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The potential macroeconomic benefits from increasing infrastructure investment

By Josh Bivens • July 18, 2017

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Introduction

The United States economy has suffered from two glaring macroeconomic problems over the past decade. The first is a severe and chronic shortfall of spending by households, businesses, and governments relative to the economy's productive potential (or, a shortfall of aggregate demand). This demand shortfall has kept growth in both jobs and wages too slow. The second problem is a rapid deceleration in the pace of productivity growth. Productivity is the amount of income (or output) generated in an average hour of work in the economy. Productivity growth in turn provides the potential ceiling on how fast average income can rise.

These are both serious problems, and policymakers should be concerned with each. One policy instrument that can address both is a large, sustained increase in infrastructure investment. Both Hillary Clinton and Donald Trump mentioned infrastructure investment as an economic priority during their presidential campaigns last year, so there is some hope that proposals to boost this investment could have bipartisan support.

This brief assesses the effectiveness of an increase in the nation's investment effort in infrastructure as a means to close the aggregate demand shortfall as well as a means to boost productivity growth. Its key findings are:

- **Infrastructure investment could be an extraordinarily useful tool for macroeconomic stabilization.** Most estimates of the output "multiplier" for infrastructure investment are substantially higher than for other fiscal interventions. If the fiscal boost of infrastructure investment were accommodated by monetary policymakers, each $100 billion in infrastructure spending would boost job growth by roughly 1 million full-time equivalents (FTEs).
- While unemployment in 2016 was roughly on par with its pre–Great Recession level, this does not mean policymakers should stop worrying about macroeconomic stabilization and maintenance of aggregate demand. **Growing fears of "secular stagnation"—a chronic shortfall of aggregate**

SECTIONS

demand relative to the economy's productive capacity—seem justified by several data points. Key among them is the unusually slow growth in nominal wages this late into an economic recovery.

- **Productivity growth has decelerated sharply in recent years**. Much of this deceleration is likely short-lived and tighter labor markets should be expected to push productivity growth back toward more historically normal levels. Since infrastructure investment can lead to these tighter labor markets, it could have an immediate effect in restoring productivity growth.
- Further, and more importantly, **a greater public investment effort can also provide a significant boost to productivity in the long run by boosting the public capital stock**. The rate of return to infrastructure investment is large; the median and average estimates of a review of dozens of studies on infrastructure indicate that each $100 spent on infrastructure boosts *private-sector* output by $13 (median) and $17 (average) in the long run.

Background

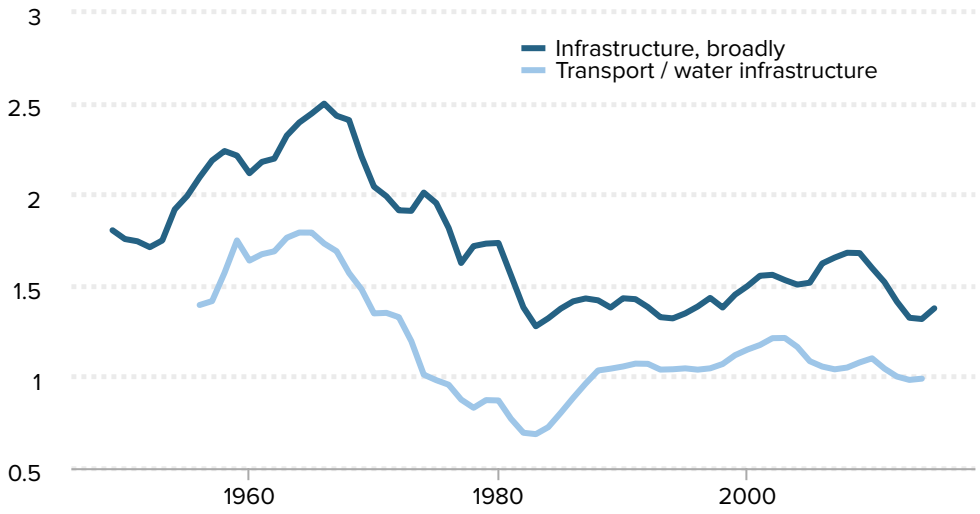
There is no fixed definition of what "infrastructure investment" includes. Generally, however, it includes capital investments in transportation, utilities, and environmental projects. Sometimes investments in the construction and maintenance of schools and hospitals are included in measures of infrastructure investment. A defining feature of infrastructure investment in the United States is the prominent public role in investment. Public funds directly finance more than half of infrastructure investment in the United States, and even private infrastructure investments often receive substantial direct or indirect public subsidies, including tax breaks (CBO 2008, 2015). Infrastructure investment that is publicly owned is often referred to as the *public capital stock.* This capital stock is simply the roads, buildings, bridges, ports, utilities, airports, and other structures and equipment that are financed by public funds and whose ultimate owners are governments.

There are a number of compelling rationales for such a strong public role in infrastructure provision. Many of the capital projects undertaken for infrastructure investment would result in a natural monopoly. For example, once the enormous upfront effort of building a new highway is made, the marginal cost of allowing an extra car on it is trivial. This provides an entry barrier to any profit-seeking economic agent thinking about building a competing highway. Given the resulting monopoly, a strong public role in either the provision or regulation of the sector is necessary to promote economic efficiency. Further, many of the spillover benefits of infrastructure investments are hard to precisely allocate to individual economic agents. For example, the construction of a dam provides benefits to farmers, homeowners who are protected from floods, fishermen who can use the reservoirs, and so on. This makes charging precise fees based on the use of infrastructure difficult, and it argues that the public benefits of infrastructure should simply be paid for with public funds. Finally, some infrastructure investment provides services that society has decided should be available to all as basic rights (safe drinking water, for example) even if some customers are not profitable to serve for a strictly private entity.

Figure A

Public investment in infrastructure has never regained its earlier levels

Capital spending on transportation / water infrastructure and broad infrastructure, measured as a share of potential GDP, 1949–2015



Notes: The broad infrastructure series includes public investment in hospital and educational structures, highways, sewers, transportation facilities, and conservation and development. Each series is scaled against measures of potential GDP from CBO 2017.

Source: Author's analysis of data from the Bureau of Economic Analysis (BEA) fixed asset series (Tables 5.9.5A and 5.9.5B) and the Congressional Budget Office (CBO 2015)

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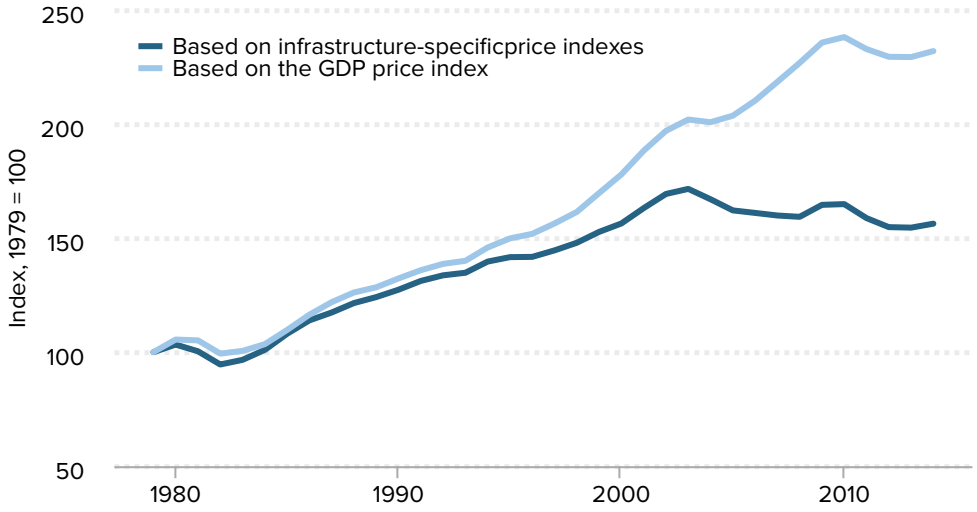
In 2014, federal, state, and local governments combined spent $416 billion just on transportation and water infrastructure projects.[1] The federal government spent $96 billion of that, and state and local governments spent $320 billion. The federal role is strongest in new capital spending, as opposed to operation and maintenance. Nearly 40 percent of all state and local capital spending on transportation and water infrastructure is financed by grants from the federal government. In addition, federal revenues foregone by providing tax exemptions for bond financing of infrastructure projects averages roughly $30 billion annually. In short, governments at all levels, but particularly the federal government, are big players every year in infrastructure investment.

Overall spending on infrastructure as a share of gross domestic product (GDP) has been in long-term decline. **Figure A** shows a broad measure of infrastructure investment as a share of the nation's potential GDP. The first (lower) line shows public investment in water and transportation. The second (higher) line includes public investments in the construction of educational and hospital structures as well as investments in conservation, development, utilities, ports, and airfields. Think of these as narrow and broad measures of infrastructure. Each saw sharp reductions in the 1970s, and the rebound since then has still left them far below the levels that prevailed on average before 1979.

Figure B

Rising prices of construction materials make increased infrastructure effort even more necessary

Real public spending on transportation and water infrastructure, using GDP deflators and infrastructure-specific deflators, 1979–2014



Note: Infrastructure-specific deflator uses prices of materials and other inputs used to build, operate, and maintain transportation and water infrastructure.

Source: Author's analysis of data from CBO 2015

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Moreover, there is strong evidence that because the prices of infrastructure investments are rising more rapidly than overall prices, a greater share of nominal spending must be undertaken just to keep the quality of infrastructure intact. **Figure B** shows two measures of transportation and water infrastructure, taken from a recent report by the Congressional Budget Office (CBO). One deflates the transportation spending by the overall deflator for gross domestic product, while the other deflates it by an infrastructure-specific deflator. The latter measure—which more accurately reflects the services provided by a given nominal amount of infrastructure spending—grows much more slowly in recent periods.

Given the large role the federal government plays in providing resources for infrastructure investment, and given that this investment effort has fallen in recent decades, recent calls to boost the rate of infrastructure investment would seem to have prima facie merit. The rest of this paper highlights the near-term and long-term potential benefits from an increased federal infrastructure investment effort.

Infrastructure investment as an effective and likely-to-be-needed macroeconomic stabilization tool

Since the Great Recession began, increased infrastructure investment has been suggested as a primary tool to restore the economy to full health. Infrastructure was not part of the first stimulus package meant to fight the Great Recession, the Economic Stimulus Act of 2008, despite some calls for it to be included (Mishel, Eisenbrey, and Irons 2008). The rationale at the time for excluding infrastructure was that stimulus must be "timely, targeted, and temporary" (Elmendorf and Furman 2008). Infrastructure investment apparently violated the "timely" part of this mantra—policymakers were worried that the recession would come and go so fast, and that recovery would be so quick, that the economy would be back at full health before meaningful infrastructure investments could be mobilized. Some of this logic even persisted with the writing of the American Recovery and Reinvestment Act (ARRA), which had a smaller infrastructure component than is commonly recognized (only about 15 percent of total spending in ARRA was on infrastructure [CEA 2010]). The debates surrounding ARRA and infrastructure often centered on whether or not enough viable infrastructure projects were "shovel-ready," meaning (again) that policymakers worried that infrastructure investment could not be mobilized quickly enough to help the economy while it was still in its unrecovered state.

Given that unemployment in 2016 was still significantly higher (4.9 percent) than its 4.6 percent average in 2006 and 2007—the years immediately preceding the Great Recession—this fear was obviously not well-founded. Infrastructure projects started in 2008, 2009, or even in 2013 *could* have helped the economic recovery. Even as of March 2017, many measures of economic slack indicate that the economy could benefit from a boost in aggregate demand. The share of prime-age (age 25–54) adults who were employed, for example, was 1.4 percentage points lower in March 2017 than the average share in 2006 and 2007. This may not sound like a lot, but this translates into roughly 1.9 million workers *just in this age group* who need to find jobs before the economy can be declared as having returned to pre–Great Recession health.

The clearest evidence that demand growth remains too slow relative to the economy's potential capacity is the unusually slow growth of nominal wages this deep into a recovery. Despite unemployment in March 2017 essentially matching its 2007 average, nominal wage growth for production and supervisory workers for the year ending in March 2017 was 2.3 percent. In 2007 this wage growth was 4.0 percent. This sluggish wage growth has in turn made it hard for the Federal Reserve to maintain price inflation at their 2 percent target.

Finally, the agonizingly slow recovery from the Great Recession and the anemic economic recovery and expansion following the 2001 recession, even as it was aided by an enormous housing market bubble, have raised fears that the shortfall in aggregate

demand relative to the economy's productive capacity could be a chronic problem moving forward. This problem, often referred to (somewhat confusingly) as "secular stagnation," suggests that macroeconomic policy—including fiscal policy—will need to adopt a more expansionary stance in the future (see Krugman 2013 and Summers 2016 on this point). So far, the lessons of these analyses have not been heeded. For example, fiscal policy has *not* been more expansionary during the recovery from the Great Recession relative to past recoveries. In fact, the recovery from the Great Recession has seen the most austere path of spending during any post–World War II recovery, a fact that explains most of the recovery's slowness (Bivens 2016).

A renewed push to increase infrastructure investment could move fiscal policy from being a drag on growth to being a boost to growth in coming years. Perhaps relevant to upcoming fiscal policy debates, infrastructure investment is routinely estimated to be a much more efficient fiscal stimulus than almost any form of tax cut, and it is *significantly* more efficient than those tax cuts whose benefits fall mostly on high-income households. To determine relative efficiency, we look at the additional economic output generated by each $1 added to the federal budget deficit from a given fiscal policy intervention.

Table 1 provides a range of comparisons of various types of fiscal policy interventions. Many of these are taken from the research literature that existed before ARRA. Since then, most research on fiscal stimulus undertaken when monetary policy is accommodating has found even higher multipliers (most famously, perhaps, in Blanchard and Leigh 2013). But the relative ranking of various fiscal policy interventions has largely been confirmed.[2]

To give a quick sense of the employment consequences of infrastructure investment in the near-term, note that an output multiplier of 1.5 means that each $100 billion in infrastructure spending would boost GDP by $150 billion. This increase in GDP would in turn boost employment by a bit over 1 million workers (see Bivens 2011 for the relationships between output and employment).

The primary virtue of infrastructure investment as fiscal stimulus is that *it is spent*. Tax cuts and even direct transfer payments can be saved by households. Because transfer payments tend to be directed toward low-income and hence cash-constrained households, they tend to not be saved and hence rival infrastructure investment as stimulus. But infrastructure investment is guaranteed, always and everywhere, to be spent.

Recent evidence on the causal short-run effect of infrastructure spending

Since 2008, research on the causal effect of infrastructure spending on short-run output and employment has been bolstered by the examination of large, exogenous fiscal events: the large fiscal boost provided by ARRA in the United States, the large (but quite variable) fiscal contraction undertaken by countries in the European Union (EU), and anti-corruption

Table 1

Fiscal stimulus bang for the buck

Output multiplier from various types of fiscal policy changes

Tax cuts	Bang for the buck
Temporary tax cuts	
Nonrefundable lump-sum tax rebate	1.01
Refundable lump-sum tax rebate	1.22
Payroll tax holiday	1.23
Job tax credit	1.29
Across-the-board tax cut	1.03
Accelerated depreciation	0.25
Loss carryback	0.24
Housing tax credit	0.88
Permanent tax cuts	
Extended alternative minimum tax patch	0.50
Make Bush income tax cuts permanent	0.35
Make dividend and capital gains tax cuts permanent	0.39
Cut in corporate tax rate	0.32
Spending increases	
Extending unemployment insurance benefits	1.60
Temporary federal financing of work-share programs	1.69
Temporary increase in food stamps	1.72
General aid to state governments	1.41
Increased infrastructure spending	1.57
Low-income home energy assistance program	1.14

Note: The "bang for the buck" is estimated by the one-year dollar change in gross domestic product (GDP) for a given dollar reduction in federal tax revenue or increase in spending. Multiplier indicates how much total output (GDP) changes in response to a $1 increase in deficit resulting from the fiscal policy change.

Source: Zandi 2010, Table 4

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efforts in Italy.

Acconcia, Corsetti, and Simonelli (2014) examine the fiscal shock that occurs in Italian provinces when public construction projects are halted in response to findings of Mafia involvement. A law issued to combat public corruption provides for forceful and sudden halts to construction activity when local police find evidence of Mafia involvement. This provides an exogenous shock to fiscal spending that can be linked to subsequent

changes in economic output. Such exogeneity is needed in studies of fiscal stimulus because of the ever-present possibility of two-way causality: fiscal changes can affect economic growth, but economic growth can also in theory affect fiscal changes. Using this high-quality instrument that isolates exogenous fiscal changes (i.e., fiscal changes uncorrelated with changes in economic output), Acconcia, Corsetti, and Simonelli (2014) estimate multipliers on public investment of between 1.5 and 1.9.

Blanchard and Leigh (2013) examine the large but varied fiscal adjustments undertaken by EU members in response to the Euro crisis of 2009–2010. They regress the fiscal adjustments against the predicted pace of output growth in the next two years (2011 and 2012). They find a systematic (and negative) relationship between the fiscal adjustments and the forecast error of subsequent output growth, suggesting that fiscal multipliers are substantially larger than forecasters assumed a priori. They interpret their results as indicating an overall fiscal multiplier of 1.5. They also find that spending adjustments matter more than revenue adjustments in restraining output growth.

Jovanovic (2017) extends Blanchard and Leigh's (2013) results by examining the fiscal adjustment in government consumption and government investment separately. They find that reductions in government investment have significantly larger (negative) effects on subsequent output growth than reductions in consumption spending.

Finally, Leduc and Wilson (2014) and Wilson (2012) assess the impact of increased infrastructure spending under ARRA. Wilson (2012) uses the fact that much of the ARRA highway spending across states was allocated according to formulas that were exogenous to economic conditions (for example, miles of highway lanes per resident, or the share of youth in each state's population). Wilson's preferred estimate indicates that each $125,000 in announced highway spending was associated with one added job. If this highway spending created jobs across economic sectors in exact proportion to existing employment shares, this would be consistent with an output multiplier of 1.[3] If instead employment generated by this spending were more concentrated in higher-productivity sectors, it would be consistent with a larger output multiplier.

Figure C shows the trajectory of employment from December 2007 to June 2011 in the highest fifth of states, ranked by ARRA highway funds, versus the lowest fifth of states. Employment fell less, stabilized sooner, and began growing more rapidly in states that saw a larger influx of ARRA funds.

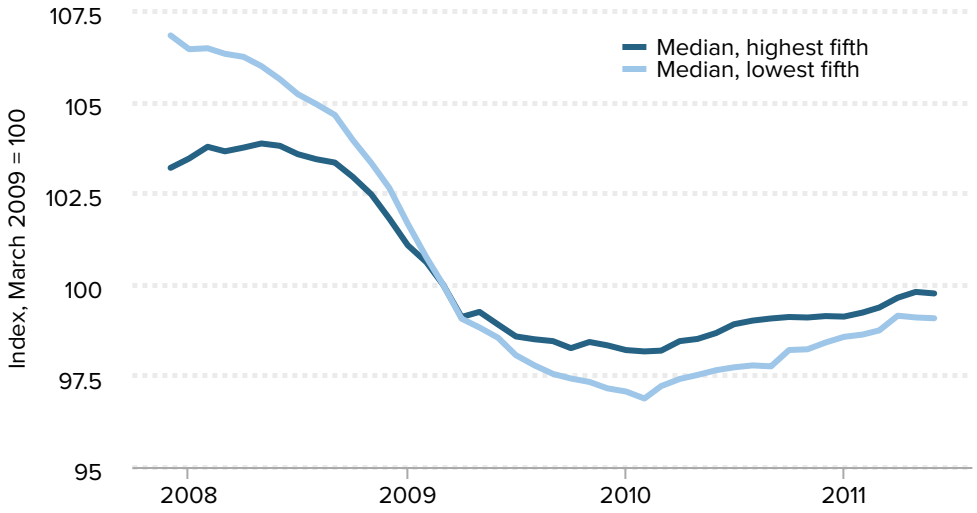
The relationship between infrastructure investment and productivity growth

Bivens (2017) notes that recent rapid decelerations in productivity growth are likely symptoms of the extended period of slack between aggregate demand and the economy's productive capacity that characterized the post-2007 period. Productivity is a

Figure C

Infrastructure spending stabilizes employment growth

Median employment in the highest versus lowest fifth of states ranked by receipt of highway grants from the American Recovery and Reinvestment Act (ARRA), December 2007–June 2011



Notes: Data on predicted ARRA grants comes from Wilson 2012, while median employment growth is measured relative to March 2009 and is taken from the Bureau of Labor Statistics (BLS) Current Employment Statistics (CES) data series.

Source: Author's replication of figure from Wilson 2012

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measure of average income (or output) generated in an hour of work in the economy. One key determinant of productivity growth is *capital deepening*—supplying the economy's workforce with more and better tools. For example, as construction workers moved from working with shovels and pickaxes to working with cranes and earthmovers, productivity growth in that sector naturally increased. A key reason for the rapid deceleration of productivity growth in recent years has been a long period of weak private investment.

As labor markets normalize and begin putting upward pressure on wage growth, there is strong reason to believe that firms will begin searching harder for ways to reduce upward labor cost pressure and will begin investing in labor-saving capital and technology. **Figure D** replicates a table from Bivens (2017) showing the relationship between lagged values of real compensation growth and private fixed investment. It shows a strong positive relationship between the two.

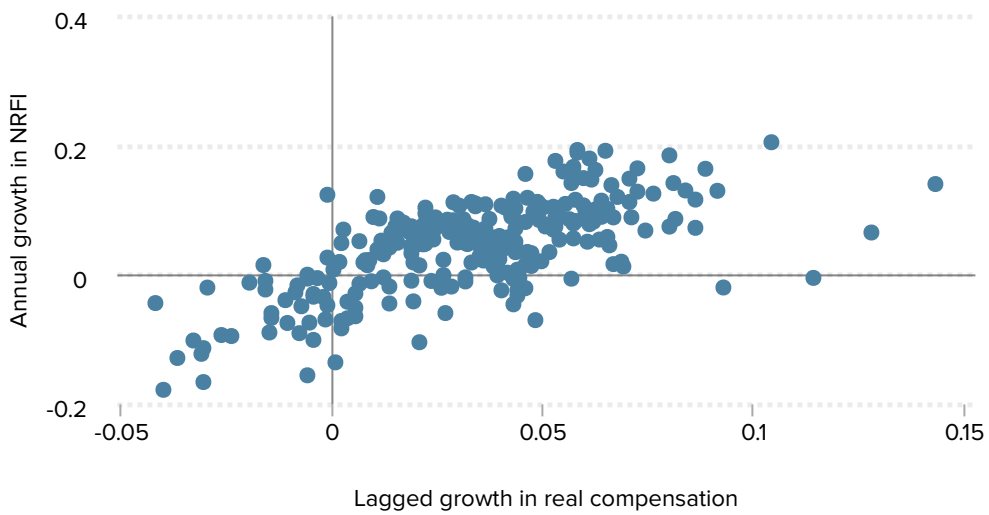
By taking up the last of any remaining demand slack, an increase in infrastructure investment could have an immediate effect in restoring productivity growth to more normal levels. More importantly, there remains a strong economic rationale for investing in infrastructure even after the economy reaches and settles into full employment.

Much of the nation's capital stock is comprised of public capital. Highways, airports, dams, sewer systems, and utilities are all necessary inputs for private production, but they are

Figure D

Faster real wage growth has been followed by greater nonresidential fixed investment (NRFI) in the United States

Lagged change in average real wages and growth of NRFI, 1979–2016



Source: Bureau of Economic Analysis (BEA) National Income and Product Accounts (NIPA) series, Table 1.16, and unpublished data from the Bureau of Labor Statistics Total Economy Productivity database

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largely supplied with public funds. When the public capital stock is allowed to degrade through lack of investment, this could in theory lead to slower private-sector productivity growth.

Before delving into evidence assessing this effect, however, it is important to note that improving private-sector productivity is just one reason to support expanded public investment. If, for example, public investment had no impact at all on private-sector productivity but allowed public goods to be delivered more efficiently, there would be a benefit. If we were to receive clean water and air, safe food and medicine, and transportation services for less money than we spend currently, this would be a perfectly fine way to enjoy the economic returns to expanded public investment, even if they do not boost private-sector productivity.

Further, the possibility that the benefits of public investment are more broadly shared than the benefits of private-sector investment constitutes another compelling reason to support it. While studies examining the link between inequality and public investment are few, several methodologically sound papers have suggested that countries with larger public capital stocks tend to have greater equality of incomes (see, for example, Calderón and Servén 2004). This should not be a shock—by its nature public capital is more broadly based in its ownership than private capital (in the United States, the wealthiest 1 percent of households own more than 40 percent of private wealth) and so its benefits should be more broadly distributed (Getachew 2008).

Finally, it should be remembered that many possible benefits of public investment may not show up as increases in cash incomes. Clean water and air and shorter commute times provide clear economic benefits, but these benefits do not generally show up in measurable cash incomes.

How large a boost does private-sector productivity get from public investment?

Serious research on the productivity of public investment was begun almost singlehandedly by David Aschauer in a series of papers in the late 1980s and early 1990s (see Aschauer 1989, 1990, for two of these). The Aschauer findings were generally based on a time-series estimation of public investment in the theoretical context of an aggregate production function model. Aschauer (1989) estimated these aggregate production functions, augmented with public capital stocks (an innovation relative to much empirical growth literature), and found that the elasticity of private-sector output with respect to public capital was between 0.24 and 0.36. The implication of this finding was that the rate of return to public capital was roughly three times higher than that of private capital.

Aschauer's work was buttressed by that of Munnell (1990, 1992), who would later become an undersecretary for the Treasury under President Clinton, as well as by the work of Holtz-Eakin (1988) and Lynde and Richmond (1992, 1993). However, the approach pioneered by Aschauer soon came under criticism from a variety of angles. Critics of the time-series component—particularly Aaron (1990) and Gramlich (1994)—argued that the link between public capital and productivity suffered from problems of both causality and simultaneity.

The *causality* criticism is that faster output growth may simply allow for stepped-up investments in public capital rather than increased public investment driving faster output growth. The *simultaneity* criticism is that neither public investment nor productivity is a "stationary" time series, and therefore the simple regression of one upon the other may yield an apparent relationship that is in reality spurious. That is, maybe both series just happened to be rising over time, and the correlation between the two simply reflected these contemporaneous trends without indicating an actual economic relationship between the series.

One suggested econometric fix for the problem of simultaneity is the transformation of the public capital and productivity data into first differences—essentially looking at the year-over-year change in each series. While this transformation does produce two stationary series and is hence a plausible statistical fix, Munnell (1992) correctly points out that this fix does not allow one to examine long-run relationships between public capital formation and productivity growth, and that the *economic* hypothesis of the relationship between the two (which is indeed a long-run relationship) hence cannot be tested if this particular *statistical* fix is adopted. Given that most empirical growth studies are concerned exactly

with such long-run relationships, this makes the first-differencing fix fatal to the project of fairly assessing the impact of public capital investments on growth.

The simultaneity problem is most clearly addressed by Heintz (2010), who uses more advanced econometric techniques (specifically, a vector error-correction model) to search for a cointegrating relationship between the two series. A cointegrating relationship exists between two nonstationary time series if some linear combination of them is stationary. Heintz (2010) confirms that a cointegrating relationship does exist between public capital and private productivity and uses this relationship to estimate a statistically and economically significant long-run relationship between public capital stocks and private productivity.

Heintz (2010) and Everaert and Heylen (2001) also point out that solving the simultaneity problem through error-correction models largely solves the causality problem along the way. Specifically, Heintz allows for the *level* of public capital to affect both the *level* and the *change* in private output. He finds a statistically significant relationship between the level of public capital and the change in private productivity. If, however, the direction of causality actually ran from greater private productivity to larger public capital stocks, then there should be no such relationship between the level of public capital and the change of productivity.

Table 2 shows regression results from replicating Heintz's (2010) methodology with more up-to-date data. Data and methods are described in detail in the technical appendix. The dependent variable is the ratio of private-sector output to capital stock, while the coefficient of interest is the lagged ratio of public to private capital. For a timespan that mirrors Heintz's—1949 to 2007—we find a coefficient on infrastructure capital of 0.16, quite close to his 0.2. For the period from 1949–2015 (i.e., including more recent years than were available to Heintz), the coefficient is essentially the same (0.147). However, the 1950s saw a more rapid pace of infrastructure investment than what came thereafter, largely due to the construction of the interstate highway system. To test whether or not the infrastructure/productivity association is driven by this one-time burst of spending, we look only at the 1959 period. Again, the coefficient is essentially unchanged.

The coefficient values imply that a 10 percent increase in the public capital stock boosts private-sector output by 1.5–2 percent. To provide a more intuitive interpretation, one can multiply this coefficient by the current ratio of private to public capital stocks to get the extra output obtained from each $1 increase in the public capital stock. This also corresponds tightly to the "rate of return" to public investment that is often noted in the literature. For the results from Table 2, this implied rate of return is very large, hovering between 30 and 40 percent.

While high, these rates of return are not clear outliers. Bom and Ligthart (2014) provide a comprehensive review of three decades' worth of empirical research on public investment. **Figure E** shows the distribution of their findings, focusing strictly on 33 studies they survey that generate estimates of the rate of return to public investment in the United States. The results range from −19 percent to 73 percent. The average rate of return is 16.7 percent and the median is 12.8 percent. If one excludes the top three and bottom three estimates,

Table 2

High rates of return estimated by Heintz (2010), confirmed

Error correction model of determinants of US private-sector productivity, various time periods

Variables	1949–2015	1949–2007	1959–2015	1979–2015
Levels (potential cointegrating relationships)				
Output-to-capital ratio, lagged	−0.202	−0.221	−0.207	−0.272
	[3.14]***	[2.97]***	[2.61]**	[3.91]***
Private capital stock, lagged	−0.46	−0.536	−0.549	−0.257
	[4.46]***	[4.21]***	[3.82]***	[2.26]**
Labor force, lagged	0.407	0.394	0.391	0.411
	[5.81]***	[5.10]***	[4.49]***	[5.82]***
Public capital stock, lagged	0.147	0.16	0.204	0.092
	[3.95]***	[3.83]***	[3.27]***	[0.82]
First differences	−1.165	−1.163	−1.19	−0.864
Private capital stock	[6.60]***	[5.94]***	[5.00]***	[4.24]***
	0.857	0.835	0.829	0.785
Labor force	[19.03]***	[16.48]***	[13.57]***	[14.47]***
	0.546	0.351	0.518	0.032
Public capital stock	[3.72]***	[1.83]*	[1.94]*	[0.12]
	0.004	0.006	0.005	
Time trend	yes	yes	yes	yes
R-squared, adj.	0.9	0.88	0.86	0.91
N	66	57	56	36

Notes: The dependent variable is the change in private-sector productivity, measured as the ratio of private-sector output to private-sector capital stock. Data and methods are discussed in the technical appendix. *T*-statistics are in brackets. Three asterisks denote significance at the 1 percent level, two asterisks denote significance at the 5 percent level, and one asterisk denotes significance at the 10 percent level.

Source: Author's analysis of data the from Bureau of Economic Analysis (BEA) Fixed Assets data series, BEA National Income and Product Accounts, and the Bureau of Labor Statistics (BLS)

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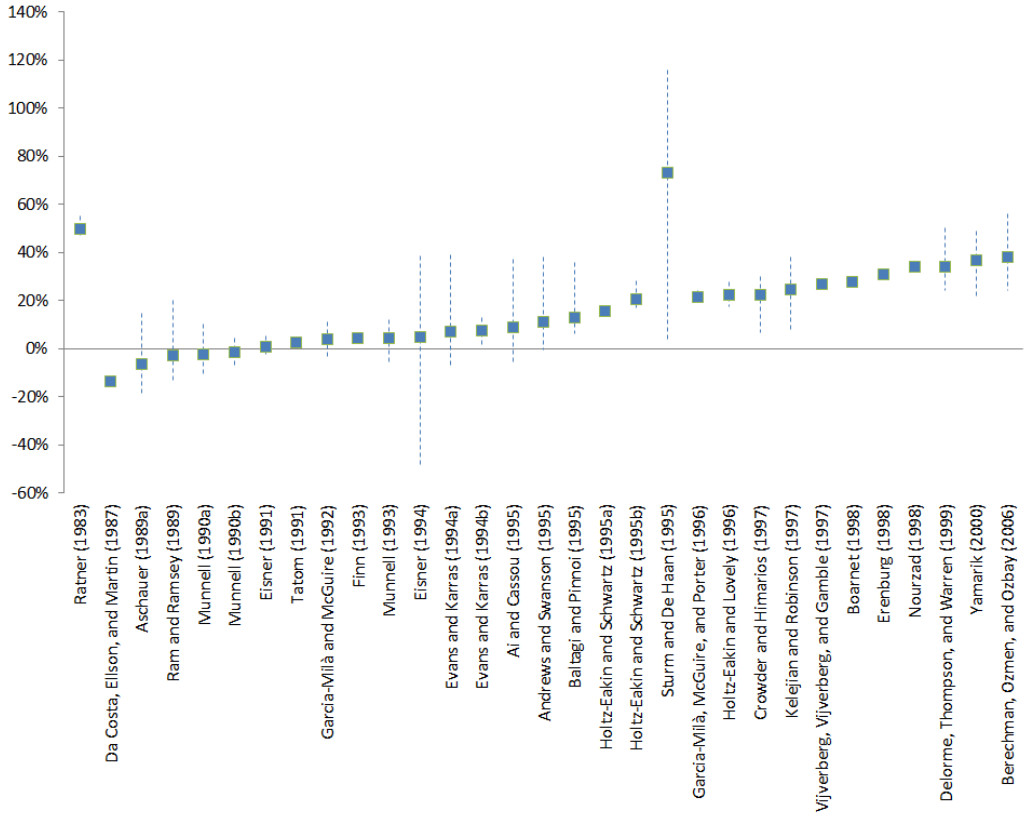
the average return drops slightly, to 14.5 percent. Figure E shows the central estimate and minimum and maximum estimated returns for the 33 studies surveyed by Bom and Ligthart (2014).

It is worth noting that even the average minimum rate of return (6.1 percent) in the 33 U.S.-centric studies examined by Bom and Ligthart (2014) is substantially larger than the gross rate of return used by CBO in its assessment of the macroeconomic effect of federal investment (CBO 2016). Thus, it seems that CBO estimates of the benefits of public

Figure E

Many studies find high estimated rates of return to US infrastructure investment

Average, minimum, and maximum rates of return estimated for US infrastructure investment in 33 studies



Note: Minimum and maximum are sometimes not reported.

Source: Adapted from Table A1 in Bom and Ligthart 2014

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investment—particularly infrastructure investment—are too low given the other evidence in this literature. Finally, another striking feature of these estimates are how consistently they tend to rise over time, as more up-to-date data and research methods are used. The studies are aligned on the horizontal axis chronologically, and the pattern of more recent studies yielding higher estimated rates of return is clearly visible in the chart.

Conclusion

There is strong evidence that a period of increased infrastructure investment effort could provide large benefits to the American economy. It could provide a fiscal expansion in an economy where aggregate demand growth has been stubbornly slow for years, even in the face of prolonged expansionary monetary policy. It could also aid the capital

deepening that is necessary for boosting productivity growth, especially during a period that has seen anemic private-sector investment. In any proposal to boost the nation's infrastructure investment, there will be many details to work out, but such details seem worth wrestling with given the large potential benefits at stake.

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About the author

Josh Bivens joined the Economic Policy Institute in 2002 and is currently the director of research. His primary areas of research include macroeconomics, social insurance, and globalization. He has authored or co-authored three books (including *The State of Working America, 12th Edition*) while working at EPI, edited another, and has written numerous research papers, including for academic journals. He often appears in media outlets to offer economic commentary and has testified several times before the U.S. Congress. He earned his Ph.D. from The New School for Social Research.

Technical appendix: Regression results from replicating Heintz (2010)

The large estimates of rates of return on public investment found by Aschauer (1989) were subsequently criticized on the grounds that they suffered from problems of simultaneity. Essentially, the argument was that the statistical relationship between public investment and output found by Aschauer (1989) was spurious, driven only by the presence of nonstationarity in one or the other of the series. A data series is nonstationary if its mean or other statistical properties change over various parts of the sample (in this case, if the mean or other statistical properties vary over time). If a nonstationary series is used in regression analysis, it can yield regression results that are spurious.

Heintz (2010), however, notes that if both series (public capital and output) have a unit root in levels (are nonstationary in the same way) but are stationary in growth rates, then an *error correction model* can be used to undertake regression analysis and the simultaneity problem can be dealt with. For his output measures, he uses private-sector GDP, and for public capital, he uses a measure of "core" infrastructure (essentially in line with how we define it in Figure A). He regresses the change in the ratio of output to private capital on lagged values of the dependent variable, the private capital stock, the labor force, and the infrastructure capital stock, as well as changes in private and infrastructure capital stocks and the labor force. **Table A1** confirms that each of the data series has a unit root in levels but is stationary in first differences. For each series, the hypothesis of a unit root cannot be

Appendix Table A1

Data series have common unit roots in levels but are stationary in first differences

Augmented Dickey-Fuller test results for data series examined in Table 2

Variable	Intercept plus trend	
	Levels	Differences
Output to private capital stock ratio	−2.282	−7.814***
	(0.3397)	(0.00)
Private capital stock	−0.652	−3.984***
	(0.9761)	(-0.01)
Labor force	−2.521	−6.542***
	(0.3177)	(0.00)
Public capital stock	−1.434	−3.367**
	(0.8506)	(0.05)

Notes: *T*-statistics are reported, with *p*-values in parentheses. Three asterisks denote significance at the 1 percent level, and two asterisks denote significance at the 5 percent level.

Source: Author's analysis of the data series described in the technical appendix

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rejected in levels, but it can be rejected at the 5 or 1 percent level of significance for the first differences. Given this confirmation, we can employ the Heintz (2010) error correction model.

Data on private and infrastructure capital stocks was obtained from the Bureau of Economic Analysis (BEA) series on fixed assets. Our infrastructure measure is the broad measure used in Figure A. Data on employment is from the Current Employment Statistics (CES) series from the Bureau of Labor Statistics (BLS). Private-sector output is total GDP with federal, state, and local government consumption and investment subtracted out. All of these series are taken from the BEA National Income and Product Accounts (NIPA) data.

Endnotes

1. All numbers in this paragraph are taken from CBO 2015.

2. It should be noted that these are multipliers that hold when monetary policymakers accommodate the fiscal expansion. If monetary policymakers instead engage in contractionary measures to offset any fiscal expansion, the best estimate of these (or any other) multiplier is zero.

3. Because this is commonly misunderstood, it is important to realize that a multiplier of 1 does not mean that stimulus has somehow failed. It means it has boosted overall output by exactly the amount of the fiscal impulse. Stimulus fails to work in some economic models when the extra output generated by the fiscal impulse leads to an equal and opposite contraction in private-sector output, resulting in a multiplier of zero.

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