The elasticity of demand for sovereign debt. Evidence from OECD Countries (1995-2011)

Giuseppe Grande*, Sergio Masciantonio* and Andrea Tiseno*

Abstract

Public debt levels in advanced economies have increased dramatically over recent years and could put considerable upward pressure on market yields. Using a novel identification approach based on financial accounts and focusing on 18 advanced economies over the period 1995–2011, this paper estimates the long-term elasticity of the demand for government securities. We find that public debt does matter: each percentage point increase in the ratio of public debt to GDP raises 10 year rates by about 3 basis points. The potential drag on growth caused by public debt through higher interest rates should thus not be overlooked.

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* Bank of Italy, Economic Outlook and Monetary Policy Department. E-mail: giuseppe.grande@bancaditalia.it, sergio.maciantonio@bancaditalia.it, andrea.tiseno@bancaditalia.it. The views expressed in the paper do not necessarily reflect those of the Banca d'Italia. All errors are the responsibility of the authors. The authors would like to thank Carlo A. Favero, Christian Upper, Gian Maria Milesi-Ferretti, Riccardo De Bonis, Nicola Borri and participants to the Workshop "The Sovereign Debt Crisis and the Euro Area" held at the Bank of Italy.

1. Introduction

The sharp run-up in public sector debt in advanced economies is likely to be one of the most enduring legacies of the 2007-09 global financial crisis.[1] A key policy question is at what interest rates foreign and domestic investors will be willing to hold such increasing amounts of government debt. So far, investors' preference for safe assets has sustained the demand for government securities, while in some countries unconventional monetary policies have contributed to relieve the pressure of bond supply on bond prices, thus diluting the effects of inflated public deficits over time. Eventually, however, all this newly created supply of government debt will be on the market and investors might start requiring higher yields in order to keep it in their portfolios.

To what extent could interest rates increase? To answer this question we need some measure of the elasticity of demand for sovereign debt to interest rates. The abundant empirical literature on the impact of fiscal variables on interest rates mostly relies upon reduced-form equations, which give biased estimates of the demand elasticity, especially in periods characterized by large shifts in the non-interest sensitive demand for bonds. The main contribution of this paper is to solve the identification problem by resorting to financial account statistics. We disentangle the long-term from the reduced-form demand curve by using as shifters of demand the financial accounts balances of three institutional sectors: households, non-financial firms and the foreign sector. We also control for foreign official reserves and the gross assets of financial institutions, following a recent strand of research highlighting the importance of gross (rather than net) capital flows in determining financial conditions.[2] Finally, we allow for shifters of demand (e.g., sovereign ratings) that capture the degree of substitutability of sovereign debt with other assets due to credit risk concerns.

For a panel of 18 advanced economies over the period 1995-2011, we find that the level of public debt does matter for interest rates: an increase by one percentage point in the public debt-to-GDP ratio raises 10-year rates by about 3 basis points. This is in line with results available for the United States, but based on reduced-form equations estimated on sample periods that do not extend beyond the mid-2000s.

The paper is structured as follows. Section 2 reviews the literature and Section 3 describes the data base. The identification framework is presented in Section 4, while Section 5 reports the econometric estimates. Some robustness checks are discussed in Section 6. Section 7 draws some conclusions.

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[1] Reinhart and Rogoff (2011). See also Cecchetti, Mohanty and Zampolli (2011).

[2] Borio and Disyatat (2011) and Shin (2012).

2. The relationship between fiscal variables and interest rates in previous studies

The subject of the impact of fiscal variables on interest rates has long been a major theme in macroeconomic theory and policy debate. Considering the last thirty years, studies flourished in the eighties and early nineties when in the United States public debt relative to GDP was raising rapidly. The debate was heavily influenced by debt sustainability considerations at that time, as in Blanchard (1984), Hamilton and Flavin (1986), Bohn (1995). Research was stimulated also by the rational expectation revolution in economic theory, which led macroeconomists to investigate public debt irrelevance propositions such as the Ricardian Equivalence hypothesis within dynamic rational equilibrium models (Barro (1989)). Interest in the issue was rekindled in the early 2000s, once again in a period characterized by a large expansion of public debt in the United States. A review of the debate can be found in Gale and Orszag (2004), Liungqvist and Sargent (2004), Engen and Hubbard (2004) and Haugh, Ollivaud and Turner (2009).

A worsening of public finances can affect medium- and long-term yields through three main channels.[3] First, if the supply of savings is not perfectly elastic, financing the budget deficit has to compete for resources with the demand for funding of the private sector, causing real interest rates to rise.[4] Second, an increase in the public debt may cause fears that even sovereign borrowers may default, leading to increased credit risk premiums on government bonds. Third, a larger deficit may fuel expectations of inflation or exchange-rate depreciation, with additional repercussions on interest rates.

While a strand of research focuses on sovereign credit risk premia,[5] most of the large empirical literature tries to assess the overall effect of fiscal imbalances on interest rates without distinguishing among the three channels. The econometric framework normally relies on reduced-form regressions. The fiscal variable of interest can be either public debt or public deficit; in several papers, both variables are interchangeably tried and compared. The majority of studies, however, focus on public deficit, because public debt is rarely significant at conventional confidence levels.

[3] See Ardagna, Caselli and Lane (2007), Balassone, Giordano and Franco (2004) and the Box "The effects of the public debt on long-term interest rates" in Banca d'Italia (2010).

[4] As pointed out by Ardagna, Caselli and Lane (2010), it is useful to distinguish between shorter- and longer-run effects. In an economy in which there is some degree of short-run nominal stickiness, a weakening in the primary fiscal balance adds to aggregate demand and leads to an increase in nominal and real short-term interest rates. Insofar as the adjustment of nominal prices is gradual and the primary fiscal balance's deterioration is perceived to be persistent, the increase in short-term interest rates feeds through medium- and long-term interest rates. In the longer run, to the extent that fiscal expansion crowds out private investment and results in a lower steady-state capital stock, it will be associated with a higher marginal product of capital and thus a higher real interest rate. For an analysis of the long-run implications of rising public debt for interest rates see Engen and Hubbard (2004).

[5] That approach is not pursued here. Reviews of recent studies related to the euro-area sovereign debt crisis can be found in, among others, Di Cesare, Grande, Manna and Taboga (2012) and Favero (2013). For earlier analyses, see Codogno, Favero and Missale (2003).

The econometric models differ considerably also in terms of the other explanatory variables considered, functional specification, estimation method, sample period and sample countries. Three of the most representatives studies are Engen and Hubbard (2004), Laubach (2009) and Ardagna, Caselli and Lane (2007).

Engen and Hubbard (2004) provide a useful discussion of the appropriate specification of the reduced-form equation. First, they argue that, in a closed production economy with a standard Cobb-Douglas technology, public debt affects interest rates because it replaces, or crowds out, productive physical capital and thus raises the marginal productivity of capital. For this reason, an appropriate specification is to regress the *level* of interest rates on the *stock* of public debt. An alternative specification is to regress the *change* in interest rates on the *change* in public debt (i.e. government borrowing or the public deficit). A third, widely used, specification in which the *level* of interest rates is regressed on the *change* in public debt is instead less consistent with what an economic model of crowding out would suggest and can be justified only by assuming sluggish nominal price adjustment and a persistent deterioration in the fiscal position.

Second, Engen and Hubbard (2004) make clear that, in open monetary economies, the substitution of public debt for capital may be less than one-to-one because part of the supply of government bonds may be met by the demand stemming from foreign investors and the domestic central bank. Moreover, since the supply and demand of loanable funds is also affected by private sector's endogenous behaviour, an increase in government debt (other things being equal) may be offset by increases in private saving, limiting its impact on the capital stock and the interest rate. They conclude that, because economic theory is not conclusive on the size of crowding-out effects, the issue must ultimately be addressed by empirical analysis. Engen and Hubbard (2004) then provide several estimates for long-term interest rates in the United States and find that the impact of public debt is statistically significant and economically relevant: about 3 basis points for one percentage point increase in the debt-to-GDP ratio. Similar results obtain if vector autoregression analysis is carried out in order to account for dynamic effects.

Laubach (2009) argues that spot interest rates are strongly influenced by the business cycle and the associated stance of monetary policy. If during recessions automatic fiscal stabilizers raise deficits, while at the same time long-term interest rates fall due to monetary easing, deficits and interest rates may be negatively correlated even if the partial effect of deficits on interest rates—controlling for all other influences—is positive. To control for business cycle and monetary policy effects on interest rates, he claims that one should focus on the relationship between long-horizon expectations of both interest rates and fiscal variables. Accordingly, his preferred specification for

the United States is one in which the endogenous variable is the 5-year-ahead 10-year forward rate and the fiscal variable is the Congressional Budget Office's 5-year-ahead projection of deficit/GDP ratio or debt-to-GDP ratio. For the 30-year 1976-2006 for which these projections are available, Laubach finds that the estimated effects of government debt and deficits on interest rates are sizable: about 3 to 4 basis points for a one percentage point increase in the debt/GDP ratio and about 25 basis points per percentage point increase in the projected deficit/GDP ratio.[6]

Ardagna, Caselli and Lane (2007) focus on the international dimension by using a panel of 16 OECD countries that covers a maximum time span from 1960 to 2002. They find that, in a simple static specification, a one-percentage-point increase in the primary deficit relative to GDP increases contemporaneous long-term interest rates by about 10 basis points. They argue that their estimates tend to understate the effects of fiscal variables on interest rates, as they use current fiscal policy variables, rather than projected variables. As for debt, they find a non-linearity: only for countries with above-average levels of debt does an increase in debt affect the interest rate. They also find that world fiscal policy is important as well: an increase in total OECD government borrowing increases each country's interest rates. However, domestic fiscal policy continues to affect domestic interest rates even after controlling for worldwide debts and deficits. They argue that the latter finding can be explained either by a less-than-perfect degree of integration of advanced economies' government bond markets or by differences in perceived government default risks.

The issue of the impact of fiscal variables on long-term interest rates has been recently reexamined by Baldacci and Kumar (2010), who estimate a panel of 31 advanced and emerging market economies for the period 1980–2008. Like most previous studies, the econometric framework is based on reduced-form regressions and focuses on deficits (rather than debt). For a country experiencing an increase in the fiscal deficit of 1 percentage point of GDP, long-term interest rates could rise by 20 basis points in the baseline case. Taking into account also a combination of adverse factors (e.g., unfavorable initial fiscal conditions, weak institutions, and elevated global risk aversion), the authors argue that the effect could be as high as 50 basis points and that, according to their computations, such effect would be equivalent to a calculated debt elasticity of 5–6 basis points.

[6] He also argues that the fact that the estimated coefficients on the deficit/GDP ratio are six to seven times as large as those on the debt/GDP ratio is consistent with the view that investors perceive increases in projected deficit/GDP ratios as highly persistent, but not strictly permanent. This argument is however challenged by Engen and Hubbard (2004), who note that public debt is also serially correlated in U.S. data, so that investors should also expect increases in federal government debt to be persistent.

Over the last decade several studies have focused on the impact on long-term yields of the demand for government securities stemming from official reserve accumulation, changes in financial regulation or, more recently, large-scale asset purchases (LSAP) programs by the Federal Reserve and other central banks.[7] Beltran, Kretchmer, Marquez and Thomas (2012) find quite a sizable effect of foreign reserves.[8] They also argue that the estimated impact of the Fed's LSAP program tends to be lower, because the program was designed as a temporary stimulus program (and announced as such) and the LSAPs apparently increased the amount of uncertainty surrounding the level of future inflation, thus rising the inflation risk premium embedded in long-term interest rates.

Andritzky (2012) addresses the thorny issue of whether changes in the investor base (e.g., domestic versus non-resident investors, or leveraged versus unleveraged investors) matter. Using a new dataset on the composition of the investor base for government securities in selected G20 and euro-area countries, Andritzky estimates a reduced form regression of 10-year yields in which the explanatory variables also include the shares of government securities held by three typologies of investor: (1) non-residents; (2) private non-bank financial institutions (institutional investors); (3) public sector. He finds that an increase in the share of government securities held by institutional investors or non-residents (i.e. the ratio of the bonds held by that type of investors to the existing stock of bonds) by one percentage point is associated with a reduction in yields by about 2 or 4 basis points, respectively. In order to evaluate whether causality goes from yields to holding shares (pull effect) rather than the other way round (push effect), Andritzky carries out a panel VAR analysis and finds evidence of a pull effect, that is that lower yields attract non-resident investors. He observes, however, that the result could be driven by the fact that the sample period is characterized by falling yields and increasing non-resident holdings. Finally, Andritzky also pursues a structural approach and estimates a portfolio balance model for the US, the UK, Germany and Japan. He finds that a one percentage point increase in the share of statutory or regulatory (i.e. zero or low interest-rate sensitive) holdings of government securities causes expected annual bond returns to decline very little, by a minimum of 0.7 basis point in the UK to a maximum of 2.5 basis points in Japan.

A new perspective comes from a recent strand of the literature on the global financial crisis which emphasizes the role played by gross (rather than net) capital flows in determining financial

[7] See, e.g., Chapter VI in BIS (2006), Greenwood and Vayanos (2010), Beltran, Kretchmer, Marquez and Thomas (2012), Andritzky (2012) and references therein.

[8] A $100 billion (about 0.7 per cent of US GDP in 2011) increase in foreign official flows into US Treasury notes and bonds would lower the 5-year yield by roughly 20 basis points.

conditions. Borio and Disyatat (2011) and Shin (2012) start from the observation that, in the global financial system, gross cross-border positions are huge and argue that a focus on current accounts and net capital flows is misleading. This is because net capital flows, by netting out the gross assets and liabilities, mask the underlying changes in gross flows and their contributions to existing stocks, including all the transactions involving only trade in financial assets, which make up the bulk of cross-border financial activity. Borio and Disyatat discuss the implications of this approach for the determination of market interest rates, mentioning as an example the downward pressure of gross capital inflows to the United States on US dollar long-term rates. Shin develops a theoretical model linking the total intermediation capacity of the banking sector and market risk premia.

Unconventional monetary policies and foreign or institutional demand for government securities certainly contribute to explain the low level of interest rates after the global financial crisis. An alternative explanation has been put forward by Krugman (2012), who argues that, because of the depressed levels of activity, business confidence in advanced economies is depressed as well and thus the private sector does not compete with the public sector for funds. Hence, budget deficits do not necessarily lead to soaring interest rates.

3. Data

The data used for the analysis are mainly obtained from the dataset published by the "OECD *Economic Outlook*". We concentrate on national macroeconomic and fiscal aggregates, for a panel of 20 countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. We use yearly data, from 1980. Much of the analysis concentrates on a shorter time-span – from 1995 – that provides complete information on national financial accounts for all countries in the panel. All macroeconomic aggregates are measured in terms of share of GDP.

In terms of data and methodology, the closest reference paper is Ardagna et al. (2007). Our panel differs in that it contains 20 countries, adding Finland, Norway, Portugal and Switzerland. It also differs in terms of estimation samples: we analyze the periods 1980-2011 and 1995-2011, whereas they concentrate on the periods 1960-2002 and 1975-2002. Our choice is motivated by two facts: firstly, few aggregate variables are available for all countries prior to 1980, while there is an almost perfectly balanced panel after that year. Secondly, 1980 is a year of structural break for public finance aggregate relationships, both in terms of monetary policy –Volcker's designation at

the Federal Reserve in 1979 – and in terms of fiscal policy – elections of Thatcher (1979) in the UK and Reagan (1981) in the USA.

Variables are listed in Table 1.

Table 1: Variables

Variable Name	Description
YIELD_10Y	10-year government bond nominal yield
YIELD_3M	3-month treasury bill nominal yield
INFLATION	Current inflation rate, YoY
INFLATION_10Y	Modelled forecasted 10-year inflation, YoY
REAL_10Y	10-year government bond real yield
REAL_3M	3-month treasury bill real yield
DEBT	Gross government debt (% of GDP)
GOV_ASSET	Gross government assets (% of GDP)
WEALTH_HH	Net wealth of households (% of GDP)
WEALTH_NF	Net wealth of non-financial corporations (% of GDP)
ASSET_FF	Gross assets of the financial sector (% of GDP)
NF_DEBT	External debt (% of GDP)
RESERVES	Share of debt held as official reserves by foreign central banks (% of GDP)
AVG_LIFE	Average life to maturity of outstanding marketable debt (years)
RATING	Maximum rating grade

YIELD_10YR and YIELD_3M are the nominal yields of the 10-year benchmark government bond and the 3-month money market interest rate, respectively, both computed on yearly basis. The inflation rate enters the regressions in two different manners: either as "expected" 10-year rate (INFLATION_10Y), on yearly basis, or as yearly "spot" rate (INFLATION). In the former case, it is subtracted from the nominal yield to compute the real 10-year yield (REAL_10Y); in the latter, it is added to the r.h.s. of the regression, either directly or subtracted from the nominal yield to compute the 3-month real rate. Expected inflation rates on the 10-year horizon are available from "*Consensus Economic Forecasts*", for 15 of the 20 countries in the panel, from 1989. We have imputed those of the other countries based on a model that predicts future 10-year inflation rates based on short-term forecasts of the inflation rate and recent past rates. Details are reported in the Appendix.

Data on the financial accounts positions of the main sectors of the economies in the panel are drawn from the National Financial Accounts as reported by the "*OECD Economic Outlook*". In particular, DEBT and GOV_ASSET are the gross positions of the public sector at large; WEALTH_HH, WEALTH_NF, are the net financial positions of the Household and Non-Financial Corporations sectors; ASSET_FF are the gross assets of the Financial sector whereas their gross liabilities are excluded from the analysis. NF_DEBT is the net position of the Foreign sector, as reconstructed by Lane and Milesi-Ferretti (2007).

RESERVES is the amount of a country's currency held by foreign central banks as reserves. As this is normally all invested in government bonds, we include it in our regressions as a proxy of "high powered" net-foreign-debt. Data are drawn from IMF COFER and more details on the methodology are in the appendix. AVG_LIFE is the average life to maturity of the outstanding marketable debt, measured in years, as collected by the OECD. RATING is a categorical variable that summarizes the rating of the three major rating agencies, according to the methodology outlined in the appendix.

We test for unit root in panel data using the diagnostics of Im, Pesaran and Shin (2003) and a Fisher-type test as in Choi (2001), based on augmented Dickey-Fuller independent tests on each country, combined together. For most of the series with longer time-span (1980-2011), we are able to reject the null hypothesis of the presence of unit roots. Only DEBT appears to be I(1), according to both tests. However, in accordance with Engen and Hubbard (2005), we prefer to include this variable into the regressions in levels rather than in first differences. Considering the other series, included in our regressions as controls, we find some evidence for non-stationarity. In fact, both the IPS and the ADF fail to reject the null hypothesis in some cases. However, given the very short time span available for these series (only 16 data points), the power of both tests is extremely low and might invalidate our conclusions about the stationarity properties of the series. Thus we prefer to use all of them in levels.

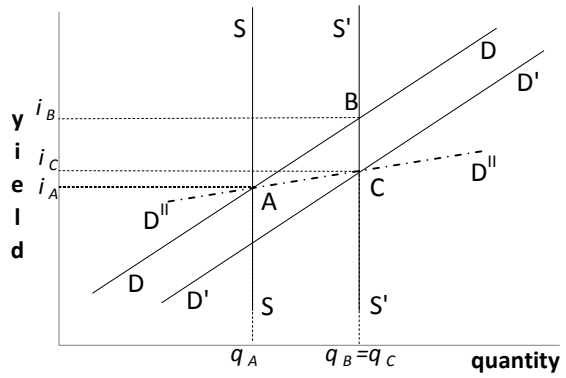
4. Identification Strategy

On bond markets yields clear demand and supply. If there is an increase in the supply of bonds, its impact on the market yield depends on the slope of the demand curve – i.e. on the so-called interest rate elasticity of demand. For a given increase in the supply of bonds, the higher the elasticity of demand the lower the increase in yield which is necessary to clear the market. The objective of the paper is to estimate the interest rate elasticity of the demand for sovereign debt for advanced countries. This is a key parameter, as it allows to quantify the potential impact, on long-term yields, of a change in the stock of sovereign debt.

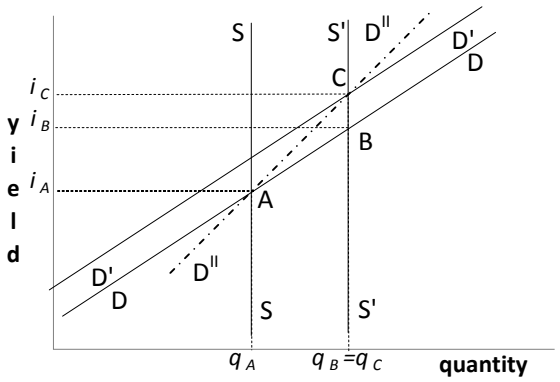
Figure 1

Interest rate effect of a positive shock to the supply of bonds in the presence of shifts in the demand schedule (1)

(*a*) Increase in the demand for bonds for given yield



(*b*) Decrease in the demand for bonds for given yield



(1) Just for illustrative purposes, the assumption is made that the supply curve is perfectly inelastic.

The reduced-form equation for the market yield i_t at time t is

$$i_t = a_0 + a_1 * q_t + e_t, \quad (1)$$

where q_t is the outstanding amount of the bond at time t and e_t is a residual. The slope parameter a_1 provides an estimate of the interest rate elasticity of demand. The main problem in estimating equation (1) is illustrated in Figure 1.a (under the hypothesis of a perfectly inelastic supply of bonds). In case of a positive shock to the supply of bonds, represented by a shift of the supply schedule from the SS curve to the S'S' curve, the market yield should increase from i_A to i_B. However, if at the same time there is an increase in the "autonomous" (unrelated to yield) demand, due, for example, to larger capital inflows from abroad, the demand schedule shifts from the DD curve to the D'D' curve and the market yield rises less, from i_A to i_C. In that case, the slope estimate provided by the reduced-form equation does not relate to the D'D' curve – which is the true or "structural" demand curve –, but relates to the D''D'' curve. The reduced-form equation thus overestimates demand elasticity. In case of a decrease in autonomous demand, the reduced-form equation underestimates demand elasticity (Figure 1.b).

In order to control for changes in the demand for bonds that are unrelated to interest rates, we allow for exogenous shifts in the demand for sovereign debt. Our baseline equation is as follows:

$$yield\_10y_{it} = a_{0+} a_1 * debt_{it} + a_2 * x_{it} + e_{it}, \quad (2)$$

where $yield\_10y_{it}$ is the yield on 10-year government bonds for country i in period t, $debt_{it}$ is the debt-to-GDP ratio, x_{it} is a set of controls and e_{it} is a disturbance term with standard assumptions.

Our parameter of interest is a_1. Depending on the specification, $yield\_10y_{it}$ may be measured either in real or nominal terms, with proper adjustments to the explanatory variables to make the two sides of the equation consistent.

The key idea that we use to obtain identification is that of exploiting the national financial accounts (or flow of funds accounts) identity. As shifters of demand, we use the balances – i.e. the difference between the value of assets and liabilities – of the financial accounts of the main institutional sectors of the economy. More specifically, we use the financial accounts identity to saturate the regression with the balances of all but one of the sectors (so as to avoid collinearity). We thus control for the net financial balances of households, non-financial firms and the foreign sector, leaving aside the net balances of financial intermediaries (see also the appendix). In order to assess whether gross (rather than net) positions also have an impact, we control for the world reserves invested in the currency of the country and for the gross assets of the financial sector. The reason to include the latter variable also lies in the implicit burden that sovereigns might shoulder in case of financial crises. Gross assets of the financial sector should give a rough measure of this burden. Finally, we include general government's gross assets among the regressors. All financial balances are measured as a fraction of GDP.

In addition to allowing for changes in autonomous demand, we limit the range of possible slopes of the yield curve, controlling for the short-term rate. We also allow for other shifters of demand that capture the degree of substitutability of sovereign debt with other assets, such as the average life to maturity of the outstanding amount of government bonds and the ratings of sovereign issuers.

The above identification approach rests upon three key assumptions:

(1) *Bond supply is exogenous*. This is a strong assumption, and later on we show how to relax it. Bond supply can be regarded as inelastic to interest rates only in the short run. In the long-run, the supply of bonds is to some degree interest-rate sensitive (the higher the interest rate the lower the supply of bonds).

(2) *The financial positions (gross assets and liabilities and/or their balance) of the institutional sectors of the economy are exogenous*. This is also not necessarily true. The portfolio choices of households and foreign investors are likely to be affected, to some degree, by the level of sovereign yields. This observation is consistent with Andritzky (2012)'s finding that declines in yields would be followed by (rather than being a consequence of) inflows of foreign investments in government bonds. Similarly, the financing decisions of non-financial corporations are affected by the level of sovereign yields. However, for the purpose of this

analysis, the failure of this assumption is a second-order problem, as our parameter of interest is the demand elasticity (coefficient a_1 in equation (2)), not the coefficients associated with the demand shifters (vector a_2 in equation (2)).

(3) *Institutional sectors' asset allocation is assumed to be constant over time and across countries*, as reflected by the fixed portfolio coefficients. This is also a simplifying assumption, because one may argue that, for example, the share of households' financial wealth held in government bonds may change. However, we have too few observations to allow for time- or country-varying coefficients.

Our baseline estimation method is least squares with fixed effects and robust standard errors. The reduced-form equation (1) can be estimated for 20 countries over the period 1980 – 2011, totalling 562 observations in the sample (on average almost 28 observation per country). For equation (2), that makes use of financial accounts variables, we have data for 18 countries over the period 1995-2011, totalling 292 observations (about 16 observations per each country) [9].

Once our best model specifications are fixed, we are able to relax assumption (1) addressing the potential endogeneity of the bond supply. The supply of bonds is well likely to be influenced by the level of the interest rate: the lower this level, the higher the supply of bonds. In practice, the endogeneity problem might be not extremely relevant, because the share of bond supply that is actually interest-rate sensitive is limited. Every year, the bond supply – which can be proxied by the debt-to-GDP ratio, $debt_{it}$ – is in fact constrained by the realized debt-to-GDP ratio one year before ($debt_{it-1}$). The fiscal room to determine the supply of bonds at time t is further constrained by the amount of interest payments on the realized government debt. Finally, the automatic stabilizers that react to the cycle would further reduce the endogeneity of the supply of debt.

In order to correctly address the endogeneity problem, we then isolate the share of the debt supply that is actually discretional and use the strictly exogenous debt supply as instrumental variable for the actual debt-to-GDP ratio in a two-stage least-squares fixed-effect estimation. The exogenous component of the debt supply - $debt\_ex_{it}$ – is calculated as follows:

$$debt\_ex_{it} = debti_{t-1} + int\_pay_{it} + aut\_stab_{it}$$

where $debti_{t-1}$ is the realized debt-to-GDP ratio at time *t-1*, int_pay_{it} is the ratio of interest payments due at time *t* to GDP and aut_stab_{it} is the share of the primary balance attributable to non-discretional automatic stabilizers. The latter variable, being a typical cyclical component, is

[9] We drop New Zealand and Switzerland from the analysis, since financial accounts data for these two countries are missing.

calculated as the difference between the realized primary balance of each country and its cyclically-adjusted value, as calculated by the OECD.

5. Estimation Results

Our main results are summarized in Table 2, in which columns differ from one another either in terms of the sample period or the set of control variables.

Right-hand side variables always include a 3-month (real or nominal) interest rate, to control for parallel shifts of the yield curve. The underlying assumption that this rate is uncorrelated with the error term is based on the fact that this is a policy rate set by the central bank. The other explanatory variables only capture movements of the slope of the yield curve.

In column 1 of Table 2 we present a "Plain vanilla" fixed effects regression, with time dummies that capture any common time trend. In the literature, this is the workhorse model for most studies like this one. As an example, Ardagna, Caselli and Lane (2007) always have time dummies as controls. The fit is very good, because the common trend captures most of the variation. However, for this specification the demand elasticity is only 1 basis point per percentage point of GDP. Column 2 presents the same specification for a shorter sample: 1995-2010. This is the sample on which all the other regressions are estimated, hence we use this as a benchmark. Also in this case the demand elasticity is 1 basis point.

The main results of our paper are presented in columns 3 and 4 of Table 1, where the common trend is replaced with our economic restriction, namely that shifts in the demand schedule are driven by changes in the balances of the financial accounts of the main institutional sectors of the economy (as explained in the previous section). This amounts to giving each country its own "time trend", driven by its fundamentals.

Table 2

Ten-year interest rates of advanced economies: Estimates of the elasticity of demand (1)

	[1]		[2]		[3]		[4]		[5]		[6]		[7]	
Public debt (% GDP)	0.013	[0.05]	0.018	[0.03]	0.0480	[0.00]	0.0309	[0.00]	0.0130	[0.02]	0.0481	[0.00]	0.0298	[0.01]
Inflation (%)	0.638	[0.00]	0.416	[0.00]	0.4502	[0.00]	0.4060	[0.00]	0.4723	[0.00]				
3-month real rate (%)	0.502	[0.00]	0.431	[0.00]	0.4977	[0.00]	0.4999	[0.00]	0.4577	[0.00]				
3-month nominal rate (%)											0.4840	[0.00]	0.4691	[0.00]
General gov't assets (% GDP)					-0.0286	[0.00]	-0.0242	[0.00]	-0.0032	[0.46]	-0.0282	[0.00]	-0.0228	[0.00]
Househ.ds' net fin. Wealth (% GDP)					-0.0287	[0.00]	-0.0240	[0.00]	-0.0065	[0.14]	-0.0279	[0.00]	-0.0223	[0.00]
Non-fin. corp.ns' net debt (% GDP)					-0.0129	[0.03]	-0.0090	[0.06]	-0.0020	[0.56]	-0.0123	[0.06]	-0.0080	[0.11]
Net foreign debt (% GDP)					-0.0067	[0.16]	-0.0064	[0.12]	0.0025	[0.53]	-0.0057	[0.28]	-0.0042	[0.36]
Foreign off. reserves (% GDP)					-0.1480	[0.00]	-0.1307	[0.00]	-0.0158	[0.51]	-0.1514	[0.00]	-0.1363	[0.00]
Fin. corp.ns' assets (% GDP)					-0.0002	[0.63]	-0.0006	[0.21]	0.0006	[0.05]	-0.0002	[0.69]	-0.0005	[0.21]
Average life to maturity (years)					-0.2165	[0.03]	-0.1643	[0.04]	-0.0472	[0.23]	-0.2267	[0.02]	-0.1837	[0.02]
AA + (dummy)							0.3361	[0.02]	0.1276	[0.51]			0.4210	[0.02]
AA (dummy)							0.5205	[0.02]	0.2957	[0.37]			0.6476	[0.01]
AA - (dummy)							1.6263	[0.00]	0.9858	[0.12]			1.7559	[0.00]
A + (dummy)							1.9507	[0.00]	2.1857	[0.00]			2.0284	[0.00]
BBB + (dummy)							5.0045	[0.00]	4.8252	[0.00]			4.8819	[0.00]
BB + (dummy)							6.4117	[0.00]	6.5398	[0.00]			6.3771	[0.00]
Constant	3.636	[0.00]	4.094	[0.00]	5.4568	[0.00]	5.9523	[0.00]	4.9441	[0.00]	5.4026	[0.00]	5.6213	[0.00]
Year dummies	Yes		Yes		No		No		Yes		No		No	
R-square	0.918		0.606		0.368		0.516		0.850		0.371		0.522	
Sample period	1980-2011		1995-2011		1995-2011		1995-2011		1995-2011		1995-2011		1995-2011	
Number of countries	20		20		18		18		18		18		18	
Number of observations	562		337		292		292		292		292		292	

Legend of model specification: [1] Common time trend; [2] Common time trend; [3] Heterogeneous time trend and economic restrictions; [4] Heterogeneous time trend, economic restrictions and ratings; [5] Common time trend and economic restrictions; [6] Heterogeneous time trend and economic restrictions; [7] Heterogeneous time trend, economic restrictions and ratings.

(1) Panel estimates with fixed effects, run on yearly data. For each specification, the table shows coefficient estimates and, in square bracket, the related *p*-values.

Starting from the specification shown in column (3), once the common trend is replaced with our economic restriction, the interest rate elasticity of the demand for government bonds becomes much smaller: an increase of one percentage point in the public debt-to-GDP ratio leads to an increase in the 10-year real rate on the order of 4 basis points. Moreover, the R^2 of the regression is fairly good and almost all of the other coefficients are significant and have the correct sign. An increase of one percentage point of GDP in general government's gross assets or households' net financial wealth lowers the 10-year real interest rate by about 3 basis points. A reduction of one percentage point of GDP in the net debt of non-financial firms or an increase of the same magnitude in the net foreign debt position[10] lower the 10-year real rate by about 1 basis point. A much stronger effect is found for foreign official reserves (a component of the net foreign debt position): one percentage point increase in the ratio of foreign reserves to GDP leads to a reduction of the 10-year real rate by more than 12 basis points. An increase in financial corporations' gross assets is also associated with a reduction of the 10-year real rate, but in this specification the effect is not statistically significant. Finally, a one-year increase in the average life to maturity of the outstanding amount of government bonds implies a decline of almost 19 basis points in the 10-year real rate.

The degree of substitutability between government bonds and alternative asset classes (e.g., corporate bonds and listed shares) is affected by changes in the creditworthiness of sovereign borrowers – i.e. sovereign credit risk. In the specification shown in column (3), the only variable that accounts for investors' sovereign debt sustainability concerns, in addition to the level of public debt as such, is the average life to maturity of the existing stock of bonds. The specification presented in column (4) of Table 1 tries to better capture investors' perception of the soundness of sovereign borrowers. It does so by including sovereign ratings dummies among the control variables, under the working hypothesis that the grades assigned by rating agencies to government bonds can be a rough indicator of financial markets participants' perceptions of sovereign credit risk.

In the specification shown in column (4), rating dummies turn out to have a strong effect on the 10-year real rate. Their coefficients are significant and proportional to the degree of riskiness associated with the rating grade. A comparison of column (4) with column (3) indicates that the inclusion of rating dummies tends to make demand elasticity higher than in the specification without rating dummies: one additional percentage point of public debt-to-GDP ratio increases the 10-year real rate by about 3 (instead of 4) basis points. The other coefficients are all remarkably stable, although most of them are a bit smaller in magnitude. The net foreign debt position is not

[10] We are grateful to Philip Lane and Gian Maria Milesi-Ferretti for providing these data. The original reference is Lane and Milesi-Ferretti (2007).

anymore significant, while financial corporations' gross assets become significant at a 10 per cent confidence level.

In column (5), the year dummies are put back into the "financial account" regression of column (4). Not surprisingly, most of the control variables are not anymore significant and have a lower effect.

In column (6) and column (7) the short-term real rate and the inflation rate are replaced with the nominal short rate. Column (6) is without rating dummies. The demand elasticity is about 4 basis points, but most of the other coefficients are not significant. Column (7) also includes rating dummies. The demand elasticity is about 3 basis points, as in column (4), while net foreign debt and the rating dummies are not anymore significant.

All in all, a number of results stand out from our analysis. First of all, in advanced economies the long-run elasticity of demand for sovereign debt is on average quite high. Controlling for sovereign ratings, the estimated impact of bond supply is around 3 basis points per percentage point of public debt-to-GDP ratio. In the specifications without sovereign ratings, the demand elasticity is slightly lower, as the slope estimate is 4 basis points per percentage point of public debt-to-GDP ratio.

Despite being very strong, our restriction on demand shifters fits the data very well and we are able to quantify the effects of several factors in a consistent way. The largest coefficient is associated with official foreign exchange reserves. This agrees with the view that the sizable stock of reserves accumulated by emerging market countries since the late nineties (due to currency intervention, current account surpluses and other factors) has exerted a strong downward pressure on the yields of advanced economies. Other factors having an impact on the demand for sovereign debt are households' net financial wealth, general government's holdings of financial assets, non-financial corporations' net debt and the net foreign debt position (which takes into account all capital flows, including official foreign exchange reserves). The coefficient associated with banks' gross assets is scantly significant. This is not necessarily inconsistent with the hypothesis that gross (rather than net) capital flows matter, for two reasons. First, the acceleration in cross-border bank assets started around the middle of the 2000s[11] and thus weighs on a rather small fraction of our sample period. Second, gross (as opposed to net) flows effects are also captured by official reserves.

As for public debt sustainability indicators, which allow us to control for changes in financial markets' perception of sovereign credit risk, we find that the average maturity of public

[11] See, e.g., Figure 5 in Shin (2012).

debt does matter. The results for ratings are instead less clear-cut, as the dummies are significant only in equation (4).

A key aspect of demand elasticity estimates is the potential endogeneity of the supply of debt. As explained in Section 4, this is addressed through instrumental variables estimates. The results are shown in Table 3. Equations (3) and (4) of Table 2 are replicated with different instruments, namely (a) lagged debt, (b) exogenous debt (as specified in Section 4) and (c) exogenous debt together with its lagged value.

The coefficients for the debt variable range from 4 to 5 basis points for equation (3) and from 2 to 3 basis points for equation (4). These results are broadly in line with the baseline estimations – respectively, 5 and 3 b.p. for equations (3) and (4). The slight reduction in the magnitude of the coefficient in both specifications is consistent with the theory, which predicts a negative relation between the level of the interest rate and the supply of bonds. Moreover, the small change in the coefficients from the baseline strict-exogeneity estimations points to a limited sensitivity of the debt supply to interest rates.

6. Robustness

Our main robustness concern regards the reliability of financial accounts in accurately capturing demand shifts. As explained in Section 4, we saturated the equations with the net balances of the financial accounts identity of all institutional sector but one (that of financial intermediaries) and also included gross assets of financial intermediaries.

To test the robustness of our findings to this specification we run several replications of equations (3) and (4) including the net financial balance of financial intermediaries and in turn the gross assets of any other institutional sector. The results – shown in the Appendix (Table A.4) – are robust to changes in the chosen financial accounts specification. The debt coefficient remains significant and changes its value only marginally. The specification shown in Table 2 appears to be the most meaningful economically.

We conducted several other robustness checks (not shown). We thoroughly looked for non-linearities (trying many different parameterizations), but we didn't find any type of non-linear effect. We also tried many different types of forward-looking variables (e.g., expected inflation and expected fiscal deficits), but we didn't get any significant gain in terms of accuracy of the estimates.

Table 3

Estimations with instrumental variables (1)

	[3]		[4]		[3]		[4]		[3]		[4]		[3]		[4]	
Public debt (% GDP)	0.0480	[0.00]	0.0309	[0.00]	0.0443	[0.05]	0.0238	[0.00]	0.0442	[0.00]	0.0248	[0.00]	0.0478	[0.00]	0.0279	[0.00]
Inflation (%)	0.4502	[0.00]	0.4060	[0.00]	0.4512	[0.00]	0.4080	[0.00]	0.4512	[0.00]	0.4077	[0.00]	0.4453	[0.00]	0.4054	[0.00]
3-month real rate (%)	0.4977	[0.00]	0.4999	[0.00]	0.4987	[0.00]	0.4955	[0.00]	0.4987	[0.00]	0.4961	[0.00]	0.4868	[0.00]	0.4923	[0.00]
3-month nominal rate (%)																
General gov't assets (% GDP)	-0.0286	[0.00]	-0.0242	[0.00]	-0.0260	[0.00]	-0.0199	[0.00]	-0.0259	[0.00]	-0.0205	[0.00]	-0.0286	[0.00]	-0.0225	[0.00]
Househ.ds' net fin. Wealth (% GDP)	-0.0287	[0.00]	-0.0240	[0.00]	-0.0264	[0.00]	-0.0205	[0.00]	-0.0264	[0.00]	-0.0209	[0.00]	-0.0282	[0.00]	-0.0224	[0.00]
Non-fin. corp.ns' net debt (% GDP)	-0.0129	[0.03]	-0.0090	[0.06]	-0.0106	[0.02]	-0.0058	[0.14]	-0.0105	[0.02]	-0.0063	[0.11]	-0.0126	[0.01]	-0.0078	[0.05]
Net foreign debt (% GDP)	-0.0067	[0.16]	-0.0064	[0.12]	-0.0045	[0.34]	-0.0031	[0.46]	0.0044	[0.36]	-0.0035	[0.40]	-0.0058	[0.22]	-0.0047	[0.26]
Foreign off. reserves (% GDP)	-0.1480	[0.00]	-0.1307	[0.00]	-0.1415	[0.00]	-0.1201	[0.00]	-0.1414	[0.00]	-0.1216	[0.00]	-0.1488	[0.00]	-0.1261	[0.00]
Fin. corp.ns' assets (% GDP)	-0.0002	[0.63]	-0.0006	[0.21]	-0.0002	[0.67]	-0.0006	[0.16]	0.0002	[0.67]	-0.0006	[0.16]	-0.0002	[0.66]	-0.0006	[0.16]
Average life to maturity (years)	-0.2165	[0.03]	-0.1643	[0.04]	-0.2146	[0.03]	-0.1600	[0.01]	-0.2146	[0.00]	-0.1606	[0.01]	-0.2149	[0.00]	-0.1658	[0.01]
AA + (dummy)			0.3361	[0.02]			0.4316	[0.01]			0.4181	[0.02]			0.3826	[0.03]
AA (dummy)			0.5205	[0.02]			0.6950	[0.01]			0.6705	[0.01]			0.6357	[0.02]
AA - (dummy)			1.6263	[0.00]			1.7841	[0.00]			1.7619	[0.00]			1.4175	[0.01]
A + (dummy)			1.9507	[0.00]			2.1499	[0.00]			2.1219	[0.00]			2.0575	[0.00]
BBB + (dummy)			5.0045	[0.00]			5.2495	[0.00]			5.2150	[0.00]			5.0799	[0.00]
BB + (dummy)			6.4117	[0.00]			6.7654	[0.00]			6.7157	[0.00]			6.5956	[0.00]
Constant	5.4568	[0.00]	5.9523	[0.00]	5.4874	[0.00]	5.9970	[0.00]	5.4879	[0.00]	5.9908	[0.00]	5.4481	[0.00]	5.9705	[0.00]
Year dummies	No		No		No		No		Yes		No		No		No	
R-square	0.368		0.516		0.389		0.553		0.389		0.548		0.365		0.525	
Sample period	1995-2011		1995-2011		1995-2011		1995-2011		1995-2011		1995-2011		1995-2011		1995-2011	
Number of countries	18		18		18		18		18		18		18		18	
Number of observations	292		292		292		292		291		291		291		291	
Instruments					Debt (t-1)		Debt (t-1)		Debt_ex		Debt_ex		Debt_ex; Debt_ex (t-1)		Debt_ex ; Debt_ex (t-1)	

Legend of model specification: [3] Heterogeneous time trend and economic restrictions; [4] Heterogeneous time trend, economic restrictions and ratings;
(1) Panel estimates with instrumental variables, run on yearly data. For each specification, the table shows coefficient estimates and, in square bracket, the related *p*-values.

7. Conclusions

We obtain an estimate of the long-term elasticity of the demand for government securities in advanced economies. We use panel data on 18 countries covering the sixteen years from 1995 to 2011. The sample period includes not only the low interest rate phase in the mid-2000s but also the further downward trend in market yields observed in the three-year 2009-11 after the most acute phase of the global financial crisis. We find that, in the long run, each percentage point increase in the ratio of public debt to GDP raises 10-year rates by about 3 basis points. This is a sizeable effect, considering that, in the three-year 2009-11, the median value of the average annual change in the debt-to-GDP ratio was equal to almost 6 percentage points in the 18 countries considered and 7 percentage points in the G7 countries.

Previous estimates of the demand elasticity of government debt in the United States are in line with our results. Most of those estimates, however, are based on sample periods that do not extend beyond the mid-2000s. More importantly, they are based on reduced form regressions, while our empirical framework is able to identify the long-term elasticity of the demand for government bonds, because it controls for short-term shifts in demand and also addresses the potential endogeneity of debt supply to interest rates.

The use of financial accounts data also allows us to take into account in a consistent way some factors that have been said to affect market yields since the 2000s, namely the accumulation of foreign official reserves by emerging market and oil exporting countries and changes in financial regulation and accounting. Our results give insights also on the interest rate effects of unconventional monetary policies, although the latter matter only in the last two years of the sample and for a limited number of countries. We also find evidence that gross (rather than net) positions do have an impact on interest rates. These results are robust to the use of different combinations of financial accounts data as right-hand side variables. Finally, we control for changes in the perceived riskiness of government bonds by using debt sustainability indicators (average life to maturity and sovereign ratings).

In conclusion, public debt does affect long-term interest rates and its potential drag on growth through higher interest rates should not be overlooked. It must be underlined, however, that the interest rate burden and other costs of public debt have always to be carefully weighed against the overall short- and long-run benefits of government intervention, especially in depressed economies.

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Appendix

In this Appendix we provide further evidence of the methodologies we use to assemble the data for some variables. All the macroeconomic and fiscal variables did not need any special care, except presenting the main fiscal variables as a share of GDP, while the long-term expected inflation, the share of debt held in foreign official reserves and the rating variables needed some additional manipulation. Moreover, some further explanation on financial account variables might be useful.

Macroeconomic Variables

The macroeconomic and fiscal variables data were collected from the n. 88 OECD Economic Outlook. Here is presented the list of the main variables selected, with their OECD code and definition.

Table A.1: Macroeconomic and Fiscal Series

Code	Description
CBGDPR	Current account balance, as a percentage of GDP
CPIH_YTYPCT	Consumer price index, harmonised, year-on-year growth
EXCHER	Real effective exchange rate, constant trade weights (New)
GAP	Output gap of the total economy
GDPV	Gross domestic product, volume, market prices
GFAR	General government gross financial assets, as a percentage of GDP
GGFL	General government gross financial liabilities, value
IRL	Long-term interest rate on government bonds
IRS	Short-term interest rate
NLG	Government net lending, value

Expected long-term inflation

The most comprehensive and reliable data source of forecasts of macroeconomic indicators is provided by Consensus Economics, from 1989 onwards. Regarding short-term forecasts, CE provides monthly updates of forecasts for the year under review and one year ahead, for all the countries of the sample[12].

However data for 10-year ahead forecasted inflation are provided only for a subset of 12 countries out of the 20 we are interested in (Canada, France, Germany, Italy, Japan, the UK and the US from 1990; the Netherlands, Spain and Sweden from 1995 and Norway and Switzerland from 2000)[13]. We specify a regression model able to explain the 10-year forecasted inflation for these 12 countries. Then, through the regression coefficients, we build a modelled 10-year forecasted inflation variable for all the countries of the sample. We estimate a fixed-effect panel regression model, following the same econometric restrictions about the robustness of the errors as in the main regression in Section 5. The model specifications we estimate are shown in Table A.2. Trying to hold the model as simple as possible, we restricted the set of regressors to realized and short-term forecasted values of inflation, while the regressand is obviously the 10-year forecasted inflation.

[12] These forecasts structure is followed from February onwards, as the January release reports data for the year before and the one under review. Collecting short-term data we chose the forecasts released every February.

[13] Actually, the average 10-year inflation forecast is not readily available. Consensus Economics provides semi-annual forecasts of inflation 1-, 2-, 3-, 4-, 5-, and the average 6-to-10-year ahead. Thus, we have averaged the data through every maturity of the reference horizon and between the two issues of every year.

Our estimation results are presented in Table A.2. According with the AIC and BIC criteria, we can consider a simple model with only the 1-year forecasted inflation as regressor as our preferred specification, as in eq. (3).

Table A.2: 10-Year Ahead Inflation Forecasts Estimation

	Dep. Var. INFLATION_10Y Time Sample (1990-2010)			
	(1) OLS	(2) OLS	(3) OLS	(4) OLS
INFL_CUR_FCAST	0.480	-0.036		
	(9.96)**	(-1.07)		
INFL_1Y_FW		0.787	0.746	0.775
		(11.69)**	(20.40)**	(17.40)**
INFLATION				-0.027
				(-1.27)
CONSTANT	1.241	0.609	0.624	0.616
	(12.60)**	(6.91)**	(7.97)**	(7.58)**
Adjusted R^2	0.73	0.91	0.91	0.91
F-Test	99.13	286.70	416.35	202.95
AIC	183.10	-89.71	-89.72	-90.49
BIC	186.48	-82.95	-86.34	-83.74
N. of obs.	217	217	217	217

As a robustness check, we plugged realized and expected values of GDP growth in our regressions. However GDP growth does not appear to play a statistically significant role in shaping long-term inflation expectations. Thus we maintain eq. (3) as our preferred model specification. From its coefficients, we can build the modelled 10-year ahead inflation forecasts.

Financial Accounts

Financial balance sheets data are collected from the OECD Database "Financial Accounts", which belongs to the System of National Accounts (SNA 93). According to the OECD definition, the financial balance sheets "record the stocks of assets and liabilities held by the institutional sectors, and give a picture of their net worth, at the end of the accounting period"[14]. Even though data are available from 1970 onwards, we find adequately populated series for the 20 countries of our sample from 1995 onwards[15]. However New Zealand did not provide this set of data with continuity, thus restricting our sample to 19 countries when using financial accounts variables.

The institutional sectors, the economy is broke-down in, are: non-financial corporations (S11), financial corporations (S12), general government (S13), households and non-profit institutions serving households (S14-15). These sectors sum up to make the total economy sector (S1). Finally, another sector is added, accounting for the rest of the world sector (S2), which reflects asset and liabilities of non-residents. Similarly to the balance of payment identity, any net worth value of the total economy sector is balanced by a net worth value of opposite and equal size for the rest of the world, such that the following identity is always true:

$$NetWorth^{S11} + NetWorth^{S12} + NetWorth^{S13} + NetWorth^{S14\text{-}15} + NetWorth^{S2} = 0$$

[14] Further details can be found at:

http://www.oecd.org/LongAbstract/0,2546,en_2649_34245_37366237_1_1_1_1,00.html. For a recent analysis based on these data, see Bruno, De Bonis and Silvestrini (2012).

[15] 1995 is the year of the introduction of the ESA95 standard, which makes the national accounts data comparable across countries. Only few countries provide data prior to this year.

We chose to use consolidated financial accounts. The reliability of consolidated accounts more accurately represents the financial position of the various sectors in the economy.

Debt held in foreign currency official reserves

Since data accounting for the share of government debt held by foreign central banks, through the allocation of their official foreign exchange reserves, are not available, a proxy variable mimicking this phenomenon is necessary. We rely on the IMF COFER database, which provides the currency composition of official foreign exchange reserves being held globally[16]. Moreover, these reserves data do not include holdings of a currency by its issuing country. Thus this dataset can serve as the best proxy for the demand of sovereign debt from foreign central banks.

Only the following currencies are identified in the database: US Dollar, Euro, Pound Sterling, Japanese Yen and Swiss Franc; and other currencies[17]. Thus we are able to attribute the share of foreign exchange reserves invested in sovereign debt only for four countries: the US, the UK, Japan and Switzerland. For the remainder of the sample – euro-area countries and others – we need some manipulation of the data. For the euro-area countries in our sample we choose to assign to each country a share of the reserves in euros equal to its share of the euro-area GDP[18]. It is hard to imagine an objective criterion able to account for the flight-to-haven phenomenon that affected the euro-denominated debt market in the aftermath of the global financial crisis of 2007-2010. Thus, our data might be slightly underestimated for core euro-area countries (e.g. Germany, France, etc.) and slightly overestimated for peripheral countries (e.g. Ireland, Portugal, etc.). For the remainder of the sample we follow a similar approach. The "other currencies" series is broke down according to the share of each country's GDP, relative to world GDP.

Rating Grades

Rating grades are collected from the three main rating agencies (Standard & Poor's, Moody's and Fitch Ratings), made comparable through the commutation criteria shown in Table A.3, and associated with the corresponding number, as reported in the Rank column, such that every country have three numbers, corresponding to three ratings, for every year. The lowest number, corresponding to the highest rating grade, is selected for every country and year. In the 1995-2010 sample the highest rating grade is always no less than 4 (that is AA-/Aa3/AA-).

[16] For further details, see: http://www.imf.org/external/np/sta/cofer/eng/index.htm

[17] Before the introduction of the euro in 1999, the COFER database also identified: Deutsche Mark, French Franc, Netherlands Guilder and the European Currency Unit (ECU).

[18] For the years preceding the introduction of the euro (1995-1998), when three national currencies and the ECU were identified, we choose a similar criterion. Deutsche Mark, French Franc and Netherlands Guilder are attributed to Germany, France and the Netherlands. In addition, a share of ECU holdings is assigned to each EU country according to its share of EU GDP.

Table A.3: Rating grades conversion table

S&P	Moody's	Fitch	Rank
AAA	Aaa	AAA	1
AA+	Aa1	AA+	2
AA	Aa2	AA	3
AA-	Aa3	AA-	4
A+	A1	A+	5
A	A2	A	6
A-	A3	A-	7
BBB+	Baa1	BBB+	8
BBB	Baa2	BBB	9
BBB-	Baa3	BBB-	10
BB+	Ba1	BB+	11
BB	Ba2	BB	12
BB-	Ba3	BB-	13
B+	B1	B+	14
B	B2	B	15
B-	B3	B-	16
CCC+	Caa1	CCC+	17
CCC	Caa2	CCC	18
CCC-	Caa3	CCC-	19
CC	Ca	CC	20
C	C	C	21

Table A.4

Robustness: Estimates of the elasticity of demand through different breakdowns of the financial accounts identity(1)

Gross assets included as regressors (% GDP)												
	Househ.ds' assets [3]		Non-fin. corp.ns' assets [3]		Foreign assets [3]		Househ.ds' assets [4]		Non-fin. corp.ns' assets [4]		Foreign assets [4]	
Public debt (% GDP)	0.0330	[0.01]	0.0376	[0.01]	0.0438	[0.00]	0.0197	[0.03]	0.0218	[0.03]	0.0266	[0.00]
Inflation (%)	0.4233	[0.00]	0.4617	[0.00]	0.4674	[0.00]	0.3698	[0.00]	0.4008	[0.00]	0.4162	[0.00]
3-month real rate (%)	0.4655	[0.00]	0.4885	[0.00]	0.4946	[0.00]	0.4798	[0.00]	0.4889	[0.00]	0.4980	[0.00]
3-month nominal rate (%)												
General gov't assets (% GDP)	-0.0116	[0.02]	-0.0168	[0.00]	-0.0221	[0.00]	-0.0121	[0.01]	-0.0149	[0.00]	-0.0172	[0.00]
Househ.ds' assets (% GDP)	-0.0191	[0.00]					-0.0183					
Househ.ds' net fin. Wealth (% GDP)			-0.0178	[0.00]	-0.0247	[0.00]		[0.00]	-0.0155	[0.00]	-0.0207	[0.00]
Non-fin. corp.ns' assets (% GDP)			-0.0014	[0.78]					-0.0051	[0.20]		
Non-fin. corp.ns' net Wealth (% GDP)	-0.0022	[0.62]			-0.0078	[0.11]	-0.0020	[0.58]			-0.0049	[0.08]
Foreign assets (% GDP)					-0.0005	[0.57]					-0.0014	[0.09]
Net foreign debt (% GDP)	0.0051	[0.28]	0.0043	[0.28]			0.0015	[0.70]	0.0013	[0.58]		
Foreign off. reserves (% GDP)	-0.0842	[0.06]	-0.1393	[0.01]	-0.1337	[0.00]	-0.0837	[0.02]	-0.1138	[0.00]	-0.1075	[0.00]
Fin. corp.ns' assets (% GDP)												
Fin. corp.ns' net Wealth (% GDP)	-0.0036	[0.72]	-0.0008	[0.92]	-0.0052	[0.44]	-0.0013	[0.86]	0.0005	[0.94]	-0.0043	[0.45]
Average life to maturity (years)	-0.1181	[0.21]	-0.1887	[0.04]	-0.1992	[0.05]	-0.1011	[0.23]	-0.1492	[0.05]	-0.1418	[0.09]
AA + (dummy)							0.2119	[0.16]	0.3225	[0.03]	0.3612	[0.01]
AA (dummy)							0.4605	[0.13]	0.5765	[0.01]	0.6380	[0.00]
AA - (dummy)							1.3928	[0.00]	1.7053	[0.00]	1.7443	[0.00]
A + (dummy)							2.0498	[0.00]	2.1132	[0.00]	2.1488	[0.00]
BBB + (dummy)							5.1739	[0.00]	5.2750	[0.00]	5.3083	[0.00]
BB + (dummy)							6.6748	[0.00]	6.6527	[0.00]	6.4626	[0.00]
Constant	6.0700	[0.00]	5.4568	[0.00]	5.2389	[0.00]	6.7892	[0.00]	6.0946	[0.00]	6.7892	[0.00]
Year dummies	No		No		No		No		No		No	
R-square	0.436		0.418		0.399		0.564		0.583		0.527	
Sample period	1995-2011		1995-2011		1995-2011		1995-2011		1995-2011		1995-2011	
Number of countries	18		18		18		18		18		18	
Number of observations	292		292		292		292		292		292	

Legend of model specification: [3] Heterogeneous time trend and economic restrictions; [4] Heterogeneous time trend, economic restrictions and ratings;
Panel estimates with fixed effects, run on yearly data. For each specification, the table shows coefficient estimates and, in square bracket, the related *p*-values