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A draft on theories of fiscal sustainability

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Fiscal sustainability has been an oft-mentioned concept since the world's last economic and financial crisis. This global crisis has drawn attention to the problems of public deficits and debt growth. It is, however, expected of modern analysis that any such lessons learnt should be based on empirical examination. To this end, we have tried to summarize the basic methodology for measurement of fiscal sustainability. We have examined and compared many ways or methods for achieving fiscal sustainability. Our experience is that the measurement of fiscal sustainability depends on the definition of fiscal sustainability itself, the definition of the balance of the public deficit and debt, the length and quality of the time series used, the particular characteristics of the countries participating in the study, and the researchers' own approaches and expectations. Here we discuss what have been the most important milestones in the literature, and what kind of methods would serve in own research.

Keywords: fiscal sustainability, fiscal policy, public deficit, public debt

1. Introduction

The economics of sustainability is based on the economics of ecology, environment and resources, but it is not a single discipline. It has three major research fields, the first of which tries to define and operate itself, the second one tries to analyse the uncertainty of connections between humanity and the environment, while the third examines the institutions, and political and government structures that are most important for sustainability. Indeed, fiscal sustainability is the main part of the economics of sustainability. Our slow economic growth rate, the ageing population and the changing model of emerging countries, have all put pressure on the European Union, in response to which Eurostat has created sustainable development indicators and fiscal sustainability indicators. Moreover, several researchers and international organisations (for example IMF and World Bank) have followed Eurostat's lead.

Our study analysed the definition of fiscal sustainability, the main elements of the measurement of fiscal sustainability, public deficit and public debt, which are components of budget constraint, and showed some econometrical methods of fiscal sustainability. Due to the limited scope of this study, we have foregone a detailed introduction to econometrical methods, and assume that our readers will all have a degree of econometrical experience.

2. Public sector deficit and budget constraints

Publications on the empirical examination of fiscal sustainability have defined a measurement of debt and deficit, while other papers have shown a budget constraint in the macro economic environment, and hence it will be necessary to provide a basic

introduction to budget constraint. After that, we will be in a position to interpret fiscal sustainability, its measurement and its econometrical examination.

The examination of several debt situations means having to face the problem of data heterogeneity, because there is no uniform measure of public debt. Some countries provide data on central government debt; while other countries record consolidated public-sector debt with their respective central banks. Other countries again list gross public debt, including public guarantees and pension liabilities, and others publish only the net basis of debt. Researchers in the field are forced to match and compare reports about public debts and fiscal deficits. They use public debt decomposition, but assume that all factors contributing to changes in the level of debt are simultaneously determined. In fact, these factors influence each other as well. Therefore, studies of this kind should attempt to link changes in debt-to-GDP ratios to episodes of marked policy change or structural factors. Most similar papers have been based on the studies by Barro (1974, 1979) and Buiter (1982), and have assumed their budget constraints.

Barro (1974) examined the economy with overlapping-generation model. The question was whether an increase in government debt causes perceived household wealth increase. He discussed the "Ricardian" equivalence theorem on public debt, i.e. that debt and tax finance shift has no first-order effect on the real interest rate, volume of private investment, etc. The paper showed that government debt and tax liabilities generate risk, and that an increase in government bonds could cause overall risk in household balance sheets to rise. The nature of the tax system, transaction costs and private insurance arrangements, however, all affected the relationship of risk and household balance sheet. The main conclusion by Barro (1974) was that there is no convincing theoretical case for treating government debt, at the margin, as a net component of perceived household wealth.

Barro (1979) showed a simple theory of "optimal" public finance that included some factors which have an effect on the choice between the tax and debt issue. The model used Ricardian invariance theorem but set up a second-order "excess burden" of taxation to determine (optimal) value of debt creation. He tested the theorem on time-series data from the United States up to World War I. The main results were evidence of the positive effect on debt issue of a temporary increase in government spending (especially in war and post-war periods), and the negative effect of a temporary increase on income (larger than in theory) and the one-to-one effect on expected inflation rate and on the growth rate of nominal debt. The historical data did not evidence an impact of such temporary changes on federal taxes. He concluded that business-cycle effects from temporary tax changes and fiscal policy in isolation were difficult to establish. He used the following government budget equation:

$$G_t + rb_{t-1} = \tau_t + (b_t - b_{t-1})$$

where G_t is the volume of real government expenditure excluding interest payments on public debt, and assumed to be exogenous, while τ_t is the real tax revenue during the period t, and b_t real public stock outstanding at the end of period t. He assumed that the initial price level could be expected to be constant over time, and the real (and nominal) rate of return on public and private debts, r, is also a constant. Meanwhile, the government's budget equation is as follows:

$$\sum_{t}^{\infty}\left[{}^{G_t}/_{(1+r)^t}\right] + b_0 = \sum_{t}^{\infty}\left[{}^{\tau_t}/_{(1+r)^t}\right]$$

Buiter (1982) discussed budgetary, financial and monetary policy evaluation with a comprehensive wealth or permanent income accounting framework. He claimed that the public sector financial deficit and the public sector borrowing requirement (at current or constant prices or as proportion of GNP) provided uninformative statistics; and therefore, he had corrected these factors with the change in the real value of outstanding stocks of interest-bearing public debt.

In addition, while several countries have significant mineral rights (e.g. Norway, UK, US and Russia and other oil-producing nations) or economic activity that depends on nationalised sector accounts (e.g. UK, and many developing countries), we have to take into account equity and public sector property rights in land and natural resources from the public sector balance sheet. These items are open-ended commitments to subsidise loss-making public enterprises, that depress net worth. He distinguished between the problem of cyclical (transitory or reversible) deficit and permanent deficit. He assumed about transitory (e.g. cyclical) deficits and surpluses, that the government has to use fiscal management, disregarding the actual level of inflation. Money creation is another solution to the problem of cyclical deficit increase, which the government has to negate during an upturn. He modified public sector budget constraint in theory in the early 1970s, plotting imputed income and consumption deflated by general price level yields and the public sector financial surplus (at constant prices) (Buiter 1982).

A special theory on the topic of budget constraint was contributed by Kornai (1992), who defined a soft budget constraint. It describes the situation when an entity can manipulate its access to necessary funds. Because of the constraints of our study, we are unable to explain this theory further, beyond referring to Trehan and Walsh (1991), and their summary of the role of intertemporal budget constraint in a variety of contexts. Bohn (1998, p. 2) said, "Under fairly weak conditions, a positive (at least linear) response of primary surpluses to the debt-income ratio also implies that government policy is sustainable in the sense of satisfying an intertemporal budget constraint". Following on from Trehan and Walsh (1991), Greiner and Fincke (2015, p. 5) said, "the intertemporal budget constraint of the government requires that the present value of public debt asymptotically converges to zero".

The World Bank, International Monetary Fund and European Union make an annual fiscal stability report about member states. They have developed particular measurement practices for debt, deficit and fiscal sustainability, and have improved them year by year. The World Bank (2005, p. 8) analysed public debt trends with the following equation:

$$\Delta d_t = pd_t - \frac{g}{(1+g)} d_{t-1} + \frac{d_{t-1}}{(1+g)} \left[\frac{\hat{\imath}}{1+\pi} - \frac{\pi}{1+\pi} - \frac{\alpha(\pi^* - \pi)}{(1+\pi)(1+\pi^*)} \right] - \alpha \frac{RXR}{(1+\pi^*)(1+RXR)} \cdot \frac{d_{t-1}}{(1+g)} + \text{otherfactors}$$

where d_t is the public debt-to-GDP ratio, pd_t is the primary deficit to GDP ratio, g is the real GDP growth rate, $\hat{\imath}$ is the weighted averages of domestic and foreign interest rates, and π is domestic inflation rate (the percentage change in GDP deflator). Further, π^* is the US inflation rate (the percentage change in US GDP deflator), α the share of foreign currency denominated debt in total public debt, and RXR the change in (bilateral, US dollar per local currency unit) real exchange rate ($RXR > 0$ means a real exchange rate appreciation).

The examination is based on 31 market access countries (MACs), however their averages for 21 MACs were computed in the period 1991-2002. We are able to see more details from 15 MACs in different periods in their study. They concluded that initial conditions and country specifics were important in similar examinations. Another main conclusion was that fiscal consolidation and quality of fiscal policy influenced debt sustainability, and that debt reduction affected growth. The quality of fiscal management is able to determine the amount of public debt. Most MACs used fiscal rules as a result of weak institutions and pro-cyclical fiscal policy. Meanwhile, automatic debt dynamics and debt structure affected interest rates and exchange rate appreciation (World Bank 2005).

The IMF kept in mind the fact that the measurement of fiscal sustainability was affected by country-specific circumstances, a country's policy track record and policy options. They distinguished between market-access countries and low-income countries (LICs). The Debt Sustainability Analysis (DSA) framework for MACs became operational in 2002 (IMF 2002). Worth noting are also early warning indicators, which try to sign financial or currency crisis (Wyplosz 2007). Because LICs often have large external debt, both the IMF and World Bank have developed the Debt Sustainability Framework (DSF) for LICs. The aim was to help guide countries and creditors finance development in such a way as to prevent the former entering excessive debt situations (IMF 2003).

3. Empirical examination of fiscal sustainability

The first definition of fiscal sustainability was originated by Hamilton and Flavin (1986, p. 811), as "the government budget must be balanced in present-value terms". Another common definition of fiscal sustainability came from Blanchard et al. (1990, p. 11): "sustainable fiscal policy can be defined as a policy such that the ratio of debt to GNP eventually converges back to its initial level … unsustainable a policy which implies a temporary bulge in the ratio". The sustainability definition by the IMF (2002, p. 5) is "An entity's liability position is sustainable if it satisfies the present value budget constraint without a major correction in the balance of income and expenditure given the costs of financing it faces in the market". Croce and Juan-Ramón (2003, p. 3) said, "the question is whether the government can continue to pursue its set of budgetary policies without endangering its solvency".

Several papers have been published about public debt since the study by Hamilton and Flavin (1986). The main question was whether the given debt policies were able to be considered as sustainable. If we examine these papers, we can find some key factors in the measurement of sustainability. The current interest rate, interest payment growth and public deficit are the main variables examined in these studies. There are econometrical examinations, which are very sensitive to the quality and quantity of data and lead to heterogeneous results. The following part of study seeks to show some more interesting measures of fiscal sustainability. Table 1 is a summary of these measures.

Table 1 Selected papers on fiscal sustainability measurement

Article	Sample	Time horizon	Model or indicator
Blanchard et al. (1990)	Selected OECD countries	1983-2028	Fiscal gap (short-, medium and long-term)
Bohn (1995)	U.S.	1916-1990	Stochastic model
Croce and Juan-Ramón (2003)	12 developed and developing countries	1990-2000	Indicator of Fiscal Sustainability
Tanner and Samake (2006)	Brazil, Mexico and Turkey	1998-2005	Vector autoregression model
Greiner and Fincke (2015)	Austria, France, Germany, Italy, The Nederland, Portuguese and the USA	1970-2012	Panel model
European Commission (2016)	European Union countries	2015-2030	Fiscal sustainability indicators (S0, S1, S2)

Source: Own construction

All papers on fiscal sustainability mentioned the fiscal gap by Blanchard et al. (1990). They used a set of indicators in different time horizons (1, 5 and 40 years), these indicators being denoted short-term, medium-term and long-term gaps. The short-term gap was given by:

$$d + (r - \theta)b_0$$

from

$$t_0^* - t = g + h - t + (r - \theta)b = d + (r - \theta)b$$

The medium-term gap:

$$[(\text{average over the next 5 years of } g + h) + (r - \theta)b_0] - t$$

from:

$$t_n^* = (r - \theta)[b_0(1 - exp - (r - \theta)n)]^{-1}\left[\int_0^n (g + h)exp - (r - \theta)s\, ds\right]$$

where r and θ are the expected average real interest and growth rates over the next 5 years, and t the constant tax rate. If we compare the short-term with the medium term, we can say that the short-term gap is a desirable characteristic of a medium-term gap; the medium-term gap anticipating movements in the short-term gap. They illustrated these indicators in OECD countries in the 1980s period, and assessed specific government programmes. In the medium term, these programmes reached far into the future, in particular, depending on population ageing. They suggested that the assessment of the fiscal sustainability should be forward-looking, and not just static.

Bohn (1995) provides one of the first tests of sustainable debt policies. He said that the public debt policy is sustainable if the primary surplus relative to GDP is a positive function of the debt to GDP ratio. The intuition behind this proposition is that if governments run into debt today, they have to take corrective actions in the future by increasing the primary surplus. Since the middle of the 2000s, researchers in the area have focused on the measurement and testing of sustainability of public debt, for example Afonso (2005), Ballabriga and Martinez-Mongay (2005), Greiner et al. (2007), Neck and Sturm (2008), Bohn (2008), Fincke and Greiner (2008), and Greiner and Fincke (2015).

The Indicator of Fiscal Sustainability by Croce and Juan-Ramón (2003) is another oft-cited indicator besides the fiscal gap. They tested 12 countries' data in the 1990s period, with the following algorithm:

$$IFS_t = (\beta_t - \lambda_t) = \frac{1 + r_t}{1 + g_t} - \frac{ps_t - ps^*}{d_{t-1} - d^*}$$

where β_t is the spread between the observed real interest rate and the observed rate of growth at time t. Meanwhile λ_t denotes a ratio between the deviation of the observed primary surplus ratio with respect to the primary ratio which would maintain the debt ratio at its target value and the deviation of the observed public-debt ratio with respect to its target value. Further, ps is the primary surplus ratio, and d^* means the lowest value reached by the debt ratio during the period. If the algorithm is greater by more

than 75 percent than the threshold during the 1990s, then the county's fiscal policy is unsustainable. In a subsequent empirical examination, Argentina, Brazil and Turkey are classified as unsustainable. In contrast, the countries (Belgium, Indonesia, Ireland, and Mexico) where the IFS was lower than 75 percent of the threshold during the 1990s were classified as sustainable.

Tanner and Samake (2006) examined the sustainability of fiscal policy in Brazil, Mexico and Turkey, distinguishing between retrospective and prospective sustainability. In determining retrospective sustainability, the following question was posed (Tanner–Samake 2006, p. 4): "If historical policies were to be continued into the future, would fiscal policy be sustainable - or will a modification of policies be required?". Meanwhile, prospective sustainability seeks to answer the following question (Tanner–Samake 2006, p. 4): "What policies should be undertaken today in order to prevent the need for further adjustments in the future?" They categorized these two types of approach to sustainability in previous papers. Hamilton and Flavin (1986) with stationarity of deficit, Bohn (1991) about cointegration of revenues and expenditures, and Bohn (1998, 2005) about the link between primary surplus and debt, all based on retrospective sustainability. Blanchard et al. (1990) with fiscal gap was included in both categories. The papers which employed Value-at-Risk, like Kopits and Barnhill (2003), Adrogué (2005), or simulated debt projections, namely Celasun et al. (2006) and Hoffmaister et al. (2001), were grouped in the prospective approach.

Tanner and Samake (2006) used vector auto-regression model, i.e. historical decomposition with fiscal and macroeconomic variables in retrospective examination. Historical decomposition is able to identify which shocks were most important in debt accumulation, when such shocks happened and whether they caused increasing or decreasing debt.

A country's policy was "unsustainable" if the debt stock rose under certainty (the baseline projection); otherwise, policy was "sustainable". Absent shocks, fiscal policy is sustainable over the period $M+1$ through $M+j$ if (Tanner–Samake 2006, p. 13):

$$\frac{b(base)_{M+j}}{GDP_{M+j}} \leq \frac{b_M}{GDP_M}$$

While in a historical decomposition, each element of X is expressed as the sum of a baseline projection of that variable, conditional on all information available in the base period M; plus the (orthogonal) impacts of shocks from all variables thereon, accumulated from $M+1$ onward. Thus, in any period $M+j$ $(j = 1,2,3,4\ldots J)$ the change in debt (that is, the deficit) Δb_{M+j} is the following:

$$\Delta b_{M+j} = \Delta b(base)_{M+j} + z^*_{b1j} + z^*_{b2j} + \cdots z^*_{bIj}$$

where $\Delta b(base)_{tB+k}$ incorporates all information about the evolution of deficit that is available before time $M+1$, while z^*_{bij} represent the impacts of the i-th variable $(i = 1,2,3,..I)$ on the deficit, accumulated from $M+1$ through $M+j$. The variables

corresponding to z^*_{bij} are both policy and non-policy, as discussed below. Thus, a country's debt level at the end of period $M + j$ is the following:

$$b_{M+j} = b_{M+j-1} + \Delta b(base)_{M+j} + z^*_{b1j} + z^*_{b2j} + \cdots z^*_{bIj}$$

Tanner and Samake (2006) presented simulations of the VAR system with randomly generated shocks. The equation is:

$$b(sim)_t = b(sim)_{t-1} + (1 + r(sim)_t) + pd(sim)_t$$

where $b(sim)$, $r(sim)$, $pd(sim)$ are simulated values of the debt, interest rate and primary deficit for any period $t > J$, and:

$$r(sim) = \zeta_{r0} + \zeta^*_{r1t} + \zeta^*_{r2t} + \cdots + \zeta^*_{rIt}$$
$$pd(sim) = \zeta_{p0} + \zeta^*_{p1t} + \zeta^*_{p2t} + \cdots + \zeta^*_{pIt}$$

with ζ_{r0} and ζ_{p0} representing the assumed mean levels of the real interest rate and primary surplus, while the terms ζ^*_{rit} and ζ^*_{pit} are simulated impacts of shocks to variable i on the real interest rate and primary deficit, respectively.

They showed with Monte Carlo simulation that the primary surplus rising causes increasing debt-GDP ratio, the worst situations the 50, 25, and 10 percent of circumstances. Although the field of simulation is a very interesting part of empirical examination in itself, we shall now focus on testing methods. That of Tanner and Samake (2006) has its advantages, the first being the richer and more sophisticated econometric framework compared to previous frameworks, and moreover, their framework communicates a clearer menu of options for policymakers than other frameworks. The central message is that the optimal primary surplus and debt reduction path depend on the specific technology and preferences of a country, and hence any analysis must incorporate general equilibrium model as well.

One of the newest empirical examination for sustainable debt level comes from Greiner and Fincke (2015). The study seeks to answer the important questions of whether a sustainable debt policy is compatible with a rising debt to GDP ratio, and of identifying the critical initial debt ratio of unsustainable debt policy. They used correlation between the primary surplus and public debt, all measured as ratios of GDP. They analysed seven countries (Austria, France, Germany, Italy, The Nederlands, Portugal and the U.S) from 1970 to 2012 in panel model. They created three-type interval (year 1, year 3 and year 5). The initial equation is:

$$s(t) = \psi(t)b(t) + \phi^T Z(t) + \epsilon(t)$$

where $s(t)$ is the primary surplus to GDP ratio, $b(t)$ the public debt to GDP ratio at time t, $Z(t)$ is a vector of additional variables which influence the primary surplus ratio, and $\epsilon(t)$ is an error term (i.i.d. $N(0, \sigma^2)$). After that, they broaden the equation with $YVar(5)$ as a business cycle variable, which means accounting for fluctuation in revenues. They were able to measure this variable with Hodrick Prescott-Filter (HP-

Filter) to the real GDP series. The primary surplus was affected by deviations of real public expenditures from its long-run trend, therefore they use $GVar(t)$, i.e. the fluctuations of public expenditure around its trend, and computed by HP-filter. Finally, they changed $b(t)$ to $b(t-1)$, which solved problems of endogeneity. The new equation was the following:

$$s(t) = \phi_0 + \varphi(t)b(t-1) + \phi_1 GVar(t) + \phi_2 YVar(t) + \epsilon(t)$$

They made a pooled OLS estimation with fixed and random effect, using control variables, too, as the following equation shows:

$$y_{i,t} - y_{i,t-q} = \phi_0 + \psi b_{i,t-q} + \phi_1 y_{i,t-q} + \phi_2 Trade_{i,t-q} + \phi_3 GCons_{i,t-q} + \phi_4 Infl_{i,t-q}\epsilon_{i,t}$$

where $y_{i,t}$ is the natural logarithm of real GDP per capita for country i at time t. Further, b is the public debt to GDP ratio, $y_{i,t-q}$ the initial real GDP per capita expressed in log units, $Trade_{i,t-q}$ is foreign trade proxied by the difference between exports and imports (i.e. the external trade balance or net exports) relative to GDP. The $GCons_{i,t-q}$ is government consumption calculated as government consumption expenditures relative to GDP and $Infl_{i,t-q}$ is the initial annual inflation rate.

Their results revealed the negative relationship between the public debt to GDP ratio and the growth rate. The panel data estimation without control variables showed significant negative relation between the public debt to GDP ratio and economic growth in the subsequent periods. When they estimated with control variables, they experienced smaller negative correlation between debt and growth. The linear relationship as empirical evidence for non-linearities is very weak, indeed they could not find any indication of non-linearities for the 3-year time interval and for annual growth rates (Greiner–Fincke 2015).

Fiscal sustainability meant "solvency" of the public sector for the European Union. They use three sustainability indicators, $S0$, $S1$ and $S2$. $S0$ is a composite indicator, a set of fiscal and financial-competitiveness variables (28 variable); therefore, their methodology is very different from others. $S0$ is described as an "early detection indicator designed to highlight shorter term risks of fiscal stress (within a 1-year horizon) stemming from the fiscal, as well as the macro financial and competitiveness sides of the economy" (European Commission 2015, p. 29). In contrast, $S1$ is a medium-term and $S2$ a long-term sustainability indicator, and these reflect the aforementioned solvency definition of fiscal sustainability. These are based on the government intertemporal budget constraint[1] and help provide fiscal projection

[1] The intertemporal budget constraint defined by "public debt and the discounted value of future government expenditure, including the projected increase in age-related public spending, need to be covered by the discounted value of future government revenues" (European Commission 2016, p. 22).

under the assumption of unchanged fiscal policy. The time horizon of interest of S1 extends to 2030 and it has a specific debt target (60% for gross public debt to GDP), but S2 has an infinite horizon and foregoes a specific debt ratio target

$$S1 = Gap\ to\ debt\ stabilising\ primary\ balance\ + \\ additional\ adjusment\ required\ to\ reach\ 60\%\ debt\ ration\ in\ 2030 + \\ additional\ adjustment\ required\ to\ finance\ the\ increase\ in\ public \\ spending\ due\ to\ ageing\ up\ to\ 2030$$

$$S2 = Gap\ to\ debt\ stabilising\ primary\ balance + \\ additional\ adjustment\ required\ to\ finance\ the\ increase\ in\ public \\ spending\ due\ to\ ageing\ over\ infinite\ horizon$$

Tóth (2014) assessed some indicators of fiscal sustainability by predicting power. These are the primary gap by Blanchard (1990), the stationary tests for public debt by Miyazaki (2014), the stationary test for the first differential of public debt by Prohl and Schneider (2006), the public revenues and expenditures cointegration by Afonso and Jalles (2012) and the fiscal reaction function by Bohn (1998). The effectiveness of the various forecasting methods was analysed by three indicators: the true positive rate (TPR)[2], false positive rate (FPR)[3] and classification accuracy[4]. The primary gap had the best forecasting capacity, in spite of the fact that the primary gap was the most static among the methods examined. Tóth (2014) drew attention to unit selection, the frequency of data series, the length of the periods, indicators, estimation methods, and hypotheses testing, together with structural breaks affecting measurement. He suggested that the studies should incorporate more country-specific factors (threshold values) in order to increase the efficiency of fiscal indicators.

4. Conclusion

We analysed the basic measurement and empirical methods of fiscal sustainability. To do this, we needed to discuss the definition of fiscal sustainability, and show the connection between debt, deficit and fiscal sustainability. The simplest definition is "the government budget must be balanced in present-value terms" (Hamilton–Flavin 1986, p. 811).

We examined several measurement models of fiscal sustainability and were able to identify the more important findings, introducing each briefly. Over the years, the empirical examination of fiscal sustainability has transformed into more sophisticated econometric framework than previous attempts. These methods help policymakers make better decision about optimal fiscal policy. But in attempting to create a model

[2] $TPR = TP/(TP + FN)$ where TP is correct classification, with unsustainable fact and unsustainable forecast and FN is type II error.
[3] $FPR = FP/(FP + TN)$ where FP is type I error.
[4] $Classification\ accuracy = (TP + TN)/(TP + TN + FP + FN)$ where TN is correct classification with sustainable fact and sustainable forecast.

to measure fiscal sustainability, we have to keep in mind that the optimal primary surplus and debt reduction path depend on a country's specific circumstances, and the quality and quantity of data available for that country.

As Wyplosz (2007) found, we could not apply sophisticated forecasting methods, because sustainability depends on the future, meaning we could not draft a statement on primary surpluses with any degree of certainty. It is future balances that matter, not just the past and not just the current debt level, and the difficult and sophisticated models in question have huge data demands.

Based on these are facts we would like to test the models presented here with Monte Carlo simulation in the next paper. In so doing, we hope to be able to identify best practice.

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