Hutchins Center Working Paper #101

February 2025

Comparing the Macroeconomic and Budgetary Costs of Debt

Louise Sheiner

Hutchins Center on Fiscal & Monetary Policy

The Brookings Institution

The author thanks Alex Conner for excellent research assistance and Greg Duffee, Doug Elmendorf, Bill Gale, and Byron Lutz for helpful comments and discussion. All errors are author's own.

Hutchins Center
on Fiscal & Monetary Policy
at BROOKINGS

THIS PAPER IS ONLINE AT

https://www.brookings.edu/articles/comparing-the-macroeconomic-and-budgetary-costs-of-debt

Over the past several decades, concerns about the sustainability of U.S. federal debt have been central to economic policy discussions. Federal debt as a share of GDP has grown significantly, reaching levels unseen since World War II, and the debt to GDP ratio is projected to continue rising in the absence of policy changes.

While the implications of this rising debt are often debated in budgetary terms—focusing on the tax increases or spending cuts necessary to stabilize debt—the real burden of debt on future generations stems from its macroeconomic consequences. High government debt can reduce capital accumulation by crowding out investment, leading to slower long-term economic growth and lower future consumption. It can also increase the foreign ownership of U.S. assets, which also reduces future consumption.

This paper uses a simple analytical framework to compare and link the two perspectives—budgetary and macroeconomic. It examines how persistent budget deficits affect the economy by reducing national saving and capital accumulation, thereby lowering future output and consumption. It also explores the fiscal consequences of debt accumulation, showing how rising debt levels necessitate future fiscal adjustments—whether through higher taxes, lower spending, or both. By linking these two approaches, the analysis provides insights into how the economic burden of debt compares to the direct fiscal costs of debt stabilization.

The model highlights key parameters that affect the comparison, including the marginal product of capital, the government's borrowing rate, the responsiveness of consumption and saving behavior to fiscal policy, and the treatment of risk.

In particular, the paper conducts the following thought experiment: What if the government allows debt to continue rising for some time, and then decides to take steps to stabilize the debt to GDP ratio. The paper compares the increase in the debt to the change in the capital stock and examines how the tax and spending adjustments needed to stabilize debt compare to the reduction in consumption required to stabilize the capital-output ratio.

My conclusions are as follows:

- In a world without risk—where the government's borrowing costs are equal to the marginal product of capital—the reduction in the capital stock from crowding out will likely be smaller than the rise in debt. Similarly, the reduction in consumption needed to stabilize the capital stock will likely be smaller than the increase in taxes/reductions in government spending necessary to stabilize the debt.
- In a world with risk, the expected decline in the capital stock from the experiment described above could be greater or smaller than the expected increase in debt. However, if the riskless return to debt is a reasonable measure of the certainty-equivalent expected return to capital, then the certainty-equivalent expected reduction in the capital stock will be smaller than the expected debt accumulation.
- In a small open economy, the certainty-equivalent reduction in U.S. asset ownership resulting from an increase in debt is equal to the marginal propensity to consume (MPC) out of the debt-increasing policies multiplied by the debt. If the MPC is 1, then the increase in debt is equal to the certainty-equivalent reduction in assets.
- If the types of policies that lead to higher debt are the same as those that are used to address the debt, then in a riskless open economy, stabilizing the debt will stabilize U.S. asset ownership. However, if the types of policies that are used to stabilize the debt lower private consumption by less than the types of policies that led to the debt (for example, if

the debt increases because of high MPC policies like increases in Social Security and Medicare spending, but the debt is then stabilized with tax increases on high-income taxpayers), then stabilizing the debt may not be sufficient to stabilize asset ownership. More broadly, the macroeconomic effects of fiscal policy depend not just on changes in the deficit and debt, but also on the incentive effects, distributional consequences, and growth implications of the policies that drive them.

- In a closed economy, the relationship between debt and capital is slightly more complicated, because an increase in debt raises private income even if the MPC from the debt-reducing policies is 1. In a closed economy without risk (or in a certainty-equivalent world), the amount of crowding out will be equal to the accumulation of debt only if the MPC out of the debt-increasing policies is 1 and there is no increase in savings as a result of the higher private capital income. In other words, private consumption has to increase more than the primary deficit in order for the amount of crowding out to be as large as the debt.
- As in the small open economy, stabilizing the debt will be sufficient to stabilize the capital stock if the policies that stabilize the debt have the same effect on consumption as those that gave rise to it.
- The costs of debt are lower in a small open economy than in a closed economy because government borrowing does not raise interest rates or crowd out private investment.

In the remainder of this piece, I walk through the logic that leads me to these conclusions. Where possible, I have put the detailed derivations in boxes and focused on the intuition in the main text.

1. **The Budget Perspective**

I follow the standard growth accounting exposition in which economic variables are expressed per unit of effective labor. Effective labor grows at rate g, which reflects both population growth and labor-augmenting technological change. In other words, the effective labor force grows either because there are more people or because each person is more productive.[1] Call debt per effective worker in time t, d_t, and call the real (inflation-adjusted) primary deficit per effective worker incurred in a year, pd_t Assume for simplicity of exposition that primary deficits were zero and now we increase them. Let r_t be the government's real borrowing cost in year t. To compare to the macro framework, I measure debt in year t as the debt at the beginning of the year.

As derived in Box 1, debt at time T (for T>1) is:

$$d_T = \sum_{i=1}^{T-1} \frac{pd_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1+r_j) \tag{1}$$

[1] The growth rate of the effective labor force will also be equal to the growth rate of potential GDP when the capital labor ratio is constant, which it is in steady state.

Debt per worker increases over time with primary deficits and interest rates but declines as the number of effective workers rise.

New steady state primary deficit

Let's say after years of deficits and rising debt, the government wants to take policy action to stabilize the debt. How much would it have to cut spending and/or raise taxes? As shown in Box 1, the primary deficit necessary to stabilize debt, $pd_{SteadyState}$, is:

$$pd_{SteadyState} = d_T(1+g) - d_T(1+r_T) = -d_T(r_T - g_T) \tag{2}$$

Assuming $r_T > g$, the government has to run surpluses (negative deficits) equal to the accumulated debt multiplied by the difference between r and g. When $r_T < g$, the government can run primary deficits while still stabilizing the debt.

2. Macroeconomic perspective: Modeling the U.S. as a small open economy

Because the intuition is simpler, I start by modeling the U.S. as a small open economy. I then show the additional considerations in a closed economy model.

In a small open economy, the wage, w_t, and the net return to capital, s_t, are independent of the debt. This rate of return, s_t, is equal to $f'(k_t) - \delta$, where k is the world's capital labor ratio and δ is the depreciation rate of capital and $f'(k_t)$ is the marginal product of capital.

U.S. residents own assets, A, which may differ from the capital stock in the U.S., K. Assets are measured at the beginning of a period. Let a denote assets per effective person. As shown in Box 2, in steady state, consumption per effective person, c, is just enough to keep the assets per effective worker constant:[2]

$$c_t = a(s_t - g) + w_t \tag{3}$$

Introducing budget deficits:

We begin in a steady state without budget deficits. Let c_b represent the baseline steady-state per worker consumption (that is, the consumption that would occur without budget deficits) and a_b the baseline asset to labor ratio. Assets earn a global rate of return s_t that is unaffected by U.S. saving rates.

Now introduce budget deficits that increase consumption by θ_t in each year.

Box 2 shows that assets at time T are:

$$a_T = a_b - \sum_{i=1}^{T-1} \frac{\theta_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1+s_j) \tag{4}$$

[2] I am ignoring the question of how to define a steady state when variables like s and g are subject to shocks.

In year T, the government takes action to stabilize assets per worker. How much does consumption have to change relative to baseline? As shown in Box 2,

$$c_{newsteadystate} = a_T(s_T - g_T) + w_T \tag{5}$$

The difference in consumption relative to the baseline is:

$$c_{NewSteadyState} - c_b = -(a_b - a_T)(s_T - g) \tag{6}$$

Consumption has to fall by $(s_T - g)$ times the change in assets.

Comparing the macro and budget perspectives when the U.S. is a small open economy

How does the level of debt (equation 1) compare to the reduction in U.S. assets holdings (equation 4)? The equations look similar but there are a few differences.

First, the accrual factor arising in the macro perspective, s, is the net marginal product of capital (NMP) $f'(k) - \delta$, whereas in the budget perspective it is the government's borrowing rate, r. In a world without risk, the NMP would equal r. However, in a world with risk, the expected NMP will exceed r because investing in physical capital is riskier than investing in U.S. Treasuries. But it is reasonable as a first approximation to think about r as the risk-adjusted or the "certainty-equivalent" expected net return to capital. Why? Because investors choosing to buy Treasuries instead of investing in physical assets must be indifferent between the two, suggesting that the difference between the net return to capital and the return on Treasuries reflects the lower risk.[3] In other words, investors may be indifferent between a bigger expected reduction in risky assets and a smaller reduction in riskless assets.[4]

Second, deficits only affect asset accumulation to the extent they affect consumption, as measured by θ. If deficits don't affect consumption, then people receiving transfers or taxes save them (or people offset any increase in government consumption by lowering their own consumption and increasing saving). The extra saving is used to purchase the Treasuries issued to finance the deficits. However, if people don't increase their saving, then in order to purchase Treasuries, they stop buying physical assets, leading to crowd out.

In a small open economy, θ is the marginal propensity to consume (MPC) out of government spending and tax cuts. (I show below that θ is not identical to the MPC out of those policies in a closed economy.) The MPC is almost surely less than 1, because some people are Ricardian and increase their saving in expectation of future tax increases, because some people view

---

[3] As the stock of debt increases, investors' portfolios might become less risky, reducing the premium they are willing to pay for the risk protection of Treasuries and pushing up Treasury yields relative to the NMP. Other factor—such as market segmentation, liquidity differences, or borrowing constraints—may also drive wedges between the NMP and Treasury returns.

[4] If the marginal product of capital turns out to be higher than expected, then the costs of crowd out in dollar terms will be higher—but future generations will also be richer, and so the percentage reduction in consumption might be smaller. Future work will examine the relationship between debt and consumption using stochastic simulations. See "The Deficit Gamble" by Elmendorf, Ball, and Mankiw (1988) for stochastic simulations of the effect of debt on future generations.

government taxes and transfers as transitory, and because some people use rules of thumb about how much to save. In addition, if the government deficit is financing public investment, there is no increase in consumption (MPC=0) and no reduction in assets.[5,6]

Thus, in a world without risk, the reduction in assets from deficits is surely smaller than the debt. In a world with risk, the expected reduction in assets may be lower or higher than the expected debt because the expected rate of return on assets is higher than the government's borrowing cost, but households offset some of the effect of debt on asset ownership by increasing saving.

Comparing the costs of debt from the budget and macro perspectives when the U.S. is a small open economy

How do the spending cuts and/or tax increases necessary to stabilize the debt compared to the costs of debt in terms of lower consumption? Comparing the two equations, we see that—in a world without risk (where $s = r$) or in a certainty-equivalent world—the only difference stems from the fact that the required primary surplus depends on the stock of debt whereas the change in consumption depends on the decline in assets.

As shown in equation 2 above,

$$pd_{SteadyState} = -d_T(r-g)$$

As shown in equation 6 above,

$$c_{NewSteadyState} - c_b = -(a_b - a_T)(r-g)$$

Because the reduction in assets is smaller than the debt, the required changes in taxes and spending to stabilize the debt overstate the costs of debt in terms of the reduction in consumption. This is because households offset some of the effects of debt by increasing private savings, and those private savings can be used to pay for some of the future tax increases/offset some of the spending cuts required to finance the debt in the future.

Does stabilizing the debt stabilize assets?

If the MPC out of government actions is constant over time, then, in a world without risk where s = r, stabilizing the debt will stabilize assets, regardless of the MPC.

If θ_i = MPC pd_i,

$$a_b - a_T = \sum_{i=1}^{T-1} \frac{\theta_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1+s_j) = \sum_{i=1}^{T-1} \frac{MPCpd_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1+r) = MPCd_T \quad (7)$$

5 Public investment includes equipment and structures, but also education, health care, nutritional assistance for children and other spending that yields long-term returns. With these types of investment, the crowd out of tangible capital would be offset by the crowd in of human capital.
6 One can define the amount of investment as the amount of spending that would yield the private return on capital. If the government spends a $1 and gets a 20% return while the private return is 10%, one can say the investment was $2. Similarly, if the government spends a $1 and gets a 5% return while the private return is 10%, one can say that the investment $0.50.

The change in assets is equal to the debt multiplied by the MPC.

To stabilize the debt, the government increases taxes or reduces spending to run a primary surplus of $-d_T(r-g)$. With $\theta_i = MPCpd_i$, consumption falls by $MPCd_T(r-g) = (a_b - a_T)(r-g)$, which from equation 6 above is exactly what is needed to stabilize assets.

Even though the decline in assets is smaller than the buildup of debt, and even though the costs of debt in terms of lower consumption are less than the increases in taxes/reduction in spending necessary to stabilize the debt, the actions taken to stabilize the debt are exactly what are needed to stabilize assets. Just as some of the tax cuts/benefit increases led to higher saving, some of the tax increases/benefit cuts will lead to lower saving, such that the change in consumption will match what is necessary to stabilize assets.

However, if the policies that lead to debt accumulation—e.g. spending on Social Security and Medicare—have higher MPCs than the policies enacted to stabilize the debt—e.g., tax increases on high-income individuals, then stabilizing the debt won't stabilize assets. Imagine that government stabilizes the debt by enacting policies with an MPC of 0. Then, while money will flow into government coffers, it will all be coming out of private saving.

In a small open economy, that may not be a concern, because there are no spillover effects on wages or interest rates. However, declining assets of U.S. residents means an increasing share of U.S. capital will be owned by foreigners, which likely raises its own concerns. What the equations above tell us is that, if the policies to address the budget problems don't reduce consumption, assets will increasingly be owned by foreigners even though the government's debt will appear stable as a share of GDP.

In any case, the U.S. is not a small open economy, and changes in national saving will affect interest rates and wages. We turn to this case next.

3. **Macroeconomic perspective: Modeling the U.S. as a closed economy**

In a closed economy, changes in consumption affect the capital stock, and changes in the capital stock affect interest rates and wages. For simplicity of exposition, I begin in a steady state baseline where the capital to effective labor ratio, k_b is constant. Output per effective person is $f(k_b)$ and capital depreciates at rate δ. As shown in Box 3, steady-state consumption per effective person, c_b, is just enough to keep the capital per effective worker constant:[7]

$$c_b = f(k_b) - k_b(g+\delta) \tag{8}$$

[7] The capital stock is measured at the beginning of a period.

Introducing budget deficits: Now introduce budget deficits that increase consumption in each period relative to baseline by θ_t. For ease of exposition, I assume that budget deficits don't affect output in the near term—only its composition.[8]

Let $ANMP_t$ be the average of the net of depreciation marginal product of capital in the baseline and at time t: $f'(k, k_t) - \delta$. As shown in Box 3, we can approximate the reduction in the capital-labor ratio in any year T as a result of the accumulation of deficits by:

$$k_T - k_b = -\sum_{i=1}^{T-1} \frac{\theta_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} \left(1 + ANMP_j\right) \quad (9)$$

New steady state consumption

Imagine that after years of a declining capital-labor ratio, action is taken in year T that lowers consumption in order to stabilize the capital-labor ratio.[9] How much lower is the new steady-state consumption than the baseline consumption with the baseline capital-labor ratio? That is—how much did the years of deficits lower sustainable consumption?

As shown in Box 3, the reduction in steady-state consumption as a result of the crowding out is approximately:

$$c_{NewSteadyState} - c_b \cong (k_T - k_b)(ANMP_T - g) \quad (10)$$

The drop in consumption is equal to the fall in the capital stock multiplied by the difference between the average marginal product of the capital that was crowded out and g.

Comparing the macroeconomic and the budget perspectives when the U.S. is a closed economy

How does the amount of crowding out in a closed economy relate to the accumulation of debt, and how does the loss in steady-state consumption relate to the rise in taxes/cut in spending necessary to stabilize the debt?

To compare the two perspectives, we need to determine (a) how the reduction in the capital stock compares to the level of debt, and (b) how any given changes in the capital stock and debt affect consumption.

---

[8] But, in the case of a budget deficit that raises output—perhaps because the economy is not at full employment—θ_t is the increase in consumption that is not offset by increased output, rather than the full increase in consumption. In particular, assume that budget deficits increase output to g(k) and raise consumption by μ_t.
Then $k_{t+1} = \frac{k(1-\delta)+g(k)}{1+g} - c - u_t = \ k_{t+1} = k - \ u_t + \frac{g(k)-f(k)}{1+g} = k - \ \theta_t$, where $\theta_t = u_t - \frac{g(k)-f(k)}{1+g}$.

[9] Stabilizing consumption imposes the same costs across all generations. A Ramsey planner would want capital to return to its optimal level and would therefore require larger consumption reductions for earlier generations if the capital stock had fallen below its optimal level. See Cutler et al (1990).

How does the stock of real debt per worker compare with the reduction in capital per worker?

From equation 9 above, the reduction in the capital stock relative to baseline as a result of annual deficits is approximately:

$$k_T - k_b = -\sum_{i=1}^{T-1} \frac{\theta_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} \left(1 + ANMP_j\right)$$

The accumulated debt from equation 1 is:

$$d_T = \sum_{i=1}^{T-1} \frac{pd_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1 + r_j).$$

There are several differences between these two equations.

First, as in the small open economy case, deficits affect the macroeconomy to the extent they affect consumption, as measured by θ_i. If consumers save part of their tax cuts/transfer increases, then $\theta_i < pd_i$ so the capital stock decreases by less than the debt. As I discuss below, θ_i is likely to be smaller in a closed economy than an open economy.

Second, also as in the small open economy case, the government pays a riskless rate r on its debt while capital owners receive a risky return on their asset holdings. But, as argued above, one can interpret the risk-free rate as the risk-adjusted or certainty-equivalent expected net return on capital.

Finally, there is a 3rd difference that is not present in the small open economy example. The accrual factor in the macro perspective is the average of the net marginal product of baseline capital and capital in each year t; on a risk-adjusted basis, this is equivalent to the average of the baseline interest rate and the interest rate in year t. But the accumulation factor used to calculate the accumulation of debt is the interest rate in year t.

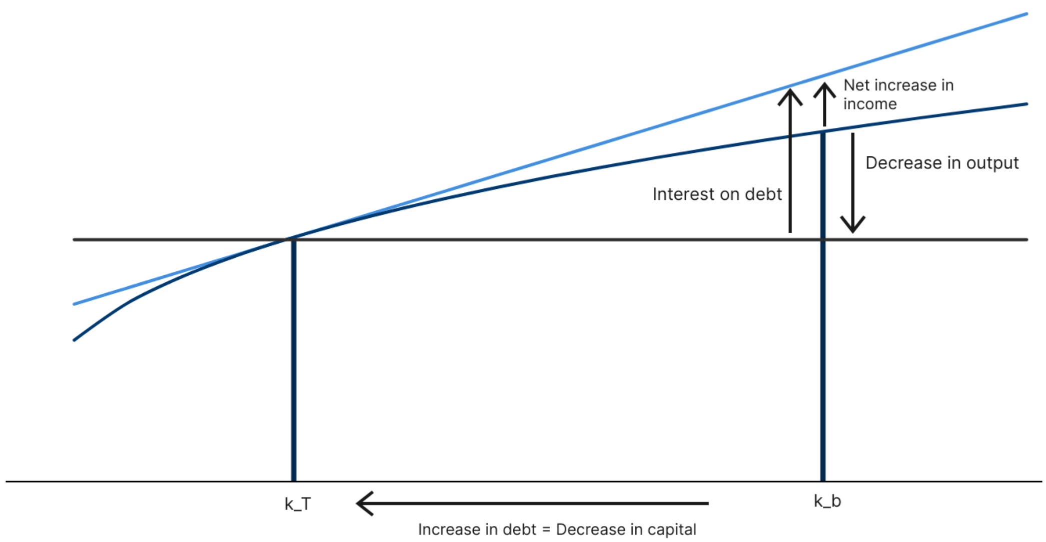
The difference arises because the effect of the reduction in capital on aggregate output is less than the change in the capital stock times the resulting marginal product of capital—because not all displaced capital would have earned that return. But the government must pay the prevailing interest rate on all its debt.[10]

[10] My exposition assumes that the government rolls over its debt each year. If the government instead issued perpetuities, there would be less (or no) additional income to the private sector—depending on whether investors in perpetuities anticipated the increase in debt and demanded higher rates upfront. In reality, the government does not issue perpetuities. The average maturity of the debt is about 6 years, and so the wedge may be smaller for a time than what is shown here. Eventually, however, all the debt will be issued at the prevailing interest rate, and so the wedge will be equal to what is shown in the analysis.

Figure 1 provides an illustration of this point when the change in the capital stock equals the change in debt, while Box 4 examines the effect of debt on private income more generally. If, as in the figure, the change in the capital stock equals the change in debt, a household's initial balance sheet would not change—they would hold less in physical capital, but more in Treasuries. However, the net-of-depreciation income earned on their portfolio would be higher, as shown by the difference between the black line (which is output less depreciation at the original capital stock) and the black line at point k, which is income net of depreciation when the capital stock has fallen to k_T and debt is equal to $k - k_T$. In order for that higher income not to lead to increasingly higher private saving, consumption would have to increase by both the primary deficit and the resulting higher income.

In other words, in order for the increase in the debt to be equal to the change in the capital stock, private saving must be unchanged, so that the change in public saving is equal to the change in national saving. So, in a closed economy, the change in the capital stock will equal the debt only if the MPC out of tax cuts/transfers/government spending is 1 **and** households increase their consumption one-for-one with any increases in income. Higher private income (which does not occur in a small open economy where the interest rate is fixed) is one reason private saving is more likely to increase in a closed economy. Higher interest rates are also likely to lead to higher saving.

Figure 1: Change in Household Income from Higher Debt when the Change in Capital Equals the Change in Debt



Hutchins Center
on Fiscal & Monetary Policy
at BROOKINGS

Finally, unlike in a small open economy, wages are affected by changes in national saving in a closed economy. An increase in deficits increases private income, for the reasons just stated, but it also changes the distribution of income: Wages decrease as the capital stock declines, and capital income increases as capital owners earn a greater return on the combination of their physical capital and their Treasury securities. Workers likely have lower saving rates than capitalists, and so this redistribution of income is likely to boost the saving rate, further reducing the effect of deficits on the capital stock.

How do the costs of debt compare between the budget and macro perspectives in a closed economy?

As shown in equation (10), the reduction in steady-state consumption required to stabilize the capital stock in year T at k_T is approximately:

$$c_{NewSteadyState} - c_b \cong (k_T - k_b)(ANMP_T - g)$$

while the primary surpluses the government has to run to stabilize the debt from equation 2 are equal to:

$$pd_{SteadyState} = -d_T(r_T - g)$$

From a certainty-equivalent perspective, the required reduction in consumption will be less than the primary surpluses required to stabilize the debt for two reasons. First, the MPC out of the tax cuts/spending increases that created the debt is almost surely less than 1, so the change in the capital stock, $(k_T - \mathrm{k})$, will be less than the debt, d_T.

Second, the loss of output is less than the marginal product of capital times the change in the capital stock, and so the reduction in consumption—even if the MPC is equal to 1—will be smaller than the required primary surpluses.

The distinction between the budgetary costs of debt and the macroeconomic consequences of debt is important to take into account when thinking about the how government could maximize consumption when r<g. Looking only at the budget perspective, one might think that the consumption-maximizing policy would be to maximize $\mathrm{d}(\mathrm{r} - \mathrm{g})$—because that would maximize the primary deficits the government could run without ever paying for them. However, we know from basic growth economics that the maximizing consumption occurs when capital is at the golden rule where $r = g$. At $r = g$, the government couldn't run free primary surpluses. As shown in Box 5, once the private benefits of debt are accounted for, the consumption-maximizing policy when $r < g$ is for debt to increase until $r = g$.

Does stabilizing the debt stabilize the capital-labor ratio in a closed economy?

In the small open economy, we showed that with a constant MPC out of primary deficits, stabilizing the debt would also stabilize assets. The same is true in the closed economy case, although now it is important that the MPC out of both the primary deficits and the higher private capital income be constant.

it was simple to show that if the policies that led to the buildup of debt had the same MPC as the policies used to stabilize the debt, stabilizing debt would stabilize assets. To show this in the closed economy, we also need to assert that the MPC out of additional capital income is 1, and then the same logic follows. Box 6 provides the details.

And, as in the small open economy case, if the MPC out of the policies used to stabilize the debt is smaller than the MPC out of the policies that accumulated the debt, the debt may be stabilized while the capital labor ratio continues to decline.

How do the costs of debt differ between a small open economy and a closed economy?

Debt is less costly when the economy is open than when it is closed.

First, let's compare the change in assets in a small open economy (equation 4) and the changes in capital in a closed economy (equation 9).

$$a_b - a_T = \sum_{i=1}^{T-1} \frac{\theta_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1+s_j)$$

$$k_T - k_b = -\sum_{i=1}^{T-1} \frac{\theta_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1+ANMP_j)$$

For a given set of consumption increases (θs), net worth decreases by more in a closed economy than in a small open economy, because as the capital stock falls, the marginal product of capital increases, resulting in ever more costly effects on output. In contrast, in a small open economy, the return on assets doesn't depend on the debt and doesn't increase as assets decumulate. The average net marginal product of capital, $ANMP$, is greater than the world return on assets, s.

Now let's compare the consumption adjustment necessary after T years to stabilize k (equation 10) or a (equation 6).

In a small open economy:

$$c_{NewSteadyState} - c_b = -(a_b - a_T)(s_T - g)$$

In a closed economy:

$$c_{NewSteadyState} - c_b \cong (k_T - k_b)(ANMP_T - g)$$

Because $ANMP_T > s_T$ even if the change in the capital stock were only as large as the change in assets, the costs of debt would be higher in a closed economy.

Conclusion

This paper bridges the gap between the fiscal and the macroeconomic costs of debt. It shows that deficits and the debt are not sufficient statistics for the macroeconomic consequences of debt, as these depend on how different policies affect consumption and future output. These effects depend on the distributional consequences of policies, their incentive effects, and the composition of government spending.

The goal of stabilizing the debt is to improve the well-being of future generations. Because different fiscal policies have different effects on growth and consumption, policymakers should consider not only the budgetary impact of debt but also its broader macroeconomic consequences when designing fiscal policy.

Box 1: Derivation of debt equations

Let D_t be the debt at the beginning of the period and PD_t be the primary deficit in year t. Assume that until year 1, there are no deficits so there is no debt. The number of effective workers at the beginning of year t is L_t, which grows at rate g. Debt per effective workers is d_t and the primary deficit (deficit excluding interest payments) per effective workers is pd_t.

$$D_1 = 0$$

Debt at the beginning of year 2 is simply the primary deficit from year 1:

$$D_2 = PD_1$$

Debt at the beginning of year 3 is D_2 plus interest plus the primary deficit in year 2.

$$D_3 = D_2(1 + r_2) + PD_2$$

Debt per effective worker in year 2 is calculated as:

$$d_2 = \frac{D_2}{L_2} = \frac{PD_1}{L_2} = \frac{PD_1}{L_1(1+g)} = \frac{pd_1}{1+g}$$

Debt per effective worker in year 3 is

$$d_3 = \frac{D_3}{L_3} = \frac{D_2(1+r_2) + PD_2}{L_3} = \frac{D_2(1+r_2)}{L_2(1+g)} + \frac{PD_2}{L_2(1+g)} = pd_1 \frac{(1+r_2)}{(1+g)^2} + pd_2 \frac{1}{1+g}$$

And in period 4 is:

$$d_4 = pd_1 \frac{(1+r_2)(1+r_3)}{(1+g)^3} + pd_2 \frac{(1+r_3)}{(1+g)^2} + pd_3 \frac{1}{(1+g)}$$

We can now generalize to debt at time T (for T>1):

$$d_T = \sum_{i=1}^{T-1} \frac{pd_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1 + r_j)$$

Suppose after years of deficits the government decides to take action to stabilize the debt. The tax increases and/or spending cuts required to stabilize the debt are calculated as follows:

$$d_{T+1} = d_T \qquad \text{if} \qquad \frac{d_T(1+r_T)+pd}{1+g} = d_T$$

The primary deficit that solves this, $pd_{SteadyState}$, is:

$$pd_{SteadyState} = d_T(1+g) - d_T(1+r_T) = -d_T(r_T - g_T)$$

Assuming $r_T > g$, the government has to run surpluses (negative deficits) equal to the accumulated debt multiplied by the difference between r and g.

Box 2: Derivation of asset accumulation equations in a small open economy

We begin in a world without deficits. The effective labor force, L, and assets, A, are measured at the beginning of each period. The effective labor force grows at rate g. Assets in year t are equal to assets in the previous year plus saving, which is the difference between income and consumption. Income consists of earnings on assets at rate s plus labor income. Assets accumulate as follows:

$$A_2 = A_1(1+s_1) + w_1L_1 - C_1$$

Dividing both sides by L_2, where $L_2 = L_1(1+g)$:

$$\frac{A_2}{L_2} = \frac{A_1(1+s_1) + w_1L_1 - C_1}{L_1(1+g)}$$

Using lower case variables to denote per worker values:

$$a_2 = \frac{a_1(1+s_1) + w_1 - c_1}{(1+g)}$$

What consumption is consistent with constant assets per worker?

For $a_2 = a_1$ if and only if $c_1 = w_1 + a_1(s_1 - g)$

Now introduce budget deficits that raise consumption in period t by θ_t. The increase in consumption can be household consumption, from an increase in transfers or a reduction in taxes, or from government purchases of consumption goods. Denote baseline consumption by c_b and baseline assets by a_b and assume that the baseline consumption keeps assets constant. $(a_t^b = a^b \ \forall\ t)$.

In the first period, $a_1 = a_b$, and

$$c_1 = c_b + \theta_1 = w_1 + a_b(s_1 - g) + \theta_1$$

Higher consumption in the first period crowds out asset accumulation:

$$a_2 = \frac{a_b(1+s_1) + w_1 - c_1}{(1+g)} = \frac{a_b(1+s_1) + w_1 - (w_1 + a_b(s_1 - g) + \theta_1)}{(1+g)} = a_b - \frac{\theta_1}{(1+g)}$$

In year 3, we have:

$$a_3 = \frac{a_2(1+s_2) + w_2 - c_2}{(1+g)} = \frac{\left(a_b - \frac{\theta_1}{(1+g)}\right)(1+s_2) + w_2 - (w_2 + a_b(s_2 - g) + \theta_2)}{(1+g)} = a_b - \frac{\theta_1(1+s_2)}{(1+g)^2} - \frac{\theta_2}{(1+g)}$$

We can then generalize:

$$a_T = a_b - \sum_{i=1}^{T-1} \frac{\theta_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1} (1+s_j)$$

Box 3: Derivation of the change in the capital stock and sustainable consumption in a closed economy

We begin in a world without deficits. The effective labor force, L, and the capital stock K, are measured at the beginning of each period. The effective labor force grows at rate g. The capital stock is equal to the capital stock the previous year, less depreciation, δK, plus new investment. New investment is equal to output, $F(K, L)$ less consumption, C.

$$K_1 = K_0(1-\delta) + F(K_0, L_0) - C_0$$

Now, dividing by $L_1 = L_0(1+g)$ to get the capital stock per worker:

$$\frac{K_1}{L_1} = \frac{K_0(1-\delta) + F(K_0, L_0) - C_0}{L_0(1+g)}$$

Using the lower case to denote per worker values:

$$k_1 = \frac{k_0(1-\delta) + f(k_0) - c_0}{(1+g)}$$

Our baseline is a steady state in which k is constant at k_b. Baseline consumption per worker is c_b.

$$\text{For } k_t = k_{t-1} = k_b, c_b = f(k_b) - k_b(\delta + g).$$

Now introduce budget deficits that boost consumption in each year by θ_t.

In the first period, $k_1 = k,$ and

$$c_1 = c_b + \theta_1 = f(k_b) - k_b(\delta_1 + g_1) + \theta_1$$

Higher consumption in the first period crowds out investment and lowers the second period capital stock:

$$k_2 = \frac{k_1(1-\delta) + f(k_1) - c_1}{(1+g)} = \frac{k_b(1-\delta) + f(k_b) - (f(k_b) - k_b(\delta+g) + \theta_1)}{(1+g)} = k_b - \frac{\theta_1}{1+g}$$

At the beginning of period 3, the capital stock is:

$$k_3 = \frac{k_2(1-\delta)+f(k_2)-c_2}{(1+g)} = \frac{\left(kb - \frac{\theta_1}{1+g}\right)(1-\delta)+f(k_2)-(f(k_b)-k_b(\delta+g)+\theta_2)}{(1+g)}$$

$$k_b - \frac{\theta_1(1-\delta)}{(1+g)^2} - \frac{\theta_2}{(1+g)} - \frac{f(k_b) - f(k_2)}{(1+g)}$$

We can approximate the change in output as the change in the capital stock multiplied by the average of the marginal products of baseline capital and capital in year t. Let $f'(k, k_t)$ bt the average marginal product: $f'(k_b, k_t) = \frac{f'(k_t)+f'(k_b)}{2}$

Then $f(k_t) \cong f(k_b) - f'(k_b, k_t)(k_b - k_t)$

$$k_3 \cong k_b - \frac{\theta_1(1-\delta)}{(1+g)^2} - \frac{\theta_2}{(1+g)} - \frac{f'(k_b, k_2)(k_b - k_2)}{(1+g)}$$

$$k_3 \cong k_b - \frac{\theta_1(1-\delta)}{(1+g)^2} - \frac{\theta_2}{(1+g)} - \frac{\theta_1 f'(k_b, k_2)}{(1+g)^2}$$

$$k_3 \cong k_b - \frac{\theta_1\big(1-\delta+f'(k_b, k_2)\big)}{(1+g)^2} - \frac{\theta_2}{(1+g)}$$

Let $ANMP_t$ be the average of the net of depreciation marginal product of capital in the baseline and at time t: $f'(kb, k_t) - \delta$. Then,

$$k_3 \cong k_b - \frac{\theta_1(1+ANMP_2)}{(1+g)^2} - \frac{\theta_2}{(1+g)}$$

We will see the full pattern if we extend one more period.

$$k_4 = \frac{k_3(1-\delta) + f(k_3) - c_3}{(1+g)} =$$

$$\frac{\left(k_b - \frac{\theta_1(1+ANMP_2)}{(1+g)^2} - \frac{\theta_2}{(1+g)}\right)(1-\delta) + f(k_3) - \big(f(k_b) - k_b(\delta+g) + \theta_3\big)}{(1+g)} =$$

$$k_b - \frac{\theta_1(1+ANMP_2)(1-\delta)}{(1+g)^3} - \frac{\theta_2(1-\delta)}{(1+g)^2} - \frac{\theta_3}{(1+g)} - \frac{\big(f(k_b) - f(k_3)\big)}{(1+g)}$$

Using the approximation from above for $f(k_b) - f(k_3)$, this is:

$$k_4 =$$

$$k_b - \frac{\theta_1(1+ANMP_2)(1-\delta)}{(1+g)^3} - \frac{\theta_2(1-\delta)}{(1+g)^2} - \frac{\theta_3}{(1+g)} - \frac{f'(k_b,k_3)}{(1+g)}\left(\frac{\theta_1(1+ANMP_2)}{(1+g)^2} + \frac{\theta_2}{(1+g)}\right) =$$

$$k_b - \frac{\theta_1(1+ANMP_2)(1+ANMP_3)}{(1+g)^3} - \frac{\theta_2(1+ANMP_3)}{(1+g)^2} - \frac{\theta_3}{(1+g)}$$

We can now generalize.

$$k_T = k_b - \sum_{i=1}^{T-1} \frac{\theta_i}{(1+g)^{T-i}} \prod_{j=i+1}^{T-1}\big(1+ANMP_j\big)$$

It is worth noting that, despite the eroding capital stock, private income is higher while the government is running deficits, both because capital income is higher and because of the tax cuts/spending increases associated with the primary deficits. Thus, until the government actually starts to raise taxes/cut spending to stabilize the debt, only the expectation of these eventual debt stabilizing policies would lead consumers to lower consumption below baseline.

New sustainable consumption:

Imagine that after years of a declining capital-labor ratio, action is taken in year T that lowers consumption in order to stabilize it.[11] How much lower is the new steady-state consumption than the baseline consumption with the baseline capital-labor ratio? That is—how much did the years of deficits lower sustainable consumption?

$$c_{NewSteadyState} = f(k_T) - k_T(g + \delta)$$

The reduction in steady-state consumption as a result of the crowding out is:

$$c_{NewSteadyState} - c_b = \left(f(k_T) - f(k_b)\right) - (k_T - k_b)(g + \delta)$$

Using the approximation from above $f(k_t) \cong f(k_b) - f'(k_b, k_t)(k_b - k_t)$, this becomes:

$$c_{NewSteadyState} - c_b = (k_T - k_b)(f'(k_b, k_T) - \delta - g) = (k_T - k_b)(ANMP_T - g)$$

[11] Stabilizing consumption imposes the same costs across all generations. A Ramsey planner would want capital to return to its optimal level and would therefore require larger consumption reductions for earlier generations if the capital stock had fallen below its optimal level. See Cutler et al (1990).

Box 4: The effect of debt on private income in a closed economy

While the debt is increasing, private income is higher than it was when the government was not running deficits, because households receive the primary deficit (in the form of tax cuts, spending increases, or spending on their behalf) and they have more capital income.

We can write net of depreciation income at time t<T:

$$f(k_t) - \delta k_t + d_t r_t + \ pd_t$$

Using the approximation: $f(k_t) \cong \ f(k_b) - (ANMP_t + \delta)(k_b - k_t)$, we can rewrite this as:

$$f(k_b) - \delta k_b - (ANMP_T)(k_b - k_t) + d_t r_t + pd_t$$

The change in net income is as a result of the debt and deficits is: $-(ANMP_t)(k_b - k_t) + d_t r_t + pd_t$

Let the amount of crowd out be a fraction f of the debt (Box 3 discusses this relationship):

$$k_b - k_t = f d_t$$

Then, the change in net income is $d_t(r_t - fANMP_t) + pd_t$.[12]

If households increase their saving to offset the debt, then f = 0 and income is higher by $d_t r_t + pd_t$ because households have private assets equal to the debt that earn a return r.

If households don't increase their saving at all, then f = 1 and private income is higher because the debt earns a higher rate of return than the crowded-out assets and households receive $+pd_t$.

[12] Note that this is positive regardless of whether $r < g$, because r is always larger than ANMP.

Box 5: Why maximizing sustainable primary deficits does not maximize consumption

Focusing only on the budget perspective might suggest that the best thing for the government to do for future generations when r<g is to maximize the primary deficits that can be run without costs. Such a strategy would require keeping r<g—that is, not crowding out so much capital that r rises to g.

But such a strategy would not maximize long-run sustainable consumption. In particular, in a steady state where households hold government debt, consumption must equal income ($f(k_T)+d_T r_T + pd_T$) less the amount of saving to replace the depreciation of the capital stock and have both the capital stock and debt rise with the growth of the effective population:

Steady-state consumption = $f(k_T)+d_T r_T + pd_T - k_T(\delta + g) - d_T g$

To keep debt constant, $pd_T = -d_T(r_T - g)$,

Steady-state consumption = $f(k_T) - k_T(\delta + g) + d_T(r_T - g) - d_T(r_T - g)$, which is just

$$c = f(k_T) - k_T(\delta + g)$$

In steady state, whatever income households earn on their debt is offset by primary deficits. When r>g, the debt is positive, and the government has to run surpluses. When r<g, the income is negative and the government offsets that by running primary deficits. The effect on steady-state consumption operates through the amount of crowd out. Maximizing steady-state consumption would increase the debt until r=g.

Box 6: The relationship between MPCs, the reduction in the capital stock, and the debt in a closed economy

What does θ_i have to be in order for the amount of crowd out to be a fixed proportion, MPC, of the debt?

Because there is no debt and no crowd out before the government starts running deficits, the θ_t that makes the increase in crowd out from t to t+1 a constant fraction of the increase in debt will be the same as the θ_t that makes the change in the capital stock at any time t a fixed fraction of the debt.

From the equation for the amount of crowd out from Box 3, we determine that:

$$k_t - k_{t+1} = \frac{\theta_t + (ANMP_t - g)(k_t - k_b)}{1 + g}$$

And from the equation for debt accumulation in Box 1, we determine that:

$$d_{t+1} - d_t = \frac{pd_t + (r_t - g)d_t}{1 + g}$$

We can solve for the change in consumption, θ_t, that makes the change in the capital stock a fixed fraction of the debt.

For $k_t - k_{t+1} = MPC(d_{t+1} - d_t)$, and $(k_t - k_b) = MPCd_t$,

$$\theta_t = MPC(1 + g)\left(\frac{pd_t + (r_t - g)d_t}{1+g}\right) - (ANMP_t - g)MPCd_t$$

$$\theta_t = MPC(pd_t + (r_t - ANMP_t)d_t)$$

If household consumption increases by a fixed fraction of both the primary deficit and the increase in private capital income, then the amount of crowd out will equal that fraction times the debt.

Under this assumption, stabilizing the debt will also stabilize the capital stock.

To stabilize the debt in year T: $pd_T = -(r_T - g)d_T$.

Given our formulation for θ_t, that means:

$$\theta_T = MPC(-(r_T - g)d_T + (r_T - ANMP_T)d_T) = -MPCd_T(ANMP_T - g)$$

$$= -(k_b - k_T)(ANMP_T - g)$$

This is exactly the decline in consumption necessary to stabilize the debt. Of course, as with the small open economy example, if the MPC for the policies used to stabilize the debt are less than the MPCs that created the debt, stabilizing the debt won't stabilize the capital labor ratio.

Hutchins Center
on Fiscal & Monetary Policy
at BROOKINGS

The mission of the Hutchins Center on Fiscal and Monetary Policy is to improve the quality and efficacy of fiscal and monetary policies and public understanding of them.

Questions about the research? Email ESmedia@brookings.edu.
Be sure to include the title of this paper in your inquiry.