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PUBLIC INVESTMENT

The next 'new thing' for powering economic growth

BY JOSH BIVENS

America's stock of human and physical capital, public and private, can be thought of as the most tangible representation of the nation's wealth. It is largely what allows the U.S. workforce to produce more per hour worked than most of the rest of the world, and it is the most valuable economic legacy we pass on to future generations.

Public investment by federal, state, and local governments builds the nation's capital stock by devoting resources to the basic physical infrastructure (such as roads, bridges, rail lines, airports, and water distribution), innovative activity (basic research), green investments (clean power sources and weatherization), and education (both primary and advanced, as well as job training) that leads to higher productivity and/or higher living standards. While private actors also invest in these areas, they do so to a much smaller degree, in part because the gains from public investment accrue not just to those undertaking the investment, but to a wide range of people and businesses.

In recent years, some debate has centered around increasing public investment to provide a near-term boost to the job market, based on research showing that infrastructure investment is about the most efficient fiscal support one

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can provide to a depressed economy. But there is also an enormous amount of economic evidence demonstrating that public investment is a significant long-run driver of productivity growth—and hence growth in average living standards. This lesson was lost in recent decades because—in a break from historical trends—productivity acceleration in the late 1990s was driven largely by private-sector investments in information and communications technology (ICT) equipment, and not by increased public investments.

However, it is time to re-learn this lesson. A new round of research in the last decade confirmed the large impact of public investment on productivity growth. At the same time, the contribution of private ICT investment to productivity growth seems to be fading. The surest route to returning to the productivity growth we enjoyed in the post-World War II era and again in the late 1990s requires a substantial increase in public investments.

This paper summarizes what the research tells us about the role of public investment in driving broad and long-term economic growth and constructs estimates of how much an increased effort in public investment could boost growth in the coming decade. The findings are compelling:

- Investments in public capital have significant positive impacts on private-sector productivity, with estimated rates of return ranging from 15 percent to upwards of 45 percent. (Our preferred estimate is 30 percent, which coincidentally is roughly equivalent to the rate of return on investment in information and communications technology.)
- A consistent research finding is that public capital offers a higher rate of return than most forms of private capital.
- Increasing public investment by just under $250 billion per year on average for the next 10 years (a path outlined in *Investing in America's Economy*, a joint EPI/Demos/Century Foundation plan described later in the text) could increase gross domestic product by a greater percentage every year—producing a GDP that is 0.9 to 2.8 percent higher in 2021 than it otherwise would have been. And a significant fraction (40–75 percent) of the plan's budgetary cost could be essentially self-financing.
- Public investment has benefits that extend beyond simply increasing measured GDP: It also offers benefits that are more broadly shared by all Americans.
- Public investment produces benefits that cannot be measured, such as safer water and cleaner air.

These findings strongly suggest that increasing public investment is a more urgent policy priority than cutting spending. A significant increase in public investment spending would boost jobs in the short run and pay enormous dividends in more rapid productivity growth in coming decades. In contrast, the payoff to spending cuts would be depressed job growth in the next few years and foregone productivity gains in the longer run.

In the short run (say, over the next three years), greater public investment would provide valuable support to an economy and job market that are growing far too slowly in the continued wake of the Great Recession. The basic problem with the economy today is a shortfall of aggregate spending. Undertaking new projects to build roads and schools, hire teachers and scientists, and retrofit houses and businesses would help to remedy that shortfall and create new jobs.[1]

In the short run, while the U.S. economy continues to operate well below potential, this public investment should be debt-financed to maximize job creation. In the long run, as the economy returns to potential, the proper financing for these projects will depend on the economic circumstances prevailing at the time. If the returns to public investment are large enough, then they can unambiguously improve the welfare of both present and future generations even if they are debt-financed. What is even

more important over the long term than how they are financed, however, is that they get done.

The short term: public investment to provide the U.S. economy with a needed boost

As of March 2012 the unemployment rate stood at 8.2 percent and had been at or above this level since February 2009. Further, the pace of economic growth dropped to just above 1.7 percent for 2011, a rate far below the 3.0 percent GDP growth of 2010 and a pace that is unlikely to put sustained downward pressure on unemployment rates.

The roots of this slow growth were the same as the roots of the Great Recession, which saw the economy shrink by 5.4 percent: Households, businesses, and governments were simply not spending enough to keep the labor force and the nation's capital stock fully employed. The normal economic mechanisms that push spending back up as some sectors' spending falters—falling interest rates and automatic fiscal stabilizers such as increased unemployment insurance—were overwhelmed by the contraction in private spending after the $8 trillion housing bubble burst. The short-term interest rates controlled by the Federal Reserve have stood at essentially zero since December 2008, and large mechanical increases in budget deficits caused by lower tax revenue and increased safety-net spending in the recession's wake have failed to spur a robust recovery.

The American Recovery and Reinvestment Act (ARRA) provided help over and above what the automatic stabilizers were able to deliver. The bulk of the ARRA's effect was felt in 2009 and 2010: The Recovery Act added roughly 3 million jobs at its peak and kept the unemployment rate about 1.5 percentage points below where it otherwise would have peaked.[2] ARRA provided for a significant temporary increase to public investment. But when spending from the Recovery Act began ramping down, it added to the overall (federal, state, and local) fiscal drag on growth in 2011. New stimulative measures passed by Congress at the end of 2010—a payroll tax cut, extension of unemployment benefits, and more generous provisions for businesses to expense investments for tax purposes—somewhat compensated for the dropoff.

Most of these policies were continued into 2012, but under the current law baseline for 2013, fiscal support to the economy would drop sharply. The payroll tax cut and the extensions to unemployment insurance are set to expire, as are the entirety of the Bush-era tax cuts. Further, additional cuts called for under the debt-ceiling deal reached in summer 2011 will occur when underlying growth in the economy is actually below the long-run trend and hence below what is needed to lower unemployment.

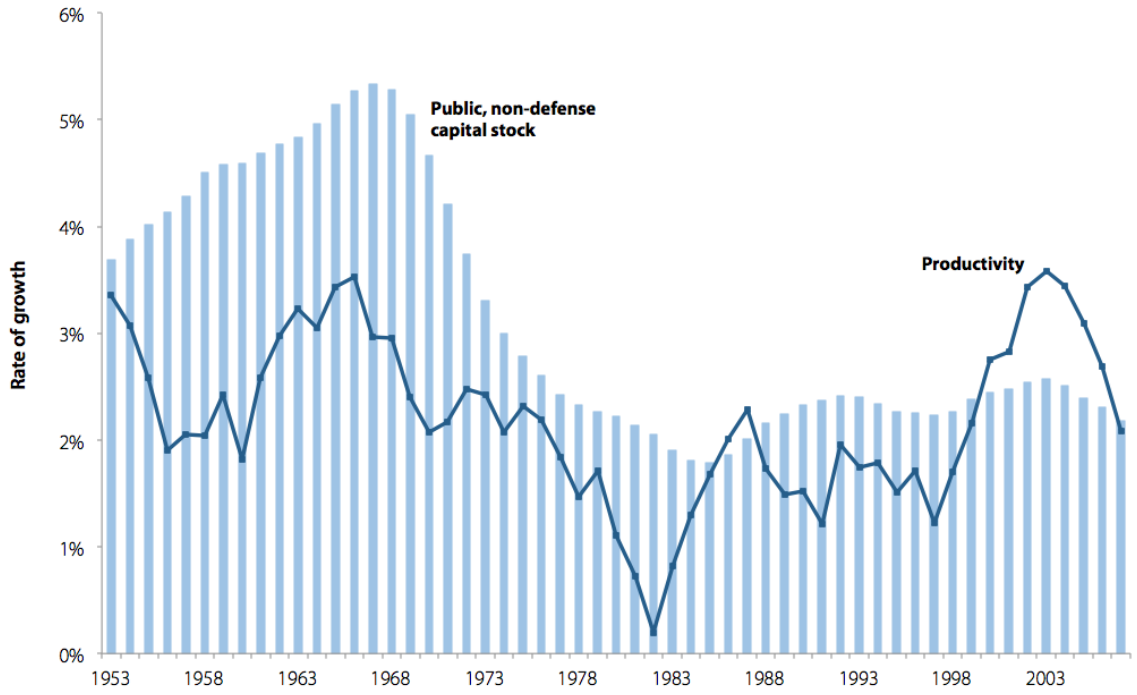
Given this context—continued high joblessness under current law implying a steep fiscal contraction—the case for expediting public investment in the near term is strong. The downsides to increasing federal deficits in a healthy economy—rising interest rates that crowd out private-sector spending—are not operative in an economy beset by large slack in aggregate demand. Indeed, the $1.4 trillion deficit of 2011 has been accompanied by the lowest long-term interest rates on U.S. government debt in history—and these lows were reached even after Standard & Poor's downgraded U.S. government debt.

New spending in the near term would essentially constitute a macroeconomic "free lunch," putting idle resources back to work without displacing any other economic activity. Indeed, by supporting overall economic activity without increasing interest rates, debt-financed spending in the next couple of years might even "crowd *in*" private-sector activity, since studies show that a primary determinant of business investment is the current state of the economy.

The Obama administration made substantial infrastructure investments (nearly $100 billion worth) a central part of its American Jobs Act, a plan proposed in 2011 that,

FIGURE A

Average growth rate of public capital stock and productivity, 1953–2007



Note: Public capital excludes defense capital stock. Productivity measures, which cover the nonfarm business sector, are in five-year averages.

Source: Author's analysis of Bureau of Economic Analysis Fixed-Assets Accounts (Table 7.6A and 7.6B) and Bureau of Labor Statistics Labor Costs and Productivity public data series

if passed, would move fiscal policy from being a serious economic drag to being a useful boost to growth in the next two years. Yet these infrastructure investments have not passed Congress. This is unfortunate, because infrastructure investment is about the most efficient fiscal support one can provide to a depressed economy—a finding supported by nearly all macroeconomic models and forecasts.[3] Further, public investment provides a long-term growth payoff as well as a near-term boost to the job market.

The long term: public investment as crucial driver of productivity growth

The last time significant public investment was seriously on the policy radar was in the early 1990s, when Bill Clinton made a program of public investment ("putting people first") a cornerstone of his 1992 presidential campaign. This embrace was driven at least in part by a growing economics literature arguing that deficient public investment could explain a significant part of the rapid deceleration in productivity growth that characterized the post-1973 U.S. economy (see **Figure A**). Between 1947 and 1973—when growth in the real (inflation-adjusted) stock of public capital averaged 4.5 percent—productivity

TABLE 1

Contributions to growth in labor productivity, 1973–2008

	1973–1995	1995–2000	2000–2008
Growth of labor productivity	1.47%	2.51%	2.50%
Contributions to growth from capital deepening	**1.05 ppts.**	**1.39 ppts.**	**1.2 ppts.**
IT capital deepening	0.46	1.09	0.6
Other capital, labor quality and adjustments to multifactor productivity	0.59	0.3	0.6
Contributions from multifactor productivity after adjustments	**0.42**	**1.12**	**1.29**
IT sectors	0.28	0.75	0.45
Other nonfarm business	0.14	0.37	0.84

Source: Adapted from Oliner and Sichel (2008)

growth averaged more than 2.6 percent.[4] But between 1973 and 1995, when growth in the real public capital stock fell nearly in half, to 2.3 percent, productivity growth slowed to just 1.6 percent. This "great productivity slowdown" was one of the most vexing economic and policy issues of this period.

Productivity growth made an unexpected recovery during the second half of the 1990s, averaging 2.4 percent between 1995 and 2007. But the recovery was not aided by a significant increase in public investment (public capital stock grew at a low 2.6 percent average during those years). As a result, interest in the public investment agenda dissipated.

Unlike the 25-year productivity slowdown that preceded it, the productivity resurgence that began in the second half of the 1990s is fairly well-understood—it was driven by a large increase in private-sector investments in information and communications technology equipment. As prices for ICT equipment fell, firms made substantial investments, and these investments increased overall productivity growth both through simple "capital deepening" (i.e., giving American workers a larger bundle of capital with which to produce) and by improving *multifactor productivity,* or gaining efficiencies by better organizing production processes (see **Table 1**).

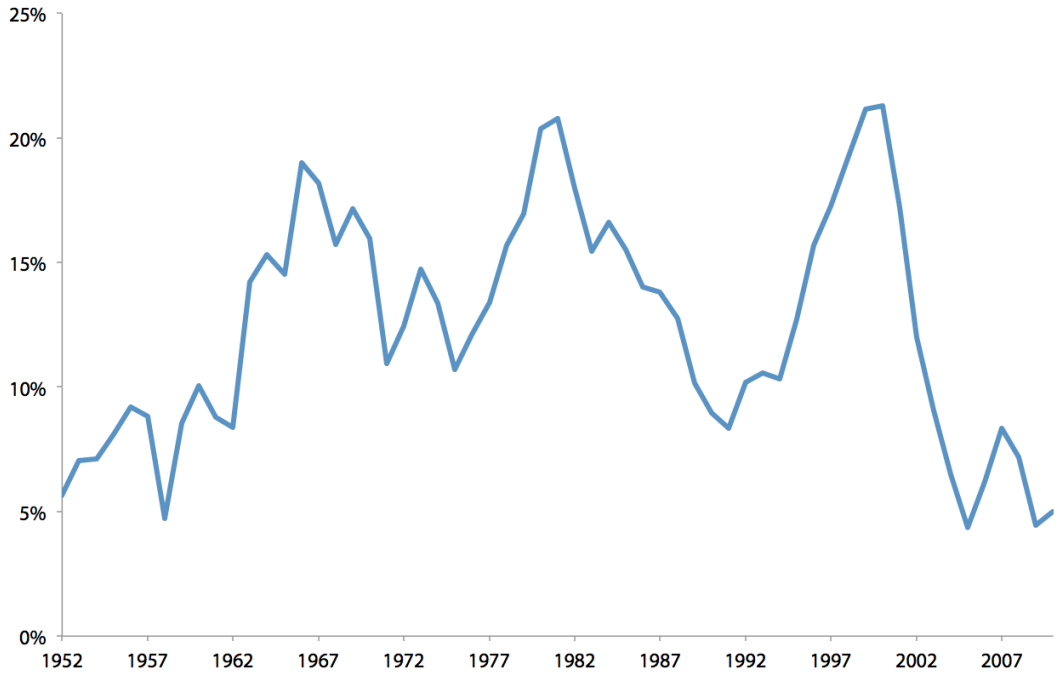
ICT investments began to lag in the 2000s. Productivity growth continued strongly until roughly 2003, when it began to lag as well. In each year between 2003 and 2007, leading up to the start of the Great Recession, the growth rate of productivity decelerated, falling to just above 2 percent in 2007.

Over the past four years, the underlying trend in productivity has been greatly distorted by the severe recession. However, given that the post-1995 acceleration in productivity was driven largely by the rise in ICT investments and that both productivity growth and ICT investments (shown in **Figure B**) have decelerated since the early 2000s, it seems likely that the ICT boom will not be an engine of further growth in the coming decade.

If so, how do we return to late 1990s levels of productivity growth? Maybe the private sector will see investment opportunities in some as yet unrecognized sector, but that is uncertain. What is certain, however, is that public investment could be used to spur productivity growth. Given that public capital has lagged or stagnated as both a share of the overall economy and relative to the private capital stock in recent decades (see **Figure C**), there should be much room for high returns from public investment, with little worry about running quickly into diminishing marginal returns.

FIGURE B

Growth of real investment in information processing equipment, 1952–2010



Note: Real (inflation-adjusted) investment in information processing equipment is calculated in five-year averages.

Source: Author's analysis of Bureau of Economic Analysis National Income and Product Accounts (Table 5.2.3)

While the round of the public investment debate that began in the 1990s largely faded away without a definitive verdict, several new studies have appeared over the last decade that, with few exceptions, confirm the general view that public investments can be very effective in lifting overall productivity growth. These new studies and their findings are discussed in the section "Just how productive is public investment?" and Appendix A.

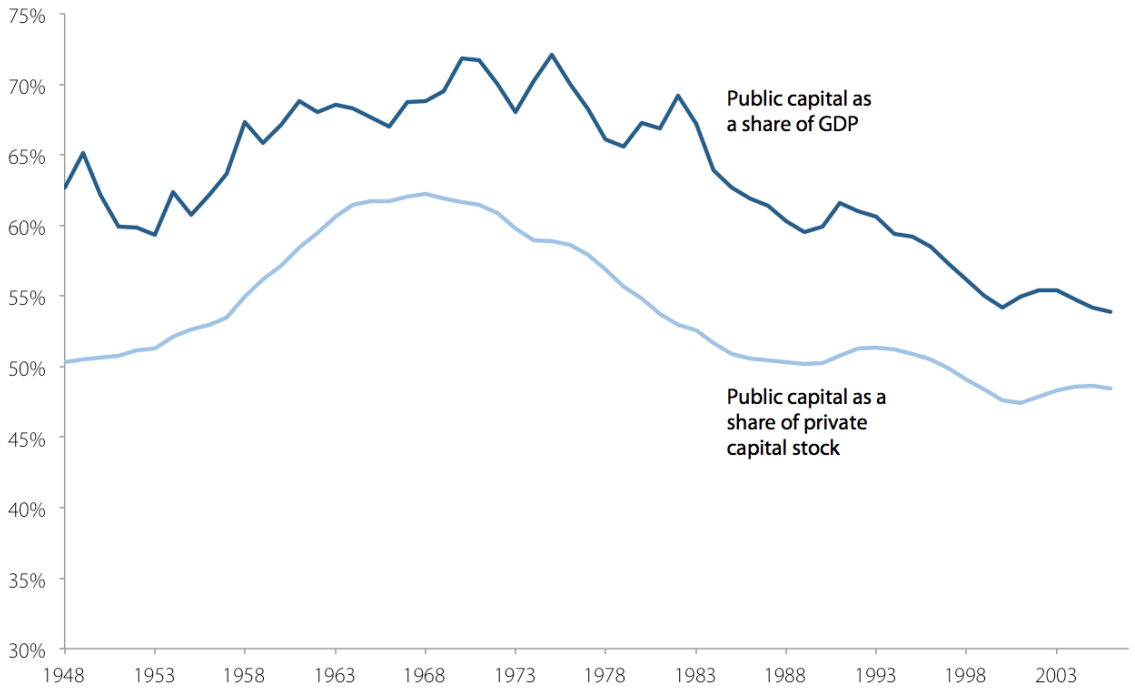
Fiscal policy and the nation's capital stock: public and private

Policy debates today are dominated by claims that the U.S. budget deficit needs to be substantially reduced. For example, the deal resolving the debate over raising the debt limit in August 2011 will result in substantial reductions in government spending beginning in 2013—a time when the unemployment rate still is forecast to be above 8 percent. Given that the U.S. economy is operating far below potential, and is likely to do so for years to come absent aggressive policy measures to boost it, such rapid fiscal contraction is extremely unwise.

Further, if public investment is a casualty of this rush to cut spending, as it almost surely will be (see Pollack 2011), then this policy trajectory is even more perverse. Consider the standard economic rationale that justifies reduction of budget deficits. When an economy is operating at or near potential, reducing budget deficits should lead to downward pressure on interest rates, as the public sector is no longer competing with the private sector for loanable funds. Lower interest rates should then allow private firms to undertake more investment in plants and equipment, and this subsequent "capital deepening" should boost productivity.

FIGURE C

Public capital as a share of GDP and as a share of private capital stock, 1948–2007



Notes: Public capital measure excludes national defense capital stock. Private capital stock excludes residential capital stock.

Source: Author's analysis of Bureau of Economic Analysis Fixed-Assets Accounts (Table 1.1, 7.1A and 7.1B) and BEA National Income and Product Accounts (Table 1.1.5)

It is important to note that this textbook case for reducing budget deficits does *not* hold today because the U.S. economy is not at full employment and will not be for years to come, and today's deficits are not crowding out private investment because the surfeit of idle resources in the economy ensures that there is no competition for loanable funds. The absence of "crowding out" is clear from the fact that interest rates actually fell as federal budget deficits rose since the start of the recession (**Figure D**).

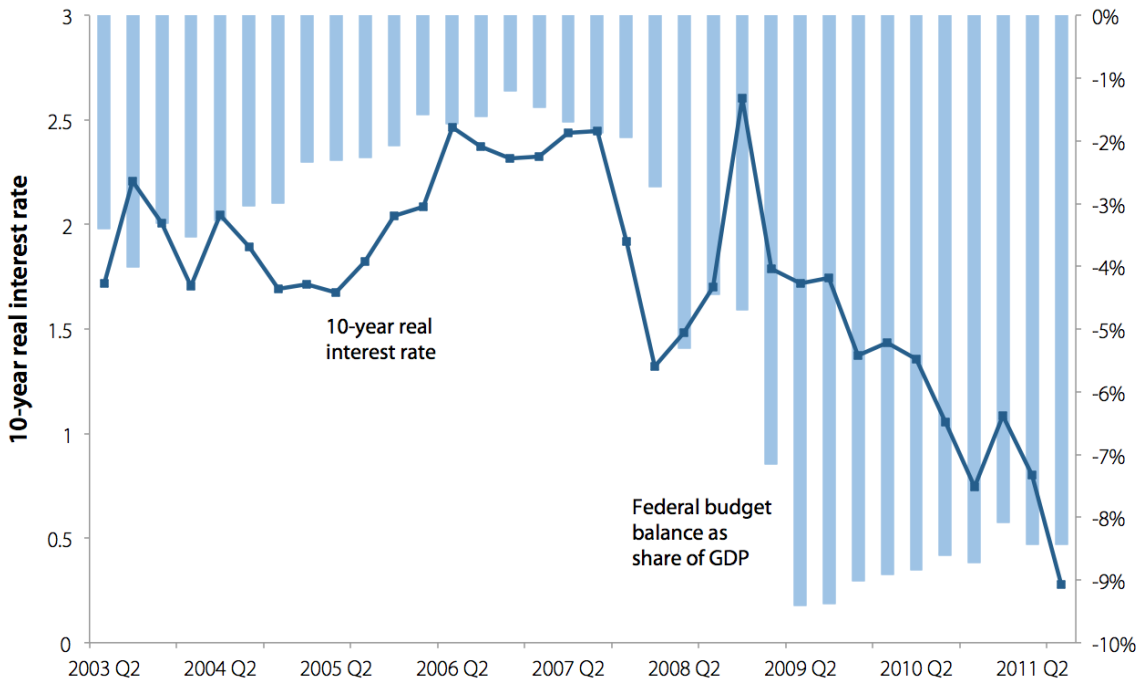
In fact, as noted earlier, because the most important short-run determinant of private investment is contemporaneous economic activity, increased public investment (even debt-financed investment) has crowded *in* private investment in recent years and could continue to do so until full employment is reached.

Even during times of full employment, the standard economic case against government deficits may not apply to deficits used to fund productive public investment. In this case, the impact of deficits on economic growth depends strictly on the relative rates of return of private versus public investments, and deficit spending on *public* investments may result in higher levels of productivity.[5]

Too often, discussions of investment, capital stocks, and productivity assume that private-sector decisions are the dominant force behind the movement of these variables. This is not the case, as is illustrated in **Figure E**, which shows current estimates of the nation's total capital stock. Note first the overwhelmingly large importance of education, a sector funded significantly by the public sector. Note also that public capital accounts for more than a third of all nonresidential structures and equipment cap-

FIGURE D

Federal budget balance as share of GDP, and 10-year real interest rate, 2003–2011



Source: Author's analysis of Bureau of Economic Analysis National Income and Product Accounts Tables (1.1.6 and 3.1) and Federal Reserve Economic Database public data series

ital. In short, the wealth of the nation (i.e., the human and physical capital that can be mobilized to produce goods and services) is crucially dependent upon public investments and public capital. Allowing these public capital stocks to wither so that funds can be available for private capital formation would be a calamitous assault on U.S. productive capacity, productivity, and competitiveness.

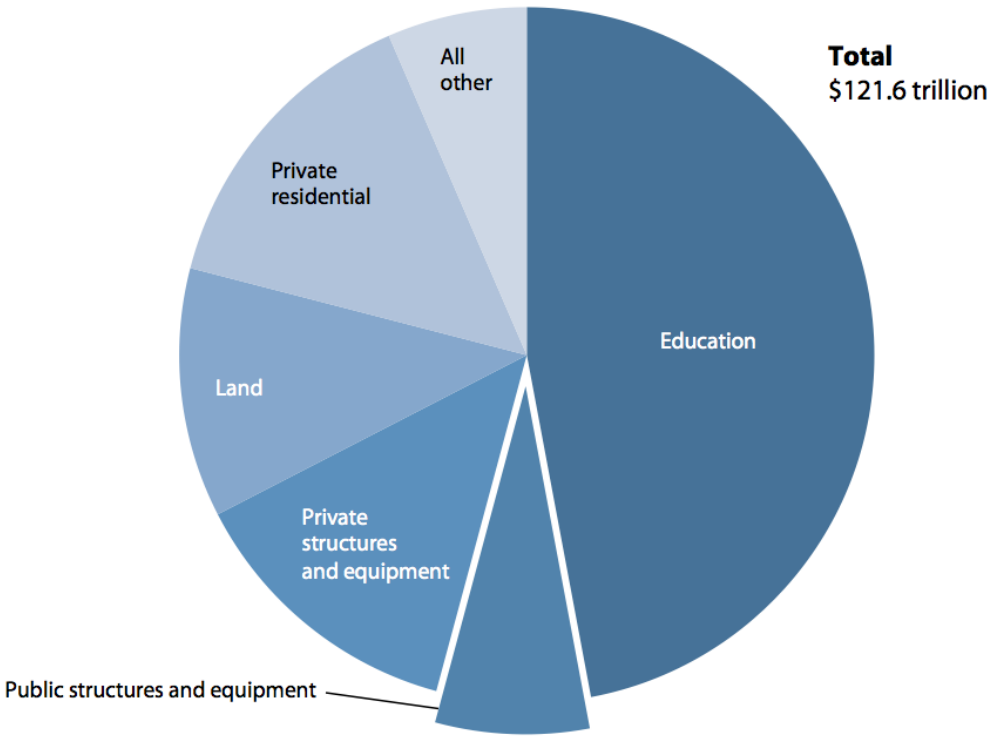
Just how productive is public investment?

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 (Aschauer 1989, 1990). The first Aschauer (1989) results, which became the benchmark for all that followed, found that the rate of return to public capital was several times higher than that of private capital. His work was soon buttressed by that of Alicia Munnell (1990, 1992), who would later become undersecretary of Treasury under President Clinton; Holtz-Eakin (1988) and Lynde and Richmond (1992). The Aschauer and Munnell results finding that public investment is a significant (both statistically and economically) predictor of productivity growth spurred some pushback in critical essays by Aaron (1990) and Gramlich (1994). (The large body of literature that has since addressed these criticisms in reviewed in Appendix A.)

After this back-and-forth, the public investment debate went largely fallow in the late 1990s as productivity growth revived in the absence of any increase in public investment. This productivity revival was often (and mistakenly) blithely attributed to the declines in budget deficits that also characterized this period.

FIGURE E

Share of U.S. capital stock, by type of capital



Note: National wealth amounts are in 2008 dollars.

Source: Office of Management and Budget (2009)

As the decade came to a close and the 2000s began, interest in the productivity-enhancing effects of public investment was revived, largely driven by cross-country studies that aimed to make policy recommendations for developing countries. Although these studies were largely not about the impact of public investment in richer countries, the data and empirical results included much useful information on the effects of public investment even for the United States. Most importantly, the vast majority confirmed the Aschauer and Munnell findings that public investment is a significant predictor of productivity growth.

In fact, the new research shows that public investment is *at least* as productive as private, and several strands of the research seem to indicate that it is substantially *more* productive.

This contribution to clarifying the impact of public versus private investment notwithstanding, the goal of all of these studies was generally to address another question: What is the impact of expanded public investment on private-sector productivity? Compellingly, most of the studies showed significant positive impacts of public investment on private-sector productivity.

Yet, 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. It

would be akin to receiving clean water and air, safe food and medicine, and transportation services for less money, which seems like a perfectly fine way to enjoy the returns to expanded public investment.

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 provide clear economic benefits, but these benefits do not generally show up in measurable cash incomes.

In short, the research is clear that public investment should boost measured economy-wide productivity while also spreading the benefits of this growth more broadly and increasing quality of life that is not captured in productivity statistics. These insights should be front and center in the current debates over the nation's budgeting and priorities.

How to finance and how much to aim for?

It is sometimes argued that even if increased public investment can increase an economy's growth performance, the necessary financing of the investment may introduce economic distortions that reduce growth. If so, it matters not just how much public investment is undertaken but also how it is financed.

The concern is that, if these investments are financed with increased debt or higher taxes, the efficiency losses induced by the crowding-out of private-sector investment, or by higher tax rates, may produce a net loss to economic growth. But there is little cause for this concern, for several reasons.

For one, debt-financed public investment in the present moment could well provide enough growth to *lower* long-term deficits. Interest rates are currently at historic lows; some long-term inflation-adjusted rates (10-year Treasury rates) have actually been negative for stretches of time in the recent past. Further, because the economy currently suffers from excess capacity (and will for years to come), new investments will have powerful multiplier effects, leading to higher overall economic activity. Given these very low borrowing costs and the powerful job growth effects public investments would have in the short run, the long-run productivity-enhancing impact of public investment would not need to be very high to make debt-financed investment increases totally self-financing (see DeLong and Summers 2012 on why even non-investment forms of fiscal stimulus may be self-financing given current low interest rates and excess capacity). Failure to undertake debt-financed public investment in the short run essentially means rejecting a free fiscal and economic lunch. This is truly irrational.

Even when the economy eventually works off this excess capacity and increased public investment financed by debt does indeed threaten to push up interest rates and crowd out private investment, it would not necessarily constitute a net economic loss. For example, as Rezai, Foley, and Taylor (2009) point out, standard economic theory suggests that public investment directed at mitigating greenhouse gas emissions should be debt-financed. Because the benefits of this investment largely accrue to future generations, financing them with debt allows present generations to keep their living standards constant

and still bequeath to future generations a capital stock that is of optimal size and balanced between traditional capital and capital installed for the purpose of mitigating greenhouse gas emissions.

Further, even if revenues need be raised to finance some public investment, diversion of these revenues would not necessarily harm economic efficiency. A range of revenue raisers are either efficiency neutral or efficiency generating. For example, Pigovian taxes (taxes on activities that generate negative externalities) on greenhouse gas emissions, other harmful pollutants, and even financial market risk can raise significant revenue while increasing economic efficiency. Putting limits on tax expenditures without raising marginal rates also could raise revenue in a progressive fashion while shrinking tax-based distortions.

Lastly, to the degree that increased public investment is financed by reduced spending in wasteful spending categories (such as defense), it will produce net benefits.

Table 2 uses estimates broadly centered around those of Heintz (2010) to show the expected payoff from the public investment proposed in *Investing in America's Economy,* a plan for long-term public debt stabilization by Demos, the Economic Policy Institute, and The Century Foundation *(*Our Fiscal Security 2010). It is an ambitious public investment plan, though it would still leave the U.S. public capital stock (measured as a share of overall GDP) barely above the 2001 average for Organization for Economic Cooperation and Development member states (the last year such OECD data were available) and far below the countries with the largest public capital stocks. In short, though the plan is ambitious, it is within the bounds of reasonable investment and estimates of its expected payoff are clearly "in sample" with regards to the existing research.

The table shows the impact of this investment on the size of the public capital stock, economic output, and the likely offset to federal budget deficits. For illustrative purposes, we use three rates of return—15 percent, 30 percent, and 45 percent. Appendix B provides the evidence that these rates of return are useful ones to examine, as there is a good chance that they encompass the actual return on public capital for the United States. Further, it makes the case that even the highest value (45 percent) is possibly the correct one, while arguing that the lowest value (15 percent) is a quite conservative lower bound on what the return to a bigger capital stock would be.

The first column, "Proposed public investment," shows the increased investment effort called for in the Our Fiscal Security plan. It would increase public investment by just under $250 billion per year on average for the next 10 years, and for these illustrations we assume the investment begins in 2012 and ends in 2021. The second column shows the cumulative impact of this increase in investment for the size of the overall public capital stock. To be conservative, we assume a 5 percent rate of depreciation, which is substantially higher than the 3 percent rate that best characterizes the public capital stock data of the last decade.

The remaining columns show the marginal impact of this larger public capital stock on GDP and on the federal budget deficit for each of the three different rates of return examined. The offset to the federal budget deficit incorporates two effects. First, in years that the Congressional Budget Office assumes the economy is operating below potential (i.e., years before 2016), we allow the extra economic activity generated by the investment to decrease the (cyclically adjusted) budget deficit. Bivens and Edwards (2010) have found that each $1 closer to potential GDP the economy moves yields a decline in the budget deficit of $0.37; in the table, each year until 2016 includes this cyclical effect on the deficit. For all years (even those after 2016) we also include the deficit offset identified by the CBO as characterizing a movement toward a permanently higher productivity growth rates. As a larger public capital stock yields a permanent increase in productivity, we allow this deficit offset to operate in each of the 10 years under examination.

TABLE 2

Outcomes following substantial increase in public investment, 2012–2021: Change in output and offset to federal deficit from public investments called for by Our Fiscal Security

			ASSUMED RATE OF RETURN: 15%		ASSUMED RATE OF RETURN: 30%		ASSUMED RATE OF RETURN: 45%	
	Proposed public Investment	Resulting public capital stock	Increase in GDP	Deficit offset	Increase in GDP	Deficit offset	Increase in GDP	Deficit offset
	$ BILLIONS		SHARE OF GDP		SHARE OF GDP		SHARE OF GDP	
2012	$250	$250	0.25%	0.75%	0.49%	0.80%	0.74%	0.89%
2013	200	438	0.41%	0.70%	0.82%	0.78%	1.24%	0.94%
2014	212	616	0.55%	0.79%	1.11%	0.89%	1.66%	1.10%
2015	225	782	0.67%	0.87%	1.34%	0.99%	2.02%	1.24%
2016	236	928	0.76%	0.95%	1.52%	1.06%	2.29%	1.35%
2017	248	1,067	0.84%	0.21%	1.67%	0.42%	2.51%	0.63%
2018	259	1,177	0.88%	0.25%	1.76%	0.50%	2.64%	0.75%
2019	270	1,271	0.91%	0.30%	1.82%	0.59%	2.73%	0.88%
2020	282	1,355	0.93%	0.34%	1.85%	0.68%	2.78%	1.01%
2021	294	1,431	0.93%	0.38%	1.87%	0.76%	2.80%	1.13%

Source: Author's analysis of Bureau of Economic Analysis Fixed-Assets Accounts (Table 7.1B and 7.6B) and *Investing in America's Economy* (Our Fiscal Security 2010)

The effect of increased public investment on both GDP and deficits is substantial. By 2021, the larger public capital stock leads to output levels that are about 0.9 percent to 2.8 percent higher (depending on the assumed rate of return), and to budget deficits that are lower by between about 0.4 percent and 1.1 percent of GDP. To put these figures in perspective, 1.1 percent of GDP in 2011 was $150 billion. Over the entire 10-year period, *growth* in economic output is 0.1 percent to 0.3 percent faster each year because of the greater public investment effort.

Can we spend this much profitably?

The extra public investment effort called for in the *Our Fiscal Security* plan is substantial, but not so large that it risks diminishing marginal returns. First, the estimated rates of return in the empirical literature are drawn from samples that include many countries (such as the United States) in many years that have had much larger public capital stocks (measured as a share of GDP) than the levels that would result from the *Our Fiscal Security* public investment plan. Second, substantial evidence supports the view that some investment opportunities, such as early-childhood education, research and development, and energy efficiency, offer very high returns that have not yet been exploited. Third, the estimates of the size of the public capital stock under the *Our Fiscal Security* plan remain below the quite conservative estimates of Aschauer (2000) regarding the optimal size of the American capital stock.

Conclusion

Research on the impact of public investment continues to show large returns to private-sector productivity, GDP growth, and even deficit reduction. But the proliferation of new, state-of-the-art research supporting this finding has been overlooked by policymakers. Were they aware, they would realize that calls to slash government spending

that reduce public investment—in the name of reducing budget deficits that allegedly threaten the living standards of future generations—are deeply misguided.

The economic case for deficit reduction is, simply, to provide room for productive investment that will bequeath to future generations a larger capital stock and hence higher productivity. Yet, this case fails if deficit reduction is accomplished in part through reductions in public investment, because these reductions shrink the nation's capital stock and impoverish future generations. Further, because growth in public investment has lagged growth in private investment for decades, there is ample reason to believe that marginal investments in public capital may provide higher social rates of return than private investments. In short, if public investment is sacrificed in the rush to reduce future budget deficits, the result will be less and less highly productive capital for future generations.

If today's policymakers are serious about "winning the future," greater public investment needs to be a high priority.

Appendix A. Measuring the productivity of public investment

In 1989, David Aschauer of the Federal Reserve Bank of Chicago published a study on the productivity of public investment that became the benchmark for all that followed. His findings (Aschauer 1989) were generally based on a time-series estimation of public investment in the theoretical context of an aggregate production function model. Aschauer 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.

This general result—significantly higher rates of return from public rather than private investment—was matched by Munnell (1990), Holtz-Eakin (1988), and Lynde and Richmond (1992). However, the approach pioneered by Aschauer soon came under criticism from a variety of angles. Critics of the time-series component argued that the link between public capital and productivity suffered from problems of both causality and simultaneity. Another line of criticism maintained that it was inappropriate to model public capital as an argument in an aggregate production function.

Time-series problems: causality and simultaneity

The causality criticism was 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 was 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) makes the correct point 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 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, and Everaert and Heylen (2001), also point out that solving the simultaneity problem through error-correction models largely solves the causality problem. 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.

Other studies have used the general production function approach and combined it with panel-level data (which combine time-series information with variation allowed by using cross-sectional data, say between U.S. states or across different countries) to solve both the problems (causality and simultaneity) raised by critics of the original Aschauer estimates. Pineda and Rodriguez (2006), for example, use "instruments" for increased public infrastructure spending that exploit legislated changes regarding how much different regions in Venezuela receive from national value-added tax revenues to solve both problems. Using this instrumental variables approach, which solves the causality problem, they find very large effects on private productivity from increased levels of public capital.

Theoretical issues: the aggregate production function approach

Many other studies have been undertaken to test the significance of the main theoretical criticism of the Aschauer results—that public capital does not belong as a simple input into an aggregate production function. Duggal, Saltzman, and Klein (1999) instead model public capital as a determinant of total factor productivity, which is a much more flexible estimating strategy. They use panel data across U.S. states to estimate the productivity impact of public capital and find an effect very close to Aschauer's. Similarly, Morrison and Schwartz (1996) use a cost-function approach to estimate the effect of public capital investments on the costs of private-sector firms instead of as a direct input into production. This approach also allows more flexibility in capturing the influence of public capital on private-sector productivity. They use manufacturing performance across U.S. states and over time to estimate the effect of public capital on private productivity and again find estimates very similar to Aschauer's (though with considerable variation across states, with those states having very large public capital stocks experiencing a lower payoff to incremental increases in public capital).

Kamps (2001, 2004) uses cross-country data from the OECD to estimate an atheoretical vector autoregressive (VAR) model to examine the effect of public capital on productivity. This approach side-steps many of the theoretical concerns raised in earlier rounds of the literature. He finds a significant impact of public capital on productivity and also finds that the public capital stock in the United States is slightly smaller than the OECD average.

Are the results "too big"?

Occasionally, the results from the empirical literature on the growth payoff from public investment are dismissed on the simple grounds that they are "too big." (As an

example, see a blog post by Macro Advisors forecasting: http://macroadvisers.blogspot.com/2011/05/macro-focus-peoples-budget-supply-side.html.) This section notes the thinness of this claim and puts the results on public investment into their wider economic context.

It should be noted at the outset that what would constitute too large an effect of increased public investment is hard to define with serious rigor. Theoretically, one would expect rates of return from various sorts of private investments to not drift too far from each other, as market forces would ensure that very high returns from investing in any one sector would attract capital flows and push these rates down to economy-wide averages. But public investment, almost by definition, is undertaken in those areas where externalities keep market forces from operating effectively. Levels of public investment are therefore largely determined by political, not economic, influences. Hence, it could easily be the case that large potential social returns from public investments could exist with no market forces at all eroding them.

Further, very high rates of return to investments in some areas of the private sector are often measured, meaning that simple magnitudes of rates of return cannot be used to throw out a carefully constructed (and supported) empirical finding. Oliner and Sichel (2003) found that over the 1995–2001 period, software investments yielded a rate of return of more than 40 percent, and accumulated software investments of less than $700 billion in real dollars over that time period increased productivity by 0.35 percent per year, roughly equivalent bang-for-investment buck to even the higher end of regression-based estimates of returns to public investment. DeLong and Summers (1992) found that social returns to all equipment investment looked to be greater than 30 percent for a large group of countries, and this estimate applied to rich countries such as the United States as well. In short, there is nothing about a "high" rate of return to public investment that constitutes prima facie evidence that it is poorly estimated.

Appendix B. Potential rates of return to public investment

Table 2 in this briefing paper shows the impact of the public investment effort proposed in *Our Fiscal Security* on the size of the public capital stock, economic output, and the likely offset to federal budget deficits. For illustrative purposes, we use three rates of return. The lowest rate of return that we examine, 15 percent, is far lower than the social return to private equipment investment identified in Delong and Summers (1992). It is also lower than the rate of return identified by two of the most critical studies of the "new" public investment literature, Romp and de Haan (2005) and Bom and Ligthart (2008). The Romp and de Haan paper is titled "Public Capital and Economic Growth: A Critical Survey" and opens with the strong claim that earlier estimates of the rate of return to public capital (such as Aschauer 1989) are too large. Their key concluding paragraph makes the following assessments:

> First, although not all studies find a growth-enhancing effect of public capital, there is more consensus [that public capital is productive] in the recent literature than in the older literature as summarised by Sturm et al. (1998). Second, according to most studies, the impact is much lower than found by Aschauer (1989), which is generally considered to be the starting point of this line of research. Third, many studies report that there is heterogeneity: the effect of public investment differs across countries, regions, and sectors.

While at first this may sound like a lukewarm endorsement of public investment, it is based on examining a large cross-country dataset, and the authors stress the very heterogenous impacts of public investment, meaning that it might be insignificant in many countries and highly significant in others. What this means for the United States, however, can be seen in a closely related paper, De Haan and Jong-A-Ping (2008), which presents evidence on the

rate of return on public investment across 21 OECD countries. It finds that the returns in the United States are very high: A 7.6 percent-of-GDP increase in public capital (a one-standard-deviation increase) leads to GDP that is more than 2.5 percent higher after 20 years, implying a rate of return of closer to 30 percent than 15 percent.

Bom and Ligthart (2008) make a strong claim that publication bias (the nonreporting of studies that show no effect of public capital on growth) has infected the research literature's estimates of the productivity of public capital. But their correction for publication bias in the same paper still shows a 17 percent rate of return on public capital.

The second rate of return we examine, 30 percent, is our preferred estimate. It is roughly the return estimated by Heintz (2010) in his time-series estimates, probably the most careful reworkings of the original Ascheuar (1989) calculations—reworkings that address the problems of simultaneity and causality. It is also roughly equal to the rate of return on investments in information and communications technology equipment identified by Oliner and Sichel (2003).

The last rate of return that we examine, 45 percent, is about half the rate of return originally estimated by Ascheaur (1989) and is roughly the rate of return corresponding to the all-country average in Isaksson's (2007) cross-country study of public capital and growth for the United Nations Industrial Development Organization. Further, the Isaksson result is probably higher for the United States: His all-country average is characterized by developing countries seeing higher rates of return than industrialized countries as a group, but in the text he notes, "Incidentally, the estimated rates of return for the United States are approximately at par with those obtained here for developing countries." Lastly, this rate of return is well within the confidence intervals estimated by Morrisson and Schwartz (1996), Lynde and Richmond (1993), Hulten and Schwab (2000), and Duggal, Saltzman and Klein (1999, 2007). In short, there is nothing about a 45 percent rate of return that, by simple virtue of its magnitude, should allow it to be ruled out of bounds in this debate.

Again, these three rates of return are well within-sample when it comes to the research literature on the effect of public capital on growth.

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Endnotes

1. In fact, even if these public investments had no long-run payoff, they would be worth doing just to address the current jobs crisis.
2. This estimate of 3 million jobs is the average of the estimates summarized in Congressional Budget Office (2012).
3. See Zandi (2011), CEA (2010), CBO (2012), Woodford (2011), and Hall (2009) for representative research pointing to the extraordinary efficiency of infrastructure spending as a macroeconomic stabilization policy.
4. While the text discussion begins with 1947, the figure begins in 1953 because the productivity growth rates are smoothed by taking 5-year averages—this smoothing is necessary to keep volatile annual changes from obscuring the longer-run trends.
5. Note that the rate of return for public investment should be net of any economic impact stemming from measures used to finance it (debt service costs or possible distortionary costs of taxation).

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