

INTERNATIONAL MONETARY FUND

Beyond Debt: Net Worth Fiscal Anchors

Hua Chai, Jason Harris, Alexander F. Tieman

WP/24/137

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**2024
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WORKING PAPER

IMF Working Paper
Fiscal Affairs Department

Beyond Debt: Net Worth Fiscal Anchors
Prepared by Hua Chai, Jason Harris, Alexander F. Tieman

Authorized for distribution by Abdelhak Senhadji
July 2024

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ABSTRACT: This paper proposes anchoring medium- to long-term fiscal policy in a Public Sector Net Worth (PSNW) target. Such a target widens the scope of fiscal policy to include public sector assets, in addition to liabilities—the focus of debt-based rules. A PSNW target is directly relevant to ongoing policy debates on green fiscal rules and more generally, the reform of fiscal frameworks (such as the Euro Area’s) to allow for public investment in a high debt environment. Modeling a small open economy with public investment and endogenous growth, we show that, compared to debt-based anchors, a PSNW anchor is more conducive to public investment and economic growth, while providing for sensible policy reactions to changes in long-term interest rates. The net worth anchor also precludes unsustainable debt dynamics. Simulated transition dynamics show that replacing a debt anchor with a net worth anchor does not necessarily lead to higher debt-to-GDP ratios. In addition to the merits of a net worth anchor, the paper also discusses some operational challenges.

JEL Classification Numbers:	H54, H30, E62
Keywords:	Fiscal policy; fiscal anchor; public investment; public sector balance sheet; public sector net worth
Author’s E-Mail Address:	ATieman@imf.org , JHarris@imf.org , HChai@imf.org

WORKING PAPERS

Beyond Debt: Net Worth Fiscal Anchors

Prepared by Hua Chai, Jason Harris, Alexander F. Tieman¹

¹ The authors would like to thank Abdelhak Senhadji, Subir Lall and Graham Prentice, as well as participants of the FAD seminar, for helpful comments. All errors remain our own.

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I. Introduction

The level of public debt has long been a focal point of fiscal policy. Most countries with a fiscal rule feature a gross or net debt target. Even in countries without fiscal rules, the debt level often serves as an anchor for fiscal policy, either explicitly or implicitly. This narrow focus on debt has been called into question in recent years, as the low interest rate environment that existed in advanced economies for decades triggered a re-assessment of the cost of debt and the role of fiscal policy in an environment with $r < g$ (see e.g., Blanchard 2019, 2023). The realization that additional public (and private) investment is needed in light of climate change, population aging, and underinvestment in public infrastructure in many countries puts strict adherence to debt rules further into question. As a consequence, the conventional practice of anchoring public finances through the debt-to-GDP ratio has been challenged repeatedly over the last few years, either as a general practice (e.g., Furman and Summers, 2020) or in the context of constraining green investment (e.g., Cottarelli, 2020).

Recent interest rate increases have amplified this debate. In the post-pandemic high inflation environment monetary authorities have pivoted towards disinflation. This has led to public debt burdens becoming more constraining due to higher interest rates, while large public investment needs have garnered more attention, mainly but not exclusively related to climate change adaptation and mitigation. Accounting for the economic benefit of such investment would require major adjustment to any debt-based fiscal rule, as exemplified by recent work on green fiscal rules (e.g., Darvas and Wolff, 2021; Cottarelli, 2020). Yet it is ever more important in the current tight(er) fiscal space environment and given the urgency of addressing climate change now. And once the current inflationary episodes are past, interest rates may revert back down in advanced economies (IMF, 2023), rekindling the previous debate as r may once again fall.

This paper suggests public sector net worth as an alternative target for fiscal policy. Information on public sector balance sheets is ever more available (see [IMF Public Sector Balance Sheet database](#)) and is increasingly being used to inform and guide fiscal policy and sustainability (e.g., IMF 2018, El Rayess et al., 2019, and Koshima et al., 2021). We show how using public sector net worth (henceforth net worth for convenience), rather than the level of public debt, as a fiscal policy anchor can offer valuable guidance on the conduct of fiscal policy over the medium-to-long term. Since net worth is defined as the difference between the value of assets and liabilities, a net worth anchor accounts for both sides of the public sector balance sheet, taking account of, e.g., the benefits of public investment, which builds assets. This contrasts sharply with debt anchors that focus on only the liability side.¹

To understand how net worth anchors guide fiscal policy, we develop a simple small open economy model. Economic growth is endogenously determined and linked to productive public investment. The government decides the paths of public investment and non-investment spending in conformity with a given fiscal anchor. Productive public capital such as public infrastructure is the only form of public assets in the model, and the value of public capital in the government's balance sheet reflects its financial and social returns.

First, we show how targeting net worth (relative to GDP) is more conducive to public investment and economic growth, when compared to traditional debt-based fiscal anchors. This is because net worth targeting implies a sharp distinction between expenditures that increase net worth and those do not. Specifically, while public investment creates new public capital and increases net worth, most current spending does not. Therefore,

¹ A net debt target accounts for financial assets but ignores non-financial assets including productive public capital.

compared to a debt rule, a net worth target provides stronger incentives for fiscal authorities to pursue productive public investment.² This is true in general, but especially pronounced in a low interest rate environment, when the associated rise in debt service burden is low.

In contrast, a gross or net debt anchor or ceiling does not strongly incentivize public investment, as it does not make a methodological distinction between public investment and other forms of spending. Policymakers have tried to overcome this issue by tweaking debt rules, treating public investment and the associated debt differently from debt accumulated through other spending. While such tweaks may help on the margin, they fail to take account of public assets fully and consistently. Moreover, fiscal rules based on debt and deficit targets, even with flexibility clauses, tend to lead governments to decrease public capital expenditures more than proportionally during fiscal consolidation episodes (Delgado-Tellez et al., 2022; Breuning and Busemeyer, 2012; Lane, 2003).

Second, we show how anchoring fiscal policy in a net worth target precludes explosive public debt dynamics. This is because in order to maintain its net worth (in percent of GDP), the government has to rein in debt build-up or to match any increase in debt by corresponding increase in public sector assets through investment. As an aside, such investment increases the productive capacity of the economy, boosting growth and allowing for slightly higher nominal debt compared to a debt rule.

Third, we show that a net worth anchor is more responsive to interest rates movements than a debt anchor. To illustrate this point, we apply an upward interest rate shock and simulate how it triggers a gradual fiscal consolidation by curtailing both public investment and current expenditure. Even as the fiscal policy targets net worth, it results in a decline in the debt level, something a debt anchor in itself would not achieve. A net worth anchor is also superior to a debt servicing target under such an interest rate shock, as it shields the economy from the excessive fiscal contraction that would occur under a debt servicing target (for example as proposed by Furman and Summer, 2020) when interest rates rise.

Fourth, we demonstrate the possibility of achieving superior outcomes when replacing existing debt anchors with net worth anchors. We do this by presenting simulated scenarios with selected numerical targets of net worth. Our numerical examples show that for economies with a high public debt level and low net worth—which at present include many advanced economies—targeting a higher net worth level would induce a rise in public investment and sustain a higher long-term growth rate. In contrast, economies with a low debt level and a high net worth could achieve higher long-term growth by targeting lower net worth. Our simulations furthermore illustrate the transition dynamics, and specifically how the long-run public debt ratio changes, as one replaces a debt anchor by a net worth anchor. Targeting net worth leads fiscal authorities to adjust assets and liabilities in a coordinated fashion such that high debt economies end up with lower debt ratios while the opposite holds for low debt economies.

The public sector balance sheet approach to fiscal policy has recently garnered attention in the literature. IMF (2018) compiled a comprehensive cross-country public sector balance sheet database and showed how balance sheet management could improve fiscal policymaking by enabling countries to increase revenues and reducing risks.³ Yousefi (2019) shows that stronger public sector balance sheets reduce sovereign borrowing

² For empirical evidence of the macroeconomic benefits of public investment, see, e.g., Abiad, Furceri, and Topalova (2016), Sturm and de Haan (1995), and Aschauer (1989).

³ For an overview of the database and guide for compilers and users, see Alves, De Clercq, and Gamboa-Arbelaiz (2020).

costs and allow greater room for countercyclical fiscal policy. Sturzenegger and Der Meguerditchian (2022) apply a balance sheet approach to study fiscal sustainability in Namibia, while Brede and Henn (2018) and Henn and Cabezón (2018) construct and analyze the public sector balance sheet for Finland and Norway respectively. More recently, Adedeji (2022) advocates substituting debt as the main indicator of the financial position of the government with net worth to ensure comprehensive coverage of governments' COVID interventions.

Net worth targeting is also directly related to ongoing policy debates on fiscal frameworks. First, in the field of climate finance, the discussion on introducing green fiscal rules centers on defining fiscal policy space to allow for public climate investment. This is needed to deal with the conundrum of the urgency of climate investment while in many countries public debt and interest rates are high. Most proposed green fiscal rules are a variation on traditional golden rules that exclude (profitable) investment from debt and deficit targets (Darvas and Wolff, 2021). Second, a similar debate is taking place on post-pandemic revisions to the Euro Area's stability and growth pact fiscal rules. These rules were originally based on the objectives of containing debt levels to 60 percent of GDP, translating into annual fiscal deficits not exceeding 3 percent of GDP. Since the GFC and even more so during the pandemic, these rules have not been applied and were even formally suspended. The current debate centers on what will replace the original rule and how this would allow for public investment needs in an environment of high debt levels. Both discussions could benefit from considering net worth as an alternative, as motivated above.

The policy discussion around using net worth as fiscal target is most advanced in the UK, New Zealand, and Australia, where variants of net worth targets have been included within the constellation of fiscal policy formulation for some decades.⁴ These countries routinely publish estimates of their public sector balance sheets, and both Australia and New Zealand project their balance sheets into the future in their budget documents. Over recent years, in the UK and New Zealand, these considerations have moved to the forefront of fiscal policy discussion (see, e.g., New Zealand's Investment Statements, and the UK discussion around broadening the fiscal rules to encompass net worth targets, Crompton, 2023). In particular, Hughes (2019) and Hughes *et al.* (2019) suggest targeting net worth together with other fiscal indicators in the UK. Similar to this paper, they argue that such a target would allow for the public investment necessary to tackle the UK's challenges in boosting productivity growth, tackling climate change, and modernizing public service infrastructure.

This paper contributes to these policy discussions by providing a theoretical underpinning for targeting public sector net worth. In addition to supporting the view that targeting net worth promotes public investment and growth, our model-based approach generates rich insights into how fiscal policy reacts to changes in the net worth target and how the economy adjusts as a debt ceiling is replaced by a net worth target. Our analysis also dispels common misconceptions of net worth targeting including the notion that it necessarily leads to fiscal expansion even when debt and interest rates are high.

⁴ Australia's earlier fiscal strategy set the aim to improve net financial worth over the medium term. New Zealand's fiscal regime includes a long-term objective of using net worth to maintain a productive, sustainable and inclusive economy, consistent with debt and operating balance objectives, as well as a policy principle of achieving and maintaining levels of net worth that provide a buffer against factors that may impact adversely on total net worth in the future. In the UK, fiscal policy includes targeting a public sector net debt path (excluding Bank of England), and features supplementary fiscal policy aims to strengthen over time a range of public sector balance sheet measures such as public sector net financial liabilities and public sector net worth.

The rest of the paper is organized as follows: Section II describes the model and explores the long-run equilibrium properties of an economy with a net worth anchor. Section III studies economic dynamics as a debt ceiling is replaced with a net worth anchor and characterizes the response of the economy to a real interest rate shock. Section IV summarizes merits of the net worth anchor in comparison with alternative fiscal anchors, such as the golden rule and the debt servicing target, which have been proposed for similar purposes of enabling more active fiscal policy. In our view, the net worth anchor offers advantages in safeguarding debt sustainability, incentivizing pro-growth spending, and ensuring macroeconomic stability against interest rate shocks. Section IV also discusses operational issues of the net worth anchor, including assessment of public investment projects and the valuation of public assets. Section V concludes.

II. The Model

In this section we present a small open economy model with endogenous growth. We first characterize equilibrium under a binding public debt ceiling as a benchmark, and then introduce a public sector net worth target as an alternative fiscal anchor. We compare its long run equilibrium (balanced growth path) properties with the benchmark economy.

2.1 Technology, Households, and the Public Sector

Time is discrete. There is one final good which is produced using private and public capital, as well as labor inputs in the following fashion:

$$Y_t = K_{t-1}^\alpha L^{1-\alpha} (AX_{t-1})^{1-\alpha},$$

where K_{t-1} and X_{t-1} denote the private and public (productive) capital stocks at the end of period $t - 1$, used in production at period t , with depreciation rates of δ_K and δ_X respectively. The productivity of public capital is captured by the parameter A . We abstract away from population growth by assuming exogenous and constant labor supply, L , which is normalized to unity for simplicity. This specification of production allows for endogenous growth a la Barro (1990). The equilibrium private-to-public capital ratio at any given period is pinned down by equating the marginal rate of return to an exogenous global rate, r_K :

$$\alpha \left(\frac{K_t}{AX_t} \right)^{\alpha-1} - \delta_K = r_K.$$

The constant ratio of public-to-private capital implies that an increase in public capital would attract more inflows of private capital. With the equilibrium condition above, it is straightforward to show that output turns out to be proportional to the public capital stock:

$$Y_t = \Phi X_{t-1}, \tag{1}$$

where $\Phi = A \left(\frac{r_K + \delta_K}{\alpha} \right)^{\alpha/(\alpha-1)}$. Identical households supply labor and earn wage income at rate w_t , which is taxed at rate τ by the government. To focus on the spending side of fiscal policy, we abstract away from tax policy

considerations by assuming that the tax rate is fixed.⁵ The after-tax wage income in period t is thus $(1 - \tau)(1 - \alpha)\Phi X_{t-1}$. To focus the analysis on the public sector, we abstract away from households' consumption and savings decisions by assuming that they spend all income on consumption. Consumption is thus given by $c_t = (1 - \tau)(1 - \alpha)\Phi X_{t-1}$. Since households do not accumulate savings, private capital is supplied by external capital owners. This assumption is for simplicity only and not essential—a positive saving rate does not qualitatively alter the results of this paper.

The government collects tax revenues, T_t , and spends resources on government consumption, G_t , and investment in public capital, I_t . The public capital stock thus evolves as

$$X_t = (1 - \delta_X)X_{t-1} + I_t. \quad (2)$$

The government can also issue one-period bonds on the international capital market at the global interest rate r .⁶ We treat r as constant in this section and will later consider interest rate shocks. The flow budget constraint is thus given by

$$D_t = G_t + I_t - T_t + (1 + r)D_{t-1}, \quad (3)$$

where $T_t = \tau(1 - \alpha)\Phi X_{t-1}$, and D_t denotes net public debt at the end of period t . Note that current spending (government consumption) G_t does not benefit households, while public investment increases the productive capacity of the economy and hence benefits both the government and households. We assume that the government—which does derive utility from government consumption—maximizes a weighted average of households ($u(c_t)$) and its own utility ($u(G_t)$), that is, it maximizes the following:

$$\sum_{t=0}^{\infty} \beta^t [(1 - \omega)u(G_t) + \omega u(c_t)], \quad (4)$$

where $\omega \in [0,1]$ is the weight assigned to households subject to the budget constraint above.

The government's fiscal policy is guided by a fiscal anchor. We first consider a ceiling on public debt, as debt-based fiscal anchors are the most common in practice. Specifically, this introduces another constraint for the government:

$$D_t \leq \bar{d}Y_t, \quad (5)$$

where \bar{d} denotes the debt ceiling in percent of output. We assume the economy starts off on a balanced growth path (BGP) with a binding public debt ceiling. We restrict our analysis to a parameter space that delivers an endogenous equilibrium growth rate higher than the interest rate, that is, $r < g$. While the standard lifetime budget constraint of the government becomes irrelevant in this case, the debt ceiling prevents the government from running arbitrarily high fiscal deficits.⁷ On the BGP, public capital stock, public debt, and output all grow at

⁵ In our opinion, the objectives of tax policy should remain efficient revenue mobilization and fair redistribution, rather than generating net worth for the public sector.

⁶ The implications of instead introducing an endogenous interest rate that reacts to the fiscal condition of the public sector is discussed in Section III.

⁷ Still, even when $r > g$ the properties we derive of net worth targeting would hold.

the same rate of g , and public investment and current spending stay constant in shares of output. The equilibrium is characterized in detail in Appendix A.

2.2 Public Sector Net Worth as Fiscal Anchor

Public sector net worth is defined as the difference between the value of government assets and liabilities. In this model, the assets of the government are the public capital stock. While the government can also hold financial assets, these are incorporated in the net financial liabilities, D_t , which in this paper we refer to as net debt or simply public debt.

We use q_t to denote the unit value of public capital, hence the total value of public assets at the end of period t is $q_t X_t$. End-of-period net worth is therefore given by:

$$N_t = q_t X_t - D_t. \quad (6)$$

How public capital is valued, that is, how q_t is determined, is of critical importance. There are several alternative valuation methods. Firstly, it can be evaluated based on the financial returns of public capital to the government, i.e., the increase in public revenue resulting from public investment and higher output.⁸ In each period, the cash flow from one unit of public capital is tax revenue of $\tau(1 - \alpha)\Phi$. Taking into account public capital depreciation, the unit value of public capital can be set to its net present value at the end of period t as given by

$$\sum_{s=t+1}^{\infty} \tau(1 - \alpha)\Phi \frac{(1 - \delta)^{s-t-1}}{(1 + r)^{s-t}} = \frac{\tau(1 - \alpha)\Phi}{r + \delta}.$$

Note that the unit net present value of public capital is constant over time, given a constant r .

This valuation method suffers from an important drawback, that is, it incentivizes governments to pursue projects with high financial returns. This can come at the expense of projects with lower financial returns but high social returns. As a matter of fact, high social returns and/or the public good nature of the project are typically why investment by the public sector is called for. To correct this problem, an alternative way to value public capital is to equate the unit value to the social return. In each period, the social return, that is, combined return to households and government from an addition one unit of public capital, is $(1 - \alpha)\Phi$. The net present value of one unit of capital based on social returns then is:

$$\sum_{s=t+1}^{\infty} (1 - \alpha)\Phi \frac{(1 - \delta)^{s-t-1}}{(1 + r)^{s-t}} = \frac{(1 - \alpha)\Phi}{r + \delta}.$$

However, pursuing projects with high social returns regardless of financial returns might jeopardize the sustainability of public finances. To strike a balance between the two approaches, we propose valuing public capital as the net present value of the weighted average of financial and social returns. Notably, as will be

⁸ Such public revenue can comprise (a combination of) tax revenue and user fees for public infrastructure such as toll roads and airports. In the remainder of the paper, we simply refer to “tax revenue”.

demonstrated in following sections, it is important that public capital is not valued by the financial cost of public investment projects. The above implies that

$$q = \lambda \frac{\tau(1-\alpha)\Phi}{r+\delta} + (1-\lambda) \frac{(1-\alpha)\Phi}{r+\delta}.$$

Let $\tau^* = \lambda\tau + (1-\lambda)$, with $0 \leq \lambda \leq 1$, then the unit of public capital could be rewritten as

$$q = \frac{\tau^*(1-\alpha)\Phi}{r+\delta}.$$

Public capital is more valuable when it is more productive (captured by Φ), and when the interest and depreciation rates are low.

We now introduce a fiscal anchor based on public sector net worth. Specifically, we set a target on the ratio of public sector net worth to output. That is, $N_t = n^*Y_t$ for all t , where n^* is the target level of public sector net worth. Using expressions for Y_t (1) and N_t (6), this constraint can be represented in the following equivalent form:

$$qX_t - D_t = n^*\Phi X_{t-1}. \quad (7)$$

Compared to the debt ceiling (5), the net worth target imposes constraints not only on government liabilities, but also on its assets. Higher debt would need to be matched by a larger public capital stock to satisfy the net worth constraint, and vice versa.

Under net worth targeting, the government maximizes its objective (4)⁹, subject to the flow budget constraint and the net worth constraint, i.e.,

$$\begin{aligned} & \max \sum_{t=0}^{\infty} \beta^t [(1-\omega)u(G_t) + \omega u(c_t)] \\ & \text{s. t. } D_t = G_t + I_t - \tau(1-\alpha)\Phi X_{t-1} + (1+r)D_{t-1}, \\ & \quad qX_t - D_t = n^*\Phi X_{t-1}, \\ & \quad X_t = (1-\delta_X)X_{t-1} + I_t. \end{aligned}$$

Note that in response to any change to the net worth target, n^* , the net worth constraint could be satisfied by different combinations of changes to public capital and public debt paths. For example, if we raise n^* , two types of adjustments can be envisaged such that the net worth constraint continues to hold. The first option is to increase public capital stock and hence its total value more than the increase in debt needed to finance more public investments. We name this strategy fiscal expansion. The other option is to reduce public debt more than the accompanying reduction in public capital. This strategy is referred to as fiscal consolidation. We will show that the optimal choice of fiscal strategy crucially depends on the level of the real interest rate.

⁹ For simplicity, we set $\omega = 0$, which implies that the government does not internalize the effect of public investment on household consumption. This assumption is not essential as positive values of ω delivers qualitatively similar results.

2.3 Long-Run Equilibrium (BGP) Properties of the Net Worth Anchor

As is the case with a debt ceiling, there exists a Balanced Growth Path (BGP) where output, public capital, and public debt all grow at the same rate, while public investment and current spending stay constant in ratio to output. Detailed derivation and characterization of the BGP is presented in Appendix B. Some key properties of the BGP are worth highlighting.

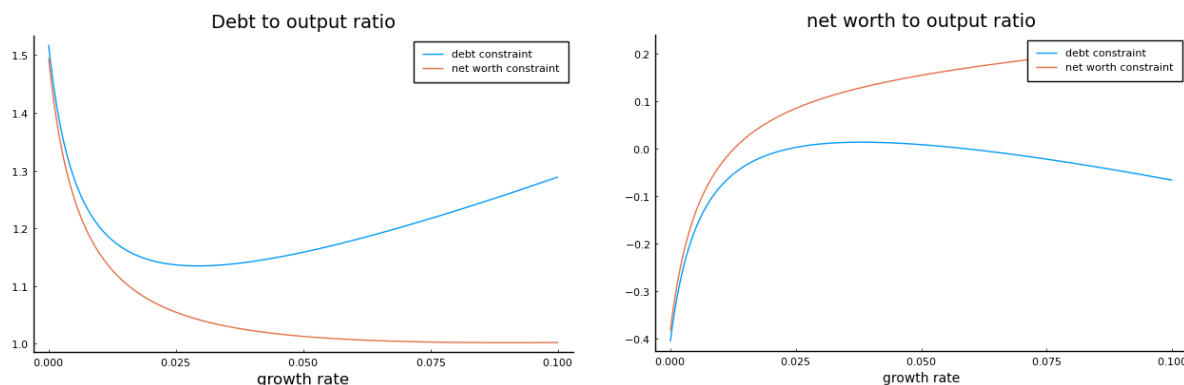
First, the public debt to output ratio is finite. The net worth constraint rules out explosive debt dynamics even though it does not directly restrict the debt level. This is because the constraint requires any increase in debt to be matched by proportional increases in public productive assets, and hence higher output. In other words, the public net worth anchor discourages the government from excessive debt-financed current spending and ensures that public investment and output goes up with borrowing.

Second, the net worth anchor features a lower debt ratio at the same growth rate on the BGP compared with a debt anchor. Suppose there are two economies with identical parameter values except that one adopts a debt anchor and the other a net worth anchor. If we impose the same BGP growth rates on these two economies, which one of them would have higher public debt? For any given growth rate, we use equilibrium conditions derived in Appendices A and B to compute the corresponding debt ceiling, \bar{d} , for the economy with a debt ceiling; and the net worth target, n^* , as well as the implied debt level for the economy with a PSNW fiscal anchor. We prove in Appendix B that the debt-to-output ratio would be lower under net worth anchor. We illustrate this here with a numerical example.¹⁰ The left chart of Figure 1 below shows that public debt is lower with the net worth anchor at any plausible growth rate. To understand this result, first rewrite (2) as

$$g_t = \frac{X_t}{X_{t-1}} = \frac{I_t}{X_{t-1}} + 1 - \delta_x$$

Together with (1), this implies that two economies that grow at the same rate would feature the same investment rate, I_t/Y_t . In the meantime, current spending as share of output would be lower in the economy with a net worth target, because its spending mix favors investment, which creates net worth. As a result, the primary deficit is lower as share of output under net worth targeting. This translates to a lower debt-to-output ratio on the BGP.

¹⁰ Parameter values used in this exercise are the following: $r = 0.02$, $r_K = 0.02$, $\alpha = 1/3$, $\beta = 0.98$, $\tau = 0.12$, $\tau^* = 0.2$, $\delta_x = 0.1$, $\delta_K = 0.05$, $A = 0.5$, and $\sigma = 3$. The implied unit value of public capital is $q = 1.21$.

Figure 1. Debt, Net Worth, and Growth Rate

Source: IMF staff calculations

On the flip side, at any growth rate, public net worth is higher as share of output with net worth target as the fiscal anchor. The definition of public sector net worth (6) implies

$$\frac{qX_t}{\Phi X_{t-1}} - \frac{D_t}{\Phi X_{t-1}} = n.$$

Since the two economies grow at the same rate, the first term on the left-hand side of the above equality is the same for both economies. It is then obvious that the economy with higher BGP debt ratio (the second term) would necessarily have lower net worth.

Third, raising the net worth target leads to higher long-term growth in a low interest rate environment. This is because fiscal expansion is preferred over fiscal consolidation at low interest rates. To develop an intuitive understanding of this result, we conduct a thought experiment. Suppose there are only two periods, $t = 1, 2$, and the following net worth constraint is originally satisfied:

$$qX_1 - D_1 = n^*Y_1.$$

Now we increase n^* such that the right-hand side of the above equation goes up by $\epsilon > 0$. Denote the resulting changes to X_1 and D_1 as ΔX and ΔD respectively. We necessarily have:

$$q\Delta X - \Delta D = \epsilon.$$

An increase in the public capital stock by $\Delta X > 0$ through higher investment (fiscal expansion) brings benefits to the government in both time periods. Note that at $t = 1$, for $q > 1$, $\Delta X < \Delta D$. This means not all new borrowing is spent on investment. In fact, part of new borrowing ΔD is used to finance more government consumption, i.e.,

$$\Delta G_1 = \Delta D - \Delta X = (q - 1)\Delta X - \epsilon.$$

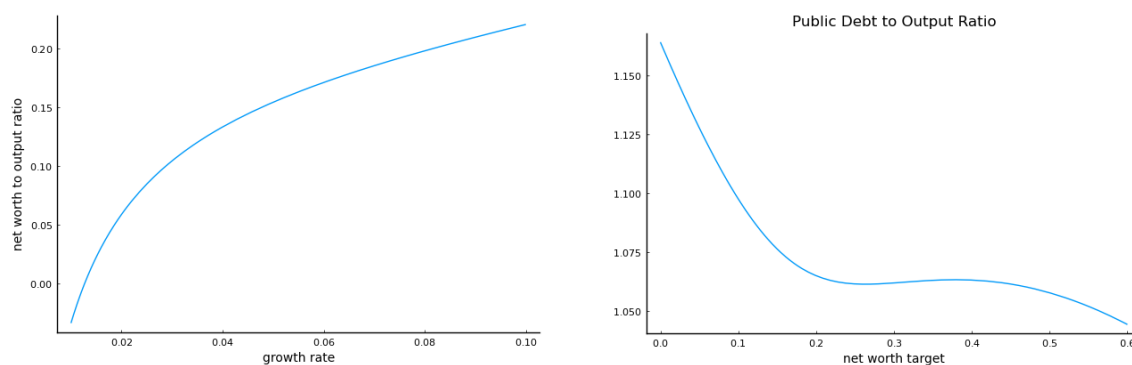
Gains for the government at $t = 2$ include higher tax revenue $\tau(1 - \alpha)\Phi\Delta X$, and additional asset $(1 - \delta_X)\Delta X$ due to more investment at $t = 1$. However, an increase in borrowing at $t = 1$ also translates into higher debt servicing cost at $t = 2$ of $(1 + r)\Delta D$.

The real interest rate affects the magnitude of gain at $t = 1$ and the cost at $t = 2$. A higher interest rate reduces the unit value of public capital q through higher discounting, and obviously raises the cost of debt servicing. Therefore, the net gain from a fiscal expansion tends to be positive in a low interest rate environment. Whereas a higher net worth target tends to bring a fiscal consolidation ($\Delta X < 0$) in a high interest rate environment.¹¹

So far in this thought experiment we have implicitly assumed that the global rate of return to private capital, r_K , (captured by the productivity parameter Φ) stays constant as the global interest rate varies. If we assume the r and r_K are correlated instead, then the conclusion would be strengthened, since a higher r_K reduces domestic private capital stock relative to public capital, decreasing Φ and hence tax revenues at $t = 2$, making investment even less rewarding in a high interest rate environment.

Figure 2 (left chart) presents a numerical example where the net worth target and the long-term growth are positively associated. Parameters values are the same as those used for Figure 1. A proof of this result is included in Appendix B.

Figure 2. Growth, Debt, and the Net Worth Target



Source: IMF staff calculations

Fourth, raising public sector net worth does not necessarily lead to a higher debt-to-output ratio. We have shown that raising public sector net worth in a low interest rate environment induces higher public investment. The associated rise in public debt used to finance public investment tends to increase the debt-to-output ratio. On the other hand, the higher growth rate achieved through public investment tends to reduce the debt ratio. The net effect on debt depends on the relative strengths these two opposing forces and does not necessarily lead to higher debt-to-output ratio. In fact, in our numerical example the debt ratio on the BGP actually declines with rising net worth targets (Figure 2, right chart).

¹¹ In this example, the threshold for r as $\epsilon \rightarrow 0$ is $\bar{r} = \frac{1}{q} \left[\frac{u'(G_1)}{\beta u'(G_2)} (q - 1) + \tau(1 - \alpha)\Phi + 1 - \delta_X \right] - 1$, where G_1 and G_2 are equilibrium current spending levels in period 1 and 2 respectively before changing n^* .

Fifth, the optimal net worth target is interest rate dependent. There may exist an optimal net worth target that maximizes social welfare on the BGP. The optimal net worth target is the one that results in the welfare-maximizing growth rate. Lower-than-optimal growth rates reduce consumption potential of households, while higher-than-optimal growth rates excessively compress government consumption. The optimal choice depends on the real interest rate. This paper does not focus on determination of the optimal net worth target.

III. Dynamics

We use the model developed above to explore economic dynamics with a PSNW target as a fiscal anchor. Specifically, we study two scenarios: (1) replacing a debt ceiling with a net worth target; and (2) a real interest rate shock to an economy with a net worth target. To generate more realistic dynamics, we introduce a standard convex capital adjustment cost to public capital stock. The only change this brings to the model is that the budget constraint is slightly changed to incorporate this additional cost to the government:

$$D_t = G_t + I_t \left(1 + \frac{\phi}{2} \frac{I_t}{X_{t-1}} \right) - \tau(1 - \alpha)\Phi X_{t-1} + (1 + r)D_{t-1}.$$

The dynamic system is fully characterized in Appendix B. Because the adjustment cost changes BGP equilibrium values of variables, some parameter values used in this section are adjusted from those used in the previous section to satisfy the set of parameter restrictions.¹²

For illustrative purposes, we present our simulations in a parameter space in which the real interest rate is lower than the real growth rate (i.e., $r < g$). Still, fiscal policy would also be anchored through public sector net worth when the opposite is true, as all the properties we derive of net worth targeting would hold. As debt dynamics become less favorable with $r > g$, and with financial markets generally looking at debt levels more than net worth¹³, it may be sensible to complement a long-term net worth anchor with an interim debt-based target, especially as normal capital market access may not be assured in all circumstances (Zaranko, 2023).¹⁴

3.1 From Debt to Net Worth Targeting

What happens to the economy when the debt ceiling is replaced with a public sector net worth target as the fiscal anchor? To address this question, we suppose the economy rests on a BGP under the debt ceiling of 60 percent of GDP at $t = 0$, with a growth rate of 3.5 percent, and a public sector net worth at 36 percent of GDP.¹⁵ The debt ceiling is replaced by a net worth target, $n^* = 38$ percent of GDP at $t = 1$. The real interest rate is assumed to be 0.

¹² The parameter values used in this section are: $r = 0$, $r_K = 0.02$, $\alpha = 1/3$, $\beta = 0.98$, $\tau = 0.14$, $\tau^* = 0.14$, $\delta_X = 0.08$, $\delta_K = 0.05$, $A = 0.55$, $\phi = 0.1$, and $\sigma = 2$. The implied unit value of public capital is $q = 1.12$.

¹³ Still, there are indications that even financial markets pay attention to net worth (see IMF, 2018, and Yousefi, 2019).

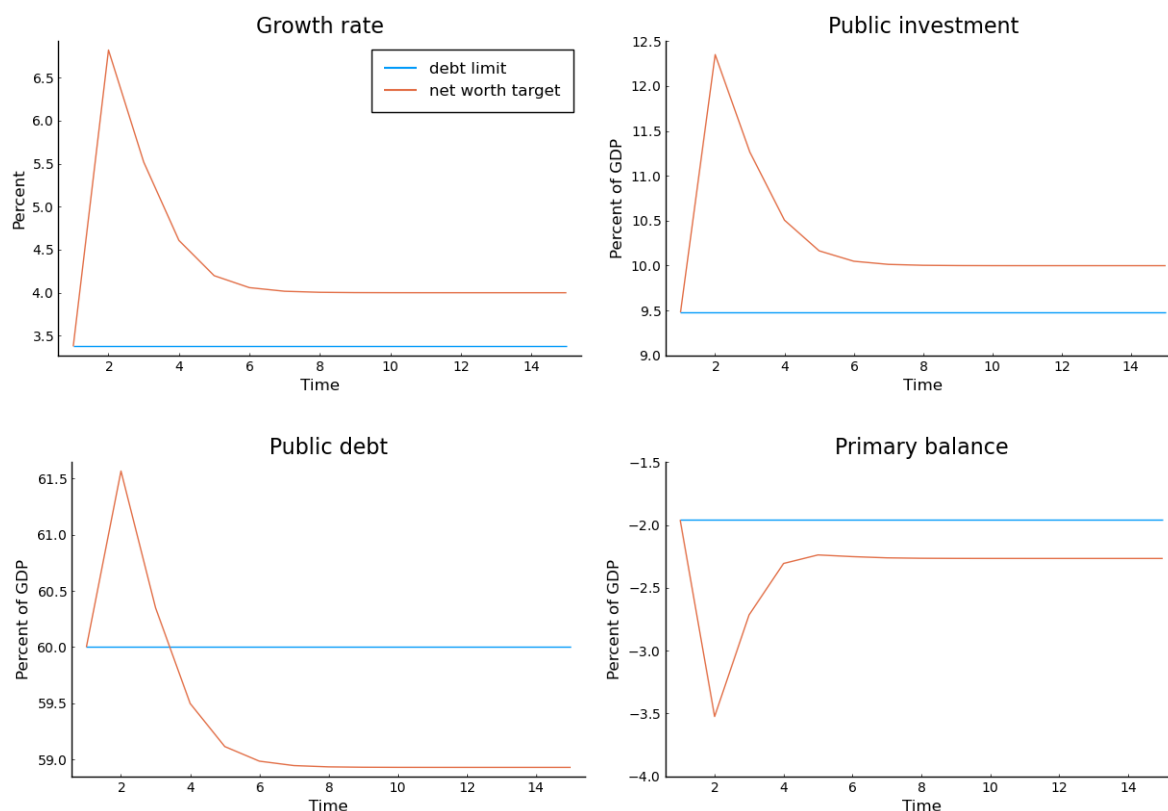
¹⁴ This can take the form of an additional debt ceiling on top of the net worth constraint. The debt ceiling is not always necessarily binding. When it does bind, both the net worth constraint (7) and debt constraint (5) have to be satisfied, which implies that $X_t/X_{t-1} = (n^* + \bar{d})\Phi/q$, essentially providing a cap on the rate of public investment.

¹⁵ The model places no restriction on the sign of the net worth ratio. A negative initial net worth does not alter the qualitative properties of the model.

As shown in Figure 3, the economy experiences a strong growth spurt before settling down to a new BGP growth rate higher than that under the debt ceiling. The changes in the growth rate reflect a similar pattern in the investment rate. As the debt ceiling is removed and a requirement for higher public sector net worth is instituted, the government responds by increasing public investment in an effort to create net worth and taking advantage of the low interest rate. The investment increase is financed by new borrowing, resulting in a temporary increase in public debt. As investment gradually converges to its BGP level and growth sits on a higher trajectory, public debt falls to just below 60 percent of GDP due to a more favorable $r - g$ differential, even though the primary deficit is larger.

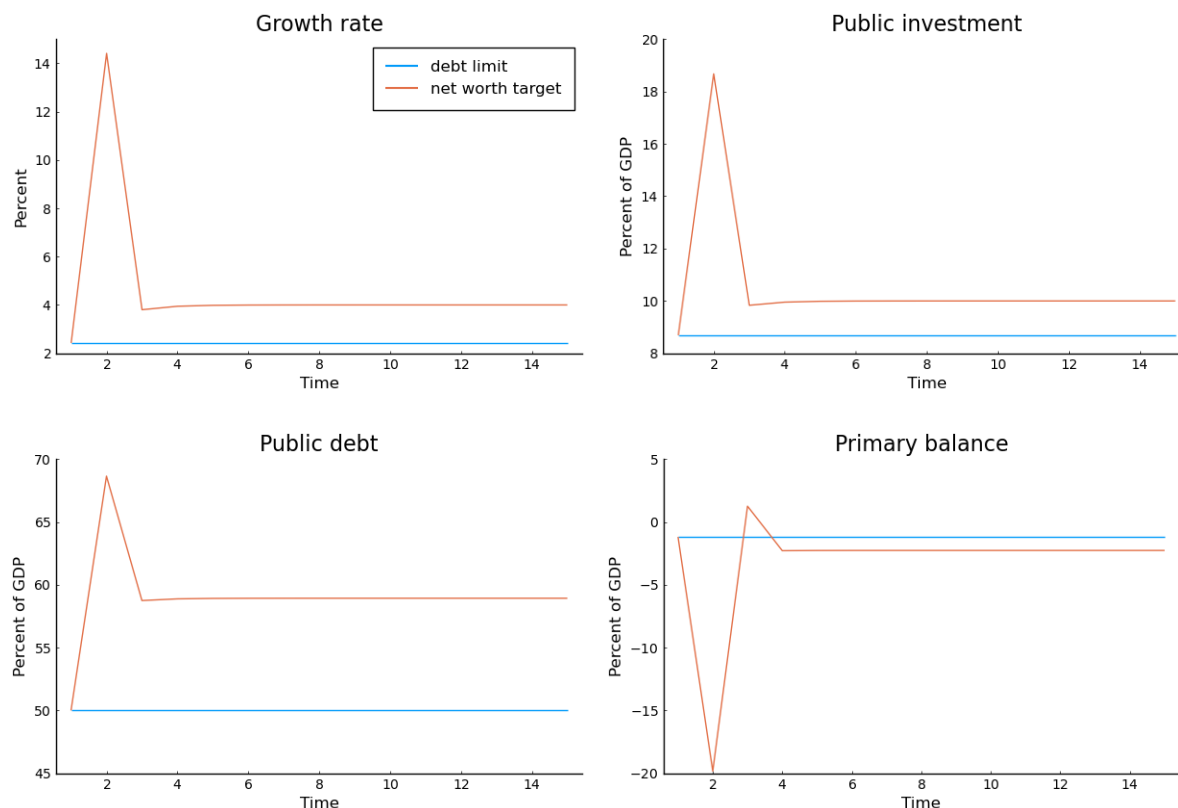
This example shows that instituting a public net worth anchor could induce higher public investment and economic growth, without jeopardizing debt sustainability.

Figure 3. From A Debt Ceiling to A Net Worth Anchor



Source: IMF staff calculations

Whether the long-run debt level will be higher than under the debt ceiling also depends on the initial debt level. In a second example (Figure 4) the economy starts on a lower public debt level of 50 percent of GDP and a higher starting public net worth of 45 percent of GDP. Otherwise, all parameter values are the same as in the first example. We set the same net worth target and hence the economy converges to the same BGP. However, in this case public debt *increases* from its initial level of 50 percent to its BGP level of just below 60 percent. We illustrate that therefore the government does not necessarily have to target a higher net worth than under the debt rule in order to achieve faster economic growth.

Figure 4. Transition from A Lower Debt Level

Source: IMF staff calculations

For simplicity, our model assumes an exogenous interest rate which does not respond to the government's level of borrowing. If instead the interest rate endogenous reacts to the amount of government borrowing, the properties of the net worth anchor derived here would still hold. Specifically, setting a higher net worth target when the interest rate is low still induces higher public investment and economic growth. However, the quantitative impact would be damped by interest rate increases as government debt rises. This as the debt service burden increases, while at the same time the net present value of public investment projects decreases. Such an endogenous interest rate setting will hence result in lower debt, investment, and growth relative to the scenario with an exogenous interest rate. However, it is worth noting that, as public investment increases, the rise in the interest rate would be mitigated through the positive effect investment would have on PSNW (Yousefi, 2019).

3.2 An Interest Rate Shock

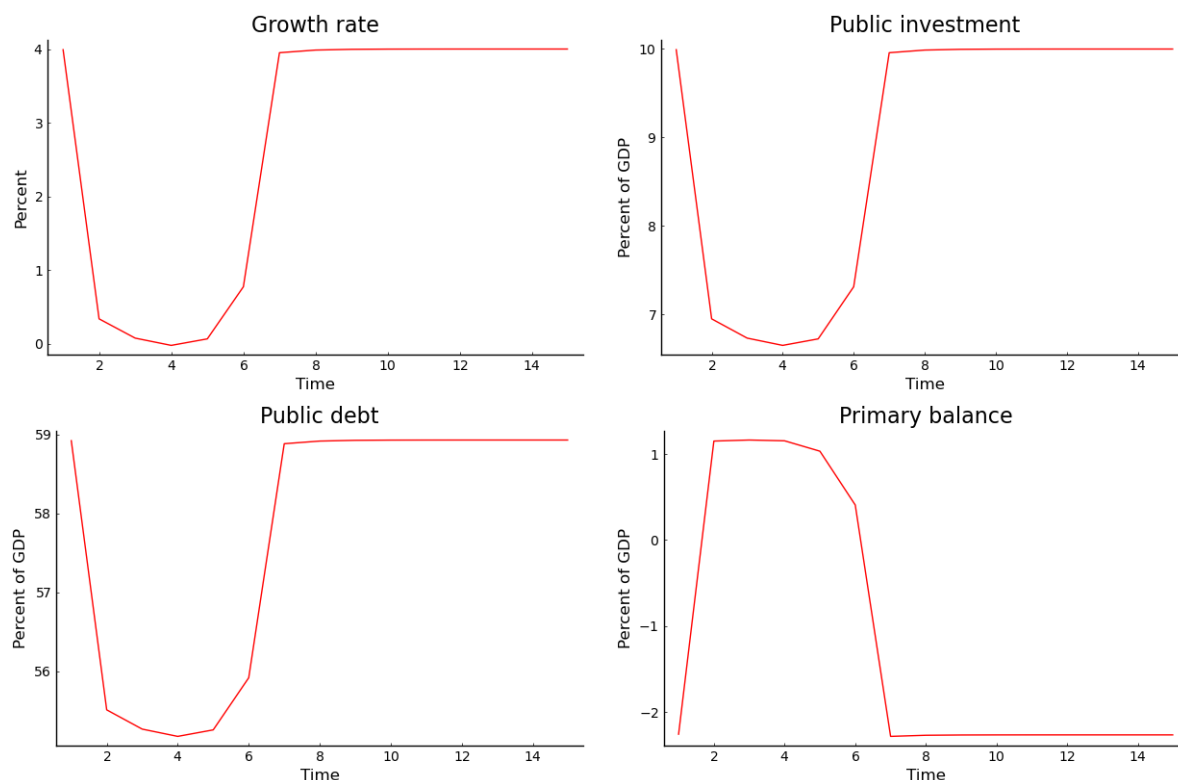
We now investigate what happens when the interest rate rises in an economy targeting net worth. Figure 5 showcases a temporary unanticipated shock to the real interest rate, which starts at zero and rises to 2 percent until period 5, when it returns to zero. Other parameters are the same as those used in Section 3.1.

Upon this shock, the economy goes through a period of consolidation. Public investment drops in response to the higher interest rate, resulting in a growth slowdown. However, the primary balance turns positive with

spending cuts, lowering the public debt to output ratio. All economic variables return to the unaltered BGP after the economy exits the high interest rate episode.

In contrast, under a debt anchor, higher interest rates would lead to a decrease in non-interest expenditures to accommodate higher interest expenses, without changing the debt-to-output ratio. The overall adjustment in the primary balance would be more limited than under a net worth target. This example hence shows that net worth targeting is more responsive to interest rate movements than a debt anchor.

Figure 5. A Positive Interest Rate Shock



Source: IMF staff calculations

Here a distinction needs to be made between a permanent shift in the real interest rate and a temporary shock. As alluded to in section II, a permanent shift in the real interest rate, typically reflecting shifting structural factors in the economy, would change the valuation of public assets and require an adjustment in the net worth target. A lower net worth target is appropriate when interest rates rise permanently, and vice versa. On the contrary, temporary fluctuations in the interest rate as in the above example do not change asset valuations and require no adjustment in the net worth target.

IV. Policy Discussions

4.1 Taking Stock

A medium-to-long-term net worth anchor provides strong benefits to fiscal policy makers. An improvement in public sector net worth can be achieved by either running surpluses, or by shifting expenditure towards

productive investment. This encourages productive public investment, which is pro-growth and hence worthy of prioritization, even as it is often politically more convenient to increase current spending or—when consolidating—cut investment rather than current spending. Furthermore, a net worth target is consistent with the principle of intergenerational equity, as it increases both public wealth and economic activity for future generations.

A net worth anchor also provides a feedback mechanism from interest rates to levels of public investment. By explicitly considering the interest rate at which the government can borrow, the amount of public investment reacts to changes in interest rates: lower rates allowing greater amounts of public investment, while higher rates reduce the amount. Thus, in cases such as those observed over the course of the 2010s, where the real cost of borrowing was far below the real growth rate, a net worth anchor would result in higher public investment. Should rates increase, such as in the immediate post pandemic world, or rates of growth decline, net worth targeting would mechanically lead to a decrease in public investment in response. Our simulations demonstrate that such an adjustment would take place gradually. When combined with prudent debt management, e.g., through pursuing long maturity of public debt, the net worth anchor shields public finances from the effect of any sudden or sustained increase in interest, while still allowing a higher level of public investment which in turn leads to higher future growth.

4.2 Comparison with Alternative Fiscal Anchors

A net worth anchor has connotations of the golden rule that has been previously used by governments, to mixed reviews. The golden rule requires that the government only borrow to fund public investments, which in effect translates into a net operating balance target, where current spending should be completely funded by revenues.

However, despite some initial attempts, the golden rule has not been favored in practice, due to some common drawbacks. First, the rule places no bounds on borrowing used to fund public investment, therefore incentivizing excessive borrowing and possibly even creating risks to fiscal sustainability (see, e.g., Valencia, 2015; Hughes, Leslie, and Pacitti, 2019). Second, the golden rule does not provide incentives for proper cost-benefit analysis. Without a strong PFM framework that rigorously assesses public investment, this may result in low quality white elephant projects with low social and economic returns (or $q < 1$ in the model above). Third, the distinction between public investment and current spending is not always clear, and this can lead to creative accounting and reclassification of current or unproductive expenditures to investment. Finally, the golden rule prioritizes investment spending over similarly worthy investments in human capital through education or health spending, which while categorized a current expenditure, share many of the same benefits as investment in physical capital.

The net worth anchor explicitly addresses two of these issues. First, by focusing on net worth, instead of just public investment, the anchor creates an incentive for productive investments. A project with greater costs than benefits leads to a reduction in net worth, thus would not make the cut under the net worth rule. Only those projects whose benefits exceed the costs would be permitted under the net worth anchor. Second, while there is no explicit debt ceiling, as shown in Section II the net worth anchor also provides an upper bound on public debt, keeping fiscal sustainability in check. Further, the golden rule provides no guide to the amount of public investment that should occur, leaving it unbounded, and insensitive to changes in interest rates.

A net worth anchor also shares similarities to fiscal rules targeting debt servicing costs (as either a percent of GDP or percent of revenue), an approach that is receiving some attention (e.g., Furman and Summers, 2020). Before the recent interest rate increases, a persistent decline in interest rates over the past three decades reduced the cost of debt significantly. This to the extent that in some cases public debt in excess of 100 percent of GDP featured the same interest expense (debt servicing costs) as debt levels half as large in previous years, suggesting that a debt servicing rule creates fiscal space. However, a debt servicing rule has drawbacks. First while the argument in favor of a debt servicing rule is often couched with reference to the extra fiscal space available to fund public investment, a debt service rule is agnostic about what the fiscal space will be used for – government could simply use the extra space to fund increased consumption. In contrast, a net worth anchor provides for both feedback from changing interest rates and an incentive to invest extra fiscal space in productive growth enhancing investments. In addition, targeting debt servicing could lead to excessive adjustments in the debt stock in response to a relatively minor change in the interest rate.

4.3 Operational Considerations

One challenging aspect to using a net worth anchor is defining exactly what represents a productive investment. Effectively investing in productive public capital is not easy. On average, countries lose around a third of the potential benefits from infrastructure investment due to inefficiencies (IMF, 2015). Ex ante assessments of the benefits of public investment are often overstated, and the costs understated, resulting in exaggerated benefits to net worth. This poses a practical challenge to the net worth anchor in countries with weak investment project evaluation capacity.¹⁶ However, it also increases the incentives to strengthen public investment management systems in order to prevent this situation arising. IMF research has indicated the improving PIM systems from the bottom quartile to the top quartile can double the return from public investments (IMF, 2015a). By requiring investments to demonstrate a positive contribution to net worth, it sets a higher bar than the golden rule and would hence prevent much of the creative accounting that sees current spending rebadged as public investment.

Another issue to be considered is what benefits should be included within the assessment of productive investments. As discussed in Section II, a purely financial approach to considering net worth could potentially discourage the pursuit of projects with lower financial returns to the government but higher social returns. In the model we assume that the value of a project depends on a weighted average of financial and social returns, with the weights assigned by authorities, reflecting their policy preferences. In practice, social returns to a public investment project are often harder to quantify than financial returns. Therefore, a net worth anchor can be usefully complemented by budgetary provisions that safeguard some fiscal resources for these low-financial-return-high-social-return projects. The weighting between financial and social returns assets provided in this paper allows for different approaches with respect to including the social returns, depending on the political preferences and degree of reliability of social return estimates.

It is important to properly evaluate public capital and carefully select public investment projects to ensure sufficiently high value of public capital. It is common practice to value public capital stock by the amount of investment that goes into capital formation. This practice essentially sets $q = 1$ regardless of the project's financial and social returns. When this is the case, debt-financed public investment does not create new net

¹⁶ See Hughes 2019 for an overview of how the UK, a pioneer in the evaluation of public investment projects, enhanced infrastructure project evaluation including through establishing the National Infrastructure Commission (NIC) for independent advice on the country's long-term infrastructure needs and evaluation of the value for money of major infrastructure projects.

worth, as new assets and liabilities offset each other and public investment only increases net worth if it is at least partially funded by government consumption cuts, leading to diminished incentives to pursue public investment. However, in practice there are many public investment projects that provide for a positive return, and the Government Financial Statistics Manual reflects this by recommending valuing assets at market value, or by an equivalent if assets are not or infrequently traded in markets, as is the case for many non-financial assets (IMF, 2014). Good public investment management practices are important to ensure investment goes to such projects with $q > 1$, and have been found to improve both the quality of public investment and its impact on economic growth (IMF 2015a).

What discount rate to apply in the valuation of public non-financial assets matters for operationalizing the net worth anchor. We favor using a long-term safe interest rate since it is less volatile than short-term rates. Nevertheless, as interest rate projections change over time, the valuation of public assets should be updated periodically, and the net worth target itself should be adjusted accordingly as well. At the same time, temporary shocks to the interest rate affect borrowing cost and would induce a response of fiscal spending but would not imply a need to re-assessment of the value of public assets.

Other operational considerations include that it may take time to realize the growth benefits of investment, while the associated debt is incurred at the onset, or that forecasts of the growth impact may turn out to be inaccurate or not correctly capture quality improvement effects. In the former case, the initial rise in the public debt to GDP level will be more pronounced. The qualitative results of applying PSNW targeting—which is forward-looking in nature—would not change unless the higher debt level were to run afoul of a secondary debt limit in the interim. And while forecast inaccuracies are unavoidable, they can be minimized by informing current practices by past experience or forecast errors. In addition, policymakers could consider including a buffer by taking a conservative view of financial and social return on investment. This is especially worthwhile in case of many competing investment priorities when some in principle worthwhile investment projects will need to be foregone or delayed. Finally, independent fiscal councils may play a useful role in cross-checking assumptions on investment returns, to counter public sector official's incentives to overestimate them in order to advance new projects. Such role to hence help ensure forecasts are not overly optimistic is in line with the role fiscal councils already play in many countries regarding macroeconomic (growth) forecasts.

Lastly, policymakers may want to weigh using PSNW or public sector *financial* net worth (which excluded nonfinancial public assets) as anchor.¹⁷ While the former is theoretically superior simply as it encompasses all productive public capital, authorities may consider using financial net worth as it is both easier to compute/compile and less ambiguous in terms of valuation. Still, even authorities that use financial metrics can work towards gradually broadening the scope towards “full” PSNW by improving their capacity to value public sector nonfinancial asset.

V. Conclusion

This paper studies public sector net worth as an anchor for fiscal policy. We find that a net worth target is conducive to public investment and economic growth, particularly in a low interest rate environment. A net

¹⁷ Japan's 2014 reform of the investment allocation profile of its Government Pension Investment Fund provides a good example of public *financial* asset management (“What Japan's most profitable policy experiment can teach us, Financial Times, May 14, 2024). This example also applies when targeting PSNW, as PSNW includes financial assets.

worth anchor also precludes explosive debt dynamics and guides fiscal policy to react to changes in the macroeconomic environment, including the interest rate. A net worth target is best used as a medium- to long-term guide to fiscal policy and can be complimented with debt-based considerations over the short-to-medium term. This leaves sufficient room for countercyclical fiscal policy at business cycle frequencies and mitigates the impact of fluctuations of the value of public assets stemming from movements in the exchange rate, interest rate, etc. While the operationalization of a net worth anchor presents challenges, these are surmountable. Overall, the potential benefit of using public sector net worth to guide fiscal policy over traditional debt-based fiscal rules is substantial.

Appendix A. Derivation of BGP under a Binding Debt Ceiling

Assume that the debt ceiling is binding (to be verified later). This implies that $D_t = \bar{d}\Phi X_{t-1}$. The budget constraint (3) then becomes:

$$\bar{d}\Phi X_{t-1} = G_t + I_t - \tau(1 - \alpha)\Phi X_{t-1} + (1 + r)\bar{d}\Phi X_{t-2}.$$

The government's problem is to choose the sequences of G_t , I_t , and X_t to maximize its lifetime utility subject to the budget constraint above and the evolution of public capital (2). We use the CRRA utility function:

$$u(G_t) = \frac{G_t^{1-\sigma}}{1-\sigma}.$$

The first-order conditions imply that

$$\left(\frac{G_{t+1}}{G_t}\right)^\sigma - \beta[\tau(1 - \alpha)\Phi + \bar{d}\Phi + (1 - \delta_x)] + \beta^2(1 + r)\bar{d}\Phi \left(\frac{G_{t+2}}{G_{t+1}}\right)^{-\sigma} = 0$$

Let the growth rate on BGP be g^d (superscript d for debt), we necessarily have the following condition: $\frac{G_{t+1}}{G_t} = 1 + g^d$.

Inserting this into the above equation, we obtain a non-linear equation from which to solve for g^d .

$$(1 + g^d)^\sigma - \beta[\tau(1 - \alpha)\Phi + \bar{d}\Phi + (1 - \delta_x)] + \beta^2(1 + r)\bar{d}\Phi(1 + g^d)^{-\sigma} = 0$$

This is essentially a quadratic equation in $(1 + g^d)$. To ensure existence of roots, we need to impose the following parameter restriction:

$$(\tau(1 - \alpha)\Phi + 1 - \delta_x + \bar{d}\Phi)^2 - 4(1 + r)\bar{d}\Phi \geq 0.$$

We select the one that makes economic sense. In numerical analysis, we pick parameter values to ensure that $r < g^d$. Equation (2) implies that on BGP, $I_t/Y_t = (g^d + \delta_x)/\Phi$. We can then use the budget constraint to obtain the current spending to output ratio as:

$$\frac{G}{Y} = \tau(1 - \alpha) - \frac{g^d + \delta_x}{\Phi} + \frac{g^d - r}{1 + g^d} \bar{d}.$$

To ensure that the debt ceiling is indeed binding, the following condition also needs to be satisfied:

$$\beta(1 + r) < (1 + g^d)^\sigma.$$

In addition, the following needs hold to ensure that lifetime utility is finite,

$$\beta(1 + g^d)(1 - \sigma) < 1.$$

For a given growth rate, g^d , the implied debt ceiling consistent with such growth rate can be shown to be:

$$\bar{d}(g^d) = \frac{(1 + g^d)^{2\sigma} - \beta(\tau(1 - \alpha)\Phi + 1 - \delta)(1 + g^d)^\sigma}{(z - \beta(1 + r))\beta\Phi}. \quad \text{A1}$$

Appendix B. Equilibrium under a Net Worth Constraint

The government's maximization problem is:

$$\begin{aligned} & \max_{G_t, I_t, X_t, D_t} \sum_{t=0}^{\infty} \beta^t u(G_t) \\ \text{s. t. } & D_t = G_t + I_t - \tau(1 - \alpha)\Phi X_{t-1} + (1 + r)D_{t-1}, \\ & qX_t - D_t = n^*\Phi X_{t-1}, \\ & X_t = (1 - \delta_X)X_{t-1} + I_t. \end{aligned}$$

The first-order conditions imply that:

$$G_t^{-\sigma}(q - 1) + \beta G_{t+1}^{-\sigma}[\tau(1 - \alpha)\Phi + 1 - \delta_X - q(1 + r) - n^*\Phi] + \beta^2(1 + r)n^*\Phi G_{t+2}^{-\sigma} = 0.$$

B.1 Balanced growth path

On BGP we have $G_{t+1}/G_t = (1 + g)$, therefore the above equation becomes the following non-linear equation,

$$(q - 1)(1 + g)^\sigma + \beta[\tau(1 - \alpha)\Phi + 1 - \delta_X - q(1 + r) - n^*\Phi] + \beta^2(1 + r)n^*\Phi(1 + g)^{-\sigma} = 0, \quad (\text{B1})$$

from which g can be solved for. Let $\psi = \tau(1 - \alpha)\Phi + 1 - \delta_X - q(1 + r)$. We can show that $\psi < 0$ (proof is available upon request).

To ensure existence of positive roots, the following parameter restrictions need to be satisfied:

$$\psi - n^*\Phi \leq 0,$$

and

$$(\psi - n^*\Phi)^2 - 4(q - 1)(1 + r)n^*\Phi \geq 0. \quad (\text{B2})$$

These conditions put restrictions on the choices of n^* .

- If $r + \delta_X - \tau(1 - \alpha)\Phi \geq 0$, then (B2) is satisfied and there is a lower bound for n^* :

$$n^* \geq \frac{\psi}{\Phi}.$$

- If $r + \delta_X - \tau(1 - \alpha)\Phi < 0$, then let n_1 and n_2 denote the two roots associated with equation (B2) with equality.

$$n_{1,2} = \frac{[\psi + 2(q - 1)(1 + r)] \pm 2(q - 1)^{\frac{1}{2}}(1 + r)^{\frac{1}{2}}(\psi + (q - 1)(1 + r))^{\frac{1}{2}}}{\Phi}$$

Then in addition to satisfying $n^* \geq \psi/\Phi$, we also need $n^* \leq n_1$ or $n^* \geq n_2$.

These restrictions are satisfied in all numerical examples provided in this paper.

We then use equation (7) to solve for the debt-to-output ratio:

$$\frac{D}{Y} = q(1 + g) - n^* \Phi. \quad (\text{B3})$$

We then use the budget constraint to calculate G/Y , using the fact that $I/Y = (g + \delta_x)/\Phi$,

$$\frac{G}{Y} = \left(1 - \frac{1+r}{1+g}\right) \left[\frac{q(1+g)}{\Phi} - n^*\right] - \frac{g + \delta_x}{\Phi} + \tau(1 - \alpha).$$

B.2. Proof that g increases with n^* on BGP

Instead of examining how g varies as a function of n^* , we do the opposite, that is, to analyze how the implied n^* changes with targeted g . Let $z = (1 + g)^\sigma$. Using equation (B1), we obtain:

$$n^* = \frac{(q-1)z^2 + \beta\psi z}{(z - \beta(1+r))\beta\Phi}.$$

Differentiate n^* w.r.t. g eventually yields:

$$\frac{dn^*}{dz} = \left[z[z - \beta(1+r)] - \beta(1+r) \left(z + \frac{\beta\psi}{q-1} \right) \right] \cdot \text{const},$$

where const is a positive constant term. Recall the assumption introduced in Appendix A that ensures a binding debt ceiling, $z > \beta(1+r)$, we have:

$$\frac{dn^*}{dz} > -\beta(1+r) \left(z + \frac{\beta\psi}{q-1} \right)$$

Note that $\psi < 0$. For a wide range of reasonable parameter values, e.g., those used in this paper, the right-hand side expression is positive for $z = 1$, that is $g = 0$. Note that the expression for $\frac{dn^*}{dz}$ is increasing in z . This implies that for positive values of g , this derivative is positive. That is, there is a positive association between n^* and g . Note that if the interest rate is high, i.e., if $\beta(1+r) > z$, then the relationship between n^* and g are more likely to be negative.

B.3. Proof that at the same growth rate g , debt level under net worth targeting is lower than that under the debt ceiling.

As in B.2., n can be expressed as a function of g . Let $z = (1 + g)^\sigma$, then

$$n = \frac{(q-1)z^2 + \beta\psi z}{(z - \beta(1+r))\beta\Phi}.$$

From equation (B3) in B.1, the debt-to-output ratio at growth rate g is given by

$$\frac{D}{Y} = \frac{(\beta q + 1 - q)z^2 - \beta(\psi + (1+r)\beta q)z}{(z - \beta(1+r))\beta\psi}.$$

By comparing with (A1) in Appendix A, we immediately notice that the debt-to-output ratios under these two constraints are equal if $q = 0$. Therefore, to compare the debt-to-output ratios, we only need to evaluate the sign of the sum of terms involving q in the above expression, that is,

$$(\beta - 1)qz^2 - \beta z(\beta - 1)(1 + r)q = -(1 - \beta)qz[z - \beta(1 + r)].$$

The term in the bracket is positive given assumption in Appendix A that ensures the debt ceiling is binding. Therefore, the above expression is negative, implying a lower debt-to-output ratio under net worth targeting.

B.4 Dynamics

We introduce public capital adjustment cost to generate more realistic dynamics. The budget constraint from Appendix B becomes

$$D_t = G_t + I_t \left(1 + \frac{\phi}{2} \frac{I_t}{X_{t-1}}\right) - \tau(1 - \alpha)\Phi X_{t-1} + (1 + r)D_{t-1}. \quad (\text{xx})$$

The first order conditions imply that

$$\begin{aligned} G_t^{-\sigma} \left(q - 1 - \phi \frac{I_t}{X_{t-1}} \right) + \beta^2 (1 + r) n^* \Phi G_{t+2}^{-\sigma} \\ + \beta G_{t+1}^{-\sigma} \left[\tau(1 - \alpha)\Phi + \left(1 + \phi \frac{I_{t+1}}{X_t} \right) (1 - \delta_X) - q(1 + r) - n^* \Phi + \frac{\phi}{2} \left(\frac{I_{t+1}}{X_t} \right)^2 \right] = 0 \end{aligned}$$

We are interested in characterizing the dynamic system in terms of ratios of variables. Let $\theta_t = G_t/X_{t-1}$, $x_t = X_t/X_{t-1}$, $d_t = D_t/X_{t-1}$, and $i_t = I_t/X_{t-1}$.

The equation above, as well as the budget constraint, the net worth constraint, and the law of motion of public capital can be written as a dynamic system of equations in these ratios.

$$\begin{aligned} \left(\frac{\theta_t}{x_t} \right)^{-\sigma} \left(q - 1 - \phi i_t \right) + \beta^2 (1 + r) n^* \Phi + \beta \theta_{t+1}^{-\sigma} \left[\tau(1 - \alpha)\Phi + (1 + \phi i_{t+1})(1 - \delta_X) - q(1 + r) - n^* \Phi + \frac{\phi}{2} i_{t+1}^2 \right] = 0, \\ d_t = \theta_t + i_t \left(1 + \frac{\phi}{2} i_t \right) - \tau(1 - \alpha)\Phi + (1 + r) \frac{d_{t-1}}{x_{t-1}}, \\ qx_t - d_t = n^* \Phi, \end{aligned}$$

and

$$x_t = i_t + 1 - \delta_X.$$

The only initial condition needed is d_0/x_0 , which is proportional to the debt-to-assets ratio. We use Dynare to solve the transition path from given initial conditions to the BGP as well as shocks to the real interest rate.

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