Fiscal policy responses to changing government debt: A comparative study of an OECD panel and the UK using a fiscal reaction function approach

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Abstract

Since the global financial crisis (GFC), as well as recent pandemic and conflict-related crises, fiscal sustainability has become a key concern in both developing and developed countries. Increasing sovereign debt burdens are complicating the maintenance of public finances amidst rising age-related expenditures and declining potential growth. This study examines how developed countries are adapting their fiscal strategies using the 'fiscal reaction function' (FRF) framework to analyse OECD countries from 2001-2022 and the UK from 1980-2022. First, it tests whether OECD countries generally increase budget surpluses in response to rising debt ratios, comparing pre- and post-GFC periods. Secondly, it specifically examines the UK's response to changing debt levels compared to the OECD sample. Lastly, it explores the fiscal fatigue hypothesis, which suggests that very high debt ratios make fiscal efforts untenable. The OECD analysis shows that for every point increase in government debt as a percentage of GDP, the primary balance improves by 0.04 – 0.27 points, after necessary controls. On the contrary, UK analysis shows that an increase in debt is associated with a deterioration in the primary balance.

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Introduction.

Research Question: How have OECD countries adapted their fiscal policy to changes in government debt levels, and is the fiscal response of the UK alone in line with these international peers?

The global financial crisis (GFC), coronavirus pandemic, as well as other OECD area sovereign debt crises, have created nearly two decades of heightened volatility and uncertainty. Within numerous academic and policy circles, significant attention has been placed on the fiscal sustainability of advanced economies. This begs the question of how these sovereigns are responding fiscally to their rising levels of government debt. Early signs of fiscal fatigue have become a prominent concern, despite huge efforts to restore fiscal sustainability. The extensive debt burdens weighing on most advanced economies has heavily impacted the economic outlook. Combined with mounting ageing population-related costs, climate change commitments, extreme private indebtedness and associated pressures on potential growth, pressures from high debt levels are complicating efforts to ensure the sustainability of public finances.

Blanchard, et al., (1990) states that any discussion of sustainability starts with the dynamic government budget constraint. This suggests the nominal value of debt change is a function of nominal government spending plus transfers minus taxes, plus the nominal debt level. Spending levels minus taxes (after factoring in transfers) is the primary deficit and is an essential part of fiscal sustainability analysis.

In empirical policy research, a key analytical tool crucial to understanding fiscal sustainability is the fiscal reaction function (FRF), introduced in (Bohn, 1998). Bohn demonstrates, using the example of the US economy, that a key condition for sustainability is the government's systematic response to increases in government debt by adjusting the primary balance, either by increasing surpluses or reducing deficits. In addition to this, sovereigns may also systematically increase deficits by trying to spend their way out of recession. However, as highlighted by Ghosh, et al., (2013), the FRF may be classed as a weak measure of fiscal sustainability as it does not rule out a permanently increasing debt-to-GDP ratio. Furthermore, FRFs do not provide insight into the forward-looking policies which may have to be implemented to mitigate sustainability issues.

Nevertheless, FRFs remain valuable in shedding light on the historical fiscal policy reactions of governments and serve as a useful indicator for potential future policy decisions. Studies utilising data from large panels of advanced economies tend to find evidence suggesting that governments adhere to weak fiscal sustainability constraints. Country-specific pieces of analysis find more mixed results, see Checherita-Westphal & Zdarek (2017). We might expect a slight differences in results given my analysis follows a panel versus country specific comparison structure.

This dissertation will estimate and interpret a fiscal reaction function for both a panel sample of 21 OECD countries and an individual UK time series. In recent decades the UK has reached heightened levels of government debt, higher than most other OECD countries. International comparisons can allow policy makers and analysts to assess whether the UK's fiscal policy response at times of financial pressure, is in line with international averages. It is important to note that within the OECD panel, the countries have differing policy and economic contexts, some of which are similar to the UK, and some of which are not. Whilst it can be helpful to broaden perspectives beyond the UK's specific circumstance and provide

insights into how various economies address challenges, it is important to consider issues of incomparability, which risk obscuring important nuances in the UK's fiscal policy behaviour.

The dataset for the OECD covers the period 2001-2022, but I conduct robustness checks for period sub-samples before and after the GFC. In an initial step, a linear FRF using instrumentation techniques is estimated on the OECD panel to interpret the government reaction of fiscal policy to changing levels of government debt. My aim here is to tackle estimation limitations such as endogeneity and reverse causality. A country-specific function is applied to a UK time series scenario, but the econometric challenges differ, and therefore I focus on correcting for cointegration and stationarity issues.

In addition to the above, this paper also explores the risk of fiscal fatigue faced by both the OECD panel and the UK separately, using a non-linear FRF estimation drawing heavily on the work published by Ghosh, et al., (2013). This measurement of fiscal fatigue involves analysing coefficients on polynomial variations of debt, to deduce whether fiscal outcomes deteriorate to a greater extent if debt levels are particularly high.

This paper differs from existing literature in two ways. Firstly, it compares an individual country (the UK) to a sample of international peers (OECD countries) to draw out how in line the fiscal behaviour of the UK is with other economies—noting here the lack of FRF literature on the UK specifically. Secondly, the models are based on more recent data to produce an up-to-date assessment of the relationship between debt levels and fiscal policy in developed economies.

The paper is structured as follows. Section 2 reviews the literature and methodology of fiscal reaction functions. Section 3 outlines the historical fiscal context of both the OECD and the UK. Section 4 contains the data and methodology. Section 5 discusses the results. Section 6 investigates the fiscal fatigue hypothesis using non-linear models, extending the linear models. Section 7 concludes the paper.

A review of the literature

Various methods exist for assessing a country's debt sustainability. A mainstream concept suggests that debt is deemed sustainable if its current level aligns with the future present discounted value of primary fiscal balances. Put simply, if the initial debt is positive, this means the government ought to run a primary surplus in the future (Turan & Varol Iyidogan, 2022).

A few sustainability assessments focus on examining whether the Intertemporal Government Budget Constraint (IGBC) is satisfied, see the work of Blanchard, et al., (1990) as an example. This suggests that revenues must finance government spending over time, plus the change in its debt level. Therefore, economic theory suggests that policymakers should engage in forward-looking behaviour when making fiscal decisions. By considering the IGBC, policymakers can recognise that current debt pressures will have implications for future debt servicing costs. Persistent increases in public debt can create larger interest payments in the future, crowding out other government spending or requiring higher taxes to service this debt.

Classical economic models like the Blanchard ratio (which combines the standard concept of debt sustainability with the IGBC) have been somewhat criticized for a failure to consider initial debt levels and whether these initial debt levels satisfy the IGBC (D'erasmo, et al., 2015). Instead, and complementing the theoretical approach of Blanchard, et al., (1990), Bohn (1998) introduces a straightforward empirical assessment for sustainable fiscal policy. This test establishes a connection between the primary balance and the debt level, with or without additional controls. Fiscal Reaction Functions (FRFs), which can capture the response of fiscal policy (as measured by the change in the primary balance) to government debt and macroeconomic conditions, are deemed a helpful tool for fiscal sustainability analysis. In Bohn and subsequent papers, FRFs are implemented to test and define fiscal sustainability. As indicated by Bohn (1998) a coefficient on debt (ρ in equation 1) that is positive and significant implies a sufficient condition to guarantee that the IGBC is satisfied.

Equation 1 – Fiscal Reaction Function (FRF)

$$pb_t = \rho \cdot d_t + \varepsilon_t$$

Where pbt is the primary balance measured as a percentage of GDP, dt is the government debt-to-GDP, and ε_t encompasses the impact of various other determinants of the primary balance (either institutional or economic etc) and the error term.

This function evaluates the extent to which public debt in a country would be sustainable in coming years and what should be the optimal path of fiscal response to address rising debt levels.

However, as highlighted across several papers (Fournier & Fall, 2015)(Daniel, 2012), a positive ρ coefficient cannot be considered conclusive evidence of achieving fiscal sustainability. This is especially true when there is a constraint on positive values of primary balances, such as at exceptionally high debt levels. In other words, there is a GDP limit, which the primary surplus cannot surpass. This indicates that as public debt reaches a high level, fiscal policy fails to manage increasingly large interest payments, and fiscal fatigue begins to set in.

As can be seen in the literature summary in Table 1, the majority of panel FRF studies typically show indications of fiscal sustainability in advanced economies (ρ>0). The intensity of the reaction (i.e. the size of ρ) varies between 0.01 and 0.48.

Table 1. Summary of fiscal reaction function literature

Study	Sample	Estimate of debt coef.	Study	Sample	Estimate of debt coef.
Bohn (1998)	US, 1916-1995	0.054	Eller & Urvova (2012)	EU-8, 1995-2011	0.026-0.060
Callen, et al. (2003)	EM, 1990-2002	0.050-0.100	Debrun & Kinda (2013)	28 Ems and 26 DMs, 1980-201	0.032-0.037
Gali & Perotti (2003)	EU-11 and OECD-5 1980-2002	-0.07 (EU-11) -0.02 (OECD5)	Ghosh, et al. (2013)	23 DMs, 1970/1985-2007	-0.208-0.225
IMF (2004)	EA-17, 1971-2003	0-0.08	Cuerpo (2014)	Spain, 1986q1-2012q4	-0.03-0.02
Celasun & Kang (2006)	34 Ems, 1990 - 2004	0.030-0.046	Schoder (2014)	15 OECD, 1981-2010	-0.015-0.028
Bohn (2008)	US, 1792-2003	0.094-0.121	Berti, et al. (2016)	EU-13, 1950-2013	-0.017-0.074
Mendoza & Ostry (2008)	22 DMs and 34 EMs 1980/1990-2005	0.033-0.072	Baldi & Staehr (2016)	EU-27, 2000-2014	0.02-0.20
Afonso & Jalles (2011)	18 OECD, 1970-2010	-0.05-0.17	Oros (2017)	10-CEE, 1995-2015	0.07-0.09
Burger (2012)	US and UK, 1970-2008	0.13 (UK)	Checherita-Westphal & Zdarek (2017)	EA countries - 18, 1970-2013	0.028-0.041
			Turan & Varol Iyidogan (2022)	64 EMs and 31 DMs, 2000-2018	-0.09-0.48

However, FRFs are frequently characterised as backwards looking (Berti, et al., 2016) because they depend on historical data and prior economic circumstances to shape future fiscal policy responses. Essentially, the results of these functions are derived from the historical reactions of fiscal authorities to economic events, rather than being forward-looking and responsive to present or anticipated future conditions. This creates issues as the function does not adequately capture changes in the economic environment or account for unforeseen events, hence limiting its effectiveness in guiding fiscal policy in dynamic and changing environments.

As well as the primary balances, Bohn (1998) focuses on cyclical changes in output and spending, commonly referred to as the output and expenditure gaps. To account for this, FRF's incorporate an economic cycle variable, such as the output gap or a growth rate, following approaches by Bohn (1998) and Gali & Perotti (2003). Numerous studies that estimate FRF's indicate that fiscal policy tends to be countercyclical in European and OECD countries, see Baldi & Staehr (2016) and Afonso & Jalles (2011). However, other findings exist, with some studies reporting an insignificant response of fiscal policy to the economic cycle, see Berti, et al., (2016) and Checherita-Westphal & Zdarek, (2017).

Studies on specific countries tend to result in more varied results, although usually indications of a "weak" sustainability condition are still observed. Berti, et al. (2016) finds a statistically significant positive coefficient on lagged debt (or lagged debt interacted with a crisis dummy) in a study of twelve EU countries. Specifically in the UK, they find a positive coefficient on a crisis-interacted lagged debt variable but observes an insignificant response of the primary balance to the economic cycle. Estimated using the cyclically adjusted primary balance (which removes economic interactions from the primary balance, thus focusing on discretionary policy), Burger (2012) finds that the UK primary balance improves as debt levels rise.

Modern literature modelling FRFs has increasingly explored non-linear fiscal behaviour contingent upon debt levels. Some papers have explored the "fiscal fatigue" hypothesis through the application of polynomial functional forms (for example quadratic or cubed debt variables) to understand how historic fiscal policy adjusted to changing debt levels. Numerous studies have found the presence of fiscal fatigue indicating that at higher debt ratios, sustaining fiscal efforts to reduce the primary balance become more challenging. This paper draws from the methodology of Ghosh, et al. (2013) who found presence of fiscal fatigue for a panel of 23 advanced economies, at debt ratios between 90-100% of GDP between 1970 and 2007. More specifically, whilst the primary balance was shown to initially increase in response to rising debt levels, this response diminishes when debt ratios approach 90-100% of GDP. At even higher debt levels at around 150% of GDP, the primary balance response (shown by a coefficient of the cubic debt term) turns negative.

Medeiros (2012) find similar results for a panel of EU countries, with thresholds of debt ranging from 80-90% of GDP. These results are shown to be sensitive to the country panel composition and the estimation methodology. In contrast, looking into country specific (individual) non-linear FRFs, Legrenzi & Milas (2013) over the period 1960-2012 for four-euro area countries concluded no sufficient evidence of fiscal fatigue. The paper finds that the four countries all adjust their fiscal imbalances towards higher levels of debt, with thresholds estimated at 69% of GDP for Greece, 49% for Ireland, 47% for Portugal and 43% for Spain.

Historical context

Understanding the historical economic context in which the UK and OECD fiscal policy was conducted is an essential first step to accurately interpreting econometric outputs (using data presented in section 4).

Figure 1

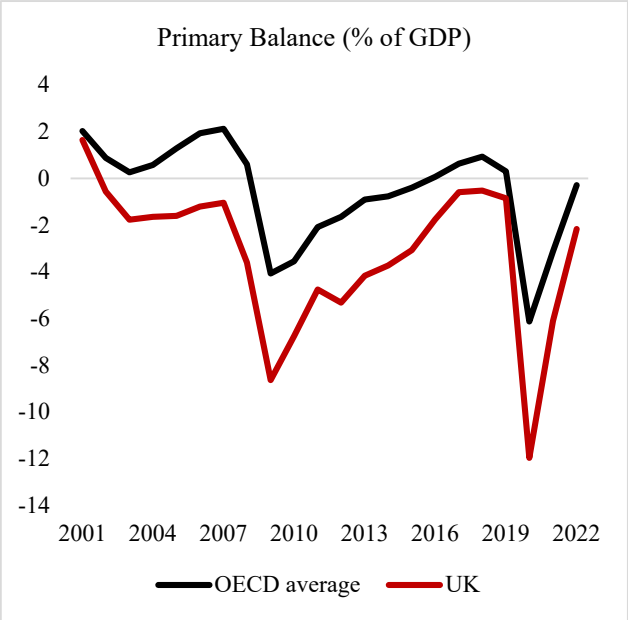
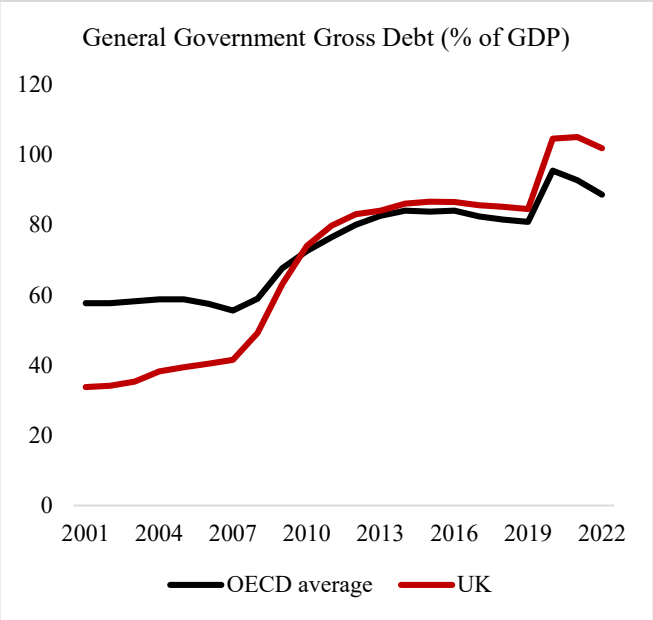


Figure 2

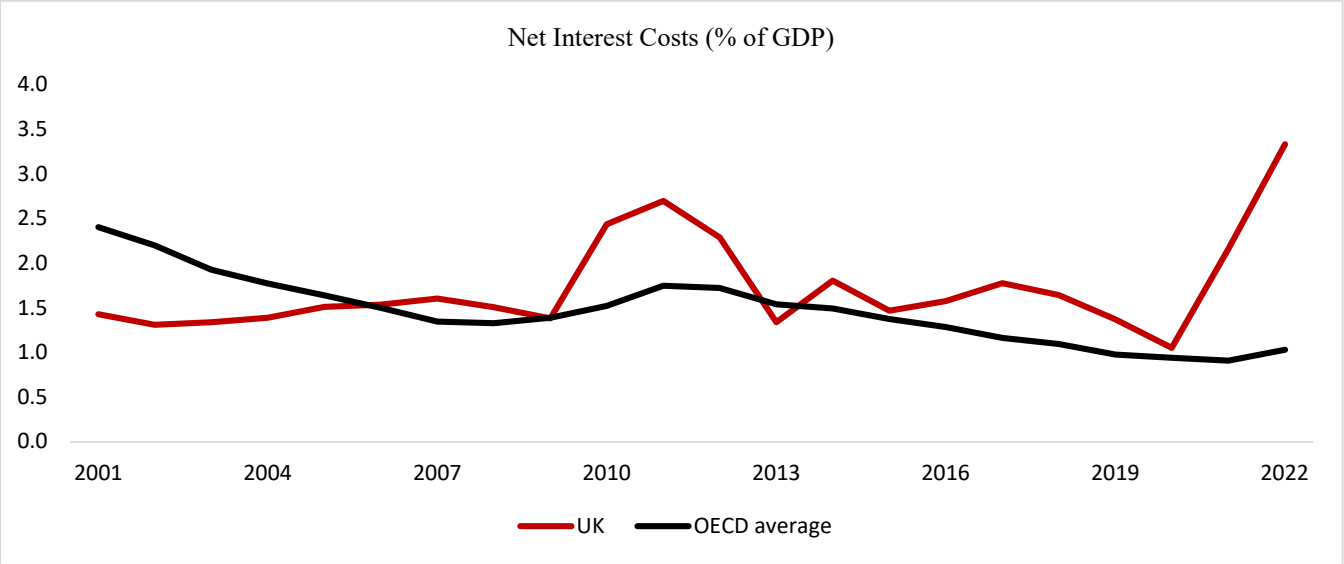


Over recent decades, numerous OECD countries, including the UK, have seen rising public debt levels, the magnitude and resulting debt level varying across nations. However, as highlighted in Treasury (2017), the UK's public finances have traditionally exhibited greater susceptibility to shocks compared to many other advanced economies. This is clear to see in figure 2.

Despite experiencing relatively steady economic growth in comparison to other OECD countries since the beginning of the 21st century, the UK's government debt has shown relatively high volatility. This scenario is likely attributable to both the progressive nature of the UK tax system and the contingent liabilities linked with having a bigger financial services sector, highlighted in Treasury (2017). It is important to consider the large limitation of this analysis where we are comparing a country sample average to an individual country. It could be that countries within the OECD average with a similar economy to the UK are performing similarly to the UK, but this is hidden within the average.

As well as volatile debt levels, the UK has historically shown to have much more volatile deviations in net interest costs compared to OECD countries, as shown in Figure 3. Interest costs are the difference between interest income earned - typically earned through investment and government bonds – and interest paid on debt and borrowing funds.

Figure 3



Intuitively, around crises periods, the government would have borrowed more through the issuance of government bonds or other debt instruments. Therefore, overall interest expense is more volatile creating higher overall government expenditure. More revenue may have therefore been directed to fund larger government expenditure, which would have led to a lower primary balance level, with deeper deficit troughs in the UK occurring around crisis periods, as shown in Figure 1.

Data and Methodological Approach

Data

The data period analysed is 2001-2022 for the OECD panel and 1980-2022 for the UK time series. These periods were selected to produce an up-to-date assessment of the relationship between debt levels and fiscal policy, whilst also ensuring complete data sets for all relevant variables. The longer time-period used in the UK model was necessary for ensuring enough observations were captured. However, it is worth noting this discrepancy in periods between the two models when comparing results.

The two main data sources for my analysis are the IMF World Economic Outlook October 2023 database, and the IMF's 'Public Finances in Modern History'. Other explanatory variables are sourced from other data sources. Data sources are consistent across the OECD panel and UK time series models.

For my panel models, data for 21 out of the 38 OECD countries is used (17 countries have been excluded given data availability issues).

In the FRF literature, two key policy variables are used as the dependent variable – either the primary balance (PB) or the cyclically adjusted primary balance (CAPB). The choice between these two variables signifies the focus of the studies: regressions using the PB illustrate the

Table 2

Variable	Source	Description
Primary Balance (Dependent)	IMF	General government primary net lending/borrowing - is net lending (+)/borrowing (-) plus net interest payable/paid (interest expense minus interest revenue) as a percentage of GDP.
Government Debt to GDP ratio	IMF and OECD	General government gross debt as a percentage of Gross Domestic Product (GDP)
Inflation	IMF	Annual percentage change in prices measured using the consumer price index.
Expenditure Gap	IMF and own calculations	The difference between primary expenditure as a percentage of GDP and trend primary expenditure as a percentage of GDP. Trend primary expenditure calculated using the Hodrick-Prescott filter
Output Gap to potential GDP ratio	IMF	The difference between an economy's actual output and its maximum potential output expressed as a percentage of potential gross domestic product.
Trade Openness	World Bank and OECD	The sum of exports and imports of goods and services measured as a share of GDP.
Crisis Dummy	Harvard Business School	Value of 1 for the years where there was a banking, systemic or currency crisis. Value 0 for no crisis.
Election Dummy	National Democratic Institute	Value of 1 for the years where an election took place, value 0 for no election year.

total 'fiscal impulse'[1], whilst those that model the CAPB estimate the fiscal effort directly[2]. The primary balance is considered the more 'observable' fiscal policy variable and so, following most studies, I use it as my dependent variable.

I also test the inclusion of additional independent variables in extended models which include an output gap variable to control for the economic cycle, a trade variable, a political risk variable (election year dummy variable) and a crises year dummy variable.

[1] The fiscal impulse is measured as the change in the government budget balance resulting from changes in government expenditure and tax policies – (J. Schinasi & Scott Lutz, 1991)

[2] Fiscal effort represents the means with which the government can achieve its policy objectives and needs to be consistent with the achievement of the desired nominal deficits – European Central Bank

Econometric Model Specification:

My empirical model is an extension of equation 1, as shown in equation 2:

Equation 2:

$$pb_t = \alpha + \beta_i pb_{t-1} + \rho \cdot d_{t-1} + \sum \beta_j X_{j,i,t} + \delta_i [+ \gamma_t] + \varepsilon_{i,t}$$

Where pb_{t-1} is the primary balance as a percentage of GDP lagged by one year (considering the persistence in the fiscal policy), d_{t-1} is the one-year lagged general government gross debt-to-GDP ratio (lagged given government debt is often serviced in the following year), $X_{j,i,t}$ is a group of macroeconomic and political determinants of the primary balance (highlighted in section 4.1), δ_i is country fixed effects and γ_t time fixed effects; any random shocks or measurement errors are captured within the error term $\varepsilon_{i,t}$.

OECD Panel Model Estimation Techniques

Endogeneity and reverse causality issues must be carefully addressed when estimating FRFs, given the probable relationship between the variables included. This paper looks to address these estimation challenges, through instrumental variable models, specific instruments used are covered later in the report.

Estimating FRFs can create stationarity issues, especially when dealing with country-specific FRFs. Crucial variables (primary balance and government debt) are expected to exhibit non-stationarity, a common finding in the relevant literature. However, surprisingly, only a limited number of studies address the issues of stationarity. Bohn (1998) actually implies that ensuring stationarity is not essential and emphasises that a positive and significant coefficient in the FRF for debt was sufficient in suggesting the sustainability of debt.

In FRFs, endogeneity can occur as the output gap may have a relationship with the primary balance due to the fiscal multiplier effect, and government debt could be correlated with the error term. Therefore, failure to properly consider this effect may result in a downward bias on the estimated FRF debt coefficient. This particular endogeneity source tends to be more prevalent in panel data analysis, than country-specific regressions.

Across the wide range of FRF literature, there is not a set model specification that is employed overwhelmingly. I initially ran a Pooled OLS, carrying out some initial multicollinearity tests using Variance inflation Factors (ViF). The Pooled OLS showed a ViF lower than 2 for all the explanatory variables. Multicollinearity was therefore not an issue given ViFs lower than 5 indicate low levels of multicollinearity. I ultimately discounted use of the Pooled OLS model due to its rejection of the Ramsey RESET test, which indicated the presence of misspecification or functional form issues (not reported due to word count restrictions).

Next, I ran a Hausman test on a Random effects model which yielded a rejection of the null hypothesis suggesting a Fixed Effects (FE) model is preferred over Random Effects. Applying residuals from the FE model, a test for endogeneity concerns using correlation matrices showed no correlation between the error term and the independent variables. This indicates no presence of downward bias on the debt coefficient. However, the primary

balance (the dependent variable) showed a 50% correlation with the error term which violates the assumption of homogeneity, indicating a need for instrumenting the lagged dependant variable. I also instrument the output gap variable to mitigate the risk of reverse causality.

Overall, in the main regressions, I prefer using an instrumental variable (IV), two-staged least squares (2SLS) estimator for my final specification given it is the most suitable estimator in this scenario for correcting endogeneity and reverse causality concerns and is commonly employed in the literature, see Baldi & Staehr (2016) and Celasun & Kang (2006) as examples. 2SLS is a technique used to address endogeneity issues in linear regression models by breaking the estimation process into two stages: first, by regressing the endogenous variables on instrumental variables to obtain predicted values, and second, by using these predicted values (which are uncorrelated with the error term) in the main regression model to estimate the parameters of interest. Additionally, as seen in Checherita-Westphal & Zdarek (2017), I employ robust standard errors to deal with heteroskedasticity and autocorrelation issues.

First, I employ the baseline specification to the whole OECD sub-group across the full-time span (2001-2022). In terms of instrumentation, most papers use lagged values of the endogenous regressors for instrumentation (Checherita-Westphal & Zdarek, 2017), others use additional exogenous variables – Celasun, et al. (2006) employs lags of one-year US bond rates and changes in real oil prices as instruments for government debt and the primary balance. Following the majority, my technique involves using instrumental variables for the lagged primary balance and the output gap where applicable as per Afonso & Jalles (2011) and Berti, et al. (2016). My set of instruments includes the second lag of the dependent variable and the first lag of the output gap. The Model (2) in Table 3 below holds up well against a range of robustness tests including a weak instruments test for the IV on the lagged primary balance, or a Sargan/Hansan overidentification test. The correlation between the primary balance is reduced from 50% to 20% when switching from Fixed effects to the 2SLS instrumentation technique, suggesting that endogeneity issues around the primary balance are mostly corrected. However, results should still be interpreted with caution given I cannot guarantee complete mitigation of endogeneity concerns in the base 2SLS models.

UK Time Series Estimation Techniques & Model Selection

For the UK time series model specification, the fundamental FRF incorporates the same model specification as set out in Equation 2 above. This includes the same four initial explanatory variables from the panel FRF, before adding the same four additional explanatory variables for robustness check purposes in an extended version of the model.

In time series estimations of the FRF, unit root and cointegration tests are frequently utilised to assess whether the time series data conform to an intertemporal budget constraint. Instances of rejection are often interpreted as indications against fiscal sustainability (Trehan & E. Walsh, 1988). Cointegration issues specifically arise when variables included in the model are non-stationary but exhibit a long-run relationship with one another. As a result, spurious regressions can arise where any significance of the variables is picked up through their shared long-run trend as opposed to any actual causal effect.

Despite this, Bohn (1998) concludes that unit root tests are specifically weak for public debt metrics. Further to this, Bohn (2007) concludes that stationarity and cointegration tests used to assess if deficits are sustainable are incapable of rejecting sustainability.

Nevertheless, correcting for cointegration between the primary balance and debt ensures that the FRF reflects actual short-term responses of the UK government to economic changes, but also gives an insight into the long-term relationship. The risk of spurious regression arising from a simple OLS model, and a need to account for cointegration, necessitates the use of alternative model specifications

A handful of papers correct for cointegration using Error-Correction Models (ECMs), see Berti, et al. (2016) and Burger (2012). An ECM is a model estimator that helps interpret how variables might adjust to long-term equilibrium relationships after short-term deviations. It is made up of two sections: a short-term dynamic part which is captured by the variables themselves, and the long-term correlation between the variables which is shown through the 'error-correction term' in the form of a lagged residual parameter. If the current primary balance level is higher or lower than the model estimates based on past data, then the lagged residual helps pull it back to its long-term relationship with debt. This adjustment mechanism therefore ensures that fiscal policy decisions are grounded in the long-term sustainability of public finances.

Testing for cointegration

To test for cointegration, unit root tests have been carried out on the variables of interest (primary balance and debt). An Augmented Dickey Filler (ADF) test suggests gross debt is non-stationary, and the primary balance is only just stationary, shown by a p-value of 0.05. The Engle-Granger approach can therefore be used as the appropriate test for cointegration between these variables. The test yielded a presence of a unit root within the residual suggesting presence of cointegration between the two variables. Cointegration correction necessitates the use of the ECM. The ECM uses first differenced variations of the parameters, where all variables are first-difference stationary. I employ robust standard errors to deal with heteroskedasticity and autocorrelation issues.

Empirical results

OECD empirical results

Table 3.

	2001-2022				Pre-GFC (2001-2006)	Post-GFC (2009-2022)
	(1)	(2)	(3)	(4)	(5)	(6)
	FE	2SLS	2SLS	2SLS	FE	2SLS
Lagged primary balance	0.554*** (0.039)	0.806*** (0.069)	0.795*** (0.077	0.878*** (0.076)	0.287*** (0.056)	0.851*** (0.081)
Lagged debt	**0.027*** (0.007)**	**0.004** (0.002)**	**0.006*** (0.002)**	**-0.002 (0.006)**	**0.091*** (0.020)**	**0.004 (0.005)**
Output gap				-0.439*** (0.164)	0.247* (0.122)	-0.294** (0.120)
Inflation	0.324*** (0.059)	0.387*** (0.075)	0.357*** (0.082)	0.558*** (0.116)	0.161 (0.102)	0.571*** (0.130)
Expenditure gap	-0.500*** (0.056)	-0.441*** (0.038)	-0.421*** (0.042)	-0.487*** (0.062)	-0.495*** (0.087)	-0.451*** (0.055)
Openness			0.007* (0.004)	0.010*** (0.003)	-0.048* (0.024)	0.007** (0.003)
Crisis dummy			-0.492*** (0.170)	-1.115*** (0.170)	-0.140 (0.200)	-0.638* (0.361)
Election dummy			-0.166 (0.118)			
Constant	-2.887*** (0.550)	-1.711*** (0.522)	-2.08*** (0.511)	-2.275*** (0.546)	-3.890* (2.093)	-1.959*** (0.502)
Observations	420	420	420	420	105	252
R-squared	0.656	0.719	0.726	0.660	0.754	0.604
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	Yes	Yes	Yes***	Yes
Weak instrument test		Strong	Strong	Strong		Strong

Source: own calculations. Notes: P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Figures in brackets represent standard errors

In the majority of specifications across the full-time span, including the full models, the lagged debt ratio stays statistically significant between 0.004 and 0.027.

Model (2) and its variations demonstrate strong explanatory power, with the R-squared statistic measuring above 0.60. Within this model, the coefficient on the debt variable is 0.004 and is statistically significant at the 1% level. This indicates that a 10-point increase in the debt ratio was on average followed by a 0.04-point increase in the primary balance. Similar to findings in Checherita-Westphal & Zdarek (2017), this coefficient indicates weak fiscal sustainability. This coefficient increases to 0.006 in Model (3) which incorporates additional explanatory variables. Finally, Model (4) incorporates an output gap variable instrumented with its lag. Strangely, the coefficient on lagged debt becomes insignificant after the inclusion of the output gap variable. Reasoning for this could be that when the output gap variable is not included, the cyclical effects on fiscal policy are being captured within the lagged debt variable, meaning the lagged debt variable could reflect past fiscal decisions made in response to cyclical fluctuation in the economy. Therefore, when the output gap variable is included, it may be the case that the need for the lagged debt variable to capture cyclicality diminishes, thereby reducing its significance.

Looking at the other variables used in Model (1), the notably large and positively signed coefficients of the lagged dependent variables indicate a persistent effect in fiscal policy, as expected. All else held constant, the primary balance exhibits a negative reaction to a widening gap between current and trend expenditure. This is expected as a widening of the expenditure gap may be an indicator of fiscal inefficiency, if government spending plans surpass sustainable thresholds or move away from planned levels, it may place pressure on the primary balance, resulting in deficits or diminished surpluses. Inflation has a consistent positive effect on fiscal policy and is always statistically significant in Models (1) to (4). One of the most cited reasons in the literature for this relationship is the "bracket creep effect", as discussed by Saez (2003). This effect refers to the fact that in a progressive tax system, government revenues tend to increase at a faster rate than inflation when there is no automatic indexation of the tax brackets.

The remaining columns for the full-time sample show an initial set of robustness checks to our baseline specification by adding a few more explanatory variables. The coefficient associated with the output gap is negative and shows a statistically significant trend. This suggests that during periods of economic expansion, indicated by a positive output gap, fiscal policy is shown to be contractionary, resulting in a deterioration of the primary balance. This result mirrors the findings of Aldama & Creel (2020) who suggest that findings around the output gap should be interpreted with caution given output gap series tend to be negative on average, which reduces the number of observations of positive output gaps. The variable 'trade openness' is incorporated in the analysis to account for the likelihood that countries more open to more trade are likely to be more vulnerable to economic shocks. The coefficient for this variable is consistently positive, and its statistical significance increases after the inclusion of the output gap variable. The addition of the output gap accounts for cyclical fluctuations, and so this may help isolate the impact of trade openness on fiscal policy more accurately. The crisis dummy shows a large negative statistically significant effect, indicating a deterioration in fiscal positions around times of crisis. Turning to the election year dummy, we expect that election years negatively impact the primary balance, informed by the electoral business cycle theory (Alesina, et al., 1993). This suggests that governments tend to

increase spending and run larger deficits or smaller surpluses in election years. The theory suggests that politicians in power use their position to influence the economy through increased government spending, to improve their chances of re-election. Despite a negative coefficient on the election dummy, I fail to find any statistical significance. Consequently, according to this model, fiscal policies in these OECD countries are relatively independent from political influence.

Period effects robustness test

To ensure the robustness of my analysis, I conduct various checks to examine how different periods affect the impact of certain variables. Given the variation observed in the literature, I divide the full-time sample into periods before and after the Global Financial Crisis (GFC), designating 2007-2008 as the crisis years. Additional regressions are run for the periods 2001-2006 and 2009-2022, but caution should be taken when interpreting results due to shorter data spans and fewer observations. For the pre-GFC model, a correlation matrix between residuals and baseline regressors suggested the absence of endogeneity issues, allowing me to proceed with a simple fixed-effect model. Notably, the response of the primary balance to debt in periods excluding the crisis years is greater than that of the full-time sample. Important to caveat the different model specifications used here, which limits meaningful comparisons. This higher debt coefficient is associated with signals of stronger fiscal sustainability compared to the post-GFC model and the full-period model. Following the GFC, there was a distinct shift in fiscal policy, and this seems to be somewhat reflected in the smaller coefficients on lagged debt in models post-GFC. This indicates an unsurprising change in fiscal strategy across OECD governments moving from pre to post GFC. Finally, the crisis dummy coefficient is no longer statistically significant for the pre-GFC model. This is unsurprising given the lack of major economic downturns between 2001 and 2006.

UK Time Series Empirical Results

Table 4.					
	1981-2022		1982-2022		
	OLS	OLS		ECM	ECM
Lagged primary balance	0.150 (0.155)	0.069 (0.129)	d_Lagged primary balance	-0.057 (0.073)	-0.053 (0.060)
Lagged Debt	**-0.051***** **(0.012)**	**-0.054***** **(0.016)**	**d_Lagged Debt**	**-0.131***** **(0.039)**	**-0.108***** **(0.030)**
Output gap		0.294** (0.108)	d_Output gap		0.277*** (0.066)
Inflation	0.149* (0.081)	-0.006 (0.061)	d_Inflation	0.153 (0.125)	0.020 (0.091)
Expenditure gap	-0.826*** (0.124)	-0.720*** (0.111)	d_Expenditure gap	-0.730*** (0.086)	-0.611*** (0.079)
Openness		0.058 (0.062)	d_Openness		0.091 (0.056)
Crisis dummy		-0.493 (0.402)	d_Crisis dummy		-0.295* (0.154)
Constant	0.661 (0.569)	-1.700 (2.974)	**Lagged residual**	**-0.333**** **(0.128)**	**-0.341**** **(0.133)**
T	42	42	T	41	41
R-squared	0.825	0.866	R-squared	0.880	0.898

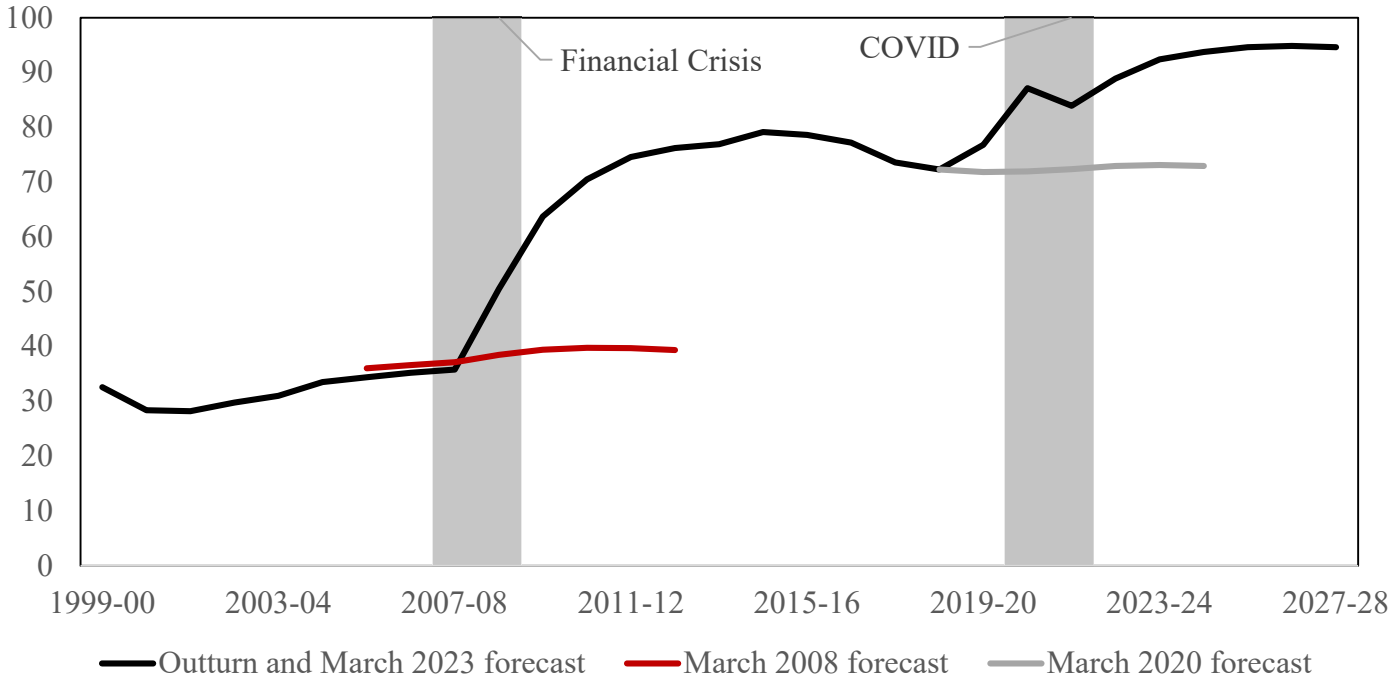
When examining these results, it is first important to caveat the smaller number of observations. With fewer data points, these regressions may have less statistical power to detect true relationships, results should therefore be interpreted carefully. Despite this, all four models have normally distributed residuals suggesting valid statistical inferences can be made about the model parameters.

Fiscal responsiveness in the UK shows a counter-cyclical fiscal policy stance to debt. The -0.12 coefficient on debt indicates that a 10-point increase in government debt is associated with a 1.2-point deterioration in the primary balance. This implies a potential significant loosening of fiscal policy as government debt levels increase. If the UK government acted in

line with historical precedent (i.e., major loosening of fiscal policy following increases in debt), then debt would ultimately fail to stabilise in the future and the government budget constraint would not be satisfied. This indicates a possible past failure for the UK to meet spending obligations without resorting to unsustainable levels of debt accumulation.

This finding differs and complement the UK FRF literature. For example, Burger (2012) finds evidence for fiscal sustainability in both the US and the UK. However, Schoder (2014) who uses a similar ECM estimation, conclude that the UK tends to have negative response coefficients, similar to my results. Schroder suggests that inconsistency in results with an opposing paper (Ballabriga, 2005), is due to the fact Ballabriga (2005) excludes crisis years in their models. We know for the UK especially, that a lot of debt accumulation is exaggerated during crisis years. Analysis by Office for Budget Responsibility (2023) state that 'of the nearly 50 per cent of GDP increase in debt over the past 15 years, almost nine-tenths of it occurred in just four years – the two years after the financial crisis and the pandemic respectively' – shown in Figure 4.

Figure 4: UK underlying debt as a share of GDP



Further to this, turbulent changes in debt interest spending across the period contributed to a deterioration in the primary balance, as more revenue was absorbed to fund these higher interest costs. This is further supported by the positive coefficient on the output gap variable in both the extended OLS and ECM models. This contrasts the negative coefficient shown in the OECD panel models and indicates that a larger positive output gap is associated with an improvement in the primary balance in the UK. Finally, the crisis dummy variable appears only mildly statistically significant. This may suggest that the negative impact of crisis years on the primary balance might be already captured by the lagged debt variable. This means that the negative effect crisis years have, could be mainly explained by the accumulation of debt, rather than solely by the occurrence of crises themselves.

Looking at the other explanatory variables, similar to the OECD models, the UK primary balance worsens as the expenditure gap widens. However, inflation and trade openness yield insignificant coefficients in the extended OLS model. The lagged residuals have a coefficient of -0.33, suggesting that a third of the deviation from the long-term equilibrium between the primary balance and debt is being corrected within one period. This indicates a fairly fast adjustment towards the long-term equilibrium. Unlike the OECD panel models, I was unable to undertake period effect robustness checks given few data points in the UK regression.

Non-linear investigation of the Fiscal Reaction Function – OECD and UK scenarios

Table 5

OECD Panel	2001-2022
	Non-linear 2SLS
Lagged Debt	**-0.167*** (0.030)**
Lagged Debt2	**0.001*** (0.000)**
Lagged Debt3	**-0.000*** (0.000)**
Output gap	0.131 (0.193)
Expenditure gap	-0.431*** (0.087)
T	440
R-squared	0.399

Table 6

UK Time Series	1982-2022
	Non-linear ECM
d_Lagged primary balance	0.057 (0.095)
d_Lagged Debt	**-0.230*** (0.042)**
d_Lagged Debt2	**0.003*** (0.001)**
d_Lagged Debt3	**-0.000*** (0.000)**
d_Output gap	0.245*** (0.085)
d_Expenditure gap	-0.464*** (0.070)
Lagged residual	**-0.361*** (0.152)**
T	41
R-squared	0.920

This section explores possibilities of a non-linear relationship between the fiscal policy and debt. Initially, my objective is to examine the fiscal fatigue hypothesis as outlined by Ghosh, et al. (2013), employing the OECD and UK datasets separately. The fiscal fatigue hypothesis posits that there may be diminishing returns or adverse effects on fiscal outcomes as government debt accumulates over time. In this context, the model estimation somewhat extends the specification outlined in equation 2 by incorporating additional lagged polynomial terms of government debt, but reduce the number of explanatory variables as per

Ghosh's baseline models (including the removal of the lagged dependant variable which creates the low r-squared in the OECD model[3]). Further to this, the additional non-linear models use the same 2SLS estimator and instruments for the OECD panel estimation and the same ECM technique for the UK estimation. The inclusion of the lagged dependent variable in the OECD model brings the r-squared back to 0.605 but does not yield the expected coefficients (not reported). The cubic specification below is only one form to capture a non-linear behaviour, but the specification includes a squared lagged debt term also.

$$pb_t = \alpha + \rho \cdot d_{t-1} + \rho' \cdot {d^2}_{t-1} + \rho'' \cdot {d^3}_{t-1} + \sum \beta_j X_{j,i,t} + \delta_i [+ \gamma_t] + \varepsilon_{i,t}$$

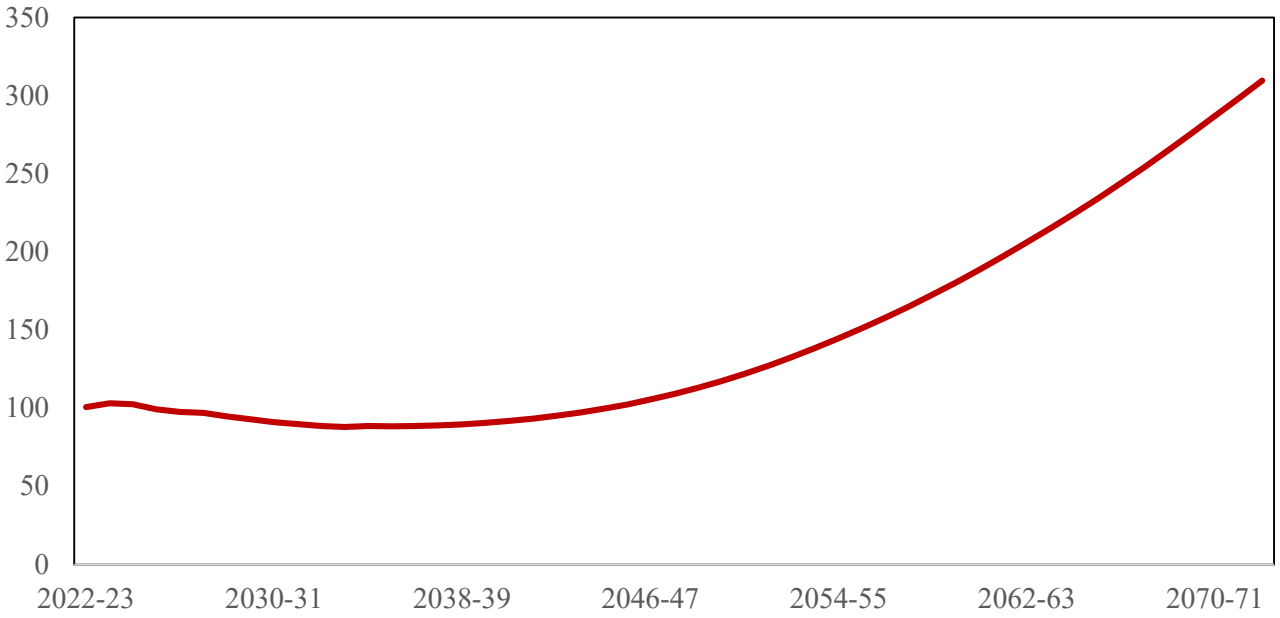
Despite differing linear results between the OECD panel model and the UK time series, both non-linear models show a negative but significant ρ" coefficient. This suggests that the effect of debt on the primary balance is not just linear but exhibits a non-linear relationship. As debt continues to increase, the impact on the primary balance becomes increasingly negative at an accelerating rate. This suggests there is a presence of fiscal fatigue in both cases. This may be because the burden of servicing and managing debt becomes increasingly difficult, leading to more severe fiscal challenges and potentially necessitating corrective actions such as more aggressive fiscal consolidation.

These results differ from the conclusions drawn by Bohn (1998). Bohn (2008) in his research of the US finds increased consolidation when debt levels are higher. However, these findings are similar to the conclusion of Ghosh, et al. (2013), who find a non-linear relationship between the marginal response of the primary balance to lagged debt. More specifically, Ghosh finds that the primary balance response to lagged debt starts to decline at debt levels of around 90-100%, and then becomes negative as debt approaches around 150% of GDP. Although we cannot conclude the same debt thresholds, similarity to Ghosh's polynomial coefficients means we might expect a deteriorating primary balance to occur somewhere around these debt thresholds. These findings also align with the conclusions presented by Mendoza & Ostry (2008) indicating that in advanced economies, the likelihood of sustainability diminishes when public debt is high compared to when it is at moderate levels.

According to OBR (2024) and shown in figure 5 below, UK debt is on an increasing trajectory due to severe spending pressures. This debt trajectory however assumes no policy response. The non-linear UK FRF implies that based on past data, the policy response for continued debt increases is to loosen, and due to fiscal fatigue, at increasing amounts. This ultimately means that the UK needs to step away from historical precedent to mitigate against this severe long-term debt accumulation.

[3] Note a lagged primary balance variable is included in the UK model as this forms part of the ECM functional form

Figure 5: OBR July 2023 UK baseline long-term debt projections



Remaining explanatory variable coefficients are reasonable and consistent with prior research. Specifically, fiscal policy improves when there is a positive output gap, whilst deviations from planned spending, as represented by the government expenditure gap variable, have a negative impact on the primary balance.

Conclusion

In a linear setting, I find evidence over the period 2001-2022 that OECD countries on average abide by fiscal sustainability constraints. Data for 2001-2006 and 2009-2022 also imply fiscal sustainability, with the pre-crisis period exhibiting far greater debt coefficients, meaning a deterioration of fiscal response in OECD countries post-GFC. The low positive coefficient on debt indicated a 'weak' level of fiscal sustainability. These results are in line with other advanced economy FRF literature, although my analysis validates these previous finding with more recent data. Using non-linear FRFs, I conclude that this sample of OECD countries exhibit fiscal fatigue. Even if the OECD sovereigns continue to operationalise a weakly sustainable linear FRF, this still has implications for long-run sustainability, suggesting that fiscal discipline ought to still be at the forefront. Further to this, uncertain output gap trajectories in a turbulent economic environment stress the need to select reasonable fiscal targets consistent with market conditions (Rawdanowicz, 2014). Overall, the more recent data used in my models show that the OECD still have not taken specific steps to improve their ability to finance spending obligations without continuing to accumulate debt.

For the UK specifically, across a longer period of 1980-2022, in a linear context, I find a deterioration of the primary balance in response to rising debt levels. Therefore, based on historic trends, UK fiscal policy is at risk of being unsustainable. Further to this, and similar to the OECD panel, the UK also historically exhibits fiscal fatigue. With this in mind, policymakers may have to prioritise fiscal consolidation measures to manage debt levels efficiently. Despite this, given ongoing economic uncertainty in the UK resulting from events

like Brexit and COVID-19, it makes it difficult for the government to implement austerity measures or tax increases. However, there may be scope for slightly more aggressive consolidation as current inflation pressures continue to ease.

As with other studies, my research has certain limitations, particularly in employing a panel approach for the OECD model to examine the fiscal fatigue hypothesis. Employing a set of country-specific models for the OECD sample may seem like an intuitive solution. Unfortunately, due to restricted availability or comparability of time series data across my selected countries, I was unable to pursue this extension in my current investigation. The limited data points used in the UK model meant it was challenging to extract meaningful relationships between variables. A possible extension could be to use quarterly data which may elicit clearer relationships between variables and therefore provide greater insight into the dynamics of debt and primary balance behaviour.

In addition to the practical applications examined in this paper, there are various other avenues for research utilising estimated FRFs that could be applied in the future. This might include more intricate concepts beyond the government debt sustainability analysis investigated in this study, such as public debt limits. However, it is essential to recognise that assessing fiscal sustainability necessitates a holistic approach. No single metric alone can adequately capture a sovereign's ability to fulfil its debt obligations.

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