Economics Bulletin

Volume 40, Issue 4

Assessing sovereign debt sustainability using a wealth-based fiscal indicator

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Abstract

Working in the context of an endogenous growth model with the public sector, we show that forward-looking agents' optimizing behavior typically gives rise to a wealth-based, rather than to an output-based, sustainability index of government policy. New insights emerge from calibrating the index to European countries along with the U.S. and Japan as reference countries.

We would like to convey our profound thanks to Giancarlo Marini for pushing us to pursue this line of inquiry. We are very grateful for valuable comments and suggestions to the Associate Editor Luis Araujo, Giovanni Di Bartolomeo, Alessia Franzini, Michele Postigliola and participants at the 18th Annual Conference of the European Economics and Finance Society (EEFS), University of Genoa, June 13-16, 2019, and at the 60th Annual Conference of the Italian Economic Association, University of Palermo, October 24-25, 2019. The usual disclaimers apply.

Citation: Paolo Canofari and Alessandro Piergallini and Giovanni Piersanti, (2020) "Assessing sovereign debt sustainability using a wealth-based fiscal indicator", *Economics Bulletin*, Volume 40, Issue 4, pages 2677-2688

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Submitted: June 10, 2020. **Published:** October 12, 2020.

"A focus on the ratio of debt-to-GDP is simply economic nonsense. No one would judge a firm by looking at its debt alone. Anyone claiming economic expertise would want to look at the balance sheet—assets as well as liabilities."

—Joseph E. Stiglitz, (*The Economists' Voice*, 2012)

1. Introduction

In the economics literature, the fiscal position and the sustainability of budgetary policies are commonly evaluated by assessing the time path of the debt-to-GDP ratio. This paper proposes and quantifies an alternative approach to examine the issue of government solvency. We use an endogenous growth model with the public sector and show that forward-looking agents' optimizing behavior typically gives rise to a wealth-based—rather than to an output-based—sustainability index of government policy.[1] We then compute the resulting fiscal indicator from 2001 to 2017 for a large panel of European countries, along with the U.S. and Japan as reference countries, and obtain results that differ from common wisdom. In particular, our analysis finds the long-run fiscal balance of countries such as Norway, the Netherlands, Denmark, Belgium, Finland, Germany and Italy to be on a sustainable path, whereas that of countries such as Austria, Portugal, Greece, France, Spain, the U.K., Slovenia, Hungary, along with the U.S. and Japan, to be on an unsustainable path.

These findings are obscured and even overturned if one concentrates on the dynamics of the debt-to-GDP ratio. The unsustainability results obtained, say, for Austria and France on the one hand, in conjunction with the sustainability results obtained, say, for Italy on the other hand, are instructive in this perspective. More in general, the analysis presented in this paper indicates that embodying agents' wealth in the construction of fiscal policy indicators may be an important, well-theoretically grounded strategy aimed to assess comprehensively fiscal sustainability.[2] A relevant advantage of the approach undertaken here reflects the fact that countries with nearly the same national income may not have the same accumulated national wealth and, hence, the same ability to sustain a given debt burden. In other words, our microfounded approach explicitly takes into account not only the liability side of the

[1]The drawbacks of the debt-to-GDP ratio indicator have been frequently recognized in the literature, prompting many to search for alternative measures, such as the debt-to-revenues ratio, the debt-to-exports ratio, or the debt-to-GNI ratio (e.g., Balassone, Franco and Zotteri, 2007; Giammarioli et al., 2007; Wyplosz, 2011; Blot, 2018; Greenwood, 2018).

[2]In this context, our paper adds to the burgeoning literature on better metrics for better policies opened up by the "Beyond GDP" roadmap adopted in 2009 in international organizations such as the European Union, OECD, IMF, World Bank (e.g., Stiglitz et al., 2009, 2018; Arrow et al., 2012; Feigl et al., 2013; Dasgupta, 2015; Stiglitz, 2016; Coyle, 2017; Giovannini and Rondinella, 2018).

government, but also the asset side, which constitutes the other component of a country's balance sheet.[3]

The paper proceeds as follows. Section 2 sets forth the optimizing model. Section 3 calibrates the implied fiscal sustainability indicator for the European countries, the United States and Japan. Section 4 concludes.

2. The Model

To make our point transparent—without unnecessary complications—consider the following simple model setup with endogenous growth, allowing fiscal policy to play a key role in the long-run economic growth and extending the seminal paper by Barro (1990) to endogenous debt dynamics:

$$U = \int_t^{\infty} \frac{1}{\sigma} \left(C G_C^{\varepsilon}\right)^{\sigma} e^{-\beta(v-t)} dv,\ \varepsilon > 0,\ -\infty < \sigma < 1, \tag{1}$$

$$\varepsilon\sigma < 1,\ 1 > \sigma\left(1+\varepsilon\right),$$

$$\dot{W} \equiv \dot{K} + \dot{B} = rB + \left(1-\tau\right) Y - \left(1+\varkappa\right) C - T, \tag{2}$$

$$Y = A G_I^{\alpha} K^{1-\alpha} = A \left(\frac{G_I}{K}\right)^{\alpha} K,\ 0 \leq \alpha \leq 1, \tag{3}$$

$$\dot{K} = Y - C - G, \tag{4}$$

$$\dot{B} = rB + G - \tau Y - \varkappa C - T, \tag{5}$$

where C = private consumption, G_C = government spending on consumption goods, $W \equiv K + B$ = real wealth, K = private capital stock, B = government bonds, r = real rate of interest, τ = (constant) tax rate on income, $\varkappa$ = (constant) tax rate on consumption, T = lump-sum taxes net of transfers, Y = output, and G_I = government spending on infrastructures. All variables, except for τ and $\varkappa$, are time dependent, though for notational convenience the time index is suppressed.

Equation (1) is the intertemporal isoelastic utility function of the (representative) household, where ε measures the impact of government consumption on the welfare of private agents, σ a parameter linked to the intertemporal elasticity of substitution ξ by $\sigma = \left(\xi - 1\right)/\xi$), and the constraints on the coefficients are imposed to ensure conventional concavity properties. Equation (2) is the household's budget constraint. Equation (3) is the economy's production function, where K is assumed to be infinitely durable, and A is an index of technological knowledge. Equation (4) is the economy-wide resource constraint, where $G \equiv G_C + G_I$. Equation (5) is the government's budget constraint.

[3] Arrow et al. (2012), Piketty and Zucman (2014), Piketty (2015), and Stiglitz (2016) further emphasize the central role of wealth and its structure (i.e., the proportions of productive capital and of financial wealth) to assess the sustainability. Indeed, there is little relationship between GDP and the amount of adequate revenues that can be collected (Larch and Nogueira Martins, 2007; Giammarioli et al., 2007; Aizenman and Jinjarak, 2010; Wyplosz, 2011; Greenwood, 2018).

Applying standard optimization techniques yields

$$\left(CG_C^{\varepsilon}\right)^{\sigma-1} G_C^{\varepsilon} = \lambda \left(1+\varkappa\right), \tag{6}$$

$$r = A\left(1-\alpha\right)\left(1-\tau\right)\left(\frac{G_I}{K}\right)^{\alpha} = \beta - \frac{\overset{\bullet}{\lambda}}{\lambda} \tag{7}$$

and the transversality conditions

$$\lim_{v\longrightarrow\infty} \lambda B e^{-\beta(v-t)} = \lim_{v\longrightarrow\infty} \lambda K e^{-\beta(v-t)} = \lim_{v\longrightarrow\infty} \lambda W e^{-\beta(v-t)} = 0. \tag{8}$$

Solving the model along the balanced growth path under constant shares of output for government expenditure yields

$$\mathbf{g} = \frac{r-\beta}{1-\sigma\left(1+\varepsilon\right)} \tag{9}$$

$$r = A(1-\alpha)(1-\tau)(A\gamma_I)^{\left(\frac{\alpha}{1-\alpha}\right)} \tag{10}$$

$$\frac{C}{K} \equiv \varphi = \frac{r\left(1-\gamma_C-\gamma_I\right)}{(1-\alpha)(1-\tau)} - \mathbf{g} \tag{11}$$

$$\frac{K}{W} \equiv \omega = \frac{r-\mathbf{g}}{(1+\varkappa)\varphi - \dfrac{r\alpha}{1-\alpha}} \tag{12}$$

$$\frac{C}{W} \equiv \eta = \frac{r\left(1+\dfrac{\alpha\omega}{1-\alpha}\right) - \mathbf{g}}{(1+\varkappa)} \tag{13}$$

where $\mathbf{g}$ is the long-run equilibrium growth rate, and $\gamma_C \equiv (G_C/Y)$ and $\gamma_I \equiv (G_I/Y)$ are the (constant) shares of government spending on consumption and infrastructures, respectively. From (9)-(13) the following (partial derivative) effects of changes in taxation and expenditure policy parameters $(\tau, \varkappa, \gamma_C, \gamma_I)$ can be computed immediately:

$$\begin{aligned}
\partial\left(C/K\right)/\partial\tau &> 0, \partial r/\partial\tau < 0, \partial\mathbf{g}/\partial\tau < 0;\\
\partial\left(C/W\right)/\partial\varkappa &< 0, \partial\left(K/W\right)/\partial\varkappa < 0, \partial r/\partial\varkappa = \partial\mathbf{g}/\partial\varkappa = 0;\\
\partial\left(C/K\right)/\partial\gamma_C &< 0, \partial r/\partial\gamma_C = \partial\mathbf{g}/\partial\gamma_C = 0;\\
\partial r/\partial\gamma_I &> 0, \partial\mathbf{g}/\partial\gamma_I > 0.
\end{aligned}$$

Now, in order to assess the long-run sustainability of the government's budget, let the sovereign bonds consist only of perpetuities, paying a coupon rate of one unit, for simplicity. Hence, the budget constraint (5) can be rewritten as

$$\frac{\overset{\bullet}{b}}{r} = b + \left[\frac{\left(\gamma_C+\gamma_I-\tau\right)r}{(1-\alpha)(1-\tau)} - \varkappa\varphi\right]K - T, \tag{14}$$

where b is the number of outstanding bonds, $1/r$ the value of the government bond, and $B = b/r$ the value of the outstanding debt. Using (12), integrating (14) over the range $[t,\infty)$ and applying the transversality conditions (8) lead to

$$\int_t^\infty T_v e^{-r(v-t)} dv = \frac{b_t}{r} + \int_t^\infty \left[\frac{(\gamma_C + \gamma_I - \tau)\, r}{(1-\alpha)(1-\tau)} - \varkappa\varphi \right] \omega W_t e^{-(r-\mathbf{g})(v-t)} dv. \tag{15}$$

Solving (15) under $r > \mathbf{g}$ and dividing through by the size of the current wealth yield

$$F_t \equiv \int_t^\infty \frac{T_v e^{-r(v-t)}}{W_t} dv = \frac{(b_t/r)}{W_t} + \frac{r\left[\dfrac{\gamma_C + \gamma_I - \tau}{(1-\alpha)(1-\tau)}\right] - \varkappa\varphi}{r - \mathbf{g}} \omega. \tag{16}$$

Equation (16) is a central relationship of the model and provides a consistent index to assess the intertemporal (or long-run) sustainability of the government budget policy. It measures the present value of fiscal policy adjustments in equilibrium necessary to ensure the sustainability of government debt along the balanced growth path. A number of advantages follow from (16). First, all values turn to be relative to the current size of wealth, differently from indicators based upon the debt-to-GDP ratio, where a stock variable is measured relative to a flow variable. Second, the right-hand side includes two (correctly normalized) components. The first is the current stock of government debt. The second is the present value of the primary budget deficit in equilibrium. Hence, the left-hand side computes the value of fiscal policy adjustments required to warrant the viability of the long-run fiscal balance as reflected by the two components in the right-hand side of (16). Third, being based on endogenous growth model, the index provides a dynamic scoring of the government fiscal balance that switches emphasis from levels to paths and computes how much adjustment is required to converge to the stability path.

Consequently, we can assess a country's fiscal position as follows: when $F_t \leq 0$, we say that fiscal policy is strongly sustainable, meaning that the long-run government's budget requires no corrective action for it generates sufficient primary budget surpluses to exactly finance the outstanding debt, b_t; when $0 < F_t \leq (b_t/r)/W_t$, we say that fiscal policy is weakly sustainable, implying that the government is running a primary surplus, but of insufficient magnitude to fully pay off its debt; when $F_t > (b_t/r)/W_t$, we say that fiscal policy is unsustainable, as the government is running a primary deficit which adds to its outstanding debt, thus requiring a corrective action to ensure the intertemporal viability of the budget.

3. Indicator Calibration

This section computes the fiscal sustainability index for European countries over the period 2001-2017 along with the U.S. and Japan as reference countries. A detailed list of the variables with the indication of their statistical source is in the Data Appendix.

Consistently with the restriction imposed on (16), we calculate the fiscal sustainability index F_t only for those countries in which the after-growth real interest rate $(r - \mathbf{g})$ came out to be positive. This condition is crucial for determining a country's maximum sustainable debt level and implies that the debt ratio will explode in the future unless the government runs a large budget surplus to compensate. Hence, to stay in a non-explosive path, the total value of the debt outstanding must be paid off by future budget surpluses.

Conversely, if $(r - \mathbf{g}) < 0$, a positive growth dividend will always ensure the long-run sustainability of the government's budget (e.g., Bohn, 2008; Barret, 2018; Blanchard, 2019). Among the 28 European economies for which data are available, the countries that exhibit a negative after-growth interest rate and therefore not included in the debt sustainability rating are Turkey (–0,101), Romania (–0,045), Estonia (–0,041), Latvia (–0,027), Bulgaria (–0,025), Ireland (–0,023), Luxembourg (–0,017), Lithuania (–0,016), Czech Republic (–0,011), Sweden (–0,006), Iceland (–0,005), Malta (–0,004) and Poland (–0,004).

It is worth pointing out that the inflation rate is a key factor determining the negative after-growth interest rate in a number of countries such as Turkey, Romania, Estonia, Latvia and Bulgaria. Thus, it should be said, two caveats to our analysis apply. First, the presence of large inflation is likely not to yield a proper assessment of the real interest rate. Fiscally responsible countries do not need to run high inflation in order to sustain their debt burden overtime. Second, we abstract from a possible (potentially nonlinear) negative effect of relatively pronounced inflationary paths on future growth perspectives (see Orphanides and Solow, 1990, and Walsh, 2017, for reviews of the standard literature on the issue), which is consistent with empirical evidence provided by Barro (1995, 1996). Constructing a monetary optimizing model with endogenous growth and deriving the implied sustainability index of government policy able to incorporate the inflation-growth nexus is an important consideration for future research. The present modeling approach to debt sustainability could then constitute a fruitful benchmark for a more complex investigation along this direction.

Table 1: Average values for parameters, 2001-2017

Country	$\gamma_C + \gamma_I$	τ	g	r
Norway	0,4367099	0,4422103	0,016317	0,017684
Netherlands	0,4264587	0,3132675	0,013323	0,018163
Denmark	0,517189	0,376253	0,010543	0,031201
Belgium	0,480232	0,372129	0,014536	0,021797
Finland	0,508657	0,394376	0,013418	0,018551
Germany	0,4294754	0,331221	0,013132	0,020585
Italy	0,4408448	0,312748	0,001837	0,024741
Austria	0,484265	0,346574	0,015045	0,021818
Portugal	0,4365296	0,27743	0,004689	0,023017
United States	0,3472825	0,252173	0,018997	0,027982
Greece	0,4542297	0,293295	0,000154	0,018351
France	0,5244487	0,358438	0,012426	0,020566
Spain	0,3957516	0,269941	0,016473	0,019586
United Kingdom	0,3993102	0,256886	0,017855	0,023555
Slovenia	0,4506114	0,287466	0,021984	0,027758
Hungary	0,4511532	0,277481	0,021817	0,02313
Japan	0,3669752	0,253663	0,0085178	0,0099018

Table 2: Average values for parameters, 2001-2017				
Country	$\varphi = \frac{C}{K}$	α	$r - g$	$\varkappa$
Norway	0,150851	0,916758	0,001367	0,301123
Netherlands	0,169699	0,918148	0,004839	0,246054
Denmark	0,195134	0,882367	0,020658	0,357328
Belgium	0,194482	0,913158	0,007261	0,247942
Finland	0,179698	0,922216	0,005133	0,258655
Germany	0,191199	0,913407	0,007453	0,189678
Italy	0,191614	0,890064	0,022904	0,23931
Austria	0,152937	0,894668	0,006772	0,271297
Portugal	0,218407	0,912956	0,018327	0,218808
United States	0,291156	0,915044	0,008986	0,103707
Greece	0,180125	0,91364	0,018196	0,200162
France	0,181802	0,914961	0,00814	0,282798
Spain	0,172008	0,91138	0,003114	0,194256
United Kingdom	0,240085	0,921131	0,005699	0,187527
Slovenia	0,264147	0,92197	0,005774	0,270917
Hungary	0,261017	0,936455	0,001313	0,312781
Japan	0,1916	0,955802	0,001384	0,131122

Tables 1-4 report the (average) values of all components, needed to determine F_t, according to equation (16). Table 1 shows the values of all parameters for which official data are available, i.e., $\gamma_C, \gamma_I, \tau, g, r$ (see the Data Appendix). Table 2 shows the values of α (the output elasticity to public investment) obtained from equation (11) and computed as

$$\alpha = \frac{(\mathbf{g} \ + \varphi)(1-\tau) - (1-\gamma_C - \gamma_I)\ r}{(1-\tau)\ (\mathbf{g} \ + \varphi)}, \tag{17}$$

using the official data of the parameters on the right-hand side of (17).

Tables 3-4 show the average value of F_t, along with the two basic components, given by (B_t/W_t) and $\{r\left[(\gamma_C + \gamma_I - \tau)/(1-\alpha)(1-\tau)\right] - \varkappa\varphi\}\,\omega/\left(r - \mathbf{g}\right)$, and the country's sustainability ranking. The tables reveal that the fiscal position of countries such as Norway, the Netherlands, Denmark, Belgium, and Finland is strongly sustainable because the index takes on a value $F_t < 0$. The position of Italy and Germany is found to be weakly sustainable because $0 < F_t \leq B_t/W_t$. By contrast, all the remaining countries are found to be on an unsustainable path as $F_t > B_t/W_t$.

Additional information on the above governments' budget position is given in Figures 1-3. The figures display the dynamics of F_t over 2001-2017 after partitioning the whole set of countries in the subsets of strongly sustainable (Figure 1)[4], weakly sustainable (Figure 2) and unsustainable countries (Figure 3). The graphs confirm the findings reported in Tables 3-4 and make visible a dynamics of the index not too far from the computed country's average values, despite a common upward trend observed in the global financial crisis period.

[4]Norway, showing a similar path, is not reported for not squeezing too much information.

Table 3: Average fiscal sustainability indicator, 2001-2017				
Country	$\frac{B_t}{Y_t}$	$\frac{B_t}{W_t}$	$\frac{r\left[\frac{\gamma_C+\gamma_I-\tau}{(1-\alpha)(1-\tau)}\right]-\varkappa\varphi\omega}{r-\mathbf{g}}$	F_t
Norway	0,371931	0,1257	-31,2034	-31,0777
Netherlands	0,561331	0,12925	-0,67376	-0,54451
Denmark	0,407923	0,116013	-0,31865	-0,20263
Belgium	1,006081	0,203936	-0,37082	-0,16689
Finland	0,474986	0,133412	-0,23673	-0,10332
Germany	0,690463	0,16937	-0,12984	0,039528
Italy	1,139237	0,224569	-0,105	0,119574
Austria	0,748577	0,160669	0,236666	0,397335
Portugal	0,921602	0,227736	0,421197	0,648934
United States	0,8313	0,15907	0,589551	0,748621
Greece	1,371274	0,295885	0,562302	0,858188
France	0,789165	0,180044	0,936081	1,116125
Spain	0,655883	0,14979	1,172252	1,322042
United Kingdom	0,620011	0,129801	1,223221	1,353023
Slovenia	0,448981	0,161833	1,27947	1,441303
Hungary	0,695468	0,245472	3,271528	3,517
Japan	1,989017	0,3564907	3,445404	3,801895
Average	**0,807249**	**0,186414**		

Table 4: Countries' classification		
Strongly Sustainable	**Weakly Sustainable**	**Unsustainable**
Norway	Germany	Austria
Netherlands	Italy	Portugal
Denmark		United States
Belgium		Greece
Finland		France
		Spain
		United Kingdom
		Slovenia
		Hungary
		Japan

The above results are at variance with consolidated beliefs about sovereign debt sustainability in European countries and suggest that assessments of government solvency based on the dynamics of the debt-to-GDP ratio should arguably be coupled with assessments based on the dynamics of the debt-to-wealth ratio. This is visible from Table 4. First, the value F_t depends and strictly reflects via $\{r\left[\left(\gamma_C+\gamma_I-\tau\right)/(1-\alpha)(1-\tau)\right]-\varkappa\varphi\omega\}/\left(r-\mathbf{g}\right)$ both the government budgetary policy and the productivity of the economy depending on the capital

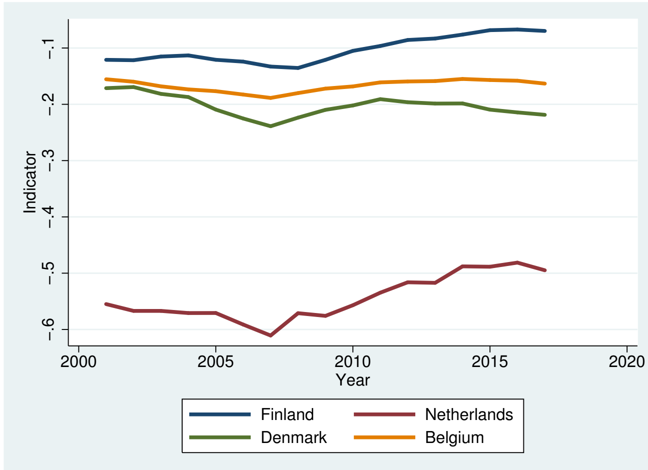

Figure 1: Strongly sustainable countries, 2001-2017

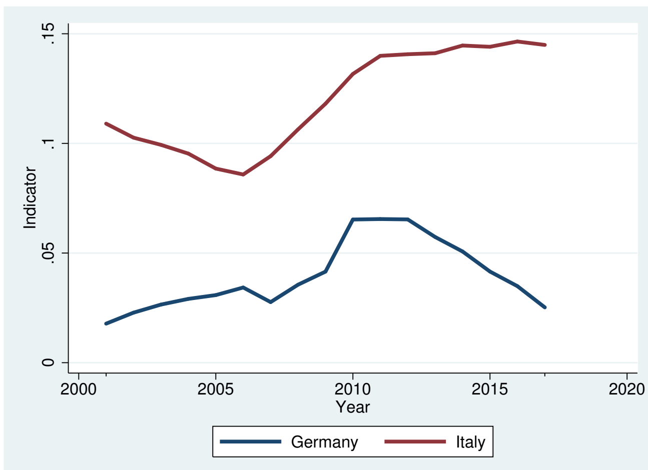

Figure 2: Weakly sustainable countries, 2001-2017

stock—a feature not found in the debt-to-GDP metrics.[5] Second, if consistently measured relative to the current level of wealth, public debt levels are much less threatening than the corresponding debt-to-GDP ratios, as they amount to less than 20 percent of total wealth on average in contrast to the 81 percent of total output.

The foregoing approach to the sustainability assessment of government debt is not without policy implications as it points to fiscal policy reactions and commitments running in the opposite direction of those recommended so far for some European countries because of their debt-to-GDP ratios. The (un)sustainability results we obtain, say, for Austria, France and Italy are enlightening, and constitute a plausible explanation about the observed course of visible disagreement on the fiscal austerity measures undertaken within the Eurozone in

[5] The central role of the capital stock in wealth metrics used to assess economic sustainability is emphasized, e.g., in Stiglitz et al. (2009, 2018) and Stiglitz (2016).

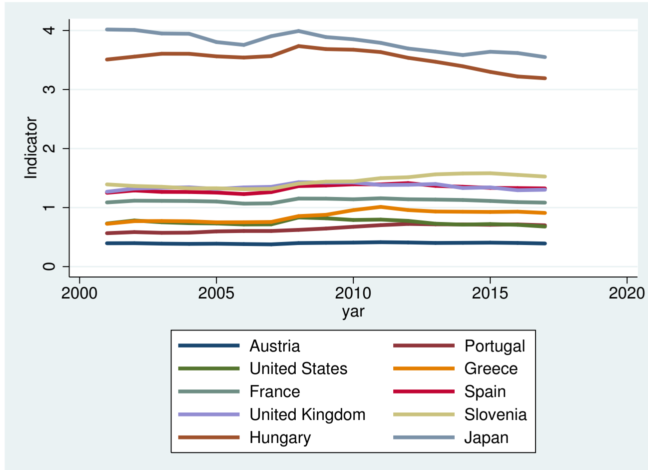

Figure 3: Unsustainable countries, 2001-2017

the post-Great Recession period.

4. Conclusions

Having a reliable indicator—theoretically grounded and internally consistent—measuring the budgetary adjustments needed to warrant the long-run sustainability of the government debt is essential to monitor appropriately the stance of fiscal policy. In this paper, we have concentrated on an alternative strategy to assess fiscal sustainability with respect to the widely adopted recourse to the debt-to-GDP ratio.

Specifically, using an endogenous growth model with the public sector, we have shown that forward-looking agents' optimizing behavior typically opens the door to a wealth-based and not to an output-based sustainability index of government policy. Computing the index from 2001 to 2017 for a large panel of European countries along with the U.S. and Japan as reference countries, we have obtained results remarkably different from consolidated beliefs. In particular, our analysis has found the long-run fiscal position of Norway, the Netherlands, Denmark, Belgium, Finland, Germany, and Italy to be on a sustainable trajectory, whereas that of Austria, Portugal, Greece, France, Spain, the U.K., Slovenia, Hungary, together with the U.S. and Japan, to be on an unsustainable trajectory.

Such results are arguably overlooked if one focuses the attention on the dynamics of the debt-to-GDP ratio—the case of Austria, France and Italy is instructive—and do signal that computing indicators and tests of debt sustainability based upon the debt-to-wealth ratio may be an essential prerequisite to evaluate comprehensively the issue of public solvency and check the robustness of (un)sustainability results grounded on the debt-to-GDP ratio.

Data Appendix

Data Description - Yearly Data (2001-2017)		
Variable's name	Description	Source
Real GDP (Y_t)	Real GDP expressed in national currency	Ameco
Real growth rate (g)	Percentage change of real GDP (Average)	Computation on Ameco
GDP deflator	Price deflator gross domestic product	Ameco
Indirect taxes (T_i)	Taxes linked to imports and production (indirect taxes)	Ameco
Real indirect taxes	Indirect taxes/real GDP deflator ratio	Computation on Ameco
Real consumption	Private final consumption expenditure at 2010 prices	Ameco
Consumption tax rate ($\varkappa$)	Real indirect taxes/real consumption ratio (Average)	Computation on Ameco
TR	Total revenue: general government	Ameco
Income taxes (T_d)	$T_d = TR - T_i$	Ameco
Real income taxes	T_d/real GDP deflator ratio	Computation on Ameco
Income tax rate (τ)	Real income taxes/real GDP ratio (Average)	Ameco
Government debt	General government consolidated gross debt	Ameco
Real public debt (B_t)	Government debt/GDP deflator ratio	Computation on Ameco
Private capital stock (K_t)	Net capital stock at 2010 prices: total economy	Ameco
Consumption/capital ratio (φ)	Real consumption/real net private capital stock ratio (Average)	Computation on Ameco
Inflation rate	Percentage change of GDP deflator (Average)	Computation on Ameco
Interest rate	Interest as percent of gross public debt of previous year	Ameco
Real interest rate (r)	Interest rate-inflation rate differential (Average)	Computation on Ameco
Real wealth (W_t)	Real net household's wealth	Ameco and OECD
Total primary expenditure (G)	Total expenditure excluding interest	Ameco
Real primary expenditure (G_r)	G/GDP deflator ratio	Computation on Ameco
($\gamma_I+\gamma_c$)	G_r/real GDP ratio (Average)	Computation on Ameco

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