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Inflation Implications of Rising Government Debt

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7.1 Introduction

Figures 7.1 and 7.2 show recent fiscal trends for six large industrialized nations. Levels of government debt increased markedly during the 1970s, then stabilized and improved during the 1980s and 1990s, but have recently shown signs of further deterioration. With OECD countries experiencing an aging population, it is widely expected that fiscal positions will worsen further in coming decades (see Roseveare et al. 1998). These considerations raise three important issues: (1) is current fiscal policy sustainable, (2) how have OECD governments achieved fiscal sustainability in past decades, and (3) what are the implications for inflation of these projected rising fiscal deficits? This chapter seeks to provide insights to each of these three questions.

A key to the analysis is the intertemporal budget constraint of the government. To answer the first question (on sustainability), the methodology of Giannitsarou and Scott (2006) is used, and a log linear approximation to the intertemporal budget constraint is derived. Using this framework, it is shown how debt sustainability requires an equilibrium relationship between the market value of government debt, the stock of narrow money, and the levels of government revenue and expenditure. It is also shown how to estimate this relationship, derive a measure of sustainability for six OECD countries, and use our estimates to characterize the dynamics of fiscal adjustment for the six countries. In order to answer the second question (how do governments achieve fiscal adjustment) it is shown analytically how deviations from the equilibrium relationship between debt, money, and the primary deficit have to be met through future changes in either primary deficits, monetary liabilities, real interest rates, inflation, or GDP growth. Using the vector autoregression (VAR) methodology proposed by Campbell and Shiller (1988),

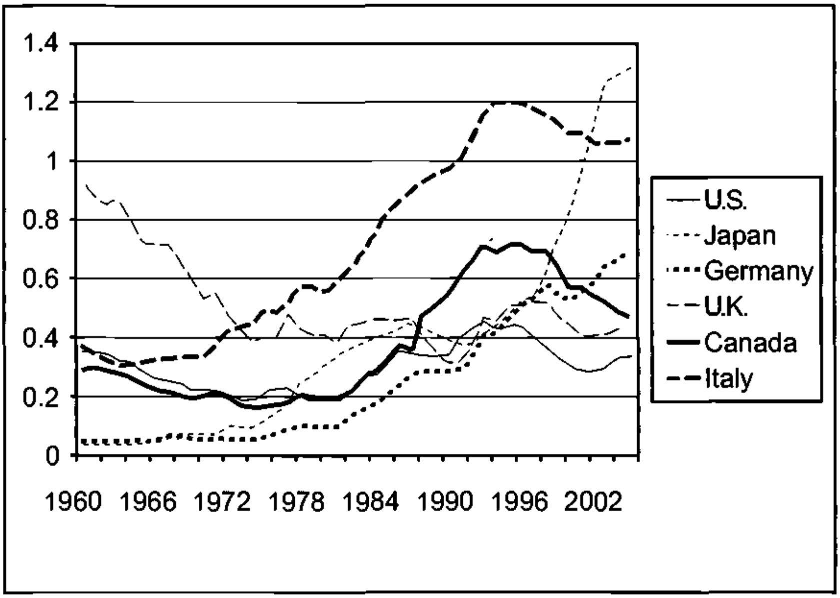

Figure 7.1
Debt Over GDP, for Six Industrialized Countries, 1960–2005

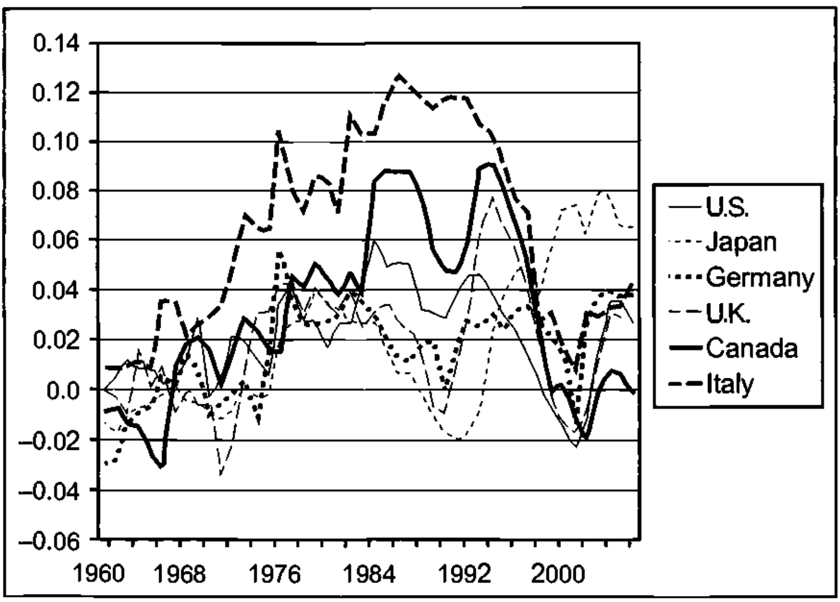

Figure 7.2
Total Deficit Over GDP, for Six Industrialized Countries, 1960–2005

we assess the relative contribution of each channel to financing fiscal activity for the period 1960–2005. The third and final focus is to use this framework to assess (statistically) whether the substantial expected increase in fiscal deficits threatens the current low levels of inflation.

The findings can be summarized as follows. For the period under consideration, and for the United States, Japan, Germany, the United Kingdom, Italy, and Canada, fiscal imbalances are mostly removed through adjustments in the primary deficit (80–100 percent), with less important adjustments through inflation (0–10 percent) and GDP growth (0–20 percent). In particular, the relation between fiscal imbalances and inflation suggests extremely modest statistical interactions between the two; this suggests that widely anticipated increases in fiscal deficits, due to demographic factors, are not necessarily predictors of higher future inflation. It is important to stress that this conclusion is based around an analysis which is, in essence, a purely accounting exercise. There exists a large and varied theoretical literature examining the economic linkages between fiscal deficits and inflation (Sargent and Wallace 1981; McCallum 1984; Leeper 1991; Sims 1994; and Woodford 1995) but, by contrast, this analysis pursues a different path. Here, the aim is to use the accounting framework of the intertemporal budget constraint to empirically document the relative statistical role of different factors in achieving fiscal balance.

The plan of the chapter is as follows. In section 7.2 the properties of the data set are examined, and argue that the sample period is appropriate for reviewing how fiscal adjustment is achieved in the face of large variations in government debt in response to sharp increases in social transfers. Using the period-by-period budget constraint, evidence for fiscal sustainability and the drivers of the debt/GDP ratio will be examined. A simple accounting exercise shows that nominal GDP growth, and especially inflation, played an important role in achieving debt stability. In section 7.3 the analysis is extended, and then the log linearized version of the intertemporal budget constraint is introduced and the key measure of fiscal imbalances, namely a relationship between levels of government liabilities and the primary deficit, is derived. How variations in this relationship are related to expected changes in future deficits, money creation, changes in inflation, real interest rates, and real GDP growth are all shown. In section 7.4 how to estimate this long run relationship between liabilities and the deficit is shown, estimates of fiscal imbalances are constructed across the countries in the sample, and conclusions are drawn about the dynamics of fiscal adjustment. Section 7.5

builds on this long-run relationship and the restrictions imposed by the intertemporal budget constraint to perform a variance decomposition for how fiscal sustainability is achieved. The framework is extended to assess the separate importance of government expenditure and tax revenue in achieving fiscal balance and examine the predictive role of fiscal imbalances in predicting future inflation. A final section concludes.

7.2 Fiscal Adjustment: A Backward Looking Approach

The focus of this chapter is not only on assessing the sustainability of fiscal policy in six industrial nations—the United States, Japan, Germany, the United Kingdom, Italy, and Canada—over the period 1960–2005, but also to identify the means through which this sustainability is achieved. These nations were chosen because of the possible interesting implications of demographic induced deficits that are expected to affect these countries in the coming decades. This time period was chosen because, in contrast to the majority of the literature, this chapter focuses on how governments achieve fiscal balance in the face of rising non war related expenditures.

With demographic change expected to lead to increasing social transfers, this sample is a natural environment with which to consider the likely impact of rising debt. For example, over this period, Canada increased social transfers by 4.7 percent of GDP, Germany by 6.6 percent, Italy 7.8 percent, Japan 9.2 percent, United Kingdom 5.9 percent, and United States 6.7 percent, accounting for 104 percent, 57 percent, 51 percent, 49 percent, 88 percent, and 146 percent (respectively) of the observed increase in total government expenditure during this period. In other words, the period used here is one where increases in government expenditure were heavily linked to rises in social transfers. A further reason for focusing on this post-WWII period is that it is the most recent and most relevant: the results in Giannitsarou and Scott (2006), using historical U.K. and U.S. data, suggest that the means through which fiscal adjustment is achieved have changed significantly across centuries, and (in particular) war induced increases in debt are financed through different channels than general increases in debt. The political economy features that might explain why military expenditure is financed through different means to social transfers is left undiscussed, but the implication is that focusing on modern times of peace is critical if the analysis is to gauge the impact of demographic induced future fiscal deficits.

Table 7.1
Debt Variability and Sustainability.

Country	Mean	Min	Max	Initial	Final	St. Dev	Feed Coef	P-Value
Canada	0.378	0.292	0.718	0.292	0.464	0.193	0.024	0.03
Germany	0.246	0.049	0.700	0.052	0.700	0.213	0.006	0.45
Italy	0.702	0.304	1.203	0.374	1.076	0.328	0.048	0.00
Japan	0.333	0.041	1.296	0.069	1.296	0.226	0.003	0.67
UK	0.523	0.312	0.928	0.928	0.429	0.381	0.034	0.01
US	0.300	0.185	0.457	0.353	0.337	0.078	0.057	0.01

Note: The first five columns report the average, minimum, maximum, initial, and final period values of the market value of government debt to GDP ratio. The next column reports the standard deviation of the debt/GDP ratio. The penultimate column shows estimates of α in a regression of a country's primary surplus on four lags of its own value, and the lagged value of the debt/GDP ratio with the final column reporting the p-value (to two decimal places) of the feedback coefficient.

For this period to be informative regarding the means whereby governments achieve fiscal sustainability, it is important that debt and deficits show significant variation. Another reason why so many previous researchers have focused on war related expenditure is it leads to dramatic swings in public debt and deficits and so is a natural period with which to examine fiscal sustainability. Table 7.1 documents some stylized facts for key fiscal variables over our post war period.[1] Debt relative to GDP shows a large volatility, with a standard deviation ranging from 0.078 to 0.381. With the exception of the United States, all countries see an increase in debt/GDP over the sample period, and in two of the six cases, debt/GDP rises above 100 percent GDP. This is far from being a period of tranquil public finances or modest variation in debt, suggesting once more its relevance as a case study for coming decades.

Performing various unit root tests (see Tables 7.2–7.5) of the market value of government debt, government expenditure (excluding interest payments), and revenue (all expressed as a ratio to GDP) provides further evidence of the variability of government finances. The strong consensus that emerges from these results is that all variables appear to be nonstationary and contain unit roots. The fact that government expenditure/GDP and tax revenue/GDP are nonstationary over this period is testimony to the rise of social transfers commented on in previous paragraphs. The suggestion that debt/GDP is also nonstationary further implies that achieving fiscal sustainability in this post war period has been a challenge. The finding that the debt/GDP ratio is nonstationary also conflicts with the findings of Giannitsarou and Scott (2006), which use

Table 7.2
Unit Root Tests, Gov Debt/GDP

		Debt/GDP		
Country	Test Statistic	Statistic	5% CV	Verdict
CAN	ADF(8) C	–3.450	–2.860	stationary
	ADF(8) C T	–3.910	–3.410	trend stationary
	KPSS(4)	0.718	0.463	unit root
	KPSS(4) T	0.159	0.146	unit root
GER	ADF(1)	–2.280	–1.940	stationary
	ADF(1) C T	–2.440	–3.410	unit root
	KPSS(4)	0.994	0.460	unit root
	KPSS(4) T	0.150	0.146	unit root
ITA	ADF(1)	–2.110	–1.940	stationary
	KPSS(4)	0.959	0.463	unit root
	KPSS(4) T	0.151	0.146	unit root
JAP	ADF(1)	–3.310	–1.940	stationary
	ADF(3) C T	–2.270	–3.410	unit root
	KPSS(4)	0.969	0.463	unit root
	KPSS(4) T	0.163	0.146	unit root
UK	ADF(2) C	–2.510	–2.860	unit root
	KPSS(4)	0.581	0.463	unit root
	KPSS(4) T	0.204	0.146	unit root
US	ADF(1) C	–1.790	–2.860	unit root
	ADF(1) C T	–2.440	–3.410	unit root
	KPSS(4)	0.381	0.463	stationary
	KPSS(4) T	0.146	0.146	unit root

Note: C means constant included. T means trend included. ADF denotes Augmented Dickey Fuller Test and KPSS the Kwiatowski, Phillips, Schmidt, and Shin test. C denotes a constant also included in the test and T a trend. Number in parentheses indicates number of lags with which test was augmented. The final column shows the inference from evaluating null of test statistic at 95 percent confidence intervals.

longer runs of historical data. It, thus, seems that the sample in this paper is one of unusual fiscal problems.

The finding that debt/GDP is nonstationary may appear to be inconsistent with fiscal sustainability but, as stressed by Bohn (2006), this is not necessarily the case. A sufficient condition for sustainability, according to Bohn's analysis, is the existence of a feedback from the level of debt to the current primary surplus. In other words, when estimating a regression of:

$$PrimarySurplus_t = A(L)X_t + \alpha Debt_{t-1} + \varepsilon_t,$$

Table 7.3
Unit Root Tests, H/GDP

		Money		
Country	Test	Statistic	5% CV	Verdict
CAN	ADF(1) C	–1.440	–2.860	unit root
	KPSS(4)	0.971	0.463	unit root
	KPSS(4) T	0.133	0.146	trend stationary
GER	ADF(1) C	1.390	–2.860	unit root
	ADF(1) C T	–1.110	–3.410	unit root
	KPSS(4)	0.839	0.460	unit root
	KPSS(4) T	0.253	0.146	unit root
ITA	ADF(0)	1.410	–1.940	unit root
	ADF(4) C T	–3.610	–3.410	trend stationary
	KPSS(4)	0.880	0.463	unit root
	KPSS(4) T	0.143	0.146	trend stationary
JAP	ADF(1)	–1.730	–1.940	unit root
	KPSS(4)	0.590	0.463	unit root
	KPSS(4) T	0.182	0.146	unit root
UK	ADF(5) C	–0.430	–1.940	unit root
	KPSS(4)	0.940	0.463	unit root
	KPSS(4) T	0.203	0.146	unit root
US	ADF(1) C	–2.080	–2.860	unit root
	ADF(0) C T	–0.450	–3.410	unit root
	KPSS(4)	0.666	0.463	unit root
	KPSS(4) T	0.252	0.146	unit root

Note: C means constant included. T means trend included. ADF denotes Augmented Dickey Fuller Test and KPSS the Kwiatowski, Phillips, Schmidt, and Shin test. C denotes a constant also included in the test and T a trend. Number in parentheses indicates number of lags with which test was augmented. The final column shows the inference from evaluating null of test statistic at 95 percent confidence intervals.

where X_t denotes a set of relevant explanatory variables, it is necessary that α is positive and larger than the interest rate paid on government debt. The final column in Table 1 reports estimates of α (and associated p values) for each of our countries where X_t consists of lagged values of the primary surplus. Only in the cases of Japan and Germany is the debt term not significant at the 5 percent level or less (although including additional variables such as GDP, interest rates, etc. remedied this problem for Germany), suggesting that most countries show evidence of fiscal sustainability over the selected period. Interestingly, Japan and Germany are the only countries where the maximum value for debt/GDP is

Table 7.4
Unit Root Tests, G/GDP

		Expenditure/GDP		
Country	Test	Statistic	5% CV	Verdict
CAN	ADF(1), C	–2.110	–2.860	unit root
	KPSS(4)	0.748	0.463	unit root
	KPSS(4) T	0.217	0.146	unit root
GER	ADF(0)	–1.820	–1.940	unit root
	KPSS(4)	0.600	0.460	unit root
	KPSS(4) T	0.198	0.146	unit root
ITA	ADF(2) C	–2.670	–2.86	unit root
	ADF(2) C T	–1.360	–3.410	unit root
	KPSS(4)	0.920	0.463	unit root
	KPSS(4) T	0.236	0.146	unit root
JAP	ADF(3)	–1.310	1.940	unit root
	ADF(3) C T	–2.455	–3.410	unit root
	KPSS(4)	0.941	0.463	unit root
	KPSS(4)	0.137	0.146	trend stationary
UK	ADF(9) C	–1.604	–2.860	unit root
	ADF(10) C T	–3.745	–3.410	trend stationary
	KPSS(4)	0.398	0.463	stationary
	KPSS(4) T	0.204	0.146	unit root
US	ADF(7) C	–1.628	–2.860	unit root
	ADF(6) C T	–1.993	–3.410	trend stationary
	KPSS(4)	0.193	0.463	stationary
	KPSS(4) T	0.194	0.146	unit root

Note: C means constant included. T means trend included. ADF denotes Augmented Dickey Fuller Test and KPSS the Kwiatowski, Phillips, Schmidt, and Shin test. C denotes a constant also included in the test and T a trend. Number in parentheses indicates number of lags with which test was augmented. The final column shows the inference from evaluating null of test statistic at 95 percent confidence intervals.

observed in the final observation in the sample period. We include all six countries in our estimation below, but these results suggest some care should be taken in interpreting the Japanese and German findings.

To better understand the movements in the debt/GDP ratio and its relationship with other fiscal variables, it is useful to consider the period-by-period budget constraint. Let $1 + \varkappa_t = (1 + \gamma_t)(1 + \pi_t)$ denote the growth rate of nominal GDP, and $1 + i_{t-1}$ the one year holding return on nominal government bonds. Let B_t, G_t, and T_t be the ratios of nominal debt, government spending and tax revenues to nominal GDP.[2] Then:

Table 7.5
Unit Root Tests, T/GDP

	Revenue/GDP			
Country	Test	Statistic	5% CV	Verdict
CAN	ADF(0)	−1.359	−1.940	unit root
	KPSS(4)	0.915	0.463	unit root
	KPSS(4) T	0.155	0.146	unit root
GER	ADF(1) C	−2.490	−2.860	unit root
	KPSS(4)	0.713	0.460	unit root
	KPSS(4) T	0.210	0.146	unit root
ITA	ADF(0)	−2.430	−1.940	stationary
	KPSS(4)	0.969	0.463	unit root
	KPSS(4) T	0.121	0.146	unit root
JAP	ADF(0)	−2.440	1.940	stationary
	KPSS(4)	0.871	0.463	unit root
	KPSS(4)	0.215	0.146	unit root
UK	ADF(1) C	−2.950	−2.860	stationary
	KPSS(4)	0.186	0.463	stationary
	KPSS(4) T	0.184	0.146	unit root
US	ADF(1) C	−3.730	−2.860	stationary
	KPSS(4)	0.141	0.463	stationary
	KPSS(4) T	0.045	0.146	trend stationary

Note: C means constant included. T means trend included. ADF denotes Augmented Dickey Fuller Test and KPSS the Kwiatowski, Phillips, Schmidt, and Shin test. C denotes a constant also included in the test and T a trend. Number in parentheses indicates number of lags with which test was augmented. The final column shows the inference from evaluating null of test statistic at 95 percent confidence intervals.

$$\Delta B_t = (G_t - T_t) + \frac{i_{t-1}}{1 + \varkappa_t} B_{t-1} - \frac{\varkappa_t}{1 + \varkappa_t} B_{t-1}. \tag{1}$$

In other words, the debt to GDP ratio increases through the ratio of the primary deficit to GDP and interest payments on debt (using the growth adjusted real interest rate), and reduces through a nominal growth dividend $\varkappa_t B_{t-1}/(1 + \varkappa_t)$. To investigate the role of variations in bond prices as a way of ensuring that the intertemporal budget constraint of the government holds (Marcet and Scott 2005) equation (1) is evaluated by considering i_t as the one year holding return on government bonds. In other words, both coupon payments and capital gains were included, so that the budget constraint is specified in terms of the market value of government debt, rather than the stock of outstanding debt.

Table 7.6
Debt Dynamics

Country	Total def.	Prim. def.	Int. paym.	Nom. gr. div.	Real gr. term	Infl. term	%Δ(*Debt/GDP*)
US	0.021	0.000	0.021	0.019	0.010	0.009	0.003
UK	0.017	–0.021	0.039	0.041	0.014	0.027	–0.014
GER	0.016	–0.001	0.021	0.009	0.005	0.004	0.064
JAP	0.018	–0.008	0.024	0.011	0.008	0.003	0.080
ITA	0.064	0.021	0.043	0.059	0.015	0.044	0.025
CAN	0.029	–0.005	0.035	0.023	0.011	0.012	0.013

Note: the first column shows the average total deficit/GDP for each country over the sample period. The next columns show average primary deficit/GDP and average interest payments/GDP. The fourth column shows the average nominal growth dividend $B_{t-1}\gamma_t/(1+\gamma_t)$, and the next two columns decompose this into a real growth term and an inflation term. The final column shows the average percentage change in the debt/GDP ratio over the period.

In order to better understand what drives changes in the debt/GDP ratio Bohn (2005) is followed, and equation (1) is evaluated using sample averages for the selected period. The results are shown in Table 7.6. As noted in Table 7.1, Japan and Germany show the most dramatic increases in debt, with only the United States and United Kingdom showing broad debt stability. These substantial differences in debt dynamics are despite the fact that, with the exception of Italy, the total deficit/GDP ratio is reasonably similar across countries. The main reason behind Germany and Japan's different debt dynamics is their low value of the growth dividend; this is particularly noticeable for the inflation component (the nominal growth dividend consists of a real growth and an inflation component). Reviewing Table 7.6, it seems that inflation has been a significant influence in the evolution of the debt/GDP ratio. At first glance, this would seem to justify serious concerns that rising deficits induced by demographic change may lead to rising inflation.

Table 7.6 is a useful accounting exercise, but focusing on ex post realizations only provides a backward looking analysis. Equation (1) holds for all fiscal policies, regardless of whether they are sustainable or not, and as a consequence cannot be used to assess the sustainability of fiscal policy. Moreover, it does not provide information on how governments expect to achieve fiscal sustainability or how fiscal policy responds to shocks to key economic variables. In order to gain insights into these issues, a forward looking perspective is analyzed by introducing the intertemporal budget constraint.

7.3 Fiscal Sustainability: A Forward Looking Approach

In this section the intertemporal budget constraint is used to derive an accounting framework with which to study fiscal sustainability. This alternative approach produces a relationship between the level of government liabilities, relative to the primary deficit and projections of future values of key fiscal variables. This relationship is argued as a natural way to characterize imbalances in fiscal policy. Furthermore, with this expression we can examine how adjustments to the government's fiscal position are made in order to restore fiscal sustainability. In other words, while the backward looking accounting equation (1) helps quantify how the average value of fiscal variables are related, this forward looking approach helps quantify how key variables change in order to ensure fiscal sustainability.

In deriving the government's intertemporal budget constraint the same log-linearization approach as in Giannitsarou and Scott (2006) is used. Log-linearizing the intertemporal budget constraint has been used in a wide variety of applications; Campbell and Shiller (1987, 1988) apply this approach to equity prices and dividends, Campbell and Shiller (1991) use it to analyze the yield curve, Lettau and Ludvigson (2001) examine the consumption-wealth ratio and its ability to predict capital gains, and Bergin and Sheffrin (2000) and Gourinchas and Rey (2005) apply the framework to the balance of payments. Although the overall methodology is similar to the other studies, this chapter shares a significant problem with Gourinchas and Rey (2005). Log-linearization requires approximating around stationary variables, but in this case the trending nature of government expenditures and revenues prevents a straightforward approach. The non stationarity of fiscal variables creates a number of significant difficulties that need to be overcome if we are to utilize a long linearization approach.

Since the focus here is on the implications of fiscal deficits for inflation, we start with a version of the government's budget constraint (1) augmented with monetary liabilities:

$$G_t - T_t = B_t - \frac{Y_{t-1}}{\Pi_t Q_t} B_{t-1} + H_t - \frac{1}{\Pi_t Q_t} H_{t-1}, \tag{2}$$

where H_t denotes the ratio of monetary liabilities to GDP, Π_t the inflation rate $(1 + \pi_t)$, and Q_t is the growth in real GDP $(1 + \gamma_t)$.

In seeking to derive a log-linear version of the government's budget constraint, Giannitsarou and Scott (2006) stress two difficulties: (1) G_t, T_t, and B_t show evidence of non stationarity; and (2) it is not possible to take logs and linearize the primary deficit $D_t = G_t - T_t$, due to its possible negative values. Therefore the log linearization needs to be done separately for G_t and T_t. To overcome these difficulties and arrive at a useful version of the intertemporal budget constraint, the following assumptions need to be made:

Assumption 1. *There exists a variable* W_t *such that* G_t/W_t, T_t/W_t, B_t/W_t *and* H_t/W_t *are stationary.*

Assumption 2. *The real and nominal interest rate, the growth rate of GDP, inflation and the growth rate of* W_t *are all stationary, with steady-states* i, r, γ, π *and* ω *respectively.*

Assumption 3. *The following No-Ponzi condition holds:*

$$\lim_{N\to\infty}\left(\frac{1}{\mu_b}\right)^N (b_{t+N-1} + h_{t+N-1}) = 0, \text{a.s.}$$

where μ_b *denotes the growth adjusted real interest rate less growth in* W_t. *This condition holds if*

$$(1 + \gamma)(1 + \omega) < 1 + r.$$

Assumptions 1 and 2 are required to pursue our log linear approach. Assumption 3 is essentially the definition of fiscal sustainability, and enables the expression of current fiscal policy in terms of finite valued infinite horizon present value expressions. Given the importance of these assumptions, it is worthwhile to discuss each of them more extensively.

Assumption 1 invokes the existence of a variable W_t, which transforms the ratios of government spending, revenues, and debt to GDP to stationary variables. As explained in Campbell and Shiller (1988), in order to be able to consider a first-order approximation to the budget constraint, the variables that are approximated need to be stationary. The standard practice is to assume that deflating variables by GDP is sufficient to induce stationarity. However, tables 7.2–7.5 suggest that apart from debt/GDP, expenditure, revenue, and money over GDP also seem to be nonstationary. We therefore need to invoke the assumption of a common trend W_t across all four variables, which are capable of inducing stationarity. An obvious issue is the identity of W_t: what variable would induce stationarity in the public finances? One possible interpretation is that W_t is a purely statistical term representing a common trend amongst these variables. Alternatively, W_t could have an economic interpretation, for instance, the value of the stock of public assets or a measure of demographic change. However, because the focus here lies in deriving a log-linearized version of the budget constraint, we only need to assume that such a variable exists and do not need to empirically observe this variable. This is because, ultimately, terms in W_t cancel out after the linearization, leaving us with just log-linear expressions for G_t, T_t, B_t, and H_t. Although W_t does not figure in the later empirical exercise, assumption 1 does have testable implications: if these variables share a common trend W_t, cointegrating relations should be found between the variables in the pairs (G_t, T_t), and (G_t, B_t), and (B_t, H_t). Evidence for such cointegrating relations is given in table 7.7, which offers general support for assumption 1.

Assumption 2 requires that certain key variables have stationary growth rates. Various unit root tests were performed that provide evidence in support of assumption 2. These tests are omitted here, but are available from the authors upon request.

Assumption 3 is more controversial, and is critical in order to derive the intertemporal budget constraint. The form of this assumption is standard across many applications, but in this case the average real interest rate is greater than the sum of real GDP growth and the growth in W_t. Assumption 3 is critical for the analysis, and is (in essence) the definition of fiscal sustainability represented in this chapter. That is why fiscal policy is sustainable if government liabilities grow at a rate less than

Table 7.7
Cointegration Tests

	G_t, T_t					G_t, B_t					B_t, H_t				
Lags	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Canada	1%	10%	5%*	5%	10%	1%	10%*	10%	5%	5%	5%	10%*			10%
Germany	1%	10%	10%	10%*	5%	1%*	10%	10%	5%	5%	5%		10%*	10%	10%
Italy		10%	5%*	5%	5%	1%	1%*	1%	1%	1%	1%	1%*	1%	1%	5%
Japan	5%			10%	10%*	1%	1%*	1%	1%	1%	5%	5%	5%*	10%	10%
UK	10%	10%	5%*	5%	5%	5%	5%*	1%	1%	5%	1%	5%	10%*	5%	5%
US	5%	5%*	5%	1%	1%	1%	5%	5%*	5%	5%	1%	5%	1%	5%*	5%

Note: the table shows the p-value of test for level of rejection of the null of no hypothesis between variables listed in top row using Johansen (1991).
* indicates the lag augmentation selected by the AIC criteria.

the growth adjusted real interest, where the growth adjustment includes an allowance for growth in W. Clearly, testing this assumption is impossible since W_t is unobserved. Nevertheless, if it is assumed that W_t has positive mean growth, then a weak test of assumption 2 is whether $r > \gamma$ or not. For this sample period, the condition holds only for Canada, Germany, and the United States. The majority of the literature simply invokes this assumption, and rarely tests whether it is true (Ball, Elmendorf, and Mankiw (1998) has an extended discussion on the validity of this assumption and the options it provides to fiscal authorities if the condition fails to hold). Presumably, the fact that so many studies do not test the assumption is because (implicitly) it is assumed that even if, over the sample period, r and γ do not satisfy the restriction, future values will ensure it holds and so the transversality condition can be imposed. For instance, Giannitsarou and Scott (2006) show that over the sample period 1700–2005 this restriction holds for the United Kingdom, so although it is violated between 1960–2005, looking forward over an infinite horizon the assumption is justified. An alternative approach is suggested by Bohn (2006), who shows it is possible to derive an intertemporal budget constraint even when $(1 + \gamma)(1 + \omega) > 1 + r$ (if one treats this as a merely technical obstacle). The trick is to use an alternative interest rate ($r^* > r$), which satisfies $(1 + r^*) > (1 + \gamma)(1 + \omega)$, and then amend the budget constraint for the difference between r^* and r. Appendix III shows how to apply this method to our approach and uses a particular example for r^* that ensures the validity of the main expressions (even when $r < \gamma$).

Fundamental to this analysis of fiscal sustainability is a relationship between the level of liabilities and government expenditures and revenues. Define:

$$l_t \equiv \alpha_b b_{t-1} + \alpha_h h_{t-1} + \alpha_g g_t + \alpha_\tau \tau_t \tag{3}$$

where:

$$\alpha_b = 1 - \frac{1}{\mu_b} \tag{4}$$

$$\alpha_h = \phi \frac{\mu_h}{\mu_b}\left(1 - \frac{1}{\mu_h}\right) \tag{5}$$

$$\alpha_g = -(\alpha_b + \alpha_h)\lambda_g \tag{6}$$

$$\alpha_\tau = -(\alpha_b + \alpha_h)\lambda_\tau \tag{7}$$

then Giannitsarou and Scott (2006) show that the log-linear version of the government's intertemporal budget constraint is:

$$
\begin{aligned}
l_t \simeq & \left[\left(1-\frac{1}{\mu_b}\right)+\phi\frac{\mu_h}{\mu_b}\left(1-\frac{1}{\mu_h}\right)\right]E_t\sum_{j=1}^{\infty}\left(\frac{1}{\mu_b}\right)^j\Delta d_{t+j} \\
& +\frac{\phi}{\mu_b}\left(1-\frac{\mu_h}{\mu_b}\right)E_t\sum_{j=0}^{\infty}\left(\frac{1}{\mu_b}\right)^j\Delta h_{t+j}+\left(1-\frac{1}{\mu_b}\right)E_t\sum_{j=0}^{\infty}\left(\frac{1}{\mu_b}\right)^j \\
& \cdot\left[-r_{t+j-1}+\phi\frac{\mu_h}{\mu_b}\pi_{t+j}+\left(1+\phi\frac{\mu_h}{\mu_b}\right)\gamma_{t+j}\right]. \qquad (8)
\end{aligned}
$$

Note that by assumption 3, it must be that $\mu_b > 1$ and $\mu_h < 1$. The variable:

$$d_t \equiv \lambda_g g_t + \lambda_\tau \tau_t,$$

where λ_g and λ_τ are of opposite signs, is essentially a transformed version of the primary deficit.

The critical variable for our analysis is l_t, which is a measure of the imbalances in fiscal policy. If $\lambda_g > 0$ and $\lambda_\tau < 0$, then l_t defines a relationship between government liabilities and the primary deficit; if $\lambda_g < 0$ and $\lambda_\tau > 0$, then the relationship is between government liabilities and the primary surplus. Since $\mu_b > 1$ and $\mu_h < 1$, the coefficient on debt is positive, and the coefficient on money is negative, regardless of the signs of λ_g and λ_τ.

Equation (8) follows from assumptions 1 to 3, and therefore must hold if fiscal policy is sustainable. It pins down a long run equilibrium relationship between the market value of government debt, monetary liabilities, and a version of the current primary deficit (d_t). This expression is interpreted in the following. For given values of mean interest rates, real GDP growth, and money holdings there has to be a long run relationship between debt and the primary deficit (if debt is to be sustainable and for the intertemporal budget constraint to hold). Under assumption 2, and given the empirical evidence on unit roots, the right-hand side of equation (8) is stationary, so that $E_t l_{t+j} = \kappa$, as $j \to \infty$. Therefore, we can test for whether fiscal policy is sustainable by testing whether l_t, as defined in equation (3), is a stationary variable. Further, if l_t is stationary, then $l_t - \kappa$ is a natural measure of required fiscal adjustment. When $l_t - \kappa > 0$, debt is too high relative to the primary deficit and fiscal tightening is required, and the converse for $l_t - \kappa < 0$. Adjustment is achieved through variations in the right-hand side of equation (8).

Further insights into equation (8) and l_t can be gained from considering the results of Trehan and Walsh (1988, 1991), and Bohn (2006). The former shows that the intertemporal budget constraint requires that the primary deficit and debt satisfy a cointegrating relationship. Given assumption 2, which implies $E_t l_{t+j} = \kappa$, the same is true for this approximation of the intertemporal budget constraint, although in this case it is debt and monetary liabilities that have to cointegrate with a transformed version of the deficit. Bohn (2006) focuses on an alternative insight, namely that debt sustainability requires a feedback rule from debt to primary deficits. Given assumption 2, we know that l_t must be stationary, which can be achieved through a feedback rule from debt to primary deficit, although in this case the feedback is (again) from a weighted average of marketable debt and monetary liabilities. As these points make clear, the key to understanding fiscal sustainability is a cointegrating relationship between b_t, h_t, g_t, and τ_t, loosely interpreted as a relationship between total government liabilities (b and h) and primary deficit (g and τ). It is for this reason that the left-hand side of expression (8) contains all of these components and not just the level of debt, as is the case in standard applications of the intertemporal budget constraint.

If the left-hand side of (8) measures the degree of fiscal adjustment required, then the right-hand side of (8) tells us how this fiscal adjustment ($l_t - \kappa$) is achieved through either: (1) future improvements in the primary deficit $-\Delta d_{t+j}$, (2) issuing more monetary liabilities (Δh_{t+j}), or (3) variations in the growth adjusted real interest rate ($r_{t+j} - \pi_{t+j} - \gamma_{t+j}$). The coefficients on each of the components of the growth adjusted real interest rate differ, as the nominal dividend effect ($\pi_{t+j} - \gamma_{t+j}$) operates on both bonds and money, while r_{t+j} affects only bonds. As a result, equation (8) tells us that, if the intertemporal budget constraint holds, any deviations in the long run relationship between debt and deficits must help predict movements in either future primary deficits, money creation, nominal interest rates, inflation or GDP growth. It must be stressed again that the intertemporal budget constraint is an accounting framework, and the predictive role of l_t is purely statistical rather than necessarily causal phenomenon.

7.4 Estimating Fiscal Imbalances

Crucial to implementing this approach to the intertemporal budget constraint is construction of an estimate for l_t, and (therefore) estimates of

α_b, α_h, α_g, and α_τ. A common approach to estimating equation (3) and its analogues in the literature is to use Stock and Watson's (1993) dynamic ordinary least squares (OLS) estimator. In this case, this would involve estimating the regression:

$$g_t = \beta_1\tau_t + \beta_2 b_{t-1} + \beta_3 h_{t-1} + \sum_{i=-k}^{k}(c_{i\tau}\Delta\tau_{t-i} + c_{ib}\Delta b_{t-i} + c_{ih}\Delta h_{t-1}). \tag{9}$$

Using equations (3), (4)–(7), and the fact that $\lambda_g + \lambda_\tau = 1$, we get the implied restrictions:

$$\beta_2 + \beta_3 = \frac{1}{1-\lambda_\tau}, \tag{10}$$

$$\beta_1 = -\frac{\lambda_\tau}{1-\lambda_\tau}. \tag{11}$$

Table 7.8 shows the results from estimating this equation, and the implied coefficients for the parameters of interest (α_b, α_h, α_g and α_τ). These estimated coefficients are calculated as follows. First, we check that in each case we cannot reject restriction (10), at either the 5 percent or 10 percent level. Next, equation (9) contains three key estimated parameters—β_1, β_2, and β_3. From these reduced form estimates we wish to esti-

Table 7.8
Estimates of Equilibrium Relationship Debt and Deficits

	US	Canada	Germany	Japan	UK	Italy
ϕ	0.302	0.174	1.060	0.612	0.103	0.267
γ	1.078	1.083	1.065	1.057	1.090	1.075
μ_b	1.027	1.033	1.008	1.021	1.008	1.041
μ_h	0.953	0.954	0.947	0.965	0.925	0.969
λ_g	–6.968	–15.650	7.690	–2564.103	–56.526	–3.073
λ_τ	7.968	16.650	–6.690	2565.103	57.526	4.073
α_b	0.026	0.032	0.008	0.020	0.008	0.040
α_h	–0.014	–0.008	–0.056	–0.021	–0.008	–0.008
α_g	0.088	0.376	0.376	–1.458	0.047	0.097
α_τ	–0.100	–0.399	–0.319	1.458	–0.048	–0.129
H_0: $\beta_2 + \beta_3 = 1/(1-\lambda_\tau)$	0.033	0.046	0.071	0.029	0.061	0.039

Note: The first row reports the sample average of H/B, and the second row reports the sample average of nominal GDP growth. The parameters μ_b and μ_τ are estimated, as are λ_g and λ_τ (subject to the restriction that $\lambda_g + \lambda_\tau = 1$). The next four rows show the implied estimated coefficients for defining $l_t = \alpha_b b_t + \alpha_h h_t + \alpha_g g_t + \alpha_\tau \tau_t$. The last row shows p-values for the hypothesis that $\beta_2 + \beta_3 = 1/(1 - \lambda_\tau)$.

mate the structural parameters ϕ, μ_b, μ_h, λ_τ, using relations (4)–(7). However, due to restriction (10) there are (in effect) only two independently estimated parameters. Therefore, identifying the structural parameters requires using additional information. In particular, ϕ is estimated as the sample average of narrow money to government debt ratio (H/B), and by definition $\mu_b/\mu_h = (1 + \pi)(1 + r)$. Using these additional restrictions, the key structural parameters of interest can be identified, and the estimate of l_t:

$$\hat{l}_t = \left(1 - \frac{1}{\mu_b}\right)b_{t-1} + \phi\frac{\mu_h}{\mu_b}\left(1 - \frac{1}{\mu_h}\right)h_{t-1}$$
$$- \left[\left(1 - \frac{1}{\mu_b}\right) + \phi\frac{\mu_h}{\mu_b}\left(1 - \frac{1}{\mu_h}\right)\right]d_t.$$

The variable $\hat{l}_t$ is a measure of the deviation of a weighted average of government liabilities from a transformed measure of the primary deficit d_t. The larger l_t becomes, the larger liabilities are relative to deficits, and greater the required degree of fiscal adjustment. Note that, given the estimates of table 7.8, the weights on government expenditure and tax revenue (λ_g and λ_τ) are of opposite sign and approximately equal in absolute value, so that d_t is only mildly different from the primary deficit (and in the case of Japan and the United Kingdom there is very little difference). The coefficients λ_g and λ_τ, reflecting the relative importance of the primary deficit relative to liabilities, clearly show significant variations across countries. These variations reflect the fact that the size of the primary deficit needed (to ensure sustainability) depends on the level of interest rates, GDP growth, and debt, and small variations in these numbers can produce large variations in λ_g and λ_τ.

While this approach is standard in the literature, the use of assumption 1 creates additional problems that make the above analysis problematic. Assumption 1 implies that G_t, T_t, B_t, and H_t all share a common stochastic trend (W_t). As a result, three linearly independent cointegrating vectors exist. Evidence for this was shown in table 7.7, which was used earlier as support for assumption 1. In other words, in this data there are the following cointegrating relationships.[3]

$$g_t = \varphi_1\tau_t + u_{1t}$$

$$b_t = \varphi_2 h_t + u_{2t}$$

$$g_t = \varphi_3 b_t + u_{3t}$$

wherein u_{it}, $i = 1,2,3$ are stationary error terms as a consequence of cointegration. Given that each of these pairs is stationary, it also must be the case that any linear combination of these cointegrating relations is stationary. In other words, assumption 1 implies that for any α_1, α_2, and α_3, the following holds:

$$\alpha_1(g_t - \varphi_1\tau_t) + \alpha_2(b_t - \varphi_2 h_t) + \alpha_3(g_t - \varphi_3 b_t) = w_t$$

where w_t is a stationary error term which is a linear combination of the $u'_{it}s$. Rearranging this expression yields:

$$g_t = \frac{\alpha_1\varphi_1}{\alpha_1 + \alpha_3}\tau_t - \frac{\alpha_2 - \alpha_3\varphi_3}{\alpha_1 + \alpha_3}b_t + \frac{\alpha_2\varphi_2}{\alpha_1 + \alpha_3}h_t + w_t$$

Assumption 1 implies that this equation must hold for arbitrary α_1, α_2, and α_3 while the intertemporal budget constraint implies, through expressions (3), and (4)–(7), that only one specific cointegrating vector is useful in predicting future fiscal behavior, e.g. the right-hand side of equation (8). Assumption 1 means that when expression (3) is estimated using dynamic ordinary least square (DOLS) some weighted average of the three cointegrating vectors is estimated, where the weights are arbitrary and not uniquely determined. While expressions (3) and (4)–(7) imply some cross parameter restrictions, they are not enough to uniquely pin down α_1, α_2, and α_3, and overcome this indeterminacy. In other words, it is not obvious that the estimates in table 7.8 truly uncover the structural parameters that we are interested in.

In order to validate the estimates of table 7.8 as reliable measures of fiscal imbalance, two independent arguments are used. The first (and most powerful) is that the intertemporal budget constraint implies more than just a linear cointegrating vector, of the form in expression (3), exists. In particular, the intertemporal budget constraint implies that the true l_t, i.e. expression (3) equals the right-hand side of equation (8). Assumption 1 entails that there exist many cointegrating vectors between b_t, h_t, g_t, and τ_t, but the intertemporal budget constraint implies that only one particular cointegrating vector should be useful in predicting the present value of future fiscal variables. This in turn implies that innovations in l_t should be equal to the innovations in the present value of these future fiscal variables. A later section shows how to exploit this to test for the validity of the estimated expression (3) as a measure of fiscal imbalances. For the cases where this test is not rejected, we can be confident that DOLS does not estimate an arbitrary cointegrating relationship but the specific one implied by the intertemporal budget constraint.

The second means of verifying the DOLS estimates of expression (3), as a valid measure of fiscal imbalances, is to provide alternative estimates of the key structural parameters ϕ, λ_g, λ_φ, μ_b, and μ_h, and use these to construct an estimate of (l_t) that can then be compared with those obtained from DOLS. Sample estimates of real interest rates, real GDP growth, government expenditure, tax revenues, and money holdings as shares of GDP were constructed and an estimate of ω (the growth of the common trend W_t) formed by averaging the trend growth rates of b_t, h_t, g_t, and τ_t. Estimating l_t in this way is problematic for several statistical reasons, and is not the preferred approach. The first problem is that g_t and τ are non stationary, and do not have a well defined unconditional mean. The second is that when DOLS is used, the order of integration of the variables can be exploited and superconsistent estimates will result. However, this approach does offer, however flawed, a further means of assessing the measure of fiscal imbalances presented here.

Table 7.9 shows the results for our key parameters from this alternative estimation method, and also offers some information on how this measure of l_t compares with that from using DOLS. For Canada, the United Kingdom, and the United States, the results are astoundingly similar, both in terms of the structural parameters and the correlation between the estimates of l_t and Δl_t. In all three cases, we can strongly reject the null of non stationarity for this alternative estimate of l_t. For Italy, the coefficient estimates are broadly similar except that those on debt and money are around twice as large, but the two estimates broadly track one another and show similar behavior in their rate of change. The only countries where there are important differences are Japan and (especially) Germany, the two countries which our earlier analysis questioned the degree to which fiscal policy had been sustainable over the sample period. For Japan, the main difference is that the coefficients on government expenditure and taxation are much smaller than from DOLS, and so this estimate of l_t places much greater weight on the debt and monetary liabilities term. This leads to a weaker correlation between the two estimates, although the fluctuations in l_t are broadly similar. The two estimates for Germany are, however, very different, with a near perfect negative correlation arising from the fact that α_g and α_τ have opposite signs to that from DOLS. Also note that there is only weak evidence that this alternative measure of l_t is stationary, which our assumptions require. These independent validations of the DOLS esti-

Table 7.9
Alternative Estimates of Fiscal Imbalances

	US	Japan	Germany	UK	Italy	Canada
μ_b	1.026	1.015	1.006	1.008	1.010	1.014
	1.027	1.021	1.008	1.008	1.041	1.033
μ_h	0.947	0.980	0.973	0.933	0.944	0.978
	0.953	0.965	0.947	0.925	0.969	0.954
λ_g	–9.371	34.703	–19.672	–52.589	20.196	–36.460
	–6.968	–2564.100	7.690	–56.526	–3.073	–15.650
λ_t	10.371	–33.703	20.672	53.589	–19.196	37.460
	7.968	2565.100	–6.690	57.526	4.073	16.650
α_b	0.026	0.015	0.006	0.008	0.010	0.014
	0.026	0.020	0.008	0.008	0.004	0.032
α_h	–0.016	–0.012	–0.028	–0.007	–0.015	–0.004
	–0.014	–0.021	–0.056	–0.008	–0.008	–0.008
α_g	0.095	–0.093	–0.441	0.040	0.105	0.383
	0.088	–1.458	0.376	0.047	0.097	0.376
α_t	–0.105	0.089	0.464	–0.041	–0.100	–0.394
	–0.100	1.458	–0.319	–0.048	–0.129	–0.399
Corr(l_t)	0.999	0.874	–0.978	0.999	0.749	0.966
Corr(Δl_t)	0.998	0.893	–0.617	0.998	0.824	0.997
ADF	0.010	0.030	0.080	0.010	0.030	0.010

Note: the first row for each country shows estimates of structural parameters and coefficients to form l_t using sample averages and the second row shows estimates from DOLS. The row labelled Corr(l_t) shows the correlation coefficient between the two estimates of l_t, and the row labelled Corr(Δl_t) shows the correlation between the first differences of the two estimates. The final row shows the p-value from an Augmented Dickey-Fuller test for stationarity.

mates of l_t suggest that, with the exception of Germany, they are valid measures of the degree of fiscal imbalance (as suggested by the intertemporal budget constraint).

We now move to consider, in more detail, what these estimates imply about the dynamics of fiscal adjustment. In order to make comparisons across countries, it is necessary to standardize measures of l_t, due to the fact that the estimated coefficients in Table 7.8 differ so much across countries. As previously described, $\hat{l}_t$ is the deviation in the relationship between liabilities and the primary deficit. Consider the case where fiscal equilibrium ($l_t = 0$) is achieved purely through adjustments in tax rates. Given the definition of l_t, this would require an increase in taxes of:

$$\hat{l}_t^* = \frac{1}{-\lambda_\tau\left[\left(1-\frac{1}{\mu_b}\right)+\phi\frac{\mu_h}{\mu_b}\left(1-\frac{1}{\mu_h}\right)\right]}[\hat{l}_t - m_l].$$

Where m_l is the sample mean for l_t, and $\hat{l}_t^*$ is a normalized measure of fiscal imbalances that can be used to make comparisons across countries. It is also the required increase in the tax revenue/GDP needed to restore fiscal equilibrium, and can be thought of as an alternative measure of fiscal sustainability to those proposed by Blanchard et al. (1989) and Polito and Wickens (2006).

Estimates of $\hat{l}_t^*$ are shown in figure 7.3, for the sample period. These suggest that the discrepancy between debt and deficit in the United States is currently on a par with the Reagan years, although it has shown some signs of improvement over the last year. After a protracted correction during the 1980s and 1990s, the estimates suggest that Canadian public finances are now in rough balance (as is German policy). Not surprisingly, Japan's fiscal situation has shown a dramatic recent deterioration, as has the fiscal position of the United Kingdom. Finally, after many consecutive years of fiscal improvements, our estimates suggest that from a long-term perspective, Italian public finances have deteriorated significantly in recent times. Table 7.10 reports some summary statistics regarding fiscal adjustment for the countries during this period. The degree of imbalance varies between around plus and minus 5 percent for all economies, except for the United States where the range is narrower (plus or minus 3 percent). In all cases, fiscal adjustment is highly persistent although not a unit root process; as discussed above, it is critical for the analysis that l_t is stationary. Fiscal adjustment is a protracted process, with a half life of between two and four years. Given that the sample period contains forty-six years of data for most countries, there are several completed cycles of fiscal adjustment. However, Japan shows the weakest evidence of adjustment in fiscal policy, perhaps reflecting earlier comments that the continual rise in Japanese government debt may reflect an uncompleted fiscal adjustment.

7.5 Financing the Budget

The previous section constructed estimates of the measure of fiscal imbalance and statistically characterized its variability. Equation (8) states that these fluctuations in l_t are associated with fluctuations in future deficits, money creation, real interest rates, inflation, and real GDP

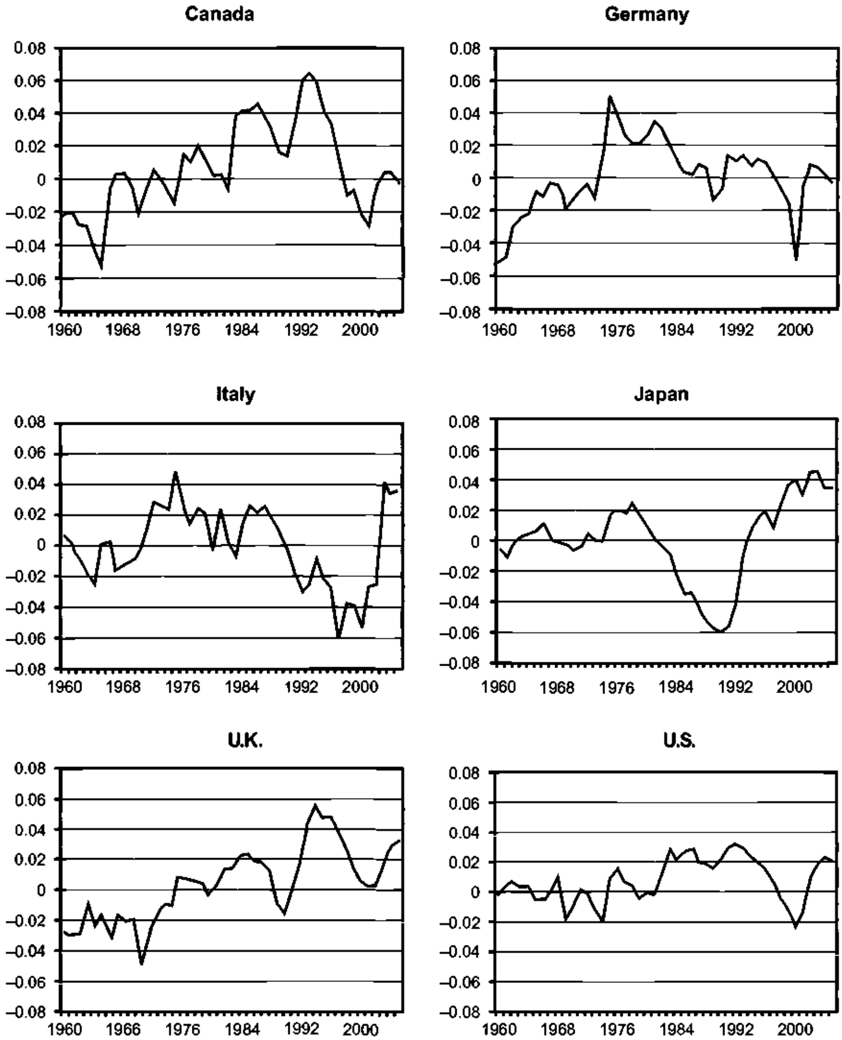

Figure 7.3
Fiscal Position

growth in a manner that ensures the government's intertemporal budget constraint holds. If the left-hand side of equation (8) shows a measure of fiscal imbalance, then the right hand side shows which variables account for variations in fiscal imbalances. We now turn our attention to using this equation to perform a variance decomposition on l_t. Define $z_t = (l_t, \Delta d_t, \Delta h_t, r_{t-1}, \pi_t, \gamma_t)$ and assume z_t follows a VAR(p) process that is:

Table 7.10
Dynamics of Fiscal Adjustment

	US	Canada	Germany	Japan	UK	Italy
Max	0.031	0.065	0.050	0.045	0.055	0.049
Min	–0.025	–0.053	–0.053	–0.060	–0.049	–0.062
Std Dev	0.015	0.027	0.022	0.027	0.024	0.026
Sum AR	0.758	0.860	0.718	0.608	0.756	0.590
Unit root	0.042	0.031	0.100	0.046	0.054	0.027
25%	0.960	3.300	0.930	1.300	0.210	3.000
50%	2.500	4.100	2.100	2.100	2.500	4.100
75%	5.000	5.200	4.100	2.900	4.960	6.900

Note: the first row shows minimum value of l_t over the sample period, while the second row shows the maximum value. The third row is the standard deviation of l_t, and the fourth row shows the sum of the AR coefficients when l_t is modelled as an AR(P) process where P is chosen optimally using AIC criteria. The next row is the p-value from an ADF test that l_t is a unit root process. The last three rows show the number of periods it takes l_t to adjust by 25%, 50%, and 75% (respectively) to a shock to its value.

$$z_t = A_1 z_{t-1} + A_2 z_{t-2} + \dots + A_p z_{t-p} + \varepsilon_t,$$

where A_k, $k = 1, \dots, p$ are 6×6 matrices. Denoting $\mathbf{z}_t = (z_t', z_{t-1}', \dots, z_{t-p+1}')$ and $\boldsymbol{\varepsilon}_t = (\varepsilon_t', 0, \dots, 0)$ we can rewrite this VAR(p) as a VAR(1) so:

$$\mathbf{z}_t = \mathbf{A}\mathbf{z}_{t-1} + \boldsymbol{\varepsilon}_t,$$

where

$$\mathbf{A} = \begin{pmatrix} A_1 & A_2 & \dots & A_{p-1} & A_p \\ 0 & 1 & \dots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \dots & 1 & 0 \end{pmatrix}$$

Noting that conditional expectations satisfy

$$E_t \mathbf{z}_{t+j} = \mathbf{A}^j \mathbf{z}_t$$

and defining appropriate indicator vectors **e** such that

$$\mathbf{e}_l' \mathbf{z}_t = l_t,\ \mathbf{e}_{\Delta d}' \mathbf{z}_t = \Delta d_t,\ \mathbf{e}_r' \mathbf{z}_t = r_{t-1},\ \mathbf{e}_{\Delta h}' \mathbf{z}_t = \Delta h_t,\ \mathbf{e}_\pi' \mathbf{z}_t = \pi_t,\ \mathbf{e}_\gamma' \mathbf{z}_t = \gamma_t,$$

we can then, following Campbell and Shiller (1988), rewrite equation (8) as:

$$\mathbf{e}_l'\mathbf{z}_t = \left[\left(1-\frac{1}{\mu_b}\right)+\phi\frac{\mu_h}{\mu_b}\left(1-\frac{1}{\mu_h}\right)\right]\sum_{j=1}^{\infty}\left(\frac{1}{\mu_b}\right)^j\mathbf{e}_{\Delta d}'\mathbf{A}^j\mathbf{z}_t+\frac{\phi}{\mu_b}\left(1-\frac{\mu_h}{\mu_b}\right)$$
$$\cdot\sum_{j=0}^{\infty}\left(\frac{1}{\mu_b}\right)^j\mathbf{e}_{\Delta h}'\mathbf{A}^j\mathbf{z}_t-\left(1-\frac{1}{\mu_b}\right)\sum_{j=0}^{\infty}\left(\frac{1}{\mu_b}\right)^j\mathbf{e}_r'\mathbf{A}^j\mathbf{z}_t+\left(1-\frac{1}{\mu_b}\right)\phi\frac{\mu_h}{\mu_b}$$
$$\cdot\sum_{j=0}^{\infty}\left(\frac{1}{\mu_b}\right)^j\mathbf{e}_\pi'\mathbf{A}^j\mathbf{z}_t+\left(1-\frac{1}{\mu_b}\right)\left(1+\phi\frac{\mu_h}{\mu_b}\right)\sum_{j=0}^{\infty}\left(\frac{1}{\mu_b}\right)^j\mathbf{e}_\gamma'\mathbf{A}^j\mathbf{z}_t,$$

or equivalently

$$\mathbf{e}_l'\mathbf{z}_t = \left\{\frac{1}{\mu_b}\left[\left(1-\frac{1}{\mu_b}\right)+\phi\frac{\mu_h}{\mu_b}\left(1-\frac{1}{\mu_h}\right)\right]\mathbf{e}_{\Delta d}'\mathbf{A}\left(I-\frac{1}{\mu_b}\mathbf{A}\right)^{-1}\right.$$
$$+\frac{\phi}{\mu_b}\left(1-\frac{\mu_h}{\mu_b}\right)\mathbf{e}_{\Delta h}'\left(I-\frac{1}{\mu_b}\mathbf{A}\right)^{-1}-\left(1-\frac{1}{\mu_b}\right).$$
$$\left.\left[\mathbf{e}_r'-\phi\frac{\mu_h}{\mu_b}\mathbf{e}_\pi'-\left(1+\phi\frac{\mu_h}{\mu_b}\right)\mathbf{e}_\gamma'\right]\left(I-\frac{1}{\mu_b}\mathbf{A}\right)^{-1}\right\}\mathbf{z}_t. \tag{12}$$

This is simply a restatement of our key equation (8), but where we have replaced the expectation terms with conditional forecasts obtained from our VAR representation for z_t. If our log linearization to the budget constraint is appropriate we have:

$$\mathbf{e}_l'\left(I-\frac{1}{\mu_b}\mathbf{A}\right)=\frac{1}{\mu_b}\left[\left(1-\frac{1}{\mu_b}\right)+\phi\frac{\mu_h}{\mu_b}\left(1-\frac{1}{\mu_h}\right)\right]\mathbf{e}_{\Delta d}'\mathbf{A} \tag{13}$$
$$+\frac{\phi}{\mu_b}\left(1-\frac{\mu_h}{\mu_b}\right)\mathbf{e}_{\Delta h}'-\left(1-\frac{1}{\mu_b}\right)$$
$$\cdot\left[\mathbf{e}_r'-\phi\frac{\mu_h}{\mu_b}\mathbf{e}_\pi'-\left(1+\phi\frac{\mu_h}{\mu_b}\right)\mathbf{e}_\gamma'\right].$$

This expression shows the restriction that the present value formula imposes on innovations to l_t relative to innovations in deficits, money, and growth adjusted real interest rates. It can, therefore, be used as a joint test for the adequacy of both the approximation to the intertemporal budget constraint and the forecasting system used for these variables. It is this test we referred to earlier as a means of validating our DOLS estimates of l_t. As shown in Giannitsarou and Scott (2006), an alternative and easier to implement formulation of this restriction is:

$$0 = E_{t-1}\left\{\frac{1}{\mu_b}(\Delta b_t - \phi\Delta h_t) + l_t - \left[r_{t-1} - \gamma_t - \phi\frac{\mu_h}{\mu_b}(\pi_t + \gamma_t)\right]\right\}.$$

This last expression can be easily tested by regressing the expression in the expectation on variables in the t–1 information set and testing for their significance. If the log-linear approximation to the intertemporal budget constraint is to hold, then these lagged variables should be insignificant.

To proceed with the variance decomposition, the system is rewritten as:

$$l_t = F_{\Delta d,t} + F_{\Delta h,t} + F_{r,t} + F_{\pi,t} + F_{\gamma,t},$$

where

$$F_{\Delta d,t} = \frac{1}{\mu_b}\left[\left(1 - \frac{1}{\mu_b}\right) + \phi\frac{\mu_h}{\mu_b}\left(1 - \frac{1}{\mu_h}\right)\right]\mathbf{e}'_{\Delta d}\mathbf{A}\left(I - \frac{1}{\mu_b}\mathbf{A}\right)^{-1}\mathbf{z}_t,$$

$$F_{\Delta h,t} = \frac{\phi}{\mu_b}\left(1 - \frac{\mu_h}{\mu_b}\right)\mathbf{e}'_{\Delta h}\left(I - \frac{1}{\mu_b}\mathbf{A}\right)^{-1}\mathbf{z}_t,$$

$$F_{r,t} = -\left(1 - \frac{1}{\mu_b}\right)\mathbf{e}'_r\left(I - \frac{1}{\mu_b}\mathbf{A}\right)^{-1}\mathbf{z}_t,$$

$$F_{\pi,t} = \left(1 - \frac{1}{\mu_b}\right)\phi\frac{\mu_h}{\mu_b}\mathbf{e}'_\pi\left(I - \frac{1}{\mu_b}\mathbf{A}\right)^{-1}\mathbf{z}_t,$$

$$F_{\gamma,t} = \left(1 - \frac{1}{\mu_b}\right)\left(1 + \phi\frac{\mu_h}{\mu_b}\right)\mathbf{e}'_\gamma\left(I - \frac{1}{\mu_b}\mathbf{A}\right)^{-1}\mathbf{z}_t.$$

Where $F_{j,t}$ denotes the projected contribution of component j towards maintaining the intertemporal budget constraint. Figure 7.4 shows the value of l_t and our estimated series for $F_{\Delta d,t} + F_{\Delta h,t} + F_{r,t} + F_{\pi,t} + F_{\gamma,t}$ in the case of the United States, and shows that our forecasting model does an excellent job capturing the restrictions implied by the intertemporal budget constraint. This is confirmed by the χ^2 test of the orthogonality condition (13), which holds at the 5 percent level or less for the majority of cases, once more confirming the validity of the DOLS estimates.

The benefits of applying this VAR forecasting framework to the intertemporal budget constraint is that it can be used to perform a variance decomposition on l_t. In other words, it is possible to measure the relative importance of each of our variables (changes in primary deficit, issuance of monetary liabilities, changes in return on bonds, or inflation

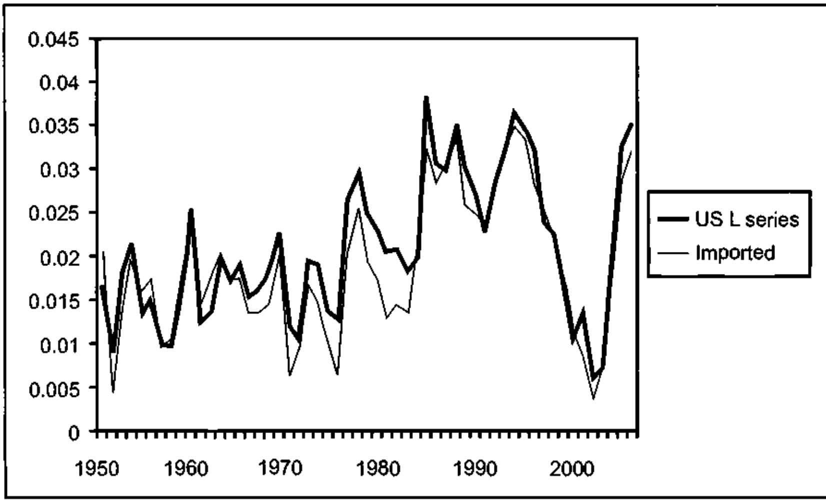

Figure 7.4
U.S. Decomposition

or GDP growth) in achieving fiscal balance. As shown by Cochrane (1992), the relative importance of variable j can be measured by the estimated coefficient from a regression of $F_{j,t}$ on l_t. Table 7.11 shows results from the sample period and clearly demonstrates the importance of deficit fluctuations as the main source of adjustment in l_t. Compared to the importance of the deficit the role of the other variables is minor, including that of inflation. The minor role for variations in rates of return on government debt in achieving fiscal balance is consistent with the findings of Faraglia, Marcet, and Scott (forthcoming) regarding the lack of fiscal insurance offered by existing debt instruments.

Because the F_{jt} components are possibly correlated among themselves, the variance decomposition is not an orthogonal one and so the estimates of the relative contribution of each variable are not bounded between zero and one. This leads to the possibility that if the inflation term is strongly correlated with fluctuations in the primary surplus, then the high estimate of the role of fluctuations in the primary deficit and the low estimate for inflation may reflect the nonorthogonality of the decomposition. However, the strongest correlations in the data are between $F_{\pi,t}$, $F_{r,t}$, and $F_{\gamma,t}$ rather than with $F_{\Delta d,t}$. For instance, for the United States, Italy, Canada, the United Kingdom, Japan, and Germany the correlations between $F_{\pi,t}$ and $F_{\Delta d,t}$ are −0.26, 0.78, −0.15, −0.24, 0.42, and −0.61 compared to −0.78, 0.46, 0.25, −0.90, 0.97, 0.67 for the correlation between

Table 7.11
Variance Decomposition of Fiscal Adjustments

	$F_{\Delta d}$	$F_{\Delta g}$	$F_{\Delta \tau}$	$F_{\Delta h}$	F_r	F_π	F_γ	Orth. test
US	1.321			–0.057	0.007	0.058	0.191	0.019
		0.815	0.718	0.073	–0.219	0.067	–0.059	0.032
Canada	0.985			0.010	–0.013	0.002	–0.018	0.022
		0.534	–0.437	–0.015	–0.039	0.006	–0.002	0.044
Germany	0.930			0.053	–0.021	0.042	0.008	0.045
		0.467	0.571	0.021	–0.016	0.034	0.004	0.061
Japan	1.071			–0.066	0.042	0.066	0.059	0.017
		0.819	0.675	–0.121	0.126	0.116	0.165	0.013
UK	0.912			0.113	–0.141	0.025	–0.003	0.038
		1.001	0.221	0.182	–0.121	–0.002	–0.002	0.031
Italy	0.881			0.007	–0.054	0.068	0.037	0.062
		0.614	0.471	0.312	–0.036	0.096	0.067	0.044

Note: for each country, the first row shows the basic variance decomposition and the second row shows the extended variance decomposition.

$F_{\pi,t}$ and $F_{\gamma,t}$. Only if the correlation between $F_{\pi,t}$ and $F_{\Delta d,t}$ is large and negative can an appeal to nonorthogonality be used to explain why the estimates of the importance of inflation may be an underestimate.

The importance of the deficit in the variance decomposition is surprising given the previous findings on the importance of the nominal growth dividend. However, (as stressed earlier) the growth dividend focuses on how the average level of the debt/GDP ratio is linked to average levels of the primary deficit, interest rates, GDP growth, and inflation. By contrast, the use of the intertemporal budget constraint focuses on how changes in these variables account for variations in the deficit to liabilities ratio. Examination of the raw data also reveals the importance of shifts in the primary deficit. For instance, in Italy the primary deficit started at 0 percent, but deteriorated to more than 8 percent before debt started to improve as the primary deficit moved to –6 percent. Similar movements in debt and primary deficits occur in the other countries in our sample.

This analysis suggests that fluctuations in the primary deficit are the main means whereby fiscal balance is achieved. This raises the question whether fluctuations in the primary deficit are driven more by government expenditure or by changes in tax revenue. Therefore the VAR is extended using the decomposition:

$$I_t = F_{\Delta g,t} + F_{\Delta\tau,t} + F_{\Delta h,t} + F_{r,t} + F_{\pi,t} + F_{\gamma,t},$$

where

$$F_{\Delta g,t} = \frac{1}{\mu_b}\left[\left(1 - \frac{1}{\mu_b}\right) + \phi\frac{\mu_h}{\mu_b}\left(1 - \frac{1}{\mu_h}\right)\right]\lambda_g \mathbf{e}'_{\Delta g}\mathbf{A}\left(I - \frac{1}{\mu_b}\mathbf{A}\right)^{-1}\mathbf{z}_t,$$

$$F_{\Delta\tau,t} = \frac{1}{\mu_b}\left[\left(1 - \frac{1}{\mu_b}\right) + \phi\frac{\mu_h}{\mu_b}\left(1 - \frac{1}{\mu_h}\right)\right]\lambda_\tau \mathbf{e}'_{\Delta\tau}\mathbf{A}\left(I - \frac{1}{\mu_b}\mathbf{A}\right)^{-1}\mathbf{z}_t.$$

The results of this extended VAR are also shown in Table 7.11. As in Bohn (1991), both expenditure and revenue variations play a substantial role in fiscal fluctuations with a slightly more important role for expenditure fluctuations, although this effect is far more pronounced in the United Kingdom.

These variance decomposition results suggest that inflation movements play only a very minor role in accounting for shifts in the fiscal position of governments. However, this does not necessarily mean that fiscal movements are insignificant in predicting future inflation. Another implication of equation (8), that I_t should be useful in predicting future inflation, is now analyzed. In particular, the ability of I_t to predict future inflation at horizons from one to twenty years. This is done by first specifying an optimal forecasting equation for inflation. Lag selection criteria are used in a model where inflation depends on lagged values of inflation, nominal interest rates, and GDP growth, where lags of up to eight periods are considered for each variable. Having arrived at an optimal model, we then add I_{t-j} to gauge the additional explanatory power from our measure of fiscal imbalance. The results are shown in table 7.12, where we quote the p-value for I_{t-j}, $j = 1, \ldots, 20$.

The results are consistent with Table 7.1, where fiscal measures have a very marginal impact on predicting inflation. The vast majority of lags are insignificant although in a few cases there is evidence of predictive ability at horizons of around three to four years. However, the marginal statistical contribution of I_t is fairly small. The pitfalls of such Granger causality tests are well known and their inability to successfully identify causal economic mechanisms well documented. Therefore, one should take care in interpreting these findings and not necessarily interpret them as implying that fiscal policy does not influence inflation. For instance, the fiscal theory of the price level would argue that expectations about future deficits, that is $E_t\Sigma_{j=1}^{\infty}(1/\mu_b)^j\Delta d_{t+j}$, would influence the current level of prices and so affect contemporaneous inflation. This is

Table 7.12
Predicting Inflation

	US	Canada	Germany	Japan	UK	Italy
1	0.04	0.08	0.21	0.13	0.23	0.16
2	0.07	0.05	0.26	0.11	0.31	0.13
3	0.08	0.07	0.32	0.07	0.17	0.12
4	0.13	0.11	0.21	0.06	0.13	0.08
5	0.09	0.17	0.17	0.08	0.04	0.04
6	0.07	0.32	0.16	0.12	0.03	0.15
7	0.21	0.25	0.35	0.15	0.05	0.31
8	0.32	0.21	0.49	0.16	0.11	0.24
9	0.36	0.42	0.45	0.21	0.19	0.42
10	0.48	0.56	0.26	0.21	0.23	0.46
11	0.63	0.54	0.32	0.19	0.35	0.53
12	0.54	0.59	0.54	0.26	0.46	0.41
13	0.52	0.58	0.56	0.29	0.32	0.36
14	0.59	0.65	0.63	0.32	0.41	0.39
15	0.73	0.78	0.78	0.33	0.53	0.55
16	0.86	0.79	0.74	0.34	0.52	0.45
17	0.88	0.82	0.72	0.30	0.46	0.34
18	0.75	0.91	0.76	0.26	0.64	0.46
19	0.82	0.96	0.73	0.45	0.71	0.74
20	0.95	0.99	0.74	0.54	0.55	0.65

Note: the table shows p-values of significance of l_{t-j} (where j is listed in the first column) in a forecasting equation for inflation, containing lagged values of inflation, interest rates, and GDP growth.

entirely consistent with our finding that l_t has only a minor role in predicting future changes in inflation, that is $E_t\Sigma_{j=1}^{\infty}(1/\mu_b)^j\Delta\pi_{t+j}$. However, while we need to be careful in the economic conclusions we draw from these findings we can draw the statistical conclusion that rising government debt is not a good predictor of rising future inflation. That is, the increased indebtedness originating from demographic change is not necessarily a statistical harbinger of rising future inflation.

7.6 Conclusion

This chapter sought to apply a log-linearized version of the intertemporal budget constraint to consider government's fiscal positions. It tried to answer three key questions, namely, (1) whether current fiscal policy is sustainable, (2) how OECD governments have financed their fiscal deficits in recent decades, and (3) what are the implications for inflation of the expected rising deficits. The contribution of the paper is purely empirical, using an accounting identity to quantify the statistical impact of certain key variables.

In answering the first question, for each country we estimated a measure of current fiscal imbalance, defined as the ratio between current liabilities and the primary deficit. If these variables cointegrate then fiscal policy is sustainable. Further, we can use the magnitude of short-term deviations from this cointegrating relationship as a measure of fiscal imbalances. Historically, large fiscal imbalances would question whether current fiscal policy is sustainable. For the United States, United Kingdom, Italy, and Canada we found strong evidence for sustainability although the evidence for Germany and Japan was more questionable.

Using our version of the intertemporal budget constraint, we analyzed how in previous years governments had achieved fiscal balance. We found an overwhelming role for changes in the primary surplus with only a minor role for inflation, growth, and interest rate effects. Further, we also found that fiscal imbalances had only a very weak forecasting role for future inflation at nearly all horizons, with some mild evidence that fiscal imbalances could help predict inflation three to four years ahead.

Obviously our results should be interpreted with care, as they are based on a certain historical period and an assumption that governments cannot take a deficit gamble if $r < \gamma$. Further, any attempt at an econometric approach to evaluating the intertemporal budget constraint is vulnerable to time dependence and nonstationarity. Our accounting framework also prevents us from attributing any causal role to the statistical relationships we discover. However, the statistical findings are striking since variations in fiscal imbalances and movements to fiscal sustainability are achieved mainly through variations in the primary deficit. Moreover, rising government debt amongst these countries is not a reliable predictor of higher future inflation.

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Notes

1. A detailed description of our data and its sources is provided in Appendix A.

2. For easy reference, the notation we use throughout the paper is summarized in Appendix B.

3. Here we follow Gourinchas and Rey (2005) and allow the coefficients in these cointegrating relationships to differ from one. An obvious justification for this would be measurement error. Because of off-balance sheet items, official debt data does not accumulate purely as a consequence of the recorded total deficit.

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Appendix A

Data Sources

Notes on data sources for the United Kingdom and United States can be found in Giannitsarou and Scott (2006). The remaining countries details are as below. The following abbreviations are used:

- GFD: Global Financial Data
- IFS: International Financial Statistics (IMF)
- OECD-EO: OECD Economic Outlook Database
- OECD-CGD: OECD Central Government Debt Statistics
- HSoC: Historical Statistics of Canada (Statistics Canada)
- DI: DataInsight

Government debt and market values. Market values are approximated for central government marketable debt, which is from OECD-CGD. For the periods before these data are available, the last available share of marketable in total debt was used to obtain marketable debt. The price of government debt is approximated as:

$$p_t = \frac{1 + NC}{1 + NI},$$

where N is the average term to maturity of outstanding government securities, C is the average coupon rate, and I is the average market yield. Data on average terms to maturity and average yields is from OECD-CGD. If no average term to maturity was available, average maturities were used. For earlier periods, the last average maturity available was taken. If average yields were unavailable, yields are constant maturity benchmark yields (from GFD). For a given year, the benchmark yield closest to the average term to maturity of that year was applied. Average coupon data is approximated as the ratio of gross interest service to gross government debt and, more precisely:

$$C_t = \frac{\text{Interest}_{t+1}}{DEBT_t}.$$

Table 7A.1
GDP, Prices and Inflation

Country	variable	sample period	source	ID/Specification
CAN	real GDP		GFD	GDPCCANM
	nom. GDP			GDPCANM
JAP	nom. GDP	1955–2005	IFS	15899B.CZF
	Deflator			15899BIRZF
JAP, ITA, GER	nom. GDP	1960–2005	OECD-EO	
	Deflator			

Note: The implicit GDP deflator is used as the price index. (Gross) inflation is then obtained as the annual rate of change of the index.

Table 7A.2
Base Money

Country	sample	source	ID/Specification
CAN	1926–1954	HSoC	J69+J71
	1955–2005	DI	MBASENS@CN
GER		DI	M1@EURNS@GY
ITA	1960–1990	Fratianni (2005), p49ff	col BP
	1991–2005	Banca d'Italia	
JAP		DI	MBASENS@JP

Note: For Canada, Italy, and Japan, base money is used. For Germany, it is the national definition of M1 (currency in circulation plus overnight deposits).

Table 7A.3
Government receipts and expenditure

Country		sample	source	ID/Spec.
CAN	Receipts, expenditure	1926–1965	HSoC	FI09, FI16
	Receipts, expenditure	1966–2005	DI	REVG@CN, EXG@CN
	Interest			EXGCDINS@CN
GER, ITA, JAP	Receipts, expenditure		OECD-EO	
	Interest			

Note: All government expenditure data is net of interest service. Revenues are net of interest receipts for Germany, Italy and Japan, but not for Canada. The primary deficit is expressed as net expenditure minus (net) receipts.

Appendix B

Variable Definitions and Notation

Table 7B.4
Variable Definitions and Notation

variable	definition	steady state
G_t	government spending over GDP	
T_t	tax revenues over GDP	
B_t	debt over GDP	
H_t	seignorage over GDP	
W_t	aggregate wealth	
P_t	price index	
Y_t	real GDP	
$R_t = 1 + r_t$	gross real interest rate	$R = 1 + r$
$\Upsilon_t = 1 + i_t$	gross nominal interest rate	$\Upsilon = 1 + i$
Ω_t	$= W_t / W_{t-1}$	$\Omega = 1 + \omega$
$\Pi_t = 1 + \pi_t$	$= P_t / P_{t-1}$	$\Pi = 1 + \pi$
$Q_t = 1 + \gamma_t$	$= Y_t / Y_{t-1}$	$Q = 1 + \gamma$
$\varkappa_t$	growth rate of nominal GDP, $1 + \varkappa_t = (1 + \gamma_t)(1 + \pi_t)$	
$\overline{G}_t$	$= G_t / W_t$	$\overline{G}$
$\overline{T}_t$	$= T_t / W_t$	$\overline{T}$
$\overline{B}_t$	$= B_t / W_t$	$\overline{B}$
$\overline{H}_t$	$= H_t / W_t$	$\overline{H}$
w_t	$= \ln W_t$	
g_t	$= \ln G_t$	
τ_t	$= \ln T_t$	
b_t	$= \ln B_t$	
h_t	$= \ln H_t$	
d_t	$= \lambda_g g_t + \lambda_\tau \tau_t$	
μ_b	$= \Upsilon / (\Pi Q \Omega)$	
μ_h	$= 1 / (\Pi Q \Omega)$	
λ_g	$= \overline{G} / (\overline{G} - \overline{T})$	
λ_τ	$= -\overline{T} / (\overline{G} - \overline{T})$	
ϕ	$= \overline{H} / \overline{B}$	
m	$= (1 - \mu_b)\,\overline{B} + (1 - \mu_h)\,\overline{H}$	
m_t	= sample mean of l_t	
κ	= summary of constants that we can ignore	

Appendix C

Derivation of the Log-Linear Budget Constraint

The budget constraint for the government, after having adjusted with GDP and prices, can be written as:

$$G_t - T_t = B_t - \frac{Y_{t-1}}{\Pi_t Q_t} B_{t-1} + H_t - \frac{1}{\Pi_t Q_t} H_{t-1}.$$

Dividing through with W_t, we get:

$$\frac{G_t}{W_t} - \frac{T_t}{W_t} = \frac{B_t}{W_t} - \frac{Y_{t-1}}{\Pi_t Q_t \Omega_t} \frac{B_{t-1}}{W_{t(-1)}} + \frac{H_t}{W_t} - \frac{1}{\Pi_t Q_t \Omega_t} \frac{H_{t-1}}{\Omega_{t-1}},$$

that is,

$$\overline{G}_t - \overline{T}_t = \overline{B}_t - \frac{Y_{t-1}}{\Pi_t Q_t \Omega_t} \overline{B}_{t-1} + \overline{H}_t - \frac{1}{\Pi_t Q_t \Omega_t} \overline{H}_{t-1}.$$

In this last expression, all variables are (by assumption) stationary. Thus we can log-linearize the expression. To do this, we rewrite it as:

$$\Omega_t \overline{G}_t - \Omega_t \overline{T}_t = \Omega_t \overline{B}_t - \frac{Y_{t-1}}{\Pi_t Q_t} \overline{B}_{t-1} + \Omega_t \overline{H}_t - \frac{1}{\Pi_t Q_t} \overline{H}_{t-1},$$

We then use the approximations:

$$\exp(z) \approx z + 1,$$

$$r_{t-1} \approx i_{t-1} - \pi_t,$$

and the steady-state relationship:

$$\overline{G} - \overline{T} = (1 - \mu_b)\overline{B} + (1 - \mu_h)\overline{H} \equiv m, \text{ or}$$

$$(\overline{G} - \overline{T}) - (\overline{B} + \overline{H}) = -(\mu_b \overline{B} + \mu_h \overline{H}),$$

to obtain

$$b_{t-1} = \frac{1}{\mu_b} b_t - \frac{1}{\mu_b} \frac{m}{\overline{B}} d_t + \frac{\phi}{\mu_b}(h_t - \mu_h h_{t-1}) - r_{t-1} + \phi \frac{\mu_h}{\mu_b} \pi_t + \left(1 + \phi \frac{\mu_h}{\mu_b}\right) \gamma_t.$$

Substituting forward we get:

$$b_{t-1} = \left(\frac{1}{\mu_b}\right)^T b_{t+T-1} + \sum_{j=0}^{T-1}\left(\frac{1}{\mu_b}\right)^j\left[-\frac{1}{\mu_b}\frac{m}{\overline{B}}d_{t+j} + \frac{\phi}{\mu_b}(h_{t+j} - \mu_h h_{t+j-1})\right.$$

$$\left. - r_{t+j-1} + \phi\frac{\mu_h}{\mu_b}\pi_{t+j} + \left(1 + \phi\frac{\mu_h}{\mu_b}\right)\gamma_{t+j}\right].$$

Let:

$$l_t = \left(1 - \frac{1}{\mu_b}\right)b_{t-1} + \phi\frac{\mu_h}{\mu_b}\left(1 - \frac{1}{\mu_h}\right)h_{t-1} - \left[\left(1 - \frac{1}{\mu_b}\right) + \phi\frac{\mu_h}{\mu_b}\left(1 - \frac{1}{\mu_h}\right)\right]d_t,$$

so that with some manipulations (and under assumption 3) we get that in the limit $T \to \infty$:

$$l_t = -\frac{1}{\mu_b}\left[(1 - \mu_b) + (1 - \mu_h)\,\phi\right]\sum_{j=1}^{\infty}\left(\frac{1}{\mu_b}\right)^j \Delta d_{t+j}$$

$$+ \frac{\phi}{\mu_b}\left(1 - \frac{\mu_h}{\mu_b}\right)\sum_{j=0}^{\infty}\left(\frac{1}{\mu_b}\right)^j \Delta h_{t+j} + \left(1 - \frac{1}{\mu_b}\right)\sum_{j=0}^{\infty}\left(\frac{1}{\mu_b}\right)^j$$

$$\cdot\left[-r_{t+j-1} + \phi\frac{\mu_h}{\mu_b}\pi_{t+j} + \left(1 + \phi\frac{\mu_h}{\mu_b}\right)\gamma_{t+j}\right].$$

More details about the steps of the derivations can be found in Giannitsarou and Scott (2006).

Violation of Assumption 3

We next consider the case where assumption 3 is violated. As above, the budget constraint:

$$\overline{G}_t - \overline{T}_t = \overline{B}_t - \frac{Y_{t-1}}{\Pi_t Q_t \Omega_t}\overline{B}_{t-1} + \overline{H}_t - \frac{1}{\Pi_t Q_t \Omega_t}\overline{H}_{t-1}.$$

Assume the existence of a nominal interest rate Y_t^*, with an associated real interest rate r_t^* for which $(1 + r^*) > (1 + \gamma)(1 + \omega)$. We can then rewrite our budget constraint as:

$$\overline{G}_t - \overline{T}_t = \overline{B}_t - \frac{Y_{t-1}^*}{\Pi_t Q_t \Omega_t}\overline{B}_{t-1} + \frac{Y_{t-1} - Y_{t-1}^*}{\Pi_t Q_t \Omega_t}\overline{B}_{t-1} + \overline{H}_t - \frac{1}{\Pi_t Q_t \Omega_t}\overline{H}_{t-1}.$$

Bohn's (2006) suggestion is to define:

$$\overline{G}_t^* = \overline{G}_t - \frac{Y_{t-1} - Y_{t-1}^*}{\Pi_t Q_t \Omega_t} \overline{B}_{t-1},$$

and then use the budget constraint:

$$\overline{G}_t^* - \overline{T}_t = \overline{B}_t - \frac{Y_{t-1}}{\Pi_t Q_t \Omega_t} \overline{B}_{t-1} + \overline{H}_t - \frac{1}{\Pi_t Q_t \Omega_t} \overline{H}_{t-1}.$$

However for our purposes, this would require constructing a synthetic government expenditure series whose interpretation would be more difficult. Instead we use the following approach and make the assumption that:

$$Y_{t-1} - Y_{t-1}^* = \frac{\varsigma \overline{H}_{t-1}}{\overline{B}_{t-1}}.$$

Given the sign of H and B, and in order for $r^* > r$, we need $\varsigma < 0$. Under this assumption we have:

$$\overline{G}_t - \overline{T}_t = \overline{B}_t - \frac{Y_{t-1}^*}{\Pi_t Q_t \Omega_t} \overline{B}_{t-1} + \frac{\varsigma \overline{H}_{t-1} / \overline{B}_{t-1}}{\Pi_t Q_t \Omega_t} \overline{B}_{t-1} + \overline{H}_t - \frac{1}{\Pi_t Q_t \Omega_t} \overline{H}_{t-1},$$

or

$$\overline{G}_t - \overline{T}_t = \overline{B}_t - \frac{Y_{t-1}^*}{\Pi_t Q_t \Omega_t} \overline{B}_{t-1} + \overline{H}_t - \frac{1 - \varsigma}{\Pi_t Q_t \Omega_t} \overline{H}_{t-1}. \tag{C1}$$

This last equation is exactly the same as equation (2), except that the coefficient on $\overline{H}_{t-1}$ is different. All the above steps for deriving a log-linear present value constraint can now be replicated by substituting μ_b and μ_h with:

$$\mu_b^* = \frac{1 + r^*}{(1 + \gamma)(1 + \omega)}, \text{ and}$$

$$\mu_h^* = \frac{1 - \varsigma}{(1 + \gamma)(1 + \omega)},$$

respectively.

Comment

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This chapter tackles an important topic that is frequently neglected in modern macroeconomics: what are the sources of fiscal financing and what are the inflationary implications of those sources? Actually, the chapter makes headway on answering only the first part of this question. As it turns out, even this accounting exercise is ambitious and difficult to accomplish.

These comments will begin by stepping back from the chapter to try to convince skeptics that the level of government debt and its source of financing have important implications even in the most bare bones neoclassical growth model. It then turns to a discussion of the government's budget constraint, raising some questions about what Giannitsarou and Scott (2006) have done. I then turn to limitations inherent in using only the government's intertemporal constraint as the basis for analysis and propose some ways to bring more economic theory to bear on the important issues this paper raises.

Sustainability

The chapter first address the question of whether current fiscal policy is sustainable in six large industrial nations. Although this question has received a lot of attention in the fiscal literature over the past twenty years, I have always been puzzled by that attention. My puzzlement stems from turning the question around: suppose we find that fiscal policy is not sustainable, then how do we explain the fact that investors willingly acquire the governments' debt? It is not at all obvious how to explain this in models with rational, optimizing agents who are forward looking. Instead, the literature has evolved into a series of explanations for why present-value tests often reject the hypothesis that policy is sustainable.[1]

The interesting question, and the one the authors would like to be able to answer is: how are future policies expected to adjust to ensure that current fiscal policy is sustainable in the face of certain perturbations to the government's budget? Because the only economic structure that the authors impose is the government's budget constraint, they cannot really answer this question. Instead, they can—and do—address the question: if government liabilities expand for the usual reasons, how do we expect them to be financed? It does not answer questions like how are tax cuts financed? More specifically, to motivate the chapter, the authors allude to the expansions in government transfers that are anticipated in aging industrial countries and ask if these are likely to be inflationary. Preliminary to answering that interesting and relevant question is: if transfer payments are expected to expand dramatically in the future, how are they likely to be financed? None of these more specific questions can be addressed within the pure accounting framework that the authors develop.

This limitation does not undermine the utility of their efforts. Theirs is a starting point for work that builds in more structure—also known as identification—that is geared toward tackling more focused questions.

Why Care About Government Debt?

Many macroeconomic policy papers abstract from government debt and claim the abstraction is without loss of generality. Because this hyper-Ricardian perspective permeates macroeconomics research—even research about fiscal policy—it is worthwhile to review how the possibility of debt financing of fiscal spending can change things.

Government debt creates a necessary link between current fiscal policies and expected future policies.[2] In the absence of debt, current and future policies are decoupled and there are no intrinsic fiscal policy dynamics. Equilibrium makes the value of outstanding debt depend on the expected present value of future net of interest surpluses. Given expectations of future policies, the current value of debt is nailed down, which restricts current policy choices. Of course, this relationship is bidirectional—current policy choices can imply a value of debt which, in turn, restricts how expected future policies must adjust. Breaking this bidirectional causality requires economic theory.

When fiscal authorities cannot (and do not) commit to future policy choices, these equilibrium dynamics can be quite complex and difficult to untangle. Yet, we must untangle them if we are ever going to make successful predictions about the consequences of current or expected fiscal changes. The authors appreciate these difficulties, which is why they aim for the more modest goal of simply accounting for the value of debt in terms of expected future sequences of macro variables.

Conventional models can quantify the role of dynamic interactions among fiscal policies. Leeper and Yang (2006) use a calibrated neoclassical growth model to demonstrate how the impacts of cuts in capital and labor taxes hinge on assumptions about how any resulting revenue shortfalls are expected to be financed. Drawing on that work, Figure 7C.1 reports the consequences for steady-state output (Y) and consumption (C) of alternative schemes for financing permanent 1 percent cuts in capital (τ^K) or labor (τ^L) tax rates. The figure also reports the consequences of allowing the steady-state debt output ratio (B/Y) to vary, with the associated changes in debt service. In the first column, govern-

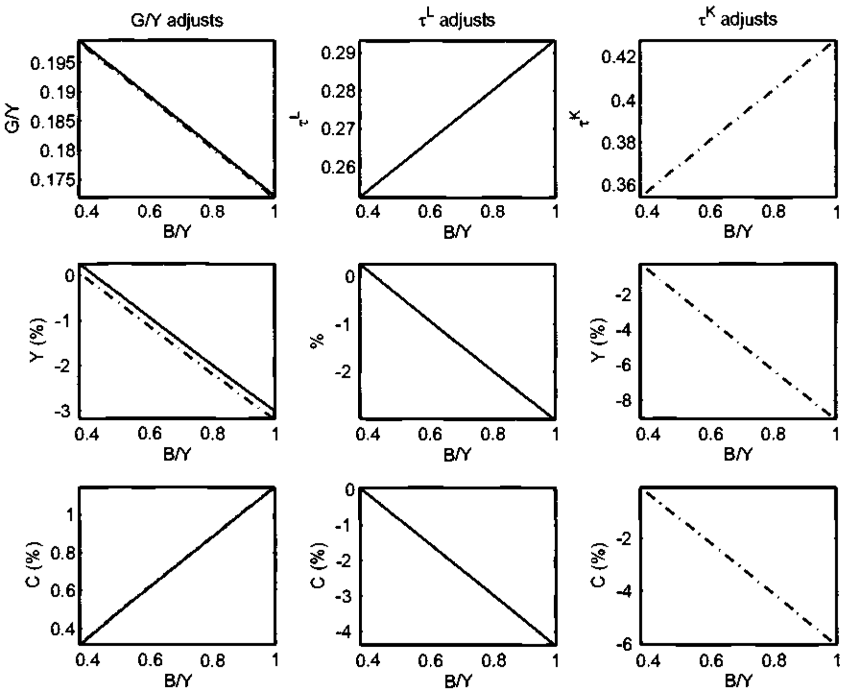

Figure 7C.1

Steady-State Effects of Fiscal Adjustments to 1% Cuts in Capital or Labor Tax Rates.

Notes: solid lines are capital tax cuts and dashed lines are labor tax cuts. First column: government consumption as share of output (G/Y) adjusts; second column: labor tax rate adjusts; third column: capital tax rate adjusts. Y is change in steady-state output, C is change in steady-state consumption, and B/Y is steady-state debt output ratio.

ment consumption as a share of output (G/Y) adjusts to each of the tax cuts; in the second, labor taxes adjust to a capital tax reduction; in the third, capital taxes adjust to a labor tax reduction.

When (G/Y) rises to ensure fiscal sustainability following a capital tax cut, output can rise (if B/Y is small) or fall (if B/Y is about 0.5 or higher). Even the sign of the output multiplier depends on the state of government indebtedness. Regardless of the source of the tax cut, consumption is crowded in by the reduction in G/Y necessitated by higher debt levels. On the other hand, as the second and third columns of the figure show, if the other tax rate rises to compensate for the initial tax cut both output and consumption are uniformly lower at higher levels of debt.

The figure shows that if tax cuts are permitted to raise government indebtedness, then the adjusting fiscal policy changes monotonically with debt—G/Y falling and τ^K or τ^L rising. As debt rises, output and consumption multipliers change monotonically. In sum, the figure highlights two ubiquitous features of fiscal finance: both the policy that adjusts to ensure sustainability and the management of government debt matter for the predicted effects of a cut in taxes.

The Government Budget Constraint

It is difficult to discern precisely what data series the authors used to construct a measure of the government's budget constraint. In the text they say they use as the nominal interest rate (i_t), the one-year holding return on government bonds. They then comment that because this includes both coupon payments and capital gains, the budget constraint is specified in terms of the market value of government debt.

The Appendix A, however, is confusing on this point. When calculating the market price of debt, the authors make a number of approximations to average across the maturity structure of outstanding debt. How good these approximations are is not discussed.

An alternative derivation of the government budget constraint follows Chung and Leeper (2006).[3] For simplicity, set aside money financing. Let $V_t = \Sigma_{j=1}^{\infty} Q_t(j)B_t(j)$ be the nominal market value of outstanding debt, where $Q_t(j)$ is the nominal price of a discount bond maturing at date $t + j$ and $B_t(j)$ is the face value of such a bond. The government's flow budget constraint is:

$$\sum_{j=1}^{\infty} Q_t(j)[B_t(j) - B_{t-1}(j+1)] = B_{t-1}(1) - S_t, \qquad (1)$$

where S_t is the nominal primary surplus (total expenditures, including transfers, less revenues). This can be expressed as:

$$V_t = (1 + i_{t-1})V_{t-1} - S_t, \tag{2}$$

where

$$1 + i_{t-1} = \frac{\sum_{j=1}^{\infty} Q_t(j)B_{t-1}(j + 1) + B_{t-1}(1)}{V_{t-1}}. \tag{3}$$

Because i_{t-1} includes the price of bonds sold at t, which is not in the date $t-1$ information set of agents, it is unclear the sense in which the authors have included capital gains in the calculation of the market value of debt. Their VAR system uses the vector $\mathbf{z}_t$, which includes $r_{t-1} = i_{t-1} - \pi_t$, but it is unclear whether their measure of i_{t-1} coincides with the definition in equation (3).

Chung and Leeper (2006) show that tranversality implies, to the first order, that the market value of debt is equal to the present value of surpluses discounted by the short-term growth-adjusted real interest rate. Do the authors have an analogous theoretical result for their interest rate measure? This would seem to be a necessary input to make sense of their tests of the sustainability of fiscal policies. They may be using a consistent framework for the government budget constraint, but without more specificity about precisely what they have done it is impossible to tell.

Two additional data issues arise in the chapter, both easily handled. First, most theoretical models predict very different effects from changes in government consumption and changes in government transfers. Moreover, in the United States these two components of expenditures, measured as shares of GDP, have exhibited opposite-signed trends over the past forty years. The authors combine these into G_t. It would be instructive to separate these conceptually distinct aspects of government spending.

Second, the authors choose to perform their analysis in terms of the fiscal imbalances measure I_t. This is defined as:

$$I_t = \alpha_b b_{t-1} + \alpha_h h_{t-1} + \alpha_g g_t + \alpha_\tau \tau_t, \tag{4}$$

a linear combination of government debt, high-powered money, government expenditures, and tax receipts. When I_t is high, outstanding government liabilities are large relative to the current surplus. Use of I_t introduces a cumbersome two-stage estimation process, first to estimate the parameters in equation (4), then to estimate the parameters in the present value relation for l_t. Use of l_t is also conceptually cumbersome, as it seems to confound debt management, monetary policy, and conventional fiscal policy—elements of monetary and fiscal behavior that are often operationally separate and probably need to be studied separately. All the analysis in the paper could more easily be executed in terms of debt (b_t) rather than l_t, and nothing appears to hinge on the notion of fiscal imbalances. Why do this?

A Need for Theory

Although the chapter is framed as an accounting exercise, it is irresistibly tempting to slip into causal inferences. In their conclusion they write that "the statistical findings are striking: variations in fiscal imbalances and movements to fiscal sustainability are achieved mainly through variations in the primary deficit." And "rising government debt . . . is not a reliable predictor of higher future inflation." It is hard to know what to make of these findings. Because the sources of fluctuations in fiscal imbalances—loosely, debt—are not identified, these results do *not* mean that an expansion in debt due to an exogenous increase in transfers (1) is likely to be financed primarily through higher future surpluses and (2) is unlikely to generate higher inflation.

They decompose fiscal imbalances into movements in the expected present values of government spending (F_{gt}), tax revenues ($F_{\tau t}$), money growth ($F_{\Delta ht}$), the ex post real interest rate (F_{rt}), inflation ($F_{\pi t}$), and output growth ($F_{\gamma t}$). Because movements in l_t are not identified, the results report how the various F's respond to a typical shock in l. Of course, the equality:

$$l_t = F_{gt} + F_{\tau t} + F_{\Delta ht} + F_{rt} + F_{\pi t} + F_{\gamma t}, \tag{5}$$

which forms the basis of their variance decomposition of l_t, holds as an equilibrium condition in all dynamic models. Nothing causal can be learned from equation (5).

So while we can learn nothing about the structure of the economy from the decomposition in equation (5), maybe it is possible to learn about the structure from the covariances among the F's. Unfortunately, the chapter does not closely examine the estimated covariances.

This suggests a research agenda that examines the implications of various classes of models and various assumptions about monetary and fiscal policy behavior for how the F's covary in response to various exogenous disturbances. One could posit alternative fiscal financing schemes—Bohn's (1998) environment in which surpluses respond to debt, Sargent and Wallace's (1981) unpleasant monetarist environment in which seigniorage finances deficits, Leeper's (1991) fiscal theory of the price level environment in which deficits are exogenous and the nominal interest rate is pegged, or even Davig and Leeper's (2006) setup in which monetary and fiscal policies fluctuate randomly among different regimes—and examine the implications of those schemes for the means and covariances of the F's.

Research along these lines would tell us what Table 11 (in the chapter) would look like under alternative assumptions about the economic structure. Why might $F_{\Delta g}$ and $F_{\Delta\tau}$ be an order of magnitude larger than the other F's? Does this tell us anything about the effects of fiscal policies?

Another aspect of the research agenda would aim to answer the question that motivates the chapter: what are the likely macroeconomic consequences of demographic shifts that imply higher future transfer payments to individuals? Addressing this question, however, is likely (in addition to calling for a good deal more economic structure) to require breaking away from the VAR methodology. As Yang (2005) illustrates in a standard neoclassical growth model, foresight about future fiscal changes can introduce a moving average component to the equilibrium, which makes the linear system noninvertible and no finite order VAR representation exists.

More specifically, the impacts of innovations in current liabilities induced by an exogenous shock to transfers need not be equivalent to the impacts of an anticipated rise in transfers. And Yang's point is that if historically changes in transfers are at least to some extent known in advance, it may not be possible to recover the exogenous shocks to transfers as a linear function of current and past forecast errors in transfers (and other variables), as VAR methods assume.

Much to Do

It is remarkable how little we know about fiscal policy effects, to borrow a phrase from Miller and Roberds (1992). Giannitsarou and Scott have made a nice start on getting the fiscal accounting right. The next step is to integrate the dynamic accounting methods this paper develops into dynamic stochastic general equilibrium models to begin to answer the pressing questions about monetary and fiscal policy interactions.

Notes

1. See Hamilton and Flavin (1986); Hansen, Roberds, and Sargent (1991); and Davig (2005).

2. Gordon and Leeper (2006) examine these links in a fully specified model of monetary and fiscal policies.

3. In contrast to the authors, who test the government budget constraint, Chung and Leeper (2006) impose it on an estimated VAR.

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