



# Infrastructure Economics

Oatmeal Club, Eagle Harbor  
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## Who Are We?

- **Honorary Board: 54 members**

- 2 Fed Chairs: Janet Yellen, Ben Bernanke
- 6 Chairs Council of Economic Advisers
  - o Furman (D), Rosen (R), Bernanke (R), Yellen (D), Tyson (D), Goolsbee (D)
- 3 Nobel Prize Winners
  - o Akerlof, Smith, Maskin

- **Delegates: 600+ members**

- At all levels of academia and some in government service
- All have a Ph.D. in economics
- Crowdsource slide decks
- Give presentations

- **Global Partners: 45 Ph.D. Economists**

- Aid in slide deck development



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## Credits and Disclaimer

- **This slide deck was authored by:**
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  - Jon Haveman, NEED
- **Disclaimer**
  - NEED presentations are designed to be nonpartisan.
  - It is, however, inevitable that the presenter will be asked for and will provide their own views.
  - Such views are those of the presenter and not necessarily those of the National Economic Education Delegation (NEED).



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## Available NEED Topics Include:

- **Coronavirus Economics**
- **Climate Change**
- **Economic Inequality**
- **Economic Mobility**
- **US Social Policy**
- **Trade and Globalization**
- **Minimum Wages**
- **The U.S. Economy**
- **Immigration Economics**
- **Housing Policy**
- **Federal Budgets**
- **Federal Debt**
- **Black-White Wealth Gap**
- **Autonomous Vehicles**



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## Outline

- What do we mean by infrastructure?
- Current state of infrastructure in the US
- Why should we invest in infrastructure?
- What **SHOULD** we mean by infrastructure?



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## What is a Useful Definition of Infrastructure?

- *Infra-* means "below;"
  - So the infrastructure is the "underlying structure" of a country and its economy.
- Miriam-Webster definition of Infrastructure:
  - the system of public works of a country, state, or region
    - *also* : the resources (such as personnel, buildings, or equipment) required for an activity
  - the underlying foundation or basic framework (as of a system or organization)
  - the permanent installations required for military purposes



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## Different Kinds of Infrastructure (& Examples)

- **Provide basic services.**
  - Electricity, water, broadband (?).
- **Improve the performance of the economy.**
  - Roads, bridges, airports, seaports.....
  - General R&D?
  - Education
- **Make people's lives better.**
  - Roads, bridges, airports...
  - Protection from natural disaster
  - Childcare, education.



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## Infrastructure – Is it:

- **Traditional:**
  - Roads, bridges, tunnels, airports, seaports, dams, water, electrical, and telephone systems?
- **Additional:**
  - Broadband
- **What about:**
  - R&D? Human capital? Institutions?
- **What definition of “infrastructure” is the most useful today?**



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## One Taxonomy:

- **Tangible**

- Traffic systems: roads, railways, bridges, and other transportation
- Utilities and disposal: energy, water, communication networks

- **Intangible**

- Human capital: education, research facilities
- Health care and social systems

- **Institutional**

- Legal system
- Economic system
- Social system
- Culture and traditions (?)



## Categories of Tangible Infrastructure

- **Transportation**

- Highways, roads, bridges
- Mass transit
- Airports, seaports

- **Water**

- Supply
- Distribution

- **Waste management**

- Trash, recycling, and wastewater

- **Energy**

- Generation
- Transmission


















- **Communications**

- Telephone
- Internet




## Current State of Infrastructure in the US


### 2021 Infrastructure Grades

 AVIATION <span style="float: right;">↑ D+</span>	 PORTS <span style="float: right;">↑ B-</span>
 BRIDGES <span style="float: right;">↓ C</span>	 RAIL <span style="float: right;">B</span>
 DAMS <span style="float: right;">D</span>	 ROADS <span style="float: right;">D</span>
 DRINKING WATER <span style="float: right;">↑ C-</span>	 SCHOOLS <span style="float: right;">D+</span>
 ENERGY <span style="float: right;">↑ C-</span>	 SOLID WASTE <span style="float: right;">C+</span>
 HAZARDOUS WASTE <span style="float: right;">D+</span>	 STORM WATER <span style="float: right;">D</span>
 INLAND WATERWAYS <span style="float: right;">↑ D+</span>	 TRANSIT <span style="float: right;">D-</span>
 LEVEES <span style="float: right;">D</span>	 WASTEWATER <span style="float: right;">D+</span>
 PARKS AND RECREATION <span style="float: right;">D+</span>	

**America's Cumulative Infrastructure Grade**



A	EXCEPTIONAL
B	GOOD
C	MEDIocre
D	POOR
F	FAILING



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Source: <https://www.infrastructurereportcard.org/>

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## How Do We Compare?

### Countries With The Best Infrastructure

# We're #9!

Rank	Country	Infrastructure Score
1	Hong Kong	6.7
2	Singapore	6.5
3	Netherlands	6.4
4	Japan	6.3
5	United Arab Emirates	6.3
6	Switzerland	6.3
7	France	6.1
8	Korea	6.1
9	United States	6.0
10	Germany	6.0
11	United Kingdom	6.0
12	Spain	5.9



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https://www.worldatlas.com/articles/countries-with-the-best-infrastructure.html

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# Current State of Transportation Infrastructure

## • Roads

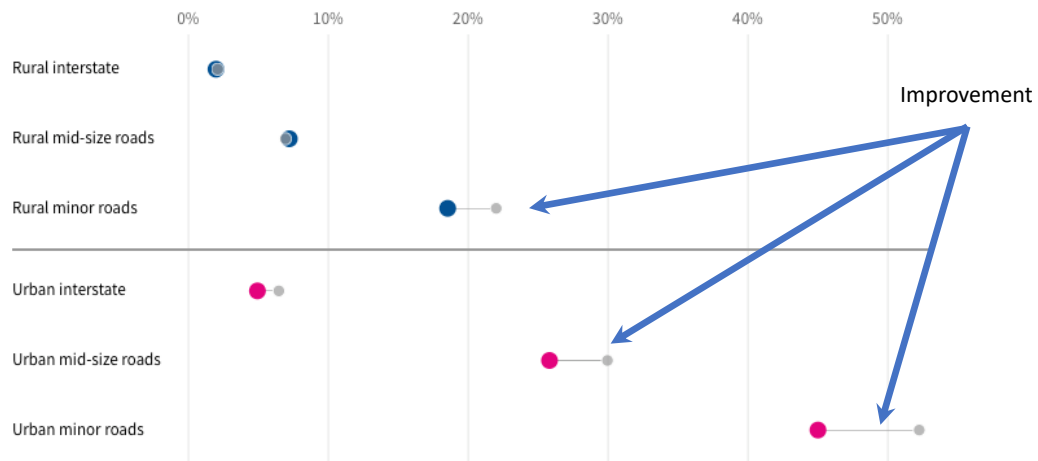
- Over 4 million miles of roads.
- In 2018: 3.3 trillion VMT (Vehicle Miles Traveled).
- 40%+ of America’s urban interstates are congested.
- In 2017, 8.8 billion hours of traffic delay.
  - o Costing the country \$166 billion in wasted time and fuel.

***“The average auto commuter spends 54 hours in congestion and wastes 21 gallons of fuel due to congestion at a cost of \$1,080 in wasted time and fuel.”***

-- 2019 Urban Mobility Report, Texas A&M Transportation Institute

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# But Some Infrastructure is Getting Better



PERCENT OF ROADS IN UNSATISFACTORY CONDITION 2000 VS 2019

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# Current Infrastructure Package

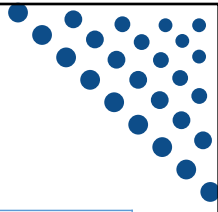


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## What is in it?


**• Transportation**

Roads, bridges, major projects	\$110 Billion
Passenger and freight rail	\$66 Billion
Public transit	\$39 Billion
Airports	\$25 Billion
Port infrastructure	\$17 Billion
Transportation safety programs	\$11 Billion
Electric vehicles	\$7.5 Billion
Zero and low-emission buses and ferries	\$7.5 Billion
Revitalization of communities	\$1 Billion

**• Other**

Broadband	\$65 Billion
Power infrastructure	\$73 Billion
Clean drinking water	\$55 Billion
Resilience and wastewater storage	\$50 Billion
Removal of pollution from water and soil	\$21 Billion

Just \$550 million new.



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## What is missing?

- **Strategic thinking:**
  - Long term thinking, planning, prioritizing.
- **Meaningful climate resilience planning.**
- **Education & R&D.**
- **Expanding/insuring water supplies.**
- **Hazardous waste.**
- **A meaningful magnitude of spending?**



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## Funding – According to the White House

- **Unspent emergency relief funds**
- **Targeted corporate user fees.**
- **Strengthening tax enforcement – crypto currencies.**
- **Revenue generated from higher economic growth.**



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# Infrastructure Benefits



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## Why Should we Invest in Infrastructure?

- **Vital ingredient to economic growth.**

- Facilitates economies of scale, raises productivity  
A 10% rise in infrastructure assets directly increases Real GDP per capita by 0.7 – 1%.
  - o Assuming increases in spending translate 1-1 to the stock of assets:
    - **~\$50 billion** will raise GDP per capita in the US by ~\$300 - \$450.
    - **\$100 to \$150 billion** in increased GDP.
- Productivity growth raises standards of living.



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## Why Should we Invest in Infrastructure?

- **Vital ingredient to economic growth**

- Reduces trade costs by improving access to markets.
  - o Port capacity improvement
  - o Reducing traffic congestion
- Reduces effective distances, facilitates trade and agglomeration.
- Advances public health by providing clean water and effective sewage systems.



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## Case for Spending More on Infrastructure MAINTENANCE

- **Rundown infrastructure increases costs**

- Longer travel time → higher costs for businesses
- Wear on cars → more spending on car repairs → faster car depreciation
- Vehicle deterioration → Additional fuel consumption

*"The average motorist in the U.S. is losing \$523 annually -- \$112 billion nationally -- in additional vehicle operating costs as a result of driving on roads in need of repair."*

-- November 2016 Urban roads TRIP report

- **Deferred maintenance is a debt burden on the future generations.**



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## Public or Private Infrastructure Investment?

- **Nonrival consumption**
- **Non-excludable use**

- Social benefits might exceed expected financial return.
- Private sector likely to underprovide key types of infrastructure.
- Economic case for public provision of infrastructure assets.



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## Public or Private Infrastructure Investment?

- **A few arguments for public provision:**

- Provision of public infrastructure increases productivity of private infrastructure
  - o Incentivizes private capital investment,
  - o Increases labor productivity,
  - o Indirectly increases employment and wages.



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## Public or Private Infrastructure Investment?

- **A few more arguments for public provision:**
  - Provides short-term stimulus to the economy by creating jobs
  - Promotes trade and commerce
  - Promotes equity
    - Pays prevailing wages
    - More demographically inclusive
    - Encompasses all congressional districts
  - Promotes public health and well-being
  - Improves public safety
  - Affects not just the present but also future generations.
  
- **Some of these are more debatable than others.**



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## Empirical Evidence on Effect of Gov't Investment

- **In studies from 80s, early 90s:**
  - A 1% increase in the stock of public capital raised GDP by 0.39%
- **In more recent studies**
  - by only 0.08% in the short run, 0.12% long run
- **In terms of multiplier, most short-term estimates are less than 1**
  - Due to negative effects of tax/interest rate increases on private C and I
- **Longer term multiplier**
  - OECD panel data – 1.6
  - US interstate highway system – 1.8



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## Empirical Evidence on Effect of Gov't Investment

- **Estimates from the 2009 American Recovery and Reinvestment Act**

- Each \$100,000 spent led to 0.8 job-years created.
- Highway construction employment unaffected in 2009-10.
  - o Fell sharply afterwards.
- Significant “crowd-in” of state and local highway spending.
  - o For each \$1 of federal grant an additional \$2.30 in state spending.



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## Infrastructure Investment in the US

- **Transportation, drinking water, and wastewater infrastructure**

- mainly funded by the public sector

- **Publicly owned transportation infrastructure**

- Highways
- Mass transit
- Aviation
- Water transportation
- Rail

- **Publicly owned water infrastructure**

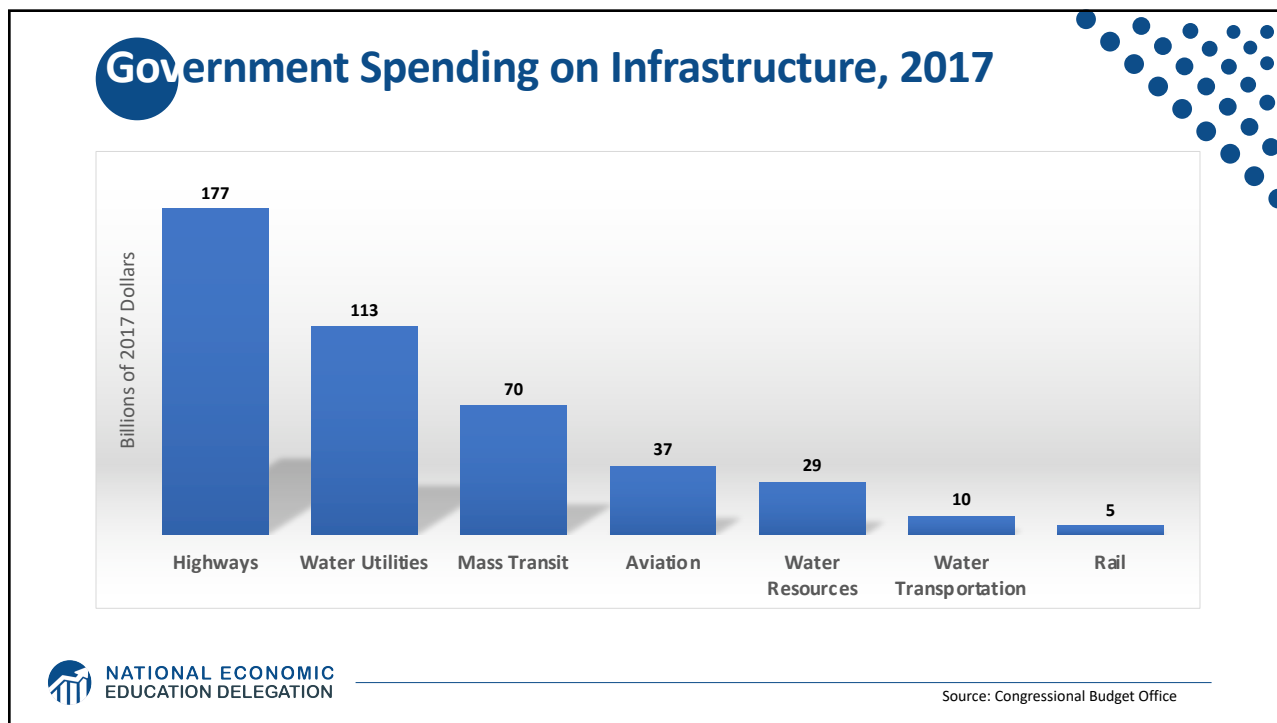
- Water utilities
- Water resources

- **In 2017, Federal, State and Local governments spent**

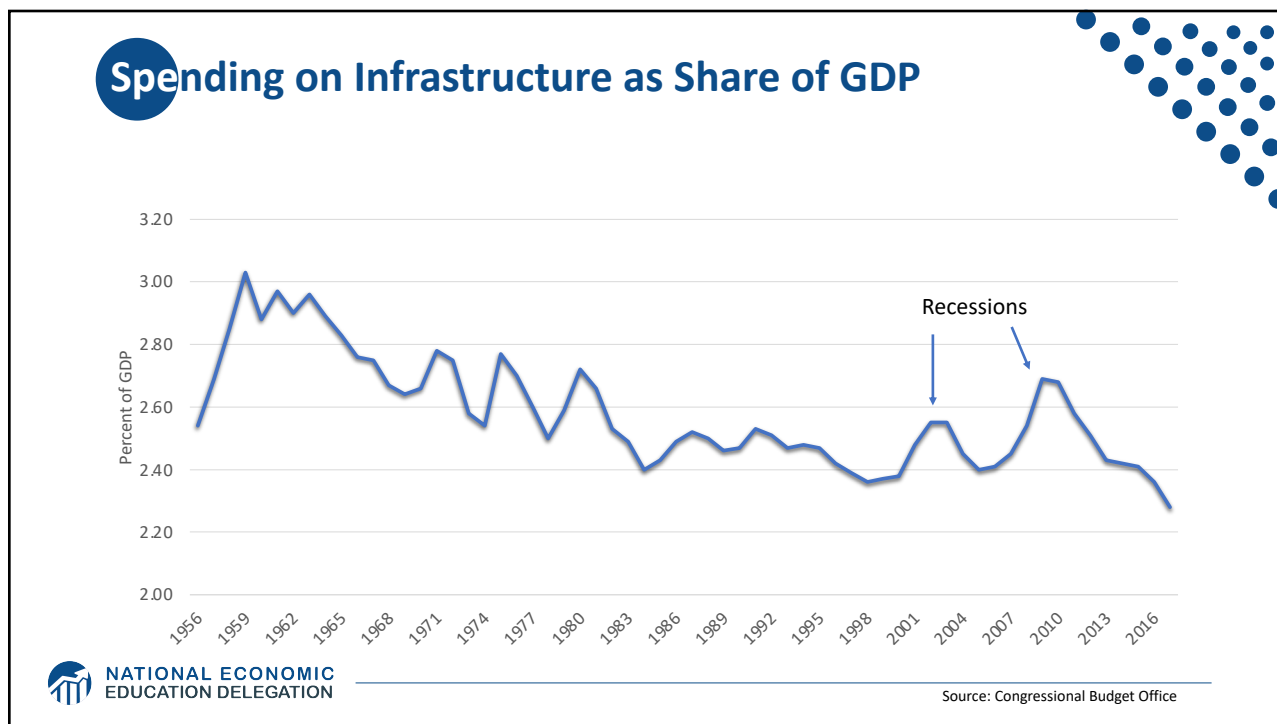
- \$441 billion on infrastructure
- 2.3% of gross domestic product



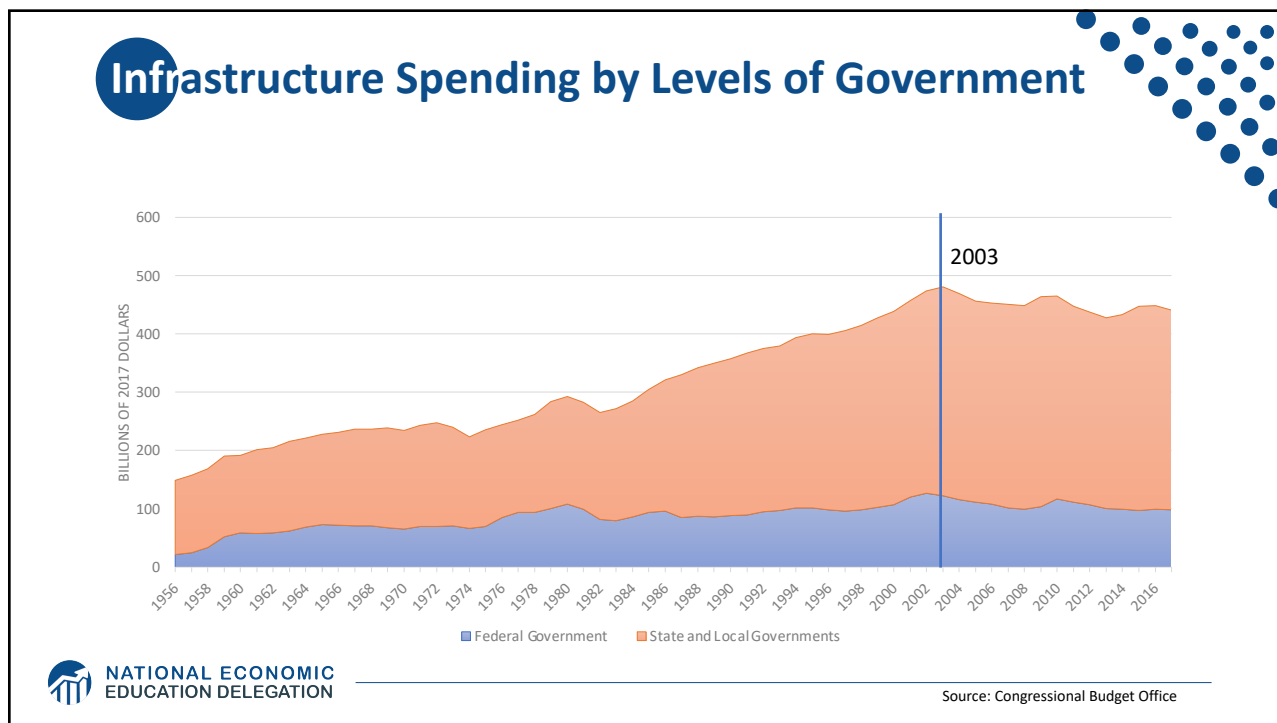
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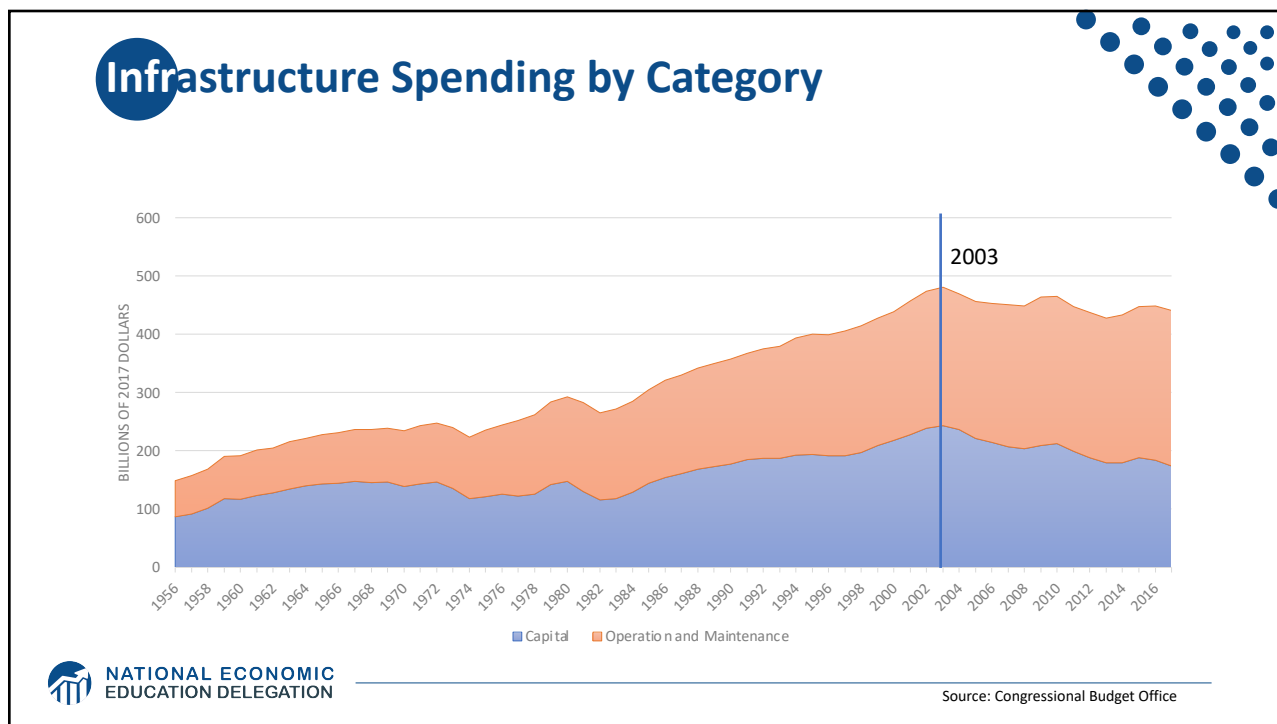
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## Another Aspect of Infrastructure – Broadband

- Talk of a digital divide ubiquitous.
  - Especially in light of the current pandemic.
- 21 million+ Americans lack meaningful access to the internet.
  - Meaningful access: 25 Mbps download and 3 Mbps upload
  - 14.5 million have no access at all.
- Lack of access more common among the less educated, low income, living in rural or suburban areas.
- 9 million+ school children lacked internet access for online schoolwork.



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## Broadband Access

- Modern-day equivalent of the interstate highway system.
- Lack of access not just a rural problem.
  - In 2016, 57% of households in Detroit, MI;
  - 49% in Memphis, TN and
  - 48% in Cleveland, OH without fixed broadband.
- Digital redlining within cities.
- Where available, service is often limited to a single service provider – natural monopolies.
  - Due to high up-front fixed costs of laying fiber-optic lines



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## Enormous Economic Benefits to Access

- **Individual benefits:**

- Better health and life outcomes.
  - o Access to health and education online.
  - o Job search and development of digital skills.
- Higher property values.
- Increased population and job growth.
  - o Higher rates of business formation.

- **Broader economic benefits:**

- World Bank
  - o 10% increase in access yields a 1.2% jump in real incomes.
- Indiana
  - o ROI = 300-400%.



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## Pace of Investment



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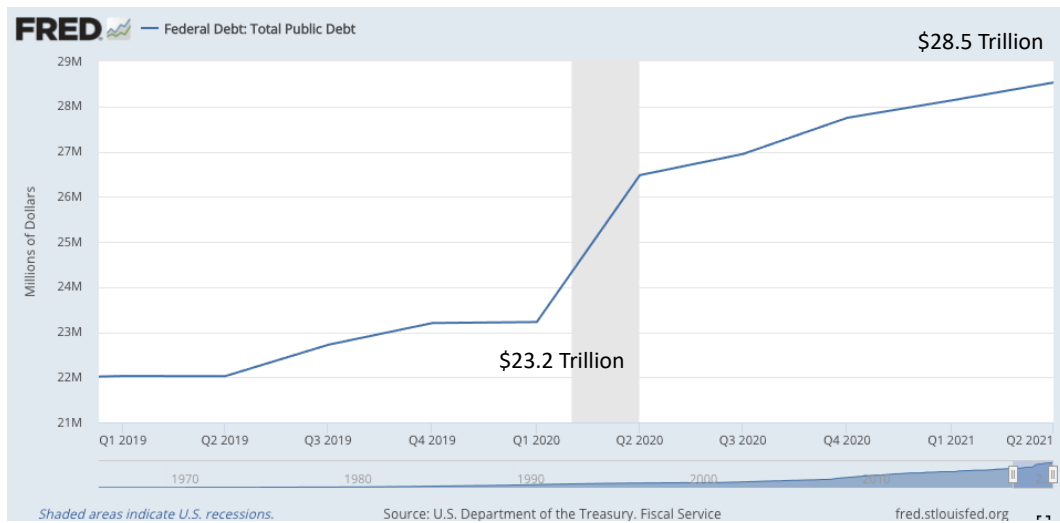
# Too Much, Too Soon? Too Little, Too Late?

- **Is the current infrastructure package appropriate?**
- **The United States has enormous needs.**
  - Basic infrastructure – bridges, roads, etc.
  - Other:
    - General R&D: 2% of GDP in the 1950s, currently 0.75%.
- **Is now the time to borrow extensively?**
  - Have just borrowed > \$4 Trillion.
  - Interest rates are very low.
- **Given the state of our infrastructure, the ROR can be very high.**



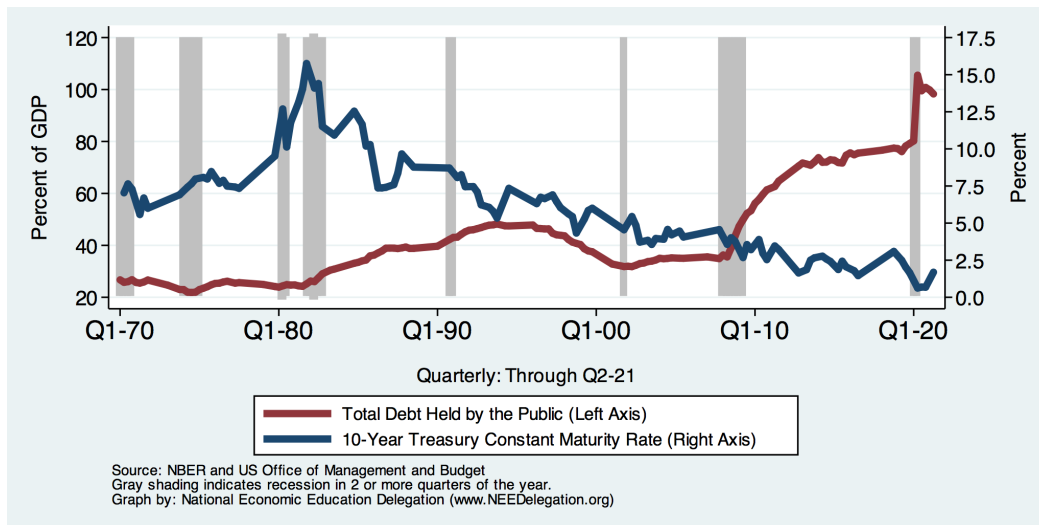
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# COVID Borrowing



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## Rising Debt and Low Interest Rates



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## Debt Outlook is Troublesome

### Federal Debt Held by the Public, 1900 to 2050

Percentage of Gross Domestic Product



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## Summary

- **Infrastructure investment is important.**
- **Current state of US infrastructure – leaves a lot to be desired.**
- **Public infrastructure investment can play a vital role in long run growth.**
  - Improve mobility
  - Raise private capital productivity
  - Improve health
- **May not be ideal as short-term stimulus.**
- **Arguments for and against going big.**
  - ROR arguments likely carry the day in today's interest rate environment.
  - Risk is always the impact on the debt.



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## Food for Thought:

- **Why do we categorize some government *investment as infrastructure*?**
  - To make spending on it politically palatable?
    - Gives the impression that it is particularly beneficial.
  - Is there a useful categorization of infrastructure?
    - If so, to what end...



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## \$3.5 Trillion Social Policy/Infrastructure Bill?

**Now: \$1.85 Trillion**

- Climate change
- Health care
- Child care tax credit
- Education (Pre-K/Pell/Training)
- Housing
- Immigration

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**Thank you!**

## Any Questions?

[www.NEEDelegation.org](http://www.NEEDelegation.org)

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## Current State of Transportation Infrastructure

### • Mass Transit

- ~2,500 separate transit agencies.
- Transit ridership: peaked at 10.7 billion in 2014.
- 50% of passenger trips by bus.
  - o 10% of fleets NOT in “state of good repair”.
- 33+% by heavy rail (subway/metro)
  - o 3% of fleets NOT in “state of good repair”.
- Transit’s physical infrastructure fairs considerably worse (% NOT in “state of good repair”):
  - o 15% of facilities (e.g., maintenance facilities),
  - o 17% of systems (e.g., power, signal, communications, fare collecting)
  - o 35% of guideway elements (e.g., tracks), and
  - o 37% of stations.



## Current State of Transportation Infrastructure

### • Aviation

- In 2018, 10 million+ commercial flights
  - o Flying ~3 million passengers daily
- National Plan of Integrated Airport Systems (NPIAS)
  - o identifies over 3,300 airports in the U.S. aviation network
- Contributed 5.1% to US GDP
  - o Generated 10.6 million jobs
- In 2017, 80% of flights were on-time. Delays were caused by
  - o late-arriving aircrafts (6.8%),
  - o air carriers (5%),
  - o weather (3.1%), and
  - o diverted flights (0.2%).



## Current State of Transportation Infrastructure

### • Ports

- 99% of US overseas trade pass through ports
- Los Angeles and Long Beach – busiest ports in the US
  - o Top 10 U.S. ports account for 3/4<sup>th</sup> of U.S. trade
- Congestion decreased port productivity by over 25% over the past decade
- Port infrastructure upgrades needed to accommodate new, larger ships with deeper navigation channels

### • Waterways

- More than 600 million tons of cargo
  - o 14% of annual domestic freight
- Beyond their 50-year design life
- 50% vessels experience delays due to maintenance shut downs



## Current State of Water Infrastructure

### • Drinking Water

- 150,000+ public drinking water systems
- 1 billion+ glasses of drinking water consumed daily
  - o 80% from surface waters such as rivers, lakes, oceans, reservoirs
  - o 20% from groundwater aquifers
- Delivered via 1 million miles of pipes
  - o Majority laid in mid-20<sup>th</sup> century and are aging
  - o estimated 240,000 water main breaks occur each year
  - o 6 billion gallons of treated drinking water lost daily due to leaking pipes
    - could support 15 million households





## Current State of Water Infrastructure

### • Wastewater

- 14,748 wastewater treatment plants
  - 1.3 million miles of public and private lateral sewers
- Used by 76% of Americans
  - Likely to serve 56 million more people by 2032
- Structural failure, blockages, and overflows cause at least 23,000 to 75,000 sanitary sewer overflow events each year



## Current State of Water Infrastructure

### • Dams

- There are over 90,000 dams in the US providing:
  - drinking water,
  - irrigation,
  - hydropower,
  - flood control, and
  - recreation
- Average age – 56 years
- By 2025, 7 out of every 10 dams will be over 50 years old
- In 2015, there were 15,500 high-hazard potential dams
  - up 52% since 2005



## Current State of Water Infrastructure

- **Levees**

- A network of 30,000 miles of levees
- Levees in the U.S. Army Corps of Engineers Levee Safety Program protect
  - o over 300 colleges and universities,
  - o 30 professional sports venues,
  - o 100 breweries, and
  - o an estimated \$1.3 trillion in property
- Built in the mid-20<sup>th</sup> century with an average age of 50 years, aging fast
- Levees are crucial with majority of the U.S. population living within 50 miles of a coast

