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Current Estimates of Sustainable Government Debt Limits for the US and 26 Other OECD Countries

By Giorgi Bokhua and Mark Warshawsky

September 24, 2024

Abstract

This paper empirically estimates sustainable sovereign debt limits for 27 OECD countries, updating the model in Ghosh et al. (2013). We assess fiscal reaction functions, confirming the fiscal fatigue hypothesis, where gross debt levels exceeding 140-145% of GDP begin to impair a country's ability to manage public spending and deficits. Using historical and projected interest rate-to-economic growth differentials, different country samples and updated time periods, we estimate countries' sustainable debt limits, on both a gross and net of central bank holdings of government debt basis. Gross and net debt limits are between 136%-234% of GDP and 181%-268%, respectively. There are some indications of restricted fiscal flexibility for Canada, France, Italy, the UK, the US, Portugal and Spain. The US, in particular, for one estimate, has a sustainable gross debt limit of 154% of GDP, which is only about 30 percentage points above its current gross debt level, projected to be reached by 2034.

When federal budget deficits in the US routinely exceed 5 percent of GDP, even in good economic times, and the debt outstanding of the federal government approaches 100 percent of GDP, when intragovernmental accounts are netted out, and over 120 percent on a gross basis, many policymakers and bond market participants want to know what the sustainable limit is. That is, they know that the US will soon blow past the historical high ratio of net debt to GDP reached at the end of World War II, which served to liberate the world and save civilization. Prudent policymakers and worried market participants, however, want to know in the current circumstances of rising spending on social insurance and other existing and new programs and stable revenues, when in the future will the federal government face an economic limit to its issuance of debt. This would be manifest in substantial increases in interest rates on its debt, difficulties in marketing bonds, and existing bondholders experiencing losses through runaway inflation or financial restrictions. This paper gives some answers to this question by updating and slightly adjusting an existing model published in a prominent economics journal, based on the past fiscal experience and behavior of the US and other developed countries, combined with various interest rate and economic growth historical experience calculations and projections.

Literature Review

Our empirical analysis is based closely and primarily on the peer-reviewed journal article by international economics scholars, Ghosh, et al. (2013), at the International Monetary Fund and the University of Pennsylvania, and, secondarily, on the article by Fournier and Fall (2017). These researchers were motivated by the question of how much fiscal space remained in the 2010s between the then current and rising government debt levels of leading developed countries and a model-based estimate of the “debt limit” each country could reach before a debt crisis would ensue. The crisis would be evidenced by rapidly rising

interest rates on new bond issues and even a shut-down of access to credit markets.

In older economic literature (Barro 1986), it was thought that, at least among developed economies, governments would cut primary deficits or run surpluses following big increases in debt caused by, say, recessions or wars, in order to eventually stabilize debt levels as a share of GDP, given the resulting rise in interest payments increasing the deficit, even if the stabilization occurred only far off in the future.¹ But Ghosh, et al. (2013) and Fournier and Fall (2017) posited that at some point, “fiscal fatigue” begins to set in, such that the movement of fiscal policy does not keep pace with increasing interest payments, even assuming steady interest rates. This fatigue may arise because it is thought that tax increases would be too harmful to economic activity (Laffer curve effect) or spending cuts would be too painful to the citizens and voters of the country. The scholars estimate a fiscal reaction function that describes how the government non-interest budget net balance (primary deficit or surplus) responds to the changing level of gross debt outstanding and discovered empirically that primary deficits start increasing with high debt levels, producing a rapidly unsustainable situation and a substantial risk of default. This is especially so, as at these points, it is likely that interest rates will begin to increase, worsening the downward spiral.

Without fiscal fatigue, assuming that the interest rate – output growth rate differential is positive, even if constant, sustainability, that is, a stable debt-to-GDP ratio, can be achieved if the response of the primary balance to rising debt is stronger than this differential. But, with fiscal fatigue, that is, the primary balance responds more slowly to rising debt than the interest rate-growth differential, a debt level, referred to as the sustainable debt limit, will be reached at which a

¹ Actually, more recent research challenges the conventional view even at modest levels of debt. In a study of 21 OECD countries, including many with low debt levels, from 1991 to 2015, Beqiraj, et al. (2018) find that, after separating out business cycle and other temporary effects on the government budget, the long-term reaction of governments on structural primary balances to increases in debt is negative. That is, fiscal policy in these countries is unsustainable, *ab initio*.

country can no longer service its debt. If the interest rate – output growth rate differential is negative, then the debt limit will be higher. If, however, interest rates increase with debt, as is commonly thought and as Mantus and Warshawsky (2022) find empirically, the sustainable debt limit will be much lower.

Using a sample of 23 advanced economies over the period 1970 -2007, Ghosh, et al. (2013) found strong support for the existence of a non-linear relationship between the primary balance and gross public debt, even after controlling for various other macroeconomic and institutional determinants and country fixed effects, showing fiscal fatigue. In particular, they estimate a cubic function such that at low levels of debt, there is no or a slightly negative relationship between the primary balance and debt, at moderate levels, there is a positive relationship, but at higher debt levels, the responsiveness weakens (at debt-to-GDP ratios around 100 percent) and turns negative (at debt ratios around 150 percent).

Fournier and Fall (2017), using a somewhat different specification for 31 OECD countries over the period 1985 – 2013, find a similar result, with fiscal fatigue negative sensitivity starting at 170 percent.

The scholars combine the panel-estimated fiscal reaction function with various interest rate and economic growth projections or assumptions, and each country's debt limit and a corresponding fiscal space is calculated. Ghosh, et al. (2013) find, based on the model and conditions in the mid-2010s, an upper bound for the median sustainable debt limit of the OECD countries is 183 percent of GDP; for the US, it is 160 percent (compared to a projected level of around 110 percent in 2015). Countries with no model solution (and high levels of debt) included Greece, Iceland, Italy, Japan, and Portugal. These countries are estimated to have no fiscal space with any degree of probability; the US is estimated to have more than 50 percentage point fiscal space with only a 23 percent probability.

Subsequently Greece had a serious and damaging financial crisis and European Union bailout (European Court of Auditors 2017). As we discuss below, Japan

has unique and non-comparable circumstances allowing it much higher gross debt levels. Fournier and Fall (2017) calculate somewhat higher sustainable gross debt limits; for example, for the US, they calculate it to be 193 percent, largely because there was some fiscal consolidation in response to the debt crisis in Southern Europe countries after 2009.

Theoretical Model

For calculating the sustainable debt limit, we base our analysis on the framework developed by Ghosh et al. (2013). Its foundation is the fiscal reaction function of the government, which describes how the primary balance, defined as the difference between the government's revenue and its non-interest expenditure, reacts to debt levels in the previous period. Equation (1) illustrates this relationship.

$$s_{i,t} = \mu_i + f(d_{i,t-1}) + \epsilon_{i,t} \quad (1)$$

Here primary balance ($s_{i,t}$) for a given country (i) in a given period (t) is influenced by the country's debt level as a share of GDP in the previous period ($d_{i,t-1}$), other systematic determinants of the primary balance unrelated to the debt (μ_i) and the error term ($\epsilon_{i,t}$). The function ($f(d_{i,t})$) represents the government's reaction to the debt level from the previous period.

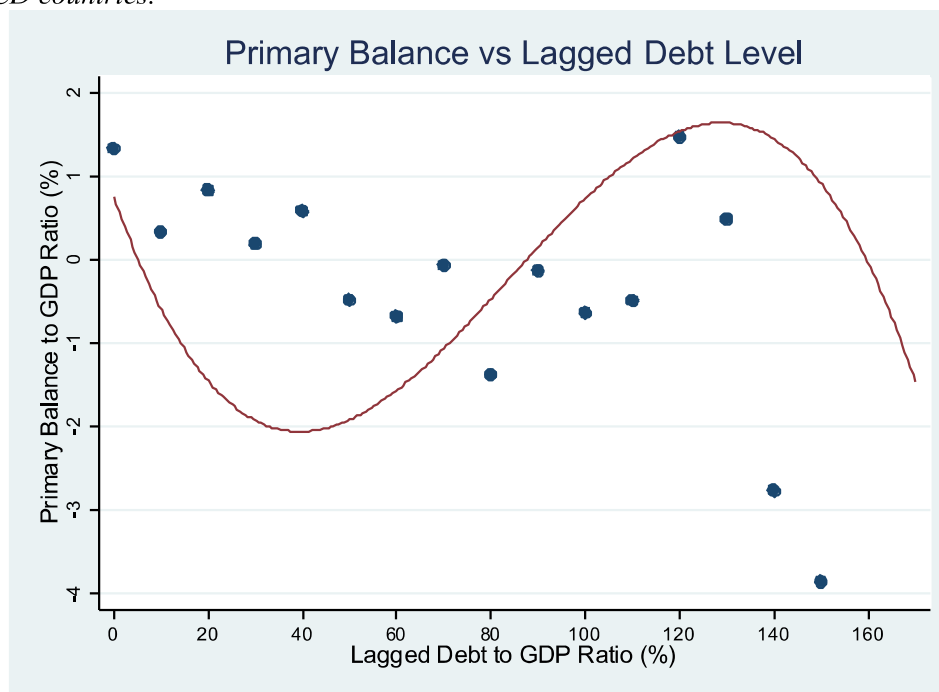
$$f(d_{i,t}) = \beta_0 + \beta_1 \cdot d_{i,t} + \beta_2 \cdot d_{i,t}^2 + \beta_3 \cdot d_{i,t}^3 \quad (2)$$

Ghosh et al. (2013) model the government's reaction function as a third-degree polynomial, as described in equation (2). This model specification allows the marginal fiscal reaction to lagged debt increase to change signs multiple times. The rationale behind this formulation is that before debt reaches a certain level, governments might not feel the need to adjust their primary deficits in response to debt increases. After reaching a certain threshold, where, among other considerations, debt starts to become prominent economically and politically,

governments respond to increased debt levels by decreasing the primary balance. Once the debt level surpasses another threshold, however, the government may lose the ability to increase the primary balance as a policy response. This is because debt service becomes a heavier burden on the public budget, and tax increases and/or spending cuts may be economically and politically difficult to implement. Additionally, if the market starts to lose confidence in a country's ability to service debt, interest rates will spike, further exacerbating the freefall.

Fournier and Fall (2017) model this relationship by finding two debt thresholds after which the marginal response of the primary balance to debt changes. They identify three debt ranges, each with a unique marginal response to debt increases. In contrast, the cubic form of the reaction function from Ghosh et al. (2013), adopted by us, allows for a continuous change in marginal responses rather than abrupt increases or decreases at specific thresholds.

Figure 1: General Government Primary Balance for different gross debt levels for 26 OECD countries.



Notes: The red line represents the estimated fiscal reaction function using gross debt.

This framework is illustrated in Figure 1, which shows the average primary balance ratios for each lagged gross debt level, ranging from 0% to 150% in 10% increments, for 26 OECD countries in our database from 1984 to 2022. (For example, the first dot on the left illustrates that for debt levels between 0-10% of GDP, the average primary balance in this sample was around 1.3.). It appears that before debt reaches around 45% of GDP, the primary balance decreases with higher debt. After that point, the primary balance starts to increase until the debt reaches around 140%, after which the relationship changes again, as an indication of fiscal fatigue. The red line in the figure represents the estimated fiscal reaction function using gross debt, further explained below.

Deriving the Sustainable Debt Limit

The sustainable debt limit is defined as the lowest level of debt at which a country can no longer service its sovereign debt and must effectively default. To derive the limit, we replicate the procedure employed by Ghosh et al. (2013), based on the relationship between primary balance and debt interest payments displayed in equation (3).

$$\mu_i + f(d_i) = (r_i - g_i)d_i \quad (3)$$

The left side of the equation represents the primary balance of a country given its existing debt level and all other fundamentals (μ_i) affecting the primary balance². The right side of the equation is the growth-adjusted interest payments for the debt. (Note that because nominal economic growth rates in recent years have been higher than interest rates on sovereign bonds in many developed countries, the term on the left can be negative too.) The debt limit for a given country is the largest root of equation (3). After a certain debt level is reached, the left side of the equation will decrease at an increasing pace, faster than the right side, due to

² We are relying on the baseline deterministic version of the Ghosh et al. (2013) model, which ignores error terms when determining the debt limits.

the cubic fiscal fatigue function, while the right side remains linear with respect to debt. At that point, the country would not be able to service its debt. This is true even if the interest rate minus growth remains constant, although it is more likely that as debt approaches its limit, interest rates will rise because investors become less confident in the country's ability to service the debt.

Thus estimating the debt limit for a country involves the following two steps:

1. Estimating the fiscal reaction function for each country, including the fundamentals (μ_i) affecting the primary balance. This allows us to estimate the expected primary balance for each country given its debt level and economic conditions.
2. Using the fiscal reaction function, along with historical and/or projected nominal economic growth and interest rates for each country, to estimate debt limits by calculating the largest roots of equation (3).

Estimating the Fiscal Reaction Function

Our main estimation is based on data for 26 OECD countries from 1984 to 2022. We focus on only developed countries, not just due to data availability, but also because we rely on the assumption that the fiscal reaction function is uniform across all these countries owing to their relative economic and institutional homogeneity. This assumption is particularly important because most developed countries have never reached debt levels higher than 140% of GDP³ and the underlying belief is that the governments of these countries would react similarly to high debt levels as those that have already experienced such levels.

In order to assure this homogeneity, we chose the OECD countries that were part of the organization before 2000. Of the resulting 29 countries, there is insufficient data available for Mexico and Turkey (and additionally for Hungary and Poland,

³ Out of the 26 countries in our data, only Greece and Italy have exceeded a debt level of 140% of GDP.

when we are using a net debt measure). We also exclude data on Greece from 2010 onwards because it started to experience a sovereign debt crisis following the global financial crisis, and then received financial assistance from Euro area member states and the IMF (European Court of Auditors 2017). These international entities monitored it closely and began to strongly influence the fiscal policy of the Greek government. Because we want to understand how countries react to high debt levels without outside direction, we decided that observations for Greece after 2010 would not be relevant for our analysis.

We use two different debt measures to estimate the fiscal reaction function, and then to estimate debt limits. The first measure is gross general government debt, sourced from the IMF's Global Debt Database. When we are using a gross debt measure, we also exclude Japan, as explained below. The second measure is net debt⁴, which we define as gross government debt minus the central bank's holdings of the domestic sovereign debt. We use this measure to exclude the largest component of intragovernmental holdings in most countries from the gross debt (where a government agency holds domestic country's sovereign debt), because it would be more indicative of fiscal pressure. Although it would be preferable to net out other intragovernmental holdings, such as Social Security Fund in the US too, such data is not consistently available internationally and therefore this version of net debt enables a more comprehensive cross-country comparison and enables using it in regression analysis without significant data gaps.

For gross debt, we use data from 1984 to 2022, while for net debt, we rely on data from 1996 to 2022. These time periods were selected based on data availability for our panel. Detailed information on all the variables used for the analysis and their sources are included in the Table A1 in the Appendix.

⁴ This definition is different than Maastricht definition of net debt used in the Euro area (European Central Bank 2010).

Table 1 presents the regression results used to estimate the fiscal reaction function. The dependent variable for all four versions is the general government primary balance to GDP ratio. Column (1) illustrates the results of the initial regression, which aims to estimate coefficients for equation (1). Here, we use lagged net general government debt levels as a percentage of GDP, along with its square and cube, as regressors. To control for country-specific effects that are constant over time and might be correlated with debt levels, we employ a fixed effects model. Also, similarly to Ghosh et al. (2013), we allow for serial correlation of error terms to further address potential endogeneity of the lagged debt values, modeling the error terms as an AR(1) process.

The coefficients in Column (1) support the stated theory on nonlinear relationship between debt and primary balance, with all variables being significant at least at the 5% significance level. These coefficients also imply, as shown in Figure 1, that after a debt level of around 60% of GDP, the marginal response of governments to debt increases becomes positive, but the sign changes again when the debt level reaches around 140-145% of GDP.

In Column (2), we add a set of 8 control variables, which are factors that could potentially influence a country's fiscal policy and its primary balance, while simultaneously being correlated with changes in the country's debt levels. Most of these control variables are also employed by Ghosh et al. (2013) and Fournier and Fall (2017).

Table 1: Estimating the fiscal reaction function using primary balance as dependent variable

	(1)	(2)	(3)	(4)
Lagged net debt	-0.159714** (0.03)	-0.194101*** (0.00)		
Lagged net debt-square	0.001857** (0.03)	0.002607*** (0.00)		
Lagged net debt-cube	-0.000006** (0.03)	-0.000008*** (0.00)		
Lagged gross debt			-0.163841** (0.04)	-0.158584** (0.03)
Lagged gross debt-square			0.002247** (0.04)	0.002624*** (0.01)
Lagged gross debt-cube			-0.000008* (0.09)	-0.000010** (0.02)
Output gap		0.609591*** (0.00)		0.551962*** (0.00)
Government expenditure gap		-0.302968*** (0.00)		-0.319759*** (0.00)
Short-term interest rates		0.176875* (0.06)		0.052073 (0.32)
Openness		0.014606 (0.22)		0.008531 (0.42)
Inflation		-0.196746 (0.26)		0.047003 (0.62)
Oil price shock		12.293459*** (0.00)		10.877467*** (0.00)
Age dependency		-0.106655* (0.10)		-0.183337** (0.02)
Political stability (WGI)		1.888454*** (0.01)		
Political stability (ICRG)				0.050827 (0.15)
Eurozone		-0.503824 (0.53)		-0.571770 (0.30)
Constant	3.012670*** (0.00)	5.037455*** (0.00)	2.603130*** (0.00)	5.478787*** (0.00)
Observations	634	574	890	861
Number of groups	25	25	26	26
AR (1) coefficients	0.642	0.555	0.709	0.722

p-values in parentheses* *p* < 0.10, ** *p* < 0.05, *** *p* < 0.01

To control for endogeneity coming from the business cycle, we add output gap and government spending gap variables, which represent the percentage differences of actual GDP and government spending from their trend values, respectively. The coefficient for the output gap is positive and significant at the 1% level, consistent with the government reducing deficits when the economy is in an upswing. Conversely, the coefficient for the government expenditure gap is negative, consistent with increased deficits arising from a government spending shock. Nonetheless, the coefficients for the debt regressors remain unchanged and statistically significant. We also use short-term interest rates on government debt, generally controlled by central banks, as a regressor. The coefficient is positive, aligning with the expectation that governments are less likely to run deficits and accumulate debt when interest rates are higher.

Other control variables Ghosh et al. (2013) use are inflation and trade openness, measured as the share of total trade (sum of exports and imports) to GDP. Unlike their findings, however, in our regression, as displayed in the column (2), neither have statistically significant coefficients. The oil price shock variable shows a positive and statistically significant effect for oil exporters.⁵ Age dependency also displays a statistically significant coefficient, supportive of the hypothesis that in countries where the working-age population bears a heavier burden of producing retirement and health benefits for a large retired population, governments have a harder time being fiscally responsible.

We also included dummies for being a member of the Eurozone, on the theory that Eurozone countries are bound by mutual agreements to avoid excessive government deficits. The coefficient in column (2), however, is not statistically significant. The coefficient for the political stability index, sourced from the

⁵ In our sample, Norway is the only such country, with oil rents averaging around 5% of GDP during the given time period, whereas for other countries, it was not higher than 1.5% (Source: World Development Indicators)

Worldwide Governance Indicators (WGI), is positive and significant at the 1% level. This suggests that political instability and politically motivated violence likely make governments less fiscally responsible.

Most importantly, we observe that the coefficients for our main lagged debt regressors remain significant and generally unchanged in column 2.

In columns (3) and (4), we repeat the same procedure as in the first two columns but instead of using lagged net debt we use lagged gross general government debt measurements as a main regressor for calculating the fiscal reaction function. In this specification we also exclude Japan due to its unique gross debt and other institutional characteristics. Although Japan's gross debt was about 260% of GDP in 2022, more than double the U.S. figure of 120%, Japan's net debt is nearly half of its gross debt. This is because the Bank of Japan, Japan's central bank, holds government bonds equivalent to around 115% of GDP. As displayed in the second and third column of Table 2, this figure is over three times higher than the second-highest central bank holdings in our list, which account for 38% of GDP in Italy, and approximately six times greater than the median figure of 17.5%. The Japanese government also holds a significant position in risky assets, including substantial domestic equities (30% of GDP) and foreign bonds and equities (55% of GDP). These investments yield high returns, especially compared to the relatively low (and sometimes negative) interest rates on government borrowing caused by monetary and regulatory policies.⁶ These factors make Japan's gross general government debt incomparable to that of other developed countries, leading us to exclude it from the regression when using gross debt. For reference and contrast, historically Federal Reserve holdings of Treasury debt have been limited to 5 percent of GDP. During the 2010s, Federal Reserve holdings increased to about 15 percent, and increased again during the

⁶ Also, see Chancellor (2024) and Chien and Stewart (2023).

pandemic to 25 percent of GDP, but more recently, in response to the resulting inflation, the Federal Reserve has cut back to 15 percent and indicates further cuts.

As we see, results in columns (3) and (4) are very similar⁷ to our previous results with the net debt. Coefficients in column (4) for gross general government debt and its exponentials also imply fiscal fatigue occurring at around 140% of GDP.

We use the coefficients from columns (2) and (4) to produce two different versions of the fiscal reaction functions for the governments. Additionally, for each country we use the 2022 values for variables used in the regression that do not represent shocks— short-term interest rates, trade openness, inflation, age dependency, political stability, and Eurozone membership—with their respective coefficients, to proxy for debt-unrelated fundamentals (μ_i) that affect the primary balance.

Estimated Sustainable Debt Limits

Another key component in equation (3) for calculating debt limits is the interest rate-growth differential ($r_i - g_i$). We use two versions of differential for our estimates: historical and projected. For the historical differential, for each country we calculate the average gap between long-term government bond interest rates and nominal GDP growth over the last 10 years in our analysis, from 2013 to 2022. For the projections, we calculate the OECD projection averages for the years 2023 to 2025.

As shown in Table 2, interest rates have been lower than growth in 25 out of 27 countries in the past 10 years, with the exceptions of Italy and Greece. Projected differentials, on the other hand, are expected to be higher than historical ones, in

⁷ We used a different measure for political stability from the International Country Risk Guide (ICRG) dataset instead of WGI due to a data availability issue (WGI is only available from 1995). The coefficient remains positive, with a p-value of 0.15.

22 out of 27 countries, indicating that relying on past experiences to determine fiscal policy would not be responsible for these countries. Even though projected differentials are still negative for 21 out of 27 countries, we would expect a different picture during periods of financial distress and economic recession, with interest rates rising and/or economic growth falling. For example, the Congressional Budget Office projects that interest rates in the next decade will be higher than economic growth in the United States. Therefore, these calculations are likely an overestimate of the debt limits.

Table 2 incorporates two different estimates for both net government debt (per our definition) and gross government debt, using historical and projected interest rates. Because no comprehensive panel data was available on Hungarian and Polish central bank holdings of domestic government bonds, we do not have net debt estimates for these two countries. Also similar to Ghosh et al. (2013) and Fournier and Fall (2017), our model does not establish debt limits for Greece and Japan. There is no clear interpretation⁸ on what that means for these countries, because establishing the debt limit is a process of finding a root of nonlinear equation in the specific range. One possibility however is that this could indicate that these countries are already nearing their debt limits. For Greece, because we are using data up to 2010, we found this to be true, as the country faced a debt crisis and required a bailout from other EU countries.

⁸ Ghosh et al. (2013) and Fournier and Fall (2017) do not offer clear interpretation either.

Table 2: Estimates of Sustainable Debt Limits

Country	Gross Debt in 2022	Net Debt in 2022	Historical Interest Rate-Growth Differential	Projected Interest Rate-Growth Differential	Net debt Limit (Historical Differential)	Net debt Limit (Projected Differential)	Gross debt Limit (Historical Differential)	Gross debt Limit (Projected Differential)
Australia	55.7	44.2	-2.3%	-1.2%	225	214	196	187
Austria	77.8	57.5	-2.4%	-2.3%	228	226	194	192
Belgium	105.3	83.6	-3.0%	-1.5%	232	220	195	181
Canada	106.6	91.3	-2.7%	-0.2%	227	200	193	168
Czech Republic	42.3	42.3	-3.4%	-1.6%	231	214	197	181
Denmark	29.7	29.7	-3.2%	0.4%	244	217	213	190
Finland	74.8	54.2	-2.4%	0.0%	230	207	197	176
France	111.7	86.8	-1.5%	-1.4%	213	211	177	175
Germany	66.5	47.2	-3.1%	-2.0%	237	229	203	195
Greece	177.4	159.9	4.7%	-1.7%	-	-	-	-
Hungary	75.9	-	-4.1%	-3.6%	-	-	202	199
Iceland	68.7	68.2	-2.1%	0.7%	225	194	193	163
Ireland	45.2	33.4	-9.3%	0.1%	268	188	231	136
Italy	144.4	106.7	0.7%	-0.2%	186	201	151	167
Japan	261.3	145.5	-0.8%	-2.8%	-	-	-	-
Korea	54.3	53.2	-1.9%	-1.3%	233	228	200	195
Luxembourg	24.3	18.9	-5.1%	-1.7%	252	227	212	186
Netherlands	48.5	34.2	-3.0%	-2.5%	235	231	200	196
New Zealand	52.8	34.7	-2.8%	-0.1%	234	209	206	186
Norway	39.6	39.6	-4.4%	6.5% ⁹	264	181	234	169
Poland	49.6	-	-3.4%	-3.3%	-	-	199	198
Portugal	116	86	-0.9%	-3.1%	203	226	165	190
Spain	112	80.6	-0.8%	-2.7%	210	227	171	190
Sweden	31.7	26	-3.8%	-2.3%	244	233	213	203
Switzerland	39.1	38.9	-1.8%	-1.6%	231	229	197	195
United Kingdom	101.4	67.9	-2.6%	-0.6%	224	202	190	169
United States	121.4	98	-2.3%	-1.0%	209	187	177	154
Median	68.7	54.2	-2.6%	-1.5%	231	214	197	186

The debt limit estimates in the table are generally consistent with those of Ghosh et al. (2013) and Fournier and Fall (2017). For the remaining 23 countries, the

⁹ Due to the sharp decline in Norway's GDP deflator in 2023, which contributed to a projected 10% nominal GDP contraction, our estimates show an unrealistically high average projected differential for Norway. This, based on our analysis, results in an unrealistically low debt limit estimation.

median net debt limit using historical interest and growth rates is 231% of GDP, while with projected differentials, it is 214% of GDP. The figures for net debt are close to those of Fournier and Fall (2017), who estimate a median debt limit of 227% of GDP, though they focus on gross debt limits instead of net. We also observe that the estimates using gross government debt in Table 2 offer lower debt limits compared to the net debt estimates, with the median gross debt limit around 197% of GDP using historical differentials and 186% using projected differentials. This is because the fiscal reaction function derived from the regression with gross debt implies relatively faster fiscal fatigue than the estimations using net debt, with high debt Japan excluded from the sample.

Knowing actual figures of net and gross debt in 2022, allows us to gauge how far countries are away from their sustainable debt limits. When looking at net debt, figures indicate that most countries have a relatively flexible fiscal space, the median country in 2022 only reaching around 23% of its net debt limit. Two countries that have a fiscal space lower than 90% of GDP are Italy and US using the net debt measure.

Gross debt limits give more concerning picture. For example, the United States, Italy, and France have tight sustainable debt limits and modest remaining fiscal space using both historical and projected differentials. Additionally, Portugal and Spain have somewhat limited fiscal spaces when using historical differentials, while the United Kingdom and Canada have limited spaces when using projected differentials. Considering that in the most cases we are still relying on negative interest rate differentials, these countries appear to have limited flexibility to accumulate additional debt, particularly if an economic or financial crisis or war were to occur.

To demonstrate the effects of an interest rate increase on the US sustainable debt limit, we also use the interest rate-economic growth differential calculated from Congressional Budget Office (CBO) projections, as the 10-year average

difference between nominal rates on 10-year Treasury bonds and nominal GDP growth projected from 2024 to 2033 (CBO 2024). The result is an average projected differential of 0.1%, significantly higher than the OECD's projection of -1% for 2023-2025. Applying this differential places the United States among the countries for which the model fails to identify a debt limit, while using both gross and net debt estimates. This highlights how much a spike in interest rates could impact a country's fiscal flexibility and sustainability.

Conclusion

In this paper, we estimate sustainable sovereign debt limits for 27 OECD countries by replicating the theoretical model developed by Ghosh et al. (2013). We calculated the fiscal reaction function to illustrate how countries adjust their fiscal policies in response to increasing government debt. Consistent with Ghosh et al., our analysis, which includes more recent data and small changes in control variables, supports the fiscal fatigue hypothesis, indicating that once a country's debt reaches approximately 140-145% of GDP, it begins to lose the ability to smooth public spending and reduce primary deficits as debt increases.

We estimated sovereign debt limits using historical and projected interest rate-to-economic growth differentials, finding a debt limit range of 181% to 268% of GDP with net debt figures, and 136% to 234% with gross debt figures. We define net debt we define as the difference between gross debt and central bank holdings of government debt. Our results indicate that Canada, France, Italy, Portugal, Spain the UK, and the US have somewhat limited flexibility to increase their foreign debt according to some estimates.. Additionally, we highlight that these sustainable debt limits might be overestimated, given our assumption of constant interest rate-to-growth differentials, which have been exceptionally low in the past decade.

As another point of reference for the US, our model gives a sustainable gross debt limit of 154 percent using OECD interest rate and economic growth projections.

Combining long-term projections of net debt, conventionally defined, from the CBO using historical averages of spending and revenues (CBO May 2024) and its analysis of differences between gross and net debt projections (CBO September 2023), that sustainable debt limit will be reached in 2034, roughly the same time as the Social Security and Medicare Trust Funds are exhausted and those programs, by law, must be reformed, likely as part of a larger fiscal consolidation package.

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Appendix

Table A1: Data sources

Variable	Description	Source
Primary balance-to-GDP ratio	General government primary balance as a percentage of GDP	OECD Economic Outlook
Gross Debt-to-GDP ratio	Total stock of debt liabilities issued by the general government as a share of GDP.	IMF - Global Debt Database
Gross Debt-to-GDP ratio	Gross Debt to GDP ratio minus Central Banks holdings of the domestic government debt	IMF - Global Debt Database and Sovereign Debt Investor Base for Advanced Economies
Output Gap	Calculated using real GDP by applying Hodrick-Prescott filter and measuring gap between trend GDP and actual GDP;	OECD Economic Outlook
Government Expenditure gap	Calculated using real Government final expenditure by applying Hodrick-Prescott filter and measuring gap between trend government spending and actual government spending	OECD Economic Outlook
Short-term Interest Rates	Rates at which short-term borrowings are effected between financial institutions or the rate at which short-term government paper is issued or traded in the market.	OECD Economic Outlook
Trade Openness	Calculated as a sum of imports and exports of goods and services as a share of GDP using nominal values	OECD Economic Outlook
Inflation	Consumer Price Inflation: Using three-year rolling average. For example, the 2020 rate is the average of 2018, 2019, and 2020.	World Development Indicators (World Bank)
Oil Price Shock	Calculated using Crude oil price by applying Hodrick-Prescott filter	OECD Economic Outlook
Age-dependency ratio	Total dependency ratio; The ratio of dependents (under 15 or over 64) to the working-age population (ages 15-64).	United Nations, World Population Prospects (2022)
Political Stability (WGI)	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. Ranges from -2.5 to 2.5	Worldwide Governance Indicators
Political Stability	Calculated averages for each country and year using monthly data for Political Risk Rating variable	International Country Risk Guide (ICRG) dataset
Nominal Interest rate	Long-term interest rate on government bonds	OECD Economic Outlook
GDP growth	Nominal GDP growth	OECD Economic Outlook