Fiscal Policy Signalling in Government Bond Issues

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ABSTRACT

The sustainability of government debt and the credibility of fiscal commitments have increasingly preoccupied scholars and policy makers in recent years. Attention is increasingly given to signaling mechanisms in which words are matched by deeds (costly talk). We argue that when default is not a serious risk, long-sighted DMOs can send signals to the public about their government's' future fiscal performance by issuing longer debt when they expect good news or shorter debt when they expect bad news. By doing so DMOs assume higher costs of debt, but build their credibility with market makers. We also argue that such signals are likelier in large issues and in times of fiscal stress, when DMOs are especially anxious to maintain their credibility with market makers. We test our hypotheses with a unique dataset of almost 25,000 issues of government debt in 26 of the OECD countries during 2004-12, and a unique compilation of legal text defining the authority of DMOs. We support these hypotheses with Fixed Effects regressions and monthly data frequency. In particular, we find that DMOs with greater autonomy from elected policy makers tend to reduce the maturity of issued debt by 2.3-3.3 years 1-3 months ahead of a deterioration in the government's credit rating.

KEYWORDS

Debt management; Yields; Elections; Credibility; Fiscal Policy

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Introduction

Financial, economic and political developments in recent years, such as the American financial market crash in 2007-2008, the euro crisis since 2010, and the fiscal policy partisan conflict in the United States, have produced new challenges and their aftermath has highlighted the importance of restraining fiscal deficits and debts

The presumption for many decades has been that the governments of the major market economies will never default, and that their debt is risk-free. However, governments have historically gone through cycles of debt defaults (Reinhart and Rogoff, 2009) and developed economies are not immune to this. Fiscal policy is central to the exercise of political sovereignty and democracy (Brender and Drazen, 2009), and inflexible rules may be deemed arbitrary and non-democratic especially in time of economic hardship. As a result, in recent years formal obligations to meet particular public deficit or debt levels have not effectively constrained governments.

What can be done to improve fiscal discipline? North and Weingast (1989) argued that constitutions that limit executive discretion enhance the credibility of a country's sovereign debt because it can more credibly commit to repaying its debts when the chief executive cannot unilaterally repudiate them. Schultz and Weingast (2003) drew the logical conclusion that democracies' promises to repay their debts should be more credible (the "democratic advantage"). Consistent with this point Stasavage (2003) and Saiegh (2009) show that changes in the preferences of veto players explain interest rate fluctuations. However, studies of more recent and extensive data sets show a different picture (Saiegh 2005; and Archer *et al*. (2007)). Beaulieu *et al*. (2012) argue that many autocracies did not enter the international bond markets because they knew they could not find purchasers at prices they were willing to pay.

Even if one accepts the argument of democratic advantage experience suggests that democracies vary in their ability to make credible fiscal commitments. One important reason is that public finances can be characterized by the Common Pool Resource (CPR) problem. The CPR problem increases with ideological, ethnic, linguistic and religious divisions; the more heterogeneity the greater the fiscal problems (Hallerberg, 2004; Hallerberg *et al.*, 2009). Indeed evidence shows that public deficits rise with government fragmentation (Hallerberg, 2004; Volkerink and de Haan, 2001) and frequent elections (Clark and Hallerberg, 2000; Sadeh, 2006), even though in developed countries voters seem to reward fiscal prudence (Brender, 2003; Brender and Drazen, 2005; 2008). The political bias of the government may also affect the credibility of its commitments (Sadeh 2011). Vaaler *et al.* (2005) found that in developing countries credit risk rises whenever a left-wing government is expected to replace a right-wing government. Finally, budgetary politics can be incremental or path-dependent (Jones *et al.*, 2014), subject to logrolling and hostage to political polarization (Alt and Lassen, 2006).

Thus, some scholars suggest that the institutional framework in which budgetary processes are embedded is an important determinant of fiscal outcomes. Some fiscal rules, institutions, and norms work better in some countries than in others because of the underlying politics of a country (Hallerberg *et al.*, 2007). One of the ways to overcome the CPR problem is to centralize the budget process, either by delegating authority to a single office or through legally binding contracts among political parties (Hallerberg *et al.*, 2009). Hallerberg and Wolff (2008) find that a strong finance minister reduces interest rate spreads of Euro area countries and allows markets to forgive temporary deficits. Breen and McMenamin (2013) argue that power-sharing and party-system-polarization affect long-term interest rates in advanced economies. Where collective responsibility is high and polarization is low, the market perceives a more credible commitment on the part of sovereign debtors.

If governments cannot credibly commit to fiscal rules, some scholars have argued that markets may discipline them by raising risk premia in response to fiscal imprudence (Afonso and Strauch 2007; Hallerberg, 2011; Heppke-Falk and Wolff, 2008). Poterba and Kim (2001) find evidence that risk premia fall with good fiscal institutions. However, doubts remain over the efficiency of markets. Market failure seems especially critical when there is asymmetric information and/or the possibility that markets may overreact to news (Mosley, 2000). Market overreaction is especially likely in periods of large market uncertainty and when large and/or negative shocks occur (Ehrmann and Fratzscher, 2005). Hallerberg (2011) suggests that market discipline will work as a fiscal restraint when there is no possibility of a bail-out, information is forthcoming, and voters support fiscal restraint (Brender, 2003). So the ball is back in the court of institutions.

Sometimes credibility can be derived from multilateral commitments, such as the Stability and Growth Pact (SGP) in Europe or through engagement in IMF programs. International institutions regularise expectations about members' future behaviour. Gray (2009) argues that the EU can send strong signals to financial markets about the trajectory of a particular country, substantially decreasing perceptions of its default risk. Goldbach and Fahrholz (2011) find that credibility-strengthening decisions and proclamations by the European Commission played a decisive role in decreasing the volatility of the common default risk premium in 1999-

2005, while statements it made signaling a weakening of fiscal credibility increased volatility.

Another important determinant of the credibility of fiscal commitments is the way targets are formulated. Numerical fiscal rules, i.e. rules that specify a fixed target irrespective of circumstances have fallen out of fashion in the wake of France and Germany's breaking of the SGP rules (von Hagen and Wolff, 2006), although Debrun *et al.* (2008) find evidence that suggests that causality runs from rules to fiscal behavior. Perhaps governments should target their credit rating, as decided by private agencies. Biglaiser and Staats (2012) find that bond ratings reward rule of law, strong and independent courts, and protection of property rights.

More recently scholars have suggested that fiscal rules can act as policy signals about the future intentions of governments. Policy signals can be crucial in making a fiscal target more (or less) credible because they improve government communication with the public and can relieve market agents' anxiety about their information disadvantage. Kelemen and Teo (2014) argue that balanced budget rules coordinate decentralized punishment of sovereigns by bond markets. The clarity of the focal point provided by the rule, rather than the strength of its judicial enforcement mechanisms, determines its effectiveness.

However, in order to win credibility, governments must match the signals with action, making the signals costly. Such costly signaling could involve, for example, exchange rate anchoring (Guisinger and Singer, 2010), which signals policy commitment and confidence in future reforms at a cost of risking higher future interest rates if policies are not delivered. Sometimes there is more than one signal sender, be they external experts, independent central banks, fiscal agencies ("watchdogs") or political rivals. In multiple sender models multiple senders compete for influence on expectations of debt holders and potential lenders. This competition changes the precision of the message sent (Baerg, 2012).

This research attempts to add value by studying a communication channel that was so far neglected by the literature surveyed above. We believe that when default is not a serious risk, the maturity of newly issued debt can serve as a fiscal policy signal. For that purpose we study the institutional features of national Debt Management Offices (DMOs) in democratic countries with a moderately high sovereign debt credit rating and show that their signaling is effective if their decision making is autonomous from elected policy makers or if their environment allows them to value long term goals.

In the next section we review the literature on optimal debt management and conclude that much of it is normative, assuming a benevolent DMO who aims to maximize aggregate welfare. We also conclude that the maturity of issued debt is almost the only parameter over which the DMO has discretion. In the third section we adopt a positive approach in order to understand how DMO's actually work. We analyze an optimization problem made up of three practical policy objectives and solve it for the optimal maturity of newly issued debt. This analysis allows us to formulate eight hypotheses.

We argue that long-sighted DMOs can send signals to the public about the government's future fiscal performance by issuing longer debt when they expect good news or shorter debt when they expect bad news. In doing so DMOs assume higher costs of debt, but build their credibility with market makers. We also argue that such signals are likelier in large issues and in times of fiscal stress, when DMOs are especially anxious to maintain their credibility with market makers; and regardless of privileged information, long-sighted DMOs are likely to issue longer debt than short-sighted DMOs in times of fiscal stress, if outstanding debt is small and short, and if the market expects interest rates to rise.

In the fourth section we describe our research design. The data that we use consists of detailed information on 24,838 issues of government debt in 26 of the OECD countries during 2004-12. It also includes analysis of legal text defining the authority of DMOs and the fundamental sources of low government turnover (which can proxy for DMO long-sightedness only in democracies), and data on yields and credit ratings. Our study is unique in using issuance rather than debt stock data and in compiling such institutional data on DMOs. Issuance data is more helpful in order to study signaling, because it allows testing hypotheses derived from a dynamic model where time lags are important.

In the fifth section we use this data in monthly frequency to test our hypotheses with fixed effects regressions. We find that in practice long-sighted DMOs behave no different than short-sighted ones when faced with a large debt stock, or when the market expects the interest rate to change. However, DMOs with greater legal autonomy from elected policymakers indeed send strong signals of credibility; they tend to reduce the maturity of issued debt by 2.3-3.3 years 1-3 months ahead of a deterioration of one notch in the government's credit rating by one of the three agencies. And indeed such behavior is more evident in times of fiscal stress. The sixth section provides conclusions.

What's on the mind of a DMO

In a market economy with a liberalized capital account the government is a peculiar borrower. Just like any other borrower the government purchases credit services for a price (the interest rate). However, the government is a very large borrower, normally the largest single borrower in the economy and its debt is normally an important benchmark asset on which banks, firms, financial institutions and households, domestic and foreign, rely. Because government debt is important to the management of private assets and to private saving and investment decisions it may indeed be compelling to view the government as a supplier of a particular form of liquidity services to firms, institutions and households.[1] Thus, the government is often regarded as a 'seller' of its debt, which is an asset for the 'buyers'.

The result is that when the government borrows (issues debt) it is not a perfect price taker: it cannot expect to receive any amount of credit it needs at some going interest rate. Rather, the government faces a supply of credit (demand for the bills,

[1] We do not enter the discussion of the famous 'Ricardian Equivalence', which stipulates that government borrowing is equivalent to tax collection, as the latter will eventually be raised in order to repay the former. Our point of departure is the observation that in reality vibrant markets exist for government debt, which means that for many people taxes and government debt are not equivalent, because they are not fully rational, because the debt burden is shifted to future generations, because of tax distortions or because capital markets are not perfect. It therefore follows that debt management is not neutral, or in other words it has real effects (Missale, 1999, Ch.2).

notes and bonds that it issues), with more credit supplied (bonds demanded) if the type of the issued debt satisfies the creditors.

There are different types of debt that the government can issue to finance its budget deficit, and which determine the quantity of credit it can receive. The types of government debt differ in the currency of their denomination, in their indexation to the price level (or some other variable), in the variability of the interest rate that they carry (the important distinction here is between fixed rate debt to periodically-adjustable rate) and in their transferability (i.e. the ability of the initial lender to freely sell on the debt in a liquid secondary market). Importantly, government debt is also characterized by its term to maturity, which among OECD countries in the past decade ranged from two days to more than 50 years.

As the sole issuer of its own debt the government could be understood as a monopoly, and as such may be able to exploit its position in order to maximize its own goals. Assuming the government is a long-sighted unitary actor with consistent preferences maximizing the aggregate welfare, the debt management strategy could aim at minimizing the welfare loss of tax distortions, enhancing the credibility of macroeconomic stabilization policies, relaxing borrowing constraints faced by private agents and insuring them against idiosyncratic shocks, improving intergenerational risk sharing, maintaining a balanced budget, providing automatic stabilizers or simply minimizing the costs of the debt and its risks (Missale, 1999; Nosbusch, 2008).

However, in practice the government cannot design its debt strategy to meet many of these goals. First, the government cannot normally act as a monopoly because government debt may have local and foreign substitutes, i.e. creditors can lend to other actors (Greenwood *et al*., 2009). In addition, under normal circumstances prevailing in OECD countries in the past decade the amount that the government borrows at any particular time is a small fraction of its outstanding debt, which is traded in a secondary market and determines the interest rate on newly issued debt. So even if it wanted, the government could not manipulate the quantity of debt to minimize its borrowing costs as a monopoly in, say apples would do; and it cannot impose on the market types of debt that are not in demand. Market agents may not cooperate with the government's attempt to reach optimal debt structure if their optimal individual choices lead to a sub-optimal aggregate equilibrium (i.e. market failure), or if they do not have the same information that the government has. Government debt is a unique asset, but governments in liberalized market economies do not control the bond markets.

Second, as discussed in the introduction, the government may not be able to act as a unitary player with consistent preferences, isolated from interest groups. Many democratic governments are based on coalitions among political parties and/or factions within parties, each with its own possibly conflicting policy priorities, and few, if any, campaigning for the aggregate good. Maintaining such coalitions requires policy choices that do not necessarily serve the aggregate good.

Third, even if the government acts as a consistent unitary actor, it rarely acts to maximize the aggregate good. Governments commonly have a partisan bias, which mean their policies favor particular groups in society at the expense of others. Political pressure from foreign governments and institutions may also not necessarily conform to the aggregate good. Possibly the only uncontested aggregate good is the minimization of the costs of the debt and its risks.

Fourth, many governments are not long-sighted. In democracies the electoral cycle is known to affect decisions of office-seeking politicians and it is rational for them to focus on short-term gains that can be flagged ahead of the next elections, and defer the costs of these policies until after the elections. Despite external appearances many autocratic governments are also short-sighted, depending on the likelihood of a coup. However, this problem of short-sightedness can be resolved in democracies with a strong rule of law by delegating authority over debt management to a non-political professional authority, especially if its goals are not contentious (such as minimization of debt's costs), as discussed below.

Finally, it is impractical to issue the kinds of sophisticated state-contingent instruments that are needed for a debt strategy to achieve most of the above worthy goals and maximize aggregate welfare. The ideal debt instrument for that would have a return that is positively indexed to output and negatively indexed to government spending. However, markets prefer simple and liquid types of debt that are unlikely to be manipulated by government policy. Some of those goals can be achieved with simpler types of instruments (Buera and Nicolini, 2004) but in order to fine tune the debt structure in this way the government must obtain very detailed and accurate information about the relationship among different economic variables. In reality, such information is only available in hindsight, and with varying degrees of accuracy (Missale, 1999).

Furthermore, huge fluctuations in positions might be necessary, and enormous changes in portfolios required for minor changes in maturities. The fragility of portfolios to small changes in assumptions means that it is safer for policy makers to follow simple and transparent rules rather than attempt to issue the optimal debt portfolio under some possibly wrongly specified model (Buera and Nicolini, 2004; Faraglia *et al.*, 2010). Empirical studies have repeatedly shown that actual debt structures do not conform to the predictions of normative analyses about optimal policies beyond minimizing the costs of the debt and its risks (Faraglia *et al*., 2008). Other policy tools may be better than debt in achieving these goals.

The result of all this is that in practice governments determine the amount they need to borrow each year in a process that reflects the above political exigencies and ask their DMOs to set the parameters of the debt in such a way as to minimize the cost of the debt and limit its risks (Blommestein and Turner, 2012). Heavy borrowing will result in higher interest rates, if doubts over the government's solvency arise, or simply because of the immediate burden placed on available credit. If creditors are not forthcoming and/or the borrowing costs are too high, or either of those are anticipated to be true, the government can try harder to reduce its borrowing needs by cutting its deficit or increasing its surplus.

The DMO's set of choices is even narrower. Given the amount it needs to borrow on behalf of the government the secondary market determines the interest rate (yield) on the issued debt. The DMO has some room for decision over the distribution of the annual borrowing in quantity and time over specific debt issues during the year. However, in practice this room for decision is limited for a number of reasons. First, the total amount to be raised during the year in order to cover for the government's deficit, which is given to the DMO, is by no means carved in stone. Fiscal surprises are very common, resulting from overshooting or undershooting of forecasts of the tax revenue, the expenses or both. Early in the year the DMO isn't really sure how large the actual deficit will be, and by the time the final amount is known little room is left for discretion with regard to specific issues.

Second, even if the actual deficit was known in advance, the progression of spending and tax collection throughout the year is not necessarily a predictable process, the former depending on bureaucratic processes and the latter depending on the business cycle. There may be little need for borrowing to finance government activity early in the year, when the government has not yet managed to spend its money, precisely when some discretion may theoretically exist about borrowing amounts. Third, a significant part of the debt to be raised is the rolling over of maturing debt. Government debt commonly pays only interest until it is repaid in full on maturity (bullet debt), and unless the government runs a surplus one dollar of new debt must be issued for every one dollar of maturing debt. In many countries, a large part of the DMO's job is to maintain an ever expanding pool of outstanding debt, which if any, shrinks with time only in proportion to GDP.

Finally, DMOs have an incentive to issue debt at regularly publicized intervals in order to reduce the costs of the debt. The reason for this is that there is always some risk that an auction will fail to raise the planned amount of credit, if the public is not sufficiently interested in the types of debt on offer. To minimize this risk the DMO can work with primary dealers or market makers – financial institutions that are expected to buy some minimum amount of newly issued debt and receive various privileges in return. Primary dealers in turn prefer the type and amount of new issues to be regular and predictable, and may pay a premium (which lowers the government's borrowing cost) for reduced uncertainty.

More precisely, mismatches between supplied and demanded quantities, which are normally observed in debt auctions in the primary market, result either from attempted deviations from secondary market interest rates, from credit rationing by the private creditors (Ali Abbas *et al.*, 2014) or from the level of liquidity of the particular type of debt in the secondary market. According to the preferred habitat approach there are investor clienteles with preferences for specific types of debt, especially specific maturities, and the interest rate for a given maturity is influenced by demand and supply shocks specific to that maturity. Some creditors, such as banks' treasury departments, are not interested in buying long term nominal debt because of the volatility of its holding return (Krishnamurthy and Vissing-Jorgensen, 2012), while others, such as life insurance companies and pension funds, focus on buying long-term government debt as assets to back their long-term commitments (Vayanos and Vila, 2009). As such, most investor clienteles have limited ability to substitute across the yield curve (Guibaud *et al.*, 2013) and attempts to compensate them for issuing debt in the wrong maturity may be unrealistically expensive (Buraschi and Jiltsov, 2007).[2]

As a result, unpopular types of debt are thinly traded in the secondary market even if they have a going price there; attempts to issue such types of debt are likely to meet insufficient demand in auctions even if 'the price is right'. Conversely, auctions of popular types of debt may well be oversubscribed. Badly designed auctions that neglect such clientele considerations can raise the financing cost for the government even when this is not macro-economically warranted. A failed auction might precipitate a financial crisis or just result in unnecessarily high borrowing costs.

However, the DMO does, in many countries, have more discretion in determining the type of issued debt. This includes determining the share of debt

[2] Of course in the secondary markets arbitrageurs can integrate maturity markets, ensuring that bonds with nearby maturities trade at similar prices (Vayanos and Vila, 2009). However, because they are risk averse they cannot entirely eliminate the preferred habitat effect, and they may be hampered by regulation. Furthermore, arbitrageurs are much less active in the primary market, where information on prices and maturities is announced only after the auction.

indexed to the price level, the share of non-marketable debt, the share of debt denominated in a foreign currency, and the maturity of the debt.[3] The former two types of debt have, with some exceptions, not been common for new issues in OECD countries in recent years, because market agents tend to regard them as unnecessarily complicated.[4]

New issues of foreign-denominated debt have not been rare among countries without an internationally-accepted reserve currency such as the Czech Republic, Denmark and Poland, but have also been relatively common in Austria, Finland and Slovakia, which are Euro-area member states. This can be explained as either a legacy from the stabilization period in the Ex-communist countries, or the use of government debt to manage these countries' foreign reserves. Nevertheless, by far the most popular type of government debt in OECD countries in the 21st century has been fixed-rate nominal domestic bullet debt (Ali Abbas *et al.*, 2014). This leaves the maturity of such debt as the most important parameter of debt issuance, which is set by all DMOs in order to achieve their goals.

How should a DMO set the maturity of newly issued debt in order to minimize the costs of the debt and its risks? Arguably the most important practical goal of the DMO is to maximize the coverage ratio in every issuance, by issuing fixed-rate

[3] For simplicity we regard decisions on the issuance of variable rate debt as part of the decisions on the maturity structure of the debt. The maturity of debt with a variable interest rate is determined by the interval to the first rate adjustment.

[4] Indexed debt has nevertheless remained a common instrument in Israel and to a lesser extent in the UK too. Australia, Canada, France and the US also frequently issue indexed debt, but in small quantities

nominal domestic bullet debt with a popular maturity. [5] The coverage ratio is simply the ratio between the subscribed amount (the amount of debt that market agents are willing to buy for specified maturities and interest – q_m) and the amount on offer (q). For auctions to be successful and to maintain the DMO's reputation as a credible borrower the coverage ratio should at the very least be greater than 1. Assuming that the DMO is offering the debt at the going interest rate in the secondary market, and following the logic of the preferred habitat approach, it can set the maturity of the issued debt in order to maximize the coverage ratio. Very long maturities may not be popular with creditors because the present value of long nominal debt is very sensitive to inflation and changing interest rates. Very short maturity may not help creditors with very long commitments. The coverage ratio will fall if the DMO insists on issuing debt at unpopular maturities.

Another important goal for the DMO is to minimize the rollover ratio. This is the ratio between the amount of debt maturing at a particular time and the total amount of outstanding debt. The higher this ratio is the more debt needs to be raised merely to rollover the existing debt, reducing the likelihood of successfully issuing debt to cover the government's deficit or even enough to rollover existing debt. In order to reduce the rollover ratio the DMO needs to keep pushing back the average maturity (X) of outstanding debt (Q), which naturally is one day shorter with every passing day. For that, the DMO needs from time to time to issue long debt even if it means paying a higher interest rate or disappointing market agents who look for shorter maturities. All else equal, the DMO should try to maximize the rise in the average maturity on outstanding debt. A given rise in average maturity is all the more important if currently it is relatively short.

[5] For a survey of DMOs motivations see Missale (1999, 4).

A third important goal for the DMO is to minimize the effective interest rate paid on the issued debt. The effective interest is made of the current interest rate (the rate actually paid on the new bond), deflation (if the bonds are nominal) and currency appreciation (if the bonds are issued in local currency) and the rollover interest rate risk. The current interest rate can be reduced if the maturity of the newly issued bond is low (assuming yields rise with maturities as in a normal yield curve). If the DMO expects high inflation and/or currency depreciation then bonds indexed to prices and/or a foreign currency should be avoided.

The rollover risk is the expected rise in the interest rate during the life of the newly issued bond, which will be the interest rate paid on the rolled-over debt when this bond matures. Since it is unlikely that a DMO can accurately forecast interest rates a few years in advance, a general expectation of higher interest rates in the future is reason to 'lock in' the current low rate by issuing long. In this the DMO faces a dilemma: The DMO may want to issue a short bond for the sake of its low interest rate compared with a long bond, but if the DMO expects a rise in the interest rate it may be better to issue a long bond, even if this means paying a higher current interest rate than it would on a short bond.

In the long term the DMO can reduce the interest rate paid on government debt by cultivating its credibility among creditors and foregoing opportunistic gains from privileged information. We assume that the government has a lead on the public in information about the development of government debt (i.e. the public has an information lag). The government in general has early knowledge of military confrontations that will result in higher military spending and lower output and taxes. It has privileged information on the likelihood of calling early elections or fiscal demands of coalition partners. The government may also have advanced knowledge on the progress of tax revenue and other statistics that signal the business cycle, and possibly on the future direction of monetary policy. Crucially, the government knows better than the public just how serious it is about its long-term commitments.

The DMO can signal upcoming good news by issuing long debt. In doing so the DMO would lock in the current relatively high rate, at a cost to the interest it pays on government debt, but buyers of the long bond would benefit when its price would rise following the announcement of the good news and the following fall in the market interest rate. Similarly the DMO can signal upcoming bad news by issuing short. The advantage of such signaling is the credibility it confers on the government's debt management and the low interest on debt that it helps maintain in the long term. Creditors suspect DMOs that lack credibility of possibly engaging in opportunistic debt issuance, and may demand a premium. Building up the DMO's credibility is important especially in view of its relations with market makers. This form of 'costly talk', incurring costs in the short term in order to maintain policy credibility in the long term, resembles known policy anchors such as currency pegs and independent central banks, the costs of which to the government help reduce inflationary expectations.

Of course the ability of the DMO to provide such credible signals depends on institutional factors that allow it to focus on the long term. Especially important are a stable political environment and legal arrangements that reduce the potential interference of elected politicians in debt management.

Making it formal

Equation (1) simplifies these three DMO goals into a loss function, which rises with the amount of interest paid on the debt (the product of the size of the bond $\boldsymbol{q}$ and the effective interest $\boldsymbol{i_{eff}}$), but falls when the relative change in average maturity on outstanding debt ($\Delta\boldsymbol{X}/\boldsymbol{X}$) increases, and with the coverage ratio ($\boldsymbol{q_m}/\boldsymbol{q}$).

$$(1)\ L_{DMO}(x) = qi_{eff}(x) - \lambda\varphi\frac{\Delta X(x)}{X} - \lambda\frac{q_m(x)}{q}$$

The costs to the DMO's loss function stemming from missing each of these three goals can be minimized with a different level of maturity at issuance (*x*) so this optimization problem obviously involves a compromise. This compromise in turn depends on the parameters discussed below, which may vary across time and countries.

First, the optimal maturity at issuance depends on the relative importance of the three goals to the DMO. $\boldsymbol{\lambda}$ (the Greek letter *lambda*) is the positive weight of the average maturity on outstanding debt and the coverage ratio relative to the interest cost of the debt.[6] Achieving the first two goals should be less important to the DMO compared with the third ($\boldsymbol{\lambda}$ should be low) when the government is especially worried about the cost of interest payments on its debt and seeks ways to cut them – i.e. in periods of fiscal stress. A long-sighted DMO (represented by a relatively high positive future preference factor $\boldsymbol{\varphi}$ – the Greek letter *phi*, when compared across countries and years) would emphasize the goal of improving $\boldsymbol{X}$.

[6] We assume for simplicity that reducing the maturity of the outstanding debt and maximizing the coverage ratio are equally important to the DMO.

This future preference factor is determined by the institutional factors discussed above. In particular, to the extent that elected policy makers control the DMO, the sooner they expect to lose office the smaller φ will be. In the long term the duration of the policy makers' office term is determined by constitutional, electoral and parliamentary rules. A DMO that takes decisions autonomously of elected policy makers is expected to be longer-sighted and have a higher φ value than politically-controlled DMOs.

Equation (2) is a linear formulation of the effective nominal interest rate (this is helpful in order to allow this optimization problem to be soluble). The current interest rate is made of some fundamental level of the nominal interest rate (affected by the country's idiosyncratic features and global conditions – I), and is sensitive to the maturity of the bond (α being the slope of the yield curve) and the quantity being issued (to reflect the fact that the government is not a perfect price taker, with β being the slope of the market supply of credit curve).

$$(2)\ \ i_{eff}(x) = I + \alpha x + \beta q + \mu \pi^e x + \psi \varepsilon^e x - \varphi\left(i_{mf} x - S_G x\right)$$

The government pays the rate of price inflation on its debt. The rate of inflation is paid when the bond matures if it is indexed to prices. Alternatively if the bond is not indexed the rate of inflation is paid annually through the nominal interest rate, which factors the public's expected rate of inflation for the period x.[7] However, if inflation rises during x relative to the public's original expectation, then the government would end up paying more for inflation if the bond is indexed than if it is not. μ (the Greek letter *mu*) is the relative balance of newly issued indexed debt. Specifically it is the

[7] For convenience the following discussion assumes that x is measured in years, but the logic obviously applies to other frequencies too.

difference between the quantity of newly issued debt that is indexed, and the quantity of the newly issued debt that is not, divided by q. Hence μ is bounded between 1 and -1, positive values reflecting a greater share of indexed debt in the new issue than the share of non-indexed debt. π^e is the difference between the average annual rate of inflation that the DMO expects at issuance during x and the rate that the public expects at that time. If the DMO expects a higher rate of inflation than the public then π^e will be positive. $\pi^e x$ is the cumulative cost of such excess inflation over the period x.

Quite similarly the government also pays the rate of its currency depreciation on its debt. ψ (the Greek letter *psi*) is the relative balance of newly issued foreign-denominated debt (calculated similarly to μ). ε^e is the difference between the average annual rate of depreciation that the DMO expects at issuance during x and the rate that the public expects at that time. If the DMO expects a higher rate of depreciation than the public, then ε^e will be positive. $\varepsilon^e x$ is the cumulative cost of such excess depreciation over the period x.

The last expression in Equation (2) represents expectations for the future interest rate and potential for signaling. i_f is the future rise in the annual interest rate (essentially the average rise in the yield curve) as expected by the public. $i_f x$ is the cumulative rise in the yield curve during period x. A long-sighted DMO will issue long if expectations in the market are for interest rates to rise in the future, in order to lock-in the current low rate.

S_G is the rise in the interest rate over and above the public's expectation, as expected by the DMO due to the information advantage that it has over the public. Any change to the maturity of debt at issuance that is related to changes in S_G is a signal of these expectations, at a cost to the DMO. i_f and S_G are independent of each other and assume negative values if the interest rate is expected to fall (the former) or the DMO has privileged good news and therefore expects an additional fall in the interest rate (the latter). The effects of these expectations and privileged information are discounted in Equation (2) by the future preference factor $\boldsymbol{\varphi}$.

Equations (3) and (4) show that the impact that the current issue has on the average maturity on outstanding debt depends on the size of the issue ($\boldsymbol{q}$) relative to outstanding debt ($\boldsymbol{Q}$), and the extent to which the maturity on the current issue ($\boldsymbol{x}$) exceeds the maturity on outstanding debt ($\boldsymbol{X}$).

$$(3)\quad \frac{\Delta X(x)}{X} = \frac{X_t(x)}{X_{t-1}} - 1$$

$$(4)\quad X_t(x) = \frac{(X_{t-1} - 1)(Q_{t-1} - M_t) + x_t q_t}{Q_{t-1} - M_t + q_t}$$

Every period $\boldsymbol{t}$ the old outstanding debt is one period shorter, so its maturity is represented by the expression $X_{t-1} - 1$.[8] In calculating the average maturity on the new outstanding debt (X_t) the old average maturity is weighted by the quantity of the old outstanding debt, which is the old quantity (Q_{t-1}) minus any debt maturing in period $\boldsymbol{t}$ (M_t).

Equation (5) represents the market demand for newly issued tradable government debt, depending on its maturity. q_b is the amount that market makers and the public in general desire at their preferred maturity (x_m), all else equal. The public's preferred maturity is affected by such concerns as the degree of liquidity at different parts of the yield curve, the sustainability of existing government debt, and their expectations for inflation.

[8] $\boldsymbol{t}$ is the frequency of debt issuance, which is independent of the frequency used to discuss yields and rates of inflation and depreciation.

$$(5)\ q_m(x) = q_b - \theta(x - x_m)^2$$

θ (the Greek letter *theta*) is the positive 'disappointment' factor by which market agents may reduce the quantity demanded if the maturity of the current issue is too long or too short for their needs. A high disappointment factor means that quantity demanded is very sensitive to the maturity of the current issue. Substituting Equations (2)-(5) in Equation (1), we solve for the optimal maturity at issuance, which is given in Equation (6):[9]

$$(6)\ x^* = x_m + \frac{\varphi q^2}{2\theta X(Q+q)} - \frac{q^2\{\alpha + \mu\pi^e + \psi\varepsilon^e - \varphi(i_f - S_G)\}}{2\lambda\theta}$$

Equation (6) tells us that an optimizing DMO will take the maturity preferred by the public (x_m) as a basis for the maturity at issuance it sets (x^*), and depending on the relevant parameters will deviate from it in order to raise the average maturity on outstanding debt and save on the interest cost on the debt. Any such deviation is likelier the more forgiving the public is (low θ) and in times of fiscal stress (when λ is low). The DMO will dare issue longer maturities than the public desires especially when outstanding debt is short and small (X and Q are small), the yield curve is flat or inverted (low α), the DMO's inflation or depreciation expectations exceed the public's and most of the newly issued debt is not indexed or foreign (or the opposite, such that the products $\pi^e\mu$ or $\varepsilon^e\psi$ respectively are negative), the market expects interest rates to rise in the future (high i_f) but according to privileged information they may fall (low S_G).

[9] See Annex 1 for a step-by-step solution.

Since we are especially interested in how the DMO signals its privileged information on the future of government policy we derive $\boldsymbol{x}^*$ by $\boldsymbol{S_G}$ (the same derivative applies for $\boldsymbol{i_f}$ of course, with a reversed sign):

$$(7)\ \frac{\partial x^*}{\partial S_G} = \frac{-\varphi q^2}{2\theta\lambda}$$

Equation (7) shows that a signal is likelier to be sent (i.e. privileged information on the government's policy is likelier to affect the choice of maturity at issuance) when the issue is large (high $\boldsymbol{q}$), the DMO is long sighted (high $\boldsymbol{\varphi}$), the public is forgiving (low $\boldsymbol{\theta}$) and in times of fiscal stress (low $\boldsymbol{\lambda}$).

In order to find how institutional factors that affect the DMO's long-sightedness influence the optimal maturity at issuance, in Equation (8) we derive the latter by the DMO's future preference factor $\boldsymbol{\varphi}$.

$$(8)\ \frac{\partial x^*}{\partial \varphi} = \frac{q^2}{2\theta\lambda}\cdot\left\{\frac{\lambda}{X(Q+q)} + \left(i_f - S_G\right)\right\}$$

Equation (8) shows that long sightedness does not necessarily lead to longer issues. If the expression inside the large parentheses is negative a long-sighted DMO may yet issue short. This is likelier when raising the maturity on outstanding debt ($\boldsymbol{X}$) is not important enough (low $\boldsymbol{\lambda}$), when post-issuance outstanding debt is very large and long (the product $\boldsymbol{X}(\boldsymbol{Q} + \boldsymbol{q})$ is high), when the market expects interest rates to rise only moderately or to fall (low or negative $\boldsymbol{i_f}$), or when according to privileged information they may rise (high $\boldsymbol{S_G}$).

Based on the above discussion, and focusing on measurable parameters we can hypothesize that all else equal the maturity of government debt at issuance ($\boldsymbol{x}$) will rise when:

1) The weighted aggregate maturity on post-issuance outstanding debt – $\boldsymbol{X}(\boldsymbol{Q} + \boldsymbol{q})$ – will fall (this is the sum of products of quantity and maturity of all outstanding issues).
2) The slope of the yield curve ($\boldsymbol{\alpha}$) will fall, especially when issue is large (high $\boldsymbol{q}^2$) <u>or</u> in times of fiscal stress (low $\boldsymbol{\lambda}$).
3) The square of – $\boldsymbol{\mu}$ – the relative balance of newly issued indexed debt rises, especially when the issue is large (high $\boldsymbol{q}^2$) and in times of fiscal stress (low $\boldsymbol{\lambda}$). The explanation for this is as follows: If the DMO expects inflation to exceed the rate that the public expects (positive $\boldsymbol{\pi}^e$) it can reduce the cost of debt by issuing more non-indexed bonds ($\boldsymbol{\mu}$ =<0), and when it expects inflation to fall short of the rate that the public expects (negative $\boldsymbol{\pi}^e$) it can reduce the cost of debt by issuing more indexed bonds ($\boldsymbol{\mu}$>0). So if the DMO takes such positions on inflation then when $\boldsymbol{\pi}^e$ is positive, $\boldsymbol{\pi}^e$ is expected to have a positive relationship with $\boldsymbol{x}^*$ (inflation erodes the value of debt especially when it is long). Conversely when $\boldsymbol{\pi}^e$ is negative it is expected to have a negative relationship with $\boldsymbol{x}^*$ (when $\boldsymbol{\pi}^e$ is negative a falling $\boldsymbol{\pi}^e$ means a greater gap of expectations, and the DMO can profit on the low inflation it expects with indexed bonds especially when they are long). This can be formalized as a quadratic relationship, the square of $\boldsymbol{\pi}^e$ being positively associated with $\boldsymbol{x}^*$. Of course $\boldsymbol{\pi}^e$ is unobservable, but being correlated

with $\boldsymbol{\mu}$ the latter can proxy for it (because of the quadratic form no reversal of signs is needed).[10]

4) The square of the relative balance of newly issued foreign-denominated debt ($\boldsymbol{\psi}$) rises, especially when the issue is large (high $\boldsymbol{q}^2$) and in times of fiscal stress (low $\boldsymbol{\lambda}$) for the same reason.
5) The rate of increase in the interest rate as expected by the market ($\boldsymbol{i_f}$) will rise, especially when the issue is large (high $\boldsymbol{q}^2$), the DMO is long-sighted (high $\boldsymbol{\varphi}$) and in times of fiscal stress (low $\boldsymbol{\lambda}$).
6) The interest rate according to privileged information ($\boldsymbol{S_G}$) – the signal that the DMO sends – falls, especially when the issue is large (high $\boldsymbol{q}^2$), the DMO is long-sighted (high $\boldsymbol{\varphi}$) and in times of fiscal stress (low $\boldsymbol{\lambda}$).
7) The DMO's preference for the future ($\boldsymbol{\varphi}$) will rise and there is no fiscal stress (high $\boldsymbol{\lambda}$).
8) The DMO's preference for the future ($\boldsymbol{\varphi}$) will rise and the weighted aggregate maturity on post-issuance outstanding debt – $\boldsymbol{X}(\boldsymbol{Q} + \boldsymbol{q})$ is low.

In short, we hypothesize that long-sighted DMOs are likelier than short-sighted DMOs to signal their privileged expectations by issuing longer debt when they expect good news, or shorter debt when they expect bad news. This signal is likelier in large issues and in times of fiscal stress. We further hypothesize that regardless of privileged information long-sighted DMOs issue longer debt than short-sighted

[10] Of course DMO's issue indexed debt for other reasons too, which our model for simplicity does not incorporate. Nevertheless, issuing few indexed bonds would be costly if inflation falls short of the public's expectations, and this can be reasonably expected to be on the DMO's mind.

DMOs in times of fiscal stress, if outstanding debt is small and short, and if the market expects interest rates to rise.

Research design

To test these hypotheses we have compiled a new dataset of debt issues. Since our model is not about sovereign default risk and since we are assuming competitive markets with relative transparency and lack of serious government credibility issues, we limit the dataset to governments and periods that none of the three major credit rating agencies rated BBB+ (or Baa1) or less.[11] Since the rule of law is essential to our measure of DMO autonomy (see below) we also restrict our study to independent democracies. Due to data availability constraints (see below) the dataset begins in 2004. We have so far been able to compile data in all relevant variables up to 2012 for 26 governments (with some missing observations).[12] Data frequency is monthly, since few countries regularly issue debt on a weekly basis.[13]

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[11] Guibaud *et al.* (2013) use a more restrictive threshold of AA-, but adopting that criterion in this study would deprive it of many observations. Our threshold makes sense given that it is common to the bailed-out euro area member states (such as Ireland and Portugal since the second quarter of 2011 and Spain since the second quarter of 2012).

[12] These include all current OECD member states minus Chile, Estonia, Greece, Iceland, Luxembourg, Mexico, Slovenia and Turkey. These countries will be added at the next stage of this research, except for Mexico and Turkey that do not qualify our credit rating threshold any time during our data period. Other potential countries

To test the above hypotheses we ran a Fixed Effects linear regression with clustered standard errors (see Table 1). Where necessary, variables were lagged in order to reduce the likelihood of endogeneity – the possibility that the very issuance of new debt affects them. Non-stationary variables were differenced (see Annex 2 for descriptive statistics). The numbering of the βs is according to the leftmost column in Table 1.

- *MATURITY*: This is the operational measure of $\boldsymbol{x}$. It is the average time to maturity (in years) of government debt issued during the month, weighted by the nominal value of issues with different maturities (current exchange rates are used to weight foreign-denominated debt). Included is any debt that is part of the national sovereign debt and issued or legally backed by the central government (such as provincial or municipal debt, to the extent that the rating agencies by definition give it the same rating as for the central government). However, non-tradable debt is excluded, as is debt issued by the central bank solely for the purpose of money supply management,[14] savings bonds,[15] bills issued with a

for our study include Andorra, Botswana, Cyprus, Latvia, Lithuania, Lichtenstein, Malaysia, Malta, Taiwan and Trinidad.

[13] Guscina and De Broeck (2011) compiled a somewhat similar dataset, but theirs has a much narrower coverage (only 16 euro area member states and Denmark, and only for 2007-09), and was not made public.

[14] In our data this includes the Israeli "Makam" and the Korean Monetary Stabilization Bonds.

[15] Savings bonds are retail debt instruments which commonly have some or all of the following characteristics: limited transferability, early redemption options, limits on

maturity of less than three months,[16] and any debt that is not included in the national sovereign debt. The data was compiled from national debt management agencies, central banks and ministries of finance and supplemented by issuance data from Bloomberg. It includes micro data on all government debt issuance for the countries in the sample in 2004-2012. The data includes, for each individual issue, the issuance and maturity dates, amount sold, average yield, average price, currency, indexation, fixed/floating interest rate, bid-to-cover ratio and amount demanded (if an auction). This type of data is less common and complete before 2004.

- *DEBT_STOCK*: This is a proxy for $Q + q$. Unfortunately data for the average maturity of the debt stock (X) is not available for any country after 2010, so using it to calculate $X(Q + q)$ would entail the loss of many observations. Since for most countries it is available only in annual frequency, and anyway is non-stationary we decided to do without it. Data for $Q + q$ is based on quarterly observations of Total Gross Central Government debt (Millions USD, current prices, current exchange rates, annual levels, not seasonally adjusted), which were downloaded from OECD Stat from the Public Sector Debt Database (consolidated, nominal value). A linear extrapolation, which

quantities purchasable by individuals. Examples include US Savings Bonds, Israel Bonds, Canada Savings Bonds, Kiwi Bonds.

[16] Many of these bills are cash management instruments, the issue of which has more to do with day to day management of government current accounts, as with an overdraft facility, than with the kind of dilemmas we are studying. Another reason to exclude these bills is the lack of consistent data on market yields at such very short maturities.

assumes that the changes between quarterly observations are evenly distributed across their component months, was then used to convert the quarterly data into monthly data. However, due to poorer availability this variable was constructed differently for six of the 26 countries in our data set (see Annex 5). Hypothesis 1 would be supported if β_1 is estimated to be <u>negative</u>.

- *QUANTITY*^{2}: This is the square of the total amount of newly issued debt during the month in millions of euros (such that 1 billion euros of issues is represented by *QUANTITY*^{2} = $1{,}000^2$). Data was acquired as part of the compilation of the issuance database (see *MATURITY*, above).
- *STRESS*: This is a dummy variable for the period of fiscal stress (low λ) starting in September 2008 (when Lehman Brothers collapsed). The five-year bond CDS rate (a common measure of risk), averaged for the governments in this dataset, picked up meteorically at that point and has not yet returned to the pre-Lehman levels. This is a time-variant but country-invariant.
- *INSTITUTION*: This is a proxy for φ. High *INSTITUTION* values represent long-sightedness. Hypothesis 7 would be supported if β_{20} is estimated to be <u>negative</u>. Hypothesis 8 would be supported if β_{21} is estimated to be <u>negative</u>. There are four alternative variables that measure φ:
  - *AUTO1* is a dummy variable scoring 1 for countries in which the DMO is legally somewhat autonomous from elected policy makers, or otherwise scoring 0. The DMO is the most senior non-elected policy maker in charge of issuing debt. The DMO is judged to be legally somewhat independent if the law delegates some authority to the DMO in deciding the parameters of debt issuance (amount issued, maturity, interest rate, and timing of issuance) or at

least if by law the state's chief executive, and/or in parliamentary democracies the minister in charge of public debt, cannot ignore the advice of the DMO or of some other body of non-elected professionals.

- *AUTO2* is a dummy variable scoring 1 for countries in which the DMO is legally or administratively somewhat autonomous from elected policy makers, or otherwise scoring 0. The DMO is judged to be administratively independent if any one or more of the following conditions are met: (1) the law mentions the DMO but allows the executive to disregard the DMO's suggestions; (2) the DMO is a distinct legal entity; (3) by law no single elected policy maker can dictate the parameters of debt issuance.

  AUTO1 and *AUTO2* are time invariant but country-variant (see Annex 3 for country-specific information). A high φ value is indicated by a high *AUTO* value.

- *DURATION1* is a measure of structural government turnover in months. Decision making horizons are expected to be shorter when governments are short-lived. In presidential democracies *DURATION1* is the constitutionally mandated electoral interval; in parliamentary democracies it is the instrumented cabinet duration. Cabinet terms are considered to have ended when the governing coalition changes and/or when elections to the legislature take place. Instrumenting is based on a regression of the average cabinet duration (during the data period) on a vector of institutional features. These include population and territory data in each country, electoral laws that affect parliamentary fragmentation, and rules of operation of the legislature that effect the ease of toppling a government in parliamentary democracies (see Annex 4 for details of the instrumenting procedure). A high φ value is indicated by a high *DURATION* value. *DURATION* differs across countries but is fixed over time.

- *DURATION2* is similar to DURATION1 but uses a different definition for cabinet duration: periods of transition governments are not counted as indication of political instability, so DURATION2 returns slightly higher values than DURATION1.

- *CURVE*: This the operational measure of $\boldsymbol{\alpha}$. It is the difference in percent points between the yield on ten year bonds and the yield on three month bills, which is based on common empirical proxies for the yield curve factors (Afonso & Martin, 2012; Diebold, Rudebusch & Aruoba, 2006).[17] Data for the yield curves were downloaded from Bloomberg. The curves are Fair Value zero coupon and option free yield curves and include the common issuance terms (3 and 6 months, 1-8, 10, 15, 20 and 30 years). The end of month closing yield for each point on the curve was taken as the monthly value. Hypothesis 2 would be supported if β_3, β_4 <u>and/or</u> β_5 are estimated to be <u>negative</u>.
- *INDEXED*: This is the operational measure of $\boldsymbol{\mu}^2$, calculated as explained above and varying between 0 (exactly one half of the debt issued during the month was in indexed bonds) and 1 (either all or none of the issued debt was in indexed bonds). Hypothesis 3 would be supported if β_6, β_7 <u>and/or</u> β_8 are estimated to be

[17] To test for the validity of this seemingly arbitrary measure of the slope of the yield curve we took the yield curve data for each country at the end of each quarter and regressed the yield on the number of years and its square separately for each country-quarter. The series of these country-quarter coefficients of time and time^2 were highly correlated ($r = 0.98$) with each other and with the simple measure of the slope of the yield curve proposed above.

positive. Data was acquired as part of the compilation of the issuance database (see *MATURITY*, above).

- *FOREIGN*: This is the operational measure of ψ^2, calculated as explained above and likewise varying between 0 and 1. Hypothesis 4 would be supported if β_9, β_{10} and/or β_{11} are estimated to be positive. Data was acquired as part of the compilation of the issuance database (see *MATURITY*, above).
- Δ_*INTEREST*: This is the operational measure of i_f. It is the average (in percent points and across maturities) market yield on government debt expected to prevail after an interval of time identical to *MATURITY*, minus the current average yield. For each maturity the expected (forward) yield is implied from the compounded yield on some long maturity bond, discounted by the compounded yield on a shorter maturity bond. For example, the implied yield on a one year bond to be issued two years from now is the market annual yield on a three year bond currently trading, compounded over three years, divided by the compounded annual market yield on a two year bond currently trading. This implied expected (forward) yield includes the risk premium on the change in the yield, which explains why yield curves are overwhelmingly upward sloping, and thus the implied expected yield tends to be higher than the current yield on the same maturity. The yields were sampled at the end of each month (remember that this independent variable is lagged). Hypothesis 5 would be supported if β_{12}, β_{13}, β_{14} and/or β_{15} are estimated to be positive.
- *SIGNAL*: This is the operational measure of S_G. It is the negative change in an index of the government's credit rating, as averaged across the three main credit rating agencies (S&P, Moody's, Fitch) at the end of each month. For this calculation the 20-notch scale of each agency was converted to numerical values

such that their average can have some 60 values in between. This variable is specified with one, two or three leads in order to capture the effect of the information later revealed about the government. Hypothesis 6 would be supported if β_{16}, β_{17}, β_{18} and/or β_{19} are estimated to be negative.

Control variables were used for the following factors:

- 8 Year dummies (time fixed effects) to control for global conditions affecting the bond market, as well as temporal variation in the market preferred maturity at issuance ($\boldsymbol{x_m}$) (2004 is the default).
- 11 month dummies to provide higher resolution to the time fixed effects (January is the default).
- A lagged dependent variable controls for serial correlation, possibly the result of national debt management plans, which specify when and how much debt is issued during the year (Melecky, 2012).

Results

We start this discussion by observing that the maturity of debt at issuance is a stationary variable while the stock of debt and the slope of the yield curve are not (see Annex 2). In simple words, the debt stock and curve's slope demonstrate long-term trends but the maturity features no such trends. This is a first sign that the latter two variables cannot explain the former. As a result we measure MATURITY's relationship with the differences of the debt stock and the slope.

Tables 1-2 show that Hypotheses 1, 4, 7 and 8 are not supported in any of the regressions. In other words, DMOs in practice do not seem to consider the debt stock in their decisions on the maturity of debt at issuance, their foreign debt issues do not seem to be opportunistically motivated, and long-sighted DMOs are no different than short-sighted ones in times of fiscal stress or when faced with a large debt stock.

In contrast Hypothesis 2 is supported in all regressions. However, this is true only because of the negative coefficient of the interaction between the fiscal stress dummy and the slope of the yield curve (STRESS×L.D.CURVE). In other words, there is no sign that DMOs consider the yield curve when deciding the maturity of the issued debt, except in times of greater need to save on the cost of debt. The coefficient of this interaction ranges between -0.6 and -0.7 in the different regressions, which means that since September 2008 a rise of one percent point in the slope of the curve during the preceding month resulted in the newly issued debt to be on average 0.6-0.7 years (7-8 months) shorter.

Hypothesis 5 is also supported in all regressions, because of the positive coefficient of the interaction between the aggregate quantities of the monthly issues and the expected change in the future interest rate ($QUANTITY^2$×L.Δ_INTEREST). There is no sign that a change in the expected rate in the market motivates the DMOs to adjust the maturity of the issued debt, regardless of fiscal stress and DMO long-sightedness, unless the issue is large. The coefficient of this interaction is around 9e-12 when long-sightedness is measured by the loose criterion of legal independence (AUTO2), which means that when issues total one hundred billion euros over the month (so $QUANTITY^2$ is the square of 100,000, or 10 billion) a rise of one percent point in the expected interest rate increases the maturity of the issued debt by 0.09 years, or one month.

Hypothesis 3 is not supported in most regressions, but there are mixed results when DMO long-sightedness is measured with the loose criterion of legal independence (AUTO2) in regressions (4)-(6). In general when the DMO takes a position on inflation in either direction (*INDEXED*=1) maturities are 2.7 years shorter, which means that the DMO is actually limiting the debt's exposure to inflation, rather than speculating on it. This is even more so with large issues. However, this pattern of behavior is reversed in times of fiscal stress, when more speculative behavior is observed.

Hypothesis 6 also receives mixed results. In general DMOs tend not to issue signals about forthcoming news, but rather to take opportunistic advantage of their privileged information (significant and positive coefficient of *SIGNAL* at the third lead). There is a small tendency to do this especially in large issues. However, crucially for the argument of this study legally independent DMOs (AUTO1) send strong signals of credibility; they tend to reduce the maturity of issued debt by 2.3-3.3 years 1-3 months ahead of a deterioration of one notch in the government's credit rating by one of the three agencies. Smaller signals are also sent by DMOs in a politically stable environment (Regressions 9 and 12). Finally, DMO's seem to worry more about their reputation when they are anxious to maintain their credibility with market makers (negative coefficients for STRESS×SIGNAL in Regressions 3, 6 and 9). Most of the signaling takes place 3 months in advance of the news.

Other interesting findings common to all regressions include the insignificance of the year dummies, which asserts that the period of fiscal stress starting in September 2008 had no direct effect on maturity. Interestingly there is strong seasonality in debt issuance – issues in August, November and December are respectively 19, 8 and 14 months shorter than in other months. The lagged dependent variable is insignificant, which means that serial correlation is very weak in this dataset.

Table 1: Government debt maturity at issuance by DMO autonomy and signal lead

β	Variable	(1)	(2)	(3)	(4)	(5)	(6)
		AUTO1			AUTO2		
		1 lead	2 leads	3 leads	1 lead	2 leads	3 leads
1 (-)	L.D.DEBT STOCK	3e-07 (4e-07)	2e-07 (4e-07)	3e-07 (4e-07)	3e-07 (3e-07)	3e-07 (3e-07)	3e-07 (3e-07)
2	QUANTITY^2	5e-11 (6e-11)	5e-11 (6e-11)	5e-11 (6e-11)	7e-11 (5e-11)	7e-11 (5e-11)	8e-11 (5e-11)
3 (-)	L.D.CURVE	0.27 (0.28)	0.27 (0.29)	0.27 (0.30)	0.29 (0.29)	0.29 (0.29)	0.30 (0.29)
4 (-)	QUANTITY^2 × L.D.CURVE	1e-12 (2e-12)	8e-13 (2e-12)	9e-13 (2e-12)	3e-12 (2e-12)	3e-12 (2e-12)	3e-12 (2e-12)
5 (-)	STRESS × L.D.CURVE	-0.63 * (0.34)	-0.63 * (0.34)	-0.65* (0.34)	-0.66* (0.35)	-0.65* (0.34)	-0.70 * (0.34)
6 (+)	INDEXED	-2.34 (1.46)	-2.34 (1.46)	-2.35 (1.45)	-2.72* (1.49)	-2.72* (1.49)	-2.71 * (1.48)
7 (+)	QUANTITY^2 × INDEXED	-2e-11 (3e-11)	-2e-11 (3e-11)	-2e-11 (3e-11)	-5e-11* (3e-11)	-5e-11 (3e-11)	-5e-11 * (3e-11)
8 (+)	STRESS × INDEXED	1.12 (0.83)	1.13 (0.83)	1.16 (0.84)	1.56* (0.78)	1.56* (0.78)	1.57 * (0.78)
9 (+)	FOREIGN	-0.69 (0.82)	-0.68 (0.82)	-0.68 (0.82)	-0.64 (0.87)	-0.64 (0.86)	-0.63 (0.86)
10 (+)	QUANTITY^2 × FOREIGN	-4e-11 (4e-11)	-4e-11 (4e-11)	-4e-11 (4e-11)	-3e-11 (4e-11)	-3e-11 (4e-11)	-3e-11 (4e-11)
11 (+)	STRESS × FOREIGN	-0.86 (0.80)	-0.87 (0.81)	-0.89 (0.81)	-0.91 (0.74)	-0.92 (0.74)	-0.94 (0.74)
12 (+)	L.Δ_INTEREST	-0.28 (0.25)	-0.28 (0.25)	-0.28 (0.25)	-0.30 (0.25)	-0.29 (0.25)	-0.28 (0.25)
13 (+)	QUANTITY^2 × L.Δ_INTEREST	4e-12 ** (2e-12)	4e-12 ** (2e-12)	4e-12** (2e-12)	9e-12*** (3e-12)	9e-12*** (3e-12)	9e-12 *** (3e-12)
14 (+)	STRESS × L.Δ_INTEREST	0.10 (0.33)	0.10 (0.33)	0.11 (0.33)	0.26 (0.31)	0.25 (0.32)	0.25 (0.31)
15 (+)	INSTITUTION × L.Δ_INTEREST	0.06 (0.26)	0.06 (0.26)	0.06 (0.27)	-0.18 (0.21)	-0.19 (0.21)	-0.19 (0.21)
16 (-)	SIGNAL (lead)	-0.12 (0.99)	0.17 (1.61)	1.34 (0.81)	-0.89 (0.99)	0.05 (1.70)	1.66 * (0.92)
17 (-)	QUANTITY^2 × SIGNAL (lead)	1e-11 ** (5e-12)	3e-12 (4e-12)	8e-12 (6e-12)	1e-11* (6e-12)	3e-12 (5e-12)	-3e-12 (6e-12)
18 (-)	STRESS × SIGNAL (lead)	-0.67 (1.00)	-1.05 (1.56)	-2.26*** (0.80)	-0.40 (0.96)	-1.17 (1.55)	-2.04 ** (0.80)
19 (-)	INSTITUTION × SIGNAL (lead)	-2.37 *** (0.83)	0.64 (0.95)	-3.33** (1.46)	0.81 (0.53)	0.44 (0.65)	-0.89 (0.65)
20 (-)	STRESS × INSTITUTION	0.36 (0.79)	0.33 (0.80)	0.36 (0.79)	-0.86 (0.57)	-0.84 (0.57)	-0.80 (0.57)
21 (-)	INSTITUTION × L.D.DEBT STOCK	5e-06 * (3e-06)	5e-06 * (3e-06)	4e-06 (3e-06)	7e-07 (3e-06)	7e-07 (3e-06)	7e-07 (3e-06)

Table 1 (continued)

Y2005	0.13 (0.36)	0.13 (0.36)	0.12 (0.36)	0.08 (0.37)	0.08 (0.37)	0.08 (0.36)
Y2006	0.40 (0.34)	0.40 (0.34)	0.40 (0.34)	0.30 (0.33)	0.31 (0.33)	0.32 (0.33)
Y2007	-0.05 (0.47)	-0.04 (0.47)	-0.04 (0.47)	-0.18 (0.47)	-0.17 (0.46)	-0.16 (0.47)
Y2008	-0.39 (0.39)	-0.38 (0.39)	-0.39 (0.39)	-0.46 (0.37)	-0.46 (0.37)	-0.45 (0.37)
Y2009	-0.63 (0.67)	-0.63 (0.67)	-0.66 (0.67)	-0.67 (0.66)	-0.67 (0.66)	-0.68 (0.66)
Y2010	-0.30 (0.73)	-0.29 (0.73)	-0.31 (0.73)	-0.37 (0.71)	-0.36 (0.71)	-0.35 (0.71)
Y2011	-0.32 (0.78)	-0.31 (0.78)	-0.33 (0.77)	-0.43 (0.74)	-0.41 (0.74)	-0.43 (0.74)
Y2012	0.44 (0.89)	0.44 (0.89)	0.42 (0.88)	0.38 (0.86)	0.39 (0.86)	0.37 (0.86)
February	-0.26 (0.30)	-0.27 (0.30)	-0.28 (0.30)	-0.26 (0.30)	-0.26 (0.30)	-0.28 (0.30)
March	-0.41 (0.41)	-0.42 (0.40)	-0.42 (0.40)	-0.41 (0.41)	-0.42 (0.40)	-0.43 (0.40)
April	-0.39 (0.33)	-0.39 (0.33)	-0.40 (0.33)	-0.39 (0.34)	-0.38 (0.33)	-0.39 (0.34)
May	0.04 (0.43)	0.04 (0.43)	0.03 (0.43)	0.05 (0.43)	0.04 (0.43)	0.03 (0.43)
June	-0.08 (0.32)	-0.09 (0.31)	-0.09 (0.31)	-0.06 (0.32)	-0.08 (0.32)	-0.08 (0.32)
July	-0.04 (0.33)	-0.05 (0.32)	-0.04 (0.32)	-0.05 (0.34)	-0.05 (0.33)	-0.05 (0.33)
August	-1.59 *** (0.46)	-1.59 *** (0.45)	-1.60*** (0.46)	-1.59*** (0.47)	-1.58*** (0.46)	-1.60 *** (0.46)
September	-0.06 (0.33)	-0.06 (0.33)	-0.06 (0.33)	-0.02 (0.34)	-0.03 (0.34)	-0.03 (0.33)
October	-0.11 (0.37)	-0.11 (0.37)	-0.08 (0.38)	-0.09 (0.38)	-0.10 (0.38)	-0.09 (0.38)
November	-0.67 *** (0.24)	-0.66 ** (0.24)	-0.66** (0.25)	-0.65** (0.25)	-0.64** (0.25)	-0.66 ** (0.25)
December	-1.19 *** (0.40)	-1.21 *** (0.40)	-1.19*** (0.40)	-1.17*** (0.40)	-1.19*** (0.40)	-1.18 *** (0.40)
L.MATURITY	0.04 (0.08)	0.05 (0.08)	0.04 (0.08)	0.04 (0.08)	0.04 (0.08)	0.04 (0.08)
Constant	7.57 *** (1.41)	7.57 *** (1.41)	7.57*** (1.40)	8.07*** (1.41)	8.06*** (1.41)	8.05 *** (1.40)
Observations	2,383	2,383	2,383	2,383	2,383	2,383
R^2	0.39	0.39	0.39	0.39	0.39	0.39

Note: Results from Fixed Effects regressions with clustered standard errors in parentheses. Entries are coefficient estimates. The dependent variable is the average time to maturity (in years) of newly issued government debt during the quarter. * $.05 < p \leq .10$. ** $.01 < p \leq .05$. *** $p \leq .01$. The beta column numbers the coefficients in reference to the discussion on the research design. The signs in parentheses indicate the hypothesized relationship with the dependent variable.

L. denotes one period lag; D. denotes one time difference (between *t* and *t-1*)

Green shaded cells indicate a result that supports a hypothesis

Red shaded cells indicate a result that refutes a hypothesis

Table 2: Government debt maturity at issuance by turnover and signal lead

β	Variable	(7)	(8)	(9)	(10)	(11)	(12)
		DURATION1			DURATION2		
		1 lead	2 leads	3 leads	1 lead	2 leads	3 leads
1 (-)	L.D.DEBT STOCK	6e-06 (9e-06)	8e-06 (4e-07)	8e-06 (1e-05)	-2e-07 (2e-05)	2e-06 (2e-05)	3e-06 (2e-05)
2	QUANTITY^2	6e-11 (5e-11)	6e-11 (5e-11)	6e-11 (5e-11)	6e-11 (5e-11)	6e-11 (5e-11)	6e-11 (6e-11)
3 (-)	L.D.YCS	0.28 (0.29)	0.28 (0.29)	0.30 (0.29)	0.28 (0.29)	0.28 (0.29)	0.31 (0.29)
4 (-)	QUANTITY^2 × L.D.YCS	2e-12 (2e-12)	2e-12 (2e-12)	2e-12 (2e-12)	2e-12 (2e-12)	2e-12 (2e-12)	3e-12 (2e-12)
5 (-)	STRESS × L.D.YCS	-0.66* (0.34)	-0.66* (0.34)	-0.70** (0.33)	-0.67* (0.34)	-0.67* (0.33)	-0.67* (0.33)
6 (+)	INDEXED	-2.44 (1.46)	-2.44 (1.45)	-2.44 (1.45)	-2.29 (1.48)	-2.31 (1.47)	-2.31 (1.47)
7 (+)	QUANTITY^2 × INDEXED	-3e-11 (2e-11)	-3e-11 (2e-11)	-3e-11 (2e-11)	-3e-11 (2e-11)	-3e-11 (2e-11)	-3e-11 (2e-11)
8 (+)	STRESS × INDEXED	1.24 (0.89)	1.22 (0.90)	1.22 (0.90)	0.93 (1.12)	0.90 (1.14)	0.91 (1.14)
9 (+)	FOREIGN	-0.61 (0.84)	-0.60 (0.84)	-0.59 (0.83)	-0.54 (0.87)	-0.52 (0.87)	-0.51 (0.86)
10 (+)	QUANTITY^2 × FOREIGN	-4e-11 (4e-11)	-3e-11 (4e-11)	-4e-11 (4e-11)	-4e-11 (4e-11)	-4e-11 (4e-11)	-4e-11 (4e-11)
11 (+)	STRESS × FOREIGN	-1.04 (0.75)	-1.04 (0.75)	-1.07 (0.75)	-1.17 (0.85)	-1.19 (0.85)	-1.21 (0.85)
12 (+)	L.Δ_INTEREST	-0.30 (0.34)	-0.30 (0.34)	-0.30 (0.34)	-0.11 (0.45)	-0.12 (0.45)	-0.11 (0.45)
13 (+)	QUANTITY^2 × L.Δ_INTEREST	6e-12*** (2e-12)	6e-12*** (2e-12)	6e-12*** (2e-12)	7e-12*** (2e-12)	7e-12*** (2e-12)	7e-12*** (2e-12)
14 (+)	STRESS × L.Δ_INTEREST	0.13 (0.32)	0.13 (0.32)	0.13 (0.32)	0.11 (0.32)	0.11 (0.32)	0.11 (0.32)
15 (+)	INSTITUTION × L.Δ_INTEREST	1e-04 (6e-03)	1e-04 (6e-03)	2e-04 (6e-03)	-4e-03 (9e-03)	-4e-03 (9e-03)	-4e-03 (9e-03)
16 (-)	SIGNAL (lead)	-0.03 (1.20)	1.60 (1.73)	2.54** (1.22)	-0.74 (1.59)	4.35 (2.68)	4.01*** (1.43)
17 (-)	QUANTITY^2 × SIGNAL (lead)	1e-11** (5e-12)	5e-12 (5e-12)	5e-12 (5e-12)	9e-12 (6e-12)	8e-12 (6e-12)	6e-12** (3e-12)
18 (-)	STRESS × SIGNAL (lead)	-0.39 (0.87)	-0.68 (1.58)	-1.10* (0.63)	-0.73 (1.04)	-0.06 (1.69)	-0.93 (0.64)
19 (-)	INSTITUTION × SIGNAL (lead)	-0.01 (0.02)	-0.04 (0.03)	-0.05* (0.03)	0.01 (0.04)	-0.12 (0.08)	-0.09** (0.03)
20 (-)	STRESS × INSTITUTION	4e-03 (1e-02)	5e-03 (1e-02)	5e-03 (1e-02)	0.02 (0.03)	0.02 (0.03)	0.02 (0.03)
21 (-)	INSTITUTION × L.D.DEBT STOCK	-1e-07 (2e-07)	-2e-07 (2e-07)	-2e-07 (2e-07)	2e-08 (4e-07)	-4e-08 (4e-07)	-5e-08 (4e-07)

Table 2 (continued)

Y2005	0.12 (0.36)	0.12 (0.36)	0.12 (0.36)	0.11 (0.37)	0.11 (0.36)	0.11 (0.36)
Y2006	0.38 (0.33)	0.37 (0.33)	0.37 (0.33)	0.37 (0.33)	0.36 (0.33)	0.37 (0.33)
Y2007	-0.08 (0.47)	-0.08 (0.47)	-0.07 (0.47)	-0.09 (0.47)	-0.08 (0.48)	-0.08 (0.48)
Y2008	-0.41 (0.39)	-0.42 (0.38)	-0.42 (0.38)	-0.44 (0.41)	-0.44 (0.41)	-0.44 (0.41)
Y2009	-0.69 (0.68)	-0.70 (0.68)	-0.71 (0.68)	-0.74 (0.70)	-0.76 (0.70)	-0.76 (0.70)
Y2010	-0.37 (0.73)	-0.37 (0.73)	-0.36 (0.73)	-0.41 (0.75)	-0.42 (0.75)	-0.40 (0.75)
Y2011	-0.40 (0.77)	-0.40 (0.78)	-0.42 (0.77)	-0.44 (0.79)	-0.44 (0.80)	-0.46 (0.79)
Y2012	0.38 (0.87)	0.37 (0.87)	0.36 (0.87)	0.32 (0.89)	0.31 (0.89)	0.31 (0.89)
February	-0.27 (0.31)	-0.28 (0.30)	-0.29 (0.30)	-0.26 (0.31)	-0.27 (0.30)	-0.28 (0.30)
March	-0.42 (0.41)	-0.44 (0.40)	-0.43 (0.40)	-0.41 (0.40)	-0.43 (0.40)	-0.43 (0.40)
April	-0.40 (0.34)	-0.40 (0.33)	-0.41 (0.33)	-0.39 (0.33)	-0.39 (0.33)	-0.41 (0.33)
May	0.04 (0.43)	0.02 (0.42)	0.02 (0.42)	0.03 (0.42)	0.02 (0.42)	0.02 (0.42)
June	-0.09 (0.32)	-0.10 (0.31)	-0.11 (0.31)	-0.09 (0.32)	-0.10 (0.31)	-0.11 (0.31)
July	-0.06 (0.34)	-0.07 (0.33)	-0.06 (0.33)	-0.06 (0.33)	-0.07 (0.33)	-0.06 (0.33)
August	-1.60 *** (0.47)	-1.60 *** (0.46)	-1.61*** (0.46)	-1.60*** (0.47)	-1.60*** (0.46)	-1.60 *** (0.46)
September	-0.05 (0.34)	-0.07 (0.33)	-0.06 (0.33)	-0.07 (0.33)	-0.08 (0.33)	-0.07 (0.33)
October	-0.11 (0.37)	-0.13 (0.37)	-0.12 (0.37)	-0.12 (0.37)	-0.14 (0.36)	-0.12 (0.37)
November	-0.68 ** (0.25)	-0.67 *** (0.24)	-0.68*** (0.24)	-0.68** (0.25)	-0.68*** (0.24)	-0.69 *** (0.24)
December	-1.19 *** (0.40)	-1.22 *** (0.40)	-1.21*** (0.41)	-1.20*** (0.41)	-1.22*** (0.40)	-1.21 *** (0.41)
L.MATURITY	0.05 (0.08)	0.05 (0.08)	0.05 (0.08)	0.05 (0.08)	0.05 (0.08)	0.05 (0.08)
Constant	7.62 *** (1.43)	7.63 *** (1.42)	7.62*** (1.42)	7.42*** (1.46)	7.45*** (1.44)	7.41 *** (1.44)
Observations R^2	2,383 0.39	2,383 0.39	2,383 0.39	2,383 0.39	2,383 0.39	2,383 0.39

<u>Note</u>: See notes to Table 1.

Conclusions

The sustainability of government debt and the credibility of fiscal commitments have increasingly preoccupied scholars and policy makers in recent years. In their attempts to avert economic collapse governments have borrowed heavily, to the extent that the credibility of many of them, even in developed and democratic countries, has been compromised. Much has been published on the difficulty of maintaining fiscal credibility under complex and highly political budgeting procedures. Neither market-led discipline nor international commitments seem to provide a satisfactory solution to the credibility problem. Thus, attention is increasingly given to signaling mechanisms in which words are matched by deeds (costly talk).

In contrast to the normative approach common to almost all of the existing literature on government debt management, we offer a new positivist model based on the practical realities in which DMOs operate. We argue that when default is not a serious risk, long-sighted DMOs can send signals to the public about their governments' future fiscal performance by issuing longer debt when they expect good news or shorter debt when they expect bad news. In doing so DMOs assume higher costs of debt, but build their credibility with market makers. We also argue that such signals are likelier in large issues and in times of fiscal stress, when DMOs are especially anxious to maintain their credibility with market makers; and regardless of privileged information long-sighted DMOs are likely to issue longer debt than short-sighted DMOs in times of fiscal stress, if outstanding debt is small and short, and if the market expects interest rates to rise.

We test our hypotheses with a unique dataset of 24,838 issues of government debt in 26 of the OECD countries during 2004-12, and a unique compilation of legal text defining the authority of DMOs and the fundamental sources of low government turnover in their countries. Using Fixed Effects regressions and monthly data frequency, we find that long-sighted DMOs behave no different than short-sighted ones when faced with a large debt stock, or when the market expects the interest rate to change. However, DMOs with greater legal autonomy from elected policy makers indeed send strong signals of credibility; they tend to reduce the maturity of issued debt by 2.3-3.3 years 1-3 months ahead of a deterioration of one notch in the government's credit rating by one of the three agencies. And indeed such behavior is more evident in times of fiscal stress.

These results may not apply to situations of crisis-management or to governments with very poor reputation. Our model focuses on the DMOs dilemma assuming a credible monetary policy and relatively sound fiscal policies. We deliberately restrict our empirical study to governments with a credit rating of A- or higher. Thus, any implications for the DMO's work under worse conditions must be addressed with a separate model.

Annex 1

Solving for the optimal maturity at issuance

Equation (8) derives the nominal effective interest rate by the maturity on the current issue.

$$(8)\ \ i_{eff}`(x) = \alpha + \mu\pi^{e} + \psi\varepsilon^{e} - \varphi\left(i_{mf} - S_G\right)$$

Equation (9) derives the average maturity on the new outstanding debt by the maturity on the current issue.

$$(9)\ \ X_t`(x) = \frac{q_t}{Q_{t-1} - M_t + q_t}$$

Equation (10) derives the quantity demanded of newly issued debt by x.

$$(10)\ \ q_m`(x) = -2\theta(x - x_m)$$

We now come back to the DMO's loss function and derive it in Equation (11) by the maturity on the current issue.

$$(11)\ \ L_{DMO}`(x) = q i_{eff}`(x) - \lambda\varphi\frac{1}{X}X`(x) - \lambda\frac{q_m`(x)}{q}$$

We next substitute the expressions in Equations (8)-(10) into Equation (11) to get Equation (12). For simplicity we do away with the temporal notation and note the post-maturation quantity of outstanding debt $Q_{t-1} - M_t$ simply with Q:

$$(12)\ \ L_{DMO}`(x)\ =\ q\{\alpha + \mu\pi^{e} + \psi\varepsilon^{e} - \varphi\left(i_f - S_G\right)\}\ -\ \lambda\frac{\varphi}{X}\cdot\frac{q}{(Q+q)} + \lambda\frac{2\theta}{q}(x - x_m)$$

Solving for the condition that the derivative of the loss function in Equation (12) equals zero, we obtain the optimal maturity at issuance in Equation (7).

Annex 2

Descriptive Statistics and Dicky-Fuller Unit Root Tests

Variable	Obs.	Mean	Std. Dev.	Min	Max	Unit	Inverse χ^2 Statistic	*p*-value
MATURITY	2,541	4.48	3.59	0.25	30.38	Years	1357.9	0.000
DEBT STOCK	2,760	1.1e06	2.5e06	13,475	15.2e06	Mil.$	43.6	0.790
QUANTITY^2	2,613	6.5e09	25e09	100	203e09	Tril.$^{2}	1170.3	0.000
QUANTITY[18]	2,613	29,803	75,172	10	450,144	Mil.$	444.3	0.000
STRESS	2,912	0.49	0.50	0.00	1.00	Dummy	Dummy variable	
AUTO1	2,808	0.23	0.42	0.00	1.00	Dummy	Fixed effect	
AUTO2	2,808	0.58	0.49	0.00	1.00	Dummy	Fixed effect	
DURATION1	2,808	39.34	12.75	12.56	60.09	months	Fixed effect	
DURATION2	2,808	41.25	10.60	15.55	61.69	months	Fixed effect	
CURVE	2,803	1.57	1.38	-9.81	7.15	% points	52.0	0.472
INDEXED	2,808	0.94	0.17	0.00	1.00	Index	673.7	0.000
FOREIGN	2,808	0.93	0.22	0.00	1.00	Index	1051.9	0.000
Δ_*INTEREST*	2,584	1.08	1.06	-3.20	5.25	% points	402.5	0.000
SIGNAL	2,886	0.01	0.13	-1.00	2.67	Index	1265.4	0.000

[18] This variable was not specified in the regression and is reported here for the convenience of the reader. The monthly observation with the highest issuance quantity is $450.1 billion by the United States in October 2008.

Annex 3

Classification of countries according to their DMO independence

Of the 26 national DMO's in the dataset six were found to be somewhat independent by law:

- Austria: the minister of finance has authority over the DMO but must win approval for issuance parameters from a supervisory board made of non-elected finance professionals.
- Denmark: The minister of finance has signed in 1991 a legally binding agreement with the central bank (which in Denmark is an independent body) to jointly manage the public debt.
- Slovakia: The Agency of Debt and Liquidity Management exists by law since 2003 independently from any government ministry, and is headed by a professional with no limit on his term of office. The State Treasury cooperates with the Agency in defining the structure and content of the State Treasury's financial plan.
- South Korea: The State Bond Act stipulates the Minister of Strategy and Finance (who is not an elected politician) will issue bonds subject to approval by the National Assembly. The Ministry of Strategy and Finance decides all parameters of issued debt but some related matters can be prescribed by a presidential decree.
- Sweden: The law refers to the National Debt Office independently from any government ministry; it is headed by a professional non-elected director general. By law the government must obtain proposed annual guidelines from the National Debt Office for management of central government debt.

  - United States: Congress has in 1917 delegated the authority of managing the public debt to the secretary of the treasury, who is not an elected politician but a joint appointment to Congress and the President; According to section 3121 to the US Code the secretary of the treasury has the final authority in debt management.
- In another nine countries the DMO was found to be administratively somewhat independent:
  - Australia: the law mentions the Australian Office of Financial Management, but subjects it to the Minister of Finance.
  - France: The Agence France Tresor was created by a statutory decree signed in 2001 by the Minister of Economy Finance and Industry, the minister of Public Service and the secretary of State for the Budget; they jointly manage France's public debt.
  - In Germany, Hungary and Ireland: The DMO exists independently of government ministries as a government (wholly) owned corporation, in which the minister of finance is the representative of the single shareholder (the government).
  - Israel: The DMO is a sub-division inside the Ministry of Finance and is not mentioned in the law, but by law the minister must gain the consent of a specialized parliamentary committee for the parameters of issuance.
  - Italy: By law the Ministry of Economy and Finance and the Department of the Treasury jointly manage the government's debt.

    - Norway: Every year the ministry of finance requests from parliament authorization to borrow on behalf of the state. This request is attached to the national budget proposal submitted to parliament and details the parameters of the debt to be issued. There is no other law governing the management of national debt.
    - Portugal: By law the government collectively (rather than the minister of finance individually) determines the parameters of its debt; the DMO (since 1996 a statutory authority, and since 2012 a public corporation) is mentioned in the law.
- In the other eleven countries (Belgium, Canada, the Czech Republic, Finland, Japan, the Netherlands, New Zealand, Poland, Spain, Switzerland and the UK) the minister of finance is by law the sole dictator of the parameters of newly issued debt, and the law does not mention the DMO, nor does it have a distinct legal entity.

Annex 4

Procedure for instrumenting *DURATION* in parliamentary democracies

1. A 2sls cross-section regression was run with the natural logarithmic transformation of the average cabinet duration during 2004-2012 in months as a dependent variable, all (initially 9) legal exogenous variables, 10 cultural and historical variables, the log of the effective number of parties in the legislature as the only endogenous variable, and all 4 instruments.

   <u>The dependent variable</u>

   Cabinet duration is calculated as a weighted average of the number of months each government survived in office during the period 2008-2012. The weight of each government in this average is the number of months falling within the period 2008-2012 that it survived. Transition, care taker or technocratic governments are disregarded in AUTO1.

   <u>Legal exogenous variables</u>

   a. CAB_CONSTRUCTIVE: A dummy variable coding 1 for a legal requirement to present an alternative cabinet before the current cabinet can be voted out of office by the legislature.
   b. CAB_HEADDIS_NR: A dummy variable coding 1 for countries in which cabinet dismissal is possible at the discretion of the nonexecutive head of state (royals excluded) without consent from other bodies.
   c. CAB_LINKAGE: A dummy variable coding 1 when cabinet dismissal automatically triggers parliament dissolution.

d. LEG_HEADDIS_NR: A dummy variable coding 1 when early elections are possible at the unconditional discretion of nonexecutive head of state (royals excluded), or through a majority in the upper house.

e. LEG_HEADVETO_NR: A dummy variable coding 1 when early elections (to the lower house) are possible only with the consent of the nonexecutive head of state (Royals excluded).

f. LEG_PM_HEADDIS: A dummy variable coding 1 for countries in which early elections (to the lower house) are possible even without a vote in the lower house.

g. LEG_PMDIS: A dummy variable coding 1 for countries in which the top executive can unilaterally call early elections.

h. lnFREQUENCY: The natural logarithmic transformation of the constitutional frequency of elections to the lower house.

i. CAB_LIMCONF: A dummy variable coding 1 when there are restrictions on the frequency, or special majorities required of no-confidence motions (including requirement for constructive vote of no confidence).

<u>Cultural and historical variables</u>

a. lnAGE: The number of years between 2008 (the median year of the sample period) and the year of first democratic elections with women suffrage since the most recent switch to democracy.

b. IMMIGRATION: A dummy variable coding 1 for countries where immigrants and their descendants greatly outnumber the native population.

c. SMALL: A dummy variable coding 1 for countries with a population of 2 million or less.

d. ENGLISH: A dummy variable coding 1 for English speaking countries.

e. SEPPARATIST: A dummy variable coding 1 for countries in which at least 1% of the population has a different ethnic identity than the rest of the population, and that identity is related to a different language and a particular part of the country's territory, but not to another existing country.
f. MED: A dummy variable coding 1 for Mediterranean countries.
g. EU: A dummy variable coding 1 for European Union member states.
h. EXCOM: A dummy variable coding 1 for ex-Communist countries.
i. LATIN80: A dummy variable coding 1 for countries in which Catholics make up at least 80 percent of the population.
j. NORDIC: A dummy variable coding 1 for Nordic countries.

The endogenous variable

This is the log of the effective number of parties in the (lower house of the), which is calculated in turn as the sum of the squared shares of the parties in the legislature.

Instruments

a. lnTHRESHOLD: The natural logarithmic transformation of the higher value of either (1) the official threshold or (2) the implied threshold arising from electoral district magnitude (=75%/(M+1)); M=average number of seats per electoral district.
b. lnDENSITY: The natural logarithmic transformation of the number of people per squared kilometer.
c. lnSEATSPOP: The natural logarithmic transformation of the number of seats in the (lower house of the) legislature per 1 million people.
d. lnPOP: The natural logarithmic transformation of the size of the population.

2. Instruments were removed and/or specified as exogenous variables as necessary in order to find the combination of instruments that achieves the best results in all of three tests:
   a. Test for the endogeneity of the log of the effective number of parties in the legislature (the variable specified as an endogenous variable).
   b. F test in the first stage regression is higher than 10.
   c. Test for zero correlation between the instruments and the errors in the structural equation.
3. Once this best combination of instruments was found, the 2sls regression was run again, as many times as there are exogenous legal variables, each time specifying the log of the effective number of parties in the legislature as an exogenous variable and one of the exogenous legal variables as an endogenous variable (without changing the combination of instruments). Each time the variable specified as an endogenous variable was tested for endogeneity.
4. If all legal variables were tested to be exogenous (at p>0.10) then the procedure ended successfully and fitted values of the natural logarithmic transformation of the average cabinet duration were produced.
5. Otherwise, the legal variable with the lowest p value in the tests for endogeneity was eliminated, and the process was repeated from stage (1) without this variable.

Annex 5

Methods for constructing data on *DEBT STOCK* in select countries

1. Switzerland: data was available only for the fourth quarter of each year. We used a linear extrapolation to convert this annual data into monthly frequency.
2. Ireland and South Korea (throughout), Poland and Slovakia (until quarterly data is available from Mid-2009 and mid-2006 respectively): Annual observations of Total central government debt (Stocks: Outstanding amounts, Million USD, Annual) were downloaded from OECD Stat from the Central Government Debt Dataset. This data was converted to monthly frequency with a linear extrapolation.
3. New Zealand: the only quarterly data available was for general government debt, rather than central and only from mid-2006. As we prefer the higher frequency data, we compared this data to the above annual data and discovered that the ratio between them was approximately 1:2.2. We therefore used the linear extrapolation from the annual data for the period until mid-2006, multiplying it by a factor of 2.2 and used the linear extrapolation from the quarterly general government data from mid-2006 on

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