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Drivers of European public debt management

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Abstract

This study analyses the choice of government debt managers in the euro area between issuing short-term or long-term debt over the period 1992-2017. Debt managers increased short-term debt issuance in response to higher interest rate spreads and to rising government debt, notably in vulnerable, high-debt countries. Thus, lower long-term rates as a result of ECB's Quantitative Easing (QE) triggered debt managers to focus debt issuance on the long-term end. Moreover, the usual increase in debt maturity when debt rises ceases to operate when QE is active, possibly because markets perceived it as a backstop to the government bond market. However, limited QE experience calls for caution in interpreting the results.

JEL codes: H63, G12

Key words: debt maturity, Quantitative Easing, debt management, reaction function

Non-technical summary

Sovereign debt managers aim to finance government debt at low medium-term costs against acceptable risks. This paper analyses the factors that debt managers in the euro area weigh in when deciding on the maturity structure of new government debt, with special attention to the role of ECB's purchases of government debt (Quantitative Easing, QE) in the reaction function of the debt managers.

Given their goal of cost efficiency, sovereign debt managers have a financial incentive to issue short-term debt (maturity below one year) when the interest spread is large, i.e. the long-term interest rate is high relative to the short-term rate. Other factors that could lead debt managers to put more emphasis on short-term financing include unexpected increases in the size of government debt and high volatility in financial markets, while it could be expected to be less in the run-up to, and at the start of, EMU, and at the end of financial assistance programmes when countries regain access to the longer end of bond markets.

A novel element in the analysis concerns the impact of ECB's policy of QE on the debt manager's maturity choice. QE could affect this choice via lowering the long-term interest rate, and via the central bank's presence in the bond market being perceived as supporting fiscal sustainability. If debt managers respond by lengthening the maturity of newly issued debt, it reduces QE's effectiveness; the increased supply of long-term bonds would limit the scarcity effect created by central banks' asset purchases.

At the same time, debt managers place value on maintaining stable relations with investors, amongst others by issuing government debt in a regular and predictable way. The policy of pre-announcing dates, maturities and/or debt issuance volumes up to one year ahead may place a limit on the degree to which debt managers amend the maturity structure when financial conditions change.

Panel estimation of the debt managers' reaction function for 10 euro area countries over the period 1992-2017 takes place via two-stage least squares to ensure that, when estimating effects from interest rates on the debt issuance composition, the estimation is not biased because of effects running in the opposite direction, from issuing more long-term debt to long-term interest rates.

Results indicate that the maturity choice of debt managers has taken into account the build-up to EMU and the end of EU/IMF financial assistance programmes in the countries concerned, both causing a lower share of short-term debt in issuances. Financial market volatility also matters, with periods of higher volatility characterised by a larger emphasis on short-term debt issuance, at least in the group of strong countries (Austria, Belgium, France, Finland, Germany, and the Netherlands).

Moreover, the analysis broadly confirms that debt managers respond to relative changes in short- and long-term interest rate, at least in the group of financially vulnerable countries (Ireland, Italy, Portugal and Spain). The lower long-term interest rates due to QE in these countries induced a shift in issuance towards the longer-term segment, thereby limiting in part the QE effects arising from the reduction of the amount of long-term government bonds in private hands. In the group of strong countries, on the other hand, the debt management choice seems immune to economic and financial developments, except for financial market volatility.

Rising government debt in the financially vulnerable countries is usually financed more than proportionally by short-term debt but during QE, such effect ceases to exist. This may reflect the presence of the central bank as an active, price-inelastic and buy-to-hold buyer that reinvests maturing securities for some time. The ECB could be perceived as a backstop to the sovereign debt market, mitigating sustainability concerns of investors if debt rises. The fact that short-term government debt is non-eligible for QE purchases may also have played some role here. In any case, caution is needed in interpreting the results given limited QE experience (2015-2017).

1. Introduction

Central banks' policies of Quantitative Easing (QE) involve large-scale purchases of securities, especially government bonds. While quite some attention has been given to the effectiveness of this additional demand, far less attention has been paid to the reaction of the supplier of government debt. Interest rates at historically low - and sometimes even negative - levels offer unprecedented opportunities for reducing the financing costs of government debt. This shifting environment creates good opportunities to analyse to what extent QE and low interest rates have affected the main debt management decision, that of issuing short- or long-term sovereign debt.

Debt Management Offices (DMOs) seek to finance government debt at low medium-term costs and acceptable risk. Part of the strategy to achieve this is to issue securities with a broad range of maturities on a regular and predictable basis, being appreciated by investors. Historically unprecedented low longer-term interest rates, however, may lead debt managers to lock in the favourable funding costs by financing a larger part of government debt long-term. If so, the increased supply of longer-term bonds would to some extent counteract the intended effects of QE, by limiting the reduction of government bonds in private hands.[1]

Another reason for considering more closely debt management in the euro area is the ongoing discussion on introducing Eurobonds and/or a truly European debt manager as part of a Fiscal Union.[2] Knowing how debt managers in the euro area actually behave can help create realistic expectations about how such debt management agency would operate, and may help in designing operational guidelines for such institution.

[1] See for instance Chadha et al (2013) and Andrade et al. (2016) for estimates of effects of increases in long-term debt issuance on the long-term interest rate. The latter study argues that some 40% of the expansionary effect of ECB's QE has been neutralised by debt managers expanding their longer-term bond issuances.
[2] The European Commission (2017) for instance suggests coordination of issuing a possible European safe asset. Also in the context of the policy response to the Corona-virus crisis, suggestions for establishing an European debt management office surfaced. See Delivorias and Stamegna (2020) for an overview of suggestions including bonds issued by a euro area Treasury.

This paper presents an empirical analysis of debt management in the euro area, paying particular attention to the question whether the maturity choice is affected by the relative costs of issuing short- and longer-term debt (despite commitments to finance in a regular and predictable way), and what effect QE had on debt management. The focus is on effects in the short run; effects of changing conditions on debt management decisions in the medium to longer run, when debt managers draw up new issuance plans, are outside the scope of this paper.

The paper concludes that there is some evidence for the interest rate spread affecting the maturity choice of debt managers, with low spreads inducing more long-term issuance in the vulnerable euro area countries. As QE lowers the long-term interest rate, it also incentivises more long-term debt issuances. In addition, whereas normally higher government debt levels lead to higher short-term debt issuance, such effect ceased to operate in QE years. Possibly, the emergence of the central bank acting as a large, fairly predictable and price-insensitive buyer encouraged additional long-term issuance, though the lower maturity limit for QE-eligible assets may also have played some role. In any case, the still limited number of observations calls for caution in drawing conclusions.

Section 2 outlines developments in the theoretical thinking about debt management and present the outcomes of the main empirical studies on debt management in Europe. Section 3 then focusses on the approach taken in this paper and the choice of data, while section 4 presents the empirical results. Section 5 concludes the paper.

2. Theory and practice of debt management

During large parts of the post-WWII era, debt management was considered a macro-economic tool. Changes in the supply of short-term debt would affect interest rates given segmented financial markets and interest-sensitive spending, and thereby economic developments (e.g. Tobin, 1963). Later on, its role as macro-economic stabilisation tool was downplayed, as e.g. in the Ricardian

equivalence theorem (Barro, 1979).[3] Other objectives for debt management developed, such as enhancing confidence when government debt needs to revert to a sustainable path (Alesina et al, 1990).[4] With the emergence of EMU, deficit-smoothing/fiscal insurance has been suggested as a debt management goal, to help stabilise (distortionary) tax rates and to avoid that European countries would exceed the 3%-of-GDP government deficit threshold (e.g. Missale, 2001).

Despite the emphasis on macroeconomic objectives in theoretical writings, debt managers in practice focussed on narrow financial goals, in what has been labelled the "micro portfolio approach" to debt management, (Blommestein and Hubig, 2012). The "financialisation" of debt management led to putting DMOs at arm's length from governments, granting them operational freedom within certain guidelines (Fastenrath et al, 2017). Thus, when asked about their main objectives, OECD debt managers mentioned: (i) ensuring government's financing needs, (ii) minimising borrowing costs, (iii) maintaining risks to an acceptable level, and (iv) supporting the development of domestic financial markets, but no reference to macroeconomic goals was made (Kappagoda, 2001).

Managing sovereign debt requires trading off costs and risks. In essence, short-term debt on average demands a lower interest rate than longer-term debt but it involves a higher refinancing risk. A relatively flat yield curve reduces the financial advantage of issuing short-term debt and would favour issuing more long-term debt.

At the same time, meeting market demand is instrumental for DMOs to finance government debt at reasonable costs. Short-term government bills, for instance, attract high investor interest as it comes closest to a risk-free asset, bearing little to no default risk. It is also valued as it is highly liquid, delivering monetary

[3] Introducing uncertainty for instance renders the debt composition relevant in the Ricardian equivalence theorem. Lacking debt instruments whose payoff are directly contingent on the relevant risks (e.g. GDP-indexed bonds), the government issues the type of conventional instruments (nominal and inflation-indexed bonds) and the maturity to isolate the budget as much as possible from economic shocks.
[4] Issuing short-term debt in such circumstances would limit any fiscal gains of inflating away government debt, thus enhancing confidence that government will not resort to unexpected inflation (Missale and Blanchard, 1994).

services (Greenwood et al 2010, 2011). A strategy of regular, pre-announced issuances makes debt management predictable, and contributes to liquid debt markets in which investors can trade continuously at low transaction costs.[5] Most DMOs announce their issuance calendar a year ahead but do not always pre-set issuing volumes.[6] This leaves them some room in the short term to take advantage of favourable interest yield constellations by shifting issuance volumes over maturity classes.[7] In the medium term, there is more room for manoeuvre when new issuance plans are drawn up.

Whether it is worthwhile taking advantage of changes in interest rates depends on the cost savings that could be generated. Glasserman et al. (2017) argue that short-term costs savings of an opportunistic US debt issuing strategy would amount to less than one basis point, disregarding effects on bidding behaviour. Dottori and Manna (2016) also underline the limited role of opportunistic issuance policies, pointing out that 'tactics" (i.e. deviations from the long-run debt maturity target) invoke additional costs given segmented bond market as a result of 'inelastic investors' that have a strong preference for specific maturities.

The usefulness of the micro-portfolio approach to government debt management has recently been questioned, with interest in the macro-economic impact returning, given the 'segmented market' approach that also underlies the portfolio rebalancing effect of QE programmes. In particular, if central banks' demand for government bonds lowers interest rates, then reducing its supply should have similar effects (Zampolli, 2012, Blommestein and Turner 2012).[8] Macro-financial stability aspects also surface in the discussion: an abundant supply of safe, liquid short-term government bonds would crowd-out of private short-term bonds that

[5] Garbade (2015) describes how the US Treasury manages to maintain the reputation of a regular and predictable issuer despite occasionally changing issuance plans in terms of volume, frequency and/or maturity of issuance.
[6] Information on national issuance plans can be found on the website https://europa.eu/efc/national-issuance-information_en.
[7] Ministry of finance Japan (2016) includes a description of key features of issuance plans in 5 major countries.
[8] Only debt in the hands of the public is deemed relevant for its interest rate effects as interest payment from the government to the central bank usually flow back to the government via a higher dividend pay-out.

commercial banks tend to oversupply to finance their long-term loan commitments, thereby limiting financial stability risks (Greenwood et al., 2015).[9]

Further insight in the behaviour of debt managers can be gained from empirical studies. However, the number of studies including a reaction function for one or several European debt managers, akin to the well-known monetary and fiscal policy reactions functions, is limited, though interest is increasing witnessing some recent contributions. Studies covering the period of Quantitative Easing in the euro area (starting 2015) are particularly scarce.

Focussing on studies covering (parts of) the euro area in the last decade, Hoogduin et al (2011) analysed the share of short-term debt in ten euro area countries over the period 1990-2009. Amongst others, they concluded that debt managers respond to the yield curve, especially in countries with high creditworthiness. Other relevant factors include the size of government debt, inflation, financial market volatility, and the start of EMU.

De Broeck and Guscina (2011) examined the factors driving longer-term, fixed-rate debt issuance in the euro area countries (plus Denmark), using Censored Tobit estimations. They arrived at heterogeneous outcomes: in moderate-deficit countries, higher debt leads to increases in the longer-term debt share, as does higher growth and lower inflation. In high-deficit and high-debt countries, however, effects from the crisis dominate.

González-Fernández and González-Velasco (2018b) estimated the determinants of the sovereign debt maturity over the period 1995-2013 for 23 EU countries based on pooled quantile regressions. They found a positive relation between debt maturity and the size of debt, especially for countries with an initial low debt maturity. Moreover, they concluded on a negative relation between maturity and

[9] Lugo and Piccillo (2018) find an inverse relation between government and private debt maturity in Europe. Eidam (2018) on the other hand argues that governments use gap-filling debt management strategies; high-rated governments in particular issue longer-term debt when aggregate euro area long-term private debt issuance is low.

risk (measured as the interest rate spread over the US) except for high maturity levels.

Focussing on the Portuguese sovereign debt market between 2000 and 2015, Afonso and Singh (2016) concluded that the debt maturity composition is irresponsive to interest rates or the yield spread but is affected by relative market size, market volatility, and the debt level.

Schalck (2015) analysed debt management in France between 1998 and mid-2015. Based on a Markov switching estimation, he inferred that there are non-linearities in debt management; the short-term debt share is much more responsive to interest rates and the liquidity of long-term bond markets in times of crisis.

Schalck (2017) also studied changes in debt management in Canada, France, the UK, and the US in the period 1998-2015 using a Kalman-filter ML approach. He argued that there is substantial heterogeneity in debt management responses to costs (short-term and long-term interest rates) and risk factors (net debt issuance, trading volumes), and that debt management behaviour changed in 2011 as a result of the economic and financial crisis.

Guggenheim et al. (2019) focussed on the market for Swiss federal government debt since 1970. They reported that an increase in (marketable) government debt shows up first in short-term debt, but subsequently in higher longer-term debt. With interest rates playing no role in Swiss debt management, they conclude that short-term debt issuance is a liquidity management instrument, not a strategic debt management instrument. They also found that the Swiss Treasury engages in one-sided interest rate positioning, as debt maturity lengthens in case of more favourable long-term financing conditions but deteriorating long-term financing conditions do not lead to an opposite movement.

3. Empirical analysis

The empirical analysis of the determinants of debt management in the euro area focusses on ten euro area economies (Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain). The selection represents the largest number of euro area countries for which reliable data are available over the past quarter of a century.[10]

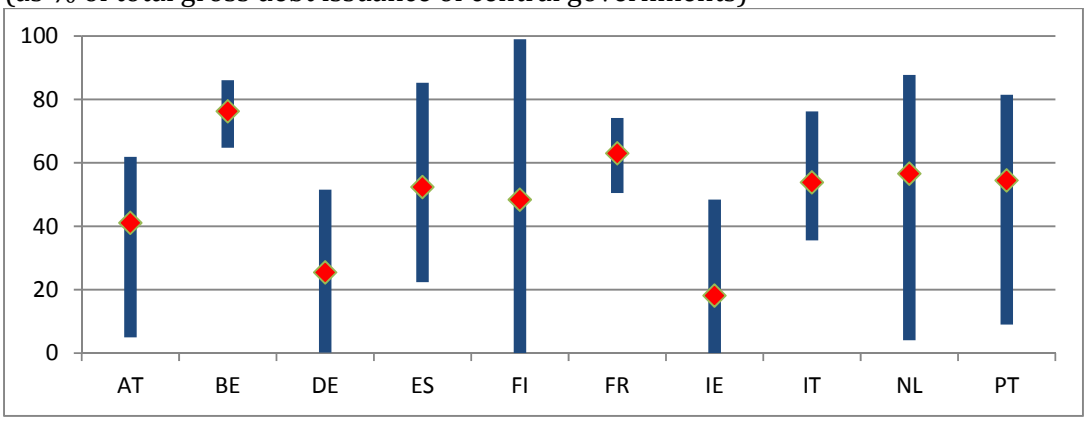
The main variable of interest is the share of short-term debt (maturity of less than one year) in total gross debt issued by central governments. This flow measure best captures the intention of DMOs as stock measures (e.g. average debt maturity, or the share of short-term debt in outstanding government debt) are much affected by past debt management decisions. Our measure includes all short-term issuances within the year, so 3-month debt that is rolled over counts four times. This feature allows for identifying shifts within short-term debt issuances as such a shift would be reflected in an increase in the share of short-term debt.[11] Thus, an increase in our measure of the short-term debt share can reflect both an increase in debt issuance with maturity of less than one year and a shift within that category to debt with a shorter maturity. Lacking long series on the maturity distribution of issuances with maturities above 1 year, changes within the longer-term segment are not part of the analysis. [12]

The data cover the period 1990- 2017. Using relatively long time-series enables taking into account the (run-up to the) final stage of European Economic and Monetary Union (EMU) in 1999, the Global Recession, and three years of ECB government bond purchases in the context of its QE programme (Asset Purchase Programme, 2015-2017).[13] The estimates are unbalanced as for a few variables for

[10] The euro area countries not included in the sample generally have fairly small government debt markets given limited borrowing requirements and a small size of the domestic market, with issuance concentrated on the most liquid longer-term segment. Greece has not been included because of incomplete data.
[11] As a result, the share of short-term debt issuances exceeds the share of short-term debt in the stock of government debt.
[12] Given very low and sometimes negative long-term interest rates, several euro area DMOs have started issuing very long-term debt in recent years, up to 100 year (OECD, 2017).
[13] While the QE bond purchases are executed by the Eurosystem (ECB plus participating national central banks), the paper will refer to the ECB for simplicity.

some countries no reliable data were available. Annex 1 includes a description of the data and their sources.

Figure 1: Average short-term debt share in central government debt issuances, 1990-2017
(as % of total gross debt issuance of central governments)



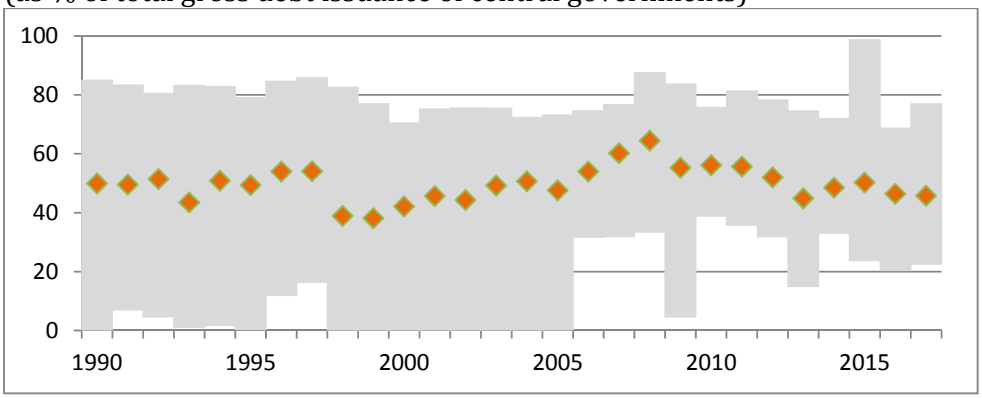
Note: diamonds indicate averages, lines show the minimum-maximum ranges. The data on Ireland may be affected by lesser-quality data around the turn of the century.

Figure 1 reveals some marked differences in issuing behaviour across countries. Rather low average shares of short-term debt in gross government debt issuance, around 20%, are seen in Germany and Ireland, while a share close to 80% prevails in Belgium. Moreover, the short-term debt shares vary markedly over time (notably in Finland, between 0 and 99%) but in Belgium and France they have remained rather stable over the past quarter of a century, fluctuating within a 25 percent-point interval.

Taking a temporal perspective, figure 2 shows that following a broad stabilisation of the average short-term debt share in our selection of euro area countries at the beginning of the 1990s, it decreased towards the end of the decade. This was followed by a gradual increase pick-up, a major increase at the start of the 2008 global crisis, and a subsequent decrease to close to the longer-term euro area average of about 50%. Since the start of QE in 2015, the average short-term share

declined by some 5 percent-point. Overall, no clear trend in the average share of short-term debt in total debt outstanding can be observed.[14]

Figure 2: Short-term share in gross debt issuance by central governments, 1990-2017
(as % of total gross debt issuance of central governments)

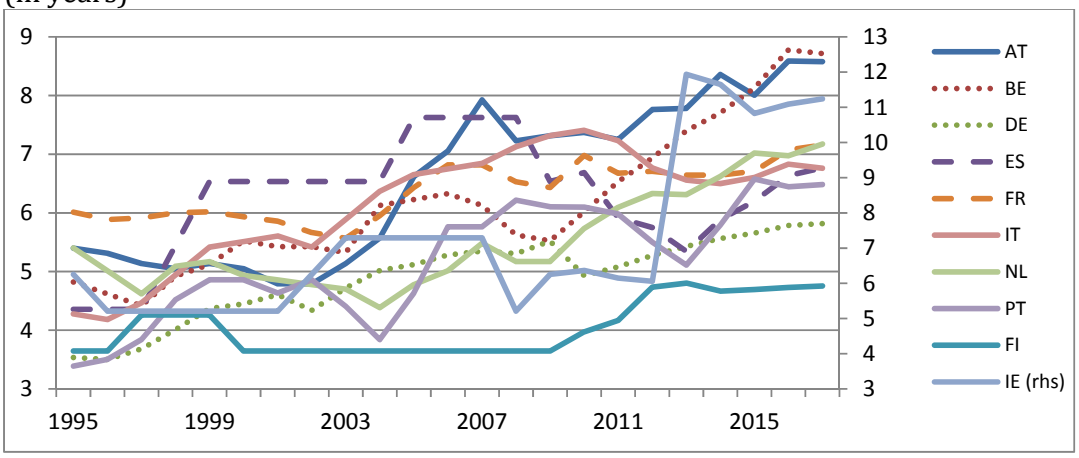


Note: diamonds indicate (unweighted) averages, columns show the minimum-maximum ranges. The zero minimum outcomes around the turn of the century may be affected by lesser-quality data on Ireland.

To put these numbers in perspective, figure 3 depicts developments in the residual maturity of government debt.[15] There are some similarities with developments shown in figures 1 and 2, but there are also major exceptions. Across countries, there is only a weak link between short-term debt shares and average maturities. Germany, for instance, has the one-but-lowest average short-term debt share but nevertheless scores relatively low on the average debt maturity. The average decrease in the share of short-term debt issuances by 3.5 percent-point over the 1995-2017 period is reflected in an increase in the average maturity by almost 3 years. [16]

[14] Taking a longer-term perspective, Abbas et al. (2014) flag an upward trend in longer-term, marketable debt as a result of enhanced liquidity and marketability of government debt, improved institutional frameworks for debt and inflation management, and financial liberalisation.
[15] Some caution is warranted as the data have been calculated by connecting data from the ECB database (2009-2017) with those from the OECD database (1995-2009). Moreover, lacking reliable resources, figure 3 refers to general government debt while data used elsewhere in this paper refer to central government debt issuances.
[16] Correlation coefficients between the average short-term debt issuance share and the average maturity over the period 1995-2017 correspond to -0.24 across countries and 0.11 over time.

Figure 3: Residual maturity of gross general government, 1995-2017
(in years)



As to the potential variables helping to explain how debt managers decide on the maturity structure of new government debt, the approach taken by Hoogduin et al (2011) was taken as starting-point.

Last year's short-term debt share in government issuance has been included to reflect inertia due to institutional aspects and a strategy of issuing predictably. Deviations from last year's plans could be motivated by an (unexpected) change in the volume of government debt to be financed, or changes in the relative pricing of the various maturity segments (yield curve).

To that, the output gap was added, to capture any potential macroeconomic stabilisation function of debt management, expected to have a negative impact on the share of short-term debt; in an expansionary phase, more long-term debt would put upward pressure on longer-term interest rates to slow down economic growth. Moreover, more favourable macroeconomic circumstances may reduce default risk, lower longer-term rates, and induce a shift towards more long-term issuances. This variable may also capture merely cyclical relations between the macroeconomic variables and the debt management decision.

Financial market uncertainty could also play a role: heightened uncertainty, for instance reflecting the evolution of the global economy or a perceived chance of

countries leaving the euro, leads investors to prefer holding short-term debt.[17] The uncertainty is approximated by the US stock market volatility (VIX).[18]

Inflation erodes the real value of nominal bonds, and coincides with higher inflation uncertainty. Investors prefer short-term debt in a high-inflation environment to avoid losses on the real value of longer-term debt holdings. At the same time, inflation considerations should only play a residual role in EMU.[19]

The liquidity in national bond markets, measured by national government debt as a percentage of total euro area government debt, has also been accounted for; large issuers may issue along the yield curve with emphasis on the most liquid, 10-year bond segment while smaller issuers may not reach sufficiently high annual volumes to regularly issue longer-term debt.[20]

Finally, some episode-specific factors are taken into account:

- The European Exchange Rate Mechanism (ERM) experienced a major crisis in 1992 and 1993, with large revaluations and the UK and Italy leaving the ERM. As (short-lived) exchange rate tensions may have made longer-term financing more difficult, a dummy has been added to capturing these effects.
- The run-up to EMU, and its actual start in 1999, led to lower long-term interest rates and a sizeable and fairly integrated euro area securities market (Wolswijk and De Haan, 2005). While the first factor is captured by the yield spread, the second factor is summarised by an EMU-dummy for the years 1997-1998. Also, the euro take-off in 1999 may have had a one-off effect on the debt maturity composition as some DMOs took the opportunity to convert national currency-bonds into euro-denominated bonds through buy-backs. Moreover, a dummy for the period since 1999 was added to capture any permanent EMU effects.

[17] Other ways to absorb shocks include eating up cash balances or seeking credit facilities with the central or commercial banks (Cruz and Koc, 2018).
[18] As the US VIX index might not capture country-specific volatility in the euro area countries, the standard deviation of the national stock markets has been used as an alternative volatility measure, but the statistical results did not change materially.
[19] See González-Fernandez and González-Velasco (2018a). Two factors are seen at play here: the achievement of price stability in the euro area and the fact that there is a common monetary policy, eliminating inflation as a debt-reducing instrument for individual euro area countries.
[20] Interest rate swaps can and have been used to bring the outstanding maturity profile of debt in line with the targeted interest-rate sensitivity.

- A few euro area countries received EU/IMF financial assistance during the financial crisis that had resulted in limited or no bond market access. A dummy has been added for the years in which Ireland and Portugal received financial assistance, and a separate dummy was added for the year in which these countries regained market access.[21]
- Large-scale purchases of government bonds by euro area central banks in the context of QE since 2015 put downward pressure on the longer-term interest rate, captured by the yield spread. For illustration, bond purchases by the central banks at hand accumulated EUR 1.7 trn at the end of 2017, equivalent to some 35% of long-term gross debt issuances by the relevant governments over the 2015-2017 period. Additional QE-related effects may arise from QE offering a 'captive market', in the sense of a large, price-inelastic investor that is expected to be in the market for a substantial period of time. DMOs may try to lock in the very low rates by shifting issuances towards longer-term segments, which also satisfies investors' search for duration/return in the low-rate environment. The lower maturity bound for QE-eligible government bonds (initially two years, since 2017 one year) may also have incentivised DMOs to issue longer-term, though the observed shift in the average remaining maturity of government debt, from 7.0 to 7.6 years between 2014 and 2017, suggests that other factors have also been at play. For measuring the effect over and above the interest rate, a QE-dummy has been added to the estimates, both separately and interacted with government debt.[22]

Summarising, equation (1) is the estimation-equation to start working on.

$$\frac{Debt^{s}_{it}}{Debt_{it}} = \alpha + \beta_1 \frac{Debt^{s}_{it-1}}{Debt_{it-1}} + \beta_2 \, Debt^{s}_{it-1} * QE + \beta_3 (R^{l}-R^{s})_{it} + \beta_4 (R^{l}-R^{s})^{2}_{it} + \beta_5 Ygap_{it} + \beta_6 VIX_t + \beta_7 \Pi_{it} + \beta_8 Size_{it} + \beta_9 QE + \varepsilon_{it} \quad (1)$$

[21] Spain also received EU/IMF financial assistance but has not been included as the programme focussed on bank recapitalisation.

[22] Using a more refined indicator, namely national government debt in the hands of the national central banks in portion to national government debt outstanding, did not result in meaningful outcomes. Given substantial spill-overs as a result of the portfolio rebalancing effect of QE, this is in line with expectations.

with

$Debt^{s}_{it}$ = short-term debt issuance in country i at time t

$Debt_{it}$ = total government debt

α = common intercept

R^{l}_{it} = long-term interest rate

R^{s}_{it} = short-term interest rate

$Ygap_{it}$ = output gap

VIX_{t} = volatility indicator (US VIX)

Π_{it} = inflation rate

$Size_{it}$ = government bond market liquidity measure

QE = variable capturing Quantitative Easing

Episode-specific factors such as the run-up to EMU have not been included here to save space.

One-year lagged values of the interest spread and the (change in) government debt ratio are used in the estimates. This best reflects debt managers' practice of issuing regularly and predictable, leaving some, but limited, leeway for within-year adjustments in the debt maturity choice. Using lagged interest rates is motivated by the practice of front-loading by debt managers, making last-years interest rates more relevant than the average rate in the current year. For all other variables, in principle current values have been selected.

4. Outcomes

Non-stationarity in the variables is generally no issue, with the exception of the government debt level, the size of the national debt market and the VIX financial market volatility index (see Annex 2). In these cases, changes in the variables have been used.

As a start off, a robust OLS estimation was conducted including country-specific intercepts (Table 1, column 1). Variables included in the final version of equation 1 have been selected using a general-to-specific approach.

The estimates reveal a fairly strong degree of inertia in the short-term debt share. The coefficient (0.65) being well below unity supports estimating in levels rather than switching to a differenced equation.

The increase in the share of short-term debt when the government debt ratio rises may reflect debt managers' expectation that the debt acceleration is merely temporary, and therefore can best be financed with a short maturity.[23] It might also indicate debt sustainability concerns, as investors may prefer shorter maturities in case of rising debt, to limit their exposure to the sovereign, with the debt manager accommodating that request. However, the effect vanishes during the period of QE as the positive coefficient is compensated by the negative coefficient for this period. Increases in government debt between 2015 and 2017 therefore did not affect the debt issuance structure.[24] Sustainability concerns could have been overruled by euro area central banks owning an increasing part of government debt, as argued by Afonso and Jalles (2017). However, caution in drawing conclusions is needed with only three years of QE included in the sample.

Yield spreads have no significant effect on the debt maturity decision according to this estimate but we will return to this later in this section.

Increased financial market volatility leads DMOs to put more emphasis on short-term debt, as expected, allowing them to bridge the period of (temporary) elevated financial conditions and weak demand for long-term bonds. Investors from their side may want to temporarily store liquidity in safe and liquid short-term bonds until the storm subsides.

The run-up to EMU induced a one-time increase in longer-term bond issuances, likely reflecting increased liquidity and integration of the European sovereign bond market. The lack of a permanent EMU effect after 1998 may reflect the

[23] The initial recourse to short-term financing does not preclude that in a later stage, once the nature of the shock becomes clear, a shift to longer-term financing takes place.
[24] Compared to 2014, the short-term debt issuance share in 2017 was substantially lower in Austria (-23 percentage-points) and -to a much lesser extent- in France (- 6 p.p.) whereas it increased by around 5 p.p. in Portugal and Belgium.

decreasing degree of financial market integration since the start of the crisis in 2008.

In countries regaining market access after ending receiving EU/IMF financial assistance, a jump to longer-term bond issuance took place (almost 20 basis points).

Various additional explanatory variables have been tested, including inflation, the output gap, the 1992/1993 ERM crisis, the start of EMU in 1999, the years a country received EU/IMF financial assistance, a crisis dummy, and market liquidity, but without meaningful outcomes. For most variables, this is not surprising considering the outcomes of previous studies. Inflation has been low and stable, especially since the start of EMU. The lack of any effect of the output gap is also not unexpected as macroeconomic stabilisation does not feature as a debt management goal in the euro area.

Regarding the lack of significance of the yield spreads, this result may well reflect endogeneity in the right-hand side of the equation. In particular, the short-term debt issuance share could be affected by the yield spread, but the yield spread in turn could reflect the relative supply of government securities in the short and in the long segment. Therefore, the debt managers' reaction function is re-estimated using Two-Stage Least Squares (2SLS). The estimates (Table 1, column 2) are based on fixed effects, supported by the Hausman test. One-period lagged values of the right-hand side variables are used as instruments to the extent that they contribute to the equation's power. Additional information on first-stage estimation results is included in Annex 3.

The results indicate that DMOs issue relatively more short-term debt when the interest rate spread is high, albeit only at the 10% significance level. Spreads were especially high a few years before the start of EMU (around 1996) and during the sovereign debt crisis (2009-2011). While this suggests that debt managers are trying to take some advantage of interest rate spreads, adding squared spreads has a negative sign, indicating that the effect wears off as spreads increase. At the

euro area average interest rate spread of 1.3 percent-point, the positive impact on the short-term debt share is just above 2 percent-point of new debt issuance. So, debt managers take advantage of favourable financial conditions but only up to a certain level.

Table 1. Basic estimation results for the short-term debt issuance share

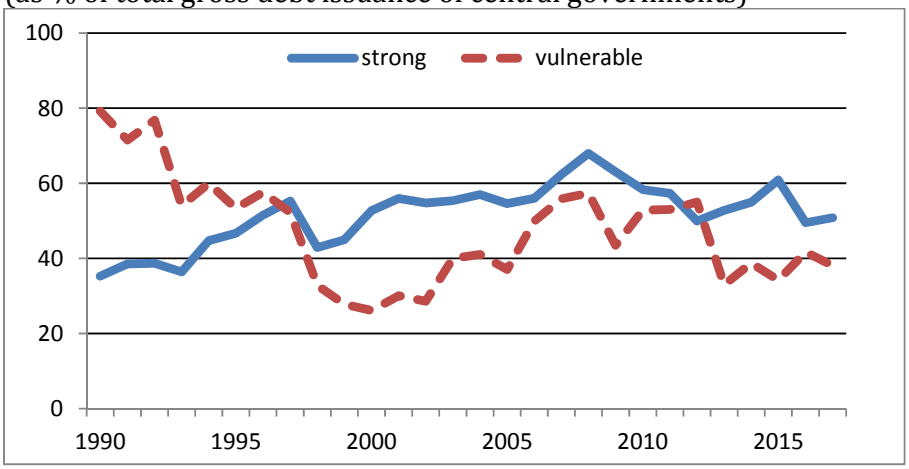
	(1)	(2)	(3)	(4)	(5)	(6)
Estimation-method	OLS	2SLS	2SLS	2SLS	OLS	2SLS
Sample period	1992-2017	1992-2017	1992-2017	1992-2017	1992-2017	1992-2017
Countries	All	All	Vulnerable	Strong	Strong	Vulnerable
				Extended	Limited	With LT
Intercept	8.15**					
	(2.18)					
ST share$_{-1}$	0.65***	0.63***	0.64***	0.56***	0.64***	0.64***
	(10.04)	(9.48)	(4.32)	(6.40)	(8.00)	(4.24)
Δ Gov. debt$_{-1}$	0.50**	0.76***	0.97**	0.31		1.00**
	(2.17)	(2.94)	(2.26)	(1.03)		(2.35)
Δ Gov. debt$_{-1}$ *QE	-0.87**	-1.08***	-1.33**	-0.95		-1.35**
	(-2.14)	(-2.64)	(-2.68)	(-0.28)		(-2.70)
QE	-1.40	-1.70	-1.83	-0.89		0.71
	(-0.47)	(-0.58)	(-0.83)	(-0.21)		(0.17)
Yield spread$_{-1}$	0.65	2.32*	3.50**	2.57		3.34*
	(0.88)	(1.94)	(2.12)	(0.74)		(1.85)
Yield spread$_{-1}^2$	-0.18	-0.58***	-0.77***	-0.48		-0.83***
	(-1.23)	(-2.97)	(-3.37)	(-0.29)		(-3.10)
Δ VIX	0.51***	0.58***	0.32	0.69***	0.56***	0.30
	(4.12)	(4.47)	(1.27)	(4.11)	(4.57)	(1.20)
EMU run-up	-8.35***	-8.68***	-13.61***	-9.77	-7.71*	-10.38
	(-2.43)	(-2.88)	(-2.80)	(-1.59)	(-1.75)	(-1.44)
End of financial support	-18.79***	-18.76***	-18.86***			-19.27***
	(-3.26)	(-3.61)	(-2.94)			(-2.98)
EMU participation	0.03		-7.20			-0.90
	(0.01)		(-1.65)			(-0.09)
Long-term interest rate$_{-1}$						0.99
						(0.66)
Adjusted R^2	0.77	0.46	0.50	0.44	0.51	0.50
# of observations	252	243	95	148	161	95
Hansen – J (P-value)	-	0.176	0.662	0.074	-	0.386

Note: *, ** and *** denote significance at the 10, 5 respectively 1% level of significance. Country-specific intercepts in the OLS estimation are not shown for brevity. The group of "vulnerable" countries includes Ireland, Italy, Portugal and Spain, the group of "strong" countries includes Austria, Belgium, Finland, France, Germany and the Netherlands.

Results on the other variables are comparable to the OLS estimates, with the debt variables gaining in significance. The 2SLS results score well on instrument test for overidentifying restrictions (Hansen J-statistic, see bottom line of the table).

Next, the sample is split into a group of "vulnerable" countries (Ireland, Italy, Portugal and Spain) and a group of "strong" countries (Austria, Belgium, Finland, France, Germany and the Netherlands). The Mann-Whitney test rejects the hypothesis of short-term issuances in the two groups having the same distribution. Figure 4 confirms the distinct development of the debt share in the two groups of countries; in strong countries, the short-term share increased over time (around 15 percent-point) whereas in the vulnerable countries the initial average short-term share of 80% halved. Moreover, fluctuations in the short-term debt share are much larger for the vulnerable countries than for the strong ones.

Figure 4: Short-term share in gross debt issuance, strong and vulnerable governments, 1990-2017
(as % of total gross debt issuance of central governments)



Note: The group of "vulnerable" countries includes Ireland, Italy, Portugal and Spain, the group of "strong" countries includes Austria, Belgium, Finland, France, Germany and the Netherlands.

Considerable differences in the estimates for these two groups of countries emerge (Table 1, columns 3- 5).

Outcomes for the vulnerable countries (Table 1, column 3) broadly correspond to those for the entire group as just discussed, but with differences in details. The effects of increases in government debt are comparable to the estimates for the entire group, though somewhat less significant (5%-level). The interest rate spread in normal times has a stronger positive effect on the debt issuance structure, and the coefficient is significant at the 5% significance level. The run-up to EMU and the end of EU/IMF programmes had a fairly strong downward impact in these countries, of 14 respectively 19 percent-point. There is no effect of financial market volatility on the debt issuance structure in these countries, though part of the effect could be reflected in the interest rates. The 1999 start of EMU has a permanent though non-significant downward effect on the short-term debt share. The outcomes as included in column 3 will serve as the benchmark for the vulnerable countries in the remainder of the paper.

Turning to the group of strong countries (Table 1, columns 4 and 5), re-estimation using the full equation used in column 2 reveals that financing conditions and government debt levels do not affect decisions on the debt issuance structure, neither in normal times nor in times of crisis or QE. As shown in the column with significant results only (Table 1, column 5), the list of relevant factors is limited to last year's debt issuance structure and changes in the market volatility, with a limited role for the run-up to EMU. None of the strong countries received EU/IMF financial support. With the endogenous interest rate spread not included as it does not show up significantly, the 2SLS estimates are equivalent to an OLS estimate. The restricted list of relevant factors, which is consistent with limited volatility in the debt issuance structure shown in figure 4, may reflect a deliberate policy to not distress investors though it may also reflect that gains from adjusting the issuing behaviour for these DMOs are small given on average lower debt ratios and interest rate spreads. The outcomes reported in column 5 will serve as benchmark for the strong countries in the remainder of the paper.

The outcomes on the role of interest rate spreads correspond to the findings of González-Fernández and González-Velasco (2018b) though they contrast those of

Hoogduin et al (2011) who concluded that the interest rate spread is relevant especially in countries with high creditworthiness.[25]

Debt managers may not only consider the interest rate spread but also the level of the interest rate when taking maturity decisions. Exceptionally low levels of interest rates, such as during QE, may induce debt managers to focus on long-term debt issuance to lock-in low rates for long, irrespective of the size of the spread. [26] At the time of QE, spreads in the euro area actually stood at levels close to their 1990-2017 average, as both short-term and long-term interest rates reached historical lows. However, no significant effects were found when testing for a separate effect of the long-term interest rate, also not when estimating separately for the group of vulnerable countries, as shown in table 1, column 6.[27]

Next, observations were split according to sovereign debt levels, as high levels of indebtedness may induce stronger shifts into short-term debt issuance with a view to reduce the interest burden, or by responding to investors that wish to limit their credit risk exposure to sovereigns with fiscal sustainability issues. Estimating the equations for debt levels above and below 60% of GDP - the European benchmark level for government debt – delivers results comparable to the ones for the strong and the vulnerable countries respectively (Table 2, columns 1 and 2). A new result is that financial volatility also affects debt issuance in the group of high-debt countries as does the QE-variable by itself. Differences to the previous results are probably related to markets assessing public finances in few instances as sound despite high government debt levels (e.g. Belgium) and countries over time switching from the high- to the low-debt group and vice versa (e.g. Ireland). However, the fit for the group of high debt/high spread countries is not as good as when grouping the results by country.

[25] Note that comparisons are hampered by a different allocation of countries over groups, and the fact that the study of Hoogduin et al (2011) covers an earlier period (1990-2009) with only few years of crisis included.
[26] A simple correlation even indicates a slightly negative relation between the interest rate spread and the long-term interest rate level (-0.20).
[27] As the long-term interest rate level is not stationary, the change in the long-term interest rate has been included as well but also with little success.

Table 2. Estimation results according to levels of government debt and interest rate spreads.

	(1)	(2)	(3)	(4)
Estimation-method	2SLS	OLS	2SLS	OLS
Sample period	1992-2017	1992-2017	1992-2017	1992-2017
Set of countries included	High debt	Low debt	High spreads	Low spreads
ST share$_{-1}$	0.36*** 3.06	0.70*** (9.07)	0.63*** (7.58)	0.711*** (6.57)
Δ Gov. debt$_{-1}$ -	0.92*** (2.62)		0.73** (2.43)	
Δ Gov. debt$_{-1}$ * QE	-1.23*** (-2.95)		-0.77 (-1.14)	-0.70* (-1.58)
QE	-4.68** (-2.30)		-2.57 (-0.74)	-1.70 (-0.36)
Yield spread$_{-1}$	4.16** (2.27)		3.58** (1.94)	
Yield spread$_{-1}$ ^{2}	-0.83*** (-2.98)		-0.75** (-2.50)	
Δ VIX	0.54** (2.52)	0.52*** (2.99)	0.24 (0.85)	0.53*** (3.09)
EMU run-up (1997/1998)	-5.05 (-1.62)	-9.70** (-2.28)	0.92 (0.15)	-12.33*** (-3.52)
End of financial support	-22.80*** (-5.67)		-21.67*** (-3.39)	
EMU participation	-5.84** (-2.17)			
Adjusted R^2	0.28	0.56	0.43	0.57
# of observations	119	138	126	125
Hansen – J (P-value)	0.535	-	0.674	-

Note: *, ** and *** denote significance at the 10, 5 respectively 1% level of significance. High debt refers to gross government debt levels above 60% of GDP, low debt to levels below that. High spreads refer to spreads (10-year government interest rate minus 3-month money market rate) above 1.5%, low spreads to levels below that.

Moreover, the equations were re-estimated with the sample distributed according to size of the interest rate spread, to test for any asymmetric reaction to financing conditions (Guggenheim et al. 2019). Splitting the sample in two equal parts by using a 1.5% spread cut-off, it indeed appears that yield spreads matter most when long-term rates are relatively high, while spreads near their long-term average (1.3%) or below do not invoke a reaction from debt managers, i.e., debt managers do not lower the proportion of short-term debt if its issuance is relatively expensive (see Table 2, columns 3 and 4). This may point to DMOs being

eager to maintain a certain minimum supply of short-term bonds even when its costs are high, to keep presence in this market or fulfil investors' demand for short-term liquidity, while extending its size if short-term interest rates are more favourable compared to long-term rates.

A cautious conclusion therefore is that debt managers in vulnerable, high-debt, high-spread euro area countries take some advantage of changes in interest rate spreads. They do so especially in case of relatively high interest spreads, although the scale of change is limited. Also, in these countries, the 'normal' increase in the short-term debt share when government debt rises ceases to operate when QE is active. The run-up to EMU and the end of financial assistance programmes had a positive impact on issuing longer-term debt.

In the strong countries, only financial market turbulence induces debt managers to change their plans but no short-term changes in issuing patterns in reaction to changing fiscal or financial conditions could be identified. Of course, in the somewhat longer-term, persistent changes in relative financing costs could induce a shift in issuances when debt managers draw up new issuance plans.

Robustness analysis

The robustness of these results has been tested as regards the choice of the dependent variable, the countries included, and the estimation technique.

The dependent variable used so far is total short-term debt issued within a year as a percentage of total gross government debt issued. This measure includes all short-term issuances within the year (e.g. four issuances of 3-month debt rolled over), and therefore places a larger weight on very short-term debt issuances. While this allows capturing shifts within the short-term debt structure, it tends to overstate the relevance of short-term debt in the stock of government debt. Therefore, another short-term debt indicator was used as well, being short-term debt outstanding at year-end as percentage of total gross debt issued by

governments ("stock measure").[28] This measure assigns equal weight to all short-term debt irrespective of its maturity.

Re-estimating equations using this alternative dependent variable for all countries and for the sub-set of vulnerable countries (Table 3, columns 1 and 2) show results different from the ones presented thus far (Table 1, columns 2 and 3), with some variables, notably all debt-related variables, ceasing to be statistically significant. Given that debt variables turned out significant in the estimates in table 1 with our preferred measure of short-term debt, a tentative conclusion could be that changes in government debt are primarily reflected in a shift within the category of short-term debt towards shorter-term debt (e.g. from 6 to 3 months maturity), but over time this very short-term debt is replaced with debt with longer maturities.

Differences in the group composition were also tested as that the position of few countries is less clear-cut. In particular, equations were re-estimated with Belgium transferred from the group of strong countries to the group of vulnerable countries.[29] The results reveal no major differences except that changes in government debt in the strong countries now also affect the debt issuance composition and the downward effect of EMU participation becomes significant (see Table 3, columns 3 and 4).

Moreover, given some data-issues for Ireland, with missing observations around the turn of the century and some years without short-term debt issuances before that, we also re-estimated the main equation for all euro area countries excluding Ireland (Table 3, column 5). Results are overall comparable to the standard equation (Table 1, column 2) except for the variable interacting government debt with QE which ceases to be significant.

[28] This is identical to the measure issued by Hoogduin et al (2011).
[29] In Hoogduin et al (2011), Belgium had been placed in the weaker group of countries, and Ireland in the group of stronger countries.

Table 3. Estimation results using alternative dependent variable and compositions

	(1)	(2)	(3)	(4)	(5)
Estimation-method	2SLS with stock measure	2SLS with stock measure	2SLS	OLS	2SLS
Sample period	1992-2017	1992-2017	1992-2017	1992-2017	1992-2017
Countries included	All	Vulnerable	Vulnerable incl. BE	Strong excl. BE	All excl. IE
Intercept					
ST share$_{-1}$	0.70*** (9.03)	0.74*** (6.55)	0.64*** (4.67)	0.52*** (5.34)	0.64*** (9.06)
Δ Gov. debt$_{-1}$	0.17 (0.95)	0.10 (0.30)	0.91** (2.40)	0.52** (2.02)	0.57*** (2.75)
Δ Gov. debt$_{-1}$ * QE	-0.12 (-0.45)	-0.10 (-0.27)	-1.25*** (-2.73)		-1.18 (-0.65)
QE	-1.31 (0.96)	-1.46 (-0.67)	-1.19 (-0.63)		-1.51 (-0.54)
Yield spread$_{-1}$	1.67* (1.79)	4.35* (1.92)	3.27** (2.25)		1.96* (1.66)
Yield spread$_{-1}^2$	-0.36** (-2.25)	-0.64** (-2.46)	-0.71*** (-3.34)		-0.53*** (-2.95)
Δ VIX	0.46*** (2.83)			0.71*** (4.02)	0.56*** (9.06)
EMU run-up (1997/1998)	-8.69*** (-2.75)	-17.93** (-2.31)	-11.43*** (-2.82)		-8.43*** (2.67)
End of financial support	-12.58*** (-4.18)	-14.55*** (-4.52)	-19.01*** (-3.18)		-12.95* (-1.87)
EMU participation		-8.23 (-1.56)	-6.51** (-2.04)	9.46*** (2.87)	
Adjusted R^2	0.52	0.56	0.50	0.51	0.47
# of observations	223	95	120	128	223
Hansen – J (P-value)	0.095	0.301	0.351	-	0.268

Note: *, ** and *** denote significance at the 10, 5 respectively 1% level of significance.

As a rough check for the outcomes for the strong countries, a debt management reaction function akin to the one for these countries was estimated for the US (Table 4, column 1). The outcomes indicate that interest rate spreads do not affect the debt maturity choice in the US, just as for the strong euro area countries. Noteworthy is that higher government debt in the US results in an increase in long-term debt issuance; for the strong euro area countries, no such effects has been found while for the vulnerable countries a debt increase is accompanied by a

reduced reliance on long-term debt issuance. One possible explanation is that - given the safe haven status of US sovereign debt and the international role of the US dollar – financial markets do not perceive fiscal sustainability concerns in the US when debt rises, giving the US Treasury the opportunity to reduce roll-over risks when debt increases, whereas the vulnerable countries in the euro area face increasing sustainability concerns if debt rises.

Table 4. Estimation results for the US and Arellano-Bond estimate

	(1)	(2)
Estimation-method	OLS	Arellano-Bond
Sample period	1992-2017	1992-2017
Set of countries included	US	Euro area
Intercept	14.43** (2.43)	8.61** (3.68)
ST share $_{-1}$	0.83*** (10.76)	0.83*** (15.84)
Δ Gov. debt$_{-1}$	-0.39*** (-4.80)	0.45** (2.54)
Δ Gov. debt$_{-1}$ * QE		-0.59*** (-3.53)
QE		-1.20 (-0.79)
Yield spread$_{-1}$		1.40** (3.08)
Yield spread$_{-1}^2$		-0.32*** (-6.03)
Δ VIX		0.53*** (4.49)
EMU run-up (1997/1998)		-9.92*** (-3.57)
End of financial support		-22.70** (-3.16)
Adjusted R^2	0.85	-
# of observations	26	243
Hansen test (P-value)	-	1.00

Note: *, ** and *** denote significance at the 10, 5 respectively 1% level of significance.

As to alternative estimation techniques, the inclusion of the lagged dependent variable causes correlation between the regressor and the error term, likely leading to a (downward) bias in the coefficient on the lagged short-term issue

share ("Nickell problem"). The equation for the entire set of countries therefore was re-estimated using the Arellano-Bond estimator for dynamic panel data. To limit the number of instruments, only two-period lagged variables have been used as instruments.

Results for the entire set of countries as (Table 4, column 2) are broadly similar to the 2SLS estimates (Table 1, column 2). However, as this estimator is meant principally for estimates involving few periods and many panels ("small T, large N"), the large number of instruments used in comparison to the number of observations calls for caution in drawing firm conclusions, as confirmed by the very high value of the Hansen-test of overidentifying restrictions. For this reason, no estimates for the subsets of vulnerable and strong countries are shown, and the results are used for a broad robustness check only, and not as the main outcome.

5. Conclusion

In strong euro area countries, changing economic, financial and fiscal conditions hardly lead to changes in the sovereign debt issuance structure, suggesting that these debt managers adhere to a regular and predictable debt issuance schedule, thereby foregoing any potential short-term financial gains. This may reflect their strategy to be predictable, which should reduce issuing costs in the longer term, but at the same time it could also reflect that financial gains are negligible given their good standing.

Debt managers in the high-debt/vulnerable countries to some extent take advantage of changes in the interest rate spread, shifting issuance toward the cheaper debt instrument. This happens mainly in case interest spreads are clearly positive, but less so if they are average or below. Moreover, rather than extending the share of short-term debt, it appears that debt managers turn to shorter-term maturities within the category of short-term debt.

The impact of QE on the issuance structure of government debt goes beyond the direct effect on interest rates. Debt managers in vulnerable countries usually issue

more short-term debt in case of rising debt ratios but not so in the 2015-2017 QE period. This may reflect the central bank's presence in the bond market as a large, fairly predictable and price-insensitive buyer for some time ("backstop function"), mitigating traditional sustainability concerns of investors on rising indebtedness. As a result, part of the effect of QE that stems from the private sector holding less government bonds ("scarcity effect") has been undone, though the lower eligibility limit for QE purchases of government debt may also have played some role here. In any case, given limited QE experience, these outcomes have to be treated with caution.

As asset purchases in the euro area are still ongoing, additional experiences within the euro area, as well as in other countries, may shed more light on the degree to which debt managers adjust their issuing behaviour when central banks become active in government bond markets. These experiences may also hold lessons for any future euro area debt management office.

Annex 1: Description of data, definitions and sources

Data have been taken from various sources, especially as regards the initial period (1990-1995), warranting some caution in interpreting the results.

Share of short-term debt (1 year and below) in gross debt issuance by the central government: ECB Government Finance Statistics, supplemented by OECD government debt statistics for 1993-2008.[30]

Short-term interest rate: 3-month EURIBOR (annual average). Source: OECD

Long-term interest rate: Interest rate on 10-year government bond (annual average). Source: ECB interest rate statistics.

Yield spread: Long-term minus short-term interest rate.

Government debt: Gross central government debt as per cent of GDP. Source: OECD Economic Outlook, supplemented with Commission AMECO data.

Government deficit: General government net lending as per cent of GDP. Source: OECD Economic Outlook. This refers to lending by the general government, lacking sufficient data on lending by the central government.

Debt market liquidity: national government debt as a percentage of total government debt of the euro area countries included.

Inflation rate: IMF World Economic Outlook.

Output gap: Gap between actual and potential real GDP, as per cent of the latter. Source: IMF World Economic Outlook.

VIX: US equity market volatility measure, annual average.

ERM: Dummy taking value 1 in 1992 and 1993 for ERM members except Germany, else 0.

EMU run-up: Dummy taking value 1 in 1997 and 1998, else 0.

EMU: Dummy taking value 1 as of 1999, else 0.

Crisis: Dummy taking value 1 between 2008 and 2014, else 0.

Financial assistance: Dummy taking value 1 in the year of receiving EU/IMF financial assistance (Ireland 2011-2013; Portugal 2011-2014), else 0.

[30] Short-term debt includes money market instruments and short-term bonds except for Ireland for the period 1993-2008 where short-term debt refers to short-term bonds only, for lack of data on money market instruments.

End of financial assistance: Dummy taking value 1 in the year of regaining market access following EU/IMF financial assistance (Ireland 2013; Portugal 2015), else 0.

QE: Dummy taking value 1 in years in which the ECB pursued quantitative easing (2015-2017), else 0.

Residual maturity of gross general government (Figure 3): OECD (1995-2009) and ECB (2009-2017).

For the US estimates (Table 4, column 1), data on short-term debt issuance have been taken from BIS securities statistics. The US QE dummy has value 1 in 2009-2014, and else zero. Data for other variables have been taken from the same sources as for the euro area countries.

Table A1.1 Short-term debt volumes

In billion euro

	AT	BE	DE	ES	FI	FR	IE	IT	NL	PT
1990	8.81	107.20	9.95	59.59	0.00	85.68	NA	291.96	0.69	16.79
1991	9.53	120.89	5.13	54.77	0.87	73.35	NA	313.70	2.49	17.99
1992	11.80	133.57	4.86	65.49	2.75	124.35	NA	352.23	1.73	13.42
1993	12.67	139.54	1.12	73.45	5.55	99.23	14.29	384.50	1.36	11.47
1994	13.42	125.59	1.24	67.50	11.85	114.58	10.73	350.93	7.05	14.10
1995	15.26	131.98	0.08	94.71	18.45	165.88	3.68	368.88	6.78	13.72
1996	15.64	122.30	9.99	80.95	11.96	182.32	16.32	343.46	14.99	13.76
1997	16.48	128.90	20.43	83.19	7.61	153.95	10.79	261.33	36.62	13.03
1998	0.62	130.54	20.52	46.73	5.98	168.34	0.00	223.92	40.06	4.93
1999	8.57	99.36	21.27	43.01	5.06	96.28	0.00	195.23	49.59	1.85
2000	28.58	80.45	20.45	39.81	8.87	94.32	0.00	168.90	34.37	0.75
2001	17.74	83.11	31.82	27.07	15.25	116.53	0.00	190.77	34.77	3.99
2002	11.08	85.88	48.82	32.24	12.54	184.86	0.00	211.35	51.14	2.87
2003	17.17	76.55	64.32	36.21	11.49	239.33	0.00	220.57	76.14	12.10
2004	11.77	62.02	71.44	36.96	12.60	226.19	0.00	227.21	71.01	12.64
2005	11.48	69.44	72.74	29.51	7.22	201.58	0.00	213.60	58.09	19.03
2006	15.84	64.03	73.55	25.89	10.02	166.56	NA	212.06	57.92	16.28
2007	30.45	83.03	70.91	26.97	12.89	186.63	NA	231.77	74.50	15.33
2008	20.54	126.44	76.88	52.66	15.79	317.78	NA	277.90	231.46	30.67
2009	9.94	136.83	175.57	110.00	19.87	512.41	1.84	273.31	258.29	42.62
2010	13.44	92.71	198.91	114.66	23.06	456.97	28.88	214.94	166.49	47.85
2011	19.39	100.25	207.39	101.84	13.76	412.72	6.01	213.73	131.06	38.41
2012	9.95	84.12	182.28	92.73	7.24	395.64	11.53	248.24	111.60	34.43
2013	9.47	102.86	165.48	58.67	6.48	392.27	6.56	218.49	154.35	21.65
2014	20.45	88.15	133.10	97.29	7.87	411.45	10.68	182.89	105.26	18.23
2015	9.82	105.04	105.08	97.87	8.39	356.92	5.87	164.13	71.64	14.54
2016	8.52	90.01	120.45	101.00	10.62	325.14	7.07	152.69	63.81	19.12
2017	9.15	124.46	89.93	94.44	10.19	329.44	7.46	151.60	63.49	19.76

Annex 2: Data characteristics

1990-2017, euro area data

	Average	Standard deviation	Minimum	Maximum	Unit root test[&]	Obser-vations
Short-term debt issuance share	49.79	21.977	0.00	99.00	-2.746**	273
Yield spread	1.32	1.657	-5.25	9.98	-2.850***	280
Government debt	66.12	27.087	12.60	131.34	2.254	278
Δ Government debt	0.86	5.354	-27.49	24.57	-4.033***	268
Government deficit	-3.10	3.631	-32.06	6.86	-2.791***	279
VIX (volatility)	19.38	5.891	11.10	32.70	-1.907**	28
Δ VIX	-0.45	4.761	-9.00	15.20	-6.442***	27
Market size	9.58	9.368	0.89	33.42	0.872	260
Δ Market size	-0.00	0.392	-1.394	2.09	-6.049***	250
Inflation	2.23	1.698	-1.68	13.37	-4.906***	280
Output gap	-0.67	2.924	-11.32	7.71	-2.773***	279
R^l	5.17	3.009	0.09	25.40	-0.710	280
Δ R^l	-0.38	0.956	-4.26	4.84	-8.260***	270
Stock measure of short-term debt issuance share	31.33	18.102	0.00	76.43	-2.108**	271

[&] The value indicates the Im, Peseran and Shin (IPS) Z-t-tilde-bar statistic except for the VIX which is not country-specific and was based on the Phillips-Perron test. Highly negative values indicate unit roots, with *, ** and *** denoting significance at the 10, 5 respectively 1% level of significance.

Annex 3. Details of estimation results

OLS estimates in Table 1, column 1 include country effects.

All 2SLS estimates have been conducted using fixed effects.

Table A3.1. First-stage results for endogenous variables $Spread_{-2}$, $Spread^2_{-2}$ and LT_{-1}

	Table 1, column nr			
	(2)	(3)	(4)	(6)
$Spread_{-2}$	X	X	X	X
$Spread^2_{-2}$	X	X	X	X
Δ.VIX	X	X	X	X
Δ Gov. $debt_{-1}$	X	X	X	X
Δ$Gov.debt_{-1}$*QE_{-1}	X	X	X	X
D9798	X	X	X	X
End IMF/EU programme		X	X	X
LT_{-1}				X
EMU				
F-test $Spread_{-1}$	36.75***	15.45***	26.35***	21.46***
F-test $Spread^2_{-1}$	7.07***	3.25***	23.27***	3.20****
F-test LT	-	-	-	13.28***

X denotes that the variable has been included in the first-stage estimation.
*, ** and *** denoting significance of the P-value at the 10, 5 respectively 1% level of significance.

Table A3.2. First-stage results for endogenous variables $Spread_{-2}$ and $Spread^2_{-2}$

	Table 2, column nr	
	(1)	(3)
$Spread_{-2}$	X	X
$Spread^2_{-2}$	X	X
Δ.VIX	X	X
Δ Gov. $debt_{-1}$	X	X
Δ Gov.$debt_{-1}$*QE_{-1}	X	X
D9798		X
End IMF/EU programme	X	
EMU	X	
F-test $Spread_{-1}$	30.62***	36.34***
F-test $Spread^2_{-1}$	4.32***	9.46***

X denotes that the variable has been included in the first-stage estimation.
*, ** and *** denoting significance of the P-value at the 10, 5 respectively 1% level of significance.

Table A3.3. First-stage results for endogenous variables $Spread_{-2}$ and $Spread^2_{-2}$

	Table 3, column nr			
	(1)	(2)	(3)	(5)
$Spread_{-2}$	X	X	X	X
$Spread^2_{-2}$	X	X	X	X
Δ.VIX	X		X	X
Δ Gov. $debt_{-1}$	X	X	X	X
Δ.Gov.$debt_{-1}$*QE_{-1}	X	X	X	X
D9798	X	X	X	X
End IMF/EU programme		X	X	
EMU	X			X
Output gap	X			X
F-test $Spread_{-1}$	29.36***	19.30***	18.26***	27.09***
F-test $Spread^2_{-1}$	5.63***	4.37***	3.99***	5.82***

X denotes that the variable has been included in the first-stage estimation.
*, ** and *** denoting significance of the P-value at the 10, 5 respectively 1% level of significance.

The Arellano-Bond estimate (Table 4, column 2) has been performed by a one-step system robust, orthogonal GMM, with the second lag of spreads, squared spreads, government debt, government debt interacted with QE, and the output gap as instruments.

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