and Air Transportation

![Graph showing breakeven distances for conventional rail, high speed rail, and air transportation.

- **Air Advantageous over Conventional Rail**
- **High Speed Rail Competitive**

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The Socioeconomic Context of High Speed Rail

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Mitigate congestion and demand along high density interurban corridors. Extending services into lower density regions for political purposes (e.g. social equity) lead to economic failure.</td>
</tr>
<tr>
<td>Spatial Structure</td>
<td>Limited impacts on the spatial structure. Routes supporting the existing spatial structure are the most effective. Limited number of stations that are well connected to their metropolitan areas most effective. HSR stations should be hubs of regional transport systems.</td>
</tr>
<tr>
<td>Investments</td>
<td>Very high construction and operation costs. Land (expropriation costs) are particularly high to secure a corridor. Cost overruns common. Limited or no profitability. Most costs are usually subsidized.</td>
</tr>
<tr>
<td>Demand</td>
<td>Significant time savings compared to existing services. Initial increase in the demand, but a stabilization after 2 years. Lower demand than forecasted common. Significant impacts on air services on distances less than 700km. Low cost airlines able to compete.</td>
</tr>
<tr>
<td>Economic Impacts</td>
<td>Little or no generation of new economic activities. Service and touristic sectors favored. Tendency to consolidate activities in the most connected locations (large cities). Medium-sized cities usually negatively impacted.</td>
</tr>
<tr>
<td>Environmental Impacts</td>
<td>Comparatively better than air transportation. Long term mitigation of environmental impacts during construction.</td>
</tr>
</tbody>
</table>
Mega Airport Projects
Passenger Density of the World’s Largest Airports (In Passengers per Hectare)

King Fahd International Airport
Cairo International Airport (Wadi al Jandali)
Kansas City
Washington-dulles
Shanghai, Pudong
Salt Lake City
Denver International Airport
Buenos Aires, Pistarni
Dallas Fort Worth
Rio de Janeiro, Galeao International Airport
New International Bangkok Airport
Madrid Barajas
New Delhi, Indira Gandhi International
Paris, Charles de Gaulle
Toronto Pearson
Amsterdam, Schiphol
Chicago O'Hare
Moscow Sheremetyevo
Rome Fiumicino
New York, JFK
Beijing Internacional airport
Dubai International Airport
Sao Paulo, Guarulhos International
Barcelona, El Prat
Frankfurt Airport
Aeropuerto Internacional Ciudad de Mexico
Hong Kong
Tokyo, Haneda
Sydney Airport
Los Angeles International
Chhatrapati Shivaji International Airport
Atlanta
London Heathrow

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Hong Kong Chek Lap Kok Terminal

Skycity

Hong Kong Boundary Crossing Facilities (under construction)

Hong Kong–Zhuhai–Macau Bridge (Completed 2018)

To Kowloon and Hong Kong
Dallas/Fort Worth International Airport
International Tourism and Transport
Share of International Tourist Arrivals by Region, 1950-2015

[Bar chart showing the percentage share of international tourist arrivals by region from 1950 to 2015. The chart includes data for Middle East, Africa, Asia, Americas, and Europe. Each bar is divided into segments representing different regions, with the percentage share indicated for each year.]
Petroleum: A Transportation Resource
OPEC Members and Countries with more than 10 Billion Barrels of Oil Reserves
Products Made from a Barrel of Crude Oil

Typical Products Made from a 42-Gallon Barrel of Refined Crude Oil

- 3% Asphalt
- 4% Liquefied Petroleum
- 10% Jet Fuel
- 18% Other Products
- 23% Diesel Fuel & Heating Oil
- 47% Gasoline

Share of OPEC and the Persian Gulf of the World Crude Oil Production, 1960-2016

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## Major Oil Price Fluctuations

<table>
<thead>
<tr>
<th>Price Change Event</th>
<th>Price Change Time Frame</th>
<th>Cause</th>
<th>Nominal Price Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Oil Shock</td>
<td>October 1973 to March 1974</td>
<td>Yom Kippur War / OPEC oil embargo</td>
<td>From $4.31 to $10.11 (+134.5%)</td>
</tr>
<tr>
<td>Second Oil Shock</td>
<td>April 1979 to July 1980</td>
<td>Iranian revolution (1978) / Iran-Iraq war (1980)</td>
<td>From $15.85 to $39.50 (+149.2%)</td>
</tr>
<tr>
<td>Oil counter shock (A)</td>
<td>November 1985 to July 1986</td>
<td>OPEC oversupply / Lower demand</td>
<td>From $30.81 to $11.57 (-62.4%)</td>
</tr>
<tr>
<td>First Gulf War (1)</td>
<td>July 1990 to November 1990</td>
<td>Iraqi invasion of Kuwait</td>
<td>From $18.63 to $32.30 (+73.4%)</td>
</tr>
<tr>
<td>Asian Financial Crisis (B)</td>
<td>January 1997 to December 1998</td>
<td>Debt defaults / Non-USD currency devaluations / Reduced demand</td>
<td>From $25.17 to $11.28 (-55.1%)</td>
</tr>
<tr>
<td>&quot;Asian Demand Contagion&quot;</td>
<td>January 1999 to September 2000</td>
<td>Rising demand / OPEC output cutbacks</td>
<td>From $11.28 to $33.88 (+200.3%)</td>
</tr>
<tr>
<td>&quot;September 11 Effect&quot;</td>
<td>August 2001 to December 2001</td>
<td>Oversupply / American recession</td>
<td>From $27.47 to $19.33 (-29.6%)</td>
</tr>
<tr>
<td>Third Oil Shock</td>
<td>December 2003 to June 2008</td>
<td>Peak oil / Rising demand / Monetary debasement / Speculation</td>
<td>From $32.15 to $133.95 (+316.6%)</td>
</tr>
<tr>
<td>Financial Crisis of 2008 (D)</td>
<td>July 2008 to February 2009</td>
<td>Collapse of asset bubbles / Demand destruction / Global recession</td>
<td>From $133.95 to $39.16 (-70.7%; Dec 2008)</td>
</tr>
</tbody>
</table>
Exhibit 7: History indicates that assuming shale/OPEC can meet demand, oil prices likely need to stay lower for longer

Source: BP Statistical Review of World Energy, Goldman Sachs Global Investment Research
Costs of Finding Oil, 1977-2007

- Costs of finding oil ($ per barrel)
- Difference between oil costs and finding costs
- Worldwide oil finding costs

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Cost of Finding Oil, 1981-2006

Costs of finding oil ($ per barrel)

- Domestic
- Foreign
Reserves and Total Resources

- **Reserves (Identified and recoverable)**
- **Sub-economic**
- **Price / Technology**
- **Potential Unrecoverable**
- **Exploration**
- **Unidentified**
- **Cost of Recovery**
- **Uncertainty**

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Types of Oil and Gas Reserves

- Gas Hydrates
- Gas Shales
- Low Permeation Oil
- Heavy Oil
- High-Medium Quality
- Tight Gas Sands
- Coal Bed Methane
- Oil Shale
## World’s Largest Oil Fields, 2005

<table>
<thead>
<tr>
<th>Oil Field</th>
<th>Output (MBD)</th>
<th>% of national output</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghawar (Saudi Arabia)</td>
<td>4.5</td>
<td>40%</td>
<td>Possibly declining</td>
</tr>
<tr>
<td>Cantarell (Mexico)</td>
<td>2.0 (1.7; 2007, 1.04; 2008)</td>
<td>60%</td>
<td>Declining</td>
</tr>
<tr>
<td>Burgan (Kuwait)</td>
<td>1.7</td>
<td>68%</td>
<td>Declining</td>
</tr>
<tr>
<td>DaQing (China)</td>
<td>1.0</td>
<td>40%</td>
<td>Possibly declining</td>
</tr>
</tbody>
</table>
Oil Production of Some Declining Regions, 1973-2016
Remaining Proven Oil Reserves for “Middle Eastern Five” According to Major Assessors, 2005

- **Bakhtiari's Estimate**
- **Colin Campbell**
- **BP Statistical Review**
- **Oil & Gas Journal**

<table>
<thead>
<tr>
<th>Country</th>
<th>Bakhtiari's Estimate</th>
<th>Colin Campbell</th>
<th>BP Statistical Review</th>
<th>Oil &amp; Gas Journal</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Arabia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kuwait</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iraq</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Billions of barrels**
Global Oil Production, 1924 (1,000s of barrels per day)

North America: 2333
South America: 73
Europe: 179
Middle East: 88
Africa: 95
Far East: 3

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## Modes Used for Petroleum Transportation

<table>
<thead>
<tr>
<th></th>
<th>Pipeline</th>
<th>Marine</th>
<th>Rail</th>
<th>Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volumes</strong></td>
<td>Large</td>
<td>Very large</td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td>Crude / Products</td>
<td>Crude / Products</td>
<td>Products</td>
<td>Products</td>
</tr>
<tr>
<td><strong>Scale</strong></td>
<td>2 ML+</td>
<td>10 ML+</td>
<td>100 kL</td>
<td>5-60 kL</td>
</tr>
<tr>
<td><strong>Unit costs</strong></td>
<td>Very low</td>
<td>Low</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td><strong>Capital costs</strong></td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td><strong>Access</strong></td>
<td>Very limited</td>
<td>Very limited</td>
<td>Limited</td>
<td>High</td>
</tr>
<tr>
<td><strong>Responsiveness</strong></td>
<td>1-4 weeks</td>
<td>7 days</td>
<td>2-4 days</td>
<td>4-12 hours</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Limited</td>
<td>Limited</td>
<td>Good</td>
<td>High</td>
</tr>
<tr>
<td><strong>Usage</strong></td>
<td>Long haul</td>
<td>Long haul</td>
<td>Medium haul</td>
<td>Short haul</td>
</tr>
</tbody>
</table>
Main Origin of Crude Oil Imports, United States, 1973-2016 (in thousands of barrels per day)
Inter-Regional Petroleum Movements, 2006

- Middle East / Singapore
- Middle East / China
- Mexico / USA
- West Africa / USA
- North Africa / Europe
- Middle East / USA
- Canada / USA
- South America / USA
- Middle East / Europe
- Middle East / Japan
- Russia / Europe
- Middle East / Other Pacific Asia

Thousands of Barrels per Day
## Factors of Oil Dependency

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Occurrence</strong></td>
<td>Localized large deposits (decades)</td>
</tr>
<tr>
<td><strong>Transportability</strong></td>
<td>Liquid that can be easily transported. Economies of scale</td>
</tr>
<tr>
<td><strong>Energy content</strong></td>
<td>High mass / energy released ratio</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td>Continuous supply; geopolitically unstable</td>
</tr>
<tr>
<td><strong>Storability</strong></td>
<td>Easily stored</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Many uses (petrochemical industry; plastics)</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>Relatively safe; some risks (transport)</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Little wastes, CO2 emissions</td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td>Relatively low costs</td>
</tr>
</tbody>
</table>