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**National Economic Education Delegation**

**Infrastructure Narrative**

Date: December 21, 2020

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   3. Ethics, morality, and values take you from economics to policy prescription.
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Slides:

1. **Opening slide**

<brief summary and opening>

1. DO NOT DELETE: National Economic Education Delegation
   1. Brief discussion of what NEED is and NEED does
   2. Use your judgement for what should be said.
2. Who we are?
   1. 45 honorary board – 3 Nobel prize winners, 6 former chairs of council, and 2 former Chairs of the Federal Reserve.
   2. 367 delegates, one in each state.
   3. 42 Global Partners
3. Where are we?
4. DO NOT DELETE: Credits and Disclaimer
5. Outline:
6. **What do we mean by infrastructure?**
7. **Current state of infrastructure in the US**
8. **Infrastructure in economic models**
9. **Why should we invest in infrastructure?**
10. **Public or private infrastructure investment**
11. **Infrastructure investment in the US**
12. **Policy options to fund infrastructure investments:**
    1. Conventional debt finance
    2. Public Private Partnerships
    3. User fees
13. **What is Infrastructure?**
14. **Economic infrastructure:** Basic services that represent a foundational tool for the economy. Can be:
    1. Physical structures
    2. Systems
    3. Institutions
    4. Services
    5. Facilities
15. **We will focus on physical structures, systems, and facilities.**
16. **Categories of Infrastructure**
    1. Transportation
       1. Highways, roads, bridges
       2. Mass transit
       3. Airports
    2. Water
       1. Supply
       2. Distribution
    3. Waste management
       1. Trash, recycling, and wastewater
    4. Energy
       1. Generation
       2. Telecommunications
    5. Communications
       1. Telephone
       2. Internet
17. **Current State of Infrastructure in the US**
    1. Report card source: https://www.infrastructurereportcard.org/
    2. This report card has been issued by the American Society of Civil Engineers (ASCE).
    3. Since 1998, ASCE has issued the Infrastructure Report Card, and beginning in 2001, the Report Card has been released every four years.
18. **Current State of Transportation Infrastructure**
    1. **Roads**
       1. The most visible and familiar forms of infrastructure
       2. Over 4 million miles of roads -- from 15 lane interstates to residential streets
       3. In 2018, U.S. roads carried people and goods over 3.3 trillion miles (i.e., VMT in 2018 was over 3.3)—or more than 300 round trips between Earth and Pluto.
       4. “More than 2 out of every 5 miles of America’s urban interstates are congested. Travel on the nation’s Interstate highways is increasing at a rate nearly triple the rate that new lane capacity is being added. From 2000 to 2018, vehicle travel on Interstate highways increased 25 percent, from 662 billion miles traveled annually to 829 billion miles. From 2000 to 2018, lane miles of Interstates in the U.S. increased nine percent, from 208,502 to 226,626 miles.”
       5. “In 2017, congestion caused urban Americans to travel an extra 8.8 billion hours and purchase an extra 3.3 billion gallons of fuel for a congestion cost of $166 billion. The variation in congestion is often more difficult for commuters and freight shippers to accommodate than the regular, predictable back‐ups.  To reliably arrive on time for important freeway trips, travelers had to allow 34 minutes to make a trip that takes 20 minutes in light traffic.”
       6. “A statistical projection of traffic fatalities for 2019 shows that an estimated 36,120 people died in motor vehicle traffic crashes.  This represents an estimated decrease of about 440 (down 1.2%) from the reported 36,560 fatalities in 2018, even though Vehicle Miles Traveled (VMT) increased by 0.9%.”

Sources -- <https://www.infrastructurereportcard.org/>; [2018 FHWA Highway Statistics](https://www.fhwa.dot.gov/policyinformation/statistics/2018/); [TRIP Interstate Report 2020](https://tripnet.org/wp-content/uploads/2020/07/TRIP_Interstate_Report_2020.pdf); [2019 Urban Mobility Report](https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-report-2019.pdf); and [Early Estimates of NHTSA Fatality Analysis Reporting System (FARS) 2019 data](https://www.nhtsa.gov/press-releases/early-estimates-traffic-fatalities-2019#:~:text=A%20statistical%20projection%20of%20traffic,VMT)%20increased%20by%200.9%25.)

1. **Current State of Transportation Infrastructure**
   1. **Mass Transit** 
      1. The 2,350 urban, rural and tribal government transit agencies offer a range of travel options, including commuter rail, subway, and light rail; transit and trolley bus; and ferryboat.
      2. Transit ridership surpassed 10 billion beginning in 2006, reaching a high of 10.7 billion in 2014.
      3. “Buses are the most common form of public transportation, accounting for approximately half of passenger trips in 2015. The 15 heavy rail (subway/metro) systems comprise the majority of non-bus trips, accounting for over a third of total passenger trips.”
      4. “According to the most recent data available, 10% of the nation’s urban bus fleet and 3% of the nation’s rail fleet are not in a “state of good repair.” Transit’s physical infrastructure fairs considerably worse: 15% of facilities (e.g., maintenance facilities), 17% of systems (e.g., power, signal, communications, fare collecting) 35% of guideway elements (e.g., tracks), and 37% of stations are not in a “state of good repair.””

Source: <https://www.infrastructurereportcard.org/>; [BTS Transportation Statistics Annual Report 2018](https://www.bts.dot.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/transportation-statistics-annual-reports/Preliminary-TSAR-Full-2018-a.pdf)

1. **Current State of Transportation Infrastructure**
   1. **US Transit Ridership Loss due to COVID-19 Lockdowns**

Source: [FAA Air Traffic by the numbers 2019](https://www.faa.gov/air_traffic/by_the_numbers/media/Air_Traffic_by_the_Numbers_2019.pdf); [APTA The Impact of the COVID-19 Pandemic on Public Transit Funding Needs in the U.S.](https://www.apta.com/wp-content/uploads/APTA-COVID-19-Funding-Impact-2020-05-05.pdf)

1. **Current State of Transportation Infrastructure**
   1. **Aviation**
      1. In 2018, in the US there were
         1. Over 10 million commercial flights
         2. Flying over 1 billion passengers (2.8 million passengers daily)
      2. The National Plan of Integrated Airport Systems (NPIAS) identifies 3,328 airports in the U.S. aviation network
      3. Contributed 5.1% to US GDP; Generated 10.6 million jobs
      4. In 2017, 80.2% of flights had an on-time performance. Delays were caused by
         1. late-arriving aircrafts (6.8%),
         2. air carriers (5%),
         3. weather (3.1%), and
         4. diverted flights (0.2%)

Source: [Report to Congress National Plan of Integrated Airport Systems (NPIAS), Federal Aviation Administration, US Department of Transportation, 2019-2023](https://www.faa.gov/airports/planning_capacity/npias/reports/media/NPIAS-Report-2019-2023-Narrative.pdf)

1. **Current State of Transportation Infrastructure**
   1. **Impact of COVID-19 on air travel**

Source: [A4A Airline Industry Review and Outlook – COVID 19 Data Updates](https://www.airlines.org/dataset/impact-of-covid19-data-updates/)

1. **Current State of Transportation Infrastructure**
   1. **Ports** 
      1. 99% of US overseas trade passes through ports
      2. The ports of Los Angeles and Long Beach are the busiest ports in the US
      3. The top 10 U.S. ports accounted for 78% of U.S. foreign waterborne trade in 2015
      4. On the land side, congestion has caused port productivity to decrease by over 25% over the past decade
      5. On the water side, as the ship sizes continue to grow, existing port infrastructure will need to be upgraded to accommodate these larger ships with deeper navigation channels
   2. Waterways
      1. Us inland waterways moves more than 600 million tons of cargo each year accounting for 14% of all domestic freight.
      2. Most of locks and dams are beyond their 50-year design life
      3. Half of the vessels experience delays as the aging locks and dams shut down for maintenance

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

1. **Current State of Water Infrastructure**
   1. **Drinking Water**
      1. Americans drink more than one billion glasses of tap water each day
      2. 80% of drinking water comes from surface waters such as rivers, lakes, reservoirs, and oceans, and 20% from groundwater aquifers
      3. There are over 150,000  public drinking water systems
      4. More than 90 percent of the water systems meet the standards issued by EPA
      5. Drinking water is delivered via one million miles of pipes across the country
      6. Majority of those pipes were laid in mid-20th century and are aging
      7. 6 billion gallons of treated drinking water are lost due to leaking pipes daily
         1. estimated 240,000 water main breaks occur each year
         2. the amount of water lost daily could support 15 million household

Source: <https://www.infrastructurereportcard.org/>; [EPA Blog -- Moving Forward for America’s Drinking Water](https://blog.epa.gov/2016/04/26/moving-forward-for-americas-drinking-water/); [2020 State of the Water Industry](https://www.awwa.org/Professional-Development/Utility-Managers/State-of-the-Water-Industry)

1. **Current State of Water Infrastructure**
   1. **Wastewater**
      1. 76% of Americans rely on the nation’s 14,748 wastewater treatment plants
      2. By 2032, 56 million more people will connect to centralized treatment plants
      3. There are a total 1.3 million miles of public and private lateral sewers
      4. Structural failure, blockages, and overflows cause at least 23,000 to 75,000 sanitary sewer overflow events each year

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

1. **Current State of Water Infrastructure**
   1. **Dams** 
      1. There are over 90,000 dams in the US providing
         1. drinking water,
         2. irrigation,
         3. hydropower,
         4. flood control, and
         5. recreation
      2. Average age – 56 years
      3. By 2025, 7 out of every 10 dams will be over 50 years old
      4. In 2015, there were 15,500 high-hazard potential dams, up 52% since 2005

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

1. **Current State of Water Infrastructure**
   1. **Levees**
      1. A levee is a man-made embankment built to keep a river from overflowing its banks or to prevent ocean waves from washing into undesired areas
      2. US has a network of 30,000 documented miles of levees
      3. Levees in the U.S. Army Corps of Engineers Levee Safety Program protect over 300 colleges and universities, 30 professional sports venues, 100 breweries, and an estimated $1.3 trillion in property
      4. Most of the levees were built in the mid-20th century with an average age of 50 years, the system is aging fast
      5. As development continues in floodplains and with majority of the U.S. population living within 50 miles of a coast, the role played by levees in protecting communities cannot be overstated

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

1. **Infrastructure in economic models**
   1. Vast macroeconomic literature on relationship between infrastructure and economic growth
   2. Neoclassical growth models aka the Ramsey Model
      1. Output is characterized with a production function that combines capital and Labor and an exogenously determined level of technology
      2. Households choose how much to save and how much to consume subject to resource constraint of the economy
      3. No long-run growth except due to exogenous technological change --
      4. Arrow & Kurz (1970) developed a model in which the available technology used the stock of public capital (core infrastructure assets), the stock of private capital and labor as complementary inputs. They also incorporated rivalness and congestion aspects in consumption of infrastructure.

[Source: Arrow, K J & Kurz, M (1970) "Optimal Growth with Irreversible Investment in a Ramsey Model," *Econometrica, Econometric Society*, vol. 38(2), pages 331-344.]

* 1. Endogenous growth models
     1. Economic growth is a result of endogenous variables like investment instead of external forces
     2. Several endogenous growth models included infrastructure, encompassed in public capital, and theorized that productive infrastructure could be a source of growth.  
        Examples:

Barro R, Sala-i-Martin X. [Public Finance in Models of Economic Growth](https://scholar.harvard.edu/barro/publications/public-finance-models-economic-growth). *Review of Economic Studies*. 1992.

Futagami, K., Morita, Y., & Shibata, A. (1993). Dynamic Analysis of an Endogenous Growth Model with Public Capital*. The Scandinavian Journal of Economics*, 95(4), 607-625. doi:10.2307/3440914

* 1. Variants
     1. Many variants of these basic models since have explored ideas such as productivity of public capital (government investment in infrastructure) under alternative fiscal policies (Turnovsky 1997, Baier and Glomm 2001), effect of government spending on private investment (Aschauer 1989), or self-financing abilities of public infrastructure investment (Perotti 2004).

[Sources:   
Aschauer, David Alan, 1989. "Does public capital crowd out private capital?," *Journal of Monetary Economics*, Elsevier, vol. 24(2), pages 171-188.  
Baier SL, Glomm G. 2001. Long-run growth and welfare effects of public policies with distortionary taxation. Journal of Economic Dynamics and Control 25: 2007–2042.  
Turnovsky SJ. 1997. Fiscal policy in a growing economy with public capital. Macroeconomic Dynamics 1: 615–639.  
Perotti R. 2004. Public investment: another (different) view. IGIER Working Paper 277, Milan.]

Despite the vast literature, a consensus on the effectiveness of infrastructure investment in economic growth and its magnitude is hard to find.

From Romp and Haan (2007) -- “In their survey of the earlier literature, Sturm et al. (1998) show that the literature contained a relatively wide range of estimates, with a marginal product of public capital that is much higher than that of private capital (e.g., Aschauer 1989), roughly equal to that of private capital (e.g., Munnell 1990b), well below that of private capital (e.g., Eberts 1986) and, in some cases, even negative (e.g., Hulten and Schwab 1991). The wide range of estimates makes the results of these older studies almost useless from a policy perspective.”

[Source: Romp W, de Haan J. 2007. Public capital and economic growth: a critical survey. Perspektiven der Wirtschaftspolitik 8: 6–52.]

1. **Econometric issues that make the task difficult**
   1. **Direction of causality**
      1. Reverse causation possible – did increased infrastructure spending cause productivity/economic growth or did increased economic growth provide resources that could be spent on infrastructure?

This endogeneity between infrastructure spending and economic growth, if not addressed, may cause the returns to infrastructure investment to be biased upwards.

* 1. **Spurious correlation –** when 2 variables are statistically related but a theoretical relationship between the two is nonexistent
     1. Non stationary data

In Time Series data, spurious correlation usually is an issue with non -stationary data (mean and variance of the variable of interest vary over time).

* + 1. Ignoring unobserved factors that might directly or indirectly affect both output and infrastructure investment could also lead to spurious regression
  1. To avoid issues relating to non-stationarity in time series, some studies have resorted to using a cross sectional or panel dataset. However, a nation’s population, current level of income, its existing stock of infrastructure might cause the effect of infrastructure development to vary across nations. Allowing for heterogenous effects of infrastructure on output across states or countries is challenging.

1. **Why should we invest in infrastructure?**
   1. Vital ingredient to economic growth
      1. Facilitates economies of scale, raises productivity - a 10% rise in infrastructure assets directly increases GDP per capita by 0.7 – 1%  
         [Source: Calderón C, Moral-Benito E and Servén L (2015). “Is infrastructure capital productive? A dynamic heterogeneous approach”.
         1. Assuming increases in spending translate 1-1 to the stock of assets, increasing spending by ~$50 billion (about 10% of $441 billion spent on infrastructure in 2017), will raise GDP per capita in the US by ~$300 -$450
      2. Productivity growth raises standards of living
2. **Why should we invest in infrastructure?**
   1. Vital ingredient to economic growth
      1. Facilitates economies of scale, raises productivity
      2. Reduces trade costs by improving access to markets
         1. Port capacity improvement
         2. Reducing traffic congestion
      3. Reduces effective distances, facilitates trade and agglomeration
      4. Advances public health by providing clean water and effective sewage systems  
         “Clean drinking water and effective sewage systems have a positive impact on popula­tion health, reducing disease, lowering infant mortality rates, and increasing life expectancy. Healthier children perform better in school, which raises human capital. Higher life expec­tancy enables productive workers to stay in the workforce longer. These factors raise human capital, productivity, and economic growth.” [Source: Krol, Robert, Will a Burst in Federal Infrastructure Spending Accelerate the Recovery from the COVID-19 Recession? (September 24, 2020). Mercatus COVID-19 Response Policy Brief Series]
3. **Case for spending more on infrastructure maintenance**
   1. Rundown infrastructure increases costs
      1. Longer travel time 🡪 higher costs for businesses
      2. Wear on cars 🡪 more spending on car repairs 🡪 faster car depreciation
      3. Vehicle deterioration 🡪 Additional fuel consumption
      4. “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.” [Source: November 2016 Urban roads TRIP report]
      5. “The number of hours wasted per driver in rush-hour traffic because of congestion more than doubled between 1982 and 1997; since then, that number has continued to rise.” [Source: David Schrank and Tim Lomax, 2009 Urban Mobility Report (College Station, Texas: Texas A&M University System, Texas Transportation Institute, July 2009)]
      6. “Nearly 20 percent of air passengers experienced flight disruptions that, on average, added an estimated 105 minutes to their travel time.” [Source: Lance Sherry, Guillermo Calderon-Meza, and Ashwin Samant, “Trends in Airline Passenger Trip Delays, 2007–2009” (paper presented at the 2010 Integrated Communications Navigation and Surveillance Conference, Herndon, Va., May 11–13, 2010)]
   2. Deferred maintenance is a debt burden on the future generations -- Minor upkeep now, if left unattended, will become costly affairs in the future.
4. **Public or Private Infrastructure Investment?**

A lot of infrastructure assets are nonrival in consumption (use by one individual does not reduce its availability to others) and non-excludable in use (individuals can’t be effectively excluded from its use).

As a result, there is a possibility that social benefits from the provision of such assets will exceed private benefit, causing the private sector to under provide those assets. Hence there is a case for public provision.

1. **Public or Private Infrastructure Investment?**
   1. Provision of public infrastructure increases productivity of private infrastructure
      1. Incentivizes private capital investment,
      2. increases labor productivity,
      3. employment and wages.

[Source: Krol, Robert, Will a Burst in Federal Infrastructure Spending Accelerate the Recovery from the COVID-19 Recession? (September 24, 2020). Mercatus COVID-19 Response Policy Brief Series, Available at SSRN: <https://ssrn.com/abstract=3698732> or <http://dx.doi.org/10.2139/ssrn.3698732>]

1. **Public or Private Infrastructure Investment?**
   1. Arguments for public provision:
      1. Creates jobs
      2. Promotes trade and commerce
      3. Promotes equity
         1. Pays prevailing wages
         2. More demographically inclusive
         3. Encompasses all congressional districts
      4. Promotes public health and well-being
      5. Improves public safety
      6. Affects not just the present but the future generations also
   2. Some of these are more debatable than others. Discuss the issues briefly:
      1. Projects need to be “shovel ready” for funding but projects require extensive planning to be able to generate high returns, so are unlikely to create jobs immediately. Environmental impact studies might create legal challenges that might delay projects even more. By the time a project is ready to be implemented, the economy may have already recovered. Also, “In America’s current situation, many unemployed workers come from the service sector. It is unlikely that a laid-off waiter can make a fast transition to driving highway construction equip­ment. Laid-off construction workers may be able to make such a transition, but as the economy recovers, this type of transition will hamper the expansion of private-sector projects” [Source: Krol, Robert, Will a Burst in Federal Infrastructure Spending Accelerate the Recovery from the COVID-19 Recession? (September 24, 2020). Mercatus COVID-19 Response Policy Brief Series]
      2. Prevailing wages may increase project costs reducing the available resources for other projects or for covering more districts
      3. Being more demographically inclusive by providing contracts/employment to women or minority businesses putting more weight on demographic attributes compared to merit might put the safety of the project output at risk
      4. Public provision may crowd out private investment
2. **Empirical Evidence on Effect of Gov’t Spending**
   1. In early studies, the estimated effect of a 1% increase in the stock of public capital was to raise GDP by 0.39%
   2. In most recent studies, after correcting for many econometric issues that characterized the early studies, the effect is to increase GDP by only 0.08-0.12%.
   3. In terms of multiplier, most short-term estimates are less than one, i.e., a $1 increase in public capital raises GDP by less than $1. This is largely due to negative effects of tax/interest rate increases on private consumption and investment
3. Net benefits are positive in the long run. “Boehm (2019) specifically compares multipliers for government investment and consumption spending in a panel of OECD countries… also controls for forecasts in order to mitigate possible anticipation biases. He also finds a long-run multiplier of 1.6 for government investment spending” . “Leff Yaffe (2020) uses state panel data and narrative evidence to estimate the output effects of the building of the U.S. interstate highway system, accounting for anticipation effects and crowding-in of state and local spending on roads. His multiplier estimates are significantly affected by the estimated “crowd-in” of state highway spending. In particular, an infusion of funds to a state (instrumented using Bartik-style instruments) typically led to additional road building to connect to the interstate highway system. When he includes the additional state and local spending in the government spending measure, Leff Yaffe’s long-run relative multiplier estimate is 1.8.”

[Sources:

[The Macroeconomic Consequences of Infrastructure Investment](https://www.nber.org/chapters/c14366), Valerie A. Ramey. in [Economic Analysis and Infrastructure Investment](https://www.nber.org/books/glae-6), Glaeser and Poterba. 2020

Krol, Robert, Will a Burst in Federal Infrastructure Spending Accelerate the Recovery from the COVID-19 Recession? (September 24, 2020). Mercatus COVID-19 Response Policy Brief Series, Available at SSRN: <https://ssrn.com/abstract=3698732> or <http://dx.doi.org/10.2139/ssrn.3698732>]

1. **Empirical Evidence on Effect of Gov’t Spending**
   1. **Estimates from the 2009 American Recovery and Reinvestment Act**

“Considerable attention has been given to the regional impact of infrastructure spending associ­ated with the ARRA. Research has focused on the impact of government investment spending at the state or county level. These estimates measure the impact on a state or county from additional spending of federal funds relative to the average state. The estimates do not control for financing issues and spillovers between regions. As Valerie Ramey shows, since state (and county) economies vary considerably by size, the impact can vary across states, and the results may not be represen­tative of the typical state.27 Without weighting each state by some measure of size, the results can be misleading.28 The impact of an additional dollar spent in California, a large state economically and geographically, is likely to differ from the impact of federal spending in a smaller state, such as Rhode Island. In Rhode Island, much of the impact can be expected to spill over and impact neighboring state economies rather than be felt entirely in Rhode Island.”

[Sources:

[The Macroeconomic Consequences of Infrastructure Investment](https://www.nber.org/chapters/c14366), Valerie A. Ramey. in [Economic Analysis and Infrastructure Investment](https://www.nber.org/books/glae-6), Glaeser and Poterba. 2020

Krol, Robert, Will a Burst in Federal Infrastructure Spending Accelerate the Recovery from the COVID-19 Recession? (September 24, 2020). Mercatus COVID-19 Response Policy Brief Series, Available at SSRN: <https://ssrn.com/abstract=3698732> or <http://dx.doi.org/10.2139/ssrn.3698732>]

1. **Infrastructure investment in the US**
2. Almost all spending on transportation, drinking water, and wastewater infrastructure is done by the public sector.
3. Publicly owned transportation infrastructure falls into five main categories:
   1. Highways—national, state, and local roads (including bridges and tunnels);
   2. Mass transit—buses, subways, and commuter rail systems;
   3. Aviation—airport terminals, runways, and the air traffic control system;
   4. Water transportation—waterways, ports, and the equipment (such as Coast Guard vessels) used to support seaborne traffic; and
   5. Rail—the intercity passenger system run by Amtrak
4. Publicly owned water infrastructure consists of two main categories:
5. Water utilities—supply systems (such as pipes and plants) to treat and distribute drinking water and to carry and treat wastewater and storm water; and
6. Water resources—systems to contain water (such as dams, levees, and reservoirs), to manage sources of fresh water (such as canals and wells), and to restore aquatic ecosystems.
7. In 2017, Federal, State and Local governments spent $441 billion on infrastructure.
8. That amount equaled about 2.3 percent of gross domestic product.
9. **Government Spending on Infrastructure in the US** 
   1. Graph -- Source: Congressional Budget Office
   2. The largest amount of public infrastructure spending in 2017 went to
      1. highways ($177 billion), followed by
      2. water utilities, which includes water supply and wastewater treatment facilities ($113 billion) and
      3. mass transit ($70 billion)
10. **Spending on infrastructure as share of GDP**
    1. Graph -- Source: Congressional Budget Office
    2. Public spending as a percentage of GDP has been falling since 2010
    3. In 2009, the share was 2.69%, which fell to 2.28% by 2017
11. **Infrastructure spending by category**
    1. Two Categories –
       1. Capital
       2. Operation and Maintenance
    2. Capital investment consists of spending to buy new structures and equipment as well as spending to improve or rehabilitate existing structures and equipment.
    3. Capital investment in infrastructure has been declining since 2004
12. **Infrastructure spending by levels of government**
    1. Graph -- Source: Congressional Budget Office
    2. About a quarter of the infrastructure spending comes from the federal government, and the rest from state and local governments.
13. **Spending by Category and Level of Gov’t**
    1. Graphs -- Source: Congressional Budget Office
    2. Over 70% of federal spending was on new, improved, or rehabilitated structures and equipment.
    3. While State and local governments spent over 70% of their spending on operation and maintenance of existing infrastructure.
14. **Federal vs. State and Local Gov’t Roles in Infrastructure Investment**

|  |  |  |
| --- | --- | --- |
| Mode | Typical Maximum Federal Share of Total Spending | Decision making roles of Federal, State and Local Gov’ts |
| Highways | 80% of capital | State and local gov’ts choose projects, following federal rules and conditions |
| Mass Transit | 80% of capital,  50% of operations | State and local gov’ts choose projects, following federal rules and conditions |
| Rail | Not applicable | Regulatory |
| Aviation | 75%-90% of capital | State and local gov’ts choose projects, following federal rules and conditions; Federal gov’t designs the national aviation system |
| Water Transportation | 40%-100% of construction,  50%-100% of operations | Federal gov’t chooses water projects with Congressional approval |

Source: <https://www.cbo.gov/publication/54933>

1. **Federal Support for State and Local Infrastructure**
2. Federal government provides major financial support to state and local governments for highways, mass transit, aviation, and water utilities.
3. Federal government provides relatively little financial support to states and localities for water transportation and water resources infrastructure (less than $100 million each in grants and loans in 2017)
4. **Funding vs. Financing Infrastructure Investment**
5. Funding
   1. Spending current resources
6. Financing
   1. Taking out loans or issuing bonds to be repaid in the future
   2. Attractive option if government doesn’t have funds now
   3. But limits future availability of funds for other projects due to limitations on usage future revenues to pay off current debt
7. Per CBO, about one-third of the public sector’s total investment in highways, mass transit, aviation, and water utilities between 2007 and 2016 involved federally supported financing.
8. **Sources of federal infrastructure financing**
   1. Discretionary spending (spending subject to appropriation)
      1. fund programs that provide capitalization grants for state banks and to fund the net subsidy costs of direct federal credit programs.
   2. Direct spending (authorization of mandatory spending) was used for the 2009-10 Build America Bonds program for transportation and water projects
      1. would probably be used for future programs of tax credit bonds.
   3. Provisions of tax law authorizing exemptions from federal taxation for the interest paid on tax-exempt bonds, grant anticipation bonds, and qualified private activity bonds.
9. **Federal Financing of State and Local Infrastructure**
   1. **More than half of state and local infrastructure spending financed through bonds that provide federal tax preferences or through federally supported loan programs:**
      1. Tax exempt bonds 🡨 Most widely used  
         Tax-exempt bonds allow states and localities to issue debt (bonds) whose holders do not have to pay federal taxes on the interest payments they receive. **Average amount of projects financed between 2007 and 2016 -- $43 billion per year**
      2. State revolving funds and infrastructure banks (or state banks)  
         These are financial institutions that state governments create and run to lend money for infrastructure projects. Most of those institutions receive the majority of their capital through grants from the federal government. **Average amount of projects financed between 2007 and 2016 -- $9 billion per year**
         1. Direct Loans -- loans made using banks’ capital funds and repayments of previous loans
         2. Leveraged Loans -- loans made using the proceeds of tax-exempt bonds issued by the banks
      3. Tax credit bonds

These were used most recently in 2009 and 2010 in the Build America Bonds program. They allow state and local governments to issue debt that provides a federal tax credit or a federal payment to the issuer or bondholder. **$82 billion new financing was raised using Build America Bonds sold in 2009 and 2010**.

* + 1. Direct federal credit programs  
       These offer loans or loan guarantees to state and local governments for infrastructure projects. **They provided an average of $4 billion per year in loans and loan guarantees for highway, mass transit, rail, and water infrastructure between 2007-2016.**

1. **[Hidden] Federal Cost per Dollar of Financed Infrastructure**
   1. Per CBO the federal cost (in forgone federal tax revenues) per dollar of financing in 2023 with a 20-year repayment period (a common length for loans from state revolving funds) are as follows:
      1. For tax-exempt bonds, 26 cents in forgone tax revenues;
      2. For direct state bank loans, 23 cents in capitalization grants;
      3. For leveraged state bank loans, 43 cents in capitalization grants and forgone tax revenues.
      4. **Tax credit bonds, 19 to 30 cents depending on the legislation authorizing the program. No new tax credit bonds program is currently in operation** for transportation or water infrastructure.
      5. For direct federal credit programs, 33 cents for 30-35 years of loans under the Transportation Infrastructure Finance and Innovation Act (TIFIA) program. This is based on fair value accounting method.

[Source: <https://www.cbo.gov/system/files/2018-10/54549-InfrastructureFinancing.pdf>]

1. **[Hidden] Factors affecting the federal cost per dollar**
   1. Length of financing -- costs increase with the length of the financing term; CBO estimates the cost of 30 years tax- exempt bonds to be 36 cents per dollar.
   2. Interest rate projections --
   3. Average tax rate of investors holding tax-exempt bonds
   4. Required state match to capitalize infrastructure banks with federal funds
   5. Average rate of interest on state bank loans
2. **Fiscal Substitution of federal infrastructure investment**
   1. State and local governments may adjust their own spending on capital projects or operations and maintenance in response to federal highway grants.
   2. There is evidence that for every $1 increase in federal highway grants, state and local governments reduce their spending on highways by 20- 80 cents.
   3. The effect will vary depending on
      1. fiscal condition of state and local governments,
      2. whether federal spending change is permanent or temporary,
      3. magnitude of the spending change,
      4. direction of the change
   4. These substitution estimates may not be directly applicable to other federal investment due to differences in funding patterns and decision-making authority

Source: [CBO Working Paper Fiscal Substitution of Investment for Highway Infrastructure](https://www.cbo.gov/publication/54371)

1. **What About Private Sector Investment?**
   1. State and local governments own almost all of the nation’s transportation and water infrastructure.
   2. Aschauer (1989) found that increases in public infrastructure investment do crowd out private investment, however the magnitude is small.   
      [Source: Aschauer, David Alan, 1989. "Does public capital crowd out private capital?," *Journal of Monetary Economics*, Elsevier, vol. 24(2), pages 171-188.]
   3. Most of the private-sector investment in these occurs through public-private partnerships for publicly owned infrastructure.
2. **What Is a Public-Private Partnership?**
   1. **Per Engel et al (2011)**

*“an agreement by which the government contracts a private company to build or improve infrastructure works and to subsequently maintain and operate them for an extended period (for example, 30 years) in exchange for a stream of revenues during the life of the contract”*

* 1. New public investment in infrastructure tends to favor less valuable new construction over maintenance of existing infrastructure.
  2. The mechanism of public funding also separates construction and maintenance of highways. Contractors involved in new construction are not incentivized to build so as to minimize future maintenance costs.
  3. PPP helps correct this incentive problem.

[Source: Engel, Eduardo, Ronald Fischer, and Alexander Galetovic. 2011. “[Public-Private Partnerships to Revamp U.S. Infrastructure](https://www.brookings.edu/research/public-private-partnerships-to-revamp-u-s-infrastructure/#:~:text=Public%2Dprivate%20partnerships%20are%20often,to%20public%20provision%20and%20privatization.&text=Enacting%20these%20reforms%20will%20help,in%20a%20public%2Dprivate%20partnership.).” Policy Proposal, The Hamilton Project, Brookings Institution, Washington, DC]

1. **Types of PPP contracts**
   1. **PPP contracts differ based on the amount of risk transferred from the public to the private sector:**
      1. **Design-Build (DB) –** private firm or a consortium of private firms responsible for both project design and construction giving it the incentive to minimize cost overruns and design flaws
      2. **Design-Build-Operate-Maintain (DBOM) --** adding operations and maintenance to the consortium’s responsibilities gives it the incentive to construct in a way that minimizes long term operation and maintenance costs
      3. **Design-Build-Finance-Operate-Maintain (DBFOM) –** bundles all aspects together. Passing on the financing responsibility to the consortium incentivizes it to be “cost and schedule efficient so that cash flows begin as quickly as possible for servicing debt and providing adequate returns to equity investors”

Source: [Expanding our Nation's Infrastructure through Innovative Financing](https://www.treasury.gov/press-center/press-releases/Documents/Expanding%20our%20Nation%27s%20Infrastructure%20through%20Innovative%20Financing.pdf)

1. **Few Public-Private Partnerships in the US**
   1. Colorado I-70 Project
   2. Denver FasTracks commuter and light rail project in Colorado,
   3. Goethals Bridge reconstruction project linking New York City and New Jersey
   4. Bayonne Water Joint Venture LLC project, a water and wastewater PPP in New Jersey
   5. Automated People Mover (APM) project at Los Angeles International Airport (LAX)
   6. LaGuardia Airport Terminal B P3 project
2. **Few Public-Private Partnerships in the US**
   1. A few unsuccessful P3s in California
      1. Route 91 toll lanes in Orange County
         1. increased the cost from $57 million to $130 million
         2. A non-compete clause prevented the public agency from improving transportation facilities elsewhere in the corridor to reduce congestion
         3. public agency bought the project back for $207 million
      2. Route 125 toll road in San Diego County
         1. costs increased from $360 million to $843 million and use of the toll facility was less than projected
         2. private consortium for the project filed for bankruptcy, becoming the first public project to default on the federal government’s TIFIA loan program
         3. SANDAG bought the project and it is now operating it successfully as part of the public roadway network in San Diego County
      3. Presidio Parkway project connecting the City of San Francisco to the Golden Gate Bridge
         1. Phase 1 was completed with some of the contracts being awarded 40% under the estimated cost during the economic recession
         2. Phase 2 of the project was halted before it began and the contract was converted from design-bid-build method and turned over to Golden Link Concessionaire as a P3 to complete and then maintain for 30 years.
         3. no-bid agreement inflated the cost of the Presidio Parkway project to $1.1 billion

[Source: http://pecg.org/issues/ppp/]

1. **An Alternative Financing Tool – User Fees**
   1. Make those who use infrastructure more heavily, pay for it.
      1. User fees help in appropriately rationing assets to the space.
      2. Help in demand management where congestion is an issue
2. **An Alternative Financing Tool – User Fees**
   1. Singapore’s congestion pricing model
      1. Singapore is an island nation with land area of 250 square miles
      2. The central business area has limited street capacity and experienced heavy congestion as far back as in the early 1970s
      3. In 1998, Singapore launched the Electronic Road Pricing (ERP) System with variable pricing designed to respond to congestion in real-time
         1. Vehicles are required to have an in-vehicle unit on the dashboard and a smart card with fare stored on it.
         2. Overhead gantries detect the type of vehicle, the congestion of the route at specific times, and deduct the variable fee from the smart card.
         3. The ERP scheme was launched in 1998, replacing a cordon pricing scheme that was first implemented in 1975.
   2. Complementary Policies to ERP
      1. Parking fees inside the restriction zone were doubled
      2. Buses and bus frequency increased
      3. HOV+4 lanes were established
      4. 15,000 park-and-ride spaces were established outside of
   3. Despite strong population growth, the ERP has reduced traffic in the inner city by 24% and average speeds have increased from 30-35 KPH to 40-45 KPH (18-22 MPH to 24-28 MPH)

Source: <https://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm>

1. **Another aspect of infrastructure – Broadband**
   1. Talk of a digital divide is ubiquitous especially in light of the current pandemic
   2. Over 21 million Americans lack meaningful access to the internet with 14.5 million without any access at all
      1. Meaningful access: 25 Mbps download and 3 Mbps upload
   3. Lack of access is more common among less educated, low income Americans, living in rural or suburban areas.
   4. Over 9 million school children lacked internet access for online schoolwork

Source: [FCC 2020 BROADBAND DEPLOYMENT REPORT](https://docs.fcc.gov/public/attachments/FCC-20-50A1.pdf); Pew Study -- <https://www.pewresearch.org/fact-tank/2019/04/22/some-americans-dont-use-the-internet-who-are-they/>;

1. **Broadband access**
   1. Often called the modern-day equivalent of the interstate highway system
   2. Lack of access not just a rural problem
      1. In 2016, 57% of households in Detroit, MI; 49% in Memphis, TN and 48% in Cleveland, OH were without fixed broadband
   3. Digital redlining within cities where network providers may systemically exclude low income or minority neighborhoods from high speed internet service
   4. Where available, service is often limited to a single service provider – natural monopolies
      1. Due to high up-front fixed costs of laying fiber optic lines

Source: [National Digital Inclusion Alliance Worst Connected Cities 2016](https://www.digitalinclusion.org/wp-content/uploads/2018/06/25-Worst.pdf)

1. **Solutions to the access problem**
   1. Many cities and communities have taken matters into their own hands, building municipal infrastructure and cooperatives providing broadband services
   2. As of January 2020, over 850 communities across the US are served by some form of municipal network or by a cooperative

Source: [Institute for Local Self-Reliance Community Network Map](https://muninetworks.org/communitymap); [Harvard Study on Community owned networks](https://dash.harvard.edu/handle/1/34623859)

1. Community Network Map

Source: [Institute for Local Self-Reliance Community Network Map](https://muninetworks.org/communitymap)

1. **Technological advancements of the future to the rescue?**
   1. Low Earth Orbit (LEO) satellite internet
      1. On June 13, 2020 Elon Musk’s SpaceX launched 58 satellites into low earth orbit as part of the Starlink program
      2. aims to provide low-latency (less lag) satellite internet
      3. better internet coverage than traditional communications satellites
      4. could potentially provide high quality internet to homes and businesses without access to cable, fiber, or reliable cellular internet

Source: <https://www.businessinsider.com/spacex-starlink-satellite-internet-service-when-available-date-2019-5>; <https://www.businessinsider.com/spacex-starlink-satellite-internet-service-when-available-date-2019-5>; <https://ruralinnovation.us/can-emerging-internet-technologies-solve-rural-connectivity-issues/>

1. Summary
   1. **Infrastructure investment is important**
   2. **Current state of US infrastructure – leaves a lot to be desired for**
   3. **Public infrastructure investment can play a vital role in long run growth** 
      1. Improve mobility
      2. Raise private capital productivity
      3. Improve health
   4. **May not be ideal as short term stimulus**
   5. **Private sector involvement via the market process will promote innovation and efficiency**
   6. **Local access issues may sometimes be better resolved locally than federally**
      1. Reforms needed to make the process less cumbersome