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Abstract

Government net worth – total assets less liabilities – has declined considerably relative to national income in a number of OECD countries in recent decades, including the United States, the United Kingdom, Japan and Germany. Notably, however, in thinking about the links between fiscal policy and bond markets, the focus of policy and academic debates has tended to be on the liabilities side of the government balance sheet. Typically, not much attention has been paid to the extent to which any increase in government debt is accompanied by government asset accumulation and hence affects government net worth. Using novel data on both sides of the government balance sheet both for a panel of OECD countries in recent decades and for the United States over the long term, we provide panel data and time series-based evidence that for bond markets, not all government debt is created equal: for explaining government borrowing cost empirically, (i) government assets are significant in addition to government liabilities, and (ii) it is government net worth rather than government liabilities that matters when both are included. The central country-specific fiscal factor driving bond yields hence appears to be government net worth.

JEL codes: E44, E62, H54, H63

Keywords: Government debt, government assets, fiscal policy, long-term interest rates, OECD countries, United States

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1 Introduction

In February 2016, The Economist, a weekly news magazine, argued that now is the time for governments in mature economies to use fiscal tools to jolt economies from their low-growth state of being, given monetary policy's declining effectiveness at the zero lower bound. It claimed that the kind of "Swabian frugality" that Germany has been promoting is harmful, given cheap or even negative borrowing costs and that, crucially, "markets and ratings agencies will look more kindly on the increase in public debt if there are fresh and productive assets on the other side of the balance sheet". This paper principally seeks to investigate the validity of this latter claim, using recent panel data for a set of OECD countries and long-term time series data for the United States on both sides of governments' balance sheets.

There is a substantial empirical literature that examines the effects of government debt and deficits on government bond yields. So far, however, this literature has largely ignored the extent to which any increase in debt is used to fund asset accumulation, which is reflected in government investment expenditure, the asset side of the government balance sheet and government net worth. This analysis instead takes seriously the reasons for which government debt is rising or falling. Our findings suggest that the asset side of the government balance sheet is significant for explaining government bond yields empirically in a variety of specifications, both for a panel of OECD countries in recent decades and for the United States over the long term. Hence, it seems that for bond markets, not all debt is created equal.

The disregard of the asset side of the government balance sheet[1] in the empirical literature and many policy discussions about debt and deficits comes in spite of striking concurrent developments (Atkinson, 2015) in government net worth, that is, total government assets less liabilities (Buiter, 1985). In the United States, government net worth declined from 80% of national income in the 1980s to 20% by 2010 (Piketty and Zucman, 2014). Based on the most recent data[2] available, net worth has even entered negative territory since, and has thus continued on its trajectory from before 2010. Note that net worth was below 10% of national income in only three periods previously: in the 1880s and in the aftermaths of World War I and World War II. It was in negative territory only twice previously: in the 1880s and after World War II. Figure 1 illustrates this.

A decline in government net worth is also apparent across a number of other OECD countries. This decline is not uniform – for example, Denmark bucked the trend – and cannot be ascribed everywhere to the same causes, with some governments shrinking their assets, others growing their liabilities and some doing both. Nonetheless, a remarkable reduction is apparent in many countries: government net worth has fallen from 68% of national income in 1990 to 9% in 2013 in Germany, from 103% in 1990 to -5% in 2013 in Japan, and from 66% in 1990 to 6% in 2010 and further since in the United Kingdom

[1] An exception is, for example, the IMF (2015), which argues for the relevance of balance sheet analysis for all sectors of the economy.

[2] The most recent available data comes from the US Federal Reserve (2017), while the data used here comes from Piketty and Zucman (2014) in the interest of consistency across countries and reaches only until 2010. Updated data was made available to us by Piketty and Zucman, which reflects this negative turn, yet does not reach as far back as the original release.

(Piketty and Zucman, 2014).[3] Figure 2 illustrates these facts. While such developments would be expected to spell trouble for individuals, corporates or banks, they seem to have gone largely unnoticed – at least in academic and policy debates – in the case of many sovereigns.

In considering both sides of the government balance sheet in an empirical analysis of the effects of fiscal policy on government borrowing cost, we build on an idea that is deeply grounded in economic intuition. For any type of agent in the economy – firms, banks, individuals or governments – when their liabilities grow, we need to take into account what is happening to their assets in order to be able to make any normative claim as to whether this growth is a good or a bad thing. Government assets comprise both financial assets such as currency, deposits, bonds and equity as well as non-financial assets such as buildings and roads. In the context of governments, balance sheets will reflect economic – and political – circumstance and necessity.

We use government balance sheet data for a panel of 10 OECD countries from 1990 and for the United States from 1870, drawn from Piketty and Zucman (2014), to explore the empirical relevance of both the liabilities and the assets sides of the government balance sheet for government bond yields and hence fiscal sustainability. To the best of our knowledge, these data have not been used previously to study the matter at hand. Due to the stationarity and cointegration properties of the time series involved and in order to ensure regression balance, we use the first differences of government balance sheet variables, measured in percent of national income, in our main analysis, in a considerable but necessary departure from the existing literature.

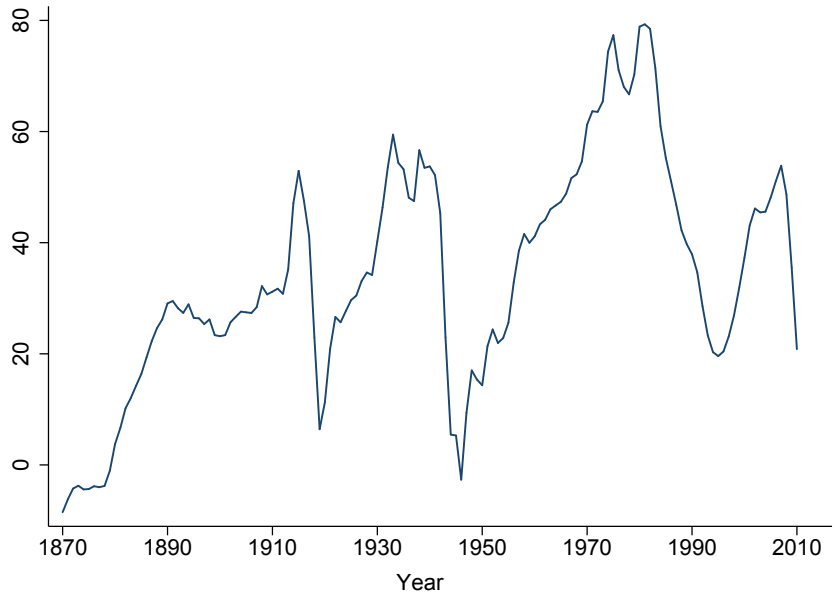
Doing so, we find that, from the perspective of government bond markets, liabilities do matter – yet assets matter just as much: in our preferred specifications, an increase in liabilities that is wholly due to and thus wholly translates into asset accumulation is neutral for bond yields. In fact, government net worth is more informative for government borrowing cost empirically than are total government liabilities. Hence, the central country-specific fiscal factor driving bond yields appears to be government net worth, rather than government liabilities. These conclusions hold both for the panel of OECD countries in recent decades as well as for the United States over the long term.

Findings in this vein – which reflect the perspective of financial markets – could have important policy implications. They provide evidence against the imposition of indiscriminate brakes on the raising of additional debt and suggest that fiscal austerity policies ought to focus on constraining government borrowing when it does not contribute to the accumulation of government assets.

This paper is organised as follows. Section 2 discusses the empirical literature and theory on the links between government bond yields and government balance sheets. Section 3 presents the panel analysis for a set of OECD countries, outlining the data and model used as well as central results. Section 4 proceeds analogously, covering the long-term time series analysis for the United States. Section 5 concludes.

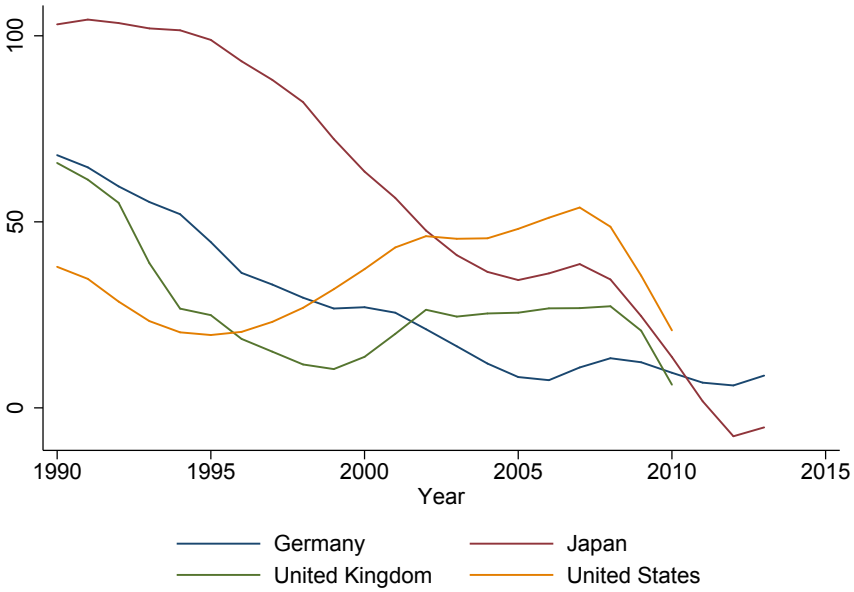
[3] "Germany" refers to West Germany until 1990, and to reunified Germany after.

Figure 1: United States government net worth, 1870-2010



In percent of national income
Source: Piketty and Zucman (2014)

Figure 2: Government net worth, selected countries, 1990-2014



In percent of national income
Source: Piketty and Zucman (2014)

2 Government balance sheets and interest rates

2.1 In the empirical literature

Most immediately, this research links to and extends the literature that analyses empirically the fiscal policy determinants of government bond yields for individual or panels of countries, such as, for example, Ardagna et al. (2007), Gruber and Kamin (2012) or Laubach (2009). It adds to this literature by explicitly taking into account both sides of the government balance sheet, and thus by investigating whether the extent to which any increase in debt is used to fund asset accumulation – which is reflected in government assets and government net worth – matters for the cost of government borrowing and hence fiscal sustainability. Furthermore, by reflecting the perspective of financial markets on government asset accumulation, this research also links back to the literature on the role of infrastructure in economic growth (see Durlauf et al. (2005)).

Most of the literature on the fiscal determinants of long-term government bond yields can broadly be thought of along three main dimensions: first, whether the focus is on an individual country (Laubach, 2009) or a panel of countries (Ardagna et al., 2007); second, whether levels of bond yields (Gruber and Kamin, 2012), levels of short-term interest rates (Plosser, 1987), or spreads vis-à-vis a "risk-free" country (Afonso et al., 2015) or vis-à-vis a short-term rate (Beirne and Fratzscher, 2013) are used as the dependent variable; and third, whether unrestricted reduced-form regressions (Gruber and Kamin, 2012), restricted forms derived from a macroeconomic model (Evans, 1987a), simple or structural VARs (Dai and Philippon, 2006) or narrative approaches (Ramey and Shapiro, 1998) are used in estimation. In addition, a range of different measures of fiscal policy have been used and are theoretically plausible. These include stock variables such as the debt-to-GDP ratio or flow variables such as the budget deficit relative to GDP (see Peppel-Srebrny, 2017), and their current or projected values or the unexpected component of changes. The debt ratio comes in gross or net form, the latter involving the subtraction of government *financial* assets only.

The results from research across all dimensions mentioned above have not been fully conclusive. Indeed, in the case of studies focussing on an individual country in particular, results have ranged from finding significant effects of fiscal policy[4] – measured in various ways – to finding none at all[5]. However, our understanding of the reasons for the apparent inconclusiveness has improved (Gale and Orszag, 2003)[6] and – in spite or perhaps because of the alleged inconclusiveness – this literature has seen renewed interest in recent years, in particular with the European sovereign debt crisis raising the spectre

[4]Feldstein (1986) for the US; Canzoneri et al. (2002) for the US in reduced forms and in a structural VAR using both the actual deficit and projections of the deficit; Laubach (2009) for the US.

[5]Evans (1987b) for the US and Evans (1987a) for six developed countries separately; Plosser (1987) using a VAR for the US; Barro and Sala-i Martin (1990) for world real interest rates; Engen and Hubbard (2005) for the US when relating yields to contemporaneous measures of fiscal policy.

[6]Gale and Orszag (2003) find that studies that do not identify significant effects of fiscal policy typically do not use both long-term and short-term interest rates in their analysis. This is in line with the finding of Dai and Philippon (2006) that inflation and the output gap can typically account for changes in the short-term interest rate, but leave some dynamics of the long-term rate unexplained, which in turn can be explained by fiscal policy.

of sovereign default again even in developed countries. This recent literature generally finds that more expansionary fiscal policy tends to raise long-term interest rates, but that effects are relatively small: most suggest that the effect of a one-percent increase in the debt ratio on the level of the yield in basis points is in the lower single digits (for example, Ardagna et al., 2007; Gruber and Kamin, 2012; Laubach, 2009).

Overall, as far as we are aware, no serious attempts have been made in this literature to consider fully the asset side of the government balance sheet, which is reflected in the level of or change in total government assets relative to national income. Kinoshita (2006) and Gruber and Kamin (2012) use net debt – that is, government gross liabilities less government *financial* assets – to reflect the fiscal policy stance, but do not discuss the implications of using this measure instead of a gross one.[7] Faini (2006) argues that it would be preferable to account for government total assets, but does not do so. Taking into account the (complete) asset side of the balance sheet in addition to regular stock measures of indebtedness provides an insightful perspective on the reasons behind rising or falling government debt, and financial markets' perceptions of these reasons. This paper hence adds to the existing literature by explicitly considering these reasons. To do so, we make use of a novel dataset recently published by Piketty and Zucman (2014), which has not been used previously in this type of analysis. It provides historical time series on government assets and liabilities, for the first time assembling valuations of both sides of governments' balance sheets using a consistent methodology for several countries and going back far in time.

2.2 In theory

Fundamentally, by the expectations hypothesis of the term structure of interest rates, the long-term nominal interest rate reflects expectations of future short-term nominal interest rates over the maturity horizon of the long rate. However, the empirical fact that yield curves typically slope (more or less) upwards – which, by this view of the world, implies that short-term interest rates are expected to rise indefinitely – suggests that we need to additionally allow for the presence of a (time-varying) term premium (Gürkaynak and Wright, 2012).

Textbook macroeconomic models tend to concern themselves with the impact of changes in government spending on short-term interest rates, and are discussed in more detail in Peppel-Srebrny (2017). The dominant prediction from these models appears to be that fiscal expansions lead to higher interest rates, even when varying assumptions across a large number of modelling dimensions (Fatás and Mihov, 2001; Gale and Orszag, 2003). By the expectations hypothesis, effects on short-term interest rates will feed through to long-term interest rates to the extent that fiscal policy changes are perceived as being persistent.

The term premium is thought to reflect perceptions of default risk and inflation risk over the time horizon until maturity. Sovereign default risk is generally presumed to rise when fiscal policy becomes more expansionary, as reflected in, say, higher current debt

[7]Note that based on Piketty and Zucman (2014) data, government financial assets typically only account for between 20% (US) and 50% (Canada) of total government assets.

levels relative to GDP or national income (Alesina et al., 1992; Ardagna et al., 2007; Laubach, 2010). The default risk premium should be related to the expected loss in case of default, which is determined by the probability of default times the exposure at default. As a bank would do when setting the mortgage rate for an individual purchasing a property – comparing assets, the value of the property and the downpayment in cash, to liabilities, the magnitude of the loan required – it seems plausible that in case of governments, too, the asset side of the balance sheet matters in an evaluation of default probabilities.[8] Hence, we would expect that a stronger government balance sheet – as reflected in higher assets, ceteris paribus – should mean that a given increase in debt raises the probability of default by less. Higher government assets may also reduce default probabilities to the extent that government asset accumulation increases growth potential (Durlauf et al., 2005), since higher current or expected future economic growth makes current debt levels more sustainable. Finally, an increase in government (liquid) assets may also reduce the probability of default directly, since these could be sold off in case of fiscal liquidity problems, or, in the same way, reduce exposure at default. Thus, the default risk channel suggests that an increase in government debt that is accompanied by asset accumulation leads to a smaller increase in interest rates than one that is not or, equivalently, that the coefficient on our measure of assets – in a regression with the bond yield as the dependent variable – is expected to be negative.

The inflation risk channel instead reflects the possibility that governments will attempt to monetise their debt through inflation (Gruber and Kamin, 2012; Gürkaynak and Wright, 2012).[9] However, insofar as any increase in government assets that accompanies a rise in debt adds to the economy's productive capacity, it should simultaneously reduce pressure on current and expected future inflation. Hence, investor expectations about the level of or change in government assets over the time horizon from today until the maturity of the bond should affect the magnitude of the inflation risk premium. Given the available data and its stationarity properties, in estimation, these expectations may be proxied by the change in the stock of assets from year $t-1$ to year t. Hence, inflation risk considerations also suggest that the coefficient on assets should be negative.

Based on the preceding discussion, this analysis thus asks whether, in a regression of the government bond yield on fiscal policy measures and controls, (i) when included jointly with gross liabilities, the coefficient on government assets is negative ("asset effect"), and (ii) more strongly, the coefficients on assets and liabilities are statistically equal in absolute terms, which would suggest that the effects of both assets and liabilities are summarised by the inclusion of government net worth ("net worth effect").

[8] However, note that in contrast to most mortgages, government debt is typically unsecured.

[9] A closely related channel, in an open economy context, works via expected depreciation (Ardagna et al., 2007). Since joining a currency union and relinquishing monetary control means that monetising one's debt is no longer possible, joining the Euro area might lower inflation risk while increasing perceived default risk of a country's government bonds (Bernoth et al., 2004).

3 Panel data evidence for OECD countries

This section explores the presence of an "asset effect" and a "net worth effect" as introduced in Section 2.2 in a panel regression setting. Available data on government balance sheets covers 10 OECD countries over recent decades. We confirm the presence of both types of effect, finding that the central country-specific fiscal factor driving bond yields and hence government borrowing costs appears to be government net worth rather than government liabilities. Section 3.1 introduces the data used in our analysis. Time series properties and model specification are discussed in Section 3.2. Our main results for the OECD panel are presented in Section 3.3.

3.1 The data

The sample used for analysis here covers 10 highly developed and stable OECD countries, specifically Australia, Canada, Denmark, France, Germany, Japan, the Netherlands, Sweden, the United Kingdom and the United States, over a maximum time span from 1990 to 2014.[10] It combines government balance sheet data from Piketty and Zucman (2014) and interest rate and macroeconomic data from the OECD, IMF and Eurostat at annual frequency. Government refers to "general government", which includes central, local and state government and social security funds.[11,12] Focussing on this relatively recent period has some important advantages. For one thing, financial liberalisation in the 1980s, particularly the abolition of capital controls, may have changed the relation between government bond yields and domestic fiscal variables. Furthermore, the relationship in more recent times is likely to provide more relevant evidence for current debates about the effects of fiscal policies. Finally, focussing on data after 1990 means we avoid structural breaks in the data for Germany as a result of reunification.

As the dependent variable, the 10-year constant-maturity nominal government bond yield is used, as is standard in the relevant literature (for example, Ardagna et al., 2007; Gruber and Kamin, 2012; Afonso et al., 2015). This is the average rate at which debt with an outstanding maturity of around 10 years is trading on secondary markets during the year of interest, or can equivalently be interpreted as a yearly average of readings of the government's yield curve at the 10-year mark. Figure 3 in the Appendix displays the cross-section average of 10-year government bond yields together with individual-country yields for the panel since 1990. It clearly illustrates both a substantial degree of comovement and a significant downward trend in yields. How these issues are addressed econometrically is discussed below. Note that because we generally include in estimation

[10] Note that the sample does not include countries that were directly affected by the recent sovereign debt crisis.

[11] This is to be distinguished from the definition of "public sector", which additionally includes public financial and non-financial corporations (2008 SNA, ESA 2010). This distinction is discussed in more detail in the Online Data Appendix.

[12] Government balance sheet data is also available for the Czech Republic, but is not included here due to the very different historical context in which the Czech Republic found itself in the 1990s compared to the other 10 countries included in our sample. However, results are robust to the inclusion of the Czech Republic.

a set of year fixed effects to account for the common component of this trend, we are effectively using the cross-sectionally demeaned bond yield in country i as the dependent variable.

Data on government balance sheet items is drawn from Piketty and Zucman (2014), who aggregate into a comprehensive dataset historical series on the balance sheets of all sectors of the economy, which many national statistical agencies have published retrospectively.[13] A multitude of measurement and valuation issues remain, ranging from valuing intangible capital to non-listed state-owned enterprises, which Piketty and Zucman discuss in detail in the Data Appendix to their 2014 paper and we summarise in our Online Data Appendix. Notwithstanding, this data provides, to our knowledge, the best available information on government balance sheets that is comparable across time – and, to an extent, across space – and has not been used before to address the question at hand. In particular, we use total assets (GTA) and total liabilities (GLI) held by general government, both measured at market value in percent of national income in the analysis. Government total assets comprise non-financial assets such as buildings and roads as well as financial assets such as currency and deposits, loans, bonds, shares and other equity (see the Online Data Appendix for details).[14]

Three points regarding the scope of the general government balance sheet are worth noting. First, because, in principle, the general government sector includes social security funds, the general government's balance sheet does include insurance and pension schemes, and hence, for example, pension fund reserves, if there are any.[15] However, government guarantees for pension schemes (for example, in unfunded or "pay as you go" schemes) are considered contingent liabilities, and are not recorded as liabilities in general government accounts (Eurostat, 2004). An interesting future line of research could be to use estimates of such contingent government liabilities in regressions of the type presented here. Second, the inclusion of public-private partnerships in government balance sheets depends on which sector is bearing the economic risks involved, and is discussed in more detail in the Online Data Appendix.[16] Third, government balance sheets do not include central bank balance sheets, so the effect of unconventional monetary policy on central banks' balance sheets is not reflected on the "general government" balance sheet.

As controls for macroeconomics conditions, in line with the literature, a short-term interest rate (specifically, the three-month interbank rate), the CPI inflation rate as well

[13] Piketty and Zucman (2014) do not provide new data as such, but aggregate and, at times, adjust data from national statistical sources in a manner that is consistent across time and space. Plausibly, bond markets thus had access to information about developments in government assets prior to the release of this dataset.

[14] Assets cannot be decomposed further into, say, more or less economically productive assets or more or less liquid assets using the Piketty and Zucman (2014) data, but worthwhile future research might attempt such decompositions building on national sources.

[15] How precisely pension schemes are included in the general government balance sheet depends on their type and on which party assumes the financial risk involved, and is discussed in more detail in the Online Data Appendix.

[16] As an aside, the United Kingdom's "private finance initiatives" are not included in the government balance sheet measures used here.

as the year-on-year rate of real economic growth are used. Table 8 in the Appendix provides summary statistics, units of measurement and sources.

3.2 Time series properties and model specification

In order to examine the stationarity properties of the series included in estimation, we use the Im et al. (2003; "IPS test") test, which estimates an augmented Dickey-Fuller equation for each variable and country. The resulting t-statistics are then averaged across countries, thus combining the results from N unit root tests performed on the data for N countries (Maddala and Wu, 1999). Series are cross-sectionally demeaned in testing in order to reflect the fact that all our main specifications include year fixed effects. Using the IPS test (2003), then, the levels of government assets, liabilities and net worth, in percent of national income, are found to be non-stationary, as Table 1 shows. For the first differences of these fiscal variables, measured in percent of national income, and for the levels of the long-term government bond yield, the short-term interest rate, the inflation rate and the real growth rate, the evidence is in favour of stationarity.[17] Note that, interestingly, both long- and short-term interest rate series are found to be non-stationary when they have not been cross-sectionally demeaned.[18]

Table 1: OECD panel: Testing for unit roots

Im, Pesaran and Shin (2003) test, p-values				
	Bond yield	*Short rate*	*Growth*	*Inflation*
Level	0.95	0.88	0.00	0.00
Level, demeaned	0.05	0.00	0.00	0.00
	Assets	*Liabilities*	*Net worth*	
Level	0.80	0.90	0.61	
Level, demeaned	0.92	0.17	0.09	
First difference	0.00	0.00	0.00	
First diff., demeaned	0.00	0.00	0.00	

All fiscal variables are expressed as shares of national income. Lag length selection by AIC. Null hypothesis: all panels contain units roots. "Demeaned": series are cross-sectionally demeaned.

[17] Fiscal variables are measured in percent of national income throughout this analysis. The first difference of these variables, accordingly, is the first difference of the relevant ratio, e.g., of liabilities to national income.

[18] This may, in part, explain why the evidence on the stationarity and cointegration properties of both fiscal variables and interest rates in the literature is extremely mixed, if rarely discussed in much detail. It has generated research that relates the two in $I(0)$ terms and research that relates the two in $I(1)$ terms (see Ardagna et al. (2007) for both). The conclusions from the IPS test are robust to different lag lengths. We reach similar conclusions regarding the stationarity properties of the data using other panel unit root tests, such as Pesaran's test (2004), although results here are more sensitive to the choice of lag length.

Hence, a valid regression set-up might relate (i) the bond yield to a linear combination of the levels of assets and liabilities, if the latter two are found to cointegrate, or (ii) the bond yield to assets and liabilities expressed in first differences, in both cases in a regression model in which year-specific fixed effects are included because – as mentioned above – we only find the bond yield and the short-term interest rate to be stationary when they are cross-sectionally demeaned, which the inclusion of these year fixed effects amounts to.

Irrespective of effects on the stationarity properties of these series, the inclusion of year fixed effects is crucial in order to capture common elements in bond yields across countries, and discussed further below. Since there is no robust evidence that the levels of assets and liabilities relative to national income are cointegrated (see Table 9 in the Appendix, using the Persyn-Westerlund (2008) or the Pedroni (1999) tests), we focus on a model that relates the bond yield to a set of stationary explanatory variables, which includes, most importantly, the first differences of government assets and liabilities, measured in percent of national income. This constitutes a departure from the existing empirical literature, which has typically specified year fixed effects and included the level of government debt relative to GDP or national income, though likely – at least in some cases – invalidly so. However, there is of course a close relationship between the first difference of government liabilities and the (non-primary) budget deficit/surplus, and the inclusion of a measure of the deficit in specifications of the type used here is ubiquitous in existing research (for example, Ardagna et al., 2007). The first difference of assets is related to the investment component of the budget deficit, although this would only be a close relationship if our measure of assets were limited to fixed assets. In any case, government investment expenditure has not typically been considered separately in this type of literature (for this, see Peppel-Srebrny, 2017).

We employ the following reduced-form regression model to investigate the effects of government balance sheet components on government bond yields for a panel of OECD countries:

$$y_{i,t} = \alpha_i + \beta \Delta F_{i,t} + \gamma C_{i,t} + \delta_t + \varepsilon_{i,t} \tag{1}$$

The dependent variable $y_{i,t}$ is the long-term bond yield. α_i is a country-specific fixed effect, which controls for time-invariant unobserved characteristics of country i that affect its borrowing cost, such as the quality of its fiscal institutions and governance (Grauwe and Ji (2013)). $\Delta F_{i,t}$ is a vector of stationary fiscal policy variables of interest, while $C_{i,t}$ is a vector of stationary controls for current economic conditions. $\Delta F_{i,t}$ includes total government liabilities ($\Delta GLI_{i,t}$), total government assets ($\Delta GTA_{i,t}$), and/or government net worth ($\Delta GNW_{i,t}$), all measured in percent of national income and expressed in first differences to ensure regression balance. As mentioned previously, the term "first differences" here applies to the ratios of fiscal variables relative to national income, so that if we define any fiscal variable $X_{i,t}$ relative to national income $Y_{i,t}$ as $\widehat{X}_{i,t} \equiv \frac{X_{i,t}}{Y_{i,t}}$, then its first difference is $\Delta \widehat{X}_{i,t} = \widehat{X}_{i,t} - \widehat{X}_{i,t-1} = \frac{X_{i,t}}{Y_{i,t}} - \frac{X_{i,t-1}}{Y_{i,t-1}}$. $C_{i,t}$ includes the short-term interest rate ($ISN_{i,t}$), the inflation rate ($CPI_{i,t}$), the real growth rate ($GROWTH_{i,t}$) and a dummy for Euro area membership ($EURO_{i,t}$), which is equal to 1 from the year in which country i adopted the Euro onwards. δ_t is a year-specific fixed

effect, accounting principally for the common long-term downward trend in bond yields. $\varepsilon_{i,t}$ is the error term.

Based on the findings of the existing literature, the sign of the coefficient on liabilities should be positive: more expansionary fiscal policy tends to be associated with higher government bond yields or perceived sovereign risk. Under the assumption of the presence of default risk and inflation risk channels in the term premium component of government bond yields, the sign of the coefficient on assets should be negative (termed "asset effect" above). As regards the controls, the sign of the coefficient on the growth rate is ambiguous. On the one hand, higher current growth may suggest higher future growth and hence higher inflation expectations, while it also makes, ceteris paribus, any given level of indebtedness today more sustainable and thus reduces default risk. The short-term interest rate and the inflation rate should both affect the long-term yield positively when included separately, but might be capturing related information and thus might not both be significant when included jointly. Finally, the effect of Eurozone membership on domestic bond yields is also ambiguous – joining the Euro might be perceived to entail the presence of a credible lender of last resort, but also to involve the surrender of monetary autonomy and thus the ability to monetise debt (Bernoth et al., 2004).

Identification of the effects of government balance sheet variables on government bond yields is achieved in this reduced-form approach if sources of potential endogeneity of fiscal policy variables – including simultaneity with respect to the cycle or with respect to institutional factors, and reverse causation – can be dealt with appropriately. These are discussed in more detail in Peppel-Srebrny (2017). In particular, controls for the state of the cycle are included and results are checked for robustness by including measures of time-varying institutional factors that might affect both the yield and fiscal policy.[19]

Finally, since there is evidence of cross-section dependence and serial correlation in the error terms from central specifications, we generally report Driscoll-Kraay (1998) standard errors, which are robust in the presence of heteroskedasticity, serial correlation and a range of forms of cross-section dependence.[20]

3.3 Results

Table 2 presents results from estimating a model of the type introduced in Equation 1 on data for a panel of 10 OECD countries over a time span from 1990 to 2014. The dependent variable is the annual average of the 10-year government bond yield.

[19]The application of instrumental variable methods – an appropriate methodology to address the potential scope for endogeneity – in the absence of plausible external instruments is complicated by the fact that there is little persistence in the first differences of government balance sheet series, so that lags of first differenced fiscal variables are weak instruments for their contemporaneous values.

[20]Based on results from the Pesaran test (2004) for cross-section dependence and the Arellano-Bond test (1991) for serial correlation, applied to specifications in Table 2. There is typically evidence of no more than second-order serial correlation. Standard errors are always adjusted to reflect the highest order of serial correlation present in residuals from each specification. The conclusions of our analysis are unaffected by using White, Newey or clustered standard errors instead.

Table 2: OECD panel: Baseline results

Dep. var.: gov. bond yield		**Including assets**		
	(1)	(2)	(3)	(4)
Liabilities (Δ_t)	1.776**	2.218**	0.369	
	(0.824)	(0.864)	(0.387)	
Assets (Δ_t)		-1.850**		
		(0.872)		
Net worth (Δ_t)			-1.850**	-2.046**
			(0.872)	(0.876)
Short-term interest rate	0.347***	0.351***	0.351***	0.352***
	(0.029)	(0.029)	(0.029)	(0.030)
Inflation rate	0.050**	0.042	0.042	0.039
	(0.021)	(0.027)	(0.027)	(0.025)
Real growth rate	0.043**	0.026**	0.026**	0.021***
	(0.015)	(0.011)	(0.011)	(0.007)
Eurozone dummy	0.409***	0.410***	0.410***	0.410***
	(0.135)	(0.128)	(0.128)	(0.127)
Test $\mid \beta_{\text{Assets}} \mid = \mid \beta_{\text{Liabilities}} \mid$, p-value		0.35		
R-squared	0.777	0.799	0.799	0.799
Observations	209	209	209	209

Notes: Significance levels are denoted as * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is the annual average of the 10-year government bond yield. Driscoll-Kraay standard errors are reported in brackets below coefficient estimates. OLS with country and year fixed effects. R2 is adjusted to exclude the impact of year fixed effects. All fiscal variables are in shares of national income.

Column (1) replicates a specification that is common – in spirit[21] – in the existing literature, where the fiscal stance is reflected by government liabilities, in percent of national income. It confirms the commonly found small but statistically significant effect of higher government debt in increasing borrowing cost, as in Ardagna et al. (2007) or Gruber and Kamin (2012), for example.[22] Column (2) contains one of our key results of interest: when government assets are included jointly with liabilities, both affect the bond yield significantly, with effects working in opposite directions. The absolute values of these two coefficients are similar in magnitude, and a Wald test of the hypothesis that they are equal does not reject this restriction. Another way of testing this restriction in presented in Column (3), which includes both government liabilities and net worth: it is government net worth that matters, rather than liabilities, when both are included. These results imply that an increase in government debt that is entirely due to government asset accumulation should leave bond yields unaffected. Columns (2) and (3) thus suggest the presence of both an "asset effect" as well as a "net

[21]Here and subsequently, all balance sheet variables are included in first differenced terms – in this respect only, this specification is uncommon in the existing literature.

[22]An increase in assets, liabilities or net worth, relative to national income, by one percentage point would affect yields by about 2 basis points, based on Table 2.

worth effect", as stipulated in Section 2.2: government assets matter, and the effects of both assets and liabilities are summarised by the inclusion of government net worth. The restriction that assets and liabilities enter with coefficients that are equal in absolute magnitude is thus empirically appropriate and is imposed in column (4) by including government net worth, which enters negatively and significantly. Interestingly, after controlling for government balance sheet variables and macroeconomic fundamentals, for this set of highly stable countries, Eurozone membership appears to increase yields significantly. Overall, results suggest that in evaluating governments' fiscal stances, bond markets look beyond simple measures of indebtedness such as total liabilities and consider their underlying reasons, as evidenced in the government's asset and net worth positions.

Table 3 assesses the robustness of these findings. Columns (1) and (2) ask whether our findings are driven by unusual developments during the recent crisis. Column (1) demonstrates that our main result of interest is also present on the pre-crisis (pre-2008) sample. Column (2) adds a dummy for crisis years, equal to 1 for the 2008 to 2012 period, and includes those interaction effects between this indicator and fiscal variables that are significant.[23] Increases in liabilities appear to be met with significantly more suspicion during crisis years. Column (3) includes a measure of the political leaning of the government in power – specifically, the share of left-leaning parties in government[24] – with the aim of controlling for at least part of time-varying institutional characteristics that might cause simultaneity. The measure enters positively and significantly, suggesting, perhaps, that some ideological factors are present in bond market pricing for these countries and years. Results are robust, as we continue to find a significant negative coefficient on assets, and do not reject the restriction that it is government net worth that matters for explaining bond yields. Column (4) uses the fourth-quarter average of the long-term bond yield as the dependent variable, in an attempt to match investors' information sets more closely, since information about fiscal stock measures in year t tends to be released in final form toward the end of the year in question, or even after. Results are unaffected. Column (5) investigates the possibility that our results are driven by the United States, for which we identify strong "asset" and "net worth" effects in the following section. Results are robust for the subsample excluding the United States. Columns (6) to (8) explore the possibility that results are driven by specific developments in Euro area countries, where government bond yields converged strongly after the introduction of the Euro. Column (6) excludes Euro area countries (France, Germany and the Netherlands) during the period from 1998 to 2007, while Column (7) fully excludes these countries from 1998 onwards. Column (8) focusses on Euro area countries from 1998 onwards only.[25] Results are robust, although the coefficient equality between assets and liabilities is rejected in column (8), with more importance being accorded to liabilities than assets (but note the very small sample size here). Thus, although Euro area countries differ from other countries due to the

[23]Results are robust to letting the crisis last until 2014 (end of the sample period).

[24]It measures the cabinet posts of social democratic and other left parties as a percentage of total cabinet posts, weighted by number of days in office (Armingeon et al., 2015), ranging from 0 to 100%.

[25]Results are unaffected when treating Denmark as an "honourary" EA member. The short-term interest rate is equal across Euro area countries from the introduction of the Euro area onwards and hence not included in column (8).

Table 3: OECD panel: Robustness

Dep. var.: gov. bond yield	**Pre-crisis sample**	**Crisis interaction**	**Political factors**	**Q4 yield (dep. var.)**	**Excl. US**	**Excl. EA 1998-2007**	**Non-EA obs.**	**EA obs.**	**By asset type**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Assets (Δ_t)	-2.381**	-2.005**	-1.884*	-1.661*	-2.055*	-1.837*	-2.642**	-1.155***	
	(0.964)	(0.877)	(0.980)	(0.869)	(1.005)	(0.988)	(0.989)	(0.293)	
Financial assets (Δ_t)									-1.422*
									(0.741)
Non-financial assets (Δ_t)									-2.453*
									(1.293)
Liabilities (Δ_t)	1.840**	1.530	2.182**	2.132**	1.560**	2.195**	2.359**	2.772***	2.130**
	(0.789)	(1.107)	(0.951)	(0.774)	(0.695)	(0.907)	(0.903)	(0.875)	(0.810)
Liabilities (Δ_t) × Crisis dummy		3.186***							
		(0.766)							
Short-term interest rate	0.308***	0.346***	0.350***	0.354***	0.358***	0.353***	0.355***		0.351***
	(0.018)	(0.028)	(0.027)	(0.026)	(0.040)	(0.023)	(0.028)		(0.029)
Inflation rate	0.027	0.044	0.046*	0.005	0.031	0.037	0.032	0.053*	0.043
	(0.021)	(0.029)	(0.025)	(0.032)	(0.031)	(0.033)	(0.031)	(0.030)	(0.026)
Real growth rate	0.000	0.022**	0.024**	0.016	0.018	0.033***	0.021*	0.004	0.024**
	(0.013)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.008)	(0.010)
Eurozone dummy	0.396***	0.383***	0.391***	0.282**	0.505***	0.505***			0.413***
	(0.112)	(0.121)	(0.137)	(0.136)	(0.133)	(0.105)			(0.121)
Eurozone dummy × Crisis dummy		0.124**							
		(0.051)							
Left-wing share of gov.			0.140***						
			(0.033)						
Test | β_{Assets} |=| $\beta_{\text{Liabilities}}$ |, p-value	0.53	0.31/0.15[1]	0.44	0.32	0.42	0.37	0.44	0.03	0.14/0.71[2]
R-squared	0.807	0.830	0.795	0.747	0.812	0.795	0.775	0.243	0.799
Observations	156	209	205	209	189	179	163	46	209

Notes: Significance levels are denoted as * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is the annual average of the 10-year government bond yield except where noted otherwise. Driscoll-Kraay standard errors are reported in brackets below coefficient estimates. OLS with country and year fixed effects. R2 is adjusted to exclude the impact of year fixed effects. All fiscal variables are in shares of national income. For tests of coefficient equality, in absolute terms: 1 The first p-value refers to the test involving liabilities in non-crisis times; the second to that involving liabilities in crisis times. 2 The first p-value refers to the test involving financial assets; the second to that involving non-financial assets.

introduction of the common currency, our central result of interest – the relevance of both sides of the government balance sheet for bond yields – is not driven by Euro area-specific developments. Finally, column (9) decomposes total assets into financial and non-financial assets, both of which appear to be contributing to the overall effect of assets in decreasing yields.[26] Note that we do not reject the restriction that the coefficients on assets and liabilities are equal in absolute magnitude in Columns (1) to (7) of Table 3, and that results are robust to including net worth instead of assets and liabilities separately, as Table 10 in the Appendix shows.[27]

Finally, in Table 11, we confirm the robustness of our central findings to the replacement of year fixed effects with the cross-sectional mean of the dependent variable. The inclusion of year fixed effects has so far served to capture a common, non-stationary component in bond yields across countries. We replace these year fixed effects with the mean of the dependent variable, for the remaining nine countries in the sample (excluding country i itself), in order to enhance the comparability of the panel regression model employed here to a time series model for the United States (presented next), in which we cannot include year fixed effects, but are able to include a cross-sectional mean bond yield from a set of comparable countries. Conclusions are unaffected.

Overall, our analysis of the data for this set of OECD countries suggests that the central country-specific fiscal factor driving bond yields is government net worth, as markets look beyond simple measures of indebtedness, such as the gross debt ratio, in evaluating a country's fiscal stance.

4 Time series evidence for the United States

This section extends the analysis of the effects of both sides of the government balance sheet from a panel setting to a long-term time series setting. Data on government liabilities and assets is available for the United States from 1870 to 2010 from Piketty and Zucman (2014), as is data on long-term bond yields from Jorda et al. (2017), which renders possible a similar analysis for the United States to the one conducted for a panel of OECD countries above. The data used in the analysis here are introduced in Section 4.1. Section 4.2 discusses time series properties and the model we employ. Section 4.3 presents our main results for the United States over the long term.

4.1 The data

The sample used for analysis here covers the United States over the period from 1870 to 2010. The dependent variable is, as above, the 10-year nominal government bond yield,

[26]The Online Data Appendix discusses how this distinction is made. The restriction that both types of assets affect bond yields equally is not rejected, with a p-value of 0.32.

[27]We also investigated dynamic models that include the lagged dependent variable, and found that the long-run effects of fiscal variables were very similar to those estimated in the static model reported here. Worthwhile future research might explore the roles of the public pension system and its liabilities, index-linked government debt, the share of externally held debt and the maturity of outstanding debt for government bond yields.

drawn from Jorda et al. (2017). Figure 4 in the Appendix displays the United States' long-term bond yield over the 1870-2010 period, and clearly shows a substantial decline in the yield since the 1980s. Note that we generally include as an explanatory variable the mean of a set of comparable countries' bond yields, also drawn from Jorda et al. (2017), in order to achieve the comparability of estimation approaches across the panel regression analysis presented above and the time series analysis presented here.[28] This is discussed in more detail in Section 4.2 below.

Data on government balance sheet items for the United States is again drawn from Piketty and Zucman (2014). As above, we use total assets (GTA) and total liabilities (GLI) held by general government relative to national income at market value in the analysis. Figure 5 in the Appendix displays total assets, total liabilities and net worth (GNW) – total assets less total liabilities – in percent of national income from 1870 to 2010. Short-term interest rate and macroeconomic data – specifically, a short-term rate for surplus funds, the CPI inflation rate and real growth rate – come from Jorda et al. (2017) and Piketty and Zucman (2014) and are used as controls for cyclical conditions, in line with the literature. Table 12 in the Appendix provides units, summary statistics and sources for included variables.

4.2 Time series properties and model specification

The conclusions reached regarding the time series properties of relevant series for the United States over the 1870 to 2010 period are comparable to the ones reached for the much shorter panel.

As before, the levels of government assets, liabilities and net worth, measured in percent of national income, are found to be non-stationary, as Table 4 shows. Once again we do not find robust evidence that assets and liabilities are cointegrated, as Table 13 in the Appendix shows.[29] For the first differences of government assets, liabilities and net worth, measured in percent to national income, and for the inflation rate and the real growth rate, the evidence presented in Table 4 is clearly in favour of stationarity. Long- and short-term interest rates are found to be non-stationary, but, importantly, cointegrated with a cross-sectional mean bond yield – constructed using data from Jorda et al. (2017) for a set of comparable countries – as Table 14 in the Appendix shows. The inclusion of this mean bond yield can be interpreted as an attempt to control for the cross-country common non-stationary component of the yield, which is achieved by the inclusion of year fixed effects (or a cross-sectional mean yield, as per Table 11) in the panel setting above.

[28] Jorda et al. (2017) typically source data on long-term government bond yields from various national sources for the period before 1948, and from the IMF's International Financial Statistics after, where in turn annual averages of secondary market rates for 10-year bonds are usually reported for the countries in question here. Thus, in recent decades at least, comparability to the bond yield series used in the panel analysis above is high.

[29] As mentioned above, fiscal variables are measured in percent of national income throughout this analysis. The first difference of these variables, accordingly, then is the first difference of the relevant ratio, e.g., of liabilities to national income.

Table 4: United States: Testing for unit roots

Augmented Dickey-Fuller test, p-values				
	Bond yield	*Short rate*	*Mean yield**	*Growth*
Level	0.49	0.25	0.72	0.00
	Assets	*Liabilities*	*Net worth*	*Inflation*
Level	0.60	0.61	0.06	0.00
First difference	0.00	0.00	0.00	

The test includes a constant. Lag length selection by AIC. Null hypothesis: the series contains a unit root. *A mean yield constructed from 14 comparable countries using data from Jorda et al. (2017)

Hence, a valid regression approach could relate the bond yield to this mean yield, the short-term interest rate and the fiscal variables expressed in first differences. Thus, we are able to apply a regression model in the time series context here that corresponds very closely to the one used in the panel analysis above.[30]

We employ the following reduced-form regression model to investigate the effects of government balance sheet components on government bond yields for the United States over the long term:

$$y_t = \alpha + \beta \Delta F_t + \gamma C_t + \delta \overline{z}_t + \varepsilon_t \tag{2}$$

Analogously to the model estimated in the previous section, the dependent variable is the long-term bond yield (y_t), while α is a constant, ΔF_t a vector of stationary fiscal policy variables, and C_t a vector of controls for current economic conditions. ΔF_t again includes total government liabilities (ΔGLI_t), total government assets (ΔGTA_t), and/or government net worth (ΔGNW_t), all measured in percent of national income and expressed in first differences, while C_t again includes a short-term interest rate (ISN_t), the inflation rate (CPI_t) and the real growth rate ($GROWTH_t$). $\overline{z}_t$ is the mean bond yield constructed from a set of comparable countries over the 1870 to 2010 period. The rationale for the inclusion of $\overline{z}_t$ is that it captures a common component in interest rates across countries. β, γ and δ are (vectors of) coefficients, and ε_t is the error term.

Finally, for central specifications, the Breusch-Godfrey test and Durbin's alternative test both indicate a high, but not unlimited order of serial correlation in the error term.[31]

[30]Data on a range of other macroeconomic variables, but not government assets, is available from Jorda et al. (2017). The data used here are long-term interest rates for Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Switzerland and the United Kingdom. The United States are excluded, as are Spain and Portugal, since interest rate series in the latter two follow markedly long-term different trends than in the other countries included. Conclusions are robust to using a mean in which the United States series is included in addition, and to using a mean from which Germany is excluded.

[31]For some of the specifications in Table 5, there is evidence of up to twelfth order serial correlation. Standard errors are adjusted accordingly.

There is also evidence of heteroskedasticity in residuals. Hence, we generally use and report Newey-West (1987) standard errors, which are robust in this context.

4.3 Results

Table 5 presents results from estimating a model of the type introduced in Equation 2 on data for the United States from 1870 until 2010. The dependent variable is the long-term bond yield. Column (1) confirms, for the United States over the long term, an effect of the type and magnitude commonly found in the literature – for example, in Engen and Hubbard (2005) or Laubach (2009) for the United States – and also identified for the OECD panel in Section 3.3 above. Ceteris paribus, increasing government liabilities tend to be associated with significantly higher bond yields.[32]

Table 5: United States: Baseline results, full sample

Full sample		**Including assets**			
Dep. var.: gov. bond yield	(1)	(2a)	(2b)	(3)	(4)
Liabilities (Δ_t)	2.097*	3.725**	4.068**	-0.914	
	(1.260)	(1.675)	(1.682)	(1.196)	
Assets (Δ_t)		-4.639**	-4.173*		
		(2.273)	(2.520)		
Net worth (Δ_t)				-4.639**	-3.897**
				(2.273)	(1.766)
Short-term interest rate	0.277***	0.290***	0.286***	0.290***	0.289***
	(0.061)	(0.065)	(0.066)	(0.065)	(0.064)
Real growth rate	0.000	-0.023	-0.025	-0.023	-0.018
	(0.012)	(0.014)	(0.017)	(0.014)	(0.012)
Inflation rate	0.000	0.005	0.007	0.005	0.003
	(0.019)	(0.016)	(0.019)	(0.016)	(0.017)
Mean bond yield	0.696***	0.686***	0.686***	0.686***	0.685***
	(0.071)	(0.066)	(0.068)	(0.066)	(0.065)
Year dummy, 1932			-1.011**		
			(0.399)		
Year dummy, 1946			-0.654*		
			(0.367)		
Test $\mid \beta_{\text{Assets}} \mid = \mid \beta_{\text{Liabilities}} \mid$, p-value		0.45	0.94		
R2	0.675	0.688	0.694	0.688	0.688
Observations	140	140	140	140	140

Notes: Significance levels are denoted as * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is the annual average of the 10-year government bond yield. Newey-West standard errors are reported in brackets below coefficient estimates. R2 adjusted to exclude the effect of the inclusion of the mean yield. All fiscal variables are in shares of national income.

[32] We depart from the literature by including liabilities in first differenced terms.

Furthermore, column (2a) shows that there are both an "asset effect" and a "net worth effect", as identified in the panel setting above: government liabilities matter, but government assets matter just as much: both enter with coefficients that are not statistically different in absolute magnitude. Column (2b) confirms that this finding is not driven by the pronounced spikes in assets and liabilities in 1932 and 1946. These reflect the Great Depression and the war economy and are "dummied out" here.[33] Column (3) also tests the presence of the "net worth effect", equivalently to column (2a), by including both government net worth, which enters significantly, and government liabilities, which enter insignificantly. Column (4) then imposes the (empirically appropriate) restriction that the coefficients on assets and liabilities are equal in absolute terms by including government net worth, which affects borrowing cost negatively and significantly.

Table 6 estimates the specifications reported in Table 5 on the postwar sample, to ensure that the effects identified are not an artefact of times long gone. Although the sample shrinks substantially, the central features of our results remain unaffected. Thus, we confirm the presence of both an "asset effect" and a "net worth effect" for the United States during the postwar period as well as over a longer horizon, analogously to those identified for a panel of OECD countries in recent decades in the previous section. Interestingly, effects of government balance sheet variables for the United States, especially during the post-war period, are considerably larger in magnitude than those identified for the set of OECD countries. This might, in part, be due to the inclusion of year dummies or mean yields in all specifications, which, for OECD countries, might be picking up the effect of the United States' yield spilling over into domestic yields. This in turn might dilute the effects of domestic factors on domestic yields outside of the United States.

Table 7 assesses the robustness of these findings. Column (1) explores the effects of the recent financial crisis starting in 2008, by limiting the sample to the post-war pre-crisis period. Results are robust, in the sense that there is no statistically significant difference in the effects of government assets and liabilities, in absolute terms, on bond yields. Column (2) examines the role of financial crises over the past century in driving results, by including a crisis dummy and those interaction terms between explanatory variables and the dummy that enter significantly.[34] The effects of both sides of the government balance sheet, but of liabilities in particular, appear to be magnified during financial crises. This suggests that – not surprisingly perhaps – bond markets perceive there to be a link between sovereign risk and financial crises.

[33]Conclusions from formal tests for structural breaks and coefficient instability depend on the method used. Results from a Quandt Likelihood Ratio statistic ("QLR test"; Quandt, 1960) are sensitive to the extent of trimming. Based on coefficient estimates from recursive regressions, 1929, 1933, 1945, 1946, 1980 and 2007 suggest themselves as possible break years, and the null hypothesis of coefficient stability is rejected at each of these years except 1980. Results are qualitatively robust – as regards the signs and significance of government assets and liabilities – to allowing coefficients to take different values before and after these years and to including dummy variables for these years.

[34]This dummy is the systemic financial crisis indicator by Jorda et al. (2017), which is equal to 1 in 1873, 1893, 1907, 1929, 1984 and 2007. We experimented with additionally including the early 1930s and 2008 as crisis years, but results were unaffected.

Table 6: United States: Baseline results, postwar sample

Postwar sample		**Including assets**		
Dep. var.: gov. bond yield	(1)	(2)	(3)	(4)
Liabilities (Δ_t)	10.440***	11.883***	2.482	
	(3.426)	(2.894)	(5.025)	
Assets (Δ_t)		-9.401**		
		(4.289)		
Net worth (Δ_t)			-9.401**	-10.907***
			(4.289)	(2.362)
Short-term interest rate	0.433***	0.488***	0.488***	0.498***
	(0.073)	(0.068)	(0.068)	(0.064)
Real growth rate	0.065	0.001	0.001	-0.021
	(0.047)	(0.052)	(0.052)	(0.027)
Inflation rate	-0.005	0.041	0.041	0.045
	(0.067)	(0.048)	(0.048)	(0.045)
Mean bond yield	0.467***	0.405***	0.405***	0.409***
	(0.110)	(0.095)	(0.095)	(0.094)
Test $\mid \beta_{\text{Assets}} \mid = \mid \beta_{\text{Liabilities}} \mid$, p-value		0.62		
R2	0.878	0.899	0.899	0.898
Observations	64	64	64	64

Notes: Significance levels are denoted as * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is the annual average of the 10-year government bond yield. Newey-West standard errors are reported in brackets below coefficient estimates. R2 adjusted to exclude the effect of the inclusion of the mean yield. All fiscal variables are in shares of national income.

Column (3) again deals with one potential source of time-varying unobservables – political factors – that may cause simultaneity by affecting both bond yields and fiscal variables. To control for this, we add a dummy variable that indicates whether the current president is leaning to the left or centre rather than to the right ideologically, sourced from Brambor et al. (2013).[35] This indicator enters insignificantly, in contrast to our findings for the OECD panel, and results are unaffected. Column (4) uses as the dependent variable the linear cointegrating combination of the bond yield, the mean bond yield from a set of comparable countries and the short-term interest rate, which leaves results unaffected.[36]

[35]This is not simply an indicator for whether the acting president is Democratic or Republican – both Democratic and Republican presidents are, at times, categorised as centrist rather than left or right wing, respectively.

[36]Results are also unaffected when "demeaned" versions of the bond yield and the short-term interest rate are used as dependent and control variables, respectively. "Demeaned" here means that a mean yield or mean short-term interest rate, using data from Jorda et al. (2017) and constructed for a set of comparable countries, has been subtracted from the original series. Furthermore, results are robust to whether or not the mean bond yield for a set of comparable countries used in all specifications actually includes the United States' yield or not. These results are available upon request.

Table 7: United States: Robustness

Dep. var.: gov. bond yield	**Post-war, pre-crisis**	**Crisis interaction**	**Political factors**	**Lin. coint. comb.**	**By asset type**
	(1)	(2)	(3)	(4)	(5)
Assets (Δ_t)	-12.789***	-4.477**	-4.535*	-4.383**	
	(4.524)	(2.233)	(2.389)	(1.993)	
Assets (Δ_t) $\times$ Crisis dummy		-14.578*			
		(7.597)			
Financial assets (Δ_t)					-5.399
					(4.391)
Non-financial assets (Δ_t)					-4.498
					(2.926)
Liabilities (Δ_t)	16.637***	3.541**	3.730**	3.508**	3.752**
	(5.135)	(1.577)	(1.707)	(1.413)	(1.569)
Liabilities (Δ_t) $\times$ Crisis dummy		38.606**			
		(17.039)			
Short-term interest rate	0.497***	0.333***	0.283***		0.290***
	(0.071)	(0.060)	(0.066)		(0.066)
Real growth rate	-0.008	-0.022	-0.022	-0.023	-0.023
	(0.052)	(0.017)	(0.015)	(0.014)	(0.015)
Inflation rate	0.085*	0.001	0.010	0.008	0.004
	(0.047)	(0.014)	(0.019)	(0.018)	(0.017)
Mean bond yield	0.325**	0.636***	0.684***		0.687***
	(0.123)	(0.057)	(0.068)		(0.073)
Crisis dummy		-0.885**			
		(0.346)			
Left-wing or centrist head of gov.			-0.113		
			(0.157)		
Test $\mid \beta_{\text{Assets}} \mid = \mid \beta_{\text{Liabilities}} \mid$[1]	0.43	0.38/0.00[2]	0.53	0.47	0.74/0.67[3]
R2	0.915	0.769	0.690	0.690	0.699
Observations	61	140	140	140	140

Notes: Significance levels are denoted as * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is the annual average of the 10-year government bond yield. Newey-West standard errors are reported in brackets below coefficient estimates. R2 adjusted to exclude the effect of the inclusion of the mean yield. All fiscal variables are in shares of national income. 1 p-values are reported. For tests of coefficient equality, in absolute terms: 2 The first p-value refers to the test involving assets and liabilities in non-crisis times; the second to that involving assets and liabilities in crisis times. 3 The first p-value refers to the test involving financial assets; the second to that involving non-financial assets.

Lastly, column (5) decomposes total government assets into financial and non-financial assets, both of which appear to be contributing to the overall effect of government assets in reducing yields.[37] Note that the restriction that the coefficients on government assets and liabilities are equal in absolute value is not rejected in the specifications displayed in columns (1) and (3) to (5), and all results presented are robust to including government net worth instead of assets and liabilities, as Table 15 in the Appendix demonstrates.

[37]The restriction that both asset types affect yields equally is not rejected, with a p-value of 0.88.

5 Conclusion

We provide evidence that the extent to which any increase in government debt is used to fund government asset accumulation, which is reflected in the asset side of the government balance sheet and government net worth, matters for government bond yields empirically. This is true both for a panel of OECD countries in recent decades as well as for the United States over the long term. Note that throughout the analyses presented here, we depart from existing research insofar as all government balance sheet variables are included in first-differenced rather than level terms in order to ensure regression balance.

Quantitatively, in our preferred specifications in both analyses, an increase in government debt that is solely due to government asset accumulation – for example, to finance a new railway – leaves yields unaffected. Thus, from the perspective of bond markets, not all government debt is created equal: markets discriminate between debt increases that are accompanied by government asset accumulation and those that are not. The central country-specific fiscal factor driving government bond yields – and hence government borrowing cost and fiscal sustainability – is government net worth rather than government liabilities.

Findings in this vein could have important policy implications. Our findings reflect a normative view on fiscal policy from the perspective of financial markets, but to the extent that this view is deemed pertinent, they speak against the imposition of indiscriminate brakes on the raising of additional government debt and suggest that fiscal austerity policies ought to focus on constraining government borrowing when it does not contribute to the accumulation of government assets.

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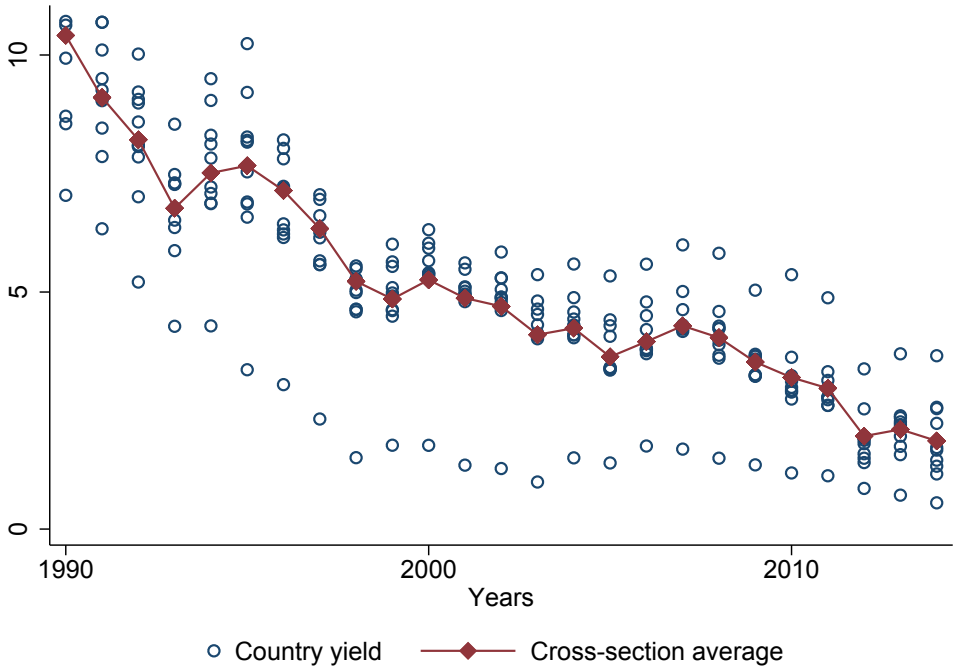
Appendix

A Additional tables, OECD panel analysis

Figure 3: OECD panel: Gov. bond yields, 1990-2014



In percent
Source: ECB, OECD, national banks

Table 8: OECD panel: Summary statistics for included variables

Variable	**Mean**	**St. dev.**	**Min.**	**Max.**	**N×T**
(1) Long-term bond yield (%)	4.82	2.14	0.72	10.69	209
(2) Short-term interest rate (%)	3.74	2.53	0.1	12.86	209
(3) Inflation rate (%, yoy)	1.92	1.36	-1.35	9.44	209
(4) Real growth rate (%, yoy)	1.21	2.62	-7.37	6.58	209
(5a) Liabilities, level (% of NI)	0.92	0.47	0.43	2.90	209
(5b) Liabilities, first diff. (% of NI)	0.02	0.06	-0.15	0.27	209
(6a) Assets, level (% of NI)	1.28	0.45	0.72	2.85	209
(6b) Assets, first diff. (% of NI)	0.01	0.05	-0.13	0.18	209
(7a) Net worth (% of NI)	0.36	0.33	-0.65	1.04	209
(7b) Net worth, first diff. (% of NI)	-0.01	0.06	-0.16	0.11	209

NI: national income. Sources: (1): BoJ, CNB, ECB, OECD; (2): Edvinsson (2014), Eurostat, IMF, OECD; (3): OECD; (4)-(8): Piketty and Zucman (2014) Countries included (10 in total): Australia, Canada, Denmark, France, Germany, Japan, Netherlands, Sweden, United Kingdom, United States.

Table 9: OECD panel: Cointegration – assets and liabilities

Coint. rel.: Assets and liabilities	**Test statistic**			
Persyn-Westerlund test (p-values)	G_τ	G_α	P_τ	P_α
(not bootstrapped)	0.64	0.91	**0.01**	0.08
Pedroni test (test statistics)	panel-v	panel-ρ	panel-t (np)	group-t (p)
(normally distributed under H0)	0.82	0.22	0.56	1.99

Null hypothesis: no cointegration. Entries in bold indicate rejection of the null hypothesis. For Persyn-Westerlund test, statistics are transformations of the error-correction parameter. G statistics are weighted averages of panel parameters; P statistics use pooled information. Lag length selection by AIC. In Pedroni test, cross-section dependence is allowed for, and statistics diverge to negative infinity, except panel-v. "np": non-parametric. "p": parametric.

Table 10: OECD panel: Robustness – net worth

Dep. var.: gov. bond yield	**Pre-crisis sample**	**Crisis interaction**	**Political factors**	**Q4 yield (dep. var.)**	**Excl. US**	**Excl. EA 1998-2007**	**Non-EA obs.**	**EA obs.**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net worth (Δ_t)	-2.013**	-1.399	-2.047**	-1.912**	-1.792**	-2.037**	-2.461**	-1.315***
	(0.741)	(1.254)	(0.968)	(0.821)	(0.757)	(0.956)	(0.897)	(0.320)
Net worth (Δ_t) × Crisis dummy		-2.367***						
		(0.742)						
Short-term interest rate	0.307***	0.348***	0.351***	0.355***	0.356***	0.353***	0.361***	
	(0.019)	(0.030)	(0.028)	(0.027)	(0.041)	(0.024)	(0.027)	
Inflation rate	0.032*	0.040	0.044*	0.000	0.035	0.038	0.036	0.044
	(0.016)	(0.026)	(0.024)	(0.030)	(0.027)	(0.029)	(0.028)	(0.028)
Real growth rate	0.008	0.018**	0.020**	0.010	0.024***	0.031***	0.026***	-0.015**
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)
Eurozone dummy	0.397***	0.386***	0.392***	0.283**	0.502***	0.532***		
	(0.113)	(0.122)	(0.137)	(0.135)	(0.132)	(0.132)		
Eurozone dummy × Crisis dummy		0.143***						
		(0.050)						
Left-wing head of gov.			0.141***					
			(0.033)					
R-squared	0.804	0.832	0.794	0.746	0.812	0.801	0.775	0.138
Observations	156	209	205	209	189	179	163	46

Notes: Significance levels are denoted as * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is the annual average of the 10-year government bond yield except where noted otherwise. Driscoll-Kraay standard errors are reported in brackets below coefficient estimates. OLS with country and year fixed effects. R2 is adjusted to exclude the impact of year fixed effects. All fiscal variables are in shares of national income.

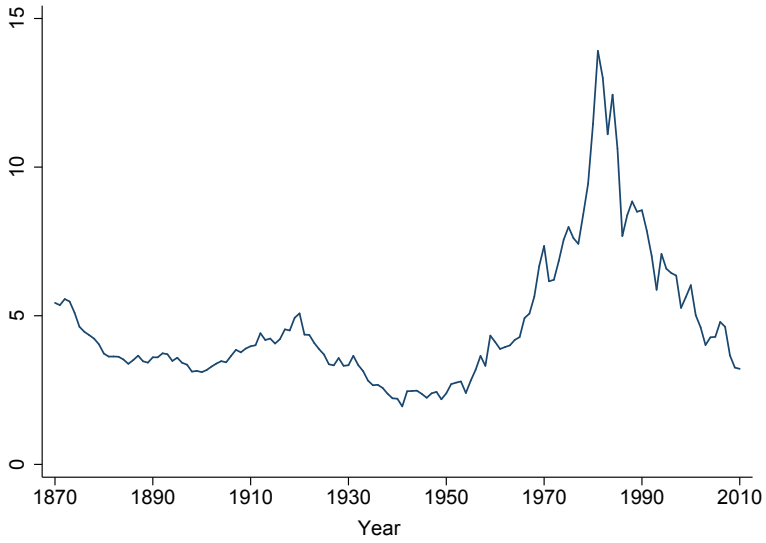
Table 11: OECD panel: Baseline incl. the mean dependent variable

Dep. var.: gov. bond yield		**Including assets**		
	(1)	(2)	(3)	(4)
Liabilities (Δ_t)	2.769**	2.981**	0.676	
	(1.180)	(1.168)	(0.694)	
Assets (Δ_t)		-2.305***		
		(0.777)		
Net worth (Δ_t)			-2.305***	-2.719**
			(0.777)	(0.984)
Short-term interest rate	0.267***	0.278***	0.278***	0.279***
	(0.031)	(0.028)	(0.028)	(0.028)
Inflation rate	0.029	0.009	0.009	0.003
	(0.036)	(0.037)	(0.037)	(0.041)
Real growth rate	0.046*	0.023	0.023	0.014
	(0.023)	(0.017)	(0.017)	(0.015)
Eurozone dummy	0.452***	0.468***	0.468***	0.464***
	(0.104)	(0.095)	(0.095)	(0.094)
Test $\mid \beta_{\text{Assets}} \mid = \mid \beta_{\text{Liabilities}} \mid$, p-value		0.34		
R-squared	0.777	0.799	0.799	0.799
Observations	209	209	209	209

Notes: Significance levels are denoted as * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is the annual average of the 10-year government bond yield. Driscoll-Kraay standard errors are reported in brackets below coefficient estimates. OLS with country fixed effects. The cross-sectional mean of the dependent variable, excluding country i, is included as an explanatory variable. R2 is adjusted to exclude the effect of the inclusion of the mean yield. All fiscal variables are in shares of national income.

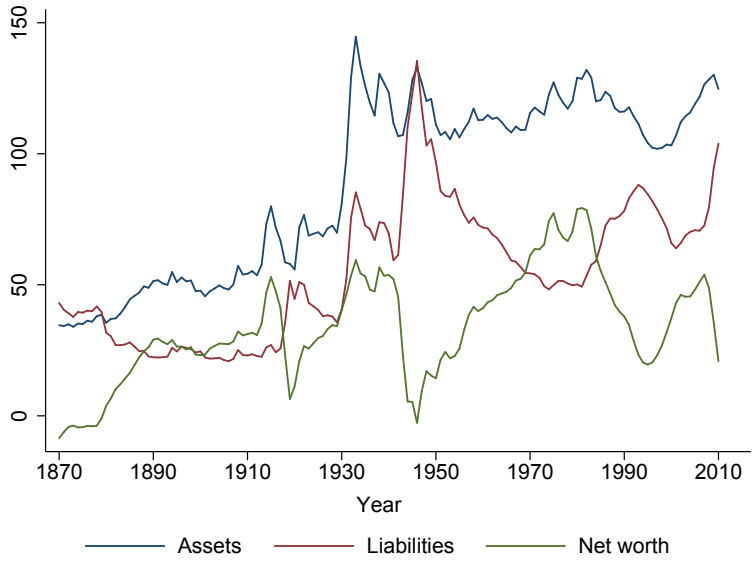
B Additional tables, US time series analysis

Figure 4: United States: Government bond yield, 1870-2010



In percent
Source: Jorda et al. (2017)

Figure 5: United States: Gov. balance sheet components, 1870-2010



In percent of national income
Source: Piketty and Zucman (2014)

Table 12: United States: Summary statistics for included variables

Variable	**Mean**	**St. dev.**	**Min.**	**Max.**	**N×T**
(1) Long-term bond yield (%)	4.68	2.28	1.95	13.91	140
(2) Short-term interest rate (%)	4.26	2.87	0.16	16.39	140
(3) Inflation rate (%, yoy)	2.17	4.73	-10.67	17.45	140
(4) Real growth rate (%, yoy)	5.82	7.47	-23.13	28.35	140
(5a) Liabilities, level (% of NI)	0.89	0.34	0.34	1.45	140
(5b) Liabilities, first diff. (% of NI)	0.01	0.06	-0.12	0.31	140
(6a) Assets, level (% of NI)	0.55	0.26	0.22	1.36	140
(6b) Assets, first diff. (% of NI)	0.00	0.06	-0.18	0.26	140
(7a) Net worth (% of NI)	0.34	0.20	-0.06	0.79	140
(7b) Net worth, first diff. (% of NI)	0.00	0.05	-0.22	0.12	140

NI: national income. Sources: (1)-(5): Jorda et al. (2017); (5)-(7): Piketty and Zucman (2014)

Table 13: United States: Cointegration – assets and liabilities

Coint. relationship: Assets and liabilities		**Number of lags**			
Johansen-based (1995) test		**1**	**2**	**3**	**4**
(of number of cointegrating relationships)		0	1	0	0
Engle-Granger (1987) test	**0**	**1**	**2**	**3**	**4**
(of stationarity of residuals from reg.)	-1.72	**-3.34**	-2.74	-2.81	-2.47

Engle-Granger test null hypothesis: the series contains a unit root. MacKinnon 5% critical value is -3.34. Entries that are underlined indicate the AIC-selected optimal lag length. Entries in bold indicate rejection of the null hypothesis, and thus evidence that the residual is stationary and the series are cointegrated.

Table 14: United States: Cointegration – interest rates

Coint. rel.: Yield, mean yield and short rate		**Test statistic**	**5% crit. value**
Johansen-based (1995) test			
(of number of cointegrating relationships;	rank 0	58.77	29.68
trace statistic)	rank 1	13.51*	15.41
	rank 2	3.10	3.76
Engle-Granger (1987) test			
(of stationarity of residuals from reg.)	$Z(t)$	**-4.30**	-3.80

Engle-Granger test null hypothesis: the series contains a unit root. Lag length selection by AIC. Entries in bold indicate rejection of the null hypothesis

Table 15: United States: Robustness – net worth

Dep. var.: gov. bond yield	**Post-war, pre-crisis**	**Crisis interaction**	**Political factors**	**Lin. coint. comb.**
	(1)	(2)	(3)	(4)
Net worth (Δ_t)	-14.554***	-3.576**	-3.881**	-3.675**
	(4.264)	(1.659)	(1.806)	(1.525)
Net worth (Δ_t) × Crisis dum.		-20.805***		
		(7.064)		
Short-term interest rate	0.510***	0.315***	0.282***	
	(0.065)	(0.060)	(0.065)	
Real growth rate	-0.038	-0.020	-0.018	-0.018*
	(0.041)	(0.013)	(0.012)	(0.011)
Inflation rate	0.084*	0.007	0.009	0.007
	(0.047)	(0.016)	(0.020)	(0.017)
Mean bond yield	0.340***	0.641***	0.684***	
	(0.125)	(0.057)	(0.067)	
Crisis dummy		-0.654		
		(0.438)		
Left/centrist head of gov.			-0.119	
			(0.156)	
R2	0.912	0.745	0.689	0.055
Observations	61	140	140	140

Notes: Significance levels are denoted as * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is the annual average of the 10-year government bond yield. Newey-West standard errors are reported in brackets below coefficient estimates. R2 adjusted to exclude the effect of the inclusion of the mean yield. All fiscal variables are in shares of national income.