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ABSTRACT

We study how the autonomy of national Debt Management Offices (DMO) in developed countries affects their credibility with lenders, given the DMO's privileged information. Using this information, the DMO can adjust the maturity of the auctioned debt opportunistically – maximizing short-term profit at the expense of the lenders, or cooperatively – not maximizing short-term profit, but rather taking lenders' interests into account, in order to signal its credibility and thus gain long-term benefits. We run Fixed Effects regressions on a unique dataset based on more than 27,500 issues of government debt in 31 mostly OECD countries during 2004-12, and a unique compilation of legal texts defining the authority of DMOs in these countries. We find that autonomy reduces a DMO's need to signal its credibility to lenders and thus reduces the cost of debt issuance. These results suggest that autonomous DMOs have more credibility with lenders and therefore have less need to signal cooperation (and forego profits) in order to build credibility.

KEYWORDS: Autonomous agencies; Relational contracts; Debt management; Elections; Credibility

עצמאות מנהלי חוב ציבורי והטווח לפדיון המקורי של חוב ציבורי

יהודה פורת וטל שדה

תקציר

אנחנו בוחנים כיצד העצמאות של יחידות ניהול חוב ציבורי במדינות מפותחות משפיעה על האמינות שלהן בעיני המלווים, בהינתן המידע הפרטי העודף של יחידת ניהול החוב. בעקבות מידע מסוג זה, יחידת ניהול החוב יכולה לשנות את הטווח לפדיון של החוב המונפק באופן אופורטוניסטי כדי למקסם רווח קצר טווח על חשבון המלווים או לחילופין להימנע ממקסום רווח טווח קצר ולהתחשב באינטרס של המלווים וזאת במטרה לאותת על אמינותה וכך להרוויח בטווח הארוך. אנחנו אומדים רגרסיות עם השפעות קבועות על מאגר מידע ייחודי המבוסס על יותר מ-27,500 הנפקות של חוב ציבורי מ-31 מדינות, מרביתן חברות ב-OECD, בשנים 2004—2012 ואוסף ייחודי של מסמכים משפטיים המגדירים את הסמכויות של יחידות ניהול החוב הציבורי במדינות אלה. אנחנו מוצאים כי עצמאות יחידת ניהול חוב ציבורי מקטינה את הצורך שלה לאותת למלווים על אמינותה ובעקבות זאת מפחיתה את העלות של הנפקת חוב. תוצאות אלו מרמזות שיחידות ניהול חוב ציבורי עצמאיות נהנות מיותר אמינות מצד המלווים ולכן יש להן פחות צורך לאותת (ע"י הפסד בטווח הקצר) כדי לבנות אמינות.

Introduction

Governments need the ability to issue debt in order to function effectively. Such debt issuance is essential for bridging fiscal deficits, and enables governments to invest in long-term projects while paying their costs over many years. The ability to issue new debt in order to roll over old enables governments to pay debt off gradually. Without it, they would need to make periodic large reductions in all other government expenditures in order to fund debt repayment or risk defaulting on their debts. As we have seen in the Covid-19 crisis, the ability to issue debt can literally save lives (Arellano et al, 2020).

The price of debt issuance is reflected in the interest rates and issuance costs governments pay in debt markets. They would prefer to minimize those costs, while still leaving themselves maximal flexibility to borrow the amounts they want. However, there are significant information asymmetries between the government and the market regarding the real-time state of government finances. The government is made up of politicians, who can both get real-time information on the economy (which is not necessarily visible to the market), and can make real-time decisions that benefit their country, government, party, and/or themselves. These factors combine to increase the risk to market participants that the government may take opportunistic actions that benefit it at their cost. Market participants therefore demand additional risk premiums on government debt issues, increasing the interest rates the government must pay. One way to reduce or eliminate these additional risk premiums is for the government to increase its credibility in the field of debt management.

In the past few decades, governments in many countries, particularly developed ones, have increasingly delegated policymaking, policy execution, and provision of public services to autonomous agencies. Autonomous agencies carry out public tasks for the government and operate at arm's length. Within their mandates, they are not subordinate to ministries, face little or no hierarchical political influence on their operations, and have more managerial, budgeting, and staffing freedom compared with non-autonomous state bodies.

The main rationale identified in the literature for such delegation is the enhanced credibility derived from reducing the policy's time-inconsistency (Gilardi, 2002; Wonka and Rittberger, 2010). However, delegation involves a trade-off between

political control and credibility. Thus, scholars have shown that the prevalence of autonomous regulatory agencies is affected by a wide variety of factors, including partisanship, political extremism, the number of veto players in the political system, and the distinction between liberal and coordinated market economies.[1] A related literature studies whether regulators are independent from the entities that they regulate, identifying different types of regulatory capture and remedies for it.[2]

A vast literature has developed, dealing mainly with defining and measuring the autonomy of regulatory agencies, explaining its benefits and drivers, and debating the agencies' accountability and legitimacy (Ennser-Jedenastik, 2015). Scholars have quantified formal and actual regulatory agency autonomy and compiled large data sets. Formally, agencies are considered more autonomous from elected politicians when their mandates fix the number of their board members, the terms of their appointment and removal, quorum requirements and restrictions on the ability of political principals to review decisions. Placing the agency outside the executive and providing it with independent financial resources, recruitment procedures, and an independent ability to litigate, also help.[3]

Economists have studied independent central banks (Cukierman, 2008; Cukierman, 1992; de Haan and Eijffinger, 2016) and fiscal councils (Beetsma, 2019; Beetsma, 2016; Kopits, 2012), while scholars of public policy have focused mostly on autonomous agencies that regulate market activity. These have proliferated in policy domains such as utilities (Haber, 2018), competition, banking (Hirsch and Shotts, 2018; Kleibl, 2013; Rex, 2018), anti-corruption policy (Di Mascio, Maggetti and Natalini, 2018), food safety, consumer protection, the environment, and even electoral commissions (Ahuja and Ostermann, 2018) and religion (Patrikios and De Francesco, 2018).

[1] See Eckert, 2018; Ennser-Jedenastik, 2016; Hanretty and Koop, 2013; Mediano, 2018; Miller and Whitford, 2016; Thatcher, 2007.

[2] See Browne, 2018; Carpenter and Moss, 2014; Rex, 2018; Zupan, 2017.

[3] See Di Mascio, Maggetti and Natalini, 2018; Ennser-Jedenastik, 2015; Fernandez-i-Marín *et al*., 2016; Gilardi, 2002; Guardiancich and Guidi, 2016; Hanretty and Koop, 2012; 2013;Maggetti, 2007; Selin, 2015.

We aim to extend this literature by categorizing the autonomy of national Debt Management Offices (DMOs) and studying the effect of that autonomy on their credibility and thus on parameters of government debt issuance.

DMOs are agents who, primarily in developed countries, issue sovereign debt in closed auctions, in which only a select group of major financial firms (primary dealers) can bid. This relationship incorporates potentially important information asymmetries. In particular, the DMO occasionally has privileged information about impending improvement or deterioration in public finances, which, to the concern of primary dealers, can affect the market value of recently issued debt. DMO autonomy varies between countries. This autonomy/independence is by definition more limited than that of most of the above types of independent institutions, for example central banks, in that the DMO does not decide the size of the deficit but is required to fund it, whatever its size. This allows the investigation of the effects of more limited independence on credibility and on the policy variables affected by credibility.

In the next section, we discuss the information asymmetry problem in government debt issuance and how in developed economies with relatively high sovereign credit ratings, the DMO's use of its privileged information to adjust the maturity of the auctioned debt can send signals. These signals can be opportunistic - gainful for the government and costly for the primary dealers - signaling the government's self-interested defection from the win-win spirit of the relational contract, or consummate – costly for the government and gainful for the primary dealers – signaling the government's cooperative attitude, and earning the trust of the primary dealers.

In the third section, we argue that all else being equal, such signals tend to be more consummate when DMOs lack political autonomy from elected decision makers because they need to compensate for their low credibility with primary dealers.

In the fourth section, we describe our research design. We use detailed information on 27,504 issues of government debt in 31 mostly OECD countries during 2004-12. In the fifth section, we test our hypotheses with fixed effects regressions. The sixth section concludes.

Sovereign debt management, information asymmetry, and signaling through debt maturity

Governments routinely borrow money to finance their deficits or rollover their existing stock of debt. In developed economies, much of this borrowing takes the form of selling government tradable securities to the public. In developed economies, the agent that manages the national debt on behalf of the government is the DMO (Debt Management Office). Governments commonly mandate their DMOs to set the parameters of the debt to minimize its cost under some prudent degree of risk (Blommestein and Turner, 2012; Faraglia *et al*., 2008; World Bank and the International Monetary Fund, 2014).[4]

One of those parameters is the ability to sell the entire amount of securities they want, and at convenient terms. A failure to sell enough securities may be understood by market participants as a lack of confidence in the government's creditworthiness, and raise its borrowing costs. In order to manage the sale (issuance) of securities and ensure its success, the DMO therefore hires the services of a select group of local financial institutions, typically the larger banks. The DMO designates these institutions as primary dealers, and gives them exclusive access to its debt auctions (Tomz and Wright, 2013, 253). This privilege provides the primary dealers with some pricing power in the secondary market, where other financial institutions and the public buy government debt. Primary dealers may enjoy preferential government treatment in other areas too (Holland, 2006). In return for these privileges, the DMO expects the primary dealers to buy all the amount of debt issued in each auction (making sure the issue is fully- or even over-subscribed, in financial jargon) and to maintain secondary trading activity (market making). In other words, either the primary dealers directly provide the government (through the DMO) with the credit it needs by holding on to its newly issued debt, or they find other buyers for this debt.

However, the borrowing requirements of the government are the result of complex economic and political processes, and of unforeseen shocks. Budget laws and fiscal rules notwithstanding, in modern democratic states no government has committed to a precise borrowing requirement, and therefore DMOs have not committed to such in

[4] Economists have suggested a variety of aims for debt management strategy, assuming the government is a long-sighted unitary actor with consistent preferences for maximizing the aggregate welfare (Missale, 1999; Nosbusch, 2008). However, in reality such conditions are often not met (Brender and Drazen, 2005; 2008; Vaaler *et al*., 2005).

formal contracts with the primary dealers. This exposes the primary dealers to political uncertainty regarding the amounts of debt they will be asked to buy and trade. As we discuss below, the primary dealers are also exposed to risks relating to the terms on which the new debt is issued. As secondary market makers, they risk being stuck with unsold securities, or selling them at a loss. For its part, the DMO is uncertain about the amounts for which the primary dealers will bid at each auction, and the terms on which they will insist.

On top of this, the DMO and the primary dealers are effectively locked into their relationship because the DMO must fund the deficit and rollover the debt, or the government will face default. Financial institutions, for their part, must purchase government securities because as relatively safe assets (at least in developed countries) they are benchmarks, and are central to portfolio management. For both sides, the alternatives for this relationship are worse.

The primary dealers therefore resemble contractors that supply the DMO with a complex service, and their relationship with the DMO can be characterized as an incomplete contract (Brown, Potoski and Van Slyke, 2016, 297; Williamson, 2005).[5] Each party in this relationship might opportunistically engage in behavior that potentially increases the value it independently receives from the exchange while lowering the value that the other party receives (Brown, Potoski and Van Slyke, 2016, 300; Hart and Moore, 2008). Thus, it is important to build mutual trust. Vast literature studies the credibility of the government's fiscal policy, its commitment to repay its debts, and how suppliers can sustain the government's trust in them. We focus instead on the effect of DMO autonomy on its credibility and thus on the parameters of auctioned debt.

DMOs have no control over the government's annual borrowing requirement, and the yield on outstanding debt traded in the secondary market mostly determines the yield on the newly issued debt (Greenwood *et al*., 2010). However, DMOs in developed economies very often have discretion over the timing and size of each issue, its type

[5] As with all government suppliers, primary dealers have formal contracts with the government, governing those aspects of the relationship that the parties can specify. Classic relational contracts are characterized by specialized (unrecoverable) investments, which lock the partners *ex-post* into the relationship, raising the stakes on the risks they are assuming. This is more typical of infrastructure projects than of debt auctions, but the lack of good alternatives is the more general feature of relational contracts.

(inflation-indexed or nominal, variable or fixed rate, foreign or local denominated), and its maturity.

As secondary market makers, primary dealers prefer a regular schedule of auctions, at which predictable amounts of debt are issued, of a type and maturity that has strong market demand. They also prefer specific maturities (benchmarks), demanded by some investor clienteles that cannot easily substitute across the yield curve (Guibaud *et al*., 2013). For example, banks' treasury departments prefer short-term nominal debt (Krishnamurthy and Vissing-Jorgensen, 2012), while life insurance companies and pension funds prefer long-term debt (Vayanos and Vila, 2009). Many DMOs prepare annual or even bi-annual national debt management plans, which are partly determined by the need to rollover maturing debt (Harkness, 2006) and which try to take the primary dealers' interests into account (Melecky, 2012).

However, even if based on consultations with the primary dealers, national debt management plans remain unilateral documents, not binding contracts. Occasional short-term political and/or economic exigencies may be incompatible with such stable arrangements. The DMO will possibly have knowledge of such exigencies well before they are made known to the public. It will also likely have an information lead (privileged information) over primary dealers with regard to the borrowing requirements of the government and its ability to comply with the terms of outstanding debt. In developed economies, the DMO has such privileged information because it usually manages the government's cash flow (i.e. daily revenue and expenditure) and often participates in bank resolution authorities (World Bank and the International Monetary Fund, 2014).[6] This information asymmetry could enable the DMO to behave opportunistically, namely benefitting the government at the cost of the primary dealers.[7]

In the short term, primary dealers may bear some limited costs of short-term opportunistic debt management as part of their special relationship with the government, which necessarily involves costs (see above). This is especially true if the DMO has already built strong reputation for behaving consummately (by considering

[6] For example, the Slovak DMO (ARDAL) and the Austrian DMO (OeBFA) manage the cash flows of their respective governments, and the Swedish DMO (Riksgälden) includes the bank resolution authority, crisis management for banks and credit institutions, and management of the deposit insurance and investor compensation schemes.

[7] Of course, even the primary dealers may agree that a certain change in circumstances warrants a revision to the debt management plan. A consummate DMO would at least consult them.

the primary dealers' interests in drawing up its debt management plans), and if primary dealers can indeed expect generally consummate behavior from the DMO over time. Alternatively, if primary dealers are sufficiently informed they can pass on the costs by quickly selling the debt in the secondary market to less informed actors, though at an eventual cost to their own reputation. In the long term, however, a DMO that ignores the interests of the primary dealers may lose many of them and come to rely on a small number of powerful dealers, who may increasingly demand higher yields from the government and determine the terms of the debt issues (Harkness, 2006; Jeal, 2006).[8]

If primary dealers suspect a tendency for generally more opportunistic behavior, the DMO has to signal that it is not using the information asymmetry against the primary dealers. Signaling is required, as the primary dealers know that the DMO may have such privileged information, and the DMO cannot credibly and time-consistently commit to the primary dealers that it will reveal such information to them when it gets it and/or not use such information for the government's benefit.

The following discussion explains how such a signaling mechanism can work.

One of the debt parameters over which the DMO has discretion is the maturity of issued debt. In its pursuit of low debt costs, the DMO must reconcile four potentially conflicting concerns. First, it could reduce maturity of newly issued debt ($\boldsymbol{x}$) to benefit from the lower yields on short debt, assuming a positive yield curve slope ($\boldsymbol{\alpha}$). In contrast, the DMO can forestall rollover risk by increasing the average maturity of outstanding debt ($\boldsymbol{X}$).[9] A third concern is to match the maturity (or combination of benchmarks) that markets (and thus primary dealers) prefer ($\boldsymbol{x_{pd}}$). The DMO's loss function can be formulated as minimizing the effective interest rate on the debt it issues:

$$(\mathbf{1})\ \boldsymbol{L_{DMO}(x) = I + \alpha x - \gamma X + \theta(x - x_{pd})^2 + \varphi S_G x}$$

$\boldsymbol{I}$ is the fundamental level of the nominal yield, affected by the country's idiosyncratic features and global conditions. $\boldsymbol{\gamma}$ (>0) reflects the priority that the DMO gives to preventing the gradual emergence of rollover risk, in advance of any market

[8] Most DMOs in the study probably rely on a mix of foreign-owned and domestic primary dealers. A DMO relying mostly on foreign primary dealers may have to send more consummate signals than one relying on domestic ones. Unfortunately, historical data on the identity of primary dealers is not publically available.

[9] Rollover risk is present when a relatively large part of the debt matures in a short time, increasing the government's exposure to large changes in interest rates and/or making it harder to find enough buyers for an equivalently large issue of new debt.

anticipation of it. θ (>0) is the 'disappointment' factor by which primary dealers may punish (with higher yields) off-benchmarks issues.[10]

The last term in (1) relates to the fourth concern, namely the handling of any information lead (privileged information) that the DMO may have over primary dealers with regard to government finances and policies.

A DMO that expects a near-term deterioration in government finance and a resulting rise in the yield ('bad news') could 'lock in' the current yield with a long issue, causing it to lose value in the secondary market when the information is revealed, at the expense of its holders. Similarly, a DMO that expects a near-term yield fall ('good news') could issue short in order to cheaply rollover the debt after the information is disclosed, at the expense of the lenders. We label such behavior as opportunistic signaling, because in doing so the DMO demonstrates a preference for short-term gains over building long-term trust with the primary dealers. An opportunistic signal is characterized as a negative relationship between privileged information and maturity, where good and bad information are regarded as respectively positive and negative values on a single spectrum.

However, opportunistic signaling may beget perfunctory behavior on the part of primary dealers, in the form of minimal bidding in auctions, demanding higher yields compared with those prevailing in the secondary market and general inflexibility on other debt parameters. Thus, a DMO may sometimes compensate primary dealers for past opportunism by engaging in consummate behavior, for example by issuing short in response to negative privileged information or issuing long in response to positive privileged information. Either way this is consummate signaling, characterized as a positive relationship between privileged information and maturity at issuance. Consummate signals may encourage primary dealers to reciprocate by consummate bidding.[11] Occasionally exchanging such small gifts can help build mutual trust (Brown, Potoski and Van Slyke, 2016, 300, 304; Akerloff, 1982).

[10] Note that α, θ and x_{pd} are parameters of demand for newly issued debt, integrated into the DMO's loss function.

[11] Consummate behavior is classically defined as decreasing the performer's gains by a smaller amount than the gains it creates for the other side. In our model, since consummate signals conform to the contract's win-win spirit, they create trust, which is a collective gain. Thus, on a net basis they may create more value to the beneficiary than they cost the performer (Hart and Moore, 2008).

DMOs alternate in the short term between opportunistic, perfunctory, and consummate signals, with baselines depending on the long-term institutional and political environment in which they operate. The greater is the suspicion of primary dealers that the DMO is institutionally inclined to opportunistic behavior, the greater is the DMO's need to send consummate signals. In contrast, if primary dealers trust the DMO more, it may save on consummate signaling.

In Equation (1), S_G is the future rise in the yield on government debt that the DMO expects, over and above the public's expectation. S_G is negative in the presence of positive privileged information. φ is the DMO propensity for consummate signaling. A positive (negative) φ represents DMO poised to send consummate (opportunistic) signals. This means both a greater likelihood of reacting consummately (opportunistic) to privileged information when it arrives, and a tendency to send a larger consummate (opportunistic) signal. We formulate the optimal maturity at issuance, by deriving $L_{DMO}(x)$ by x and solving for the condition $L_{DMO}'(x) = 0$:

$$(2)\ x^* = x_{pd} - \frac{\{\alpha - \gamma q + \varphi S_G\}}{2\theta}$$

q is the marginal effect of x on X – the ratio of issue quantity to quantity of total outstanding debt. Thus, an optimizing DMO is likelier to deviate from benchmarks (x_{pd}) the more forgiving primary dealers are of off-benchmark issues (low θ). The optimal maturity at issuance falls in the yield curve slope (α), but rises in the relative size of the issue (q), especially when the rollover factor (γ) is large. Optimal maturity falls, *ceteris paribus*, when a consummate-signal DMO ($\varphi>0$) has negative privileged information ($S_G>0$) or when an opportunistic-signal DMO ($\varphi<0$) has positive privileged information ($S_G<0$), and rises in other combinations of signaling propensity and information.

DMO autonomy and cycles of consummate and opportunistic signaling

As discussed above, the DMO's propensity for consummate signaling is expected to have an inverse relationship with the level of primary dealer trust, built over the long-term by consummately drawing up debt management plans. However, convincingly

consulting and compromising with primary dealers, and thus building trust, may be difficult for a politicized DMO due to the time inconsistency problem.[12]

There are a few non-exclusive ways to boost such trust. First, DMOs can commit to a policy of transparency. As the World Bank and the International Monetary Fund (2014) recommend, at the very least this means disclosing the DMO's objectives and its measures of cost and risk, regularly publishing information on outstanding debt, and submitting to external audit (Harkness, 2006; Jeal, 2006; Wheeler, 2004).

Some governments establish their DMOs as state-owned corporations, and attract staff from primary dealers. Examples in recent years include Austria, Germany, Hungary, Ireland and since 2012, Portugal. This could improve communication and understanding with primary dealers, but it might also come at the expense of the interests of the government, if it results in a revolving door staffing practice and excessive intimacy between them and the DMO.

Another way, and the one we focus on in this paper, is that a DMO may enjoy more trust on the part of primary dealers if it is politically autonomous from cabinets, because it would potentially be less focused on the short term compared with politicians and less directly obligated to them in its maturity setting decisions. This would also reduce its obligations to constituencies, partisan and other special interests, so it could act with greater probity from the primary dealers' perspective (Flinders, 2008). Agency autonomy may also encourage bureaucrats to invest in expertise (Gailmard and Patty, 2007), which is especially important for this task. Indeed, expertise may in turn encourage DMOs to adopt a long-term perspective (Miller and Whitford, 2016). Thus, we expect a politically autonomous DMO to be less institutionally prone to opportunistic debt management.[13] Consequently, it will have a lesser need to convince primary dealers that it is not doing so, and will therefore need to resort less to consummate signaling (lower φ).

[12] We abstract here from agency capture models a la Stigler. (Carpenter and Moss, 2013)

[13] Note that the definition of autonomy here is legal autonomy from elected politicians, i.e. the ability to make policy decisions without being subject to politicians and political influence. It is not a measure of the organization's connection to the rest of the government. This type of autonomy is very unlikely to limit DMOs' access to privileged information, especially that necessary to perform their functions, any more than central bank independence significantly limits the relevant information available to central banks.

We are not aware of any DMO that in practice can formally dictate the parameters of issuance to the senior policymakers. DMOs are never as autonomous as, say, central banks can be. However, relatively autonomous DMOs have some legally defined authority and institutional independence in designing the parameters of debt issuance, command professional expertise in debt management that is unrivaled by other government bodies, and the executive must receive their independent advice before taking a decision. For example, in Austria, a board of non-elected professionals supervises the minister of finance on debt management. In Denmark, the minister of finance and the central bank co-manage the debt. In Slovakia and Sweden, statutorily independent DMOs propose the debt plan to the government.

Even relatively non-autonomous DMOs may still be able to play political veto players against each other, or have some legal standing in the process, which makes overruling them politically costly. For example, in Australia, Germany, Greece, Hungary and Ireland, the law stipulates that the DMO is independent, or a government-owned corporation, although it is subject to the Minister of Finance. In Finland and Japan, all cabinet members share collective responsibility for cabinet decisions, so no single member of cabinet has absolute control over the DMO. In Iceland, the central bank manages the debt, under the guidance of the Ministry of Finance. In Portugal, the law mentions the DMO specifically (since 2012 a government owned corporation), but the government determines the parameters of its debt collectively. In Israel, Norway, Poland, South Korea, Switzerland, Taiwan and the US, the minister of finance decides debt parameters, but is still subject to legislative and/or executive approval.

The least autonomous DMOs ultimately follow the orders of a single elected policymaker (normally the minister of finance), are governed (and may even be disbanded) by ministerial regulations and decrees, and have no separate legal entity (Guardiancich and Guidi, 2016; Hanretty and Koop, 2013). This is the case in the following eleven countries in our sample: Belgium, Canada, Chile, the Czech Republic, France, Italy, the Netherlands, New Zealand, Slovenia, Spain and the United Kingdom. We henceforth refer to such DMOs as dependent DMOs. The next section elaborates on the operationalization of DMO autonomy.

Of course, building trust depends on assuming long-term commitments, so adjusting DMO autonomy cannot be meaningfully understood as a short-term policy move. The level of autonomy shapes the environment within which the DMO operates, and

influences the balance that the DMO strikes between consummate and opportunistic signals. However, as our model and results show, DMO autonomy does not exclusively determine that balance or any individual act of signaling; other factors influence these too. Therefore, DMO autonomy - an idiosyncrasy - influences specific acts of signaling in the short term, but is not shaped by any single such act.

We argue that consummate signals are on average larger and more likely (i.e. φ increases), and opportunistic signals are on average smaller and less likely when DMOs are dependent, because they would have to compensate for the low trust generated by that dependency. Recall that a consummate signal involves a long issue in the presence of positive privileged information, or a short issue in the presence of negative privileged information and the signal's size is inversely related to the level of trust. Thus, the hypothesis we formulate is:

> *Under positive privileged information, when DMO dependency (independent variable) rises, maturity at issuance (dependent variable) rises too. Likewise, under negative privileged information, when DMO dependency rises, maturity at issuance falls.*

Before moving to the empirical sections in which we test this hypothesis, it is important to emphasize that we restrict our argument to countries with relatively low sovereign credit risk in order to exclude crisis-prone situations. When default becomes a significant risk, spreads from risk-free debt largely determine the maturity of newly issued debt, which tends to shorten as an assurance to lenders that the government will repay them (Arellano and Ramanarayanan, 2012), depriving the DMOs of their ability to send any signals (low x_{pd} and high θ).

We do not discuss how DMO autonomy is determined in the long term, as our study focuses on short-term signaling. National DMO autonomy measures (see next section) are fixed for the data period, and the frequency of past variation in them is measured in decades, so they cannot be explained by any of the other variables.

Research design

We assembled a new dataset of national debt issues during 2004-12, from DMOs, central banks, ministries of finance and Bloomberg Professional Service. Focusing on developed economies with relatively low credit risk, we limit the dataset to observations in which at least one of the three major credit rating agencies (S&P, Moody's, Fitch) rated the sovereign debt higher than BBB+ (or Baa1). Since the rule of law is essential to our measure of DMO autonomy, we restrict our study to independent democracies (with a score of 8 or more in Polity IV database). Finally, we exclude countries that have rarely issued debt in that period, or lack good yield-curve data.

These restrictions leave 31 countries, including Taiwan and all current 36 OECD member states, minus Costa Rica, Estonia, Latvia, Luxembourg, Mexico and Turkey. Issuance data availability determines our period. Data frequency is monthly since few countries issue debt on a weekly basis. Due to country-months without issues, poor credit rating or missing data there are in practice 2,833 observations; of these 132 additional observations are lost in the regressions due to differencing and lagging of variables.[14]

The dependent variable (*MATURITY*) is the average time to maturity (in years) of the debt that the government issued during the month, weighted by the nominal value of issues with different maturities, and current exchange rates for foreign denominations (see Table A1 for descriptive statistics). By default, the data include any type of the national sovereign debt issued or legally backed by the central government. However, the data exclude maturity swap transactions, non-tradable debt and savings bonds, for lack of consistent and reliable cross-country data. The data also exclude bills shorter than three months (cash management instruments) and monetary policy instruments because they are unlikely instruments for debt maturity optimization.

We ran Fixed Effects linear regressions with standard errors clustered on the panels. The fixed effects are necessary to control for cross-country differences in benchmarks ($\boldsymbol{x_{pd}}$) and reliance on maturity swaps.

DEP_RvGILARDI is an index of DMO dependency on cabinet members (and hence associated with a greater propensity for consummate signaling – a positive $\boldsymbol{\varphi}$), based on

[14] In Robustness Tests we demonstrate that non-issuance is not driven by any of the factors in our model, and that correcting our empirical tests for this selection effect returns near-identical results.

the law.[15] We disregard regulations and decrees that the legislature did not adopt as law, because they are relatively easily revocable and are not a truly binding constraint on elected policymakers.

We code DMO dependency based on Gilardi's (2002) index of regulator autonomy.[16] Only nine countries in our data have legal documents with sufficient detail to allow meaningful coding. Their reversed scale Gilardi index values are (0=full autonomy, 1=no autonomy): Austria 0.75; Denmark 0.61; Germany 0.90; Greece 0.70; Hungary 0.86; Iceland 0.79; Ireland 0.72; Slovakia 0.53; Sweden 0.43. The other 22 countries are coded 1, because it is a known fact that they have not formalized their DMO's autonomy. *DEP_RvGILARDI* is a country fixed effect (no relevant legal changes have occurred in the data period in any data country) consistent with our view of DMO autonomy as a country idiosyncratic feature.

DMOs are not regulators and they face different tasks and challenges, so Gilardi's index may not be entirely appropriate for this study. In addition, debt management is carried out in some countries by the ministry of finance, without any legally mandated specialized agency. We therefore constructed our own classification of DMOs, based on analysis of the governance structure of debt management, as laid down by law. We define the DMO as the most senior non-cabinet policymaker in charge of deciding the parameters of newly issued sovereign debt. For example, this could be a specialized agency outside any ministry, a specialized unit inside a ministry, a government owned enterprise, or simply the general director of the ministry of finance, as demonstrated in the previous section. Based on this analysis, *DEP_LAW* is a dummy variable that flags the eleven dependent DMOs mentioned in the previous section, and like *DEP_RvGILARDI* is a country fixed effect.

The DMOs of the other 20 countries in our study enjoy varying degrees of autonomy as described above. Table A2 lists country DMO dependency according to both measures.

[15] We are inspired by literature on the autonomy of market regulators, which argues that *de facto* measures of regulator autonomy are more problematic than formal ones (Guardiancich and Guidi, 2016), or that legal autonomy of regulators is strongly correlated with their measures of actual autonomy (Hanretty and Koop, 2013). See review of other relevant literature in the introduction.

[16] We preferred Gilardi's index to central bank independence measures, because the former is general enough to be applicable to DMOs, while the latter are specific to monetary policymaking.

We do not separately explore incorporated DMOs because there are too few countries with such DMOs. Other potential credibility mechanisms discussed above are informal and leave no objective trace.

SIGNAL: This is a proxy for the presence of privileged information. It is the change in an indicator of the government's credit rating, such that positive (negative) changes are associated with falling (rising) interest on government debt. Credit ratings changes are driven by publicly available new information about the prospects of governments repaying their debts. Some of such public news used to be privileged information at an earlier time. Thus, specifying in the regression the change in the credit rating (the news) with a lead of one, two and three months (assuming privileged information becomes public by then) allows us to establish a relationship between today's bond issue and tomorrow's news (i.e. the future release of information which is currently privileged).

Note that we are not suggesting that all changes to credit ratings result from disclosure of privileged information. However, if enough rating changes do result from such disclosure, and if other changes are unrelated to maturity at issuance, then we should observe the hypothesized relationships empirically.[17] In addition, by measuring the signals at one, two and three-month intervals we are not suggesting that in any individual case the rating changes in response to debt issues in all three intervals. Rather we are estimating the average signal (over the data period and countries) in each interval, while in any individual case the signal may occur in only one of the three intervals (because once the privileged information has been revealed, it cannot be revealed again).

SIGNAL is based on the sovereign credit ratings that the three main agencies publish. For this purpose, the 20-notch scale of each agency was converted to numerical values (1-20), of which only the top seven (14-20) fall within our rating selection criterion for the dataset. *SIGNAL* is the change in this scale, averaged across the three agencies. Thus, the average scale has potentially 60 notch-fraction levels, of which 21 fall within

[17] To the extent that credit ratings lag the prices of asset prevailing at the time of issuance (Mora, 2006), lead ratings may partly reflect information that was disclosed at the time of issuance. However, ratings also lag prices of assets prevailing after the issuance (there is no set interval for this lag) which are driven by information that was not public at the time of issuance. In addition, research shows that ratings also drive asset prices, supplementing publicly available information (Bernal *et al*., 2015; Binici *et al*., 2017; Cantor and Packer, 1996). Otherwise, there would be no need for sovereign credit rating. Thus, lead credit ratings are a rough, not clean proxy for information that was not disclosed at the time of issuance.

the dataset. We record a one-notch rating change by one agency as a change of 0.33 in *SIGNAL*. A one-notch rating change by all three agencies is a change of 1.00 in *SIGNAL*. In practice, out of the 2,701 observations there are 84 with changes, 54 of which are downgrades. Table A3 lists the rating changes by country and year.

We also use a variant of *SIGNAL* that accounts for watch announcements. Announcing a positive watch or withdrawing a negative watch by a single agency, each counts as a rise of one half of a notch by that agency, and thus 0.17 in *SIGNAL*; Similarly, announcing a negative watch or withdrawing a positive watch, each counts as a fall of 0.17 in *SIGNAL*. This creates 120 potential notch-fractions, of which 42 fall within the dataset. In practice, there are 109 observations with changes (non-zero values of *SIGNAL*), 72 of which are negative.[18] Table A4 lists the rating changes including watches by country and year.

We define the size of a consummate (opportunistic) signal as the size of the increase (decrease) in *MATURITY* that is associated with a one-unit rise in lead *SIGNAL*.[19] An increase in the size of the signal is an increase in the change in *MATURITY* in the appropriate direction for a given one-unit rise in lead *SIGNAL*. The larger is the consummate (opportunistic) signal, the more beneficial (expensive) is a given change in the yield to the holder of the debt. Because a rise in the credit rating is associated with a fall in the yield ($\boldsymbol{S_G}$), a positive value for an interaction of lead *SIGNAL* with either *RvGILARDI* or *DEPENDENT* reflects a costlier signal by a dependent DMO under positive privileged information. Thus, a positive coefficient estimate in either of its leads would support the hypothesis (see Table 1).

CURVE is the difference in percentage points at month-end between the yields on ten-year bonds and three-month bills, a common proxy for the yield curve slope ($\boldsymbol{\alpha}$). Since *CURVE* contains a unit root, (at least within our data countries and years) we must difference it to avoid spurious regression results. We also lag it to reduce endogeneity to *MATURITY*. The prefix LD represents this transformation (See Table 1).

[18] Investors may use heuristics to group countries in regional "baskets" (Brooks *et al*., 2015), but this is not necessarily true of credit rating agencies. Indeed, we found no significant correlation in *SIGNAL* between any pair of data countries (*p-value of* 0.87 or higher on all correlation coefficients).

[19] Conversely, the size of a consummate (opportunistic) signal is the size of the decrease (increase) in *MATURITY* that is associated with a one-unit fall in lead *SIGNAL*.

SIZE is a proxy for the relative size of the issue (***q***), calculated as the ratio of the monthly sum of all new debt issues to the sum of all outstanding debt. Size of outstanding debt was taken from OECD Stat (Ministry of Finance for Taiwan), with linear interpolation from quarterly or annual data where necessary..

We use a set of 31 crisis-country dummy variables, for the period after September 2008 when Lehman Brothers collapsed, to control for the country-specific shocks to benchmarks. Year dummies (time fixed effects) control for global conditions affecting the bond markets, and month dummies control for seasonality. A lagged dependent variable controls for serial correlation, possibly the result of national debt management plans.

Results

Table 1 focuses on the effects of the DMO's dependency on debt issuance, under two alternative measures of signal (with and without watch announcements) and the two alternative operational definitions of DMO dependency.

The significant and negative coefficients of *SIGNAL* in Regressions (1) and (2) at the first lead mean that, ceteris paribus, an autonomous DMO will reduce maturity at issue by 9-9.6 years on average, one month ahead of a full notch increase in rating. This fits with the theory that the ideal response of a DMO to privileged information that would cause a future rise in rating (namely a drop in yields) would be to reduce maturity at issue currently, enabling future refinancing of that shorter debt at better yields rather than locking in current high interest rates for more time. The response to negative privileged information would be symmetrically identical.

The positive and significant coefficients of the interactions of *SIGNAL*×*DEPENDENT* show that dependent DMOs respond differently than autonomous DMOs, increasing their maturity at issue relative to the autonomous DMO response. In Regressions (1) and (2) this means that one month ahead of a rise of one notch in a county's average sovereign credit rating (by all three agencies), the 22 dependent DMOs according to the Gilardi index increased the maturity at issuance by 9.5-10 years on average, relative to the autonomous DMO behavior of reducing maturity at issuance. This shows that signaling takes place as hypothesized.

In Table 2 we sum these two effects. In total, the 22 less autonomous DMOs did not significantly change maturities in response to privileged information, while the autonomous DMOs significantly reduced (increased) maturities at issuance in response to positive (negative) privileged information.

Table 1: Government debt maturity at issuance by DMO dependency measure and inclusion of watch announcements in signal

		(1)	(2)	(3)	(4)
		DEP_RvGILARDI		***DEP_LAW***	
	Variable	***SIGNAL*: Watch included**	***SIGNAL*: Watch excluded**	***SIGNAL*: Watch included**	***SIGNAL*: Watch excluded**
Signals by autonomous DMOs	F1.*SIGNAL*	-9.56***	-9.04***	-1.39	-1.32
		(2.23)	(3.38)	(0.83)	(0.87)
	F2.*SIGNAL*	0.21	2.44	0.51	0.67
		(2.16)	(2.54)	(0.46)	(0.59)
	F3.*SIGNAL*	-1.47	-2.44	-0.36	-0.4
		(2.69)	(2.46)	(0.45)	(0.49)
Difference in signal between dependent and autonomous DMOs	F1.*SIGNAL* × *DEP_*	10.07***	9.53**	2.53***	2.41**
		(2.48)	(3.53)	(0.9)	(0.91)
	F2.*SIGNAL* × *DEP_*	0.38	-1.98	0.48	0.09
		(2.26)	(2.62)	(0.56)	(0.65)
	F3.*SIGNAL* × *DEP__*	1.48	2.52	0.32	0.46
		(2.98)	(2.65)	(0.85)	(0.72)
	LD.*CURVE*	0.01	0.01	-0.02	-0.02
		(0.16)	(0.16)	(0.16)	(0.17)
	SIZE	26. 9**	26. 7**	26. 7**	26. 6**
		(12.3)	(12.3)	(12.3)	(12.3)
	Observations	2,701	2,701	2,701	2,701
	R^2	0.50	0.50	0.50	0.49

Notes: Coefficient estimates from Fixed Effects regressions with clustered standard errors in parentheses. Coefficients for year and month dummies, crisis-country dummies, lagged dependent variable and the constant are not reported to save space. Dependent variable is average time to maturity (in years) of newly issued government debt during the month. * $.05 < p \leq .10$; ** $.01 < p \leq .05$; *** $p \leq .01$. LD prefix denotes one period lag and one period difference. F1, F2 and F3 prefixes denote one, two and three leads. Green shaded cells indicate a result that supports a hypothesis.

The results in Regressions (3) and (4), where the 11 dependent DMOs by our own classification method are compared with the 20 autonomous ones (DEP_LAW), are also supportive of the hypothesis. In this specification the coefficients of Signal were negative but insignificant, indicating that the autonomous DMOs did not act on their privileged information (i.e. were neutral). The coefficients of the interaction of Signal

and DEP_LAW were positive and significant, which means that one month ahead of a rise of one notch in a county's average sovereign credit rating (by all three agencies) the 11 dependent DMOs according to the LAW index increased their maturity at issuance by 2.4-2.5 years on average, relative to the neutral response of the autonomous DMOs.

Table 2 shows that in all four specifications the dependent DMOs sent signals that were more consummate than that of other DMOs – whether it was no signal versus an opportunistic one in (1)-(2) or a consummate signal versus no signal in (3)-(4). This is in line with our hypothesis.

Table 2: Total effect of signals by dependent DMO, by DMO dependency measure and inclusion of watch announcements in signal

	Variable	(1)	(2)	(3)	(4)
		DEP_RvGILARDI		***DEP_LAW***	
		***SIGNAL*: Watch included**	***SIGNAL*: Watch excluded**	***SIGNAL*: Watch included**	***SIGNAL*: Watch excluded**
Total signals by dependent DMOs	F1.*SIGNAL*+F1.*SIGNAL* × *DEP*	0.5 (0.46)	0.5 (0.42)	1.14*** (0.41)	1.09*** (0.37)
	F2.*SIGNAL*+F2.*SIGNAL* × *DEP*	0.59* (0.33)	0.46 (0.3)	0.99*** (0.35)	0.76*** (0.31)
	F3.*SIGNAL*+F3.*SIGNAL* × *DEP*	0.01 (0.49)	0.08 (0.4)	-0.05 (0.69)	0.06 (0.51)

Notes: Coefficients are linear combinations of coefficient estimates from identically numbered regressions from Table 1 with standard errors in parentheses. F-tests for significance of results. Dependent variable is average time to maturity (in years) of newly issued government debt during the month. * $.05 < p \leq .10$; ** $.01 < p \leq .05$; *** $p \leq .01$. F2 and F3 prefixes denote one, two and three leads.

The coefficient of the differenced and lagged *CURVE* is statistically insignificant. *SIZE* behaves as expected in all four regressions. For every one percent point greater relative quantity (0.01 ratio units), average maturity rises by about 3 months (0.27 years).

There is significant variation between the country fixed effects. The average debt maturity at issuance in seven countries is significantly shorter (at $p < 0.01$) than the sample average: Australia, Chile, Greece, Hungary, Ireland, Israel, Slovakia. It is significantly higher than the sample average in two countries: Denmark and Finland.

The results from both sets of regressions (1-2 and 3-4) show that dependent DMOs engage in significantly more consummate signaling than do autonomous DMOs. This

is consistent with the idea that autonomy in DMOs is a proxy for credibility and that autonomous DMOs have lower issuance costs relative to dependent DMOs, ceteris paribus.

Robustness test

Since our dependent variable is the time to maturity of newly issued debt, months without any issuances are coded as missing observations. Out of a total of 3,336 monthly observations,[20] 3,161 qualify the credit rating threshold (see below), and of these we drop 239 observations for which we have verified that there were no issuances. The results reported in Table 1 would be biased if the lack of issuances was endogenous to the signaling game, or other parameters affecting maturity at issuance. In this section, we test for this possibility and demonstrate that it is unlikely, using a Heckman selection model.[21]

Table 3 reports results from Probit regressions in which the dependent variable is a dummy for the occurrence of debt issuances in each month (the selection equations). All observations are included, regardless of credit rating. *BORROW* is the annual borrowing requirement, converted to billions of euros, calculated as the aggregate sum of all sovereign debt issuances during the calendar year (with a maturity greater than three months), but discounting issuances that matured within the same calendar year (to avoid double counting). A larger borrowing requirement is likely to result in more frequent issuances, in order to reduce the risk of undersubscription. It follows that the probability of issuances in any particular month rises with the annual borrowing requirement.

LOW_RATING is a dummy for country-months in which none of the three major credit rating agencies rated the sovereign debt higher than BBB+ (or Baa1). Such observations were excluded from our analysis of the maturity of newly issued debt. Table 3 shows that issuances are neither likelier, nor less likely in those periods. The other independent variables in Table 3 are similar to those in Table 1, and demonstrate that the timing of

[20] We could not obtain any information for Korea in 2012.

[21] Other studies of debt issuance (focusing on either the quantity issued or the incidence of issuance, not the maturity at issuance) have overcome the problem of missing observations by using three-month rolling averages (De Broeck and Guscina, 2011), or aggregating the data to quarterly (Eidam, 2017) or annual (Guscina and Jeanne, 2006; Hoogduin *et al*., 2011) frequency.

the auctions is not related to the determinants of optimal maturity at issuance.[22] Thus, issuance scheduling is not part of the signaling.

To save space we do not report the coefficients of year and month dummies, which control for global and seasonal conditions (such as timing of government expenditure and revenue flows) respectively. We found that issuances were less likely in 2006 compared with other years (i.e. countries tended to concentrate their issuances in a small number of large auctions). We also found that issuances are likelier in September and October compared with other months, but less likely in December (when the market is less active).

Table 3: Likelihood of debt issuance by type of DMO and signal

	(5)	(6)	(7)	(8)
Variable	***SIGNAL*: Watch included**	***SIGNAL*: Watch excluded**	***SIGNAL*: Watch included**	***SIGNAL*: Watch excluded**
F1.*SIGNAL*	0.38	0.32	0.38	0.32
	(0.24)	(0.23)	(0.24)	(0.23)
F2.*SIGNAL*	0.26	0.29	0.26	0.29
	(0.22)	(0.22)	(0.22)	(0.22)
F3.*SIGNAL*	-0.16	-0.19	-0.16	-0.19
	(0.21)	(0.21)	(0.21)	(0.21)
LD.*CURVE*	-0.02	-0.02	-0.02	-0.02
	(0.04)	(0.04)	(0.04)	(0.04)
DEP_RvGILARDI	1.13	1.13		
	(1.76)	(1.76)		
DEP_LAW			0.43	0.43
			(0.73)	(0.73)
BORROW	0.06***	0.06***	0.06***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)
LOW_RATING	-0.21	-0.2	-0.2	-0.2
	(0.26)	(0.26)	(0.26)	(0.26)
Observations	3,206	3,206	3,206	3,206
Chi2	165.45***	166.18***	166.23***	165.95***

Notes: Coefficient estimates from Probit regressions with standard errors in parentheses. Coefficients for year and month dummies and the constant are not reported to save space. Dependent variable is a dummy for months with debt issuances. * $.05 < p \leq .10$; ** $.01 < p \leq .05$; *** $p \leq .01$. LD prefix denotes one period lag and one period difference. F1, F2 and F3 prefixes denote one, two and three leads.

[22] Of course, the size of issuances cannot be included in the regressions, as it will return missing values in non-issuance months.

We next calculated the non-selection hazard, also known as inverted Mills' ratio (Heckman, 1979), based on the estimated parameters of each selection equation. Table 4 is similar to Table 1, but it also includes this ratio in all four regressions. The statistical insignificance of *MILL* supports the claim that the results of Table 1 are not biased by selection. Indeed, the coefficients of all variables in the Table 4 are very similar to those reported in Table 1.

Table 4: Government debt maturity at issuance by type of DMO and signal controlling for issuance selection effect

	Variable	(9)	(10)	(11)	(12)
		DEP_RvGILARDI		***DEP_LAW***	
		***SIGNAL*: Watch included**	***SIGNAL*: Watch excluded**	***SIGNAL*: Watch included**	***SIGNAL*: Watch excluded**
Signals by autonomous DMOs	F1.*SIGNAL*	-9.51***	-8.96**	-1.38	-1.32
		(2.3)	(3.51)	(0.83)	(0.86)
	F2.*SIGNAL*	0.3	2.55	0.52	0.67
		(2.14)	(2.49)	(0.47)	(0.6)
	F3.*SIGNAL*	-1.49	-2.46	-0.37	-0.4
		(2.68)	(2.44)	(0.45)	(0.49)
Difference in signal between dependent and autonomous DMOs	F1.*SIGNAL**DEP_	10.03***	9.47**	2.52***	2.41**
		(2.53)	(3.64)	(0.9)	(0.9)
	F2.*SIGNAL**DEP_	0.31	-2.08	0.48	0.09
		(2.22)	(2.56)	(0.56)	(0.65)
	F3.*SIGNAL**DEP_	1.5	2.54	0.32	0.47
		(2.97)	(2.63)	(0.85)	(0.72)
	LD.*CURVE*	0.01	0.01	-0.02	-0.02
		(0.16)	(0.16)	(0.17)	(0.17)
	SIZE	27**	26.8**	26.7**	26.6**
		(12.3)	(12.3)	(12.2)	(12.2)
	MILL	0.46	0.39	0.13	0.09
		(1.33)	(1.34)	(1.62)	(1.62)
	Observations	2,701	2,701	2,701	2,701
	R^2	0.50	0.50	0.50	0.49

Notes: Coefficient estimates from Fixed Effects regressions with clustered standard errors in parentheses. Coefficients for year and month dummies, crisis-country dummies, lagged dependent variable and the constant are not reported to save space. Dependent variable is average time to maturity (in years) of newly issued government debt during the month. * $.05 < p \leq .10$; ** $.01 < p \leq .05$; *** $p \leq .01$. LD prefix denotes one period lag and one period difference. F1, F2 and F3 prefixes denote one, two and three leads. Green shaded cells indicate a result that supports the hypothesis.

Conclusions

We argue that in developed economies with relatively high sovereign credit ratings, the autonomy of DMOs is an indicator of their credibility with lenders, and the maturity of auctioned sovereign debt can be adjusted to send opportunistic or consummate signals to lenders. DMOs can send opportunistic signals by issuing shorter debt when they expect good news or longer debt when they expect bad news. Alternatively, DMOs can send consummate signals by taking the reverse actions.

All else being equal, the extent of DMOs' political autonomy from cabinets affects the maturity of newly issued debt in the presence of privileged information. Debt issuance is costlier when DMOs lack autonomy from elected policymakers, because they lack credibility with lenders. Dependent (less autonomous) DMOs need to send more consummate signals, which are costly, in order to compensate for their lower credibility.

We test our hypothesis with a unique dataset based on 27,504 issues of government debt in 31 mostly OECD countries during 2004-12, and a unique compilation of legal text defining the autonomy of DMOs. We measure the size of consummate (opportunistic) signals as the increase (decrease) in issue-maturity associated with a one-notch future rise in the sovereign credit rating. Using Fixed Effects regressions and monthly data frequency, we find that the potential maturity difference between an autonomous DMO and a dependent DMO is between two and ten years, depending on the operational definition for DMO dependency, with dependent DMOs sending more consummate signals. This supports our hypothesis that autonomous DMOs are perceived by market participants to be more credible and therefore pay lower debt issuance costs.

Our study adds to the literature on the causes and effects of agency autonomy. It quantifies the effect of autonomy in the realm of national debt management, and shows that it can help mitigate credibility and time-inconsistency issues. For the regulation and governance literature, our study is innovative in demonstrating the importance of agency autonomy not only in regulating market activity, but also in managing relational contracts between governments and their suppliers. We break out of the unitary actor mold to study the behavior of debt managers, bureaucrats within an executive agency, and compile original institutional data on DMO political autonomy.

For the relational procurement literature, our contribution is to demonstrate empirically what governments do to build trust with private actors, rather than the more common emphasis in the literature on how suppliers can sustain the government's trust in them. Specifically, our study is original in studying the relationship between governments and primary dealers.

Our results may not apply to situations of crisis management or to governments with very poor sovereign credit rating. Our model focuses on the DMOs' dilemma assuming a credible monetary policy and relatively sound fiscal policies. Thus, any implications for the DMO's work under worse conditions deserve a separate discussion. In addition, our model focuses on the very short term. Future research should explore the origins of DMO autonomy, and study the long-term relationship between governments and their lenders. More work should also be done to define and measure DMO autonomy more carefully, rather than borrowing methods from the literature on regulatory agencies.

Our results have broader implications for the public policy literature on autonomous agencies. To our knowledge this is the first study of the role that agency autonomy could play in managing relational contracts with government vendors. Providing agencies with such autonomy can contribute to reducing costs for the government, while maintaining a stable relationship with suppliers.

Naturally, autonomy may have other effects. On one hand, autonomous agencies are often more accountable to the public, which may give autonomous DMOs a greater incentive to maximize benefits for the public in the short term. On the other hand, autonomy from elected politicians raises the risk of capture by suppliers. In our case, the risk is that autonomous DMOs come to systematically prefer the interests of the lenders over those of the government, raising the cost of the public debt and exposing the government to excessive risks. In addition, autonomous DMOs may develop their own agendas and exceed their mandates. As with all situations of autonomous bureaucracy, agency accountability and legitimacy are a concern as well. Future studies should address these aspects of autonomous procurement agencies.

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References

Ahuja, Amit and Susan L. Ostermann (2018). 'From Quiescent Bureaucracy to "Undocumented Wonder"', *Governance* 31(4): 759-76.

Akerlof, George. A. (1982). 'Labor Contracts as a Partial Gift Exchange', *The Quarterly Journal of Economics* 97(4): 543-69.

Arellano, Cristina and Ananth Ramanarayanan (2012). 'Default and the Maturity Structure in Sovereign Bonds', *Journal of Political Economy* 120(2): 187-232.

Arellano, C., Yan Bai, & Gabriel P. Mihalache (2020). Deadly Debt Crises: COVID-19 in Emerging Markets (No. w27275). National Bureau of Economic Research.

Beetsma, Roel, et al. "Independent fiscal councils: Recent trends and performance." *European Journal of Political Economy* 57 (2019): 53-69.

Beetsma, Roel, and Xavier Debrun. *Fiscal councils: rationale and effectiveness*. International Monetary Fund, 2016.

Bernal, Oscar, Alexandre Girard and Jean-Yves Gnabo (2015). *The Impact of Sovereign Credit Rating Surprises on Asset Prices Dynamics in Europe*. Available at: https://gdrnanterre2017.sciencesconf.org/143748/document.

Binici, Mahir, Michael Hutchison and Evan Weicheng Miao (2017). *Are Credit Rating Agencies Discredited?* Available at: https://ideas.repec.org/e/pbi168.html.

Blommestein, Hans J. and Philip Turner (2012). 'Interactions Between Sovereign Debt Management and Monetary Policy Under Fiscal Dominance and Financial Instability', *OECD Working Papers on Sovereign Borrowing and Public Debt Management* 3.

Brender, Adi and Allan Drazen (2005). 'Political Budget Cycles in New Versus Established Democracies', *Journal of Monetary Economics* 52 (7): 1271-95.

Brender, Adi and Allan Drazen (2008). 'How Do Budget Deficits and Economic Growth Affect Reelection Prospects?', *American Economic Review* 98(5): 2203-20.

Brooks, Sarah M., Raphael Cunha and Layna Mosley (2015). 'Categories, Creditworthiness, and Contagion, *International Studies Quarterly* 59(3): 587-601.

Brown, Trevor L., Matthew Potoski and David M. Van Slyke (2016). 'Managing Complex Contracts', *Journal of Public Administration Research and Theory* 26(2): 294-308.

Browne, Jude (2018). 'The Regulatory Gift', *Regulation & Governance*. doi:10.1111/rego.12194.

Carpenter, Daniel P. and David A. Moss (eds.) (2014). *Preventing Regulatory Capture* (Cambridge: Cambridge University Press).

Cukierman, Alex (1992). *Central Bank Strategy, Credibility, and Independence* (London: The MIT Press).

Cukierman, Alex. "Central bank independence and monetary policymaking institutions—Past, present and future." *European Journal of Political Economy* 24.4 (2008): 722-736.

De Broeck, Mark and Anastasia Guscina (2011). 'Government Debt Issuance in the Euro Area', *International Monetary Fund Working Paper* WP/11/21.

de Haan, Jakob and Sylvester Eijffinger (2016). 'The Politics of Central Bank Independence', *DNB working paper* 539.

Di Mascio, Fabrizio, Martino Maggetti and Alessandro Natalini (2018). 'Exploring the Dynamics of Delegation Over Time', *Policy Studies Journal*. doi:10.1111/psj.12253.

Duflo, Esther, Michael Greenstone, Rohini Pande and Nicholas Ryan (2018). 'The Value of Regulatory Discretion', *Econometrica* 86(6): 2123-60.

Eckert, Sandra (2018). 'Two Spheres of Regulation: Balancing Social and Economic Goals', *Regulation & Governance* 12(2): 177-91.

Eidam, Frederik (2017). *Gap-Filling Government Debt Maturity Choice*. ZEW - Centre for European Economic Research Discussion Paper No. 18-025. Available at: https://ssrn.com/abstract=3084052 or http://dx.doi.org/10.2139/ssrn.3084052.

Ennser-Jedenastik, Laurenz (2015). 'Credibility versus Control', *Comparative Political Studies* 48(7): 823-53.

Ennser-Jedenastik, Laurenz (2016). 'Do Parties Matter in Delegation?', *Regulation & Governance* 10(3): 193-210.

Faraglia, Elisa, Albert Marcet and Andrew Scott (2008). 'Fiscal Insurance and Debt Management in OECD Economies', *The Economic Journal* 118: 363-86.

Fernández-i-Marín, Xavier, Jacint Jordana and Andrea C. Bianculli (2016). 'Are Regulatory Agencies Independent in Practice?', *Regulation & Governance* 10(3): 230-47.

Gailmard, Sean and John W. Patty (2007). 'Slackers and Zealots', *American Journal of Political Science* 51(4): 873-89.

Gilardi, Fabrizio (2002). 'Policy Credibility and Delegation to Independent Regulatory Agencies', *Journal of European Public Policy* 9(6): 873-893.

Greenwood, Robin, Samuel Hanson and Jeremy Stein (2010). 'A Gap-Filling Theory of Corporate Debt Maturity Choice', *The Journal of Finance* 65(3): 993-1028.

Guardiancich, Igor and Mattia Guidi (2016). 'Formal Independence of Regulatory Agencies and Varieties of Capitalism', *Regulation & Governance* 10(3): 211-229.

Guibaud, Stéphane, Yves Nosbusch and Dimitri Vayanos (2013). 'Bond Market Clienteles, the Yield Curve, and the Optimal Maturity Structure of Government Debt', *The Review of Financial Studies* 26(8): 1914-61.

Guscina, Anastasia and Olivier Jeanne (2006). 'Government Debt in Emerging Market Countries', *International Monetary Fund Working Paper* WP/06/98.

Haber, Hanan (2018). 'Liberalizing Markets, Liberalizing Welfare? Economic Reform and Social Regulation in the EU's Electricity Regime', *Journal of European Public Policy* 25(3): 307-26.

Hanretty, Chris and Christel Koop (2012). 'Measuring the Formal Independence of Regulatory Agencies', *Journal of European Public Policy* 19(2): 198-216.

Hanretty, Chris and Christel Koop (2013). 'Shall the Law Set Them Free?', *Regulation & Governance* 7(2): 195-214.

Harkness, Euan (2006). 'Interaction with the Private Sector', in Mike Williams (ed.) *Government Debt Management* (London: Central Bank Publications).

Hart, Oliver and James Moore (2008). 'Contracts as Reference Points', *The Quarterly Journal of Economics* 123(1): 1-48.

Hirsch, Alexander V. and Kenneth W. Shotts (2018). 'Policy-Development Monopolies', *Journal of Politics*, 80(4):1339-54.

Holland, Allison (2006). 'The structure of debt markets', in Mike Williams (ed.) *Government Debt Management* (London: Central Bank Publications).

Hoogduin, Lex, Bahar Öztürk and Peter Wierts (2011). 'Public Debt Managers' Behaviour Interactions with Macro Policies', *Revue économique* 62(6): 1105-22.

Jeal, Valerie (2006). 'Effective Communication and Marketing for DM Offices', in Mike Williams (ed.) *Government Debt Management* (London: Central Bank Publications).

Kleibl, Johannes (2013). 'The Politics of Financial Regulatory Agency Replacement', *Journal of Politics* 75(2): 552-66.

Kopits, George (2011). "Independent fiscal institutions: developing good practices." *OECD Journal on Budgeting* 11.3 (2011): 1-18.

Krishnamurthy, Arvind and Annette Vissing-Jorgensen (2012). 'The Aggregate Demand for Treasury Debt', *Journal of Political Economy* 120(2): 233-67.

Maggetti, Martino (2007). 'De Facto Independence After Delegation', *Regulation & Governance* 1(4): 271-94.

Mediano, Andrés Pavón (2018). 'Agencies' Formal Independence and Credible Commitment in the Latin American Regulatory State', *Regulation & Governance*. doi:10.1111/rego.12187.

Melecky, Martin (2012). 'Formulation of Public Debt Management Strategies: An Empirical Study of Possible Drivers', *Economic Systems* 36(2): 218-34.

Miller, Gary J. and Andrew B. Whitford (2016). *Above Politics* (New York: Cambridge University Press).

Missale, Alessandro (1999). *Public Debt Management*. Oxford: Oxford University Press.

Nosbusch, Yves (2008). 'Interest Costs and the Optimal Maturity Structure of Government Debt', *The Economic Journal* 118: 477-98.

Patrikios, Stratos and Fabrizio De Francesco (2018). 'Churches as Firms', *Socio-Economic Review*, mwy013, https://doi.org/10.1093/ser/mwy013.

Rex, Justin (2018). 'Anatomy of Agency Capture', *Regulation & Governance*. doi:10.1111/rego.12209.

Selin, Jennifer L. (2015). 'What Makes an Agency Independent?', *American Journal of Political Science* 59(4): 971-87.

Thatcher, Mark (2007). 'Reforming National Regulatory Institutions', in Bob Hancké, Martin Rhodes and Mark Thatcher (eds). *Beyond Varieties of Capitalism* (Oxford: Oxford University Press) 147-72.

The World Bank and the International Monetary Fund (2014). *Revised Guidelines for Public Debt Management* (Washington: The World Bank Treasury).

Tomz, Michael and Mark L. J. Wright (2013). 'Empirical Research on Sovereign Debt and Default', *Annual Review of Economics* 5: 247-72.

Vaaler, Paul M., Burkhard N. Schrage and Steven A. Block (2005). 'Counting the Investor Vote', *Journal of International Business Studies* 36: 62-88.

Wheeler, Graeme (2004). *Sound Practice in Government Debt Management* (Washington: The World Bank).

Williamson, Oliver (2005). 'The Economics of Governance', *American Economic Association Paper and Proceeding* 95(2): 1-18.

Wonka, Arndt and Berthold Rittberger (2010). 'Credibility, Complexity and Uncertainty. *West European Politics* 33(4): 730-52.

Zupan, Mark (2017). *Inside Job* (Cambridge: Cambridge University Press).

Appendix

Table A1: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max	Unit
MATURITY	2701	4.86	4.25	0.25	32. 6	Years
DEP_RvGILARDI	2701	0.92	0.16	0.43	1	Index
DEP_LAW	2701	0.38	0.49	0	1	Dummy
SIGNAL	2701	-0.007	0.106	-2.17	1	Index
SIGNAL (no watch)	2701	-0.007	0.112	-2.33	1	Index
LD.*CURVE*	2701	-0.004	0.349	-4.8	3.74	Δ% points
SIZE	2701	0.024	0.017	0.000	0.208	Ratio

Table A2: DMO dependency by country and measure

	DMO Dependency measures[1]	
	DEP_RvGILARDI[2]	DEP_LAW[2]
Australia	1	0
Austria	0.75	0
Belgium	1	1
Canada	1	1
Chile	1	1
Czech Republic	1	1
Denmark	0.61	0
Finland	1	0
France	1	1
Germany	0.9	0
Greece	0.7	0
Hungary	0.86	0
Iceland	0.79	0
Ireland	0.72	0
Israel	1	0
Italy	1	1
Japan	1	0
New Zealand	1	1
Netherlands	1	1
Norway	1	0
Poland	1	0
Portugal	1	0
South Korea	1	0
Slovakia	0.53	0
Slovenia	1	1
Spain	1	1
Sweden	0.43	0
Switzerland	1	0
Taiwan	1	0
UK	1	1
USA	1	0
# of dependent DMOs	22	11

[1] DMO dependency is fixed for each country within the sample.
[2] 1=dependency.

Table A3: Rating changes (excluding watch announcements) by country and year

		Watch excluded		Rating Changes (watch excluded)†								
Country	# of obs in sample	Negative changes	Positive Changes	2004	2005	2006	2007	2008	2009	2010	2011	2012
Australia	88	0	1								1	
Austria	101	0	0									
Belgium	107	3	1			1					2	1
Canada	107	0	1	1								
Chile	62	0	4				1			1	1	1
Czech	107	0	4		1		1	1			1	
Denmark	107	0	0									
Finland	55	0	0									
France	107	2	0									2
Germany	107	0	0									
Greece	63	3	0						2	1		
Hungary	61	4	0		1	2		1				
Iceland	40	3	1		1		1	2				
Ireland	24	6	0						4	2		
Israel	87	0	4				1	2			1	
Italy	107	7	0	1		1					2	3
Japan	107	4	2	1			1		1		2	1
NZ	107	1	0								1	
Netherlands	103	0	0									
Norway	86	0	0									
Poland	107	0	4	2			2					
Portugal	86	7	0		1				1	4	1	
Skorea	45	0	1							1		
Slovakia	77	2	5		2	1		2				2
Slovenia	24	2	0									2
Spain	100	9	0						1	3	2	3
Sweden	101	0	2	2								
Switzerland	107	0	0									
Taiwan	107	0	0									
UK	107	0	0									
USA	107	1	0								1	
Total	**2701**	**54**	**30**	**7**	**6**	**5**	**7**	**8**	**9**	**12**	**15**	**15**

† Green shaded cells indicate positive rating changes. Grey shaded cells indicate negative rating changes.

Table A4: Rating changes (including watch announcements) by country and year

		Including watch		Rating Changes including watch†								
Country	# of obs in sample	Negative changes	Positive Changes	2004	2005	2006	2007	2008	2009	2010	2011	2012
Australia	88	0	1								1	
Austria	101	0	0									
Belgium	107	3	1			1					2	1
Canada	107	0	1	1								
Chile	62	0	5				1	1		1	1	1
Czech	107	0	4		1		1	1			1	
Denmark	107	0	0									
Finland	55	0	0									
France	107	3	0								1	2
Germany	107	1	1								1	1
Greece	63	4	1	1					2	2*		
Hungary	61	6	0		1	3		2				
Iceland	40	3	1		1		1	2				
Ireland	24	6	0						4	2		
Israel	87	0	5				1	3			1	
Italy	107	10	0	1		2					4	3
Japan	107	5	2	1			1		1		3	1
NZ	107	1	0								1	
Netherlands	103	1	1								1	1
Norway	86	0	0									
Poland	107	0	4	2			2					
Portugal	86	9	0		1				1	6	1	
Skorea	45	0	1							1		
Slovakia	77	3	7		2	2		3			1	2
Slovenia	24	3	0									3
Spain	100	13	0						1	5	4	3
Sweden	101	0	2	2								
Switzerland	107	0	0									
Taiwan	107	0	0									
UK	107	0	0									
USA	107	1	0								1	
Total	2701	72	37	8	6	8	7	12	9	17	24	18

* In March 2010 S&P removed the negative watch from Greece's credit rating (which is counted as a rise in rating). In April 2010 all three rating agencies downgraded Greece, S&P to below investment grade. In June 2010 Moody's downgraded them to below investment grade, at which point they were dropped from our sample

† Green shaded cells indicate positive rating changes. Grey shaded cells indicate negative rating changes.