The Effects of Low Productivity Growth on Fiscal Sustainability

Prepared for the Peterson Institute of International Economics Conference on "The Policy Implications of Sustained Low Productivity Growth"

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I. Introduction

Productivity growth has slowed recently. After rising 2.2 percent per year between 1996 and 2004, growth in labor productivity has slowed to an average of just 1 percent between 2004 and 2015.[1] Analysts disagree about the prospects for future productivity growth, with some, like Roger Gordon, seeing growth continuing to be relatively muted, while others, like Erik Brynjolffson, expecting productivity growth to pick up rapidly as the economy learns to make better use of recent advances in computing and robotics.[2]

Productivity growth is the key determinant of changes in future living standards, because with slower productivity growth, consumption grows more slowly too. Productivity growth is also an important assumption for projecting government revenues and expenditures, because these may be tied to GDP. Although the Congressional Budget Office sometimes presents the sensitivity of its projections to its assumptions about productivity growth, it does not release any details of its analysis or examine the channels through which productivity might affect the fiscal outlook. In addition, because of the complexities in modeling the policies across the 50 states, there are few analyses of the effects of productivity growth on the budgets of state and local government.

This essay will explore the implications of productivity growth for the long-term outlook for government budgets. I first discuss the low-productivity scenario and discuss the relationship between productivity growth and interest rates. I then assess the direct effect of changes in productivity growth on federal, state, and local government revenues and non-interest spending. Finally, I explore the impact of a productivity slowdown on interest costs and debt dynamics. Because of the lack of CBO-like projections for state and local governments, my analysis for them is less comprehensive, although I do try to shed some light on the channels through which productivity might affect the state and local sector.

II. Background and Downside Scenario

The Congressional Budget Office regularly publishes thirty-year projections of federal budget deficits and federal debt under current law. These show rising deficits and debt, with the federal debt climbing from 77 percent of GDP today to about 130 percent of GDP by 2042.[3] As shown in Sheiner (2017), this increase in the deficit largely can be attributed to population aging, as rising revenues and falling non-entitlement spending essentially offset the effects of rapid medical cost increases on entitlement spending.

Productivity growth—the efficiency at which inputs are turned into outputs--is a key assumption underlying these projections. There are various measures of productivity growth.[4] Changes in labor productivity, or output per hour worked, reflect changes in capital intensity, changes in

[1] CBO, data supplementing www.cbo.gov/publication/52480.
[2] https://blog.ted.com/the-future-of-work-and-innovation-robert-gordon-and-erik-brynjolfsson-debate-at-ted2013/
[3] CBO, Long-Term Budget Outlook, March 2017.
[4] Many times, productivity growth is measured for the nonfarm business sector—omitting the household, nonprofit, and government sectors, but here I use numbers for the whole economy as these are more relevant for projecting government revenues and expenditures.

labor quality, and multifactor productivity. Multifactor productivity is the increase in efficiency that is not explained by increases in inputs, and reflects improvements in technology and better organization of production.

As noted above, productivity growth has slowed sharply over the past decade. To some extent, this weakness may reflects temporary factors associated with the aftermath of the Great Recession. Looking forward, CBO expects labor productivity to average 1.6 percent per year over the next 25 years, about the same as the average over the past 30 years, but well below the rates observed during the high-productivity years of the late 1990s and early 2000s.

Downside Scenario

Productivity growth is extremely difficult to measure, and some commentators believe that it is likely to remain quite subdued going forward. To measure a reasonable downside risk, I analyze the effects of a ½ percentage point lower rate of total factor productivity growth over the next 25 years, so that total factor productivity growth averages 0.7 percent per year instead of 1.2 percent per year, as in CBO's baseline. This translates into a labor productivity growth for the whole economy of about 1.0 percent per year, down from the 1.6 percent assumed by CBO.[5] The history, CBO projection, and downside scenario are illustrated in Figure 1.

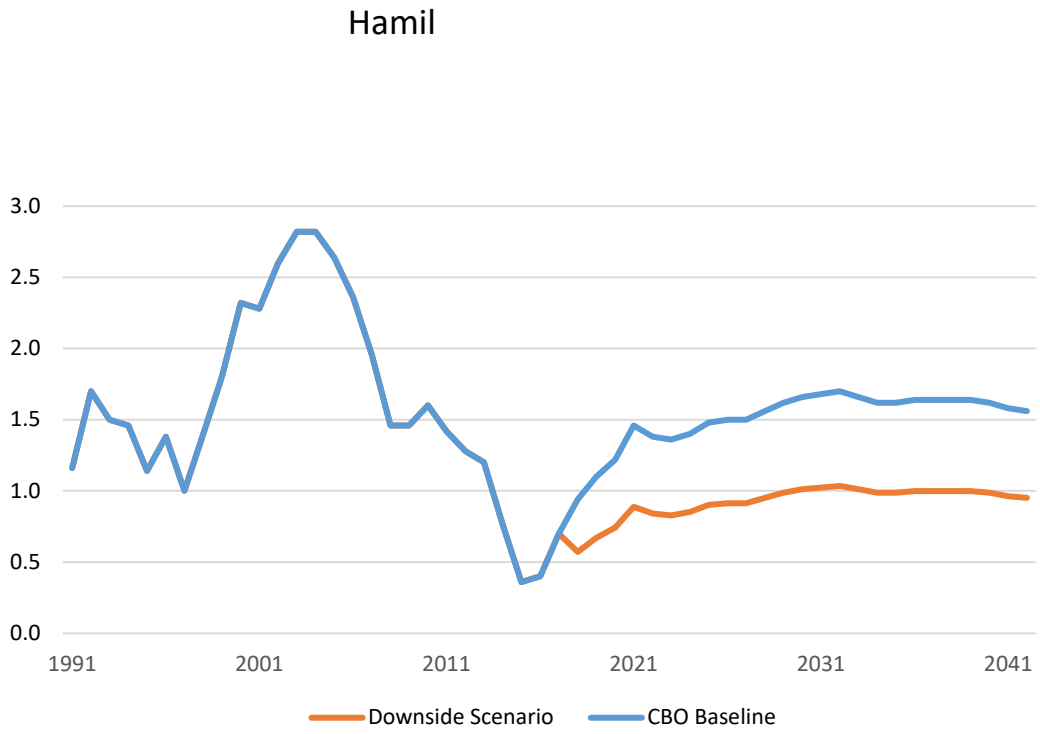
I assume that the decline in productivity growth relative to CBO's baseline affects income across-the-board, rather than having differential effects by skill level. This is an important assumption, because the distribution of income has important implications for government revenues and expenditures. Whether this is the best assumption or not is hard to know. Many believe that the widening disparity in income observed in the United States over recent decades is attributable to the fact that technological advancements have improved the productivity of the highly-skilled, but not those at the bottom of the skill distribution. If productivity growth is slowing, it could be slowing across-the-board, or it could be slowing at the top of the earnings distribution.

Productivity growth and interest rates

Interest rates are also an important assumption in projecting the fiscal outlook, and interest rates likely depend on productivity growth. There is a strong theoretical link between interest rates and productivity growth. As noted by Hamilton et al (2015), in both the Ramsey model and the baseline New Keynesian model, the interest rate moves with productivity growth, with the exact relationship depending on the intertemporal elasticity of consumption, which measures how willing people are to forego consumption today in order to have more consumption tomorrow. When consumption is not very substitutable across time, people care a lot about consumption smoothing. In this case, a decline in productivity growth means that people will be poorer in the future, and thus they choose to increase saving now to mitigate the impact on future consumption, pushing down interest rates. However, when consumption is very substitutable

[5] Measured for the non-farm business sector, this is roughly a drop in labor productivity from 1.8 percent to 1.1 percent.

over time, people don't increase saving in response to lower future income, and interest rates don't decline as much.



Empirically, there is some evidence that interest rates do move with productivity growth. Laubach and Williams (2015) estimate that a 1 percentage point reduction in the growth rate of the economy lowers interest rates by 1.3 percentage points. Rachel and Smith (2015), pointing to empirical estimates of the intertemporal elasticity of consumption, suggest that a 1 percentage point reduction in productivity growth could lower interest rates by as much as 2 percentage points. However, Hamilton et al (2005) note that the relationship between interest rates and productivity growth is "much more tenuous than widely believed."[6] They show that the correlation of average US GDP growth with average interest rates from peak-to-peak varies across time and across samples, and is often negative or zero. They argue that "if, indeed, we are headed for stagnation for supply side reasons, any such slowdown should not be counted on to translate to a lower equilibrium rate over periods as short as a cycle or two or a decade."

Because of this uncertainty, I analyze the effects of a productivity slowdown under three different assumptions about interest rates: (1) interest rates move one-for-one with productivity growth; (2) interest rates moves two-for-one with productivity growth; and (3) interest rates are invariant to productivity growth.

[6] Hamilton et al, (2015) Summary.

III. Productivity Growth and the Fiscal Outlook

The effect of productivity growth on government deficits and on fiscal sustainability depends on the extent to which government spending and revenues are implicitly "indexed" to GDP growth. If spending and revenues move one-for-one with GDP, and if the government had no debt, then changes in productivity growth would not affect fiscal sustainability. Deficits relative to GDP and ratios of debt to GDP would be unaffected. Of course, even in this case, lower productivity growth would have real effects on taxpayers. Spending and revenues would both be lower, but no changes in policy would be required to restore fiscal sustainability. On the other hand, to the extent that government outlays and revenues do not move one-for-one with productivity growth, changes in productivity growth can affect the fiscal outlook, and would require policy changes. For example, if government spending and taxes are invariant to productivity, then a slowdown in productivity will increase the deficit relative to GDP.

In addition, when the government holds debt, a slowdown in GDP growth boosts the debt to GDP ratio and makes fiscal sustainability more difficult. If interest rates also decline, however, then this effect will be muted or even reversed, depending on how much interest rates fall. If interest rates fall one for one with productivity growth, then, holding the primary deficit constant as a share of GDP, the debt to GDP ratio would not change very much with a productivity slowdown.

In the remainder of the paper, I walk through the implications of our downside productivity scenario on the federal and state and local outlooks.

a. Federal Revenues

Figure 2 details the sources of revenues for the federal government and for the state and local sector. As shown in the top panel, individual income taxes and payroll taxes are by far the most important components of federal revenues. How do each of these move with productivity?

Federal Individual income taxes: The individual income tax system is progressive, meaning that tax rates are higher for higher-income taxpayers. The tax system is almost fully indexed to inflation, so that increases in nominal income due to inflation do not push people into higher tax brackets over time. However, the tax system is not indexed for real income growth. As productivity increases raise national income, more and more income is pushed into higher tax brackets, and tax collections increase. This phenomenon is known as "real bracket creep" because "real" growth allows tax brackets to creep up over time. CBO estimates that, over the next 30 years, real bracket creep will increase federal individual income taxes by about 1 percent of GDP.[7]

A slowdown in productivity growth would reduce real bracket creep. To gauge the magnitude of the effects, it is necessary to compare total productivity growth under the baseline and under the low-productivity scenario using a CPI deflator instead of a GDP deflator, because tax brackets

[7] CBO, Long-term Budget Outlook (2017), Table 4.

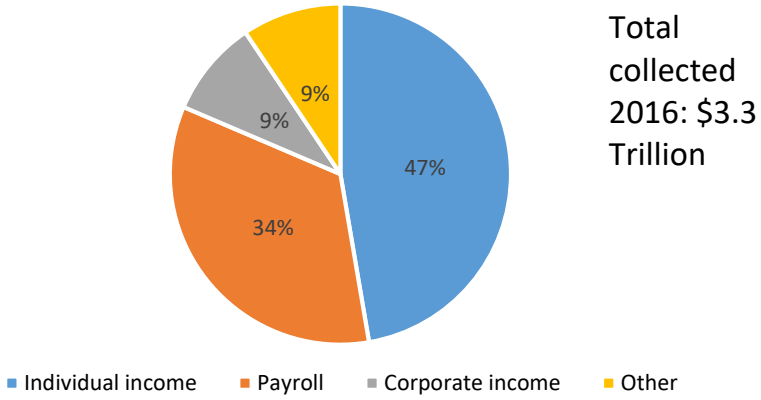
are adjusted using CPI inflation. CBO projects that the CPI will increase about 0.4 percent per year faster than the GDP deflator. Thus, for the purposes of this calculation, the average annual growth rate for real labor productivity is 1.2% in the baseline and .6% in the low-productivity scenario. This means that, after 30 years, real income is 43% higher in the baseline and 20% higher in the low-productivity scenario. Thus, a rough estimate is that, rather than boosting tax revenues by 1.1 percent of GDP as in the baseline, real bracket creep under a low productivity scenario would only increase tax revenues by about ½ that much, or about ½ percent of GDP.[8] Thus, under the low-productivity scenario, federal individual income tax revenues as a share of GDP would be about ½ percentage point lower than in the baseline after 30 years. Assuming that individual income taxes decline linearly over time, this mean that the share of individual income taxes in GDP will decline .017 percentage points per year, so averaging .2 percent of GDP over 25 years.

Payroll taxes and productivity growth: For payroll taxes, tax collections move close to one-for-one with wages, and hence productivity, because the tax rate is mostly flat. Social Security taxes (½ levied on employers and ½ levied on employees) are equal to 12.2 percent of wages up to a cap, which was $127,200 in 2017. The cap is adjusted annually so that it rises with economy-wide average wages. So, a stepdown in productivity growth that lowered wages equally across the board would lower social security taxes proportionately.[9] For most workers, the Medicare tax is 2.9% of all wages (also paid ½ by employers and ½ by employees). However, there are two types of Medicare taxes that are levied only on high-income taxpayers, adding a progressive component to the Medicare tax. First, individual taxpayers with earnings over $200,000 and couples with earnings over $250,000 face an additional 0.9 percent tax on their earnings above those amounts. Second, taxpayers with income above these amounts face a 3.8 percent tax on net investment income. While these taxes comprise only a small share of payroll taxes today (on the order of 2% in 2017), the threshold are not indexed, meaning that, over time, they will affect a larger share of earners. Still, the tax rate is low, so it is not a bad approximation to say that real bracket creep will have negligible effects on payroll tax collections.

[8] This might be an overestimate, because the effects of real bracket creep might diminish over time as more and more income is pushed into the top tax bracket. Thus, the effects of productivity growth on real bracket creep might not be linear.
Another way to try to estimate this relationship without a full micro-simulation model is to use the tax elasticities from the NBER's TAXSIM, which measure the percentage change in tax liabilities for a percentage change in income. (See http://users.nber.org/~taxsim/elas/). Using these elasticities, I find that the downside productivity scenario would have a larger effect on revenues. To some degree, this may be because TAXSIM includes the refundable portion of the Earned Income and Child Tax Credits as tax liability, whereas CBO includes them as outlays. But a more important reason is likely that tax elasticities will decline over time as more income is pushed into the highest tax bracket.

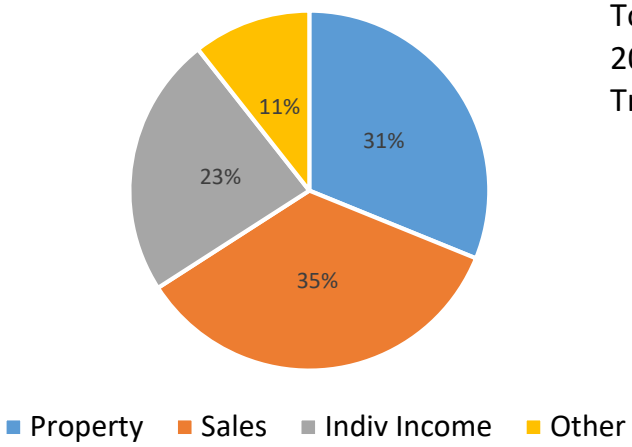
[9] The Earned Income Tax Credit, which can offset payroll taxes paid by lower-income workers, is viewed as part of the income tax scheme, and is discussed below.

Figure 2a
Federal Revenues



Total collected 2016: $3.3 Trillion

Figure 2b
State and Local Tax Revenues



Total collected 2015: $1.6 Trillion

Federal Tax summary Table 1 summarizes the effects of the downside productivity scenario on federal revenues. Only individual income taxes are likely to fall as a share of GDP from a slowdown in productivity growth, and the effect is not large, averaging less than ½ percent of GDP over 25 years.

Table 3
Effect of Slower Productivity Growth on Federal Revenues

	GDP Share 2017	Average Share of GDP 2018-2042	Estimated Change Relative to GDP over 25 years
Individual Income Tax	8.6%	9.8%	-0.2%
Payroll taxes	6.0%	5.9%	0%
Corporate taxes	1.7%	1.6%	0%
Other taxes	1.5%	1.3%	0%
Total Revenues	17.8%	18.6%	-0.2%

Table 2. Federal and State Average Income Tax Rates by Expanded Cash Income Percentile

	Federal	State
Bottom Quintile	-4.8	0
Second Quintile	-1.9	0.7
Middle Quintile	2.9	1.3
Fourth Quintile	6.1	1.8
Top Quintile	13.1	3
All	8.1	2.2
Addendum		
80-90	8	2.2
90-95	10	2.5
95-99	13.9	3
Top 1 Percent	20.2	4.3

Source: Sammartino and Francis, June 2016.

b. State and Local Revenues

State individual income taxes: The degree of progressivity in income taxes varies widely across the states. According to Sammartino and Francis (2016), 41 states have a broad-based income tax, and, out of these, 33 have a graduated rate structure with multiple tax brackets.

However, they find that, in many states, the top tax bracket begins at a very low income level, so that most income is taxed at the highest tax bracket already, meaning there is very little room for real bracket creep. However, in other states, tax rates rise measurably with income. Table 2 reproduces the table from Sammartino and Francis (2016) about the variation in tax rates by income. State tax rates are much lower than federal tax rates and show much less variation. Thus, although state tax collections as a share of GDP might decline with lower productivity growth, the effect is likely to be very small.

State and local property taxes: Property taxes are an important source of state and local tax revenue, and so changes in the property tax base over time will have important implications for the health of state and local finances. A simple model of the value of residential property would suggest that a change in productivity growth could affect the ratio of property values to GDP.

In particular, if we assume that the value of real property is the present discounted value of housing rent, then the value of real property is:

$$V = R \int_0^{\infty} e^{-(r-g)t} \quad \text{(Error! Bookmark not defined.1)}$$

which solves to

$$V = \frac{R}{(r-g)} \quad \text{(Error! Bookmark not defined.2)}$$

where R is housing rent, r is the interest rate, g is GDP growth, and t is time.
If, as appears to be true in the data, rents move with GDP[10], so that R = b*GDP, then

$$V = \frac{b * GDP}{(r-g)} \quad \text{(Error! Bookmark not defined.3)}$$

and

$$\frac{V}{GDP} = \frac{b}{(r-g)} \quad \text{(Error! Bookmark not defined.4)}$$

In steady state, when r and g are fixed, the property tax base is a constant proportion of GDP.

[10] The share of housing and utility services in consumption has been about 18% since 1980. (BEA, NIPA Table 2.3.5)

What happens when productivity growth falls? If interest rates moves one for one with productivity growth, then (r-g) will be unchanged and a slowdown in productivity will not change the share of property taxes in GDP.

However, if interest rates decline more than productivity growth, so that the denominator in (4) declines, then a reduction in productivity growth can raise the share of property taxes in GDP, holding tax rates constant. On the other hand, if interest rates do not fall when productivity growth falls, then a decline in productivity growth will lower the ratio of property taxes to GDP, putting pressure on state and local governments.

Sales taxes: General sales taxes move one-for-one with consumption, which would move with productivity and GDP. Thus, sales tax collections that are administered as a percent of sales are likely to be a constant share of GDP.

State and local tax summary State and local revenues will remain about constant as a share of GDP if interest rates move one-for-one with labor productivity growth, which seems like a reasonable base case. If interest rates don't move with productivity growth, then states may actually see higher tax revenues relative to GDP.

c. Federal Non-Interest Spending

The effect of a productivity slowdown on spending will depend on a number of factors, including program rules and the effects of productivity on relative prices, health care demand, and interest rates. To gauge the effects, it is necessary to examine each major element of government spending, which are detailed in Figure 3a.

Discretionary spending: It is hard to know how to project discretionary spending on a "current law" basis because discretionary spending is subject to annual appropriations by legislators, rather than controlled by program rules like taxes and mandatory spending. CBO makes different assumptions about discretionary spending for the first ten years of its projection than for its last twenty years. Over the next ten years, CBO projects discretionary spending will fall as a share of GDP. Through 2021, spending is controlled by the caps on discretionary budget authority specified in the Budget Control Act of 2011 (and later amendments) and will not change with GDP. For 2012 through 2027, CBO assumes that discretionary budget authority increases with inflation.[11] Under those assumptions, CBO projects that discretionary spending will decline from 6.4 percent of GDP to 5.4 percent by 2027. For its-long range projection (from 2028 to 2047), CBO assumes discretionary spending will remain constant at 5.4 percent of GDP.[12]

Assuming a slowdown in productivity that starts next year, CBO's procedures would mean that discretionary spending would rise a little relative to GDP—because over the next ten years,

[11] Budget authority allows agencies to contract to spend certain amounts of monies; some of that spending may actually be spent in later years.

[12] This is not quite accurate because the latest CBO long-term budget projection predates its latest 10-year budget forecast, and has discretionary spending in year 10 at 5.2 percent of GDP.

projected discretionary spending would be unchanged, while GDP growth slowed. A slowdown in productivity growth of 0.6 percentage point would increase the share of discretionary spending in 2027 to 5.7 percent, 0.3 percentage point higher than in the baseline. Spending would then be assumed to stay at 5.7 percent of GDP throughout the remainder of the long-term forecast.

Figure 3a. Federal Outlays
20% of GDP

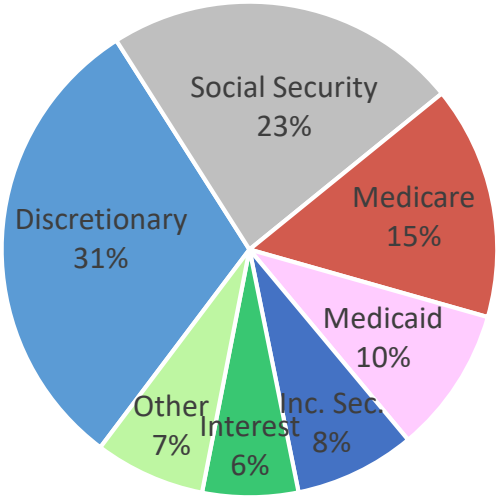
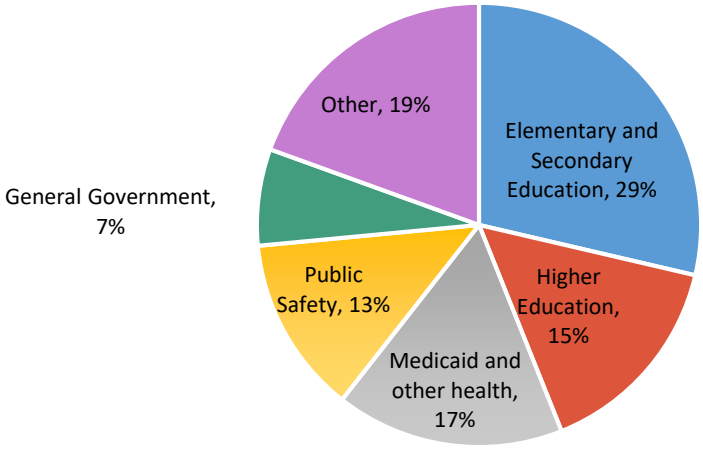


Figure 3b. State and Local Spending (out of own funds)
12% of GDP



Source: 3a. Congressional Budget Office (2017a). 3b. Author's Calculations based on U.S. Census Bureau, "State and Local Government Finances", Table 1. 2015 and Office of Management and Budget, Historical Tables 12.2.

Social Security: Social security benefits are indexed to wages, so when productivity falls, benefits decline as well. However, benefits for existing retirees are indexed to the CPI, not real wages, so are unaffected by a productivity slowdown. (Put another way, retirees don't get the benefits of real wage growth once they have retired, so are also unaffected when wage growth slows.) Thus, when productivity growth falls, government spending on Social Security benefits falls too, but not quite so much as GDP, thereby raising the share of Social Security in GDP.

The 2017 Social Security Trustees report contains information on the effects of productivity growth on benefits. It shows that a decline in real wage growth from 1.2 percent to .6 percent (using the CPI deflator to define real wages) increases the share of Social Security spending in GDP by .3 percentage point on average over the next 25 years.[13]

This calculation ignores a number of potential effects, including the possibility that changes in productivity will affect life expectancy, fertility, labor force participation and hours, immigration, and the share of compensation that is taxable (which affects benefits too, as these are based on taxable wages.) However, these effects are not likely to have large effects on spending, particularly over the next 25 years. More important is the assumption that a slowdown in productivity growth affects wages across the board. If productivity growth mostly affected wages in the top of the wage distribution, then Social Security benefits would not decline with productivity growth, and the increase in Social Security as a share of GDP would be larger than estimated here.

Medicare: Medicare spending has increased over time as a share of the economy, from 1.2 percent in 1980 to 3.8 percent in 2015.[14] The forces driving Medicare spending up are largely the same as those driving up health spending in general. These include the effects of higher income on health care demand, improvements in technology, and relative price pressures. Analysts disagree about the importance of each of these factors (See, Technical Review Panel Report, 2012, page 47, for example) mostly because they disagree about whether the observed increase in measured health prices over time represent real relative price increases or mismeasurements related to the lack of quality adjustments. Furthermore, regardless of why health spending has increased in the past, forecasting health spending into the future is extremely difficult: Over time, it has tended to increase faster than GDP, but it can't continue to do that forever (lest it take up all of GDP) and so is likely to decelerate in the future.

Both CBO and the Medicare Trustees develop detailed year-by-year forecasts for the first ten years of the projection. Because of the way Medicare payments are set, both agencies would lower their projection of Medicare spending over the next ten years if productivity growth were to slow.[15] The reduction would probably be roughly in line with GDP, although it is possible that Medicare spending wouldn't slow quite as much as GDP.

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[13] Table VI.D4 shows the effect on taxable payroll, and Table VI.G5 shows the relationship between taxable payroll and GDP, which I assume is invariant to productivity changes.

[14] Medicare spending net of beneficiary premiums, CBO Historical Budget Data, 2017.

[15] In particular, the payment rates for many parts of Medicare are set as equal to the growth in prices less the ten-year average of economy-wide multifactor productivity growth. The ten-year average would mean that Medicare payments would slow more slowly than GDP. But lower productivity growth would also lower demand for health

After the first ten years, however, the agencies have taken different approaches. CBO, acknowledging the inherent difficulty in making long-range projections of health spending, has taken a basically formulaic approach. They assume that the rate of excess cost growth in Medicare—defined as the difference between per-beneficiary health spending and per-capita GDP, will decline linearly from year 10 to year 30 of their forecast, starting at the 2027 value (year 10 of their detailed forecast) and ending at 1. (That is, in 30 years, per-beneficiary spending is projected to rise 1 percentage point faster than per capita GDP).[16] Because of this one-for-one relationship between Medicare spending and GDP growth, a slowdown in productivity would have little effect on CBO's projection of Medicare spending as a share of GDP.

The Medicare Trustees take a slightly different approach which involves decomposing changes in health spending into its various factors, and requires specifying and projecting the income elasticity of health spending, relative price inflation, and price elasticities. They too need to slow spending over the projection future, and do so by assuming a falling income elasticity of demand and a rising price elasticity. (See Trustees Report, 2017). But, because they start their projection with an income elasticity of demand higher than 1, they likely would project that a fall in productivity would lead to a reduction in Medicare spending as a share of the economy. Over the first 25 years of their projection, however, this effect would likely be quite small. Thus, assuming the Medicare spending grows in line with GDP is reasonable.

One question is whether the reduction in Medicare spending would mean a real reduction in health benefits. For those who believe that medical prices increase over time because the health sector is labor intensive and thus has slower labor productivity growth than the economy in general (that is, is subject to what is known as Baumol's Cost Disease), a reduction in economy-wide productivity will lower the price of medical care, allowing spending to drop without a reduction in real benefits. If that is not an important explanation for the rise in medical spending, then a drop if productivity will lower Medicare spending by reducing real health care benefits.[17]

Other mandatory programs: Table 3 provides a more detailed breakdown of other mandatory spending, and shows the importance of each of the categories of spending. One interesting question about the effects of slower productivity growth on the fiscal outlook is the extent to which spending on means-tested programs will be affected by slower productivity growth. Spending on means-tested programs can be affected by productivity growth in two ways: First, reductions in productivity growth might increase the number of people whose income is

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spending, and this would likely lead to some reduction as well. Furthermore, the Independent Payment Advisory Board (IPAB) has targets for Medicare per capita spending that require the Board to propose cuts to Medicare should per-capita spending be projected to rise faster than per-capita GDP + 1 percentage point (beginning in 2019). Thus, a reduction in per-capita GDP growth would automatically lower the target. However, the IPAB is very controversial and has never been staffed.

[16] Long-term budget outlook, March 2017, supplemental data, Table 8, Projected Excess Cost Growth, found here: https://www.cbo.gov/about/products/budget-economic-data#1)

[17] Furthermore, to the extent certain industries don't contribute to productivity growth, a drop in economy-wide productivity of 0.6 percent would mean a larger drop in the industries that do contribute to productivity growth, and hence a larger drop in other types of consumption.

low enough for them to be eligible for the programs. Second, a change in productivity can affect the value of the program benefits themselves.

Table 3
Federal Mandatory Spending, 2016

	Spending (billions)	Share of Outlays
Social Security	910	24%
Medicare	588	15%
Medicaid, SCHIP, and Exchange Subsidies	425	11%
Refundable Earned income and child tax credits	85	2%
SNAP	73	2%
SSI	59	2%
Federal Employee Retirement	94	2%
Veterans Programs	107	3%
Other	87	2%
Total	2428	63%

Effect of productivity growth on poverty

One interesting question is whether changes in productivity growth would even affect the poverty rate. A striking fact is that the official poverty rate—which is based on pre-tax cash income (so includes Social Security, but excludes the benefits of tax credits like the EITC and in-kind benefits like Medicaid)—has remained quite flat over time, as shown in Figure 4. The threshold that determined whether a family is poor is linked to inflation, not real growth, so, holding all else equal, one might have expected poverty to decline over time.

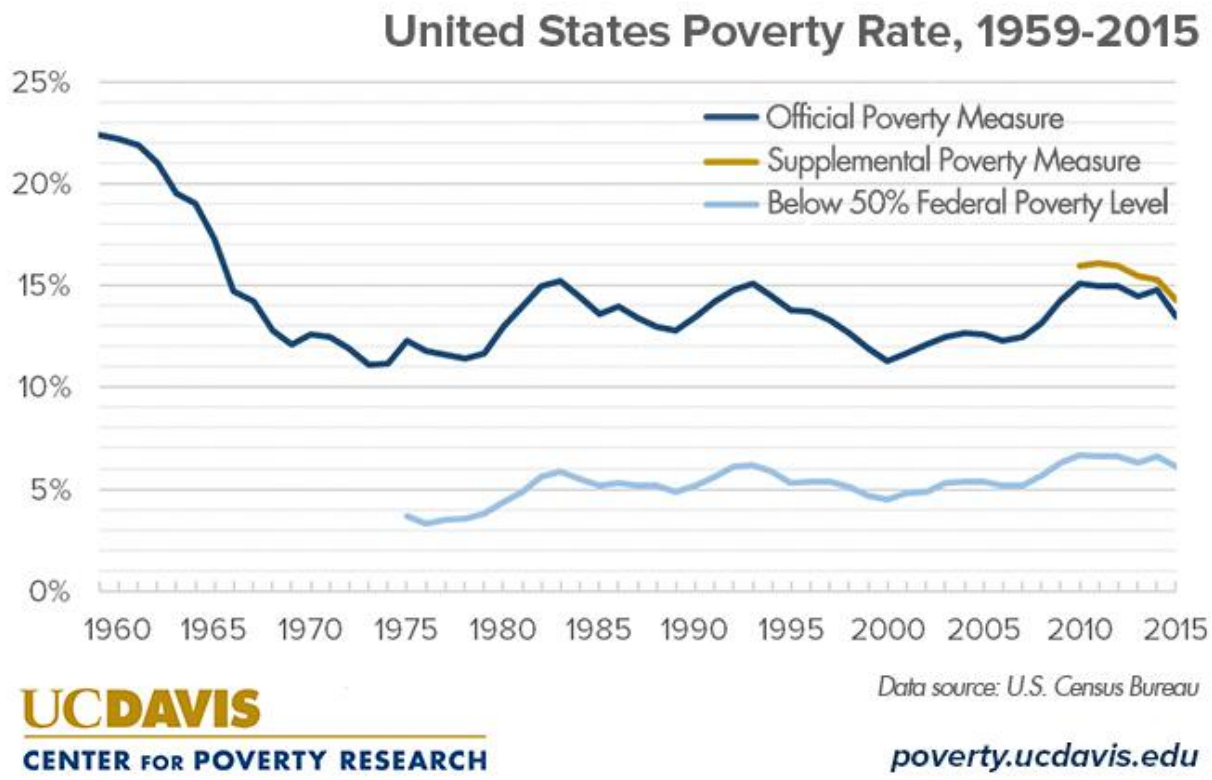
There are several reasons poverty rates might not move with productivity growth. First, many poor people don't work very much. According to Semega et al (2017), only 11% of poor 18 to 64 year olds worked full time in 2016, and only 38% had worked at all during the year. Other sources of income that are counted as money income for the definition of the official poverty measure include Social Security and SSI, both of which are indexed to inflation only, and so won't increase with productivity growth. Furthermore, many poor people have income well below the poverty threshold. In 2016, about 50% of poor households had income less than 50% of the poverty threshold, meaning that even substantial increases in earnings wouldn't have pushed them out of poverty.

It is also clear that, over the few decade, changes in the distribution of wages have hurt people at the bottom of the distribution. According to Bivens et al (2014), from 1979 to 2012, workers in the bottom 90% of the wage distribution saw increases in real annual wages of only 17%, while average wages increased about 35% over that time, with the bulk of the increases going to those

in the top 10%. It is unclear whether the disconnect between productivity growth and earnings reflects declining worker bargaining power, as argued by Bivens et al (2014), or is the result of skill-biased technological change, meaning that productivity growth has been low for people at the bottom of the skills/earnings distribution (Autor and Salomons, 2017).

If changes in productivity growth occur primarily at the top of the wage distribution, then a slowdown in productivity might have little effect on poverty and little effect on eligibility for means-tested programs. But, as discussed above, for the purposes of this exercise, I am assuming that, going forward, the downside productivity scenario is one in which productivity growth across the board declines. To gauge the impact of such a change in wage on poverty rates, I use results from Hoynes et al (2006). They estimate a regression model that examines the impact on nonelderly poverty rates of changes in median wage and wage inequality (using the ratio of

Figure 4



wages at the 50th percentile and the 20th percentile as a measure of wage inequality.) Holding constant wage inequality (and holding constant the fraction of women working, which also has an important effect on poverty), they find that a 10% increase in the real median weekly wage lowered the poverty rate from 1980 to 2003 by 1.1 percentage point.

A decline in the annual growth of real wages from 1.2 percent to 0.6 percent will lower real wages by 14 percent after 25 years. Using the Hoynes et al (2006) results, this would lead to a

1.5 percentage point increase in the nonelderly poverty rate after 25 years, or about 11 percent. I assume that eligibility for programs tied to the federal poverty guidelines (even if tied to 125% of poverty, for example) increases by this amount after 25 years. On average over 25 years, then, I assume that eligibility for poverty-based programs increases about 5 percent.

With this estimate, I can gauge the likely impacts of a productivity slowdown on means-tested government programs.

Medicaid, Children's Health Insurance, Exchange Subsidies: *Benefit eligibility:* All of these programs tie eligibility to the federal poverty guidelines, which are only indexed to inflation. Hence, a slowdown in productivity growth would likely increase spending on these means-tested health programs as a share of GDP because of the increase in poverty.

Benefit amount: A similar reasoning to that used for Medicare suggests that a slowdown in productivity would not affect per-person health spending for Medicaid, CHIP, and the ACA's tax subsidies relative to GDP. However, changes in family income can affect the number of people eligible for these programs and the benefit amount they receive.

Refundable part of Earned Income and Child Tax Credits: Most of the earned income credit that is received is refunded—that is, for most EITC recipients, their EITC benefit makes their income tax liability negative. About ½ of the child tax credit is refundable. In 2017, the refundable parts of these two tax credits amounted to $90 billion, or about 2% of federal outlays.[18] Refundable credits are technically outlays. CBO's estimates of the effects of productivity growth on tax revenues (real bracket creep), discussed above, don't include the effects of real growth on the refundable part of the EITC.

Eligibility: The earned income tax credit is a tax credit for low-income working families, with the credit amount equal to a fixed percentage of earnings (up until the credit reaches its maximum, at which point it begins to phase out.) The credit thresholds are indexed for inflation, not real wage growth, so reductions in productivity will raise the number of people receiving the credit and raise the share of the credit that is refundable.

Benefit amount: In general, the benefit amount is tied to earnings, so a reduction in earnings will reduce benefit amounts about one-for-one with earnings. The maximum credit is indexed to inflation, however, so for those receiving the maximum amount, benefit will increase relative to earnings.

On the whole, EITC outlays would likely increase a very small amount relative to GDP were productivity growth to decline.

Supplemental Nutrition Assistance Program (SNAP): *Eligibility:* To be eligible for SNAP, households generally have to meet income tests that require that gross income be less than 130% of poverty.[19] Because poverty guidelines are indexed by the CPI, increases in

[18] Maag (2017). http://www.taxpolicycenter.org/publications/refundable-credits-earned-income-tax-credit-and-child-tax-credit/full

[19] In addition, there is also a requirement that net monthly income (income less a number of deductions) be less than 100% of poverty, and that families not have assets exceeding certain amounts. Families that are receiving TANF,

productivity growth that raise family income can lower the number of families eligible for the program.

Benefit amount: The benefit amount is calculated as the monthly allotment less 30 percent of household income, because households are expected to spend 30 percent of their income on food. The monthly allotment is tied to the cost of the Department of Agriculture's Thrifty Food plan, and so is effectively indexed by food prices. A reduction in productivity growth will not affect the monthly allotment, but it could lower household income and so raise benefit amounts slightly for families.

Supplemental Security Income (SSI): *Eligibility:* is based on poverty or disability. But few SSI recipients have wage income, so eligibility is unlikely to be affected by changes in productivity growth.

Benefit amount: The benefit amount is indexed to inflation, so that benefits will rise as a share of GDP if productivity growth declines.

Federal non-interest outlays summary Table 4 summarizes the effects of a slowdown in productivity growth on federal government outlays. To calculate the effect on Medicaid, I use the Hoynes et al (2004) estimate on poverty as a measure of the effect on eligibility. Because I don't have detailed breakdowns of CBO's projections of other mandatory spending (mandatory spending excluding social security and major health programs by category), and so don't know what they are assuming in the baseline, it is difficult to do a detailed estimate of the effects of the downside productivity scenario. But, as is shown in Table 4, CBO's projections for other mandatory spending shows that it is declining as a share of GDP, averaging 0.2 percent lower over the next 25 years. Instead of separately estimating benefit and eligibility effects category by category, I assume that the decline in CBO"s projection of other mandatory spending over time is attributable to the effects of real GDP growth, and , because productivity growth in the downside scenario is about ½ that in the baseline, I assume that other mandatory spending declines ½ as much. Adding all the effects together, I find that outlays increase by about 0.8 percent of GDP on average over the next 25 years when productivity slows.

d. State and Local Non-Interest Spending

Table 3b reported the composition of state and local spending out of own funds. This spending is spending net of charges (so higher education net of student-paid tuition, for example) that is not financed by federal grants. (So, only the state share of Medicaid is included, for example, rather than the part paid for by the federal government but that flows through to states as federal grants.

Most state and local spending is discretionary and appropriated annually. In addition, most states have balanced budget requirements so, in some sense, "current law" spending automatically declines when the tax base declines. A key question, though, is how difficult it will be for states and localities to continue to balance their budgets in the face of slower productivity growth.

SSI, or, in some places, general assistance don't have to meet income tests. See the USDA's website at: https://www.fns.usda.gov/snap/eligibility#Income

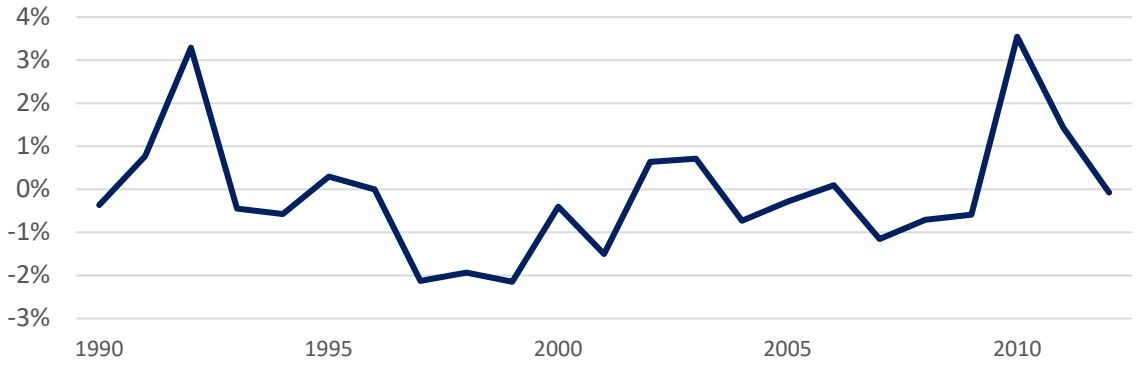
Table 4
Effect of Slower Productivity Growth on Federal Outlays and Primary Deficits

	GDP Share 2017	Average Share of GDP 2018-2042 CBO Baseline	Change in nominal benefit relative to GDP	Change in Eligibility	Average Change as a Share of GDP over 25 years Relative to CBO Baseline
Non-Interest Outlays					
Discretionary	6.3%	5.5%	Higher	N/A	0.24%
Social Security	4.9%	5.9%	Higher	Unchanged	0.3%
Medicare	3.1%	4.4%	Lower/ Unchanged	Unchanged	0.0%
Medicaid, CHIP, Exchange Subsidies	2.4%	2.8%	Lower/Unchanged	Higher	0.14%
Other Mandatory (SNAP, EITC, CTC, other)	2.6%	2.4%	Higher	Higher	0.10%
Total	19.3%	21.0%			0.78%
Revenues (from Table 3)	17.8%	18.6%			-0.22%
Primary Deficit (outlays less revenues)	1.5%	2.4%			1.0%

The big ticket items for state and local governments are education (about 45% of total spending out of own revenues), Medicaid and other health spending (17%) and public safety (12%). Much of this spending represents compensation for state and local workers. This means that state and local government expenditures will likely decline naturally with GDP, as competition between the state and local and private sectors for employees should equilibrate wages. If private sector wage growth declines in response to lower productivity growth, the growth in government compensation should decline as well.

As in the case of health care, an important question is the extent to which this decline in spending will represent a price decrease, because of a less intense Baumol effect, or a decrease in real services. Measured productivity in the K-12 education sector, for example, even with some quality adjustments, has generally been negative. (Figure 5). If these quality adjustments are

Figure 5
Productivity Growth of Public K-12 Educational Services
(BLS, Test Scores used as Quality Measure)



adequate, this suggests that education spending increases over time because of the need to maintain comparability in wages with other more productive sectors. In that case, government spending on education will decline with lower productivity growth without any loss is the real quantity/quality of education. If, on the other hand, this low measured productivity growth is due to mismeasurement, a slowdown in productivity growth might result in slower productivity growth in education as well. In that case, the reduction in would also be accompanied by a cutback in real education services. (Which might be fitting given that lower incomes would reduce demand.)

Medicaid. The largest mandatory state program (in the sense that states can only change spending by changing program rules) is Medicaid, which in 2015 represented less than 15% of state-own spending. (Other health spending includes spending on hospitals and public health, which is discretionary.) The Medicaid program is a joint federal/state program, with the federal government paying a share of at least 50% (more for lower-income states). On average, in 2016, the federal government paid 63% of Medicaid costs, and the states paid 37% (CMS, 2016). As noted above, Medicaid spending is likely to increase a little as a share of GDP if productivity growth declines, because eligibility should increase somewhat faster than in the baseline, meaning that states will have to cut other programs in order to maintain their balanced budget requirements. Using the methodology adopted for determining the change in federal Medicaid spending, I calculate that a slowdown in productivity growth that increases poverty and hence Medicaid eligibility will increase state Medicaid spending by about 2½ percent on average over 25 years, equal to just .4 percent of own-spending. As a share of GDP, it is perhaps just 0.1 percent.

Defined benefit pensions: Most state and local governments offer their employees a defined benefit pension plan. These plans operated much like social security, in the sense that the initial benefit depends on final wages, and thus will move one-for-one with productivity growth. And, as with Social Security, once employees retire, their benefits move with inflation (in general), but almost never with wage growth. Thus, a slowdown in productivity growth will

increase the share of GDP accounted for by state and local expenditures on the pensions of already-retired employees.

Of course, unlike social security, state and local pension plans are largely pre-funded (with the extent of pre-funding depending on the rate used to discount the liabilities—an issue of long-standing debate in the pension community.) The comparison with Social Security may seem inapt, as Social Security is largely unfunded and benefits are mostly paid out of current taxes, not assets. But, when considering the impact of a productivity slowdown on state and local budgets as a whole, and not only on their pension plans, it is equivalent and easier to think of the pension plans as fully unfunded, and then to count the assets in the plan as state and local assets whose returns depend on interest rates.[20] I show the effects of slower productivity growth (and lower interest rates) on federal and state and local debt in the next section.

One caveat to this methodology is that it assumes that the real compensation costs of state and local employees—including the costs of providing their pensions--are determined by competitive forces. A decline in interest rates raises the costs of providing defined benefit pensions; going forward, this analysis (imlicitly) assumes that this increase is offset by reductions in other compensation or by pare backs in pension benefits. If not, then a reduction in the interest rate would raise employee compensation costs going forward, having much larger negative effects on state and local budgets.

I use the Social Security Trustees estimate of the effects of lower productivity to gauge the likely effects of lower productivity on state and local pension obligations. In 2016, state and local pension benefits amounted to $304 billion, or about 1.6% of GDP and 20% of tax revenue. If state and local pension benefits climb with population aging like Social Security, then these benefits will be about 20% higher over the next 25 years then they are today, or about 1.9% of GDP. For Social Security, a .6 percentage point reduction in labor productivity increased the average spending on Social Security benefits by 5%, on average, over 25 years, implying that slower productivity growth will increase state and local pension spending by about .1 percent of GDP. This represents about 1 percent of state and local revenues.

State and Local Non-Interest Outlays Summary State and local non-interest outlays should move almost one-for-one with productivity, so that a slowdown in productivity shouldn't create large fiscal stresses. Some small increases in Medicaid and pension expenditures as a share of GDP will require some offsets, but these appear relatively minor.

e. Federal Interest Spending and Debt

As noted above, federal debt has increased sharply in recent years. It now stands at about 77 percent of GDP, and is projected to increase sharply over time, reaching 130 percent of GDP by 2042. Increases in primary deficits arising from slower productivity would lead to further

[20] Note that Social Security also has a trust fund, but budget analysts, including CBO, prefer to analyze the unified budget, rather than distinguishing between on-budget (excluding Social Security) and off-budget (Social Security) surpluses and deficits.

acceleration in the ratio of debt to GDP. But if interest rates fall along with productivity, these effects will be muted, and possibly even reversed.

To gauge these various effects, I calculate the deficit and debt to GDP ratios under a number of scenarios. In all, I assume that productivity growth decline by 0.6 percent per year. As shown in Tables 3 and 4, I estimate that this slowdown in productivity growth will lower federal revenue by about 0.2 percent of GDP, and increase spending by about 0.8 percent of GDP, increasing the primary deficit by 1 percent of GDP, on average, over the next 25 years. The implications of these assumptions are shown in Figure 6, which compares the primary deficits in CBO's baseline to those in the low-productivity simulation.

To see the effects of lower interest rates, I run these simulations under the three interest rate assumptions described above: no effect, a 1-for-1 reduction in interest rates, and a 2-for-1 reduction in interest rates. Of course, not all the US debt is rolled over each year, so some of the interest rate effects will take time to materialize. The average maturity of marketable US debt is 5 years.[21] As a rough adjustment for the interest rate delays, I only start lowering interest rates in my simulation in 2023.

The results are shown in Figure 7 and summarized in Table 5. Without an interest rate adjustment, the slowdown in productivity growth increases the debt to GDP ratio at the end of 25 years from 130 percent in the baseline, to 170 percent. But, if interest rates fall 1 for 1 with GDP, the debt to GDP ratio still climbs, but not quite so dramatically, reaching 157 percent by 2042.[22] Even if interest rates fall 2-for-1, the slowdown in productivity still worsens the fiscal outlook. However, in this case, the effect is not large. Instead of reaching 130 percent of GDP as in the baseline, debt reaches 143 percent of GDP.

F. State and Local Interest Spending and Debt

In contrast to the federal government, the state and local sector is a net lender once pension assets are included and unfunded pension liabilities are omitted. According to the most recent Financial Accounts of the United States, the net assets of the state and local sector, ignoring the unfunded liabilities of state and local pension plan, totaled $2.9 trillion in 2016, or about 15 percent of GDP.[23]

[21] https://www.treasury.gov/resource-center/data-chart-center/quarterly-refunding/Documents/August2015TreasuryPresentationToTBAC.pdf

[22] This is a bit higher than the effects of lower productivity growth that CBO reports, which shows a decline in productivity growth about the same magnitude as the one studied here increasing the debt to GDP ratio in 2042 to 149 percent of GDP. Because CBO gives few details about its methodology, it's hard to know the sources of the difference.

[23] https://www.federalreserve.gov/releases/z1/current/z1.pdf

Figure 6
Primary Deficits under Baseline and Downside Productivity Scenario

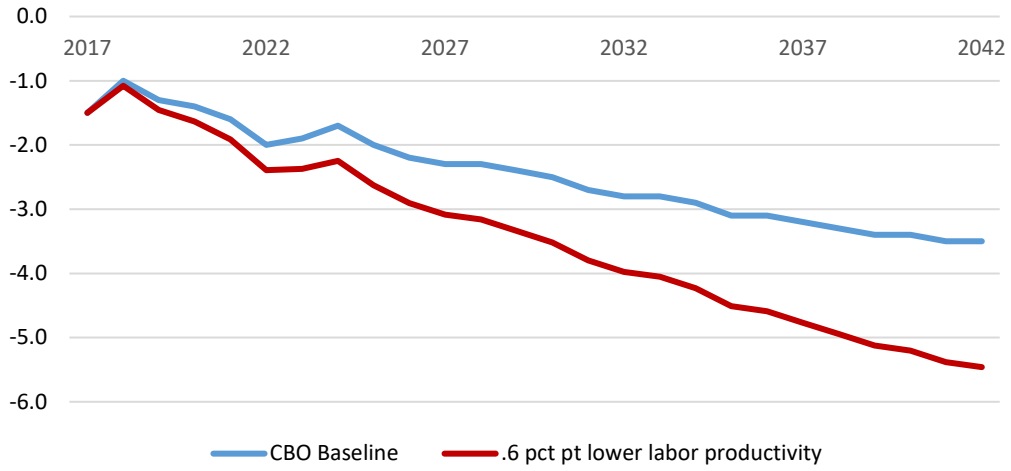


Figure 7
Debt to GDP Ratios under Baseline and Downside Productivity Scenario

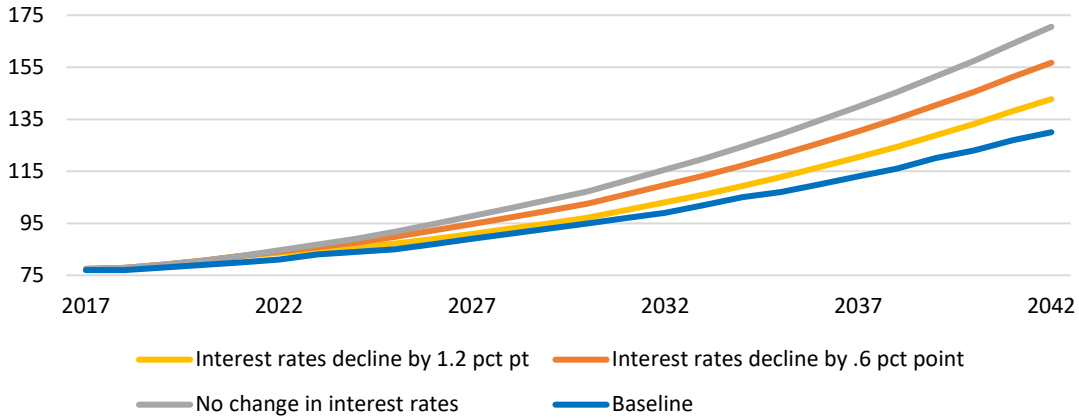


Table 5
Debt to GDP Summary

	Baseline	Low Productivity		
		No interest rate adjustment	Interest rates adjustment is 1-1	Interest rates adjustment is 2-1
Productivity Growth	1.2%	0.6%	0.6%	0.6%
2042 Primary Deficit Share of GDP	3.5%	5.5%	5.5%	5.5%
Interest Rates	Baseline	Baseline	Baseline-.6	Baseline-1.2
2042 Debt to GDP	**130**	**170**	**157**	**143**

A decline in productivity growth that doesn't lower the return to capital will increase the asset to GDP ratio, because the value of assets will be unaffected but GDP growth will be slower.[24] So a decline in productivity growth holding interest rates constant will improve the financial position of state and local governments, partially offsetting the effects identified above. In particular, holding interest rates constant, at .6 percentage point decline in productivity would allow the sector to increase its spending by .006*15% of GDP, about 0.1 percent of GDP each year.[25]

On the other hand, if interest rates decline along with productivity, then, as net lenders, this hurts the state and local sector. Of course, the effect depends on the types of assets the sector hold. If pension plans held long-term fixed rate securities, then they wouldn't be much affected by changes in interest rates---they would be hedged. In fact, however, most of the holding of state and local pension plans are not in fixed income securities. Instead, about 75% of the funds are held in assets that are vulnerable to interest rate declines.[26]

[24] How can this be? If capital intensity falls in response to the decline in interest rates, then even though the physical product of existing capital falls, so too will wages, and this may be enough to fully offset the decline in the physical product of capital.

[25] To maintain a stock of assets relative to GDP, the sector can consume (i-g) A, where A is the asset to GDP ratio, i is the interest rate, and g is the rate of growth. When g declines, consumption can decrease. To see this another way, think about how much one would have to for retirement if the amount of income one wanted in retirement was dependent on final wages. With slower productivity growth, the amount of saving relative to current wages would decline, because retirement needs would decline much more than current income (because the decline in productivity growth compounds over time.)

[26] According to the financial accounts, 65% of the assets of state and local pension plans in 2016 were in corporate equities, and an additional 6% was held in mutual funds. Plans held about 25% of assets in Treasuries, GSEs, and corporate and foreign bonds, but the accounts don't report on the average maturity of those holdings.

Assuming that the state and local sector has 75% of its assets in assets that would experience lower rates of return should interest rates decline, I estimate that a .6 percentage point reduction in interest rates would lower state and local revenues by about .07 percent of GDP, almost fully offsetting the benefits received from the slower productivity growth. If, on the other hand, interest rates fell by twice as much as productivity growth, the net effect would be to increase the stress on state and local governments, as the interest rate effects would (.14 percent of GDP) would be larger than the benefits of slower productivity growth. On the other hand, in that case, property values would likely increase (see discussion above), leaving the sector relatively immune to productivity changes.

IV. **Summary**

A slowdown in productivity growth will lower living standards, increase poverty, and worsen the fiscal outlook for federal, state and local governments. Although the estimates in this paper are rough, I calculate that a slowdown in labor productivity growth of 0.6 percentage point per year, from 1.6 percent to 1 percent, will increase primary deficits relative to GDP. This occurs because some outlays are invariant to changes in productivity growth and because revenues are tied more than 1-for-1 with productivity growth, so that a productivity slowdown lowers revenues more than it lowers GDP. These increased deficits imply that the federal debt will reach between 140 percent and 170 percent of GDP by 2042, compared to the baseline CBO estimate of 130 percent of GDP. The 140-170 range is attributable to differences in assumptions about the relationship between productivity growth and interest rates, which is subject to a great deal of uncertainty and is a key assumption underlying the simulations.

It is much harder to discuss the long-term fiscal outlook of the state and local sector, as it is many times more complicated and studied far less. Still, it is possible to get some idea of the effects slower productivity might have on that sector. In general, state and local tax revenues are less tied to productivity growth than are federal revenues, because the state and local income tax system is less progressive than the federal system, and because sales taxes and property taxes make up a much larger fraction of tax collections. Interestingly, the relationship between interest rates and productivity is important here as well, because the value of the property tax base should depend on be how much interest rates change in response to a productivity slowdown. Assuming a one-for-one relationship, state and local revenues should be little affected by productivity. Similarly, there likely will be some upward pressure on state and local spending relative to GDP stemming from somewhat higher burden of pension spending and increased eligibility for Medicaid and other poverty related programs, but these increases are likely to be small.

The interest and debt dynamics for the state and local sector go in opposite directions from those for the federal sector. Because the state and local sector is a net lender, not a net borrower, reductions in productivity increase the stock of assets relative to GDP and reductions in interest rates lower asset returns relative to GDP. But, if interest rates moves one-for-one with productivity growth, there is little effect on the fiscal outlook for the state and local sector.

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