PDM NETWORK

Public Debt Management Network

Sustainability of Debt Management in the Post-Pandemic Era

Proceedings of the 2nd Public Debt Management Conference Rome, 26-27 May 2022

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Sustainability of Debt Management in the Post-Pandemic Era

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Sustainability of debt management in the post-pandemic era

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*Please note that the four sessions listed in this publication slightly differ from those of the Public Debt Management Conference, as they include only the selected papers to which Authors gave their consent to this publication. However, they substantially reflect the themes discussed.

Foreword

On May 26-27, I took part to the second Public Debt Management (PDM) conference titled "Sustainability of debt management in the post-pandemic era" in Rome, an initiative organized by the PDM Network, the entity founded by the OECD, the World Bank and the Italian Treasury that puts together experts, institutions, academics, and practitioners (that I also joined several years ago) to improve the knowledge and disseminate the best practices on public debt management.

Many crises have hit the world economy since the first Public Debt Management (PDM) Conference in Paris in 2019. The second PDM conference took place against the backdrop of the on-going Covid-19 pandemic, the Russia-Ukraine war and a rapidly worsening environmental and climate crisis: all these new challenges combine to exacerbate economic, financial and debt vulnerabilities. Due to especially the large stock increase, the debt management landscape has become increasingly complex and government debt management offices are facing a range of new challenges that require continuous adaptation and strengthening of capacity.

These challenges require a collective and coherent policy response, and call for strengthening sustainable debt management strategies and developing new ones.

This second international conference of the PDM Network has been therefore very timely. What constitutes sustainable public debt is not an exact science. Debt sustainability assessments are subject to considerations about wider economic, social, and political objectives. Recent examples include the urgent need to integrate financing needs for climate change adaptation more systematically in debt sustainability assessments. Sovereign debt should be managed more than ever with a forward-looking approach.

The conference has explored both current and topical issues and traditional ones, with a focus on policy options to address debt management challenges. Conference sessions included areas of public debt dynamics and debt sustainability, environmental sustainability and public debt, liquidity in government securities markets, the development of local bond markets, and active debt management.

The papers offered different perspectives, linked to a specific country experience, leveraging a different methodology, or looking at the longer term. Once more, this emphasizes that, importantly, debt dynamics, financing opportunities, and options to manage public debt in a sustainable way may differ significantly between emerging and advanced economies.

I do hope that this collection of selected high-quality papers sets the stage for further debate and discussion on new and old challenges for the management of rising developing and developed countries debt burdens.

There is still a lot to explore and analyse in these areas. Looking forward to the next PDM Conference!

Prof. Alessandro Missale

Full Professor, University of Milan

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Shai Somek, OECD
Lars Jessen, World Bank
Sébastien Boitreaud, World Bank
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Members' affiliations and role descriptions as of the 2022 Conference date.

The PDM Network is extremely grateful to Fabio Vittorini, who led the PDM Network Secretariat from April 2017 to March 2022, for his invaluable contribution, dedication and enthusiasm.

Introduction

The Public Debt Management (PDM) Network, an initiative fostered by the OECD, the Italian Treasury, and the World Bank, held the second Public Debt Management Conference in Rome on May 26-27, 2022. The event brought together around 250 participants from all continents.

Senior national public debt managers, representatives of international and regional organizations, leading academics as well as the authors of the 17 peer-reviewed papers, participated to the debate.

Speakers included the Director-General of the Italian Treasury, Alessandro Rivera, the Deputy Secretary-General of the OECD, Yoshiki Takeuchi, the Practice Manager in the Finance, Competitiveness & Innovation Global Practice at the World Bank, Anderson Silva, and the Director of the OECD Directorate for Financial and Enterprise Affairs, Carmine Di Noia.

This volume contains contributions by the selected authors and the renowned speakers, exploring highly cited and timely topics central to the management of public debt with a focus on debt sustainability, including from an environmental perspective, its impact on economic growth, and its link with the development of capital markets. Moreover, it includes country case studies on the liquidity of the secondary government bond market, the development of local currency bond markets and the effects of the adoption of unconventional measures to cope with the pandemic.

This volume is divided into four sessions: I) Public debt dynamics, environmental and debt sustainability; II) Liquidity in government securities markets; III) Development of local currencies bond markets and IV) Active debt management.

A short description of the speeches and the essays is provided below.

In the welcoming remarks, **Yoshiki Takeuchi** recalls the recent challenges which severely affect public debt management and require a collective and coherent policy response, which allows governments to develop sustainable borrowing strategies, while also managing a high debt stock. He emphasizes the importance of a forward-looking approach for sovereign debt managers. This entails consideration of medium and long-term risks as well as costs. In this respect, research on modelling of public debt dynamics, scenario analyses and optimal debt strategy provides valuable insights and improves our understanding of the impacts of potential shocks. This, in turn, enables policy makers to build more resilient debt portfolios, develop risk mitigation techniques such as liquidity buffers and communicate such adjustments with relevant stakeholders.

Alessandro Rivera, in his opening remarks, recalls that this year marks the 20th anniversary of the launch of the idea of setting up the PDM Network among public debt managers, academics and multilateral institutions, and briefly describes the evolution of the PDM Network since its origins. In summarizing the conference's programme, he highlights the increasing importance of environmental sustainability and its impact on debt sustainability, which is indeed gaining growing attention among governments, market participants, analysts, rating agencies and multilateral institutions.

In his keynote speech ***Sovereign debt in times of crisis***, **Carmine Di Noia** explores the dynamics of sovereign debt in crisis times. In particular, he describes how sovereign debt markets react to pressures caused by the war in Ukraine and the COVID-19 pandemic. In doing so, it highlights the key uncertainties

facing countries and debt managers and lessons learned so far. It also addresses possible risks on the horizon.

Paola Subacchi, Paul van den Noord and Rodrigo Olivares-Caminal, in their essay ***Debt Sustainability after the Pandemic: a Rift between the Advanced and Developing Economies?***, pose attention to major fiscal challenges, after the pandemic, to many countries, both advanced and developing. A key issue facing policymakers is the amount of available fiscal space given the recent surge in public debt. Their analysis suggests that advanced and developing economies face entirely different conditions for the conduct of independent fiscal policies to address major shocks, with the former generally much better placed.

In their essay ***Sovereign debt management in the face of climate liabilities: Perspective of European Union member states***, **Iustina Alina Boitan and Kamilla Marchewka-Bartkowiak** consider that climate liabilities raise the cost and risk of capital of all climate-vulnerable countries and threaten debt sustainability. Consequently, governments should manage climate debt as part of the traditional direct or contingent liabilities by the implementation of green financial mechanisms and instruments. Their findings indicate a growing role of climate financial mechanism implementation in a sovereign debt management and on the green debt market.

Samantha Cook, Cigdem Aslam, Philip Anderson, David Bevan, Mellany Pintado and Jelena Kostic, in their essay ***The Impacts of Disaster Risk on Sovereign Asset and Liability Management***, apply the Sovereign Asset and Liability Management (SALM) framework as a new and comprehensive way of looking at the potential impact of a disaster on public assets and liabilities. Its implementation can help build key practical recommendations for understanding risk in its multiple dimensions (economic, fiscal, financial). They introduce a theoretical framework to understand the potential impact of natural disasters on countries' economy and public finances, by applying it in three case studies: Peru, Serbia and New Zealand.

Marianna Blix Grimaldi and Johanna Hirvonen, in their essay ***Government Bond Market developments and the Usage of the DMO's Security Lending Facility - Evidence from Sweden,*** introduce a novel approach based on proprietary information of the Swedish Debt Management Office's security lending facility (SLF) to investigate key changes in government bond markets and their implications for market functioning after the COVID-19 pandemic. They show that quantitative easing (QE) policies have had a persistent influence on usage of the facility and demand from primary dealers, and that the terms and conditions attached to a SLF are a powerful policy tool and that altering them can cause significant shifts in SLF usage.

Angelica Ghiselli and Filippo Mormando, ***Auctions and liquidity conditions in the Italian government bond market,*** analyse the liquidity loop between primary and secondary markets of government bonds. Based on primary market and MTS data, they empirically assess and identify a significant information effect of auctions on price discovery process in the secondary market, including in the days after the auction. They also introduce a new auction's performance indicator, showing that better auctions lead to more liquid quoting books, although the presence of heterogeneous quoting behaviour among dealers and over time.

Daniel C. Hardy, in its essay ***Sovereign Eurobond Liquidity and Yields,*** stresses the importance of market liquidity for asset pricing. By analysing Eurobonds, he shows that bid-ask spreads (a proxy for market liquidity) and yields are closely related to volume, time to maturity, inclusion of enhanced collective action clauses, and jurisdiction of issuance. Debt management offices can choose these characteristics in a way that has economically significant and persistent effects on both liquidity and pricing.

Endo Tadashi, in its essay ***Endogenous Market Development for Government Securities in Lower-Income Economies***, remarks that many lower-income economies have difficulty in developing government securities markets (GSMs). He proposes a "Two-Dimensional Policy Framework for GSM Development" as a solution to implement upon the twenty-year-old World Bank/IMF's conventional policy framework. It differentiates GSMs by their development phases and presents endogenously phase-coherent policy sets. In his research the endogenous variables explained 40 percent of trading volume growth in the early phase of India's GSM development and utilities played a dominant role in increasing trade volumes in the early-phase market.

María del Carmen Bonilla, Omar Mendizabal and Gabriel Yorio, in their essay ***Road to Efficiency in Emerging Local Debt Markets: the Mexican Experience,*** analyze the evolution of the efficiency of the Mexican debt market. Between 2020-2022 it has been developed an efficient Overnight Indexed Swap (OIS) curve in local currency to allow national debt market participants to price a debt product in different time horizons. A threefold strategy is implemented by the Ministry of Finance to accomplish this curve, with the expected outcome that derivatives on the Funding Interbank Equilibrium Interest Rate (TIIEF in Spanish) will structure a enough nodes to obtain an efficient OIS curve in local currency.

Charlotte Rommerskirchen, in her essay ***Making a Market: On the Diffusion, Benefits, and Risks of the Primary Dealer Model*** examines the diffusion of the primary dealer model across 32 rich economies. In so doing, it provides a cross-national political-economy analysis of primary dealership creation and of its consequences. The results suggest that the costs of public debt have been a central driver of reform and there is strong evidence that primary dealer systems reduced governments' borrowing costs substantially. At the same time, the growing role of repo finance within the primary dealer model, points to inherent risks emerging from cyclical effects and systemic fragilities.

Helano Borges Dias, Luís Felipe Vital Nunes Pereira and Paulo de Oliveira Leitão Neto, in their essay ***Extraordinary actions: The use of Buyback and Spread Auctions – The Brazil National Treasury Experience,*** review the use of extraordinary actions by the Brazil National Treasury (BNT), with special attention to the COVID-19 crisis. They sought to understand the tools and contexts that gave rise to the extraordinary actions of the BNT, as well as the construction of the underlying factors that supported them. Using a probit model and a principal component analysis they verified that important indicators of financial market volatility are relevant to explain the actions of the BNT in the public bond market.

Finally, **Anderson Silva Caputo** in his concluding remarks, appreciates the high quality of conference papers, and welcome the increase in diversification, related to both topics and authors, in terms of professional experience, institution, geography and gender. He envisages that this positive trend be sustained and strengthened in the future, with, possibly, the exploration of new topics - such as the use of Fintech and Digital Ledger Technology (DLT) and the participation of private sector experts and researchers from civil society organizations/NGOs.

Welcoming Remarks

Yoshiki Takeuchi

Deputy Secretary-General at the OECD[1]

Good morning, ladies and gentlemen.

It is my great pleasure to welcome you all - those of you who are with us today in Rome and those who are joining us virtually - to the second PDM Network Public Debt Management Conference. This conference reflects the collaborative work across the members of the Public Debt Management Network (PDM Network).

The OECD and the Italian Treasury established the PDM Network eighteen years ago, in 2004, and we were glad to welcome the World Bank into the group in 2013. Together, the Network's members aim to share and disseminate sound practice and recent developments in public debt management, including through conferences like this one and via the Network's website and communications. I would like to thank especially the Italian Treasury's Public Debt Directorate, which acts as the PDM Network Secretariat, for its efforts to support the Network and its activities.

This is the second PDM Network research conference. With these meetings, we hope to bring together a wide variety of stakeholders—including academics, investors, policymakers and practitioners—to address the challenges arising from effective public debt management. So much has happened since we last met in Paris in 2019: Today's conference is taking place against the backdrop of the global pandemic, the war in Ukraine and geo-economic challenges.

We live in an age of uncertainty and risk. Some say this is the age of "permacrisis", where one challenge is seamlessly followed by the next. Looking back, we have faced the largest financial crisis since the 1930s, the worst pandemic since 1919, and now the most serious geopolitical crisis in Europe since the end of the Cold War. Crisis always poses additional challenges to sovereign debt management. Often, sudden and massive increases in government borrowing needs occur when financial markets are volatile. For example, the 2008-2009 financial crisis, and the policy response to it, implied drastically increased additional borrowing requirements. The impact of that crisis lifted debt-to-GDP ratios by more than 15 percentage points between 2007 and 2009 in the OECD area.

The pandemic has brought about additional and unprecedented challenges for public debt management. The upsurge in government spending and reduced revenue collection mean that the gross borrowing needs of governments have risen significantly. The pandemic's impact on public finances has been more dramatic than the 2008 financial crisis. It lifted OECD area debt-to-GDP ratio by more than 16 percentage points only in 2020.

[1] Disclaimer: Opinions expressed in this speech are personal and do not necessarily represent those of the OECD.

We now face the impacts of the war in Ukraine. Russia's war against the people of Ukraine and the pain and suffering it is causing, are deeply distressing. First and foremost, this is a terrible humanitarian crisis inflicted on the people of Ukraine. The war also poses challenges for policy makers. Coupled with the expectation of a change in the global liquidity conditions, the war has further heightened uncertainty. It is posing challenges for policy makers by simultaneously threatening economic growth and exacerbating already-rising inflation. In March, the OECD estimated that global economic growth will be more than 1 percentage point lower this year as a result of this conflict. Inflation, already high at the start of the year, could rise by about a further 2.5 percentage points on aggregate across the world.

These developments continue to affect public debt management through borrowing needs, borrowing instruments, market liquidity conditions, investor base and investor behaviour. Policy makers must address these challenges while also ensuring their economies are on a sustainable path for implementing the structural transformations needed to address the digital transformation of our economies, persistent inequalities, and the existential threat of climate change. Debt managers and financial policy makers are facing these challenges at a time when sovereign debt is at a nearly all-time highs across advanced economies and emerging markets. Levels continue to rise, exceeding 100 percent of GDP in some cases, including in Japan and Italy.

We are moving away from the long era of low interest rates and stable market conditions that created a favourable funding environment for sovereign issuers in most jurisdictions. These conditions enabled governments to finance borrowing requirements at low cost. They, in part, facilitated the hard work of debt managers who need to urgently respond to the COVID-19 crisis. With the strong support of accommodative monetary policies implemented by the major central banks, this massive amount of borrowing and the sudden changes in the borrowing plans were carried out smoothly, without undermining the functioning of bond markets. Since 2019, the outstanding level of marketable debt for OECD governments increased by more than USD 10 trillion to USD 50 trillion in 2021 and is projected to reach USD 53 trillion in 2022. As a percentage of GDP, central government marketable debt for the OECD area is expected to gradually decline from 90% in 2020 to 88% in 2022. This is driven inter alia by stabilised borrowing needs and low interest payments. These estimations for 2022, made before the war in Ukraine, are now subject to the economic effects of the war, as well as the monetary and fiscal policy responses.

Today's reality is shifting, and possibly becoming more challenging for the effective management of public debt: Global liquidity is tightening, and the need to search for yield is becoming less intense. Despite the extended maturities of new issuance, debt redemption profiles are expected to be elevated. Governments' debt service to the markets constitutes one-quarter of the public debt in emerging market economies and one-third in OECD countries. In many countries, the high refinancing burden from maturing debt is combined with continued budget deficits.

Today's challenges require a collective and coherent policy response, which allows governments to develop sustainable borrowing strategies, while also managing a high debt stock. Sovereign debt should be managed with a forward-looking approach. This entails consideration of medium and long-term risks as well as costs. In this respect, research on modelling of public debt dynamics, scenario analyses and optimal debt strategy provide valuable insights and improve our understanding of the impacts of potential shocks. This in turn, enables policy makers to build more resilient debt portfolios; develop risk mitigation techniques such as liquidity buffers and communicate such adjustments with market and related stakeholders.

This second research conference of the PDM Network is therefore very timely. It showcases high-quality papers tackling some of these challenging issues. Research scholars, policy makers and industry practitioners are joining us today to present their high quality, original theoretical/applied empirical

papers. Also, prominent academics, high-level officials of international organizations as well as national authorities, industry executives working in the field of public debt and allied areas, are here with us.

I am sure everyone is looking forward to the presentations and the dialogue during the policy panel sessions today and tomorrow. I would like to thank the Italian Treasury for hosting this year's conference, as well as our team from the OECD Secretariat and the World Bank for their support in organising it. In addition, I would also thank the authors for submitting their papers and participating this conference.

I hope that the conference convenes today will enable us to reconnect, exchange insights, gain fresh perspectives and advance solutions on the key issues related to debt management and government bond markets.

I wish you all excellent conference and fruitful discussions during these two days.

Thank you.

Opening Remarks

Alessandro Rivera

Director General of the Italian Treasury

Dear Participants,

It is a real pleasure for me to welcome you at this 2nd Public Debt Management Conference organised by the Promoting Institutions of the Public Debt Management Network, namely the OECD, the World Bank and the Department of the Treasury of the Italian Ministry of Economy and Finance.

"Debt Management in Uncertain Times" was the title of the 1st Public Debt Management Conference, held in Paris in 2019 at OECD's Headquarters. The success of that conference persuaded the Promoting Institutions that this initiative was worth repeating, possibly every other year. Indeed, the second one was firstly programmed in 2021, but the Covid-19 pandemic imposed to wait for another year.

Incidentally, this year marks an anniversary, since it was during the 2002 OECD Global Forum on Public Debt Management and Emerging Government Securities Markets that for the first time we discussed the idea of setting up a Network among public debt managers, academics and multilateral institutions, focused on the analysis of policy issues related to sovereign debt management. That Forum was held in Rome, organised under the aegis of the OECD and with the collaboration of the newly constituted unit within the Italian Public Debt Directorate in charge of organizing initiatives aimed at disseminating debt management *best practices* among DMOs from emerging and low-income countries. After 20 years that initial idea is now largely realized.

An initial Memorandum of Understanding signed in 2004 between the Italian Treasury and the OECD Directorate for Financial and Enterprise Affairs (DAFFE) formally set up the Public Debt Management Network; the Memorandum was then updated in 2013 and 2017, with the World Bank Treasury also joining the club. Over time, indeed, the Network widened its area of interest to cover not only emerging and low-income countries, but also advanced economies.

The PDM website, that relies on the Italian Treasury IT infrastructure is operationally managed by its Secretariat here at the Treasury. The website encompasses a very broad set of topics related to debt management policies and techniques according to which all the website documents (academic papers, discussion and policy papers, articles and so on) are organized.

Website subscribers regularly receive newsletters and are also continuously updated on initiatives organised by the three institutions and other multilateral institutions on the topics covered by the Website.

Subscribers belong to DMOs, Multilateral Organizations, Universities and Governments, for the great majority, and their geographical distribution is truly global.

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The numbers of this 2nd PDM Conference tell us a lot about the characteristics and the nature of the Network that basically aims at closing the gap between practitioners (such as DMOs, multilateral institutions) and the experts (from universities and research centres also from the private sector) on several areas related to debt management. 41 among DMOs, multilateral institutions, recognized experts (including several academics) coming from 24 countries, responded to the call of papers that was launched in April 2021. A panel of 11 experts, nominated by the OECD, the World Bank and the Italian Treasury, evaluated the papers. 18 of them will be discussed during this conference, written by both academics/experts and practitioners.

To join this conference, 235 participants have applied, coming from more than 40 countries worldwide. Almost half of them is here in person while the rest is remotely connected. More than 20 per cent of them comes from multilateral and supranational organizations.

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The conference comes at a very peculiar moment after more than 2 years of the Covid-19 pandemic and a dramatic situation in Europe because of the war in Ukraine. As we all know the pandemic has brought a significant increase of public debt stock throughout the world. In most of the cases this increase was the necessary consequence to avoid much heavier damages on the economies caused by the measures adopted by governments to contain the virus. The pandemic and now the war are having very strong repercussions on inflation, growth, and interest rates.

This is making even more evident the challenges that as policy makers we are now called to face due to this higher debt levels.

Looking at the conference program all the sessions can bring a lot of insights on our way forward. How to assess debt sustainability and to cope with its consequences, how to improve local currency debt markets, how to organize and improve the liquidity of debt securities through a proactive debt management: the interaction on these topics from different perspectives will be extremely valuable also for us as policy makers.

Not to mention the session focused on environmental sustainability: the interlinkage between climate change and debt sustainability is indeed gaining increasing traction among governments, market participants, analysts, rating agencies and multilateral institutions.

Let me conclude by saying that after 20 years of continuous efforts made by the three cofounders of the Network, we can currently rely on a valid and original tool based on the international cooperation between governments, multilateral institutions, academics, and experts to share experiences and findings on several crucial areas related to public debt management. Something that, especially in these times, is so essential.

Let me thank the OECD and WB and all the colleagues belonging to the Department of the Treasury for organizing this event. I would also like to mention our colleague Fabio Vittorini who in recent years contributed significantly to the development of the Network.

I wish you all a very rich and productive discussion over these two days.

Thank you!

Keynote Address - Sovereign Debt in Times of Crises

Carmine Di Noia

Director, OECD Directorate for Financial and Enterprise Affairs[1]

I will focus my remarks this morning on sovereign debt in times of crises – a word that I willingly admit is somewhat disheartening to use in the plural. In the current context of the pandemic and the war in Ukraine, on top of the pressing need to address climate change, however, one can legitimately speak of multiple crises.

Public debt is particularly sensitive in crisis times. Sharp upward pressure on public borrowing will often coincide with significant financial turmoil and uncertain market conditions, as was the case at the outbreak of the pandemic, to mention the most notable recent example. Crises serve to remind us that sovereign debt is a complex mix not just of macroeconomics, finance and law, but indeed also of politics, both domestic and international.

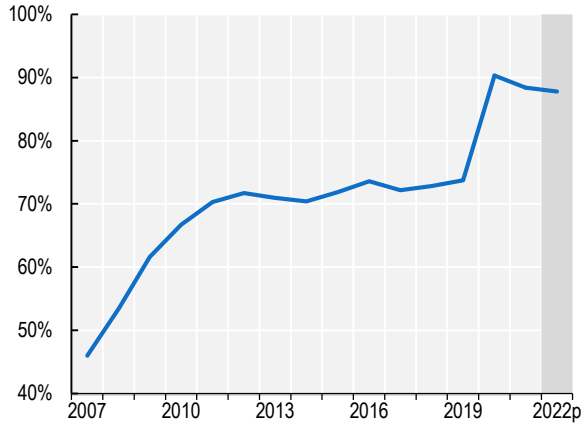
Against this backdrop, my intention for today is to highlight both the key uncertainties facing countries and public debt managers in the difficult current context, as well as lessons learned so far about the management of public debt in crisis scenarios. I will finish by raising some questions about possible risks on the horizon.

Going into the crises - not NICE, but not so bad?

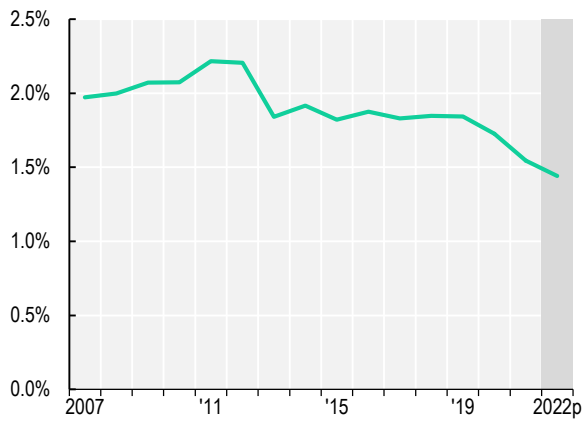
To set the scene, let me start by providing a broad overview of the state of sovereign borrowing going into the current crises. It is a familiar story, but one worth repeating to understand today's context. The figures I am showing here begin at the cusp of the global financial crisis, in 2007. That crisis, as you know, marked the end of the so-called Great Moderation of reduced macroeconomic volatility.

[1] Disclaimer: Opinions expressed in this speech are personal and do not necessarily represent those of the OECD.

A. Central govt. marketable debt, % of GDP (OECD)



B. Net general govt. interest payments, % of GDP (OECD)



Note: Shaded areas are projections
Source: OECD Sovereign Borrowing Outlook 2022; OECD Economic Outlook 110

The post-crisis environment was also decidedly a break with what Mervyn King once called the **N.I.C.E.** decade, **n**on-**i**nflationary, **c**onsistently **e**xpansionary. It paved the way instead for uneven and sluggish GDP growth as well as elevated unemployment rates, notably in Europe.

But even if it wasn't **nice**, in many OECD countries it was perhaps not so bad either, as far as public debt management is concerned. As the graphs show, there has been an effective decoupling between interest costs and sovereign borrowing levels in many advanced economies. The blue line on the left shows how central government marketable debt in OECD countries increased from 46% of GDP in 2007 to 74% in 2019, before jumping to over 90% in 2020 as the pandemic led to substantial increases in public expenditure.

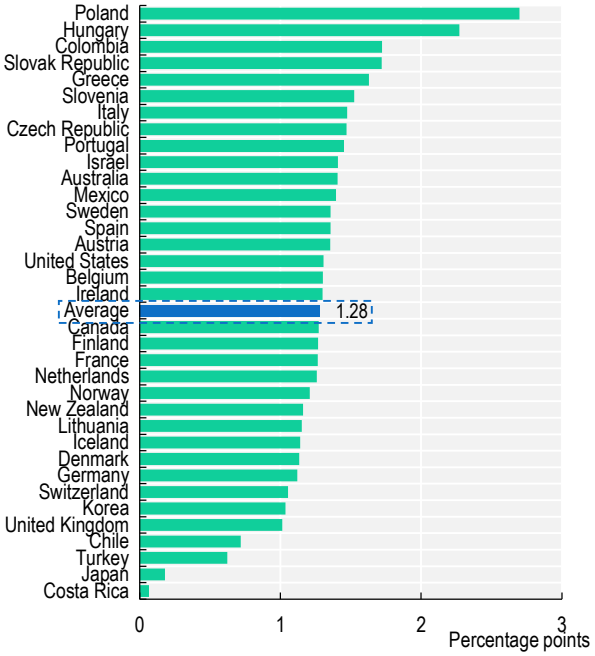
During the same period, net general government interest payments as a share of GDP decreased from 2.7% to 1.7%. The correlation between debt-to-GDP and net interest payments to GDP is, strikingly, sharply negative, even as maturities have shown an increasing trend.

Of course, as you are all well aware, this is an effect of a prolonged period of extraordinarily accommodative monetary policy in response to persistently low growth and inflation. Those conditions, however, are changing.

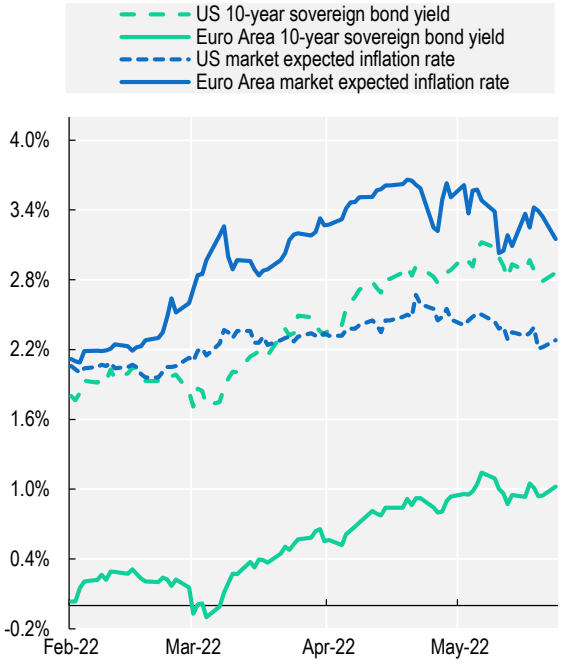
A turning of the tide?

Inflation is picking up pace again, fuelled at least in part by pandemic and war-related supply chain issues. In response, central banks are shifting to tighter monetary policy positions, unwinding their asset purchasing programmes and raising interest rates.

A. Change in 10-year benchmark yields between December 2021 and April 2022 (percentage points)



B. US and Euro Area 10-year sovereign bond yields and 5-year market inflation expectations



Note: Inflation expectations are 5 years
Source: OECD Sovereign Borrowing Outlook 2022; OECD Economic Outlook 110

The graph on the left side shows how the 10-year yield has increased rather significantly in 2022 in both the US (green dashed line) and the Euro Area (full green line). Market inflation expectations have also picked up compared to recent years, although still remain at *relatively* modest levels.
As the graph on the right side of the slide shows, all OECD countries saw their 10-year benchmark yield increase between December 2021 and April 2022, and all but a handful by more than 1 percentage point. It is still too soon to say whether this represents a more permanent, widespread increase in inflation levels and expectations, but it is clear that macroeconomic change is afoot, with consequent effects on sovereign debt markets.

Twin crises, triple pressures

Against this brief background, let me now outline what I see as the three key pressures facing sovereign debt markets, and how they relate to the twin crises of the pandemic and the war in Ukraine.
The first pressure is a general surge in government borrowing, and in future borrowing needs. This relates to the current crises – the most evident example is the cost of dealing with COVID-19, illustrated by the fact that gross borrowing by OECD governments jumped by 70% in 2020.
But this shock increase in public spending to fight the pandemic only constitutes one among many fiscal pressures. Aside from crisis spending, there are also more structural issues. Firstly, ensuring an equitable and sustainable green transition will require significant investment, public as well as private. It is a non-negotiable cost. We heard some perspectives yesterday on the interplay between environmental stability and public debt. This impact can already be seen. For example, while still in the early stages of development, the ESG-labelled sovereign bond market has grown significantly in recent years. More than 30 countries have issued ESG-labelled bonds, and the amounts issued have more than tripled since 2019.

Secondly, there is a demographic shift towards ageing populations in many developed countries, simultaneously reducing the tax base and increasing public expenditure related to old age. This will inevitably add additional strain on public finances.

Already, OECD governments are estimated to borrow more than 14 trillion US dollars from the markets in 2022. Net borrowing requirements are estimated at around 3 trillion US dollars, which is twice as much as pre-pandemic levels.

The second pressure is inflation, as I have briefly touched upon. The pick-up in inflation is partly an effect of the crises we are living through, as supply chain disruptions from both the pandemic and the war in Ukraine are leading to price increases globally, notably in food and energy.

As central banks around the world tighten their positions, we will see higher interest rates in a context of very elevated debt levels – and significant refinancing needs. Between now and end-2024, OECD government have more than 20 trillion US dollars' worth debt coming due.

The unwinding of central banks' asset purchase programmes will also lead to a shift in the investor base, increasing the yield-sensitivity of bondholders and likely putting further pressure on borrowing costs.

The third pressure is more abstract, but an important challenge nonetheless. I am talking about the general degree of uncertainty facing us all, in terms of the economy, in terms of financial markets and, of course, in terms of geopolitics. This clouded outlook exacerbates the other two pressures, making borrowing needs more difficult to estimate and the nature of the current inflation difficult to assess.

For example, how long will the war and the sanctions last, and what will the subsequent geopolitical landscape look like? What will be the cost of reconstruction? Will we have entirely new global supply chains, and if so, what will the inflationary impact be? Can COVID-19 be said to be over from a public finance perspective, or is there a risk of a resurgence, or a new variant that would cause another sudden shock to public finances? Is there a risk of another pandemic altogether, be it monkeypox or something else? What is the nature of the inflation we are seeing? These are all critical questions to consider when designing a public debt management strategy, but at this stage we can only guess what their answers will be. Life, as Kierkegaard noted, can only be understood backwards, but must unfortunately be lived forwards.

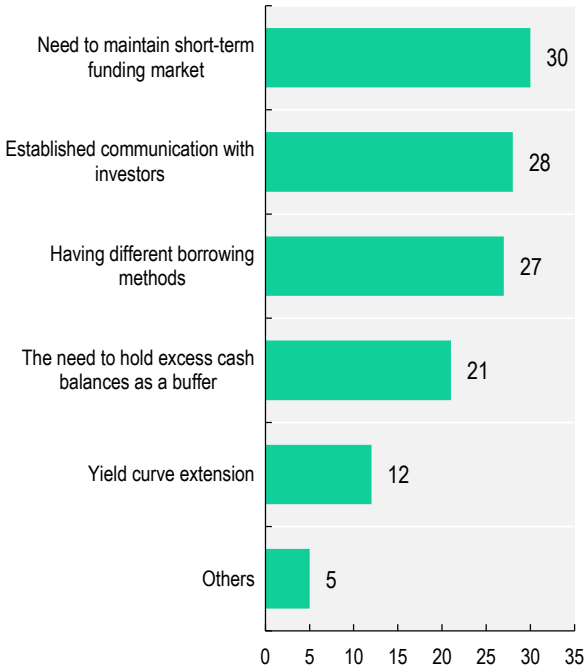
Implications and lessons learned from the pandemic

Still, in the midst of all this uncertainty, some clarity remains and we are learning as we go. At the OECD, we are lucky to be able to draw upon the expertise of our Working Party on Public Debt Management, whose members have shared with us the key lessons learned from dealing with the COVID-19 crisis in a unique OECD survey. As the graph on the left shows, the most commonly cited lesson is the need to maintain a short-term funding market. Several countries, including Germany and Italy, have focused on repo activity to improve cash management, provide more flexibility in issuance plans and support market liquidity. Another interesting point raised by many countries is the importance of having different borrowing methods in place – be it auctions, syndications or private placements. Several debt management offices also relied on cash buffers in the wake of the pandemic, when market conditions were acute.

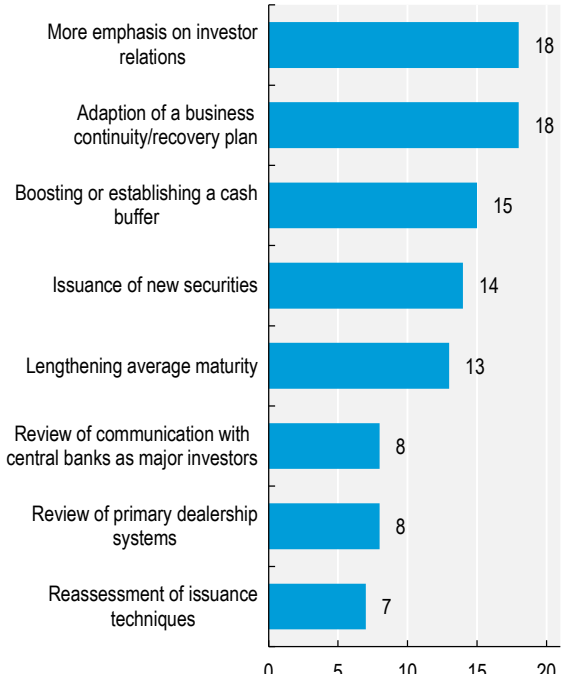
In our survey, we also asked about the main implications of the pandemic on public debt management. More than a third of the respondents are considering reviewing long-term funding strategies because of increased debt levels following the pandemic. Change, in other words, is definitely taking place.

Also as a result of the pandemic, many countries are considering changes in investor relations, cash buffers and business continuity plans. Several want to extend their maturity profiles.

A. Key lessons learned from the COVID-19 crisis



B. Potential implications of the pandemic on public debt management



Source: OECD Sovereign Borrowing Outlook 2022 (2021 OECD Survey on Primary Market Developments)

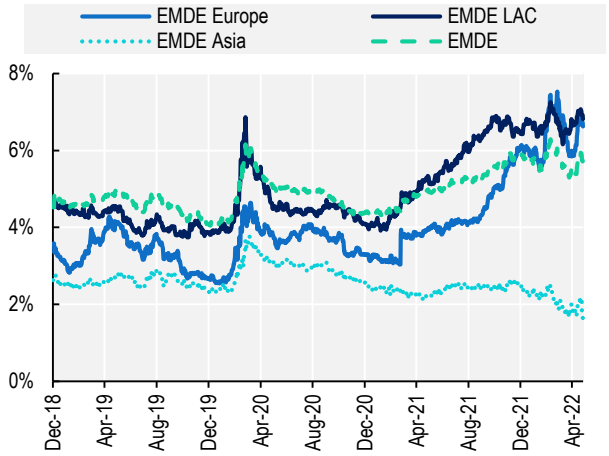
The general trend seems to point towards a greater focus on resilience against unexpected outcomes – or, if I must use the plural again – against crises.

Risks on the horizon – emerging market debt distress?

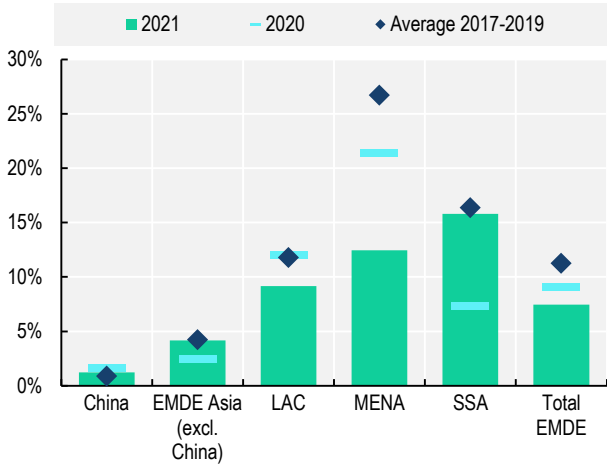
Recent years have taught us all too well that difficulties tend to cluster together, and that new ones may be waiting around the corner. It is therefore useful, and indeed prudent, to consider what a next crisis might look like. To wrap up my remarks this morning, I will raise two possible such scenarios. The first is the prospect of a scenario of debt distress in emerging markets.

Because market confidence is typically lower for emerging economies than advanced ones, these markets are much more sensitive and exposed to the three pressures I raised before. This is evident from the graph on the left, which shows the spread of emerging market local currency bond yields over the US 10-year yield. Across most regions, with the exception of Asia, it has increased sharply in recent months. In Latin America and Europe, spreads are now higher than in April 2020. This creates substantial refinancing risk for debts coming due, as is already clear in some countries.

A. Emerging market local currency bond yield spreads over US 10-yr



B. Share of foreign currency issuance by emerging market group



Note: EMDE = emerging markets and developing economies; LAC = Latin America and the Caribbean; MENA = Middle East and North Africa; SSA = Sub-Saharan Africa
Source: OECD Sovereign Borrowing Outlook 2022; Refinitiv

As monetary policy positions in reserve currency countries begin to shift, many emerging economies may be exposed to substantial capital outflows. This has the potential of dealing a significant blow to emerging markets. The most obvious is the direct effect on interest costs for floating rate debt. To the extent that they have borrowed in foreign currencies, increasing interest rates in the currency issuer country may possibly also – all else equal – lead to a local currency depreciation. This makes it more expensive both to service the debt and to import goods and services.

As the graph on the right shows, the share of foreign currency debt in total emerging market issuance not negligible, in particular in sub-Saharan Africa and the Middle East and North Africa, even if the latter has decreased its share of foreign currency borrowing over time.

This is all taking place in a context of highly elevated emerging market borrowing. Repayment difficulties in certain countries will be all but inevitable. That makes it imperative to have a well-functioning mechanism for handling debt restructurings in emerging markets. Global coordination will be essential, and must reflect the changing creditor landscape. For example, China, which is not a permanent member of the Paris Club of creditors, is the largest bilateral creditor to a large number of emerging economies.

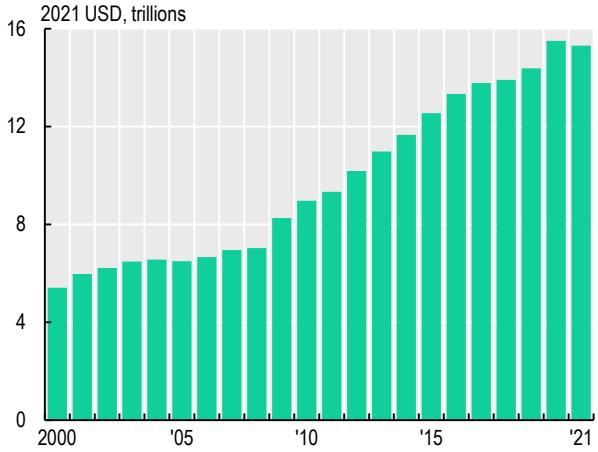
It should be one of the international community's key priorities to ensure that there is not a full-blown emerging market debt crisis. It is our duty to avoid the loss of hard-gained poverty reductions and living standard increases.

Risks on the horizon: private risks becoming public liabilities?

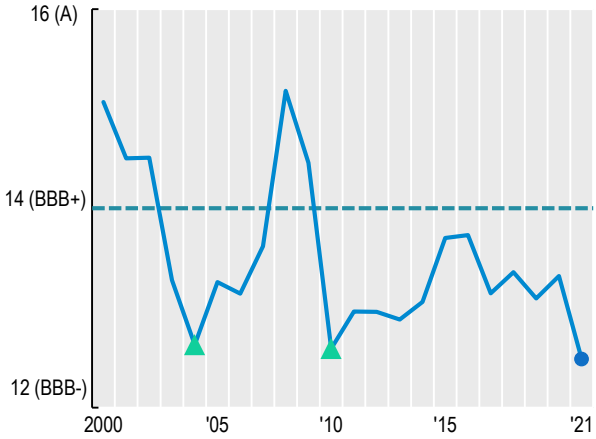
The final point I would like to raise relates not to sovereign, but to corporate debt. Corporate indebtedness has been increasing sharply since the 2008 financial crisis. As the graph on the left shows, at the end of 2021 the total amount of outstanding non-financial corporate bonds globally had reached 15.3 trillion US dollars. That is more than twice the amount in 2008.
In parallel to this increase, the credit quality of the outstanding debt has been decreasing. The graph on the right shows how the average weighted credit rating of non-financial corporate bonds has fallen to just half a notch above speculative grade in 2021 – the lowest figure on record. We should also keep in

mind that several central banks are exposed to corporate bonds. This, in turn, exposes the market to a change in investor base as purchase programmes end and central banks withdraw from the market, likely pushing up yields, as I have mentioned.

A. Global outstanding amount of non-financial corporate bonds



B. Global non-financial corporate bond rating index



Source: OECD Capital Market Dataset

Add to this mix the growth in leveraged loans and a picture of a relatively risky corporate debt landscape emerges.

The crucial point in all of this is that these currently private risks could become public liabilities in times of financial distress. It may happen directly, in the case of a bailout, or indirectly if a debt crisis were to cause an economic slump that requires fiscal stimulus. For this reason, public debt managers should also keep an eye on developments in private borrowing.

I do not want to leave you on a gloomy note this morning, so let me finish by saying in all sincerity that disaster is never inevitable.

We must remain vigilant in the face of these risks, and others we have not thought about yet. But, as I have said, we are learning more every day. Today's conference is a brilliant example. So let me thank you, ladies and gentlemen, for being here to exchange your experiences and ideas, and for listening to my opening remarks. I wish you all a very fruitful day.

SESSION I

PUBLIC DEBT DYNAMICS, ENVIRONMENTAL AND DEBT SUSTAINABILITY

Debt Sustainability after the Pandemic: a Rift between Advanced and Developing Economies?

Paola Subacchi[1], Paul van den Noord[2], Rodrigo Olivares-Caminal[3]

Abstract

The aftermath of the Covid-19 health crisis poses major fiscal challenges to many countries, both advanced and developing. A key issue facing policymakers is the amount of available fiscal space given the recent surge in public debt. Exceptional shocks like the pandemic can push countries beyond their debt sustainability limit,-inevitably constraining countries' fiscal space. Against this backdrop this paper estimates the development of public debt limits and ensuing fiscal space for a panel of G20 economies - developed and developing - since the 1990s. This analysis suggests that advanced and developing economies face entirely different conditions for the conduct of independent fiscal policies to address major shocks, with the former generally much better placed.

Keywords: Fiscal policy, debt sustainability, fiscal space

JEL Classification: E32, E63, F33

1. Introduction

The (aftermath of the) Covid-19 health crisis poses significant fiscal challenges to many countries, both advanced as well as developing economies. A key issue being faced by policymakers is the degree of fiscal space given the recent surge in public debt. The experience during the outbreak of the Covid-19 pandemic has shown the importance of having fiscal space to implement exceptional measures of fiscal policy that are necessary to support people and the economy - "lives and livelihood" – during an emergency, thus keeping societies and economies resilient.

However, exceptional shocks like the one triggered by the pandemic can push countries beyond their limit vis-à-vis debt sustainability. This will inevitably constrain these countries' fiscal space until the level of debt regains sustainability. The trade-off that politicians and policy makers' face is between fiscal stimulus to respond to the emergency and fiscal restraint to manage debt sustainability. For a variety of reasons, the terms of this trade-off appear to be more challenging for developing than for developed

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economies, which gives rise to a fundamental inequality. This is particularly concerning in view of the global climate challenge, which is likely to make a strong call on the available fiscal space across the globe, putting additional strain on many economies and widening the gap between developed and developing countries.

In this paper we aim to estimate the public debt limit and ensuing fiscal space for a panel of developed and developing economies for the period 1990-2022. Drawing on Bohn (1998, 2008) we explore how the primary fiscal balance responds to increases in the level of debt as an indicator of whether public debt can be repaid in the long run. Importantly, the relationship between a country's primary balance and debt dynamics is non-linear. Our research question is to what extent this relationship is fundamentally different for advanced economies and developing countries.

This discrepancy stems from the fact that advanced economies have favourable access to capital markets, have credible institutions, can issue their debt in their own currency, rely on money financing, benefit from zero-bound nominal interest rates below the nominal output growth rates so that "public debt may have no cost" (Blanchard, 2019). Developing countries, in contrast, have limited access to capital markets, often have poor institutional governance, are constrained vis-a-vis issuing debt in their own currency, cannot rely on money financing; therefor they are facing tighter credit conditions and higher costs of servicing the debt. As a result, they are often under pressure to implement extraordinary fiscal efforts to restore debt sustainability, especially if they face an increase in risk premium that may make the case for fiscal consolidation more urgent (Andres et al, 2020).

The paper is organised as follows. Section 2 reviews the existing literature on debt sustainability and fiscal space and the relevance of our contribution in the context of the current debate. Section 3 discusses the operational definitions, methodology and analytical framework that we employ to estimate the public debt limit and the fiscal space. In Section 4 we present the results for the countries in the Group of 20 (G20) and we discuss three cases – the US, Argentina and Turkey – where the results show that the notion of debt limit, whereas debt has become or is near to become explosive, is less binding for the former than for Argentina and Turkey. Section 5 concludes.

2. Literature review

Within the existing literature there is a broad consensus to consider public debt as being sustainable when the government can manage current and future financial obligations without having to resort to unfeasible or undesirable policies. Debrun et al (2020, 153-4) observes that solvency is a prediction about future budget balances over an infinite horizon. On the other hand, concrete approaches to assess debt sustainability have focused on sufficient (but by no means necessary) conditions for solvency, but this has resulted in an "eclectic" approach rather than a single operational definition of debt sustainability.

The existing literature is also ambiguous about the definition of fiscal space. It is often considered as equivalent to and sometimes synonymous with debt sustainability. Kose et all (2017) broadly define fiscal space as the availability of budgetary resources for a government to service its financial obligations. Through a comprehensive cross-country database of fiscal space, they show the multiple dimensions of debt service capacity, including financing needs that are related to budget positions, access to liquid markets, resilience to valuation changes, and contingent liabilities (Kose et al., 2017:2). Similarly, Bi (2012) and Bi et al. (2016) define a country's fiscal space or fiscal limit as the maximum amount of public debt relative to GDP that a country can sustain without defaulting on its financial

commitments. For Ghosh et al. (2013) fiscal space is room for fiscal manoeuvre. However, both fiscal space and debt sustainability imply the ability of a government to service its debt. Unless debt service capacity is maintained, a government cannot indefinitely finance its operations in a sound manner.

Drawing on Alvarado et al. (2004), Hausmann (2004) and Reinhart et al. (2003), Bi et al. (2016) demonstrate the constraints that are faced by developing countries and their relatively low fiscal limits compared with the developed countries. Their analysis shows that low fiscal limits are largely based on expected future revenue; developing countries have much lower effective tax rates than developed countries due to inefficient tax collection systems, tax evasion and large informal sectors. In addition, these countries are more vulnerable to temporary disturbances in exchange rate due to currency holders' perceptions of fiscal sustainability. Developing countries that rely heavily on external borrowing are exposed to real exchange rate fluctuations. Thus, a large real depreciation lowers a country's fiscal limits, constraints the government's ability to service its debt and suddenly raise default probabilities of ~~an~~ economies with large external debt. Bi et al. (2016: 126) conclude that perception about the fiscal solvency can change suddenly even without changes to economic policies or structures.

Developed economies have high fiscal limits; nonetheless they too need to assess their 'debt limit' (Ghosh et al., 2013: F4) beyond which fiscal solvency is in doubt. Following Bohn (1998, 2008) who looks at how the primary fiscal balance responds to increases in the level of debt as an indicator of whether public debt can be repaid in the long run, Ghosh et al. (2013) develop a framework to assess debt sustainability in developed economies. Their analysis shows that Bohn's sustainability criterion, that the primary balance always reacts positively to lagged debt, is a weak one. Instead, they adopt a stricter sustainability criterion that public debt should converge to some finite proportion of GDP.

In their analysis Ghosh et al. (2013) also introduce the concept of "fiscal fatigue", as a slower policy-induced improvement of the primary balance to rising debt relative to the interest rate-growth rate differential. In their approach, "fiscal fatigue" means that fiscal consolidation is stopped in its tracks beyond a certain debt threshold. As debt approached the debt limit, the cost of financing will depart from the risk-free rate within a very narrow range of debt ratios (Ghosh et al., 2013: F6).[1] The model developed by Ghosh et al. is helpful to identify cases where fiscal consolidation is needed to keep debt on a sustainable path and avoid that shocks derail sustainability (Ghosh et al., 2013: F23). The model also highlights the fact that the relationship between a country's primary balance and debt dynamics is non-linear and that debt limits and the corresponding fiscal space vary considerably across countries.

In a controversial paper Reinhart and Rogoff (2010) use a multi-country historical dataset on public debt and estimate the debt limit above which growth rates are lower than otherwise. They empirically determine this debt threshold at around 90% of GDP for both advanced economies and emerging markets. They conclude that debt/GDP levels at or above 90% are associated with lower growth outcomes due to the nonlinear response of growth to debt as vulnerabilities associated with debt build up. Reinhart and Rogoff's paper sparked a strand of literature broadly vindicating their findings despite criticism regarding their methodology (De Rugy and Salmon, 2020). According to Kassouri et al (2021), however, this debt threshold in developing economies is found to be at 35% of GDP, significantly lower than 90% of GDP in developed economies.

Pappas and Kostakis (2020) identify an increase in debt limits when interest rates are beyond a certain debt threshold surging due to market perceptions of growing insolvency risk. This literature so far has

[1] Ghosh et al. (2013) use the model to analyse the effects of unanticipated fiscal shocks that lower the debt limit. The model also shows the results of "fiscal shocks" with Greece as a case study.

focused mostly on the eurozone in the wake of the sovereign debt crisis of 2010-2013, but it is also relevant for developing economies that rely on foreign currency debt (Poghosyan, 2012).

Blanchard's contribution raises the question of what debt policy a government should embrace when interest rates are historically low (Blanchard, 2019; Blanchard, 2022). Using the concept of neutral interest rate r*, that is the risk-free rate needed to maintain output at potential, he observes the steady decline in the neutral rate over the last thirty years. This decline has resulted in r* becoming lower than GDP growth and occasionally running into the effective lower bound constraint. This in turn results in lower fiscal costs of debt and so the welfare costs of debt. If nominal interest rates are lower than nominal GDP growth rates – and that has been the case in the United States, for instance, on average since 1950 - then the intertemporal budget constraint no longer binds. Thus, fiscal policy can be used to support demand.

Blanchard argues that the 'right' fiscal policy is calibrated around relative weights that depend on the strength of private demand. If the latter is strong while debt is deemed too high, then fiscal policy can focus on debt reduction and monetary policy on keeping output at potential. But if private demand is weak and monetary policy is constrained, then fiscal policy needs to provide macro stabilisation. Blanchard concludes that there is no serious risk for debt sustainability currently in the advanced economies. However, he reckons that each case presents specific features that affect the safe level of debt – including different conditions in developed countries and emerging markets.

3. Analytical framework

Drawing on the existing literature, our analysis offers a contribution based on the following points. First, combining the findings from Reinhart and Rogoff (2010), Pappas and Kostakis (2020) and Gosh et al. (2013), we develop a model that considers features that are country and time specific. For instance, "fiscal fatigue" (Gosh et al., 2013) may imply slower fiscal consolidation. Similarly, an increase in a country's risk premium on the back of market perceptions of growing insolvency risk could push debt above its limit. Thus, our model identifies a single debt threshold, that is country and time specific, above which the debt dynamics become explosive.

Second, drawing on the existing empirical literature, our model considers the (non-linear) feedback effects of debt on each of the following variables – economic growth, the real interest rate and primary balance. Unlike other contributions in this field, our model does not take these variables as exogenous. The core of the model is the dynamic relationship between the interest-growth differential and the primary balance on the one hand and the change of the ratio of debt to GDP on the other.

Third, taking the interest rate as a measure of the cost of borrowing our model estimates the feedback effects of debt and determines the debt threshold. Thus, while compared to Blanchard (2019, 2022) our approach is rather crude, it is appropriate to address our research question. We reach conclusions similar to Blanchard's when we introduce mitigating factors, such as, for instance, the issuance of reserve currency by advanced countries that expand their fiscal space, notably of the United States.

We refer to a widely accepted definition of debt sustainability (IMF, 2020) that considers not only the impact of economic and financial shocks on public debt dynamics, but also to its impact on the economic outlook and the ability of governments to take corrective action.[2] Building on the Debt Sustainability

[2] 'Public debt can be regarded as sustainable when the primary balance needed to at least stabilize debt under both the baseline and realistic shock scenarios is economically and politically feasible such that the level of debt is consistent with an acceptably low rollover risk with preserving potential growth at a satisfactory level' (IMF, 2020).

Analysis (DSA) – a helpful signalling device to detect if at prevailing (or projected) rates of economic growth, real interest rates and the primary balance public debt over time converges towards a stable equilibrium - we include the feedback effects of public debt on growth, yields and fiscal policy should be considered. Specifically, increases in public debt tend to exacerbate adverse growth or interest rate shocks, while, in contrast, a tightening of fiscal policy induced by an increase in public debt may serve to mitigate the impact of these shocks. It is the balance between these forces that ultimately determines the path of public debt. The method applied throughout this section incorporates these feedback mechanisms.

Figure 1 illustrates how these mechanisms jointly determine the sustainability of debt (see the Appendix for a more detailed discussion). Specifically,

- The curve marked '*Growth of real GDP* (g)' depicts how economic growth g is affected by the debt ratio to GDP. At low levels, the debt ratio is likely to have a positive impact on growth, reflecting the vital role of public debt in the functioning of the financial system and the economy at large. However, at high levels, public debt tends to exert a negative impact on economic growth, for instance by squeezing private credit or lowering profit expectations as taxes are likely to be raised.

- The curve marked '*Growth of real debt* (δ)' indicates how the debt ratio to GDP affects the growth rate of real debt δ. This relationship is based on the dynamic budget constraint, which implies that for a given primary balance position, the growth rate of real debt mechanically gets smaller as the debt ratio increases.[3] Additionally, two feedback channels are at play with an increase in the debt ratio affecting the growth of real debt through:

    - an increase in the primary balance due to sustainability concerns (fiscal policy reaction function) slowing down the growth of real debt, and

    - an initial fall and then increase in the real bond yield and an associated acceleration and slowdown of the growth or real debt. This mechanism assumes that at low levels, increases of debt push the real yield down via lower liquidity risk, while above a certain debt threshold growing insolvency risk outweighs the further declines in liquidity risk.

- The two curves intersect twice[4], and at these intersections the debt ratio is constant since the growth rate of real debt and the rate of economic growth are the same. However, these intersections have distinct characteristics. Specifically, the first (left) intersection corresponds to the *steady-state equilibrium* for the debt ratio, whereas the second (right) intersection corresponds to the *threshold* above which the debt ratio becomes explosive. The corollary is that, to keep debt sustainable, it would need to be below that threshold. Moreover, if that is the case the debt ratio automatically tends towards its equilibrium level over time. However, as will be discussed below, these conditions are not (always) satisfied.

For a proper understanding of the model three important additional observations are in order:

[3] See Appendix. For a given primary balance as a per cent of GDP p, the growth rate of real debt δ converges to the real interest rate r for higher levels of the debt ratio as a per cent of GDP d. This can be derived from the familiar dynamic budget constraint $\dot{D} = (r/100)D - P$, where $\dot{D}$ is the absolute change in real debt, D is the absolute level of real debt and P is the absolute level of the primary balance. Dividing the left-hand and right-hand sides by the level of debt D and rearranging yields $100 \cdot \dot{D}/D \equiv \delta = r - 100 \cdot p/d$, where p and d are the ratios to GDP of the primary balance and public debt, respectively.

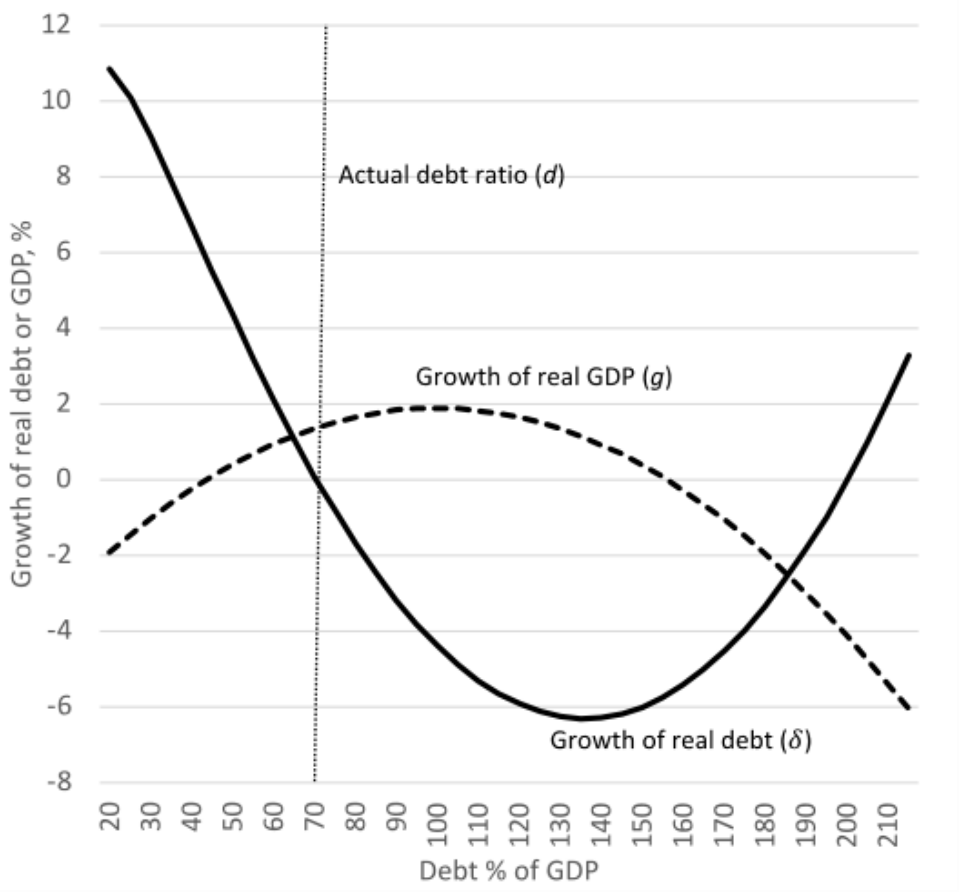
[4] There may be a third intersection located in the second quadrant, which has, however, no economic meaning since the debt ratio can never be negative.

- First, in principle it is possible that the two curves fail to intersect, which means that debt growth δ always exceeds economic growth g, regardless of the actual debt ratio. This means that debt is explosive regardless of its initial level. As will become clear below this may well be the case in several countries. It may also be that the curves intersect only once, which means that the steady state debt ratio is nil.

- The assessment of debt sustainability is *invariant to inflation* because it is the *differential* between the real bond yield and real economic growth $r - g$ (alongside the initial debt ratio and the primary balance) that matters for public debt dynamics, with the inflation rate canceling out (see Appendix).[5]

- If part of public debt is issued in a foreign currency, the yield on the latter may be lower than on domestic currency due to exchange rate risk. However, assuming uncovered interest rate parity holds, the *effective* foreign currency interest rate -- corrected for expected exchange rate depreciation -- is taken to be the same as the domestic currency rate.

Figure 1: Stylized debt dynamics



Source: authors' computations, see Appendix

[5] That is, unless inflation affects the real bond yield r. This may well be the case if inflation is more volatile at higher rates of inflation, entailing an inflation risk premium on bonds. Note that higher inflation would make debt therefore *less* sustainable, *not more* sustainable (except in the short run when inflation has yet to feed through into nominal yields and interest expenditure).

4. Numerical results

This section applies the model developed in the previous section to the (G20) member states for the period from 1990 to 2022. The G20 provides a sample that covers approximately 85 per cent of the world economy, included the largest advanced economies – the G7 – as well as mid-sized advanced economies such as Australia and South Korea. It also includes the BRICS – Brazil, Russia, India, China and South Africa – and some large developing countries such as Turkey and Indonesia. Argentina, a country that repeatedly defaulted on its debt, is also a member of the G20.

To estimate debt sustainability and assess fiscal space for the G20 countries over the period 1990-2022 we use the following indicators: real GDP growth (to calculate 10-year geometric mean of potential growth), debt to GDP ratio, cyclical primary balance, inflation, and long-term interest rates (Table 1). These data series come from the IMF and World Bank public databases. For more coverage on data points for long term interest rates, we use OECD and Trading Economics databases. To model an exchange rate shock, we rely on BIS estimates of debt held in foreign currency.

As series on real yields data are patchy, we use instead long-term interest rates minus inflation. Some long-term interest rate data has been pulled from separate databases rather than a cohesive set. Pre-2011 long-term interest rates come from the IMF while those post-2011 come from the OECD and Trading Economics. Inflation rates and long-term interest rates for Argentina are not publicly available, so we use estimates published by Trading Economics.

Table 1: Indicators and sources

Indicator	Source
Debt to GDP ratio	IMF, World Bank
Cyclically Adjusted Primary Balance	IMF, World Bank
Potential Growth	IMF, authors' own calculations
Inflation (CPI)	IMF, World Bank
Long term interest rates (10 years)	IMF, OECD, Trading Economics
General government debt held in foreign currency (except China: central government debt)	BIS

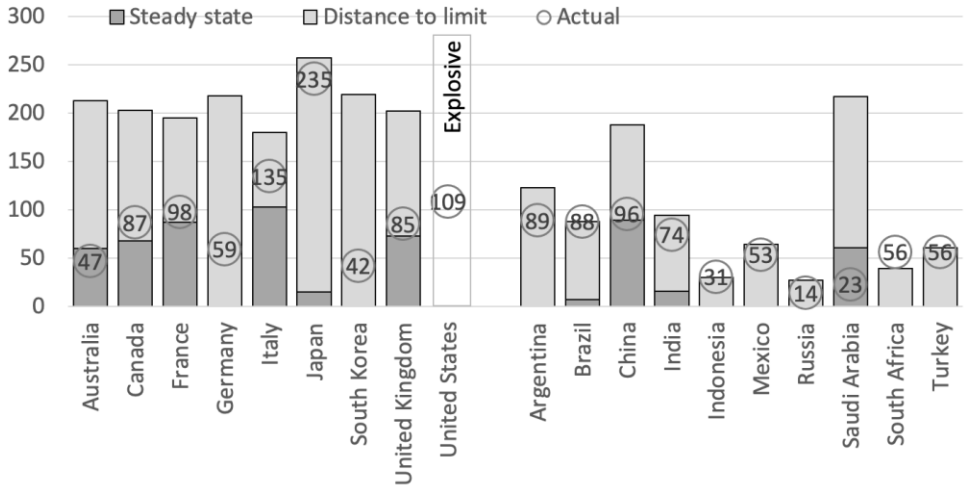
Sources: see right column

4.1 Snapshot of the G20 economies

Figure 2 depicts the situation regarding debt sustainability in the G20 just prior to the pandemic in 2019, based on estimates for the actual debt to GDP ratio, potential economic growth, real bond yields and the cyclically adjusted primary balance as a per cent of GDP. One take-away is that in all but one advanced G20 country (the United States being the exception) debt looked comfortably sustainable, although in Japan the situation could be characterised as 'border line' in the sense that the debt ratio was relatively close to the limit above which debt becomes explosive. By contrast, in all but two

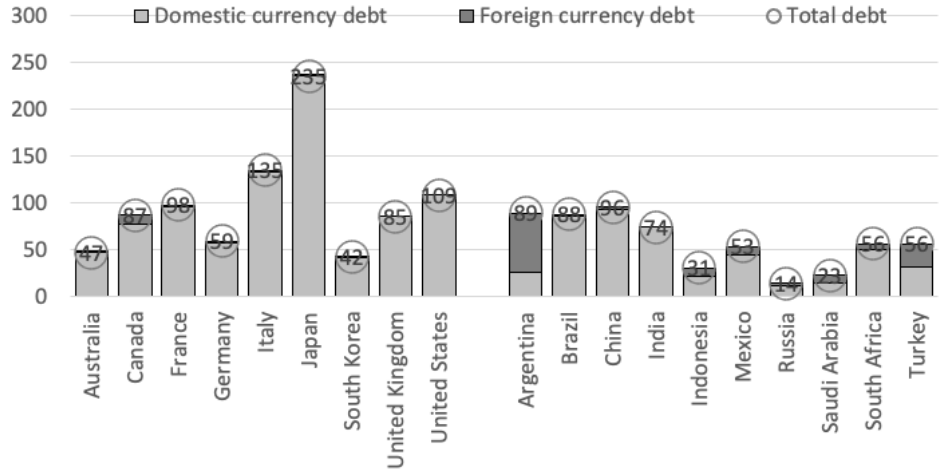
emerging G20 countries – China and Saudi Arabia being the exceptions -- debt sustainability was borderline, meaning that it was close to the debt limit. The situation looked at that stage particularly risky in Argentina and Turkey given their large share of foreign currency debt in total public debt (Figure 3). The amount of fiscal space available to the advanced G20 economies according to our metric was considerably larger than that in the emerging G20 economies – again with the exceptions of China and Saudi Arabia (Figure 4).

Figure 2: Debt sustainability analysis – situation in 2019 (% of GDP)



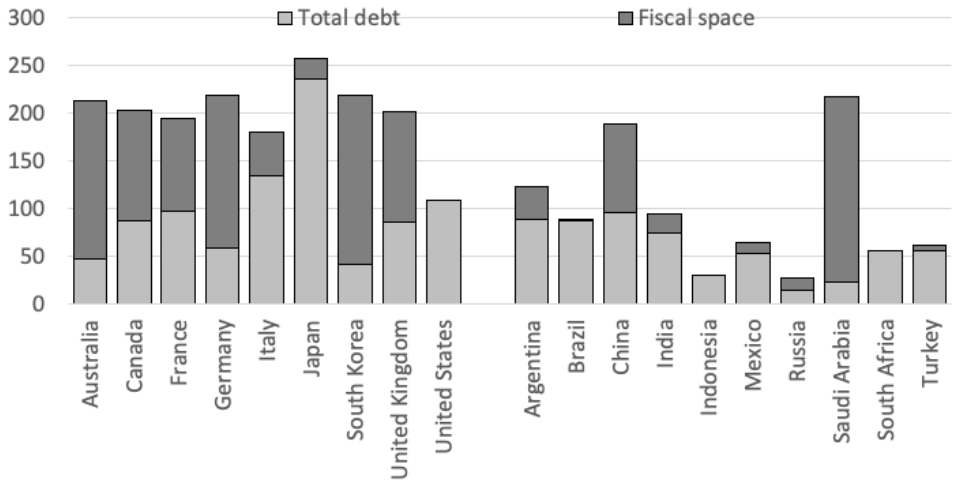
Sources: IMF, OECD, World Bank, Trading Economics, authors' computations

Figure 3: Home versus foreign currency public debt – situation in 2019 (% of GDP)



Sources: IMF, OECD, World Bank, BIS

Figure 4: Public debt and fiscal space – situation in 2019 (% of GDP)



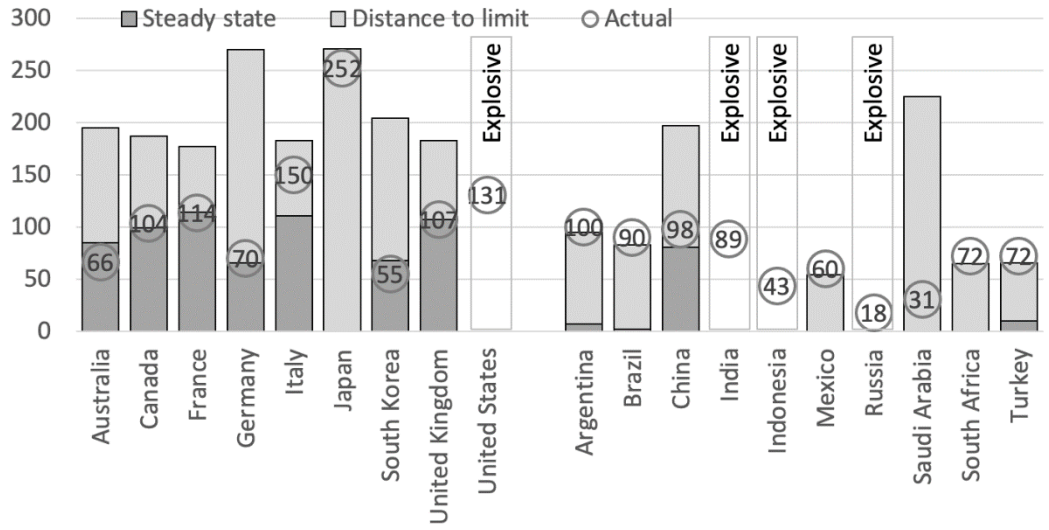
Sources: IMF, OECD, World Bank, BIS, Trading Economics, authors' computations

Figure 5 depicts the current situation regarding debt sustainability in the G20 in 2022, based on estimates or projections for the debt to GDP ratio, potential economic growth, real bond yields and the cyclically adjusted primary balance as a per cent of GDP. The following features emerge:

- The United States is still the only advanced G20 country where debt is on an explosive path, meaning that the debt threshold is effectively nil and the debt ratio bound to rise at an accelerating pace if the primary balance is not raised (or the primary deficit cut) by the required amount.
- Moreover, among the advanced G20 countries, debt sustainability in Japan can still be characterized as 'border line', in the sense that the current debt to GDP ratio is very close to the debt limit above which it becomes explosive. This implies that a minor (permanent) shock to real interest rates, economic growth or the primary balance position would suffice to result in debt becoming explosive.
- Among the emerging G20 economies debt is comfortably sustainable only in China and Saudi Arabia. Not surprisingly, these are also the only emerging G20 economies that dispose of fiscal space according to our metric (Figure 6). In Brazil and Turkey debt is on an explosive path and in the other emerging G20 economies debt is borderline unsustainable or slightly worse in the sense that the debt ratio is at ore just above the limit. In Argentina the underlying situation would likely have been much worse than depicted if not for the ongoing efforts to qualify for (yet another) IMF program, as discussed in more detail below. Indeed, Argentina, and to a lesser extent Turkey, is particularly vulnerable given their large call on foreign currency debt, as noted. Moreover, the situation in Russia is in fact worse than depicted if the expected collapse of GDP this year materializes as the sanctions work their way through.

The bottom line is that in the majority of emerging G20 countries public debt is either explosive or borderline, hence without any fiscal space left. Those with significant fiscal space left are the usual suspects China and Saudi Arabia. Among the advanced economies fiscal space would still be available, although to a lesser extent in Japan while according to out metric no fiscal space is left in the United States. The situation in the United States is special, however, as we will explain below.

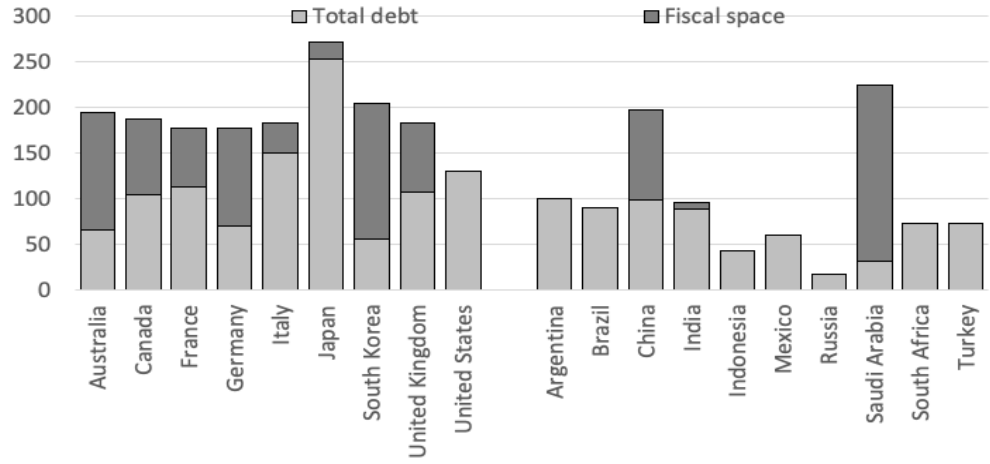
Figure 5: Debt sustainability analysis – situation in 2022 (% of GDP)



Sources: IMF, OECD, World Bank, Trading Economics, authors' computations

These results are consistent with Ghosh et al. (2013) insofar that more open economies and countries with strong institutions exhibit, on balance, more fiscal space. South Korea, Australia, Germany and Canada are part of this group (Figure 6). Oil and commodities exporters, when oil and commodities prices rise, also exhibit good fiscal performance. In our example, Saudi Arabia belongs to this group. These results are also consistent with the 'original sin' that forces developing countries to borrow in dollars or (to less extent) euros rather than in their own currencies. However, it is important to note that the sources of domestic financing have increased in many developing countries, reducing the need to issue debt denominated in foreign currencies (World Bank, 2022: 18-19).

Figure 6: Public debt and fiscal space – situation in 2022 (% of GDP)



Sources: IMF, OECD, World Bank, BIS, Trading Economics, authors' computations

4.2 Some specific cases

The central tenet of our paper is that advanced and developing economies face entirely different conditions concerning the possibility to conduct independent fiscal and monetary policies to address

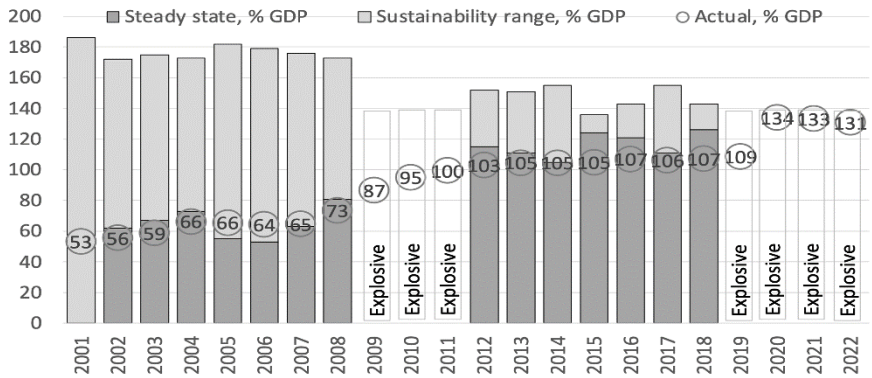
major shocks. Among the G20 economies, the United States – as the issuer of the main global reserve currency (the US dollar) and the main global safe financial asset (Treasury bonds) – enjoys full independence in both policy domains. It can therefore pursue full employment and price stability with relative ease (though if the zero-lower bound on interest rates is binding the emphasis necessarily shifts towards fiscal policy as argued by Blanchard 2022). At the other extreme, Argentina and Turkey stand out as G20 economies where the terms of the trade-off between fiscal and monetary policy sovereignty are particularly harsh, in part due to their reliance on foreign currency debt. We illustrate this empirically using our debt sustainability metric presented in section 3.

Figure 7 depicts the development of relevant variables over the last two decades or so for *the United States*. It shows that up to the financial crisis in 2009, the US public debt ratio to GDP was comfortably below a comparatively high estimated limit of roughly 180% of GDP. As a matter of fact, at around 60% of GDP, the debt ratio stayed close to its estimated steady state equilibrium, reflecting the favourable differential between interest and growth rates and the modest primary deficit. Not surprisingly, this changed in the immediate aftermath of the financial crisis because of a soaring primary deficit and an increase in real interest rates as inflation stalled. However, the previous favourable situation of debt comfortably below the limit was quickly restored thereafter – albeit at a higher level of the debt ratio at around the new steady state equilibrium of 100% of GDP.[6]

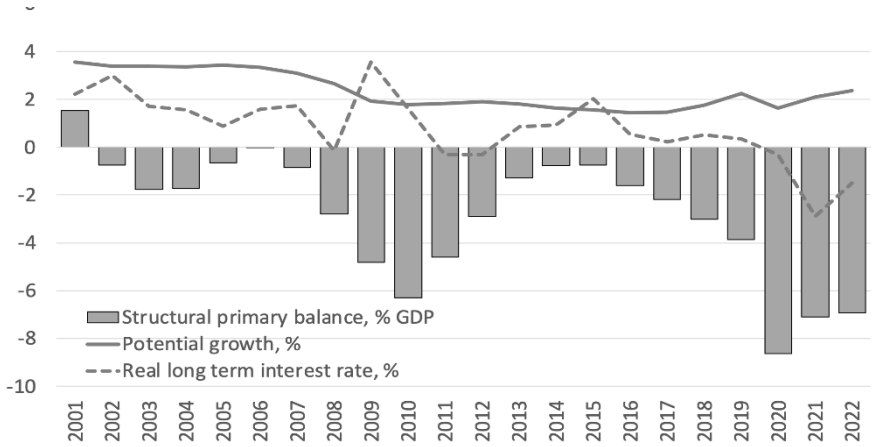
[6] With the exception of 2015, due to a sudden drop in inflation and an associated surge in the real interest rate – which proved transitory.

Figure 7: Debt sustainability analysis – United States

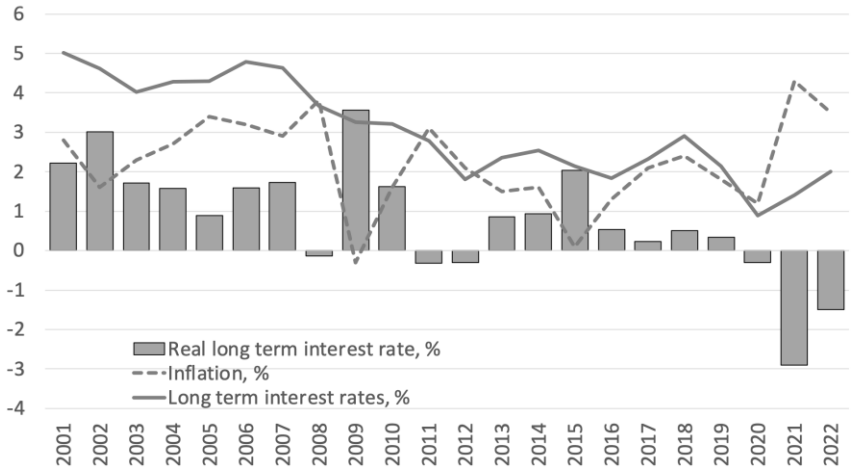
A. Public debt



B. Primary balance, potential growth, real interest rate



C. Interest rate and inflation



Sources: IMF, OECD, World Bank, BIS, Trading Economics, authors' computations

This all changed again when the pandemic hit in 2020 and beyond, due to a massive increase in the primary deficit. And although this deficit is officially projected to fall in 2022 and 2023, the debt ratio at around 130% of GDP remains explosive. Yet real interest rates have remained relatively low, indicating that market confidence in the solvency of the US public sector has remained intact. This clearly illustrates our point that – while in a mechanical sense the United States has used up all its fiscal space during the pandemic – it seems poised to rebuild it in the years ahead. More fundamentally, in a longer-term sense the United States disposes of more fiscal space than our metric suggests owing to the international demand for risk-free dollar-denominated assets.

The situation in *Argentina* could not be more contrasting. In the period 2014-2017 the fiscal situation looked still relatively comfortable, with the actual debt ratio well below the debt threshold, as shown in Figure 8 below. However, things went sour from 2018 onwards when debt rose towards the debt threshold and in 2020 became explosive.

This can be explained by the following (see panels B-D of Figure 8 below). In the period 2014-2018 Argentina enjoyed a hugely favourable *r-g* differential, mostly because the real yield plummeted to negative two-digit territory (Panel B). However, this was almost entirely driven by massive inflation (Panel D). That, in turn, was the result of a steep depreciation of the exchange rate. This also explains the upward trend in the debt ratio in this period, given that more than half of debt is foreign currency (mostly USD) denominated.

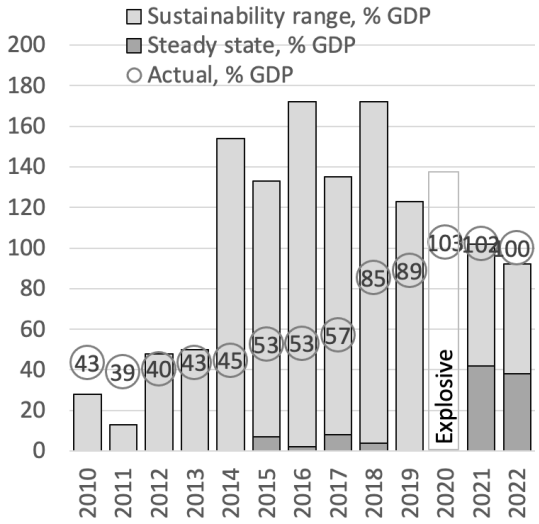
So, this was a crisis in the making, and it came. In 2018 Argentina got a bail-out from the IMF, but this failed as capital stampeded out of the country. In 2019 bond yields caught up with inflation and the favourable *r-g* differential disappeared. In June 2022 Argentina received US$ 4bn as the first step of a larger IMF programme.

In *Turkey,* the fiscal situation looked manageable until 2017. Turkey was hard hit by the financial crisis in 2008-2009, but this was quickly corrected in 2010, with the primary balance in comfortable surplus and the interest-growth differential very favourable (Figure 9). However, in 2017 Turkey started to adopt a looser fiscal policy stance as the primary balance turned negative and deteriorated over time. In its wake, the real interest rate versus growth differential deteriorated significantly while the debt ratio drifted up and in 2022 debt was outright explosive according to our metric. Meanwhile also large contingent liabilities were built up related to COVID-19 support (credit guarantees).

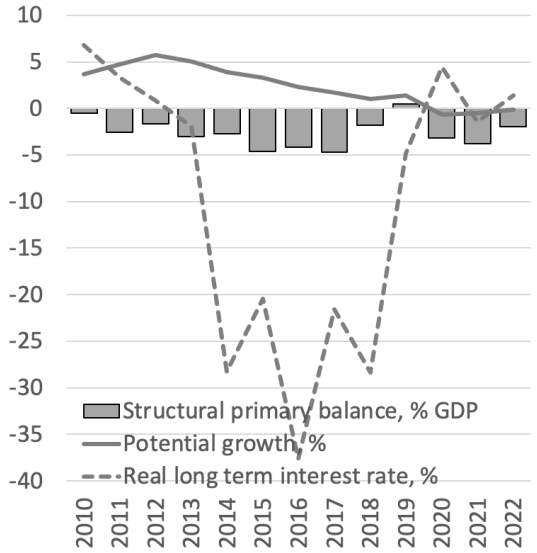
Both the cases of Argentina and Turkey show the adverse impact of inflation on the debt dynamics. In both cases, it is inflation that makes the differential *r-g* favourable, keeping debt manageable, at least initially. Our debt sustainability analysis shows debt to be close to or over the limit before it feeds into real interest rates. This is mainly due to the lagged response of monetary policy to inflation, providing temporary breathing space of fiscal policy. But sooner or later interest rates catch up with inflation. This points to another feature that gives the United States an extended fiscal space, that is historical low inflation in the last decades. Low inflation has consistently helped to keep real interest rates below the GDP growth rate, by allowing monetary to stay supportive without any risk of capital outflows adversely affecting financial conditions (Figure 7).

Figure 8: Debt sustainability analysis – Argentina

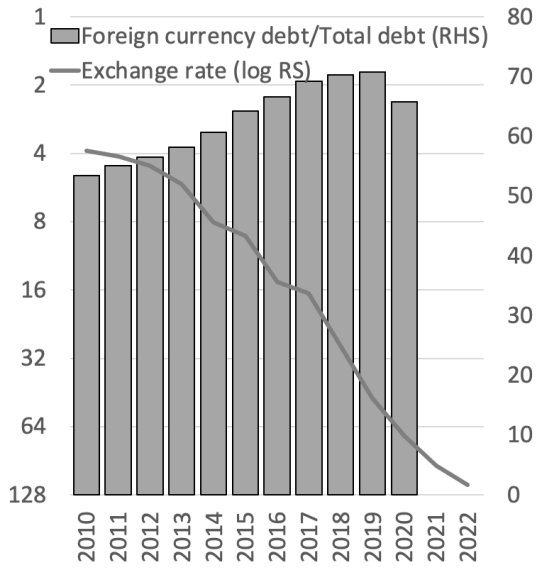
A. Public debt



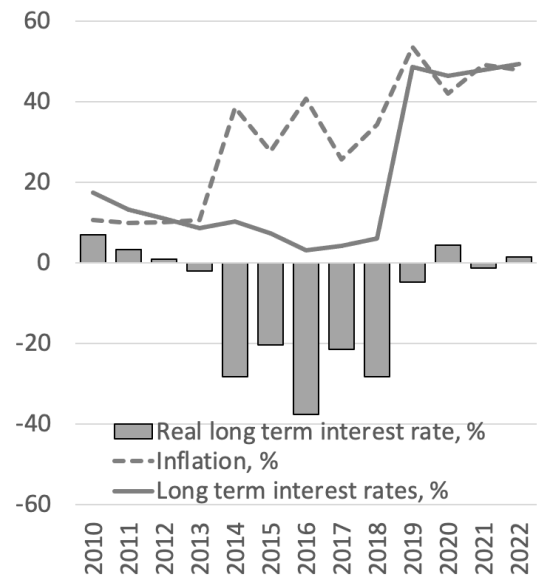
B. Primary balance, potential growth, real interest rate



C. Foreign currency debt and exchange rate



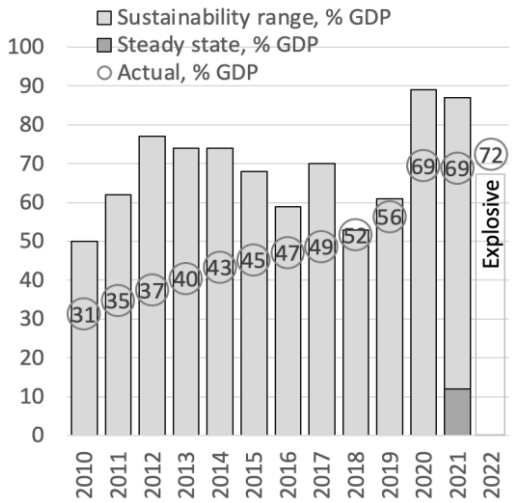
D. Interest rate and inflation



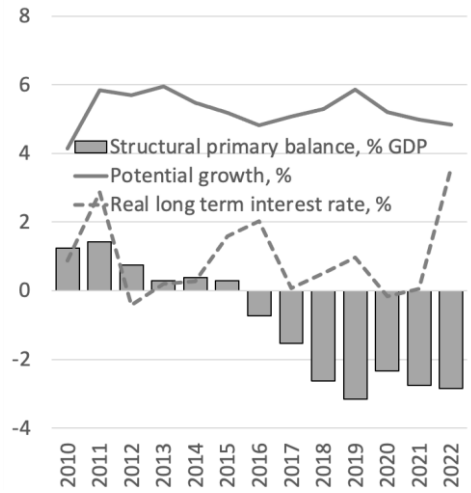
Sources: authors' computations, IMF WEO, BIS, Trading Economics

Figure 9: Debt sustainability analysis – Turkey

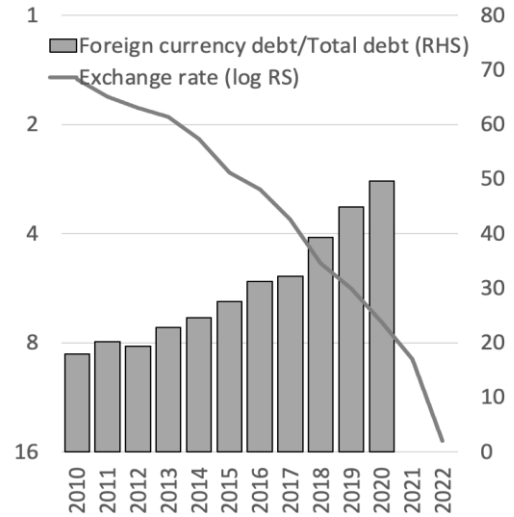
A. Public debt



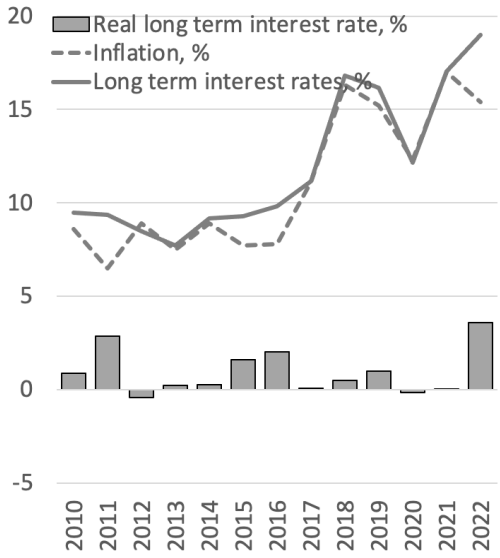
B. Primary balance, potential growth, real interest rate



C. Foreign currency debt and exchange rate



D. Interest rate and inflation



Sources: Authors' computations, IMF WEO, BIS, Trading Economics

5. Conclusions

In this paper we estimate the public debt limit and ensuing fiscal space for a panel of developed and developing economies for the period 1990-2022. For this we devise an analytical framework that expands the methodology of DSA to detect whether a country's debt is on an unsustainable path at prevailing (or projected) rates of economic growth, real interest rates and the primary balance. Our analytical framework includes the *feedback effects* of public debt on growth, yields and fiscal policy.

Using this methodology, we assess whether increases in public debt tend to exacerbate adverse growth or interest rate shocks, while, in contrast, a tightening of fiscal policy induced by an increase in public debt may serve to mitigate the impact of these shocks. It is the balance between these forces that ultimately determines the path of public debt.

The application of our model to the G20 shows three groups of results that we describe as following: 1. countries with explosive debt; 2. countries with borderline debt; 3. countries with balanced debt. However, a more detailed analysis of three countries – the United States, Argentina and Turkey – shows that the debt limit is less binding for the United States than it is for the other two. Being the issuer of the main global reserve currency and the main global safe financial asset means that the US can enjoy full sovereignty in both fiscal policy and monetary policy. It can therefore pursue full employment and price stability with relative ease. Argentina and Turkey, on the other hand, stand out as G20 economies where the terms of the trade-off between fiscal and monetary policy sovereignty are particularly harsh.

These results from our analysis are consistent with the central tenet of our paper, i.e. advanced and developing economies face entirely different conditions concerning the possibility to conduct independent fiscal and monetary policies to address major shocks. Developing countries have limited instruments to expand their fiscal space at the time of shocks such as the Covid-19 pandemic, especially if they are already close to the limit of debt sustainability, exacerbating the risk of falling into a 'debt trap'. These countries are often pushed to tackle the debt before it gets to the point where it may be difficult to generate a primary balance that is sufficient to ensure sustainability, even if fiscal consolidation may run against the need to provide macro stabilisation when private demand is weak and monetary policy is constrained.

Appendix

This Appendix discusses the formal model that underpins the results presented in the main text. Starting point is the government's long-run dynamic budget constraint, formulated as:

$$\frac{\dot{D}}{D} = \frac{r}{100} - \frac{P}{Y}\Big/\frac{D}{Y} \qquad (1)$$

where a dot indicates a change in the variable over time, $\dot{D}/D$ is the growth rate of real public debt, r is the real bond yield, P/Y is the primary balance as a share of GDP and D/Y is the ratio of debt to GDP. This indicates that as the debt ratio to GDP D/Y increases, for a given primary balance as a share of GDP P/Y, the growth rate of real debt will fall asymptotically towards the real bond yield r.

By equating the growth rate of real debt in equation (1) to the growth rate of real output $\dot{Y}/Y \equiv g/100$ – a necessary condition for a sustainable debt ratio – one obtains the familiar condition:

$$p = \frac{r-g}{100}\, d \qquad (2)$$

where lower-case characters are used to denote ratios to GDP in per cent – hence $d \equiv 100 \cdot D/Y$ and $p \equiv 100 \cdot P/Y$. From equation (2) the primary balance required to maintain a stable long-run debt ratio at a given level d can be solved for a given interest rate/growth differential $r - g$.

A crucial shortcoming of this formula, however, is that it is not obvious what target for the debt ratio d should be adopted and whether it represents a stable equilibrium (the formula describes a *necessary* condition for debt sustainability but not a *sufficient* condition). Moreover, as stated, the formula ignores that the variables g, r and p may all in turn depend on the debt ratio d. This is what is meant by the feedback mechanisms discussed in the main text.

The three feedback mechanisms of debt via g, r and p are incorporated as follows.

First, the following stylized relationship between long-run economic growth g and the debt ratio d is adopted:

$$g = g^* + a_1\, d - a_2\, d^2 \qquad (3)$$

where g^* is the component of long-run economic growth unrelated to public debt. The remainder of the equation therefore describes the feedback of public debt on economic growth. This feedback is conventionally formulated as a quadratic relationship, with growth rising with debt up to a certain threshold after which the relationship turns negative. The debt threshold where the negative impact of debt on growth overtakes the positive one is equal to $\frac{1}{2}a_1/a_2$.

The numerical values for the parameters are derived as follows:

- *High-income countries*. We use as our source Checherita -Westphal and Rother (2011), who find $a_1 = 0.1198$ and -$a_2 = -0.0006$ for their baseline model to $\frac{1}{2}a_1/a_2 = 100\%$. Although their estimate is for the 19 countries of the Euro Area, we use this estimate for all high-income countries given that the implied debt threshold is in the ballpark of the consensus.
- *Middle-income countries*. We use as our source Kassouri et al (2021)[7], who find $a_1 = 0.0867$ and -$a_2 = -0.00125$. They present three estimates for each, but we pick the version for which the

[7] We use the results from their Table 1. There seems to be a typo in their tables, however, as the values of a_2 they report all appear to be a factor 10 too high. Fortunately, they also report the debt thresholds which seems to be consistent with our interpretation of the numerical values of the parameters.

coefficients are significant at the 1% level and ignore results for larger samples but with less significant results. This yields a debt threshold of $\frac{1}{2}a_1/a_2 = 35\%$.

- *Low-income countries*. We use again Kassouri et al (2021), who find $a_1 = 0.0059$ and -$a_2 = -0.00008$.[8] This yields a debt threshold of $\frac{1}{2}a_1/a_2 = 37\%$.

Note that for each point in time g^* can be computed as $g^* = g - a_1\, d + a_2\, d^2$.

Second, in a similar fashion the real bond yield r is assumed to depend on the debt ratio d, as follows:

$$r = r^* - b_1\, d + b_2\, d^2 \qquad (4a)$$

or

$$r = r^* + b_1\, d \qquad (4b)$$

Hence according to specification (4a) at low levels of the debt ratio d increases thereof push the real yield down (owing to a lower liquidity risk premium), while above the debt threshold $\frac{1}{2}b_1/b_2$ the impact of debt on real yields turns positive (when solvency risk outweighs liquidity risk). Alternatively, a linear specification as in (4b) can be adopted, depending on the country in question. As to the numerical parameters:

- *United States.* We use the linear specification (4b) based on findings by Laubach (2009), with in his baseline model $b_1 = 0.039$, so roughly four bps per percentage point of public debt.
- *Other high-income countries*. We use as our source Pappas and Kostakis (2020), who find for their baseline model $-b_1 = -0.108$ and $b_2 = 0.000555$. This yields a debt threshold of $\frac{1}{2}b_1/b_2 = 97\%$. Their results are based on data for the euro area, but we assume this result to apply to all advanced economies other than the United States.
- *Other countries*. Studies for developing economies do not generally estimate a non-linear yield equation but assume a positive relationship between the yield and the level of the debt to GDP ratio in equation (2b). A good study is Naidu et al (2016) who find $b_1 = 0.24$.

Again, r^* is computed as $r^* = r + b_1\, d - b_2\, d^2$ if specification (4a) is used and as $r^* = r - b_1\, d$ for the other cases.

Third, the primary balance position p is assumed to depend on the debt ratio d via a fiscal policy reaction function of the flowing stylised form see Ghosh et al (2013):

$$p = p^* - c_1 d + c_2 d^2 - c_3 d^3 \qquad (5)$$

The idea is that as debt increases its impact on the primary balance wanes as a result of 'consolidation fatigue'. The baseline estimates in Ghosh et al (2013) are $-c_1 = -0.208$, $c_2 = 0.0032$ and $-c_3 = -0.00001$. However, to keep things simple for now

Finally, incorporating equations (4) and (5) in the debt-growth equation (1) yields:

$$\delta = r^* - b_1\, d + b_2\, d^2 - 100\, p^*/d + 100c_1 - 100c_2 d + 100c_3 d^2 \qquad (6)$$

[8] See previous footnote.

where $\delta \equiv 100 \cdot \dot{D}/D$.[9] In equilibrium the growth rate of debt and output must be equal, so $\delta = g$. Making use of the growth equation (1) and the real debt growth equation (6) this condition can be reformulated as a cubic equation of the following form:

$$-(a_2 + b_2 + 100c_3)\, d^3 + (a_1 + b_1 + 100c_2)d^2 + (g^* - r^* - 100c_1)d + 100p^* = 0 \qquad (7)$$

This equation potentially has three roots. However, one root is effectively meaningless because, at the above assumptions of the parameters, it would imply negative gross debt. As discussed in the main text, there are therefore two feasible roots, here labelled $\bar{d}$ and $\bar{\bar{d}}$, which have distinct characteristics. Specifically, $\bar{d}$ corresponds to the *steady-state equilibrium* for the debt ratio, whereas $\bar{\bar{d}}$ is the *threshold* above which the debt ratio becomes explosive. If the cubic equation has no roots, it means that debt is always explosive, regardless of its in initial level. As discussed in the main text this means that the debt threshold $\bar{\bar{d}}$ is effectively nil. In some cases, a root for the debt threshold $\bar{\bar{d}}$ exists, but no root is found for the steady state equilibrium $\bar{d}$. This means that if the debt ratio is smaller than the threshold $\bar{\bar{d}}$, debt will shrink until it is nil, which would then be the effective steady state equilibrium as again debt cannot be negative.

[9] This is the curve marked 'δ' in Figure 1. By way of example, the curves depicted in Figure 1 are based on the numerical values thus derived for the euro area as a whole, with $g^* = -1.4$, $r^* = -0.1$ and $p^* = -6.5$.

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Sovereign Debt Management in the Face of Climate Liabilities: Perspective of European Union Member States[1]

Iustina Alina Boitan[2], Kamilla Marchewka-Bartkowiak[3]

Abstract

Climate change has a financial impact on sovereign debt management and fiscal risk through effects on public budgets. Climate liabilities raise the cost and risk of capital of all climate-vulnerable countries and threaten debt sustainability. Consequently, governments should manage the climate debt as the part of the traditional direct or contingent liabilities by the implementation of green financial mechanisms and instruments. The aim of this paper is to reveal and analyse the changes in the traditional approach of sovereign debt managers (in terms of strategies, tasks, instruments, institutional and communication solutions) in the face of the pursued climate policy and different scenarios of climate liabilities for 2050. We follow a novel three-fold research approach: 1) assessment of the estimated level of current climate liabilities based on the Fiscal Risk Matrix; 2) performing forward-looking climate debt projections over the timeframe 2025-2050 for the EU member countries; 3) conducting a case study research on European Union member states, to identify the sovereign climate debt management activities undertaken so far and to define a series of good-practice guidelines. Our findings indicate a growing role of the climate financial mechanism implementation in a sovereign debt management and on the green debt market. Because of the lack of European guidelines and common arrangements in this field, changes are observed currently only in the individual approaches of the EU member states to the sovereign asset and liability management. In particular, our climate scenario approach reveals those scenarios in which a country's fiscal position indicators are more vulnerable from the standpoint of rising public expenditure due to country's inability to manage the CO2 gas emissions by carbon-intensive industries. Conclusions highlight that each country is responsible for its climate pathway by 2050 and this will be mainly determined by the timeliness, efficacy and appropriateness of the public policies and measures implemented to mitigate climate change.

Keywords: climate change, sovereign debt management, climate debt (liabilities), fiscal risk
JEL classification: C33, E30, H63, Q54

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1. Introduction

Sovereign debt management is a key area of public finance, linking the public budget needs with the financial sector in terms of external (market) financing. Thus, the main goal of debt managers is to cover the borrowing requirements of public authorities, considering cost minimization and prudent management of risks associated with incurring debt (Missale, 1999). These standards are also introduced as international practical guidelines recommended by the World Bank and the International Monetary Fund, providing a basis for assessing the effectiveness of public debt management in countries around the world (World Bank and IMF, 2002).

In sovereign debt management, there are generally two approaches, depending on the scope of tasks to be performed and the type of dominant debt instruments, i.e., the portfolio approach and the balance sheet approach (Allen et al., 2002; Bloomestein, 2006). The portfolio approach relates mainly to decision making in the scope of managing a portfolio of treasury securities (bills and bonds) with particular emphasis on limiting market risk. The balance sheet approach, on the other hand, is used by debt managers, who in their decisions also consider the broad items of assets and liabilities (Cassard and Folkerts-Landau, 2000). The latter is a characteristic for countries borrowing from international financial institutions due to their limited access to the financial market, and also for those countries that organizationally combine several tasks related to the problem of the broadly defined government overall liabilities, e.g., contingent liabilities management (Weeler, 2003; Currie and Velandia, 2002)

However, regardless of the approach used, the cost and risk trade-off is the most important basis for funding decisions by debt managers.

In this context, views have recently emerged that sovereign debt managers should increasingly incorporate climate change financing, including climate risk, into their strategies as an important determinant of investment decisions by many investors, including banks. These views are based on several considerations. One is the adoption of new international strategies to combat climate change (including those agreed at international Climate Summits[1] and in the European Union within the European Green Deal). Another driver is the introduction of regulatory obligations for financial institutions in the area of environmental risk management and Environment-Social-Governance (ESG) reporting. Moreover, within the framework of the Action Plan: Financing Sustainable Growth, the European Commission adopted important objectives, in which it postulates redirecting a part of budget resources to support sustainable development and including sustainable development in risk management based on the so-called "green taxonomy". It also indicates the necessity to include sustainable development issues in the methodology of rating agencies. All these regulatory solutions will have a significant impact on the new requirements for sovereign asset and debt management.

On this background, the major contribution of our paper is to identify a suitable approach to be followed by sovereign debt managers in terms of strategies, tasks, instruments, institutional and communication solutions in the face of the pursued climate policy and different scenarios of climate liabilities for 2050.

We develop a complementary three-fold analytical framework that relies on three pillars: 1) assessment of the estimated level of current climate liabilities, based on the Fiscal Risk Matrix methodology; 2) performing forward-looking climate debt projections over the timeframe 2025-2050 for the EU member countries; 3) conducting a case study research related to the sovereign climate debt management

[1] Including mainly after the international climate summit in Copenhagen in 2009 and Paris in 2015.

activities undertaken so far by debt managers in the 27 European Union member states. A first issue of novelty brought by our paper is the integration of climate debt into the range of direct and explicit liabilities. In this regard, our analytical approach has the benefit of relying on the internationally agreed and implemented Fiscal Risk Matrix methodology, to increase decision makers' understanding and acceptance on the positioning of climate liabilities in the broader context of traditional forms of liabilities.

A second novel feature resides in computing the future climate debt (as a share of national GDP) to be borne by each EU country until 2050, by following the climate path hypotheses considered by the Network for Greening the Financial System's climate scenarios. This is a singular forward-looking approach of its kind in existing literature. We substantiate our approach in the consensus that the world is witnessing nowadays a critical juncture in terms of climate mitigation action policies and strategies. Specifically, it is globally acknowledged that climate pathways are surrounded by uncertainty and could move in materially different directions: from a successful transition to net-zero emissions by 2050, to a hot house world scenario with a global warming trend of 3˚C or even more by 2100. The findings obtained under the various climate scenarios allow the ranking of EU countries in terms of their climate change mitigation performance, enhance the comparability of results across countries and may provide an awareness raising signal for decision makers, to better understand future risks and exposures to climatic challenges.

The case study approach provides new insights to expanding the scope of traditional sovereign debt management by including climate debt in the regular country-level debt sustainability analyses. Our arguments are substantiated in the lack of common, harmonized guidelines at European level regarding the sovereign climate debt management in both broad and narrow terms. Thus, our contribution to existing literature is the development of a series of proposals for the management of the sovereign debt that accounts for the inclusion of climate debt.

Another original feature of this paper is that we gathered qualitative and quantitative data from manifold sources. Apart from using Eurostat and OECD data, we performed an ample desk research of official documents available on the websites of sovereign debt management institutions (ministries, agencies, central banks) from 2019-2021 and counted the frequency of occurrence of climate change-related words. Additionally, this is the first paper that comprehensively employs all the six climate scenarios developed by the Network for Greening the Financial System (NGFS).

The paper is structured as follows. In section two we classify and estimate the current level of climate liabilities based on two methodologies: the Fiscal Risk Matrix and the proposed methodology for calculating climate debt including the maturity term (as the accepted climate goal). In the third section we perform a forward-looking analysis, by relying on the newest set of climate scenarios developed by the Network for Greening the Financial System. A series of climate debt projections are conducted over the timeframe 2025-2050 for the EU member countries, by using the NGFS's projected carbon price and the projected CO_2 emissions/year which are specific to each of the six scenarios. In the fourth section we present the results of research conducted on a group of European Union member states in which, due to the EU regulatory changes (European Green Deal), the motivation to correct their approach to sovereign debt management is expected to be relatively high. The last section concludes.

2. Sovereign climate debt in the face of the fiscal risk matrix – the case of EU Member States

There is currently no clear definition of climate debt in monetary terms. However, climate debt can already be identified as one of the important government liabilities, which have and will have in the future an impact on the fiscal risk of the public budget in all countries across the world. To determine the scale of fiscal risk generated by climate debt, it is worth indicating its position in the classification of government liabilities. For this purpose, we use the methodology of the Fiscal Risk Matrix developed at the World Bank in 1989 (Polackova, 1989), which distinguishes four basic groups of government overall liabilities according to their characteristics based on the legal (contractual) basis and the probability of occurrence of a given event.[2]

According to the above methodology, climate debt (interchangeably regarded as climate liabilities) is classified as contingent and implicit (called as the traditional approach). This is the result of the original approach in assessing fiscal risk, due to the fact that environmental events are unpredictable in their nature and therefore also difficult to plan for in the public budget on an annual basis (table 1).

Table 1. The Fiscal Risk Matrix – major instruments of government overall liabilities

Criteria	**Direct** *(obligations in any event)*	**Contingent** *(obligation if a particular event occurs)*
Explicit *(obligation recognised by a law or contract)*	Government debt **Climate debt** (proposed approach)	Contingent liabilities
Implicit *(obligation reflects public and interest group pressures)*	Pension liabilities	**Climate debt** (traditional approach)

Source: own elaboration based on (Polackova, 1989)

However, we take a critical approach to the above division, particularly in the context of European Union analyses. This position stems from two important developments in the estimation of fiscal risks. First, according to international scientific research (IPCC 2021), climate change will be permanent and probably worsening, with differences in scale depending on the region of the world, which means that the observed effects of environmental change cannot be regarded only as incidental anymore. Secondly, at present, the fight against climate change forms the basis for the formulation of many strategic documents and legal acts at both the EU and Member State levels, which obliges public authorities to finance climate liabilities. Moreover, the adopted European Green Deal (EC 2019) sets a deadline of 2050 for reaching the climate target of net zero emissions. In this way, the European climate goal can be

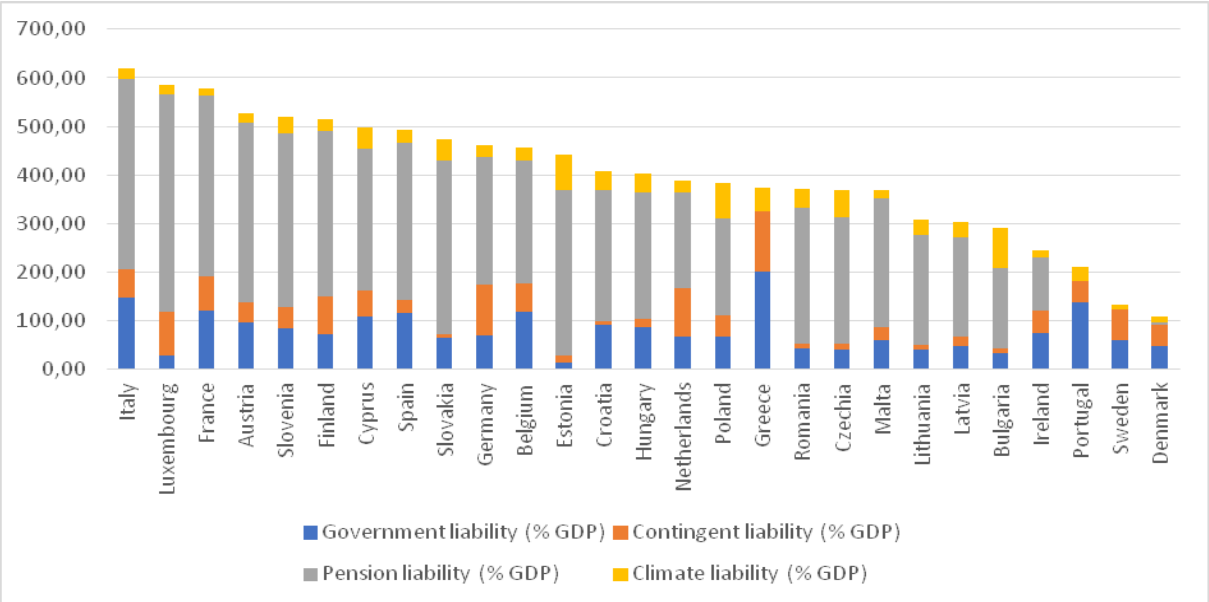
[2] Direct, explicit liabilities are defined as liabilities classified according to applicable national regulations and budgeting methods. This is the primary category of government liabilities, comprising liabilities that are foreseeable in terms of value and future realization or maturity. Contingent, explicit liabilities are defined as liabilities based on regulations or legal agreements that may or may not have a future funding date. Funding often occurs as a result of an underwritten operation with prior credit risk. Direct, implicit liabilities are defined as liabilities required for future implementation, the amounts and timing of which are not directly derived from current regulations. However, their implementation will be directly funded by the government due to such public expectations. Contingent, implicit liabilities are defined as liabilities derived from an informal government pledge based on expected government responses in emergency situations; failure to fulfil these commitments may result in a crisis or moral hazard phenomenon affecting the public or specific groups of actors. Based on: (Polackova, 1998; Marchewka-Bartkowiak, 2007).

treated as the maturity term. This assessment therefore implies a change in the nature of climate debt to direct and explicit (proposed approach in table 1).

These assumptions also influenced the methodology adopted in the article for calculating climate debt. The climate liabilities are assumed as the amount of the carbon liability expressed in millions of US dollars, illustrating the value of the pollution generated through CO_2 emissions that the originating country has to pay for. However, assuming that the EU will be climate-neutral in 2050, we estimate climate financial-based liabilities as the cumulative value of annual obligations, which should be taken into account by individual countries in their financial strategies and whose maturity (implementation) expires in 2050 (according to the agreed assumptions of the European Green Deal). Estimates of climate financial liabilities are not discounted, but they are assumed to decrease annually if a member state manages to meet its climate targets. In this way, it is possible to monitor the present value of future climate liabilities, valued in money terms at their declared carbon reduction path[3]. As a starting point the lower-end estimate of the carbon costs in 2020, which is of US $ 40/tCO_2, within the average estimates and forecasts adopted by international organisations.[4]

Based on the adopted methodological assumptions, it is possible to assess the scale and share of climate debt in the total structure of government overall liabilities for individual EU member states. Although, from the accounting point of view, such presentation may raise doubts, it offers the possibility to assess the financial impact on the public budget and enables the estimation of the total level of fiscal risk. As can be seen from the presented data (Figure 1), climate debt is estimated for all member states, and depending on the country it ranks third or fourth in the hierarchy of overall liabilities.

Figure 1. Sovereign overall liabilities in EU member states (amount and structure)* in 2018



** Note: data access restrictions set out in a footnote 2*

Source: own computations based on Eurostat data and (Boitan and Marchewka-Bartkowiak, 2021)

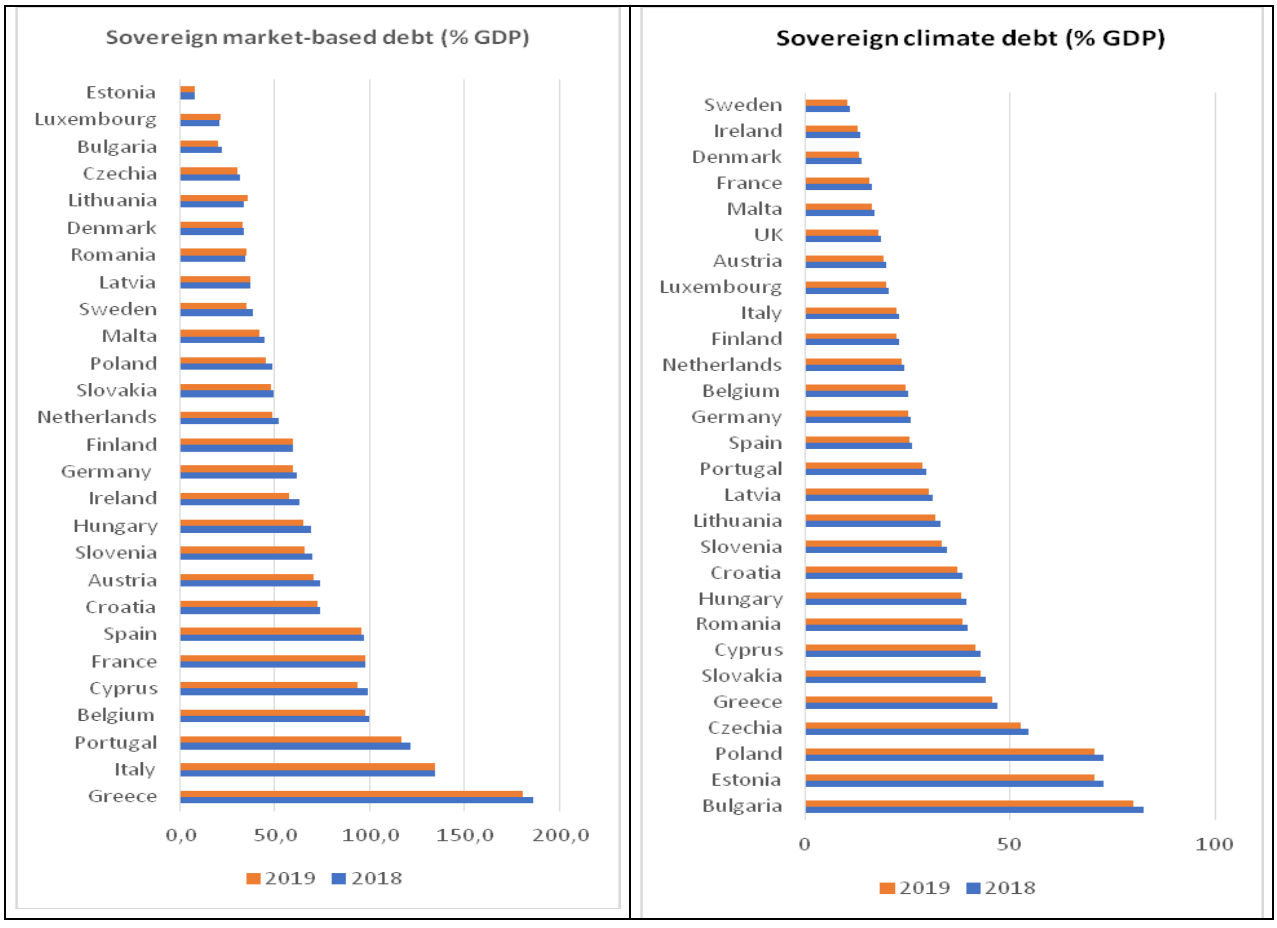
[3] More in: (Boitan and Marchewka-Bartkowiak, 2021).

[4] For example, the report issued by the OECD is pricing CO_2 emissions at EUR 30/t CO_2, the low-end estimate of the cost of carbon (OECD, 2016), the Report of the High-Level Commission on Carbon Prices estimates an explicit carbon-price level that is consistent with achieving the Paris Climate Agreement temperature target, namely a cost of US $40–80/t CO_2 by 2020 and US $50–100/t CO_2 by 2030 for each tonne of carbon emissions (World Bank, 2017). The Climate Leadership Council calls for the introduction in 2021 of an economy-wide fee on CO_2 emissions starting at US $ 40/t CO_2 and increasing every year by 5% above the inflation rate (Climate Leadership Council, 2019). Similarly, the IMF relies on a US $35 carbon price per tonne of CO_2 in 2030 to compute the burden to be witnessed by various economic sectors that are CO_2 emitters (IMF, 2019).

The highest level most often concerns pension liabilities calculated using the "accrued-to-date liabilities" methodology. For example, in 2018, the average level of climate debt was 34% of GDP, with government debt at 79% of GDP, contingent liabilities at 45% of GDP and pension liabilities at 271% of GDP.

From the sovereign debt management perspective, however, it is worth pointing out the relationship between government (market-based) debt and climate debt (Figures 2 and 3). As can be seen from the presented data, climate debt for 2018 and 2019 was on average about a half of the value of government debt calculated in relation to GDP for the EU member states. It should be made clear at this point that climate debt is calculated as a liability for the public authorities of a country, but with possible diversification of financing, i.e., public and private financing. However, the reduction of carbon emissions in terms of the private sector, which leads to the fulfilment of the state's commitments, should be supported, motivated, and monitored by the government.

Figures 2 and 3. Sovereign market-based and climate debt (% GDP)

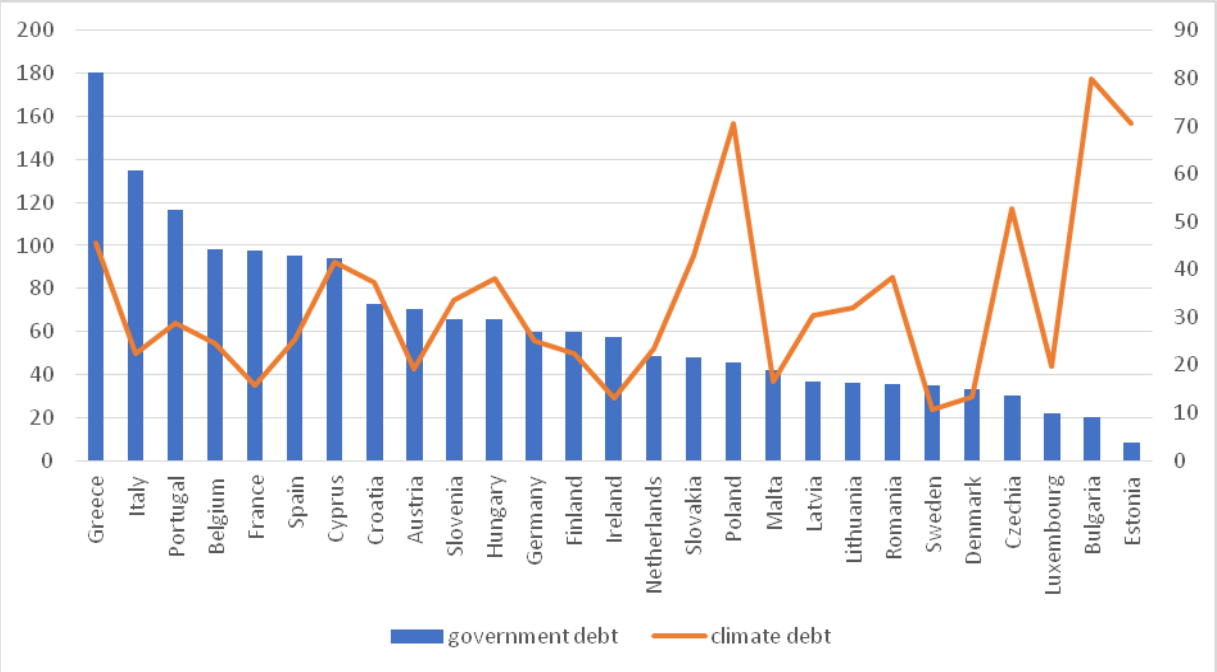


Source: own computations based on Eurostat data

From the perspective of individual Member States, it is also worth noting that euro area member states are often characterised by a relatively higher ratio of marked-based debt as a % of GDP to climate burdens (e.g., Greece, Italy, Portugal, Belgium, France, Spain). In contrast, as for countries outside the Eurozone, particularly in Central and Eastern Europe, the relationship is in many cases reversed (e.g., Bulgaria, the Czech Republic, Poland, Romania, Slovakia) (Figure 4).

Thus, as the analysis shows, climate commitments are an important part of government overall liabilities. Moreover, due to their new features, these liabilities should require greater attention from public debt managers and possibly undergo some changes at the strategic, instrumental, and institutional levels, as will be discussed later in this article.

Figure 4. The relation between sovereign debt (left axis) and climate debt (right axis) as % GDP in 2019



Source: own computations based on Eurostat data

3. Projections of the sovereign climate debt path till 2050 – the case of EU Member States

To increase decision makers' awareness on the subsequent potential costs to be supported by the national economy (represented by a climate debt), in case of failure in meeting the carbon-neutral economy till 2050 as stated by the European Green Deal, we perform a scenario-based forward-looking analysis.

We start from the premise that the transition process towards a carbon-neutral economy can take different paths, with different climate costs, depending on the strength and timeliness of the national policies adopted for mitigating climate change. The most suitable analytical tool is to conduct a scenario analysis due to its manifold advantages, such as: flexible methodological framework, forward-looking nature in making assumptions about the future trends, design of hypothetical but plausible scenarios (ECB, 2021a).

In conducting our analysis, we rely on the climate scenarios introduced in June 2020 and updated in 2021 by the Network for Greening the Financial System (NGFS – Bertram et al. 2021). They are already referred to in recent policy reports and analyses published by the European Central Bank (ECB, 2021a; ECB, 2021b) or research centres (Robins et al., 2021), so they are relevant and provide a common basis for interested authorities (such as central banks, governments, etc.) in integrating climate risks into their decision-making process related to the monitoring of the financial and macro-economic fundamentals.

The NGFS reference scenarios consist of 6 climate scenarios which are classified in 3 main categories, namely: orderly, disorderly, and hot house world based on a different set of assumptions for how climate policies, gas emissions, and temperatures will evolve. Their purpose is to estimate how different levels of climate change mitigation could be achieved among given countries, under specific climate outcomes and socio-economic background assumptions. Importantly, the outcomes of the 6 scenarios (in terms of carbon emissions and carbon price) vary according to how climate mitigation policy measures' design and implementation might evolve on both short and long term, in close connection with technological progress, such as the availability of carbon dioxide removal technologies. These policies can be introduced either immediately, later on, or remain insufficient in meeting the European Green Deal temperature target.

The main source of our data is the NGFS database. For the computation of the estimated climate debt, we rely on the projected carbon price, expressed as US$/t CO_2, and on the projected CO_2 emissions/year, data being reported for every 5 years. The levels of both indicators are estimated distinctly in each NGFS climate scenario, in a cross-country manner. The long-term forecast of the real GDP until 2050 is extracted from the OECD database. It is estimated by relying on a combination of model-based analyses and expert judgement, in order to assess the future path of the economic climate in individual countries.

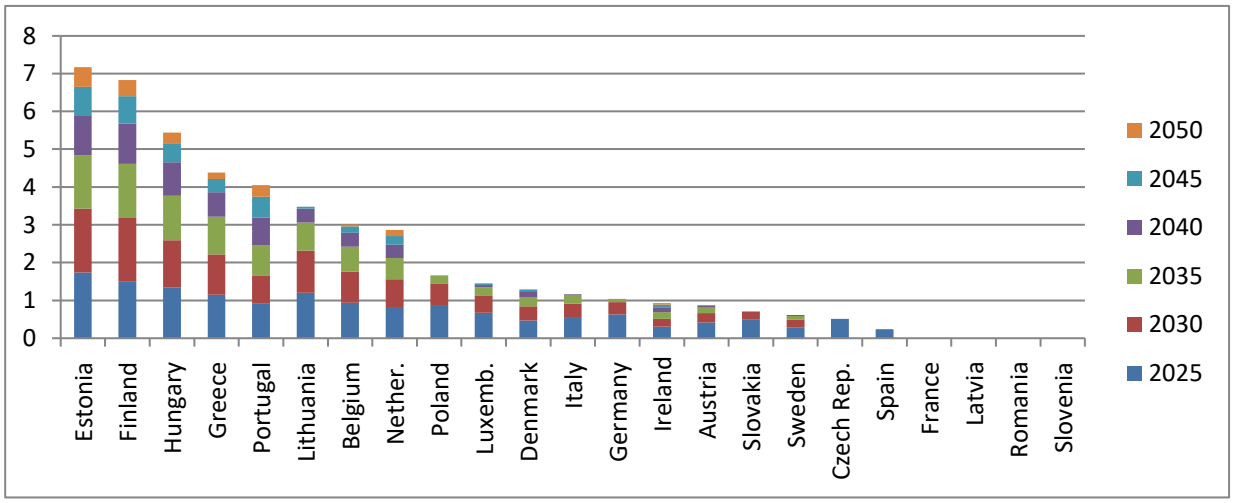
The final output of our computations, represented by the share of climate debt in national GDP for EU member states in each of the six climate scenarios, is presented in more details in Appendix 2. Our approach is to discuss the prospects for this climate debt under various climate scenarios developed for a timeframe ranging between 2025 – 2050, by estimating the future climate debt levels for different carbon prices and CO_2 emissions, with a focus on EU member states.

In the following, to gain an illustrative overview of the climate debt size (as % of GDP) to be potentially borne by EU countries in the next decades, in direct connection with their efforts for achieving carbon neutrality, in figures 5 to 10 we present a graphical ranking of countries in terms of the cumulative climate debt they will face till 2050. When a country achieves a status of negative CO_2 emitter, it means that it is a best performer as it succeeds in absorbing more CO_2 that it emits. Consequently, its climate debt will be zero. If it is still emitting more CO_2 that it absorbs, then it qualifies for paying a carbon cost for each ton emitted. This reasoning is exhibited also through the codes of colour used in every figure: the missing colour for a given country indicates that, for the particular year the colour is assigned to, the country has achieved carbon neutrality.

Figures 5 and 6 correspond to a climate debt projection (as % of GDP) computed for the orderly scenarios, which assume that climate policies are introduced early by each country and become gradually more stringent. Consequently, the process of transition to a low carbon economy takes place in an orderly manner and appropriate policies are implemented immediately. In this scenario, the carbon emissions prices increase gradually, allowing companies to adapt their business models and develop green technologies, and households to change their consumption behaviours into one that is environmental-friendly (ECB, 2021a).

In the Below 2°C scenario (see figure 5) the stringency of climate policies increases gradually, giving a 67% chance of limiting global warming to below 2°C until 2050 (Bertram et al., 2021).

Figure 5. Estimations of the climate debt-to-GDP ratio for the Below 2°C scenario

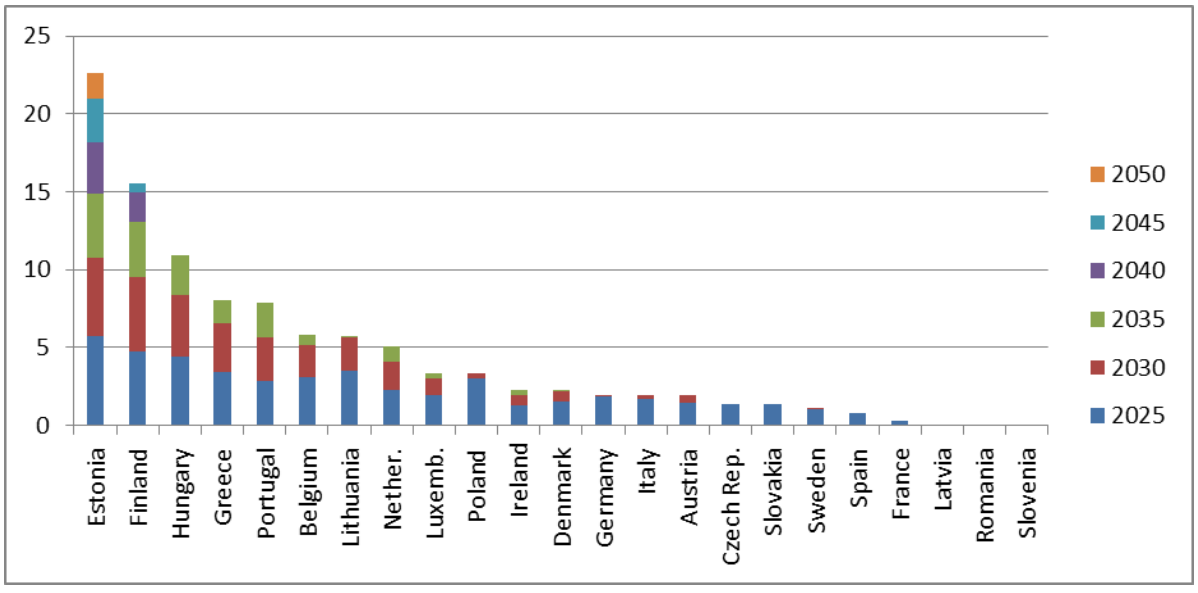


Note: Bulgaria, Cyprus, Croatia, and Malta were not considered, due to the lack of available data for each benchmark year under analysis.
Source: own elaboration

The figures indicate both the cumulative value and the annual value to be recorded by the climate debt-to-GDP ratio. In the Below 2°C scenario, most countries are expected to witness larger values of the climate debt in GDP in 2025 and 2030, while Estonia, Finland, Hungary, Greece, and Portugal will face a climate debt burden in every benchmark-year considered.

The Net Zero 2050 scenario (figure 6) envisages limiting global warming to 1.5°C through the adoption of stringent climate policies and technological innovation, in order to reach global net zero CO_2 emissions by 2050. According to European Central Bank (2021a), this scenario is the most compatible with the long-term temperature goal established by the European Green Deal.

Figure 6. Estimations of the climate debt-to-GDP ratio for the Net Zero 2050 scenario



Note: Bulgaria, Cyprus, Croatia, and Malta were not considered, due to the lack of available data for each benchmark year under analysis.
Source: own elaboration

The projections for the Net Zero 2050 scenario are similar with the preceding one regarding the EU countries exposed to the highest cumulative values of the climate debt in GDP (Estonia, Finland, Hungary, Greece, and Portugal). In terms of annual climate debt levels, the year 2025 will be the costliest for the majority of EU countries considered.

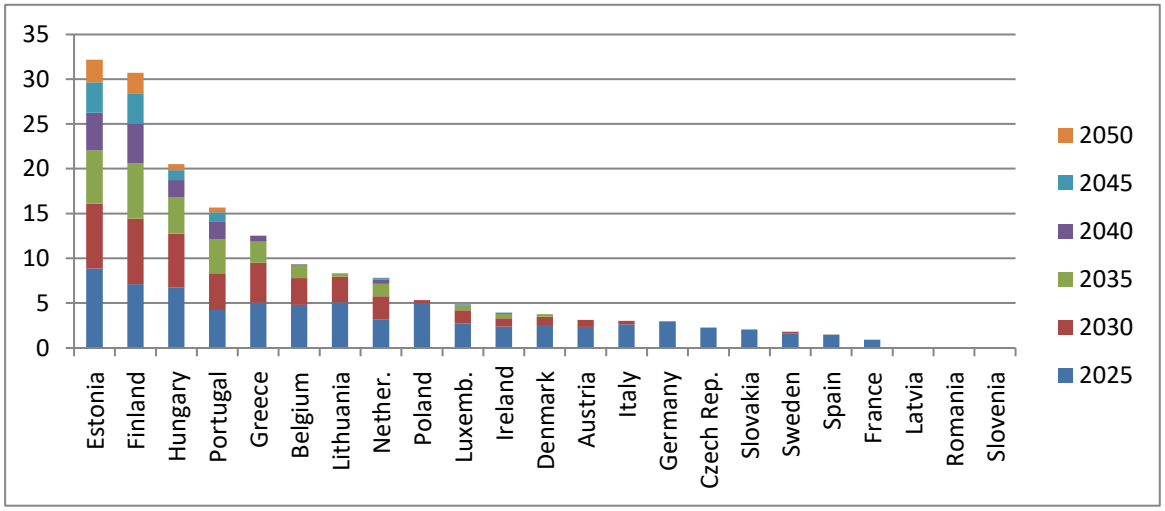
Figures 7 and 8 correspond to a climate debt projection (as % of GDP) computed for the disorderly scenarios, which are characterised by higher transition risks due to delays in the implementation of climate public policies or divergences across countries and economic sectors. Hence, the prospects for carbon dioxide removal are slow. A direct effect of this delay period is the need for implementing more stringent policies and measures from 2030 onwards, triggering a sharp increase of the carbon prices till 2050. The report published by the European Central Bank (2021a) explains that the late and abrupt implementation of policy measures for fighting climate change will still allow for the 2°C target envisaged by the Paris Agreement to be met, but with a sharper upward revision of the carbon emissions price.

In the Divergent Net Zero scenario (see figure 7) countries are expected to reach net-zero CO_2 emissions around 2050, but at the expense of higher costs due to divergent policies introduced across polluting sectors, leading to a quicker phase out of oil use (Bertram et al., 2021). To meet the climate targets, carbon prices may jump up to 528 US$/tonne of CO_2 by 2050 leading to higher transition risk faced by EU countries.

The ranking of the most exposed EU countries at larger values of the climate debt/GDP is dominated by the same countries as in the orderly scenarios: Estonia, Finland, Hungary, Greece, and Portugal. In terms of climate debt annual levels, the year 2025 will be the costliest for the majority of EU countries considered, while few countries will face similar costs also in 2030 and 2035.

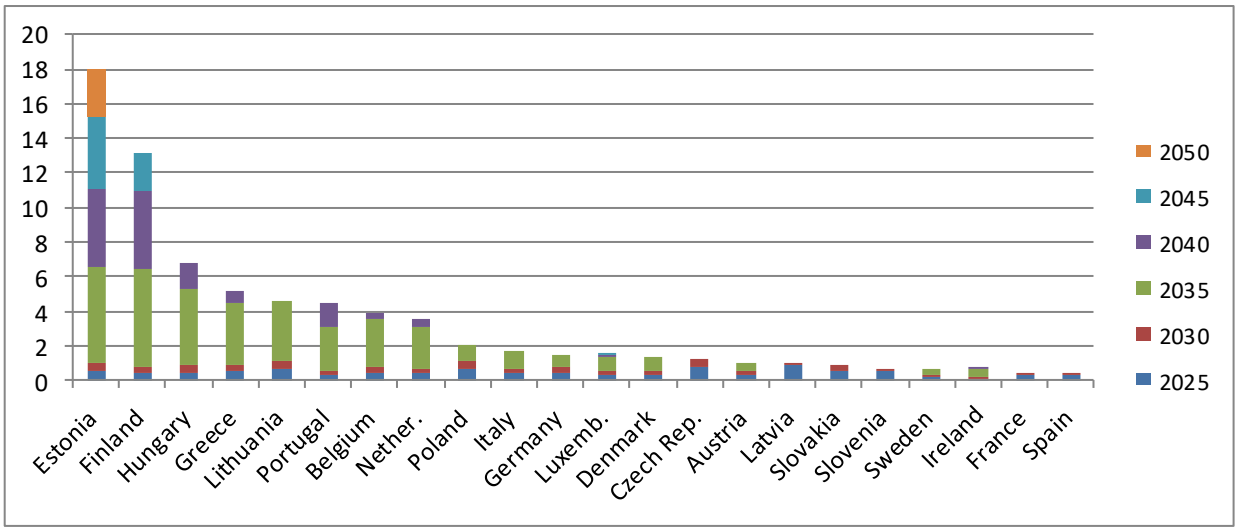
The Delayed Transition scenario (figure 8) assumes that the annual CO_2 emissions do not decrease until 2030. On the contrary, during 2020 – 2030 countries will experience a "fossil recovery" and will follow the trajectory of the current policies scenario until 2030. Starting with 2030 countries will begin to implement stronger policies for limiting global warming to below 2°C. To meet the climate targets, carbon prices are expected to increase up to 1,058 US$/tonne of CO_2 by 2050.

Figure 7. Estimations of the climate debt-to-GDP ratio for the Divergent Net Zero scenario



Note: Bulgaria, Cyprus, Croatia, and Malta were not considered, due to the lack of available data for each benchmark year under analysis
Source: own elaboration

Figure 8. Estimations of the climate debt-to-GDP ratio for the Delayed Transition scenario



Note: Bulgaria, Cyprus, Croatia, Malta, and Romania were not considered, due to the lack of available data for each benchmark year under analysis
Source: own elaboration

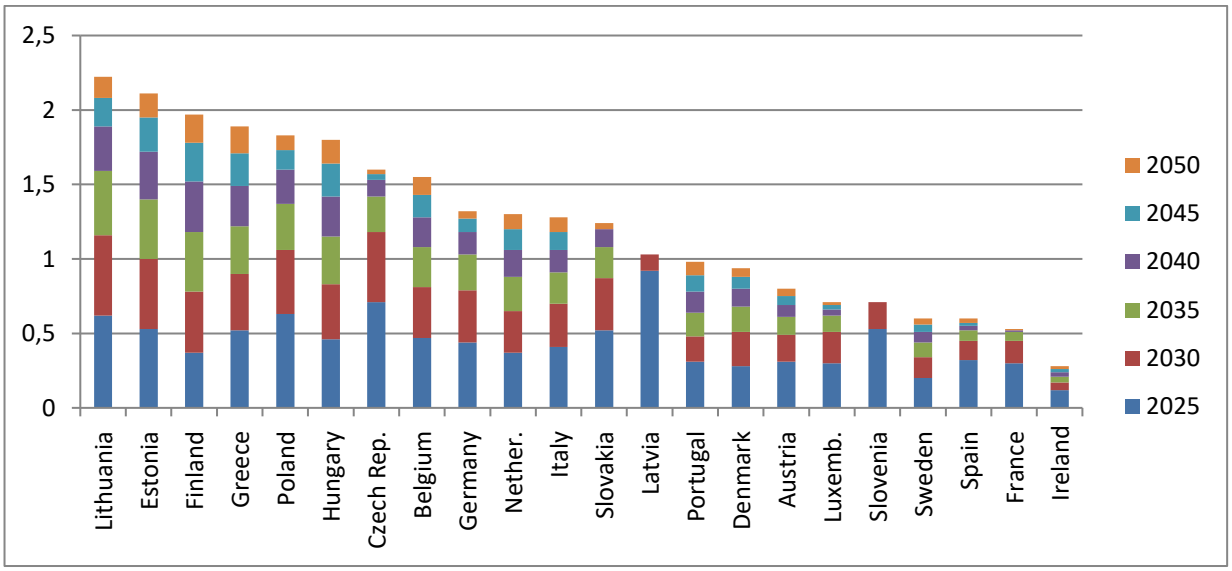
Under this scenario, the highest costs incurred by meeting the climate target will be borne by most EU countries in 2035. Estonia will be the only country failing to meet the target by 2050. A common finding is that in both orderly and disorderly scenarios Estonia and Finland persistently occupy the first two positions in the highest climate debt/GDP cumulative values by 2050.

Figures 9 and 10 illustrate the climate debt projection (as % of GDP) computed for the Hot House World scenarios. These scenarios start from the premise that some climate policies and measures are partially implemented in some economic sectors and countries, but at the global level these efforts are insufficient to determine significant reversal of global warming. The main result of the occurrence of these scenarios relies in the manifestation of severe physical risks, some of them irreversible such as sea-level rise (Bertram et al., 2021).

The European Central Bank report (2021a) associates the Hot House World scenario with the failure to meet the European Green Deal temperature target. The policy reaction is slow as only current climate policies are implemented, while CO_2 emissions „continue to increase steadily leading to a rise in estimated median temperature of about 3.5°C by 2100". Consequently, the occurrence of the Hot House World scenarios leads to higher physical risks, compared with the preceding scenarios.

In a Current Policies scenario (figure 9) only the currently implemented climate policies remain in place, the policy reaction is slow and unevenly represented across different economic sectors. Technological investments are small and the capabilities for carbon dioxide removal from the atmosphere are low.

Figure 9. Estimations of the climate debt-to-GDP ratio for the Current Policies scenario

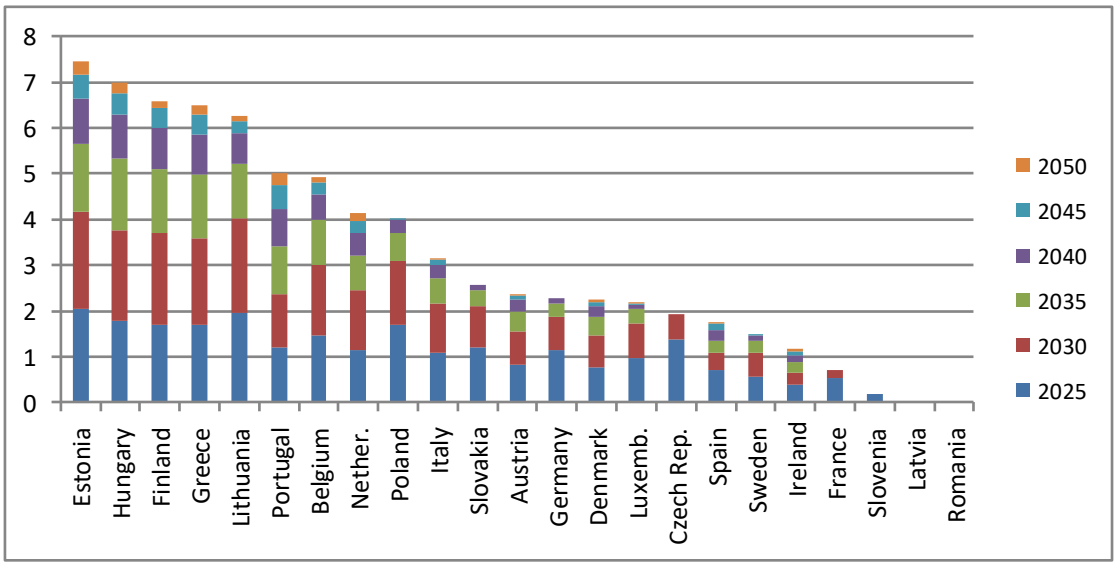


Note: Bulgaria, Cyprus, Croatia, Malta, and Romania were not considered, due to the lack of available data for each benchmark year under analysis.
Source: own elaboration

According to the projections computed for this scenario, the costs incurred by meeting the climate target will be staggered annually for most EU countries. Each of the six benchmark years is represented in the above figure, thus the majority of EU countries will bear a climate debt till 2050. Only three countries succeed to become zero-CO_2 emitters in 2050.

The Nationally Determined Contributions (NDCs) scenario (figure 10) is more comprehensive than the Current Policies one, because it considers all promised policies, even if currently they are not yet implemented.

Figure 10. Estimations of the climate debt-to-GDP ratio for the Nationally Determined Contributions (NDCs) scenario



Note: Bulgaria, Cyprus, Croatia, and Malta were not considered, due to the lack of available data for each benchmark year under analysis
Source: own elaboration

Under this last scenario, the highest costs to be incurred in order to meet the 2050 climate target will be borne by most EU countries in 2025, 2030, and 2035.

To sum up the informational content of each abovementioned figure, the divergent net zero scenario seems to be the costliest for several EU countries (it exhibits the highest share of climate debt in national GDP – see the maximum values of the descriptive statistics in the Appendix 2), followed by the net zero 2050 scenario and the delayed transition scenario. The years 2025, 2030, and 2035 are expected to be the costliest in the first two scenarios, while in the delayed transition scenario the higher costs for the state budget will be borne in 2035, 2040, and 2045. Our findings suggest that EU countries will face the lowest level of climate debt in the current policies scenario; however, this strategy is the least beneficial from the standpoint of achieving the carbon neutrality till 2050 because only three EU countries will have become zero-CO_2 emitters. By comparing the maximum values recorded by the climate debt/GDP ratio across the EU countries, for each of the six scenarios, we uncover that Estonia will persistently face the highest costs due to its CO_2 emissions. Therefore, decision makers in this country have to implement strong policies and strategies for limiting CO_2 emissions and complying with the global warming target till 2050.

On average, the divergent Net Zero scenario is the costliest among all, both for the entire timespan 2025-2050 and on an annual basis (a cumulative EU countries' average of 1.25). The standard deviation statistic exhibits too the largest values among all scenarios, confirming the presence of extreme values, both large and small in the climate debt/GDP time series.

The number of EU countries that will become net zero-CO_2 emitters in 2050, and hence will not be exposed to any climate debt payment (as a share in national GDP) is different for each scenario analysed:

- only 3 out of the 27 countries considered will record a null climate debt/GDP in the Current Policies scenario. The majority of EU countries will persist in emitting CO_2 and therefore will face a persistent climate debt burden for their public budget;
- 10 countries will record a null climate debt/GDP in the NDCs scenario;
- 15 countries will record a null climate debt/GDP in the Below 2°C scenario;
- 20 countries will record a null climate debt/GDP in the Divergent Net Zero scenario;
- 26 countries will record a null climate debt/GDP in the Net Zero 2050 scenario and the Delayed Transition scenario.

By correlating this finding with the carbon price estimated to be paid in 2050 by each EU country on its CO_2 emissions, an interesting conclusion arises. The Net Zero 2050 scenario and the Delayed Transition scenario exhibit the highest carbon price projected to be paid for each tonne of CO_2 (of 889.28 US$ and respectively of 1058.68 US$). Therefore, these scenarios penalise the most those EU countries that are still CO_2 emitters by the end of 2050, and thus countries are more inclined to comply with the climate target. At the opposite is the current policies scenarios, which uses the lowest carbon cost estimate of only 20.76 US$/tonne of CO_2 emissions in 2050. This may explain the countries' lack of efficiency in implementing climate change policies for decreasing the CO_2 emission level till the net zero target.

Among the sample of EU countries considered, Latvia and Slovenia are assumed by all the 6 scenarios to become net zero-CO_2 emitters starting with 2035. This situation may be the result of the implementation of immediate, timely and strong climate policies, complemented by investments in new technologies meant to increase the carbon dioxide removal through various processes, such as afforestation, geological sequestration, and exploration of bioenergy resources.

In this regard, the European Central Bank (2021a) explains that the direct carbon dioxide removal from the atmosphere can come from bioenergy (with carbon capture and storage) and/or land-related sequestration (i.e., afforestation). Consequently, countries having already in place various carbon dioxide removal technologies are susceptible to follow an orderly scenario.

To sum up, our conclusion highlights that each country is responsible for its climate pathway by 2050 (that may fall under one of the six abovementioned climate scenarios) and this will be mainly determined by the timeliness, efficacy, and appropriateness of the public policies and measures implemented to mitigate climate change. Decision makers are encouraged to perform a screening of the climate policies currently in place and of the next steps in this regard, with particular focus on the investments in alternative sources of energy to fossil fuels, to alleviate or counteract the negative effects of the polluting economic sectors and significantly impact the future downward path of CO_2 emissions. The scale of the carbon cost they may bear in the next decades, and hence the climate debt-to-GDP ratio as an additional component of the public debt, will directly depend on the conduct of current policies (including sovereign debt management).

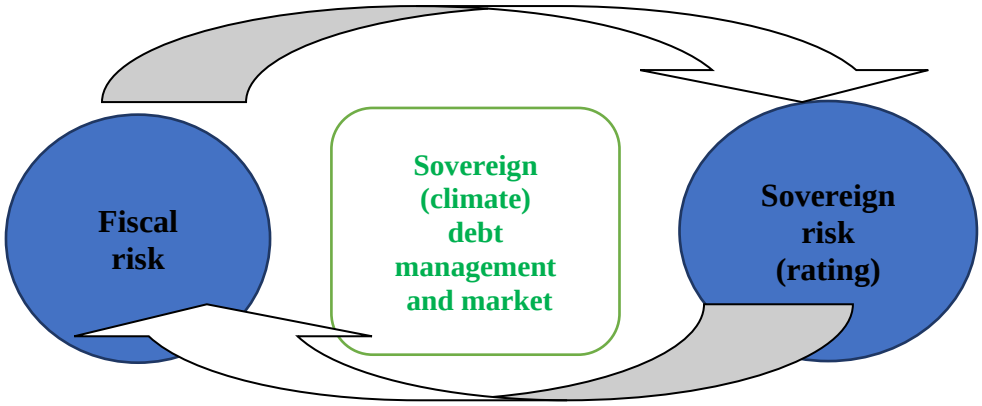
4. Sovereign debt management in the face of climate change – the case of EU Member States

In most countries, sovereign debt management is a separate and regulated area on the borderline between public finance and the financial market. Due to its specific nature and tasks, it is often characterised by a certain level of operational and institutional autonomy (Wolswijk and de Haan, 2005;

Williams 2006). The incurrence and servicing of public debt also implies the need for active risk management by debt managers. The treasury securities market is also usually one of the largest segments of the debt market in the country, offering assets with the lowest sovereign credit risk. However, the valuation of instruments in this market is based on the current and projected situation of the public budget, assessed on the basis of the fiscal risk generated.

As indicated above, at present and in the future, fiscal risk will be additionally determined by the public authorities' implementation of climate commitments indicated in the new regulations. Consequently, actions taken under sovereign climate debt management will translate into sovereign ratings (Figure 11).

Figure 11. The relation between fiscal risk and sovereign risk in the context of sovereign debt management role



Source: own elaboration

Already, the world's largest rating agencies include climate risk in their methodology for assessing a country's creditworthiness. As the rating agency Standard & Poor's (2014) points out, climate change can be treated as “global mega-trend for sovereign risk” and it will have an impact on creditworthiness probably through various channels, including economic growth, external performance, and public finance. Moody's (2019), in turn, identifies four main transmission channels through which climate change will affect sovereign risk: impacts on economic activity, damage to infrastructure, social costs, and population shifts.

We can therefore talk about “sovereign climate debt management” in broad and narrow terms. In the former case, the concept will refer to the various actions and financial initiatives taken by public authorities in the fight against climate change and the implementation of carbon liabilities in terms of CO_2 emissions. In the narrow sense, it will refer to actions taken in sovereign debt management as part of the implementation of long-term strategies, using a new approach that takes climate risk into account. This article will focus on the latter approach.

As already pointed out in the literature, “climate risk should be integrated in public sector funding and debt management strategies” (Centre for Sustainable Finance, 2021, p. 93). A survey of debt managers from 19 countries around the world conducted by the Climate Bonds Initiative (2021) found that the

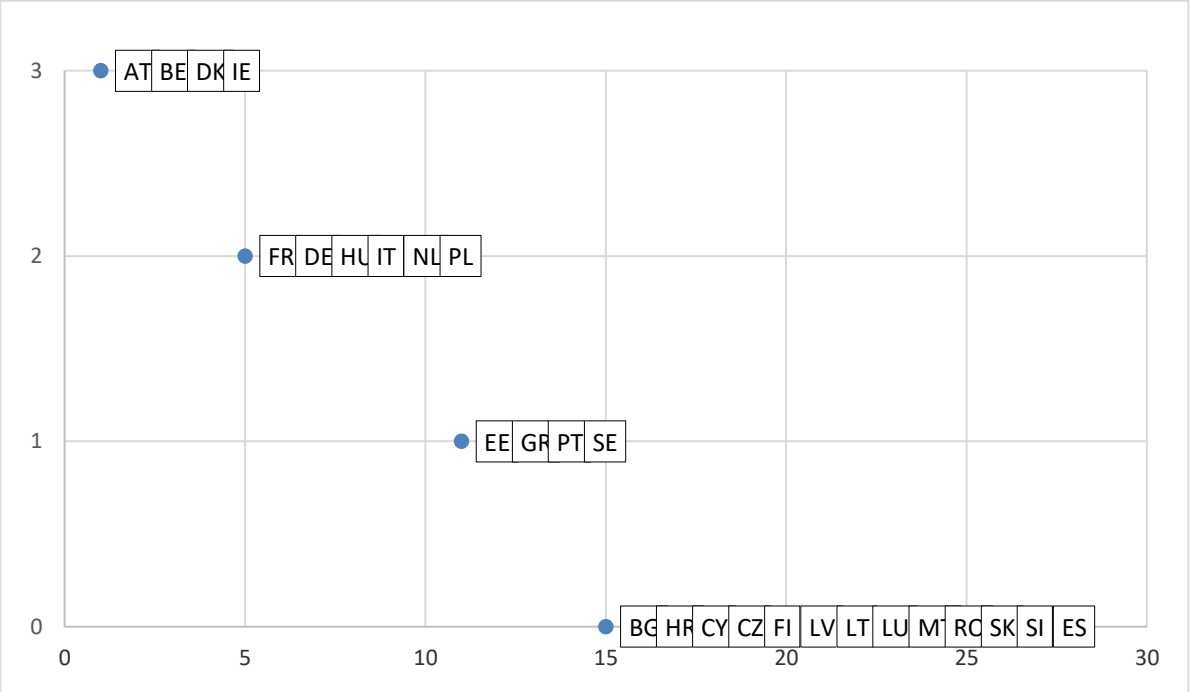
flagship solution is now issuing bonds (Sovereign Green, Social and Sustainability Bonds - SSE Bonds) dedicated to financing green investments. Respondents indicated that the main purpose of the issuance was to support the development of local green market bonds, attract new investors and gain reputational benefits. Interestingly, the least motivation for issuing GSS bonds was the cost of their servicing. Some countries have also adapted their SSE bond issuance procedures to taxonomy requirements (EU Taxonomy, Climate Bonds Taxonomy, other taxonomy).

However, scientific studies as well as many new practice reports are increasingly proposing new solutions dedicated to climate debt managers. One of the most recent solutions is the rules for issuing sustainability-linked bonds, hurricane and natural disaster clauses or green certificates (ICMA 2020, IMF 2020, Bongaerts and Schoenmaker, 2020). Another type of specialised financial operations is the debt-for-climate swaps designed for debtors from underdeveloped countries and generally involving the conversion of traditional external government debt (loans) into investments in climate-smart fixed assets (Sommer, Restivo and Shandra, 2020).

To identify the activities undertaken by debt managers in the 27 European Union member states (excluding the UK) in the above regard, the documentation available on the websites of sovereign debt management institutions, including strategies, reports, and investor presentations from 2019-2021, was first reviewed. The use of the words "climate", "carbon", and "green" in these documents and the content that related to them was verified.

As Figure 12 (details in the Appendix) shows, in 14, or about a half of the member states studied, references to climate issues were found in the documentation analysed.

Figure 12. Climate change references in sovereign debt management documents of EU member states



Source: own elaboration based on documents of EU government debt management institutions (websites)

In contrast, 13 countries lacked any reference to the issue under study. In four countries, all three words could be found, most often involving information on both the country's climate strategy ("climate"), the issuance of green bonds in the country ("green"), and the climate targets set or the organisation of a carbon market ("carbon"). This means that in some EU countries, debt managers provide narrower or broader information aimed primarily at market investors and a wider range of users.

In the next part, the analysis concerns possible changes related to the narrow approach to sovereign climate debt management in terms of the adopted strategy objectives, tasks, risk management, institutional foundations, debt instruments and markets as well as Investor Relations reporting and presenting. The results of the study we carried out are summarised below (Table 2).

Table 2. Sovereign debt management – actual and proposed approaches

Features	Actual approach	Actual experience based on new approach	Proposed approach
SDM objectives	Financing of budget borrowing needs Debt cost minimizing Medium and long term strategy Prudent risk management	None	Financing cost of climate change included
SDM tasks	Market-based debt management Liquidity management Contingent liabilities management* Sovereign assets management*	Carbon market settlements (France) Carbon fund management (Ireland)	Sovereign climate assets and liabilities
SDM risk management	Refinancing risk Market risk Credit risk Liquidity risk Operational risk	Climate risk (Ireland)	Climate risk assessment and management
SDM instruments	T-bonds and bills Loans State guarantees* State fund management*	Green Bonds (Poland, France, Belgium, Ireland, Lithuania, the Netherlands, Germany, Hungary, Sweden, Italy)	Green bonds Carbon fund Other financial operations
Institutional background**	Ministerial model Agency model Central bank model	SDM agency (Ireland, France)	Sovereign agency for the broader debt (liabilities) management
Debt market organization	Auctions Syndications On-tap Private placement	Carbon fund investment (Ireland) EU-ETS auction settlement (France)	Carbon auctions Climate assets investments
Investor Relations and reporting	Annual and periodical reports Investor Relation presentation on sovereign debt portfolio	Carbon Fund Report (Ireland) Green bond report (Netherlands) Green Bond Investor presentation (Italy)	Detailed information on climate debt management, also based on e.g. the EU Sustainable Finance Taxonomy

** separate countries*

*** details in Appendix*

Source: own elaboration based on documents of EU government debt management institutions (websites)

The present analysis has led to the following conclusions about current experience across EU member states:

- no country has yet changed its debt management objectives, focusing mainly on financial objectives,
- the remit of debt managers is beginning to shift towards the carbon market and carbon fund management,
- some debt managers are introducing climate risk into their sovereign risk management,
- the predominant instrument of climate debt management is green bonds, whose issuing procedures (Table 3) (at present, ten EU member states are issuing this type of bonds) and financing of climate needs are slowly being adapted by member states to EU taxonomy,
- one of the new tasks in climate debt management are being transferred to sovereign debt management agencies,
- the new tasks entail the participation of debt managers in new procedures, including the auctioning of CO_2 emission rights,
- some debt managers include information on climate policy and climate liabilities in official documents published on websites and in presentations given directly to investors.

Table 3. Green bonds issued by sovereign debt management institution in EU member states

Member state	Term of first issue	Number of issues	Cumulative amount (EUR in millions)	Max maturity (in years)
Poland	2016	3	3.7	30
France	2017	1	27	22
Belgium	2018	1	5.7	15
Ireland	2018	2	5	12
Lithuania	2018	1	0.07	10
Netherlands	2019	1	12	20
Germany	2020	2	11.5	10
Hungary	2020	1	1.5	15
Sweden	2020	2	8.3	10
Italy	2021	1	8.5	24

Source: own elaboration based on documents of EU sovereign debt management institutions (websites, access 30.06.2021)

In the last column of Table 2, we propose several directions of change, which can be the basis for the formulation of a new, complementary approach to sovereign debt management in view of the inclusion of climate debt in the tasks of debt managers. This direction should be considered legitimate in reference to previously presented climate liabilities scenarios. A comprehensive approach to the tasks related to government overall liabilities and ensuring their financing and refinancing should be taken as a necessary change. The market nature of many instruments for financing carbon liabilities directly by sovereigns requires a professional approach, which can be guaranteed by market-based debt portfolio managers.

Because of the lack of common guidelines, we propose to expand the scope of debt management objectives to include a broader goal of minimising the costs associated with CO_2 emissions, to include

climate risk in the assessment of risks of the entire public debt portfolio, to introduce new tasks associated with the service of carbon funds, which involves the use of the balance sheet approach, to introduce new climate financial instruments, to concentrate management tasks in the scope of established Treasury debt management agencies, which will ensure professionalism and transparency. The additional focus should be also put on the communication within Investor Relations regarding sovereign climate debt management and the tasks performed by public authorities in this field.

5. Conclusions

Reducing CO_2 emissions and climate debt will play an increasingly important role in determining the future activities, strategies and policies of various market players and institutions, ranging from public authorities to financial institutions and businesses. The analytical framework we develop in this paper focuses on the interplay between climate change and the process of sovereign debt management. However, the broader picture towards achieving a zero-carbon economy is very complex, multifaceted and it intertwines the responsibilities and implications of all major parts: governments, the financial industry and the business sector. For instance, Umar et al. (2021) explain that the development of a green financial intermediation channel is imperative to achieve the status of carbon neutral economies, while Wang et al. (2020) have empirically found out that financial development, in its traditional form, fuels the carbon emissions and hence causes adverse climatic consequences.

A number of legislative changes in this field, both at the European and national level, will be a major criterion for scrutiny. However, the increasingly emerging real effects of climate change will additionally determine not only the assessment of financial, but also social and economic, consequences of the climate policy implemented by the government.

In the European Green Deal, the European Commission estimated that additional investments of €260 billion per year, or about 1.5% of 2018 GDP (EC, 2019) will be required to meet the set climate targets by 2030. During the conference COP26 in Glasgow the public financial priority is to achieve and surpass the $100bn a year goal by developed countries (COP26 Presidency, 2021). A part of these funds will have to be provided from the public finance. Therefore, it will be of utmost importance to diversify the internal (public budget) and external (financial market) funding sources dedicated to green and sustainable investments.

As the article points out, investors themselves, lenders and rating agencies are also increasingly concerned about climate risk and its consequences for borrowers (including the Treasury). In view of the above research, undertaking strategic changes in individual EU member states in sovereign debt and climate debt management seems to be a necessity and a matter of the nearest future.

APPENDIX 1. CLIMATE CHANGE REFERENCES IN SOVEREIGN DEBT MANAGEMENT DOCUMENTS – DETAILED INFORMATION

EU country	Institution	2019/2020 Annual Report	2020/2021 PDM strategy/ funding plan	Investor Relations – information for investors
Austria	OeBFA - Austrian Treasury	R	NR	NR
Belgium	Belgian Debt Agency	R	R	R
Bulgaria	Bulgarian National Bank	NR	NR	NR
Croatia	Ministry of Finance, Department for Public debt Management	NR	NR	NR
Cyprus	Ministry of Finance (Public Debt Management Office)	NR	NR	NR
Czech Republic	Ministry of Finance (Debt Management Office)	NR	NR	NR
Denmark	Danmarks Nationalbank (Government Debt Management)	R	R	R
Estonia	Ministry of Finance of Estonia (State Treasury Department)	NR	NR	R
Finland	Finnish State Treasury	NR	NR	NR
France	Agence France Trésor	R	R	NR
Germany	German Finance Agency	NR	R	R
Greece	Public Debt Management Agency	R	NR	NR
Hungary	Government Debt Management Agency Pte.	NR	R	R
Ireland	National Treasury Management Agency	R	R	R
Italy	Treasury Debt Management	NR	R	R
Latvia	The Treasury of the Republic of Latvia	NR	NR	NR
Lithuania	Ministry of Finance (State Treasury Department)	NR	NR	NR
Luxembourg	Ministry of Finance	NR	NR	NR
Malta	Debt Management Office (Treasury Department)	NR	NR	NR
Netherlands	Ministry of Finance	R	R	NR
Poland	Ministry of Finance (Public Debt Department)	R	R	NR
Portugal	Portuguese Treasury and Debt Management Agency	NR	NR	R
Romania	General Department of Treasury and Public Debt	NR	NR	NR
Slovakia	Debt Management Agency (ARDAL)	NR	NR	NR
Slovenia	Ministry of Finance	NR	NR	NR
Spain	Treasury and Financial Policy General Directorate	NR	NR	NR
Sweden	Swedish National Debt Office	NR	R	NR

R - Reference; NR - No reference
Source: own elaboration based on information from the electronic documents published on the websites

APPENDIX 2.CLIMATE DEBT-TO-GDP RATIO (%) - COMPUTATION BASED ON THE NGFS' SCENARIO-BASED PROJECTIONS

Country	Orderly scenarios												
	Below 2° C scenario							Net zero 2050 scenario					
	2025	2030	2035	2040	2045	2050		2025	2030	2035	2040	2045	2050
Austria	0,42	0,24	0,15	0,06	0	0		1,42	0,48	0	0	0	0
Belgium	0,94	0,82	0,66	0,37	0,17	0,05		3,06	2,08	0,66	0	0	0
Bulgaria	na	0	0	0	0	0		na	0	0	0	0	0
Croatia	na	0	0	0	0	0		na	0	0	0	0	0
Cyprus	na	na	na	na	na	na		na	na	na	0	0	0
Czech Rep.	0,51	0	0	0	0	0		1,38	0	0	0	0	0
Denmark	0,47	0,37	0,25	0,15	0,05	0,002		1,52	0,64	0,02	0	0	0
Estonia	1,74	1,69	1,41	1,06	0,75	0,52		5,71	5,01	4,12	3,33	2,83	1,58
Finland	1,51	1,67	1,43	1,07	0,72	0,43		4,7	4,81	3,57	1,88	0,57	0
France	0	0	0	0	0	0		0,25	0	0	0	0	0
Germany	0,63	0,32	0,09	0	0	0		1,86	0,09	0	0	0	0
Greece	1,15	1,07	0,99	0,65	0,35	0,17		3,45	3,11	1,46	0	0	0
Hungary	1,34	1,25	1,18	0,88	0,51	0,28		4,38	3,99	2,51	0	0	0
Ireland	0,31	0,2	0,18	0,13	0,07	0,04		1,28	0,65	0,33	0	0	0
Italy	0,54	0,37	0,24	0,02	0	0		1,67	0,27	0	0	0	0
Latvia	0	0	0	0	0	0		0	0	0	0	0	0
Lithuania	1,2	1,12	0,74	0,37	0,05	0		3,52	2,12	0,03	0	0	0
Luxemb.	0,67	0,46	0,22	0,06	0,03	0,02		1,91	1,07	0,37	0	0	0
Malta	na	na	na	na	na	na		na	na	na	0	0	0
Nether.	0,8	0,76	0,56	0,35	0,23	0,16		2,28	1,81	0,94	0	0	0
Poland	0,88	0,57	0,21	0	0	0		3,01	0,29	0	0	0	0
Portugal	0,91	0,75	0,8	0,73	0,55	0,31		2,83	2,8	2,23	0	0	0
Romania	0	0	0	0	0	0		0	0	0	0	0	0
Slovakia	0,5	0,21	0	0	0	0		1,35	0	0	0	0	0
Slovenia	0	0	0	0	0	0		0	0	0	0	0	0
Spain	0,24	0	0	0	0	0		0,81	0	0	0	0	0
Sweden	0,29	0,2	0,1	0,02	0	0		0,99	0,1	0	0	0	0
Descriptive statistics													
min	0	0	0	0	0	0		0	0	0	0	0	0
max	1,74	1,69	1,43	1,07	0,75	0,52		5,71	5,01	4,12	3,33	2,83	1,58
average	0,67	0,49	0,38	0,24	0,14	0,08		2,06	1,17	0,65	0,19	0,13	0,06
st. dev.	0,51	0,54	0,48	0,36	0,24	0,15		1,56	1,6	1,19	0,72	0,55	0,3

Country	Disorderly scenarios												
	Divergent net zero scenario							Delayed transition scenario					
	2025	2030	2035	2040	2045	2050		2025	2030	2035	2040	2045	2050
Austria	2,35	0,76	0	0	0	0		0,31	0,18	0,54	0	0	0
Belgium	4,81	2,98	1,39	0,15	0	0		0,47	0,34	2,73	0,31	0	0
Bulgaria	na	0	0	0	0	0		na	na	0	0	0	0
Croatia	na	0	0	0	0	0		na	na	0	0	0	0
Cyprus	na	na	na	na	0	0		na	na	na	0	0	0
Czech Rep.	2,28	0	0	0	0	0		0,71	0,48	0	0	0	0
Denmark	2,57	0,92	0,29	0	0	0		0,28	0,22	0,88	0	0	0
Estonia	8,87	7,22	5,94	4,21	3,4	2,54		0,53	0,47	5,56	4,55	4,14	2,77
Finland	7,12	7,29	6,22	4,38	3,36	2,35		0,37	0,41	5,69	4,47	2,23	0
France	0,9	0	0	0	0	0		0,3	0,15	0	0	0	0
Germany	2,93	0,01	0	0	0	0		0,44	0,35	0,72	0	0	0
Greece	5,06	4,43	2,37	0,64	0,03	0		0,52	0,38	3,61	0,68	0	0
Hungary	6,76	5,98	4,12	1,88	1,1	0,67		0,46	0,37	4,46	1,48	0	0
Ireland	2,36	0,94	0,51	0,11	0,02	0		0,12	0,05	0,46	0,06	0	0
Italy	2,63	0,39	0	0	0	0		0,41	0,29	1,01	0	0	0
Latvia	0	0	0	0	0	0		0,92	0,11	0	0	0	0
Lithuania	5,1	2,83	0,41	0	0	0		0,61	0,54	3,39	0	0	0
Luxemb.	2,73	1,48	0,57	0,07	0,05	0,03		0,3	0,21	0,84	0,13	0,03	0
Malta	na	na	na	na	na	na		na	na	na	na	0	0
Nether.	3,18	2,57	1,4	0,5	0,14	0,01		0,37	0,28	2,38	0,53	0	0
Poland	5	0,34	0	0	0	0		0,63	0,43	1,02	0	0	0
Portugal	4,23	4,1	3,79	1,94	1,06	0,53		0,31	0,17	2,64	1,29	0	0
Romania	0	0	0	0	0	0		na	0	0	0	0	0
Slovakia	2,05	0	0	0	0	0		0,52	0,35	0	0	0	0
Slovenia	0	0	0	0	0	0		0,52	0,18	0	0	0	0
Spain	1,49	0	0	0	0	0		0,32	0,13	0	0	0	0
Sweden	1,64	0,17	0	0	0	0		0,2	0,14	0,36	0	0	0
Descriptive statistics													
min	0	0	0	0	0	0		0,12	0	0	0	0	0
max	8,87	7,29	6,22	4,38	3,4	2,54		0,92	0,54	5,69	4,55	4,14	2,77
average	3,22	1,7	1,08	0,56	0,35	0,24		0,44	0,27	1,45	0,52	0,24	0,1
st. dev.	2,34	2,36	1,9	1,24	0,94	0,67		0,18	0,15	1,82	1,24	0,89	0,53

Source: own elaboration

Country	Hot house world scenarios												
	Current policies scenario							Nationally Determined Contributions (NDCs) scenario					
	2025	2030	2035	2040	2045	2050		2025	2030	2035	2040	2045	2050
Austria	0,31	0,18	0,12	0,08	0,06	0,05		0,83	0,72	0,45	0,26	0,08	0,01
Belgium	0,47	0,34	0,27	0,2	0,15	0,12		1,47	1,54	0,99	0,56	0,26	0,1
Bulgaria	na	na	na	na	na	na		na	na	0	0	0	0
Croatia	na	na	na	na	na	na		na	na	na	na	na	na
Cyprus	na	na	na	na	na	na		na	na	na	na	na	na
Czech Rep.	0,71	0,47	0,24	0,11	0,04	0,03		1,37	0,57	0	0	0	0
Denmark	0,28	0,23	0,17	0,12	0,08	0,058		0,77	0,69	0,4	0,24	0,1	0,04
Estonia	0,53	0,47	0,4	0,32	0,23	0,16		2,04	2,14	1,48	0,97	0,54	0,29
Finland	0,37	0,41	0,4	0,34	0,26	0,19		1,69	2,01	1,41	0,89	0,43	0,15
France	0,3	0,15	0,06	0,01	0	0,01		0,54	0,16	0	0	0	0
Germany	0,44	0,35	0,24	0,15	0,09	0,05		1,14	0,74	0,29	0,1	0	0
Greece	0,52	0,38	0,32	0,27	0,22	0,18		1,71	1,89	1,39	0,86	0,43	0,21
Hungary	0,46	0,37	0,32	0,27	0,22	0,16		1,79	1,97	1,57	0,96	0,47	0,22
Ireland	0,12	0,05	0,04	0,03	0,02	0,02		0,39	0,26	0,22	0,16	0,1	0,05
Italy	0,41	0,29	0,21	0,15	0,12	0,1		1,09	1,06	0,56	0,3	0,11	0,04
Latvia	0,92	0,11	0	0	0	0		0	0	0	0	0	0
Lithuania	0,62	0,54	0,43	0,3	0,19	0,141749		1,96	2,05	1,2	0,67	0,26	0,11
Luxemb.	0,3	0,21	0,11	0,04	0,03	0,02		0,98	0,76	0,3	0,08	0,04	0,02
Malta	na	na	na	na	na	na		na	na	na	na	na	na
Nether.	0,37	0,28	0,23	0,18	0,14	0,1		1,16	1,29	0,77	0,47	0,28	0,18
Poland	0,63	0,43	0,31	0,23	0,13	0,1		1,7	1,38	0,63	0,27	0,04	0
Portugal	0,31	0,17	0,16	0,14	0,11	0,09		1,19	1,17	1,05	0,82	0,52	0,26
Romania	na	0	0	0	0	0		0	0	0	0	0	0
Slovakia	0,52	0,35	0,21	0,12	0	0,04		1,2	0,91	0,34	0,11	0	0
Slovenia	0,53	0,18	0	0	0	0		0,18	0	0	0	0	0
Spain	0,32	0,13	0,07	0,03	0,02	0,03		0,7	0,38	0,27	0,24	0,13	0,04
Sweden	0,2	0,14	0,1	0,07	0,05	0,04		0,56	0,52	0,26	0,13	0,03	0
Descriptive statistics													
min	0,12	0	0	0	0	0		0	0	0	0	0	0
max	0,92	0,54	0,43	0,34	0,26	0,19		2,04	2,14	1,57	0,97	0,54	0,29
average	0,44	0,28	0,19	0,14	0,1	0,08		1,06	0,96	0,57	0,34	0,16	0,07
st. dev.	0,18	0,15	0,14	0,11	0,09	0,06		0,61	0,71	0,53	0,34	0,19	0,09

Source: own elaboration

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The Impacts of Disaster Risk on Sovereign Asset and Liability Management

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Abstract

Applying the Sovereign Asset and Liability Management (SALM) framework is a new and comprehensive way of looking at the potential impact of a disaster on public assets and liabilities. Its implementation can help build key practical recommendations for understanding risk in its multiple dimensions (economic, fiscal, financial). This paper introduces a theoretical framework to understand the potential impact of natural disasters on countries' economy and public finances. To evaluate this impact, existing alternatives for modeling and stress testing and the challenges that arise from lack of data are discussed. The theoretical framework is applied in three case studies, Peru, Serbia and New Zealand to derive lessons about the potential impact of natural disasters on the sovereign balance sheet and highlight the importance of accounting for disaster impacts across public sector balance sheets. The case studies demonstrate that estimating the potential impact of disasters on the national economy and the sovereign balance sheet is complex requiring significant data and modeling. However, they demonstrate that viable mechanisms to assist timely post disaster response and reconstruction can have very high payoffs, especially when assisted by an appropriate SALM framework, moreover, that the lack of these may be very costly.

JEL codes: H12, H30, H68, H81, H83, H84

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ABBREVIATIONS

ALM	Asset Liability Management
ARCC	Authority for the Reconstruction with Changes (Peru)
CERA	Canterbury Earthquake Recovery Authority
CERF	Canterbury Earthquake Recovery Fund
DRFI	Disaster risk financing and insurance
DSGE	Dynamic stochastic general equilibrium
EQC	Earthquake Commission (New Zealand)
FEF	Stabilization Fund (Peru)
GDP	Gross domestic product
GIMF	Global Integrated Monetary and Fiscal Model
GST	Goods and services tax
IMF	International Monetary Fund
LTGM	Long-Term Growth Model
MEF	Ministry of Economy and Finance (Peru)
MFMod	Macro-Fiscal Model
NDF	Natural Disaster Fund (New Zealand)
OCR	Official cash rate
SALM	Sovereign asset and liability management
SOE	State-owned enterprise

1. Introduction

When sovereign disaster risk financing and insurance (DRFI) is limited or absent, governments act as insurer of last resort, and as such carry much of the financial burden of natural disasters. Consequently, the impacts posed by disaster risk can result in fiscal pressure which suggests that disasters could, and perhaps should, be considered contingent liabilities. In the event of a disaster, governments tend to rely on increased borrowing, increased taxation, or—most likely—budget reallocation, in which budgeted lines of public spending are reduced to release resources for the unbudgeted post-disaster categories that need to be increased. There is a growing body of literature on the need for pre-arranged finance to help manage these unforeseen expenditures, but there is a sizeable gap on the public financial management issues associated with this. By applying the Sovereign Asset and Liabilities Management (SALM) approach a new and comprehensive way of looking at the impacts of disasters on public assets and liabilities is presented. This can serve as a useful tool to design disaster risk finance policies to help create additional fiscal space when needed.

It is useful at the outset of this paper to distinguish between the impacts of natural disasters and climate change on government balance sheets. Natural disasters are probabilistic events, the risk of which can be transferred to insurance markets. For governments, natural disasters represent a fiscal risk or shock. By contrast, the impacts of climate change occur gradually over longer time periods. From a fiscal standpoint, climate change leads to fiscal pressure, as opposed to shocks, though it may increase the frequency or severity of shocks. This paper focuses on the problems posed by disaster shocks, setting aside the trend problems posed by climate change.

Implicit contingent liabilities, such as those generated by natural disasters, are often not quantified in the government balance sheet. However, when they materialize, they place pressure on government finances that may raise interest expenditures and financial risks. Understanding the impacts of disaster risk on sovereign assets and liabilities plays a key part in understanding the potential impact of sovereign DRFI strategies which can allow governments to reduce the costs of disasters using prearranged financing and insurance methods. When governments understand the impacts from natural disasters including the increased risks posed by climate change, for example, they can link their debt and cash management strategies with their DRFI strategy by taking into account the country's risk profile.

When the impacts of disasters on balance sheets is unknown it is difficult to approach disaster risk comprehensively and to make adequate financial decisions on how to protect and restore public assets with finite public funds. Traditionally, many governments have treated the management of their assets and liabilities separately, usually with separate institutional responsibilities for different classes of assets and for different classes of liabilities. Taking no account of net positions, this approach can lead to inefficient management of risk and inefficient implementation of policy more generally.

The main objective of the SALM approach is to develop a comprehensive public sector balance sheet, and to use this to develop a coordinated management strategy that reflects government's various objectives.[1] An example of how this issue might be tackled is offered by Amante et al. (2019); they provide an overview of the strategic, operational, and institutional challenges involved, using Uruguay as an illustration.

In practice, even when governments set out to implement SALM, it has proved to be challenging, and the implementation has usually been partial in nature. It is often restricted to financial assets and

[1] For an extended discussion, see for example Das et al. (2012) and IMF (2018a).

liabilities and does not include physical assets (such as infrastructure) or the government's future revenue-generating capabilities.

This paper will serve to build the body of evidence on the impacts of disaster risk on SALM and, in turn, support countries' efforts to mitigate the impact and occurrence of fiscal shocks. It seeks to increase countries' resilience to financial shocks from disaster risk through improved understanding of the impacts of disaster risk on both sides of the sovereign balance sheet.

2. Public sector balance sheets and SALM

There has been growing awareness that the analysis of public sector (sovereign) balance sheets provides a valuable tool to improve the implementation of fiscal policy and management of public sector assets. For example, the International Monetary Fund (IMF 2018a) notes that standard fiscal analysis misses much government activity by focusing on flows—revenue, expenditure, and deficits—and debt. Furthermore, it can encourage illusory fiscal practices, such as establishing pay-as-you-go pension schemes for public employees, which may improve fiscal balance outcomes in the short run, but lead to an expanding liability that is not recognized in traditional fiscal measures.

An approach that takes account of the full public sector balance sheet can improve outcomes in a number of ways. First, by revealing the full extent of public sector assets, it shines a light on how effectively these are being managed. And they are large: an IMF (2018a) analysis of 31 countries covering 61 percent of the global economy estimates they are worth US$101 trillion, or 219 percent of gross domestic product (GDP) in the sample. Even modest improvements in the return on these assets could yield significant fiscal benefits.

A second improvement to outcomes involves improved fiscal policy making. The balance sheet approach supports a more thorough and systematic evaluation of the impact of policies on public finances, recognizing the effects on both assets and liabilities in the long run.

The overall strength of a balance sheet, i.e., the level of net worth, can also support fiscal decision making. Research has shown that countries with stronger public sector balance sheets experience shallower recessions and recover faster from economic downturns (Yousefi 2019). This can be explained by there being more room for countercyclical fiscal policy when net worth is high than when it is low or negative.

The third improvement is in the identification and management of financial and other risks. Examining both sides of the public sector balance sheet—which is a consolidation of central government and other entities—may reveal mismatches. Or it may show natural hedges across assets and liabilities in separate entities, reducing the need for risk management at the level of an individual entity. An example of a natural hedge would be where the public sector has foreign currency debt and foreign currency financial assets; the exposure to changes in exchange rates would be the net value of these positions. The currency mix of these assets and liabilities can be adjusted to minimize the exposure to individual foreign currencies.

Activity in this third area entails a SALM approach, which is based on the asset liability management (ALM) approach undertaken in the private sector, in particular by financial institutions, with the goal of maximizing return subject to an acceptable level of financial risk (such as currency, interest rate, and liquidity risks). The application of ALM to the public sector balance sheets has been a fairly recent development, perhaps reflecting the lack of information in most countries about the assets and liabilities

that make up their balance sheet. The New Zealand government was an early adopter of SALM, as it published its first balance sheet in 1991 and applied ALM principles during the 1990s to guide the composition of public debt (Anderson 1999).

In applying the ALM approach to public sector balance sheets, SALM needs to reflect the unique nature of governments. The strength of a government's balance sheet (and indeed the government's creditworthiness) arises from the sovereign power to tax residents and citizens. At the same time, a significant share of public sector assets does not directly produce revenue, for example national parks, cultural assets, and military equipment. This observation has led some authors and practitioners to include the present value of government expenditure and revenues in SALM.

In practice, the application of SALM has been to subsets of public sector assets and liabilities that are financial in nature and of material size, such as public debt, foreign currency reserves, and other financial asset portfolios. Amante et al. (2019) describe four situations, each with a number of country examples: (i) coordinated management of foreign currency reserves and foreign currency debt; (ii) management of asset levels to provide a buffer against adverse market conditions; (iii) transactions between the central bank and government that strengthen policy outcomes, reduce cost, and reduce risk; and (iv) analysis of the variables that drive government revenues and the fiscal balance to inform decisions about the composition of public debt. In addition, IMF (2018a) provides examples of using the balance sheet framework to conduct stress tests of fiscal sustainability.

One practical constraint in implementing SALM may be a lack of information. Unlike advanced economies (e.g., New Zealand, Australia, the United States, Canada), developing countries in general do not produce comprehensive balance sheets, which would require them to consolidate individual balance sheets of various public institutions. Many countries lack a complete inventory of nonfinancial assets. Furthermore, consistent pricing of financial and nonfinancial assets is complicated, since different accounting principles, accrual based or cash based budgeting, may be used. Producing a balance sheet based on accrual accounting is important to ensure that policy makers can assess and monitor effectively the mismatches between stocks of assets and liabilities.

There are also institutional and policy complexities in implementing SALM, as the public sector balance sheet is managed by separate entities to deliver a range of policy outcomes. Further, some of these entities have constitutional, statutory, or policy independence. For example, the assets and liabilities of a central bank accumulate in order to implement monetary policy and other objectives; often central banks are granted independence to pursue these. The governance of publicly managed financial asset portfolios (such as sovereign wealth funds, pension funds, and insurance companies) tends to emphasize granting boards and fund managers independence to pursue agreed objectives. This arrangement is designed to address historic underperformance, for example from a lack of contestability, imposition of noncommercial objectives, and political interference in asset allocation. However, most countries include state-owned enterprises in the sovereign balance sheet, but only a minority also consider central banks, in some cases only international reserves and sovereign funds (World Bank, 2018). In the cases where a SALM framework is implemented, there are significant differences across countries. A survey of 28 countries found that the objective of countries who have developed a SALM framework is often limited to monitoring sovereign assets and liabilities rather than determining mismatches between them.

3. How natural disasters impact sovereign balance sheets

A natural disaster will impact the public sector balance sheet through three channels:

1. *Impact on the value of public sector assets and liabilities. For example:*

   Loss of or damage to publicly owned infrastructure and buildings. For this loss or damage to be recognized, the value of these assets prior to the disaster needs to have been recorded. (The valuations would reflect the age and condition of the assets—i.e., they would be depreciated accordingly.)

   Changes in market variables (such as exchange rates and interest rates)—for example, an increase in the value of foreign currency public debt if the disaster triggers exchange rate depreciation.

2. *Direct fiscal costs.* These are the actual costs incurred as a result of the disaster. Examples include disaster relief and other financial support to citizens, cost to rebuild infrastructure, and triggering of contingent liabilities, such as loan guarantees to state-owned enterprises (SOEs) or subnational governments that are badly impacted by the disaster. The impact on the balance sheet will depend on the nature of the expenditure. Capital expenditure results in the creation of an asset, which increases net worth; if such expenditure is funded by debt, then the impact on net worth is neutral (the value of the debt and the new asset are equal initially). Operating expenses related to the disaster, such as grants and other assistance, would result in more borrowing than otherwise would have been the case, thereby decreasing net worth.

3. *Indirect fiscal costs.* These are the costs incurred by the disaster's impact on government revenue and (non-disaster) expenditure, which arise from the disaster's impact on the national economy.

Figure 1 provides a summary of these impacts on the public sector balance sheet, as well as the analysis that is required to estimate the size of them. The availability of data on disaster risks and the assets exposed to perils will be a challenge in many countries. In particular, there will be a need for data on public sector assets, including infrastructure. Estimating the economic impact of disasters, and therefore the indirect fiscal costs, is also challenging.[2]

The impact on SALM could arise through:

Rapid depletion of government contingency funds and cash balances, increasing the liquidity risk faced by central government.

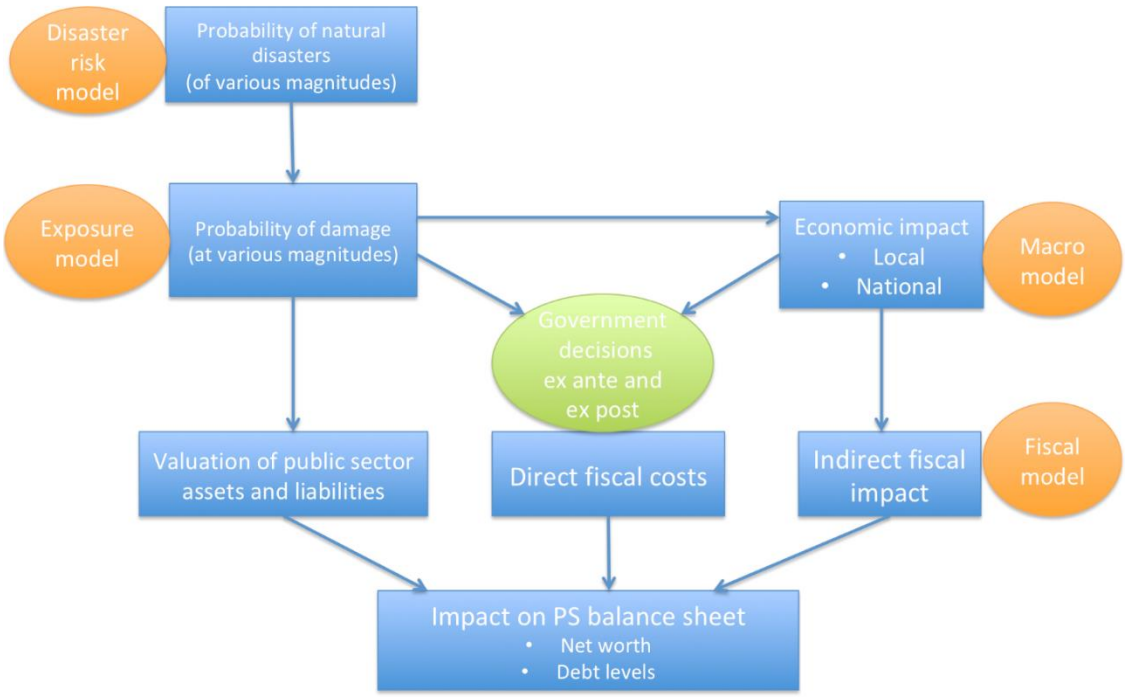
Additional borrowing by the government may be required to meet the fiscal costs that cannot be fully financed in the local market, meaning that the government is forced to borrow externally. This may lead to increased currency risk in the debt portfolio, and interest rate risks in case debt is contracted at variable rates. In addition, a government that is limited to short-term borrowing from local markets would see increased refinancing risks.

The magnitude of these impacts can be mitigated by measures taken by the government before disaster strikes, and as a result many Ministries of Finance now view financial resilience as a core component of macro-fiscal policy. This formed a key discussion during the G20 Finance Ministers' and Central Bank Governors' Meeting in 2019. The discussion highlighted that a growing number of countries are developing financial protection strategies leveraging different financial instruments (such as contingency funds and risk transfer mechanisms such as catastrophe risk insurance, catastrophe bonds

[2] Wouter Botzen, Deschenes, and Sanders (2019) provide a useful stocktake of models and empirical studies and note shortfalls in existing approaches, particularly in relation to geographical and spatial detail.

etc.) to secure timely and efficient access to funds for governments to respond to shocks (World Bank, 2019). More generally, the availability of "fiscal space" through prudent debt levels, as well as careful management of risks in the debt portfolio, can provide a buffer for natural disasters as well as other shocks.

Figure 1: Framework for impacts of disasters on the public sector balance sheet



Source: World Bank
Note: PS = public sector

4. Current state of knowledge on the impact of natural disasters on public finances

There is a vast literature on the financial impacts of natural disasters and on SALM, although there is limited information on the interrelationships of the two. This section presents a sample of the empirical literature that addresses considerations of balance sheet management following a natural disaster and the impacts on the broader macrofiscal context.

In the past, the idea of any relationship between macrofiscal risk and disaster risk was often dismissed. However, with the emergence of sustainable finance, the literature on these links is increasing. Feyen et al. (2020) discuss the implications of disaster risk posed by climate change for balance sheet and macrofinancial management. They find that the two forms of risk may be correlated, so that many countries face a form of "double jeopardy." Two studies published by the World Bank go further, examining how resilience might be increased by appropriate fiscal policy (Forni, Catalano, and Pezzolla 2019) and how the fiscal risks associated with natural disasters might be managed (Schuler et al. 2019). These studies show that early, preventive action to address disaster risk —for example, ensuring that public spending in risk reduction (or adaptation) is complemented with public debt reduction, or the

accumulation of savings in a reserve fund—is always superior to late, remedial action. Investing in adaptation increases the resilience of the capital stock, while containing or reducing the debt burden improves financial sustainability and eases future borrowing constraints.

In trying to build an understanding of natural disasters' impact on public expenditures, and how this impact might be valued, Bevan and Cook (2015) make some suggestions toward developing an operational framework to address these issues, while stressing that the available evidence is extremely incomplete. They also provide a demonstration of the problems with the Cobb-Douglas assumption and show that outcomes may be very different if the assumption of complementarity between public and private capital is made instead. To identify the budgetary savings required to create fiscal buffers for self-insurance, Nishizawa, Roger, and Zhang (2019) use estimates of revenue loss and increased spending pressures from disasters combined with information on frequency; they find an average annual fiscal cost of 1–1.5 percent of GDP for an event that occurs approximately every 14 years. This cost would then need to be financed by the budget and additional financial instruments, including external borrowing, to meet the associated costs of the disaster.

Many governments have moved toward proactive risk management and seek to prearrange financial instruments so that finance can be released immediately after a disaster. IMF (2019a), which examines ways of building resilience to large natural disasters, proposes a three-pillar strategy emphasizing in turn structural, financial, and post-disaster resilience, and then goes on to outline a framework for coordinated action. Many favor a tiered approach, with different instruments being utilized in sequence as shocks increase in severity. When combining instruments, prearranged financing is key, whether this finance is domestic or from the international donor community. Both Cantelmo, Melina, and Papageorgiou (2019) and Marto, Papageorgiou, and Kluyev (2018) find that it is more cost-effective for donors to contribute to the financing of resilience before a disaster than to disburse aid afterward. They also find, however, that welfare gains to countries that self-finance investments in resilient public infrastructure are negligible, and international aid must be sizable to alter this.

The concept of public balance sheet strength was introduced by Yousefi (2019), whose empirical work suggests that financial markets take into account government assets and net worth in addition to their liabilities when pricing sovereign bonds. Moreover, given that countries with a strong balance sheet recover faster in the aftermath of shocks, they have incentives to improve their financial resilience in addition to their handling of SALM.

5. Preparedness: what countries can do to understand the potential impact of natural disasters on the sovereign balance sheet

This section canvases the issues relevant to this question, in particular the alternatives for modeling and stress testing and the challenges that arise from lack of data.

5.1 Modeling issues

It is clear that natural disasters have impacts on the real economy and have fiscal and financing implications. To examine these thoroughly would require a pretty comprehensive modeling approach, or more plausibly several complementary approaches. The reason for the latter is that different aspects of the analysis require quite varied features, including a disaggregated model of the real economy, capable of addressing structural issues as well as fiscal interactions with these; a model capable of tracking financial links with the macroeconomy; and a model capable of addressing public and private

responses, ex ante and ex post, to a set of surprises and other matters requiring revision of expectations in a stochastic world. The economics profession simply has not developed an integrated model capable of handling all this; it will not do so any time soon, and perhaps should not attempt to do so.

The current study does not aim to develop purpose-designed models, so it will have to use what is currently available, from two sources. The first is whatever set of models is currently being utilized in a case study country. This may include computable general equilibrium (CGE) models utilizing input-output information and social accounting matrixes, econometric models, and dynamic stochastic general equilibrium (DSGE) models, among others. These models are usually located in different institutions (for the above trio, typically in academic institutions, the ministry of finance, and the central bank respectively); accessing the full set may therefore be complicated. The other source involves adaptation of one or more of the "generic" models that have been developed by international agencies, suitably adapted and calibrated to the country in question.

5.2 Risk analysis and stress testing

There is now a substantial literature on the analysis of risk and the development of appropriate scenarios within which to conduct stress tests. Much of the focus has been on financial risks (e.g., Adrian, Morsink, and Schumacher 2020), but attention has more recently been devoted to fiscal risks, as in the approach to fiscal risk analysis and management developed by IMF (2016). This methodology looks at the impact of shocks on fiscal flows and balance sheet aggregates, including fiscal solvency, government liquidity, and the government financing burden.

As regards debt, the World Bank and IMF framework for debt sustainability analysis has been upgraded recently; it now takes a much more systematic approach to incorporating risk into the analysis and pays greater attention to country specifics. In particular, it recommends deeper and more extensive analysis for countries that appear to be in most danger of debt sustainability problems (IMF 2013). The new debt sustainability analysis framework for low-income countries, implemented in July 2018, includes stress scenarios for natural disasters (IMF 2018b).

In the present context, developing appropriate scenarios is particularly difficult. Much of the existing work on natural disasters postulates that the economy starts in an unshocked steady state (or more often, some balanced growth path) and is then hit by a shock of some severity early in the simulation, with no further shocks occurring within the simulation horizon. The exercise can then be repeated for single shocks of different magnitudes, and the implications of different combinations of financing instruments (ex post and ex ante) can be examined over the recovery period. In forward-looking models, it is assumed that the shock was unanticipated but that perfect foresight then prevails. While convenient and tractable, these assumptions are hardly plausible. The economy's initial state is likely to be characterized by an awareness that there is some probability distribution of future shocks, and it may already be in recovery from an earlier shock. Also, suffering one shock does not preclude further shocks within the simulation horizon.

5.3 Data issues

Problems of inadequate data loom large in the present context. Two aspects of this problem are the paucity of information about very rare events, and the lack of information about an uncertain future evolution, exacerbated by climate change. There are also the familiar issues of incomplete information about production relationships, and about the relationship between economic observables and population well-being. The discussion here, however, focuses on data problems specific to the public sector.

On the side of public expenditure, the main problem is one of tracking relevant changes, both in composition and in levels. In many countries, there is a mismatch between what is budgeted and what gets spent, even in the absence of major shocks. This may reflect technical implementation problems, a lack of proper budgetary controls, or a political imbalance where some spending departments are raided by other more powerful ones. This means that, post-shock, it may not be possible to infer reallocations by comparing outcomes with budget.

On the side of revenue, there is the problem of gauging to what extent revenues were affected at given tax rates, and another of assessing the revenue consequences of any changes in these rates. Disentangling these from the record is challenging. Using this information on a forward-looking basis also involves some judgment as to what changes in rates might be feasible and desirable.

To the extent that the deficit was altered, partly as a consequence of the shock itself, and partly as a result of policy responses, there will also have been changes in financing. These may have been ex ante, such as a decision to carry extra precautionary foreign exchange reserves or take out sovereign insurance; or they may have been ex post, such as increased domestic or international borrowing. For the ex post changes, there will also be the question of the extent to which interest premiums rose.

5.4 Coping with inadequate models and data

If available models are seen as complicated but still inadequate, it may be hard to interpret the results they generate. They may suggest some general equilibrium feedback that is unexpectedly powerful or unexpectedly weak, and the underlying mechanisms may be quite opaque. It is then difficult to decide whether this result is an artifact of the model design or a genuine insight. The best rule of thumb in these circumstances is not to rely on a model's output unless it is possible to provide a plausible (verbal) analytic explanation of what is happening. If we are to accept results that are not intuitive, we need to gain some understanding of why our intuition is wrong.When this sort of difficulty arises, it may be appropriate to supplement the analysis using a very simple model, possibly a part of the larger model, focusing on the direct impacts only.

Regarding inadequate data, there are broadly two ways to proceed. The first procedure is to have some mechanism for generating a substitute for the missing information. This is central to the "calibration" exercises that accompany much modeling, frequently with reference to "the literature." Either empirical data are borrowed from other countries, or recourse is had to theoretical priors. Though far from ideal, this may not be too problematic provided the missing information is not too extensive; but it becomes more problematic when the missing information covers much of the model's required input. The second way to proceed is to reconfigure the model so that it does not require the missing data. Once again, this might involve using only part of a larger model.

Given the challenges presented by the existing theoretical frameworks, several case studies were conducted to understand what can now be inferred from the application of existing data in country. These case studies are discussed in the next section.

6. Case studies

In light of the channels through which natural disasters impact sovereign balance sheets (outlined in section 3) and the insights from the literature (sections 4 and 5), three cases are examined. The objective is to derive lessons from these cases that may help other countries understand and prepare for the potential impact of natural disasters on the sovereign balance sheet.

6.1 New Zealand earthquakes

Situated on the Pacific Ring of Fire, New Zealand is particularly prone to disasters that are caused by forces at a tectonic plate boundary, namely earthquakes, tsunamis, and volcanoes. The New Zealand case study describes the impact of the 2010–11 Canterbury earthquake series on the government's finances and balance sheet.

The Canterbury region of New Zealand was impacted by a series of destructive earthquakes between September 2010 and December 2011. Although technically an aftershock, the most damaging and deadly tremor was in February 2011, which resulted in 185 deaths and considerable destruction in the city of Christchurch, near where it was centered.

The cost of the damage caused by the earthquakes has been estimated at around NZD 40 billion, equivalent to around 20 percent of GDP and 7 percent of the nation's building stock at the time.[3] There are uncertainties associated with this estimate and it does not include items such as interruption to business, which is an insurable risk, and central government expenditure to provide support for citizens through a range of measures. On the other hand, uncertainty also arises from differences between the value of the assets destroyed and value of replacements—for example, the additional value of rebuilding to a higher standard or other discretionary improvements (Parker and Steenkamp 2012).

The insurance liability for the Canterbury earthquakes totaled just over NZ$32 billion. Private sector insurers bore NZ$22 billion and the government-backed scheme for households—the Earthquake Commission (EQC) (see box 1)—bore around NZ$11.4 billion (Insurance Council of New Zealand 2020; New Zealand EQC 2019). The level of insurance relative to losses at around 75 percent was high compared to earthquakes in other high-income countries – for example one study surveyed events in Japan, Chile, and the United States, and observed coverage ranging from 3 percent to 35 percent of damage (Wood, Noy, and Parker 2016). Both the EQC and private sector insurers had substantial reinsurance in the international markets. Claims on foreign reinsurers improved the net international investment position of New Zealand by around eight percentage points of GDP, although this unwound as payments were made (Parker and Steenkamp 2012).

Box 2: New Zealand's Earthquake Commission

The Earthquake Commission (EQC) is a New Zealand government entity that provides disaster risk insurance to residential property owners; it also invests in natural disaster research and education. It provides cover for damage caused by earthquakes, natural landslips, volcanic eruptions, hydrothermal activity, and tsunamis. For residential land, there is also cover (within limits) against damage caused by storms and floods.

The EQC was founded in 1945 as the Earthquake and War Damages Commission, following destructive earthquakes in 1929, 1931, and 1942. Recovery and reconstruction after these events had been funded by government support to citizens, as commercial insurance against earthquakes was expensive at that time and not taken up by many households. Since its establishment, the EQC has undergone a number of changes, including the entities and perils that are covered.

[3] The New Zealand Treasury (2013), the Insurance Council of New Zealand (2020), and Wood, Noy, and Parker (2016) use this figure.

The EQC is funded by a levy added to fire insurance, provided by private insurers. At present the levy is 0.2 percent for a maximum coverage of NZ$150,000. For disaster cover beyond this amount, households rely on their private sector insurers.

The levies collected by EQC are used to (i) fund its operations; (ii) contribute to the National Disaster Fund managed by EQC; and (iii) purchase reinsurance in the international market. If the EQC is unable to meet all claims as a result of a very large event, it can fall back on the unlimited guarantee provided by government to make up the shortfall. The EQC pays a fee for this guarantee.

Source: New Zealand EQC (2020)

Despite damage estimated at 20 percent of GDP, the Canterbury earthquake had very little negative impact on the national macroeconomy in the short run.[4] A number of factors have been identified as to why the impact was muted: (i) the relatively high level of insurance cover relative to comparable cases in high-income countries; (ii) the nature of supply networks in the region and the central role of agriculture, which were largely undisturbed; (iii) the region's manufacturing hub escaped significant damage; (iv) transportation was largely unaffected – the local port recommenced activity within four days and volumes reached their previous peak within a few months, supporting exports; (v) the monetary easing by the central bank shortly after largest earthquake may also have buffered the impact (Doyle and Noy 2015, Parker and Steenkamp 2012).

As would be expected after a disaster of this nature, there was a rebound in activity once reconstruction started. Based on a total cost of NZD 40 billion, one study estimated that rate of rebuilding activity would average around 1.5 percent of potential GDP from 2012 to beyond 2020, peaking at just below 2 percent of potential GDP in 2014 (Wood, Noy, and Parker 2016). However, official forecasts cautioned that it was difficult to isolate the effect of the earthquakes from other factors during both the short-run and long-run (New Zealand Treasury 2011c, 2012a, 2013, 2014, 2015). At the time of the earthquakes, the economy was still recovering slowly from the global financial crisis of 2008-2009 (GFC) and the Eurozone crisis was intensifying; on the other hand New Zealand's terms of trade were improving. During the period of reconstruction, the economy was also benefiting from a surge in tourism, strong inward migration, near-record terms of trade, and strong labor income growth.

In the Canterbury region, building activity rose by 150 percent from pre-earthquake levels by 2016, compared to 20 percent in the rest of New Zealand, and nominal GDP growth surged to 10.5 percent in 2014 (Wood, Noy, and Parker 2016). The recovery of small and medium-size enterprises can be tracked from goods and services tax (a value-added tax), which rose from 11.6 percent of the national total in 2011 to 13.4 percent by 2015 (New Zealand Inland Revenue Department 2015), this indicates that Canterbury's share of the national total is higher relative to the rest of the country.[5] Overall, therefore, the impacts of the earthquakes on the economy were relatively localized and then further offset through reconstruction gains.

The disaster had a sizable impact on the government's finances. By June 2017, the amount recognized in the government's financial statements, including both operating and capital expenditure, was NZD 15.1 billion, equivalent to 7.5 percent of GDP at the time of the disaster (New Zealand Treasury 2017). This was spread out over many years, and indeed beyond 2017. The government's financial statements

[4] To provide perspective on the scale of the Canterbury earthquakes, the world's most expensive natural disaster, the Great East Japan (Tōhoku) Earthquake of 2011, had estimated damage of US$210 billion, equivalent to around 3.5 percent of GDP (Ranghieri and Ishiwatari 2014).
[5] The percentage had been below 12 in the eight years prior to the earthquakes.

are prepared on an accrual basis, which results in many expenses being recognized before cash is paid out. For example, in the 2011 financial statements, earthquake expenses of NZD 9.1 billion were recognized, but net cash payments were only NZD 1.7 billion (New Zealand Treasury 2011a). Of the NZD 15.1 billion in expenditure, NZD 0.7 billion was absorbed within exising budget baselines.

Just under half the direct fiscal costs were insurance payouts to households by the EQC. This would have been much higher, around NZD11.2 billion, were it not for the NZD4.5 billion recouped from reinsurance. Other significant costs included support for local government to restore infrastructure, capital expenditure for government-owned assets, compensation for land deemed unsuitable for rebuilding, and welfare support.

The government established the Canterbury Earthquake Recovery Fund (CERF) in the 2011 Budget, which helped provide transparency around the level of expenses. Nevertheless, the 2017 financial statements (New Zealand Treasury 2017), which was the last year that estimates of expenditure relating to the earthquakes were provided, note that as time elapses, the ability to directly attribute costs to the original events in 2010 and 2011 becomes more diffcult.[6]

In addition to direct fiscal expenditure, the government impaired a total of NZD 375 million against the asset valuation reserve in respect of damage to assets owned by the government. The impact of the earthquakes on the value of Crown assets and liabilities caused by changes to variables such as interest rates and exchange rates was likely to have been negligible. While the currency dipped initially after the February 2011 earthquake, it had fully recovered within a month. The New Zealand equity and bond markets were not impacted.

The New Zealand Treasury has not estimated the full indirect fiscal costs, such as the impact on tax or other revenues as a result of the earthquakes, and this is noted in the financial statements. As the government's tax revenues are driven to a large extent by changes in nominal GDP, it is reasonable to assume that the short-term impact of the earthquakes was negligible. Over the longer term, the indirect impact on the government's finances could be expected to have been positive, given the boost to activity from the reconstruction. The government's budget statements in the 2012 to 2014 refer to this, and estimates of the boost to the value-added tax ranged up to NZD1.3billion, but it was noted that this was partly offset by refunds to insurers, as a large part of the rebuild was funded by insurance claims (New Zealand Treasury 2012b, 2013, 2014).

To summarize, based on information provided in financial statements, the public sector's net worth is NZD 12.1 billion lower and public debt NZD 7.7 billion higher than if the Canterbury earthquakes had not occurred, assuming no second-round effects and other things being equal. To provide a sense of scale, in June 2017, when the majority of the expenses had been recognized and cash paid out, the Crown's net worth was NZD 116.5 billion (around 9.6% lower than otherwise) and gross central government debt was NZD 87.1 billion (around 10% higher than otherwise). At the time, gross central government debt was 32.5 percent of GDP; without the earthquakes it would have been 29.6 percent of GDP.

[6] For the purposes of this case study, the 2017 amounts are assumed to reflect the cost of the disaster to the government.

Table 1

Item	**Accounts**	**Expenditure** (NZ$ billion)	**Assets** (NZ$ billion)	**Liabilities** (NZ$ billion)	**Net worth** (NZ$ billion)	**Net worth** (percentage of 2017 GDP)
Valuation of assets and liabilities	Impairment of Crown assets		-0.375		-0.375	-0.1
	Valuation impact from market variables		Negligible	Negligible	Negligible	
Direct fiscal cost	Total expenditure	15.1[a]				
	Absorbed in existing budget	-0.7				
	Depletion of NDF		-6.9		-6.9	-2.6
	Funded by debt[b]			7.5	-7.5	-2.8
	Capital expenditure		2.6		2.6	1.0
Indirect fiscal cost	Negligible	Negligible	Negligible	Negligible	Negligible	
Total			**-4.7**	**7.5**	**-12.1**	**-4.5**

Source: World Bank

a. The expenditure figure is net of reinsurance payouts totaling NZ$4.5 billion

b. In some fiscal years there may be cash surpluses—the NZ$7.5 billion represents the increase in debt compared to a base case without earthquake expenditure and all other expenditure remaining the same

The increase in public debt levels was not on a scale that would have an impact on the composition of public debt, particularly as the cash impact of the expenses was spread over a number of years.

The ability of the New Zealand Government to comfortably withstand the impact of Canterbury earthquakes on the public sector balance sheet was shaped by two policy actions. The first was building fiscal space during economic expansion prior to the GFC – on the eve of the crisis, central government debt was 17 percent of GDP. The combined shocks of the crisis and the earthquakes raised this to 38 percent of GDP by 2012, with the GFC accounting for a much greater share of the increase.

The second policy action was the establishment of the EQC in 1945 to provide insurance for households against a range of natural hazards. During the next 65 years the Natural Disaster Fund (NDF) grew to over NZD 6 billion, funded by levies on households and investment returns; in addition some of its revenue was used to purchase reinsurance in the international market. The NDF was completely depleted, for the first time in its history, by the Canterbury earthquakes, resulting in a loss of net worth on the public sector balance sheet. Nevetheless, the NDF shielded the government from some additional borrowing after the event. Reinsurance payouts of around NZD4.5 billion provided some protection to net worth. Without the NDF and reinsurance, a further NZD11.4 billion would have been borrowed between 2012 and 2018 to settle the claims by households. This would have increased central government debt by 7.0 percent of GDP, compared to the 2.8 percent that actually occurred.

6.2 Serbia: 2014 floods

In May 2014, Serbia suffered flash floods and landslides as a result of heavy rains across the region. During the third week of May, record-breaking levels of rainfall were recorded: more than 200 mm of

rain fell in western Serbia within a week, equivalent to three months of rain under normal conditions. Already-high levels of soil saturation before the rains increased the presence of unstable soils in hilly areas and led to landslides in both inhabited and uninhabited areas. The landslides destroyed houses, roads, bridges, and other infrastructure works. The 2014 floods are considered the most severe in 120 years, impacting more than 38 municipalities and affecting more than 1.6 million people, or 23 percent of the total population (Government of Serbia 2014).

Post-disaster needs assessment and response

With the support of the European Union, the United Nations, and the World Bank, the Government of Serbia conducted a post-disaster needs assessment that estimated damages and losses in the affected municipalities at €1.7 billion (US$1.4 billion), equivalent to 4.8 percent of GDP. Of this amount, €0.9 billion (US$0.7 billion) represents the value of destroyed physical assets, and €0.8 billion (US$0.6 billion) refers to losses in production. The hardest hit economic sectors were energy, mining, and agriculture, but significant damages were also inflicted on transport infrastructure (roads, bridges, and railways). The public and private sectors were affected differently by the disaster, although the damages and losses they incurred were similar in size (Government of Serbia 2014).

Financial requirements were estimated for all sectors of social and economic activities, under both public and private domains. Post-disaster needs were valued at €1.3 billion (US$1.1 billion), of which €403 million (US$332 million) was for recovery activities (e.g., ensuring the recovery of personal income) and €943 million (US$777 million) was for reconstruction needs. Financing needs for recovery and reconstruction were estimated to last into at least 2016 (Government of Serbia 2014).

The disaster led Serbia into an economic recession and deteriorated its fiscal position. As a result of the ensuing recession (mostly caused by the floods), the Serbian economy contracted by 1.8 percent in 2014, rather than growing by 0.5 percent as previously projected. After the floods, an estimated 125,000 people fell below the poverty line, an increase of almost 7 percent compared with the level of the previous year. The Human Development Index also fell to 0.77, pushing Serbia back to 2012 levels (World Bank 2016).

Following the floods, the government of Serbia launched a significant response and reconstruction operation with extraordinary support from the international community. Various sources were used to finance the emergency response, reconstruction, and recovery: a combination of government funds, private sector resources (including personal and enterprise contributions, family remittances from abroad, and limited insurance proceeds), cash grants and donations from the international community, and new and rescheduled loans from international financial institutions. The total funding raised to implement recovery and reconstruction activities over the period May 2014–October 2015 was €514 million (US$423 million), of which €227 million (US$187 million) was from international borrowing, €193 million (US$159 million) was European Union funds, €42 million (US$35 million) was from individual donations, and €40 million (US$33 million) was from bilateral international donations. According to the National Bank of Serbia, only €16.9 million (US$14 million) had been paid out by private insurance companies by the end of 2014, and total post-flood insurance claims amounted to only €38.8 million (US$32 million)—less than 2.5 percent of the total damages and losses and less than 2.9 percent of the recovery needs (World Bank 2016). The size of this contribution highlights the fact that the overall insurance market in Serbia is underdeveloped and dominated by a state-owned company which may deter other market entrants. This suggests that there is an opportunity for the government to incentivize the insurance sector to improve product offering on flood insurance to reduce future

government liabilities. However, the affordability and attractiveness of any new products would need to be carefully assessed.

6.3 Sovereign asset and liability and disaster shock

Like many developing countries, Serbia does not prepare comprehensive balance sheets, does not have a complete data set on nonfinancial assets, and does not consolidate SOEs. Financial statements are prepared by the Treasury's Budget Accounting and Reporting Department. Quarterly and year-end aggregated financial statements are based on the balance sheet and on budget execution information submitted both electronically and manually by direct and indirect budget beneficiaries. Accounting and financial reporting in Serbia are currently maintained on a modified cash basis. Several measures have been introduced into Serbian public sector accounting to supplement cash-based data with noncash information. According to the Republic Property Directorate, it is solely the responsibility of the budget user to enter accurate data on nonfinancial assets, such as their value, changes in value, and information related to the disposal of assets. The directorate does not assume responsibility for data quality; does not validate or verify information in the asset registry; and does not demand it when missing (World Bank 2017).

The three channels affecting the balance sheet—valuation of assets and liabilities, direct fiscal cost, and indirect fiscal cost—are described below for the case of the Serbian floods.

Valuation of assets and liabilities

Since no accurate asset valuation is available, as a proxy, the analysis assumes that €450 million (US$371 million), or half of the total damages, falls within the public sector.

Over 2014, the Serbian dinar depreciated around 2.8 percent, influenced by developments in the international financial markets, reduced foreign exchange inflow from investments, and deterioration in the foreign trade deficit in the second half of the year. In November 2014, the National Bank of Serbia lowered its key policy rate by 0.5 percentage points to the level of 8 percent. This decision was due mainly to low inflationary pressure.

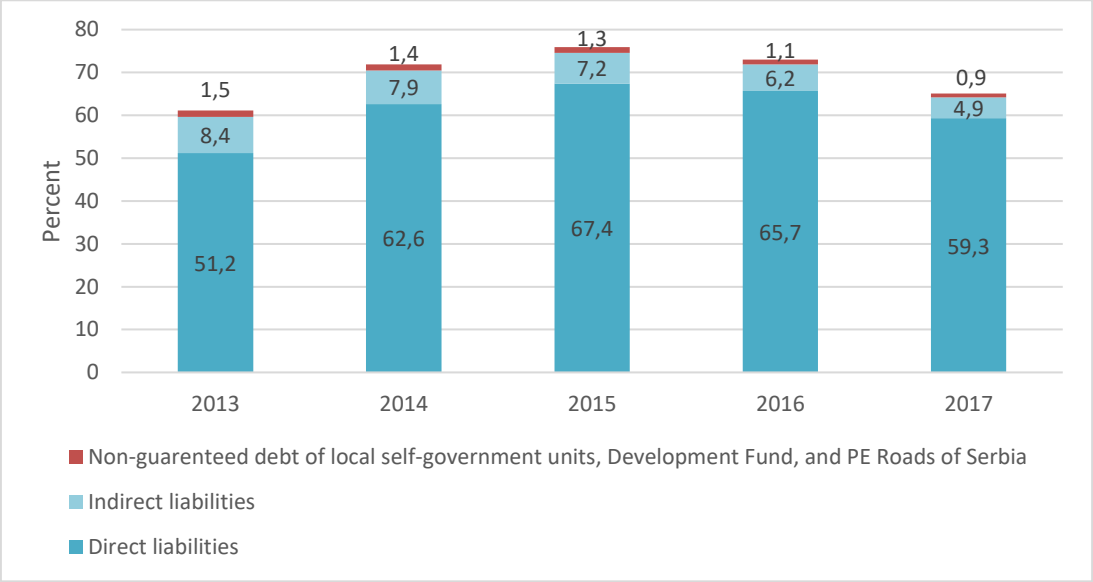
Direct fiscal cost

Direct costs are those incurred as a result of the damage, including emergency support and recovery. The availability and quality of data are key determinants in adopting a SALM framework, and in Serbia, data on post-disaster expenditures are limited and fragmented. Much of the spending on disasters remains embedded in other budget lines like operations and maintenance budgets. The primary financial sources in 2014 were government revenues, debt (US$300 million), and grants (US$182 million) (World Bank 2016). In addition, public utility companies financed reconstruction from their own funds and loans backed with state guarantee. Based on a review of balance sheets, other current expenditures were RSD 14 billion (around US$95 million) higher than initially planned as a result of floods and early elections.

Compared to 2013, the total debt stock in 2014 increased from 61.1 percent of GDP to 71.9 percent of GDP (around US$4.3 billion) (see figure 5). Public debt levels increased due to the 6.2 percent increase in the budget deficit, lower real GDP growth rate, and depreciation of local currency (dinar) against foreign currencies. In October 2014, the World Bank approved the Floods Emergency Recovery Loan to Serbia in the amount of US$300 million, and Serbia issued 10-year dinar-denominated bonds for the first time. The issue amount was RSD 10 billion (US$0.1 billion) with an effective yield rate of 12.99 percent

and 10 percent coupon. The issuance of the bond was planned before the floods with a strategic goal of a maturity extension, but it likely also covered the financial requirements from the flood.

Figure 2: General government public debt in Serbia as a share of GDP (2013–17)

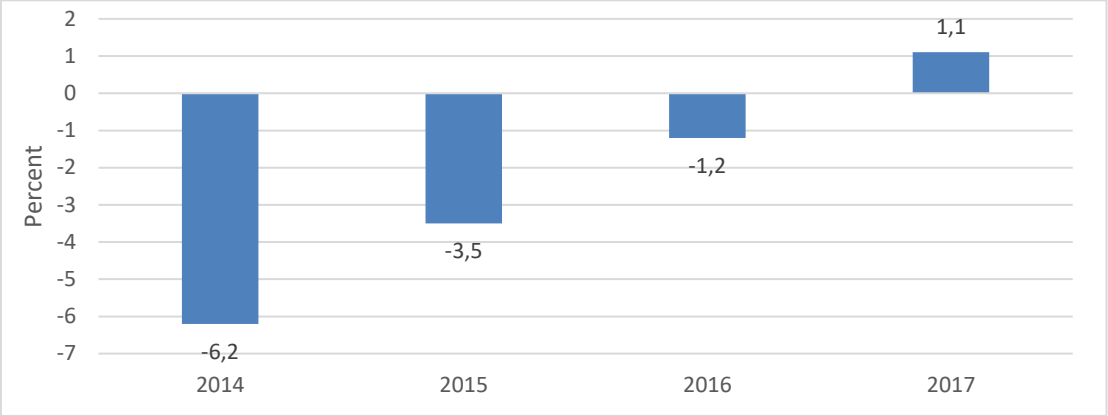


Source: Ministry of Finance of Serbia
Note: PE = Public Enterprise. Indirect liabilities include guarantees issued by Serbia for other legal entities

Indirect fiscal cost

Disaster shocks are expected to decrease the revenue base. The Serbia damage and loss assessment estimated a reduction in revenues of €130 million (US$107 million). Based on the 2014 balance sheet, the collection of total revenues was RSD 35 billion (US$247 million) lower than expected, while tax revenues were RSD 53 billion (US$358 million) lower than expected. The exact impact of floods here cannot be determined, as lower collection of revenues was greatly influenced by other factors, such as slower nominal growth of private consumption (partially caused by lower inflation) and growth of activity in the gray market, especially in the market for tobacco products. It is impossible to determine the disaster impact over the following years, given that Serbia concluded a Precautionary Arrangement with the IMF and started implementing fiscal consolidation measures and structural reforms at the end of 2014. All the budget positions—like current expenditures, capital expenditures, and deficit—were agreed with the IMF in the budget preparation process. In the first year of the program's implementation, a strong turnaround occurred in fiscal policy, with results higher than expected. The improved fiscal position of the country has reduced the need for borrowing and the costs of servicing liabilities.

Figure 3. Consolidated fiscal balance in Serbia as percentage of GDP (2014–17)



Source: Serbian Ministry of Finance

Since there is no comprehensive balance sheet, list, or valuation of nonfinancial assets, it is very difficult to determine in what way the 2014 floods affected the government's balance sheet. According to the available data, it can be assumed that €450 million (US$371 million), half of the total damage for physical assets, falls within the public sector. As a direct result of floods, public debt increased by US$300 million. Considering that the deficit in 2014 was 6.2 percent (see figure 7), mainly caused by the floods, it is fair to assume that the direct effect on public debt was significantly higher. Total reduction of revenues in 2014 was around €300 million (US$247 million), and it was estimated that €130 million (US$107 million) was caused by the floods.

6.4. Peru: 2017 coastal El Niño flooding

Disaster event

In the first half of 2017, an El Niño costero (coastal) event, one of the strongest El Niño events documented in Peru, caused major impacts in the country. A sudden and unexpected increase in the temperature of the Pacific Ocean created heavy storms and rainfall, which triggered floods and landslides that continued for nearly four months. The impacts were unevenly distributed in the country, affecting mainly the coast, with half of the geographic regions declaring a state of emergency. These events ultimately triggered the overpopulation of mosquitos that spread dengue and chikungunya virus. An El Niño event with such a localized impact had not been documented since 1925 and is comparable to the strongest ones in the 20th century (Government of Peru, 2017a).

The event affected 1.7 million people (around 5 percent of the population), caused 132 deaths, and damaged 413,000 houses and 132,000 ha of crops. Buildings and infrastructure were severely damaged, including 2,600 km of national roads, 192 bridges, 7,000 km of regional roads, about 1,500 school buildings, and 726 health facilities (Government of Peru 2017a). There are no official records about the cost of these impacts. However, Macroconsult, a local consulting firm, estimated such physical damages at US$3 billion (equivalent to 1.6 percent of the 2017 GDP); roads and bridges alone accounted for 48 percent of the total (Macroconsult 2017). This amount is to be interpreted as a lower bound, as it does not include total physical damages in infrastructure (e.g., the collapse of sewage systems).

Economic activity was affected by the closing of roads, the damage to physical capital, and lower demand. According to a preliminary analysis performed by the Ministry of Economy and Finance (MEF),

the shock was expected to shrink GDP growth by 1.2 percentage points (Government of Peru 2017d). The impact was difficult to isolate, however, given the Lava Jato corruption case in 2017, which compounded the shock by decreasing investors' confidence and paralyzing public-private partnership investment projects.

The recovery process started with the establishment of an agency, the Authority for the Reconstruction with Changes (ARCC), to lead implementation of the 2017–21 reconstruction plan. The entire plan's allocation is S/. 26.7 billion (US$7.8 billion, 3 percent of 2017 GDP) programmed into four components: (i) public infrastructure (73 percent of the total amount), (ii) mitigation projects (21 percent), (iii) houses (3 percent), and (iv) capacities of recipient entities (3 percent). The reconstruction of public infrastructure focuses mainly on transport (US$2.5 billion), education (US$1 billion), and drainage and sewerage systems (US$1 billion). In the case of houses, ARCC is financing 100 percent of the cost for rebuilding or replacing around 41,000 dwellings among the most vulnerable families affected by the event (Government of Peru 2017c).

The Government of Peru has a combination of instruments to finance disaster recovery, aligned with its fiscal policy and financial strategies. The Stabilization Fund (FEF) was established in 1999 with the aim of creating fiscal savings to respond in adverse scenarios (Government of Peru 2019). Peru officially launched its national Disaster Risk Financing and Insurance (DRFI) strategy in 2016, after several years of work. The strategy builds on extensive analytical support, and includes the following financial instruments for recovery: (i) the FEF, (ii) contingent credit lines, and (iii) debt (Government of Peru 2016). In 2016, a pass-through disaster fund was established (FONDES). In addition, in 2017 the country joined a three-year catastrophe bond that provides US$200 million in seismic coverage (World Bank, 2018b). The management of these financial instruments is governed by the Global Asset and Debt Strategy (Government of Peru 2017b).

The financial needs raised by the coastal El Niño were covered mainly by assets. According to the MEF, 80 percent of total financial needs due to the event will be covered by assets—including FEF, Treasury, and non-Treasury resources[7] as well as donations—with a mild impact on the debt stock. Indeed, a total of US$2.8 billion was mobilized from the FEF to FONDES over the 2017–19 period.[8] These resources were authorized by law on an annual need basis, with US$1.8 billion in 2017 followed by lower amounts thereafter. It is important to highlight that FEF had accumulated US$5.4 billion by the end of 2019.

Sovereign asset and liability and disaster shock

Financial statements are published annually by the MEF, covering the entire public sector. Before discussing the impacts of the El Niño event on sovereign assets and liabilities, it is necessary to understand how Peru defines the public sector balance sheet and what the basis is for its financial reporting. Financial statements in Peru are a consolidation at the public sector level. The Accounting Department of the MEF (DGCP) is responsible for annually compiling and publishing the financial statements, which covered the following units by 2017:

- 2,505 public sector entities, of which 2,345 were general government units and 160 were public corporations, including the reserve bank
- 272 central government units (including the health insurance system, the military pension scheme, and three housing funds), 27 regional government units, and 2,046 local government units.

[7] Non-Treasury resources include nontax revenues collected and accumulated from national institutions and subnational governments, such as fees, property levies, and supply of goods and services, among others.
[8] Stabilization Fund Report. Reports from 2017, 2018 and 2019.

In Peru, public financial accounts are based on a combination of accrual and cash-based methods, with accounts still pending to move into full accrual. The government has been working to strengthen the valuation of public financial accounts. For example, an IT module was created for registering the updated value of buildings and structures at the general government level.

Table 2 summarizes the impacts of the El Niño event, including the valuation of assets and liabilities and direct and indirect fiscal costs. Net worth is estimated to decline by S/. 13.2 billion, with increased in debt by S/. 2.5 billion over the 2017–19 period. The estimations are limited, given the data and assumptions, and should be interpreted to illustrate trends rather than as offering precision.

Table 2: Estimated impacts of 2017 El Niño event, 2017–19 (S/. billion)

Item	Account	Asset	Liability	Net worth
Valuation of assets and liabilities	Building and properties	-10.3		-10.3
Direct fiscal cost	Fixed assets	+3.5		+3.5
	Financial assets, debt and operative results	-3.9	2.5	-6.4
Indirect fiscal cost				
Total		**-10.7**	**2.5**	**-13.2**

Source: World Bank

The three channels affecting the balance sheet are described below.

Valuation of assets and liabilities

The 2017 financial statement did not specify a decrease in the valuation of properties due to the shock (Government of Peru 2018a). This is probably related to difficulties in the valuation of fixed assets mentioned above. As a proxy, damage of US$3 billion (S/. 10.3 billion) can be considered a lower bound. In the balance sheet analysis, the damages due to the disaster (destruction) lead to a reduction in the fixed assets, thus reducing the assets and net worth by S/.10.3 billion.

Changes in the exchange rate and interest rate may affect the valuation of financial assets and debt. However, Peru's financial statements did not report any impact attributed to the disaster shock. See figure 8 for more details on the evolution of variables. Over the first half of 2017, the Peruvian sol appreciated about 3.4 percent, influenced by the recovery of commodity prices and global depreciation of the dollar.[9] In May 2017, the monetary policy rate was cut by 25 basis points to 4 percent, and then further reduced to 3 percent over the same year. The lower dynamism of the economy explained this reduction.

Direct fiscal cost

This section covers the actual cost incurred as a result of the damage, including emergency support and recovery. Table 3 summarizes the executed expenditures through FONDES over the 2017–19 period. The amount recognized for operating and capital expenditures is S/. 6.3 billion. The primary financial sources were central government revenues and debt, in the amounts of S/. 3.3 billion and S/. 2.5 billion,

[9] Debt variation was registered at S/. 1.4 billion due to the sol appreciation, but there is no evidence on a relation with the disaster shock.

respectively. Smaller shares were contributed by non-treasury commodity resources and donations.[10] By type of expenditure, capital investment amounted to S/. 3.5 billion. Thus, the government fixed assets and net worth increased S/. 3.5 billion. At the same time, financial assets decreased by S/. 3.9 billion, debt increased by S/. 2.5 billion, and net worth decreased by S/. 6.4 billion (total expenditures in the operating results). The result is a total decrease of S/. 2.9 billion in net worth.

Table 3: Peru's emergency and reconstruction expenditure following 2017 El Niño event (S/.million)

Item	2017	2018	2019	Total
Total expenditure	896	1,906	3,551	6,353
By financing source				
Revenues and buffers[a]	830	1,541	1,479	3,850
Debt	66	365	2,072	2,503
By type of expenditure				
Operating	846	1,103	939	2,888
Capital	50	804	2,612	3,465

Source: Ministry of Finance data tracking expenditure from FONDES
a. Includes Treasury and non-Treasury revenues, FEF, and donations

Expenditure in table 3 is less than a quarter of that programmed in the reconstruction plan due to significant delays. According to the Audit Office, delays arose in the first years of the plan's implementation because the central government was in charge of executing around 84 percent of the total budget, with minimum participation of local governments. Then, in 2018, a more decentralized approach was implemented, and subnational governments are now in charge of executing 50 percent of the total budget. This new approach has raised the levels of budget execution from 15 percent in 2017 to 35 percent in 2018 and 2019 (Government of Peru 2018b).

Indirect fiscal cost

Finally, disaster shocks decreased the revenue base. According to the 2017 financial statements, tax revenues were reduced by 3.4 percent, explained in part by the disaster shock and in part by the Lava Jato case (equal to S/. 600 million). However, the impact was not explicitly included in the financial statements (Government of Peru 2018a). In the short term, it is difficult to isolate the disaster shock, though a decrease in the operating result of S/. 0.6 billion could be considered as a proxy. Ultimately, it is not possible to determine whether the shock impacted the asset or the liability side. There is no evidence that the disaster impact lasted over the following years.

7. Conclusions

Accrual accounting and cash based accounting both recognize reconstruction as an investment, however, one identified advantage of accrual accounting over cash based accounting is that it allows better identification of when and how reconstruction occurs, and hence of the associated costs and benefits, which can be used to inform measures to build financial resilience against disasters. Recognizing reconstruction as an investment; the value of public assets increases as old assets are

[10] Government of Peru, Ministry of Economy and Finance, data tracking expenditure from FONDES.

replaced with new—even if funded by debt, this is neutral in terms of net worth. The loss of net worth arises from the impairment or write-off of the old assets. However, accrual accounting with a public sector balance sheet provides higher-quality information about the value of government assets that are susceptible to disaster risk and as such can be used to develop and implement disaster risk finance policies.

Countries that are only starting to consider SALM should start with simple analysis (e.g., debt analysis). Countries like Serbia, with cash accounting and no complete data set on government assets, face challenges in adopting and implementing the SALM approach. However, as highlighted in the discussion not all aspects need to be included at once, and having some basic level of understanding on how disaster risk can impact the structure of your debt portfolio would benefit many countries.

In practice, it can be difficult to identify the total direct cost of a disaster with any precision. The Peru, Serbia, and New Zealand cases demonstrated that reconstruction can last for many years; there might be reallocation within existing budget baselines that is difficult to track, and replacement assets might be of a higher standard.

Given these complexities, it is a significant challenge to estimate the potential impact of disasters on the national economy and the sovereign balance sheet, as it requires modeling many variables and relationships. Nevertheless, broad-brush scenario analysis can provide useful input to the development of long-term fiscal policy, in particular the degree of fiscal space that may be required to accommodate the realization of large, credible fiscal risks.

The application of SALM can increase countries' resilience to financial shocks posed by disaster risk through improved understanding of the impacts of disaster risk on both sides of the sovereign balance sheet. Going forward it could even be used to define a country's risk tolerance to disaster risk, monitor changes in this position and help to inform policy design on disaster risk and where needed support the introduction of financial instruments to manage disaster risk.

Reserve funds can mitigate the need to borrow after the event, as demonstrated by both the Peru and New Zealand cases. Establishing an off-budget fund, specially designated for natural disasters, allows governments to keep and accumulate resources over the years, thus mitigating the need to borrow after the disaster event.

Reinsurance can play a major role in reducing the economic impact of disaster. The New Zealand case study included the use of the global reinsurance market, both by the government scheme and private sector insurers; it showed that claims on foreign reinsurers improved the net international investment position of New Zealand by around eight percentage points of GDP. Without this, the government would have been required to borrow more, as the NDF was exhausted (for the first time in 70 years).

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SESSION II

LIQUIDITY IN GOVERNMENT SECURITIES MARKETS

Government Bond Market Developments and the Usage of the DMO's Security Lending Facility - Evidence from Sweden[1]

Marianna Blix Grimaldi[2], Johanna Hirvonen[3]

Abstract

The Covid-19 pandemic halted economic and financial development in many parts of the world, placing substantial pressure on governments. It also created new risks and global challenges for Debt Management Offices (DMOs), with potentially significant implications for domestic-market functioning and investor behaviour. In this paper, we use a novel approach based on proprietary information of the Swedish Debt Management Office's security lending facility (SLF) to investigate key changes in government bond markets and their implications for market functioning. We show that quantitative easing (QE) policies have had a persistent influence on usage of the facility and demand from primary dealers, while the acute effects of the pandemic were temporary. We also show that the terms and conditions attached to a SLF are a powerful policy tool and that altering them can cause significant shifts in SLF usage.

Keywords: Government Bond Market, Quantitative Easing (QE), Public Debt Management, Covid-19.
JEL Classification: E52, E58, G12, H63.

1. Introduction

Not only was the rapid spread of Covid-19 in the spring of 2020 a serious threat to public health, but it also had a major impact on global financial markets. Public institutions and fiscal and monetary authorities swiftly implemented powerful macroeconomic policies aimed at improving the economic outlook and controlling financial volatility. Despite the pandemic's toll on public health through several waves of contagion and, tragically, the casualties involved, the crisis measures were arguably successful and perhaps even instrumental in restoring "normalcy" to the economy (OECD, 2021a). Although crisis responses were necessary, they also resulted in a rapid surge for central-bank balance sheets and government debt, which were already at high levels. Consequently, the medium- to long-term vulnerability of economies to potential future shocks has increased.

[1] We thank Karolina Ekholm, Johan Bergström, Erika Färnstrand Damsgaard, Klas Granlund, Jörg Hofmeister and participants at SNDO and Riksbank seminars and the 2nd PDM conference for valuable comments. The opinions expressed in this paper are the sole responsibility of the authors and should not be interpreted as reflecting the views of the Swedish National Debt Office or of the Sveriges Riksbank.
[2] Swedish National Debt Office and Sveriges Riksbank.
[3] Swedish National Debt Office.

Most of the existing literature on crisis response focuses on the economic impact of fiscal and monetary policy measures during stress events like the Covid-19 pandemic. The effects on both bond markets and stock markets have been analysed (see, among many others, FSB, 2020). Yet the impact of economic policies on government bond markets and in particular their functioning, along with the response of Debt Management Offices (DMOs) and the implications for investor behaviour, remains an under-researched topic.

In this paper, we use a novel approach based on evidence from Sweden to describe government bond market developments and identify key changes that significantly influenced government bond market functioning. Such developments are not unique to Sweden but in fact common to many advanced and emerging economies.

More specifically, we analyse the impact that periods of increased financial stress, central bank quantitative easing policies, and changes in DMO policies have had on government bond market functioning and demand for government bonds.

For our analysis, we use highly granular and non-public data on the security lending facility (SLF) of the Swedish National Debt Office (the Swedish DMO). The general purpose of a security lending facility is to allow the DMO to mitigate a possible scarcity of securities in the government bond market by offering the DMO's primary dealers the possibility of borrowing government securities on a temporary basis. As such, the SLF is a powerful tool of a DMO. Through it, the DMO can influence government bond market functioning while contributing to market liquidity and financial stability.

The SLF is often the most detailed source of information available to policy makers on investor demand in the government bond market. Most importantly, it provides exclusive information about the inner workings of the government bond market and can offer unique insight into the broader dynamics of short-term funding markets. Usually only debt managers have direct access to information based on a SLF.

Our analysis is based on daily data and covers almost two decades, from 2002 to 2021. To our knowledge, the data in our study are the longest and most granular data on which research and policy analysis in this area have been based to date.

We show that the Covid-19 pandemic had a substantial but only temporary impact on the SLF. By contrast, QE policies have had a more persistent influence on the usage of the facility, leading to potentially permanent changes in market functioning. Proprietary data we obtained from market participants support our results by indicating that government bonds targeted in the QE programme have been trading as "specials", i.e. they have become more expensive to borrow in the repurchase agreement (repo) market than other comparable bonds.

We also show that flight to quality and flight to liquidity were opposing forces in the Swedish government bond market and that flight to liquidity may have become more dominant after the QE was initiated.

Finally, we show that the terms and conditions attached to a SLF serve as a key tool for a DMO and that changes to these can cause significant shifts in usage of a SLF.

This paper is organised as follows. Section 2 briefly describes the impact of the Covid-19 crisis and the ensuing policy measures on supply and demand in the government bond market; Section 3 describes key long-term and potential structural changes that were already underway before the pandemic. In Section 4, we present the Swedish DMO's SLF and its usage during the latest two decades. In Section 5,

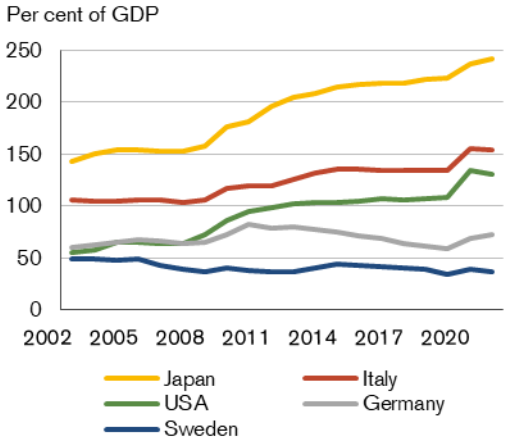
we formally analyse the drivers of the changes that occurred over the period of February 2015–November 2021. Our conclusions are presented in Section 6.

2. The Impact of the Covid-19 crisis on government bond market supply and demand

Governments and central banks around the world implemented rapid and powerful policy responses in order to mitigate the effects of the shock to financial markets and the economic contraction due to the onset of the Covid-19 pandemic. These crisis measures resulted in a rapid surge in the already previously high levels of government debt, central bank balance sheets, and asset prices.

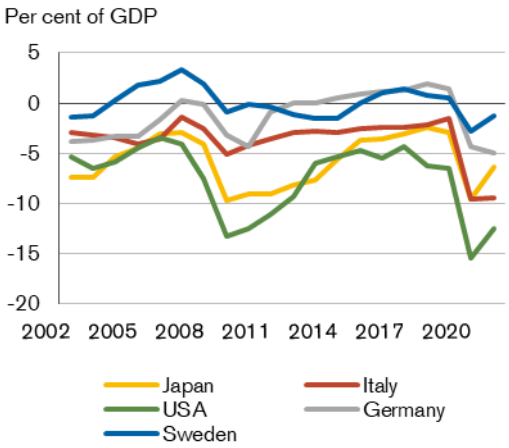
Expansion of central bank balance sheets during the Covid-19 crisis exceeded the expansion during the 2007–2009 global financial crisis. During the first half year of the pandemic, balance sheet expansion for the major central banks measured between 8 to 14 per cent of GDP, which was nearly two-fold (4 to 9 per cent of GDP) compared with the first six months of the global financial crisis (BIS, 2020). At the same time, governments' fiscal deficits surged at a magnitude not seen since the Second World War (Baker et al., 2021).

Figure 1: Government debt to GDP



Source: OECD

Figure 2: General government net lending



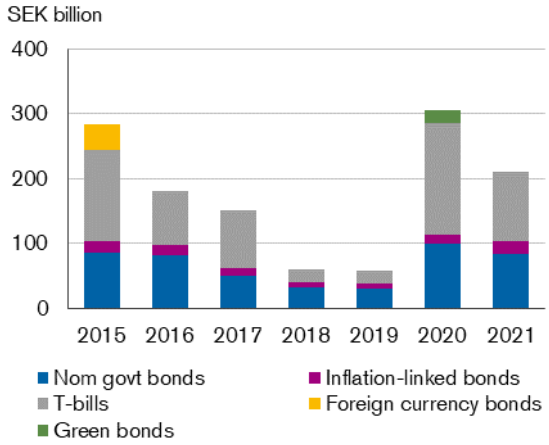
Source: OECD

The policy responses affected the supply and demand of government bonds. In order to fund the crisis-induced fiscal policy measures, governments substantially increased their issuance of government securities (OECD, 2021a). In 2020 and 2021, the stock of outstanding government debt securities increased by over 50 per cent in Australia, Canada, and New Zealand and by around 30 per cent in the United States and the United Kingdom (Baker et al., 2021). In Sweden, the increase amounted to about 10 per cent.

The Swedish government debt is low by international comparison. The debt-to-GDP ratio has generally been on a downward trajectory since the beginning of the 1990s. Apart from the temporary deficit arising from pandemic-related aid for households and firms, the Swedish government has had a budget surplus since 2015.

In many OECD countries, higher government borrowing requirements were largely accommodated by increasing the supply of treasury bills (OECD, 2012b). The rationale was to allow for greater borrowing flexibility in light of heightened volatility and uncertainty about future borrowing needs than would have been possible with longer-term debt securities (Baker et al., 2021). In 2020–2021, in accordance with the borrowing policies it already had in place, the Swedish DMO also concentrated the majority of its new issuance to T-bills (Figure 3). This made it possible to adjust the issuance to a lower-than-expected borrowing requirement when the recovery of the Swedish economy turned out to be stronger and more rapid than expected. In 2021, the fiscal surplus resulted in a contraction in government debt in Maastricht terms from 40 per cent of GDP at the end of 2020 to 38 per cent of GDP in 2021[1].

Figure 3: Issuance of government securities



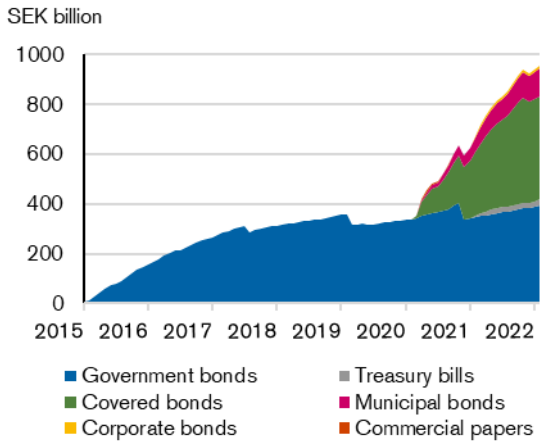
Source: Swedish National Debt Office
Note: The amount of T-bills refers to outstanding stock at year-end

Emergency support in the form of expansionary policies by fiscal authorities was complemented with expansionary monetary policies. To mitigate strain in financial markets, central banks resorted to more outright asset purchases, among other measures. In the OECD countries, some central banks launched asset purchase programmes for the first time while others scaled up existing programmes and established new ones targeting new types of securities (BIS, 2020).

[1] General government gross debt according to the convergence criteria set out in the Maastricht Treaty comprises currency, bills and short-term bonds, other short-term loans and other medium- and long-term loans and bonds, defined according to ESA 95. Source: The OECD Economic Outlook: Sources and Methods.

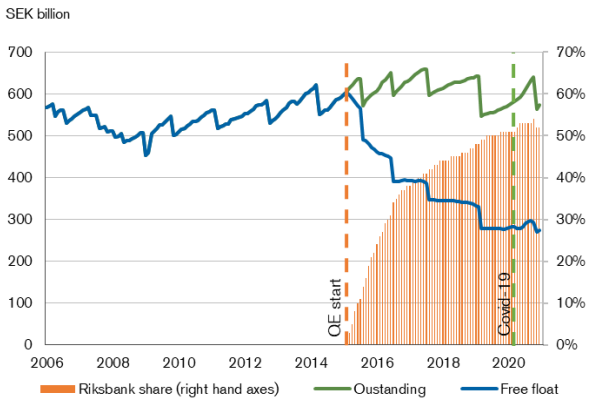
Sveriges Riksbank (the Riksbank) expanded its asset purchase programme both in size and by broadening the scope to include new types of securities. In addition to Swedish government bonds, which the Riksbank had already had been buying since 2015 when it first started its QE programme, the central bank started purchasing Swedish covered (mortgage), municipal, and corporate bonds, as well as Swedish government T-bills (see Figure 4). Although the programme grew significantly in size, the move to buy other types of securities, together with the increased issuance of government bonds, meant that there was no significant change in the so-called *free float* of nominal government bonds, i.e. outstanding bonds net of bonds held by the Riksbank. It also did not significantly change the overall share of the Riksbank's nominal government bond holdings (see Figure 5).

Figure 4: Composition of Riksbank QE



Source: Sveriges Riksbank

Figure 5: Free float and Riksbank's share of nominal Swedish government bonds



Source: Sveriges Riksbank and Swedish National Debt Office

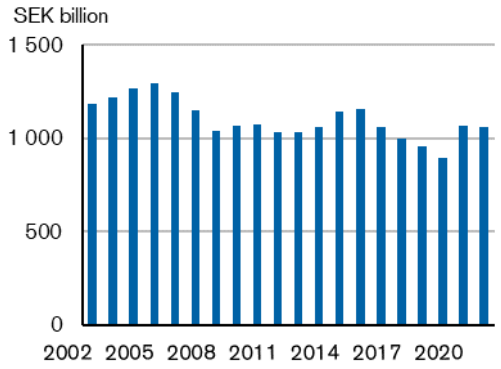
Overall, central banks and fiscal authorities were successful in mitigating the fallout of the crisis. Interest rates on government bonds remained fairly stable at historically low levels in all major economies. In Sweden, as in most of the other OECD countries, the Covid-19 pandemic had only temporary effects on the economic output, similar to, for example, those of a natural disaster.

3. Trends and potential structural shifts in the government bond market

Before the Covid-19 pandemic, long-term trends and structural shifts were already changing market dynamics in the Swedish government bond market. In this section, we identify two of these effects and briefly discuss them.

The first effect relates to the long-term downward trend in public debt. Government debt has mostly been declining over the past two decades, both in nominal terms as well as in relation to GDP (see Figure 6). In 1995, the Swedish government debt as a share of GDP was close to 70 per cent and above the requirement of the Maastricht agreement. Positive growth coupled with a series of fiscal reforms – which had been agreed upon by all the Swedish political parties in the aftermath of the country's banking crisis of the early 1990s and then implemented in successive governments – led the debt-to-GDP ratio to decline steadily over time. In March 2022, it was at 38 per cent, among the lowest of the OECD countries. A low and steadily declining government debt can pose challenges to DMOs. Over the years, the Swedish DMO has strived to concentrate mostly on the issuance of benchmark maturities. This has primarily been to ensure continued liquidity.

Figure 6: Central government debt



Source: Swedish National Debt Office
Note: Central government debt including on-lending and assets under management

Second, similarly to other central banks, the Riksbank has engaged in large asset purchases as part of its monetary policy since launching its QE programme in 2015.

The implementation of the QE programme posed new challenges for the DMO by creating a significant shift in market dynamics and investor demand for government bonds. Both the pace and the size of the Riksbank's QE programme stand out by international comparison.

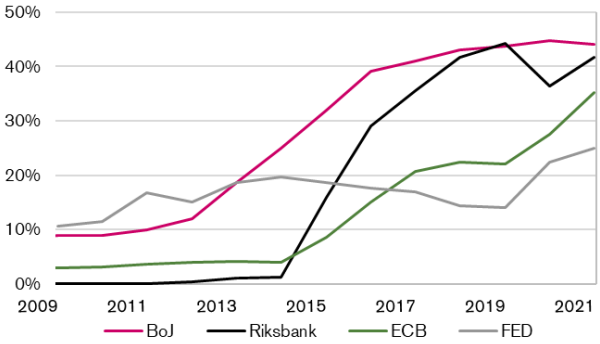
Compared with the QE programmes of other major central banks, the pace of the Riksbank's asset purchases has been significantly higher. Figure 7 shows the relatively steep upward slope of the curve representing the Riksbank's accumulated purchases. Only two years into the programme the Riksbank held more than 30 per cent of the Swedish domestic government securities.

Notably, when compared with other major central banks, the Riksbank's share of the government securities eligible for asset purchases is high. It is worth pointing out that, often because of limited availability of data, the size of a QE programme is measured in terms of the GDP of the country. GDP, though, is not the best reference for measuring the impact of QE on government bond markets. We therefore use as our reference measure the outstanding volume of government bonds that are eligible

under the QE programme. By that measure, compared with major central banks' QE, the size of the Riksbank's QE is close to the largest, at around 40 per cent, and near that of the Bank of Japan (BoJ), which holds the largest share at 45 per cent. In contrast to the Riksbank, the BoJ started its QE programme almost a decade earlier, in 2001, and already held a relatively significant share of government securities by the time the Riksbank's – and other central banks' – QE programmes were launched.

At the onset of its QE programme, the Riksbank bought only nominal Swedish government bonds, but in 2016 it then broadened the programme to also include inflation-linked government bonds, as well as other securities during the pandemic. Throughout the programme, nominal bonds have accounted for the majority of the purchases, resulting in the Riksbank holding over 50 per cent of the nominal Swedish government bonds. The Riksbank's total holdings (nominal, inflation-linked bonds, and T-bills) as a share of all outstanding domestic government securities was about 40 per cent at the end of the sample (see Figure 7).

Figure 7: Central bank holdings as share of domestic government securities eligible for asset purchase programme

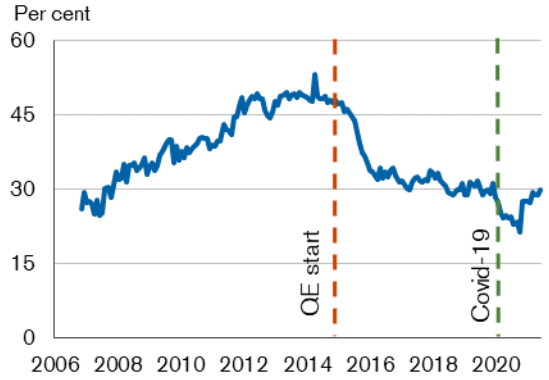


Source: Bank of Japan (BoJ), Sveriges Riksbank, Swedish National Debt Office, European Central bank (ECB), Eurostat, Federal Reserve (FED), US Treasury, IMF and authors' calculations.

The Riksbank's asset purchase programme significantly reduced the amount of government bonds that were available to trade in the market (so-called free float), especially for nominal bonds. This has likely contributed to deterioration in indicators that are commonly used by DMOs for identifying and assessing liquidity problems.[2] Foreign ownership has decreased significantly after QE start (see Figure 8) and daily market turnover, that has been deteriorating over a longer time period, has declined further (Figure 9). Also perceived liquidity has decreased significantly (see Figures 10). The share of foreign ownership increased somewhat during the Covid-19 pandemic as a result of syndicated offerings of bonds with longer maturities, which attracted foreign investors.

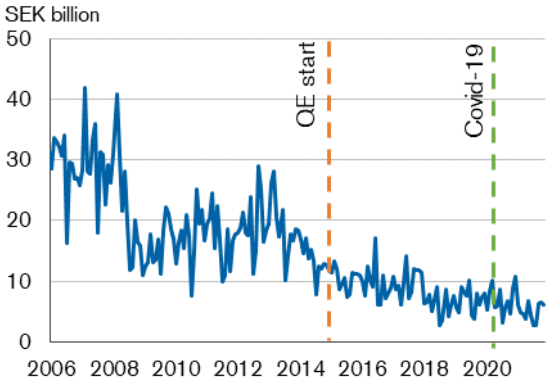
[2] Blommestein (2017) provides an overview of indicators for identifying and assessing liquidity problems.

Figure 8: Foreign ownership of government bonds



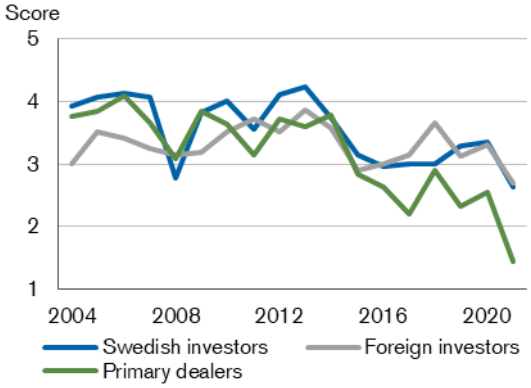
Source: Statistics Sweden

Figure 9: **Daily turnover of government bonds**



Source: Sveriges Riksbank

Figure 10: Perceived liquidity of government bonds



Note: Score relates to ranking of liquidity in the investors' survey conducted annually by Kantar Prospera on behalf of SNDO. A higher score stands for higher liquidity
Source: Sveriges Riksbank and Swedish National Debt Office

4. The DMO's securities lending facilities

The main objective of the Swedish DMO is *to minimise the cost of central government debt in the long term while taking risk into account*.[3] This objective adheres to best global standards as described in the *Guidelines for Public Debt Management* (IMF, 2001 and 2014).

In practice, a DMO achieves its main objective through a set of related goals and operational procedures. The Swedish DMO has four related goals. These can be summarized as: (1) minimising risk-adjusted funding costs, (2) maintaining an efficient government debt market, (3) reducing uncertainty for investors, and (4) ensuring that the investor base is as diversified as possible.

The operational tools that a DMO employs involve decisions on what type of securities are issued, issuance maturity, size and schedule of auctions, degree of investor-base diversification, level of risk tolerance, and overall transparency. The mandate of the DMO also includes contributing to the development and liquidity of the government debt market.[4] It can do so by conducting security lending operations through its SLF. In fact, a SLF is the DMO's primary tool for safeguarding and enhancing, where possible, the liquidity of the government bond market and market functioning.[5]

A well-functioning bond market implies a lower liquidity premium and consequently lower borrowing costs for the government, which directly relates to the DMO's mandate. But a liquid government bond market is more than that. It is an invaluable public asset. Government bonds remain one of the key pricing benchmarks for a broad range of financial assets even as some other assets, such as cleared interest rate swaps, are emerging as alternative benchmarks.[6] Government bonds are also the security of choice of many investors for managing financial risks in capital markets. The key feature of a SLF is that its availability strengthens investors' *confidence* in the continued liquidity and functioning of the market. In this way, the DMO's SLF plays a critical role in maintaining and improving the liquidity of government bonds.

Because of this critical role, usage of the SLF can be associated with episodes or longer periods in which government bonds are difficult to obtain and traders thus resort to the facility to overcome that *scarcity*.[7] The usage of the facility strongly correlates to how well the government bond market and the repo market for government securities are functioning.[8] Notably, the information from the SLF can indicate the level of bond scarcity in the repo and government bond markets and, in other words, whether the bonds are sufficiently liquid. The SLF can be therefore be seen as a measure of liquidity in the government bond market.

A complication in interpreting the information from the SLF *directly* as a measure of liquidity is that the relationship between SLF usage and market liquidity might be nonlinear. Higher usage of the facility can

[3] See Facts about central government debt – Riksgälden.se (riksgalden.se).
[4] Bond liquidity refers to the capacity of traders to undo positions at reasonable costs. For a discussion of liquidity in fixed-income markets, see Crosta and Zhang (2020) and references therein.
[5] Market liquidity can be affected by factors that are outside a DMO's influence, among others funding liquidity, defined as the ability to settle obligations immediately when due. Theoretical research has rationalised strong interactions between funding liquidity risk and market liquidity in periods of crisis (See M. Brunnermeier and L. H. Pedersen, "Market liquidity and funding liquidity", National Bureau of Economic Research Working Paper No 12939, February 2007).
[6] See ISDA (2022), for a description of interest rate swaps (IRS) and the emergence of cleared IRS as standard contracts.
[7] For scarcity is meant the shrinkage in the available supply of bonds, see e.g. Pelizzon et al. 2019.
[8] The market for repurchase agreements (repo) is a short-term market that facilitates the flow of cash and securities in the financial system. It is often described as the plumbing of the financial system. The market is in fact a key source of liquidity in the trading of government bonds. If banks, which make markets for investors, do not hold a specific bond themselves, they can use repo agreements for borrowing it in exchange for cash. Traders can also use repo transactions to obtain funding by using securities as collateral. In a repo transaction, a party sells government debt securities to a counterparty subject to an agreement to repurchase the securities later at an agreed price. Repos are economically similar to a collateralised loan.

be associated with bond scarcity. However, it could also be associated with high liquidity if it is caused by high activity in the government bond market rather than scarcity. Based on the evidence we have, higher transacted volumes in the Swedish SLF tend to be associated with lower market liquidity (see Blix Grimaldi et al., 2021).

Another advantage of the SLF is that compared with other measures of market liquidity, which are normally derived measures based on *ex-post* information from the secondary market, the SLF-based measures are based on transacted volumes and, most importantly, are related to both the DMO's overarching mandate and the core purpose of a SLF.[9]

A SLF can take many forms (World Bank, 2015). The Swedish DMO's SLF consists of two type of facility: a *repo cash facility* and a *repo swap facility*.[10]

In the *repo cash facility*, government securities – usually bonds – are traded overnight (ON) or tomorrow-next (T/N) at a set price (the repo cash facility thus comprises what we refer to here as the O/N repo facility and T/N repo facility).[11] The DMO has conducted O/N and T/N reverse repos on a daily basis since 2000. As of 2004, it also manages a *repo swap facility*, whereby government bonds can be swapped for another government security, including T-bills, at a set price with the swap having a one-week maturity on a cash-neutral basis, meaning that the transactions cancel each other out.[12]

The DMO provides its repo facilities only to its primary dealers. The Swedish SLF is governed by primary dealers' demand and is offered irrespective of the borrowing requirement. Operationally, the SLF contributes to the smooth functioning of the short-term funding market by *fine-tuning the supply of bonds* in the government bond market.

The different types of SLFs have somewhat different purposes, while all contribute to the liquidity of Swedish government debt by enhancing trust and confidence among investors and primary dealers in always having access to the bonds they need for their commitments.[13] The primary dealers only use the O/N repo facility to avoid fails to delivery. The SLF's task is to offer government securities to facilitate trading and settlement. The purpose of the T/N and repo swap facility is to help primary dealers fulfil their commitments of quoting two-way prices and to manage market risk (market-making).

In practical terms, the arrangements of the SLF allow primary dealers to borrow any bond from the DMO against cash, of *unlimited size*, overnight or tomorrow-next. In the repo swap facility there is a maximum

[9] Market liquidity is widely recognized as a multidimensional concept, which is difficult to capture with a single measure. It is instead described by a variety of measures included traded volumes and ex-ante and post-trade metrics. Post-trade measures are rare and hard to come by as they are based on supervisory reporting, see Blix Grimaldi et al. (2021) for an overview of post-trade liquidity measures and their application to the Swedish government bond market.

[10] The Swedish SLF is available as buy-/sell-back transactions.

[11] O/N repo transaction is settled on the same date as it trades (T) and the collateral is repurchased on the next business day (T + 1). The T/N repo transaction is settled at T + 1 (one business day after the repo trade date), whereas the bond is repurchased at T + 2.

[12] More specifically, the buy-/sell-back and sell-/buy- back transactions cancel each other out. A transaction in the repo swap facility (T/W) is settled T+1.

[13] The SLF is not the only tool the Swedish DMO uses to promote liquidity in the secondary government bond market. It also uses switches from time to time. Switches are a common tool among DMOs and are typically used for achieving several goals within debt management (Blommestein, Elmadag and Ejsing, 2012). In a switch operation, a DMO provides investors with the opportunity to exchange existing bonds – typically less-liquid and off-the-run – with newly issued bonds of higher liquidity. The Swedish DMO uses switches mainly to build up the volume of selected bonds more quickly. In the past, it has also used switches to concentrate liquidity across the yield curve by consolidating issuances into larger and more liquid maturities. This was done, for example, at times of declining public debt and significantly reduced issuance needs (SNDO, 2017). Switches are performed through auctions, the terms and conditions of which are announced well in advance, – up to four weeks – to give investors time to adjust by a large margin.

volume that can be transacted.[14] Notably, both facilities come with the option of rolling over the transactions *indefinitely*.[15]

Through their exclusive participation agreement in the DMO's SLF, primary dealers are provided access to bonds outside the regular securities auctions in the primary markets. In exchange, primary dealers have to comply with a set of requirements. For example, they are to quote buy and sell prices in the secondary market. They also need to maintain a market share that is at least 2.5 per cent of the total turnover in the primary market at every auction, and they are expected to submit bids that, at the time of the auction, are reasonable in terms of market pricing in all government securities auctions.[16] Once dealers become primary dealers, they are expected to continue to comply with the DMO's standards and eligibility criteria on an ongoing basis.

An apparent paradox of a SLF is that it is "best used when little used".[17] The rationale is that the facility is intended to be a last-resort mechanism. Primary dealers are expected to first try to cover their positions by finding securities in the market. A SLF is intended to provide only a safety net: if dealers encounter a delivery problem or need to cover (or create) a position in the market and cannot meet their commitments, the DMO provides for the missing securities via a repo or a repo-swap transaction. In this way, the DMO acts as a *"securities lender of last resort"*.

In general, a SLF is an effective backstop insofar as it supports bond market liquidity without hampering the normal functioning of short-term funding markets. As with any backstop or safety net, there is a risk of a SLF being "gamed". Such a risk, which relates to potential moral hazard behaviour and speculative arbitrage, can damage general investor confidence and the overall functioning of the government bond market.

The terms and conditions attached to a SLF are the key features that ensure the SLF is only used as a safety net. A critical tool is the pricing framework. By setting a lending fee at a premium in relation to short-term funding market interest rates, a DMO can ensure that its SLF is used only as a last resort.[18] The choice of the short-term funding market rate is therefore a key policy choice of the DMO.

The choice of the short-term funding market rate can vary. The Eurosystem central banks have chosen the repo market rate as the reference rate for setting the premium of the SLF. In the repo market, government securities that primary dealers acquired through the SLF enter transactions as collateral.[19] The advantage of choosing the repo market rate as a reference rate (over a fixed fee) is that it allows the SLF premium to vary with market rates thereby reducing the risk of primary dealers extracting rents from non-primary dealers.

Arrata et al. (2020) and Jank et al. (2021) show that the repo market rates declined significantly following the ECB's QE (APP and PEPP) programmes. A *specialness premium* arose, which made it more expensive for market actors to borrow specific government bonds against cash.[20] This is in line with Schaffner et al. (2019), who show that collateral scarcity from ECB asset purchases boosted activity in specific

[14] Repo swaps (T/W) of government securities are transacted in multiples of SEK 500 million and up to SEK 2 billion, per government security and primary dealer. The transaction is cash neutral.
[15] Primary dealers can use the SLF for subsequent transactions of the same bonds until one day prior to maturity.
[16] See Primary dealers – Riksgälden.se (riksgalden.se).
[17] It is worth noting that the mere existence of a SLF can affect investors' behaviour by increasing confidence in their understanding that the government bond market is functioning well.
[18] See World Bank (2015). Generally, changes in the SLF's charged premium are rare as to foster the DMO's predictability and reduce uncertainty for primary dealers and investors.
[19] See Securities lending under the APP and PEPP | Deutsche Bundesbank.
[20] A *specialness premium* arises when borrowing a specific bond in the repo market against cash may come at a cost and require a premium to be paid for it in the form of a lower cash remuneration.

collateral segments of the European government-bond repo market and reduced it in the general collateral segments. This change is consistent with a shift in the European repo market towards transactions that are more securities-driven and less funding-driven, i.e. the repo market is used to obtain securities rather than cash funding.

Proprietary market data we obtained from market participants indicate that a *specialness premium* arose also in the Swedish repo market following the Riksbank's QE. The data show that the prevailing rate in the repo market declined to a significantly lower level than the monetary policy rate. The repo rate for bonds that were in high demand in the QE programme dropped lower than the SLF premium.[21]

In the period covered by this study, January 2002 – November 2021, the SLF premium for the Swedish O/N and T/N repo facilities was set at the monetary policy rate minus 45 and 40 basis points, respectively. For the repo swap facility, this price was 30 basis points below the monetary policy rate since its inception.[22] In January 2020, the terms for the repo swap facility were changed to 20 basis points below the monetary policy rate, and the maximum volume was raised to SEK 4 billion per government security and primary dealer.

In September 2021, the ordinary terms for the repo swap facility were restored to their previous levels of 30 basis points below the monetary policy rate, whereas the maximum volume was allowed to remain at SEK 4 billion up to September 2022.[23]

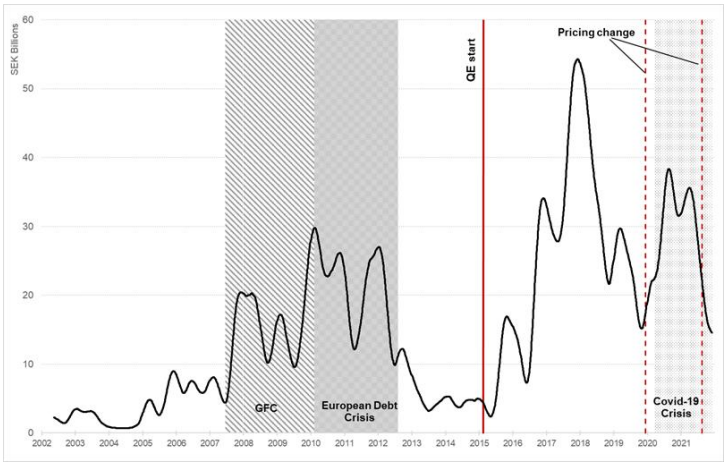
5. Usage of the SLF

Figure 11 shows the volumes of nominal government bonds created in the facility and lent out to the primary dealers from 2002 to 2021.

We observe heightened usage of the SLF in several periods.[24] We identify four main periods, which coincide with the 2007–2009 global financial crisis (GFC), the subsequent European sovereign debt crisis in 2010–2012, the quantitative easing period starting in 2015, and the Covid-19 pandemic period from March 2020 to the end of our sample in November 2021 (see Figure 11).

[21] The monetary policy rate is also called the repo rate in Sweden. It is the interest rate at which banks can borrow or deposit funds at the Riksbank for a period of one week.
[22] The maximum volume allowed to be transacted was in multiples of SEK 500 million. See footnote 11.
[23] See Market-supporting repos and switches – Riksgälden.se (riksgalden.se).
[24] In this paper, we mainly focus on nominal government bonds because this fits the general purpose and scope of our analysis. We refer to other government debt securities such as T-bills and inflation-linked bonds only for comparison where appropriate.

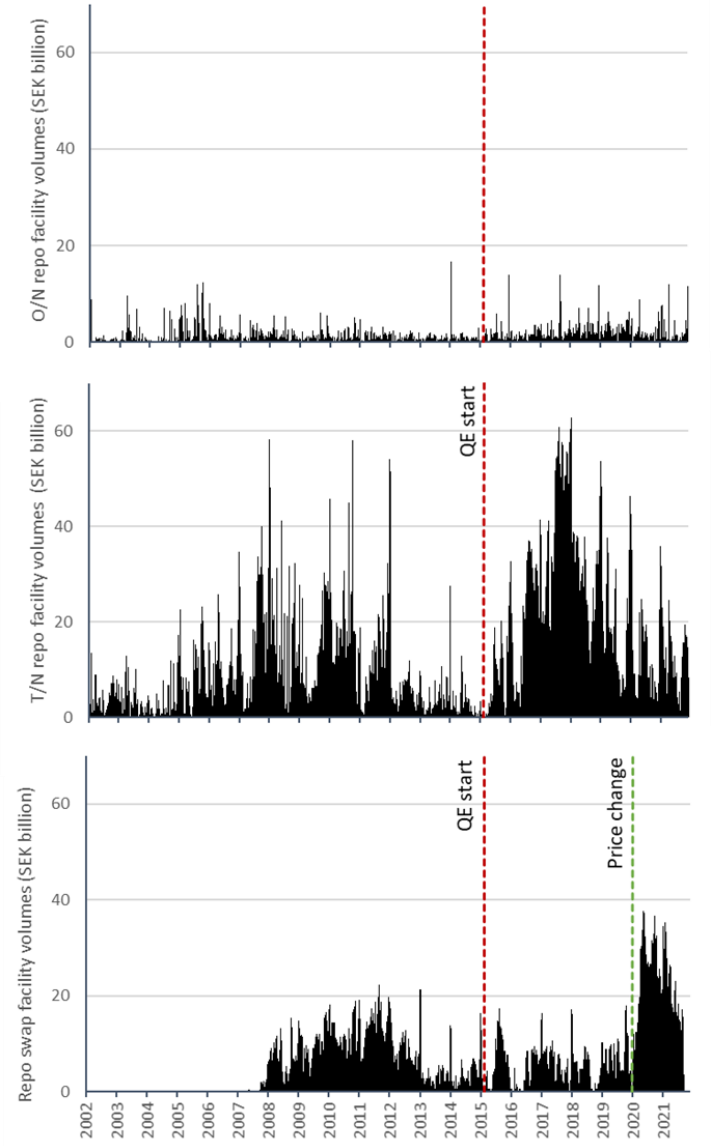
Figure 11: Lending volumes in SLF



Note: Figure 11 shows a three-month moving average of the daily total volumes of nominal government bonds lent out in the SLF expressed in SEK billion. GFC stands for global financial crisis
Source: Swedish National Debt Office and authors' calculations

We separate the volumes by facility type. The usage over time of the SLF significantly differs across types. The T/N repo facility is notably the largest facility with average daily volume of about 10 billion and is significantly larger than the O/N and repo swap facilities combined. Compared with the other types, the O/N facility has the lowest volume at about 0.5 billion on average over the period we analysed (Figure 12).

Figure 12: Volumes lent out in the repo facility by facility type



Note: Figure 12 shows volumes of nominal government bonds lent out in the O/N, T/N and repo swap facility in SEK billion at daily frequency. The vertical lines show the date of the start of the QE programme in February 2015 and the date the Swedish DMO announced the change in the pricing and volume policy for the repo swap facility.
Source: Swedish National Debt Office

5.1 The global financial crisis and the European sovereign debt crisis

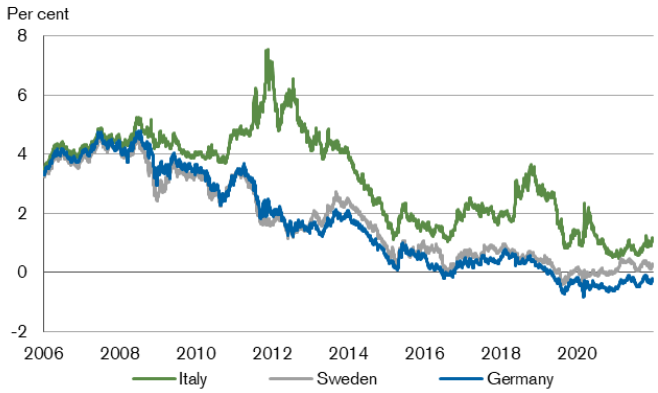
During the global financial crisis (GFC), the volumes of government bonds lent out in the cash T/N repo facility and the repo swap facility increased significantly – from an average of about 5 SEK billion and 1 SEK billion before the GFC to 10 SEK billion and 8 SEK billion during the crisis, respectively. At the peak of the GFC, the volume transacted in the T/N repo facility increased to about 30 SEK billion. During the GFC and the European sovereign debt crisis, demand for safe and liquid government bonds increased significantly. The importance of flight to liquidity flows in government bond markets has been documented before (see, among many others, ECB (2009).[25] Swedish government bonds belong to a very small group of ultra-safe (AAA credit rating) European bonds. However, the Swedish government

[25] De Santis (2013) and Garcia and Gimeno (2014) discuss the prominence of flight to liquidity during the European sovereign debt crisis.

bond market is relatively small compared with other European countries, and while it may be an attractive alternative for investors driven by flight to quality concerns, the intrinsic low liquidity of the government bond market may carry more weight when liquidity is perceived to be especially low.

Figure 13 shows that yields on Swedish government bonds decreased during the European sovereign debt crisis (2010-2012), similar to the German bond yields, possibly indicating some flight to quality flows into the Swedish government bond market. At the same time, we observed a relatively moderate increase in the usage of the SLF, which will be addressed further in the empirical section of this report.

Figure 13: Government bond yields (10-year) in selected European countries



Source: Macrobond

5.2 Central bank quantitative easing

Usage of the SLF has increased significantly since the Riksbank launched its QE programme in 2015. The volumes in the facility reached an all-time high, over 70 SEK billion, during 2017. They declined somewhat after 2017 but have remained at a significantly higher level than the average level from before the QE period. Blix Grimaldi et al. (2021), show that the unusually high usage of the Swedish SLF is related to bond scarcity and demand from the central bank. As the so-called free float – the amount of bonds available to private investors for trading – diminishes, primary dealers resort more to the SLF to avoid fails to deliver and be able to continue to fulfil their market-making commitments. Survey data from the DMO provide supportive evidence of a scarcity-induced usage of the SLF and the key role of the SLF in mitigating a decrease in free float.

In addition, demand from the central bank increases the *specialness premium* of government bonds in the repo market (Arrata et al., 2020). *Specialness premiums* can also be related to the bargaining power that primary dealers, who have access to the SLF, acquire in the money (repo) market as they can remunerate non-primary dealers at a lower rate. Our proprietary data from Swedish market actors provide supportive evidence of the existence of a specialness premium in the Swedish market.

5.3 The Covid-19 pandemic

In the previous section, we described how the fiscal response to the Covid-19 crisis led to a larger government borrowing requirement for most OECD countries, but that by the second half of 2020 economic conditions had already improved, although with significant variation from country to country.

In Sweden, by the end of 2021 the DMO's net borrowing was once again back to negative and in line with the trend from before the pandemic. Nevertheless, the increased supply of sovereign debt in 2020 may have contributed to keeping the lending volumes in the T/N and O/N facilities at a relatively low level during the period of the Covid-19 crisis covered in this analysis (up to November 2021).

5.4 Change in the SLF pricing in early 2020

Volumes in the repo swap facility increased significantly at the beginning of 2020, before the Covid-19 crisis. In January 2020, the DMO temporarily decreased the premium that primary dealers need to pay to use the repo swap facility, by 10 basis points to 20 basis points below the monetary policy rate, and it increased the maximum volume to SEK 4 billion per security and primary dealer while leaving premiums on the O/N and T/N facilities unchanged.[26] Following the change, in the first two months of 2020 the average volume of securities transacted in the repo swap facility increased to around 8 SEK billion on average, from an average level of about 4 SEK billion recorded in 2015–2019. Volumes fell back to the previous level or even lower by September 2021 when the premium was restored to 30 basis points below the monetary policy rate. In the next section, we show evidence suggesting that the effects of the pricing change in the repo swap facility were not limited to this facility but affected T/N volumes as well. The change in the swap facility's premium may have encouraged primary dealers to switch from the T/N facility to the repo swap facility thereby contributing to lower volumes in the T/N facility.[27]

6. Data and estimation procedure

6.1 Data

To compute the nominal bond volumes traded in the SLF, we use proprietary daily data provided by the DMO at the security level.[28] For each SLF transaction, we have the trade and settlement dates, the nominal amount, and the ISIN identifier. We aggregate the data to monthly frequency to mitigate noisiness in the daily, transaction-based data and compute the bond-by-bond ratio of the SLF volumes to the outstanding volume of the bond. The outstanding volume of each bond is also provided by the DMO. We also use the DMO data to explore changes in the investors base and investors' holding structure. For each bond, we complement the daily SLF volumes with the Riksbank's purchases retrieved from the Riksbank's webpage and compute its holdings and the ratios of each bond purchase and holdings of the total bonds outstanding.[29] We also retrieve variables from Macrobond such as the bond volatility index IIMA.[30]

Our data consists of a total of 699 monthly observations. We use 14 nominal bonds. We organise the data in a panel. Our panel data is unbalanced because not all bonds are transacted in the SLF on each date. The time period in the panel regression is February 2015 - November 2021.

Table A1 in Appendix shows key descriptive statistics of the main variables we use in our empirical exercises.

[26] There are no limits on the volumes allowed to be transacted in the repo cash facility.
[27] Another possible contributing factor to the higher usage of the repo swap facility during 2020 is the increased supply of T-bills during that period. T-bills were used as collateral.
[28] See footnote 24.
[29] The Riksbank started purchasing Swedish government bonds as early as 2012 on a small scale. We only include in our analysis the government bonds that were purchased for QE purposes (14 bonds). There were 16 outstanding nominal bonds during the period of February 2015-November 2021. Five months into the QE program the Riksbank made purchases in all outstanding nominal bonds.
[30] The IIMA index is the global market volatility index (bond) produced by the Institute for International Monetary Affairs. Correlation between bond volatility indices IIMA index and MOVE is about 75 per cent.

6.2 Estimation results

We estimate a panel regression with bond fixed effects. The left-hand variable is therefore the volumes of the SLF for each bond in a given month. Our main independent variables are the ratio of the Riksbank's purchases and holdings to outstanding amount. To account for the possibility that error terms may be correlated across similar bonds, we adjust the standard error for cross-sectional and serial correlation. Our baseline specification is as follows:

$$SLF_{i,t} = \alpha_i + \beta_1 Holdings_{i,t-1} + \beta_2 Purchases_{i,t} + \beta_3 Issuance_{i,t-1} + \beta_4 Vol_t + \beta_5 RSdummy_t + \epsilon_{i,t} \quad (1)$$

where $Holdings_{i,t-1}$denotes the lagged Riksbank's holdings as a share of outstanding volumes, $Purchases_{i,t}$ are bond purchases by the Riksbank as a share of outstanding, $Issuance_{i,t-1}$ is the lagged ratio of bond issuance volumes to outstanding amount, Vol_t denotes macroeconomic variables such as the IIMA index, which captures changing market conditions.[31] We also include a dummy variable, $RSdummy_t$, which picks up the temporary change in the repo swap facility premium.[32] The dummy variable takes the value one for the period in which the premium was changed and set to 20 basis points below the monetary policy rate and zero otherwise.[33] Table 1 summarises our main results.[34]

[31] We lag the variables in order to reduce potential multicollinearity.

[32] The maximum volume allowed to be transacted also changed to SEK 4 billion per security and primary dealer.

[33] With the exception of the period January–September 2020, the premium in the repo swap facility has been set at 30 basis points below the monetary policy rate.

[34] We use Arellano robust standard error in our main regression which corrects for cross sectional and serial correlation. In robustness checks, we use cross sectional robust standard error. We also use time fixed effects instead of bond fixed effects and two-way fixed effects. We also use alternative regressors for Vol_t, such as the MOVE Index. We also run alternative specification of equation (1) by adding a new variable $RSdummy_t * \beta_3 Issuance_{t-1}$to take into account possible interactions between the repo swap facility pricing change and government bond issuance volumes. To account for non-normal residuals due to skewed distribution in the dependent variable, which only takes positive values, we log transform the dependent variable and run the regression in log - levels. We also run the regression as a pooled GLM panel regression. The results of all robustness checks are qualitatively similar to those of our main regression.

Table 1: Panel regression results

	(1)	(2)	(3)	(4)
Holdings	0.22***	0.22***	0.22***	0.08**
	(0.07)	(0.08)	(0.08)	(0.04)
Purchases	10.69***	11.90***	11.88***	10.38**
	(4.09)	(3.67)	(3.68)	(4.14)
Issuance		-1.84***	-1.85***	-1.63**
		(0.66)	(0.66)	(0.64)
Vol			0.94	-0.02***
			(1.87)	(0.01)
RS dummy				-0.01
				(0.01)
Bond FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	No
N. obs	699	699	699	699
R-Sq.	0.13	0.14	0.14	0.08

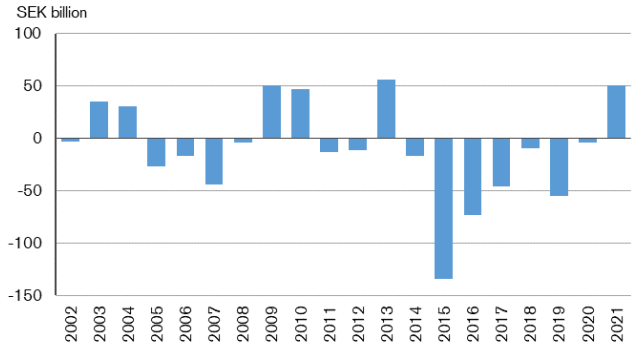
Note: Total SLF volumes are the dependent variable for each regression in Table 1. Standard errors in parentheses.
** p<0.1; **p<0.05; ***p<0.01*

The central bank QE programme significantly affects the total volumes of the SLF, across all specifications.[35] Both purchases and holdings increase the usage of the repo facility. The coefficient of *Purchases* is greater than the one of *Holdings* suggesting that the Riksbank's demand has a large effect on the bonds transacted in the SLF. Blix Grimaldi et al. (2021) discuss the differential impact of central bank purchases and holdings on government bond liquidity. They find that although the effect of purchases is larger than that of holdings, the economic significance of holdings tends to be greater, as purchases are one-off events while holdings continually grow with new purchases. A similar rationale may also be applied to the usage of the SLF and the fact that the impact of one-off purchases tends to be smaller than that of holdings (i.e. accumulated purchases that can cause scarcity) over time. As expected, we find that an increase in issuance lowers the usage of the repo facility.

An alternative way of assessing the impact of purchases is by visualising the market's net supply, i.e. net issuance volumes of purchases. Net supply of nominal government bonds turned significantly negative in 2015 and remained negative until 2020. In 2021, net supply turned positive with the supply increase from fiscal stimulus in response to the pandemic (Figure 14).

[35] In Appendix II we show alternative specifications of our baseline estimation and robustness checks.

Figure 14: Net supply of nominal government bonds



Note: Net supply of nominal government bonds is defined as the difference between the annual change in nominal government bonds outstanding and the annual change in the Riksbank's holdings of the nominal government bonds
Source: Sveriges Riksbank, Swedish National Debt Office and authors' calculations

The impact of deteriorating economic conditions on the usage of the SLF is a priori ambiguous, depending on whether flight to quality or flight to liquidity concerns tend to dominate.[36] We found that an increase in the IIMA index, i.e. deteriorating financial conditions and heightened financial stress, is associated with a decline in the usage of the SLF, thereby offering some support to the prevalence of flight to liquidity flows. It is reasonable that flight to liquidity concerns have tended to dominate after the start of the QE and ensuing bond scarcity. Figure 8 in Section 3 shows the changes in foreign investors' share of Swedish government bonds. The share of foreign investors, an indicator for liquidity problems, which can be interpreted as measure of flight to liquidity, declined noticeably after 2015, when QE was launched, and has remained at a low level since. Altogether, flight to quality and flight to liquidity work as opposing forces in the Swedish government bond market. We find that heightened financial stress is associated with a decline in SLF usage, lending support to the prevalence of flight to liquidity flows.

Finally, we included the change in pricing for the repo swap facility and found that it is not statistically significant for the overall volumes in the SLF.

Table 2 shows estimation results as in Table 1 but for the different types of the SLF. Column 1 shows the results for the overall volumes in the SLF as in column (4) of Table 1 to facilitate comparison. Columns (2)-(4) show the results for the repo T/N, O/N, and repo swap facilities, respectively. There are three key results.

First, the QE appears to affect all types of the SLF, albeit to differing degrees. The QE impact is significantly lower for the O/N repo facility. This is not surprising, given that the purpose of the O/N facility is to help primary dealers avoiding fails to deliver, which occur when a trade fails to settle on schedule. In general, settlement fails are not treated as a default event by market participants but more as operational friction. Therefore, while imbalances in supply and demand such as those potentially associated with QE programmes can create more and/or larger fails to deliver, their frequency and/or size remains relatively low. Figure 12 shows the daily volumes traded in the O/N facility. Clearly, while volumes have increased since 2015, the overall volumes remain comparatively low at about 3 per cent of the total volumes transacted in the SLF.

[36] Flight to quality concerns may create additional demand for Swedish government bonds that may in part be absorbed through the increased supply via the SLF, even if on a temporary basis.

The T/N and the repo swap facilities, which account for about 55 and 42 per cent of the total volumes respectively, absorb most of the impact of the QE. The main common purpose of both types of facility is to contribute to smooth market functioning and support market liquidity in the government bond market. It is therefore reasonable that both facilities are used more when demand increases, all other things being equal. As we noted before, the usage of the T/N facility increased significantly during 2015-2017 and peaked in the end of 2017 (see Figure 12). We will discuss this further below.

The results in Table 2 also show the differential impact of the change in the premium of the repo swap facility. Column (4) shows that – as expected – the pricing change affected the volumes transacted in the repo swap facility positively. The impact of the change in the repo swap facility was not confined to this facility. In fact, the results in columns (2) and (3) show that both the volumes in the O/N and, especially, the T/N facility were affected. This suggests a substitution effect rather than an overall enhanced liquidity effect, which could have been expected by the change of the pricing policy. This can also explain why the coefficient on the RS dummy is not significant in column (1). More analysis needs to be done to further corroborate these findings.

Table 2: Panel regression results

	Total (1)	T/N (2)	O/N (3)	Swap (4)
Holding	0.08** (0.04)	0.04* (0.02)	0.004* (0.002)	0.02 (0.02)
Purchases	10.38** (4.14)	6.06* (3.30)	0.68* (0.41)	4.10** (1.87)
Issuance	-1.63** (0.64)	-1.04* (0.55)	0.05 (0.07)	0.24 (0.62)
Vol	-0.02*** (0.01)	-0.03*** (0.01)	-0.00 (0.00)	0.01 (0.01)
RS dummy	-0.01 (0.01)	-0.03*** (0.01)	-0.002*** (0.001)	0.02** (0.01)
Bond FE	Yes	Yes	Yes	Yes
Time FE	No	No	No	No
N. obs	699	674	656	382
R-Sq.	0.08	0.13	0.03	0.14

*Note: Volumes by total and type of SLF are the dependent variable for each regression in Table 2. Standard errors in parenthesis. * p<0.1; **p<0.05; ***p<0.01*

6.3 Riksbank's demand affects usage of the SLF

The above results show that usage of the SLF increased with the implementation of the QE programme. Government bond scarcity was a driving force, which the SLF, at least partly, helped mitigate through additional on-demand issuance.

By the end of 2017, the Riksbank's nominal bond holdings had reached about 40 per cent of the nominal bonds outstanding. In the following years, as we have shown in previous sections, government bond scarcity continued to increase. In early 2020, before the start of the Covid-19 pandemic, the Riksbank's holdings of nominal bonds had reached 50 per cent of total nominal bonds outstanding.

Yet by 2017, despite the continuing increase in the Riksbank's holding ratio (*scarcity*), usage of the SLF peaked, although it fell to a higher level than that observed in the period before QE, as we pointed out in section 4.1. This may seem puzzling.

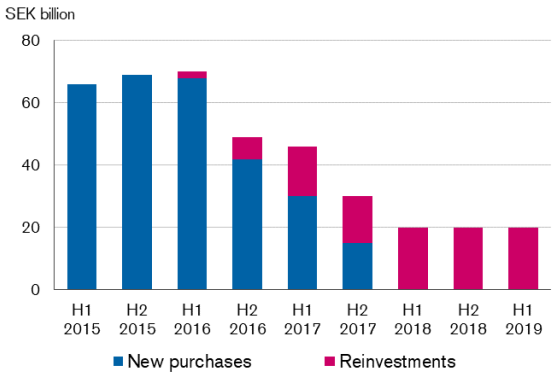
We argue that the apparent contradiction of increasing scarcity and significantly decreased usage of the SLF is likely related to the *demand effect* induced by outright purchases and the impact of the Riksbank's communication about its QE programme.

In December 2017, the Riksbank announced that it would reinvest redemptions and coupons payments (until the monetary policy rate had reached an appropriate level) but would not make new purchases. The change was communicated as part of the Riksbank's strategy for a gradual normalisation of monetary policy (Riksbank, 2017).[37]

From a market participant's perspective, this implied that trading opportunities with the central bank would significantly diminish (see Figure 15). Starting in December 2017, following the announcement of the change in the demand from the Riksbank, primary dealers significantly reduced usage of the SLF.

The announcement of the change in policy provides a distinct way of separating the demand from scarcity-induced usage of the SLF. We plan to publish a detailed analysis on this in future research.

Figure 15: Riksbank's purchases and reinvestments



Source: Sveriges Riksbank and authors' calculations

7. Conclusions

In this paper, using a novel approach based on proprietary information of the Swedish DMO securities lending facility from 2002 to 2021, we investigate key changes in the government bond market. We focus on the usage of the SLF and primary dealers' demand.

Governments and central banks around the world were successful in implementing rapid and powerful policy responses, and they managed to mitigate the effects of the shock to financial markets and the

[37] See Press Release at Monetary policy report, December 2017 | Sveriges Riksbank.

economic contraction that resulted from the Covid-19 crisis. In Sweden, the Covid-19 crisis had only temporary effects on the Swedish economic output and the government bond market.

We can observe heightened usage of the SLF in several periods. We identify four main periods coinciding with the 2007–2009 global financial crisis (GFC), the subsequent European sovereign debt crisis in 2010–2012, the quantitative easing period starting in 2015, and the Covid-19 pandemic period from March 2020 to the end of our sample (November 2021).

We find that QE policies have had a significant influence on the usage of the facility, leading to potential persistent changes in market structure. We find that the central bank QE programme significantly affected the total volumes of the SLF across all specifications.

Our results show that flight to quality and flight to liquidity were opposing forces in the Swedish government bond market. We find that deteriorating financial conditions and heightened financial stress is associated with a decline in the usage of the SLF, thereby giving some support to the prevalence of flight to liquidity flows.

Finally, we show that the terms and conditions attached to a SLF are a powerful DMO policy tool and that changes can bring about significant shifts in the usage of the SLF. We show that a temporary pricing change in the repo swap facility did not affect total lending volumes in the SLF. The increase in the volumes transacted in the repo swap facility appear to have been offset by lower volumes in the cash facilities. While more analysis needs to be done to fully understand such a change, this finding suggests a substitution effect rather than an enhanced liquidity effect of the DMO's pricing change.

Appendix

Table A1: Summary statistics of key variables

Variable	mean	min	max	median
Nom. outstanding volume (SEK billion)	57.38	0.00	108.10	53.37
Total SLF volume (SEK billion)	0.48	0.00	9.01	0.54
ON SLF volume (SEK billion)	0.20	0.00	2.57	0.11
TN SLF volume (SEK billion)	0.46	0.00	9.00	0.54
RS SLF volume (SEK billion)	0.60	0.00	2.58	0.55
Riksbank's purchases (SEK billion)	0.03	0.00	3.50	0.00
Riksbank's holdings (SEK billion)	27.10	0.50	66.21	27.10

Source: SNDO, Sveriges Riksbank and authors' calculations
Note: Summary statistics are based on nominal government bonds included in the Riksbank's QE program

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Auctions and Liquidity Conditions in the Italian Government Bond Market[1]

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Abstract

In this paper, we contribute to the literature analysing the liquidity loop between primary and secondary markets of government bonds. Relying on primary market and MTS data, we empirically assess and identify a significant information effect of auctions on price discovery process in the secondary market. The informative power lasts also in the days after the auction. In addition, by the introduction of a new auction's performance indicator - which we measure as an overpricing index - we show that better auctions lead to more liquid quoting books. Furthermore, our findings suggest heterogeneous quoting behaviour among dealers and over time.

Keywords: Market microstructure; Market Makers; Public Debt Auctions Performance; Market Sentiment; MTS data.

JEL Classification Numbers: G12, G14, G18, H63.

1. Introduction

The efficiency of the secondary markets of government debt securities is crucial in a world of growing public debts (OECD, 2020). The capacity of public debt managers to trade off risk exposures and debt service minimization by their issuing strategies on primary markets requires an appropriate microstructure of secondary markets. In particular, the latter should be conducive to liquidity. If the secondary markets of government bonds do not afford *quick trade of large quantities of assets at a low cost*, primary dealers and other market participants will request a larger *premium* - hence higher yields - on issued bonds to face such a liquidity risk. On the other side, the issuing strategy of public debt managers, particularly the outcomes of auctions, plays an important role in determining the liquidity conditions of secondary markets. Understanding such a liquidity loop between primary and secondary markets is an interesting, policy-relevant issue.

Auctions can impact on the performance of secondary markets through two intertwined channels. First, the performance of an auction, that is driven by the equilibrium between supply and demand of concerned government bonds, determines a mechanical effect that is linked to the relative scarcity of assets in the balance sheets of market participants and, thus, on the secondary markets. Second, the

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auction's performance provides an informative signal to primary dealers and other market participants about the "market sentiment", which influences the future value of traded securities.

The finance literature has investigated the impact of primary market performance on prices and yields on secondary markets. As regards government securities, the literature has documented a cyclic movement of prices and yields around the auction day (e.g., Lou et al, 2013; Beetsma et al. 2016). Moreover, the stylized facts of the functioning of government bond markets suggest some kind of relationship between auctions and market liquidity, an issue that has not been explored systematically in the literature yet. For example, different liquidity measures of the Italian government bond market in the period 2016-2019 show that, on average, liquidity improves in the 11-day time window around the auction. Similar descriptive statistics suggest that the way auctions impact on market liquidity is an interesting research issue and this motivates our paper.

With this paper, we empirically assess the relationship between government bonds' auctions[1] and the liquidity of the MTS cash market[2] of specific Italian government bonds around the auction event, covering three on-the-run maturities (i.e., 3-year, 7-year and 10-year BTPs), from January 2016 to December 2019. To measure the performance of the auctions we rely on two indicators. First, we use the *bid-to-cover ratio*, which is commonly considered a measure of auctions' success (Beetsma et al., 2018a).[3] Second, we introduce a new indicator, the *overpricing index,* which is intended to proxy the "good news" effect of the auction.[4]

We make empirical contributions to the existing literature. We mainly contribute to the literature regarding the relationship between primary and secondary markets by identifying an information channel between the auction (and its outcome) and secondary market liquidity.[5] We find that the main event itself - irrespective of the outcome - affects positively liquidity conditions of the secondary market on the same day and this impact is not short-lived, yet, in some cases, it lasts also in the 5 days after the issuance. Furthermore, a "good" auction, in terms of high auction performance indicator, has an impact on overall dealers' behaviour leading to a more liquid quoting book. Nevertheless, only the overpricing index is significant in driving the liquidity discovery process of the book. As regards the external validity of our empirical findings, the Italian government bond market is an interesting case concerning public debt management and the functioning of primary and secondary markets. Since early 1990s, a growing and very large public debt forced the Italian government to pursue a path-breaking model of secondary market, eventually leading to the establishment of MTS Italy, the first electronic market of government securities in Europe.

The paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the dataset, presents the empirical treatments and the final results. Section 4 concludes. The appendix in

[1] There are two main periods for auctions, one takes place at the middle of the month and concerns, regarding medium-long term allocation, 3-, 7-, higher than 10-year BTPs and the second one at the end of the month which involves 5- and 10-year BTPs.

[2] MTS is an interdealer platform with a high level of pre- and post-trade transparency established in 1988 by the Italian Treasury. The MTS trading system is quote-driven, electronic limit-order interdealer market, in which market makers' quotes can be hit or lifted by other market participants via market orders. MTS Italy is a branch of the entire MTS trading system and it is the secondary market where Specialists (a subset of primary dealers) are monitored by the Italian Treasury. It is regulated by the Italian Treasury, the Bank of Italy and the Stock Exchange Regulator (Consob).

[3] The bid-to-cover ratio is the ratio between the total amount bid by primary dealers on the auction day and the total amount supplied by the Treasury. See Section 3.1.1 for a more comprehensive definition of the indicator.

[4] The overpricing index is the difference between the allocation price and the mid-price of the bond on the secondary market five minutes before the auction scaled down but the original maturity of the security. Therefore, the larger the index the better is the signal about the value of the issued bonds, with respect to pre-auction perception. See Section 3.1.1 for a more comprehensive definition of the indicator.

[5] We rely on different metrics of market liquidity to provide a more comprehensive approach. A review of several measures can be found in Mormando and Greco (2018).

Section 5 gives higher-level information about the institutional framework and the government debt securities used in the analysis.

2. Related literature

As first, this paper contributes to the literature concerning the relationship between primary and secondary markets of government securities. The existing literature has shown that prices and yields follow a specific pattern around auction day, the so called *auction cycle* (Lou et al., 2013, Beetsma et al., 2016, Cafiso, 2019). Prices (yields) start decreasing (increasing) on the days before the auction and increase (decrease) thereafter. Also, the cycle is larger in periods of turmoil and unconventional monetary policy dampens further yield changes (Van Spronsen et al., 2021).

The auction cycle has been attributed to the limited risk-bearing capacity of dealers and to other factors, such as: profit-seeking purposes (Fleming et al., 2007), the gradual arrival of buyers in the market (Duffie, 2010),[6] the price impact of other traders who sell ahead the issuance of bonds (Bessembinder et al., 2016),[7] the characteristics of the auctioned bond and of those already traded in the secondary market (Eisl et al., 2019), and the release of information by the Treasury (Bikhchandani and Huang, 1993; Sigaux, 2018). To our knowledge, our contribution is the first to analyse the movement of liquidity around and on the auction day.

Yield changes can be altered by a specific indicator of the result of auctions. Beetsma et al. (2018a) find evidence that the bid-to-cover ratio is a good predictor of the yield movements in the secondary market around auctions. The bid-to-cover ratio is the only indicator of auction performance that has been used in the literature so far. For instance, Lou et al. (2013) use it as a proxy of the state of the Treasury markets and of the overall economy. In our work, we focus on the informative effect of auctions on market liquidity on the auction day, which is why we also introduce a new indicator, the overpricing index, which measures the (positive) surprise effect of the auction in terms of prices. Section 3.2 describes how this indicator is calculated.

The second strand of literature to which we contribute concerns market microstructure. From an empirical standpoint, information plays an important role in the liquidity discovery process. Nguyen et al. (2020) show that liquidity conditions, specifically market depth and trading volumes, change after announcements of macroeconomic data. More generally, (good) news have a (positive) impact on market liquidity (Riordan et al., 2013; Han et al., 2016).[8] In line with this literature, we find that also the performance of government bond auctions has an informative effect on market liquidity. Furthermore, as pointed out by Choi (2019), in periods of higher volatility liquidity - in the sense of trading volume - increases around announcements under periods characterized by higher uncertainty. Our results corroborate this statement as we find proof that information from auctions' outcome is more important in higher volatility periods.

Related to our contribution there is also a vast literature analysing the different determinants of liquidity on government bond markets. Mormando and Greco (2020) identify the causal relationship between changes in the evaluation criteria of specialists' activity by the Italian Treasury and market liquidity

[6] Duffie (2010) explains that if capital constraints of market participants are less severe over time because more dealers arrive in the market, yields will be on a decreasing path in the days before the emission of the bond.
[7] Bessembinder et al. (2016) do not deal with the Treasury market directly, but their work relates to trading strategies of market participants around large and predictable trades that affect the price pattern of securities traded.
[8] For example, Riordan et al. (2013) show that the intraday liquidity in the Toronto Stock Exchange is positively affected by good and neutral news, and negatively affected by bad public news.

conditions. Ferrari et al. (2019) point out that secondary market liquidity development of government bonds is also affected by the financial constraints of primary dealers.[9] Pelizzon et al. (2014) find a strong correlation between liquidity shocks in the futures and cash markets for the Italian government bonds.[10] Moreover, liquidity is determined by the characteristics of issued bonds (Corwin et al., 2004; Rappoport et al., 2015; Eisl et al., 2019). At the same time, (il)liquidity conditions affect dealers bidding behaviour. In particular, Rappoport et al. (2015), show that secondary market illiquidity pushes investors to ask for a higher liquidity premium when they participate at auctions. Complementary to this finding, Buis et al. (2019) analyse the effect of issuance fees in syndicated issues on liquidity conditions of European government bonds.

3. Empirical analysis

For our empirical analysis, we use primary and secondary market data for specific Italian government bonds in order to assess whether there is a new channel through which the primary market is linked to the secondary one. In the first place, we aim to demonstrate empirically whether, and to what extent, public debt auctions of specific debt instruments have an impact on secondary market liquidity of the same security. In the second place, we intend to establish if not only the auction but also its outcome has a significant effect in driving market liquidity. In order to do this, we rely on the Italian government bond markets. In Section 3.1 we introduce the dataset and in Section 3.2 we discuss the empirical strategy and present our results.

3.1 Data

Data are collected from the Italian Treasury, which allow us to measure two auction performance indicators (Section 3.1.1), and from MTS Italy, which enable us to estimate the evolution of secondary market liquidity in time spans around the auction days (Section 3.1.2).[11]

Auctions' performance and other primary market data

Based on auctions data published by the Treasury, we consider all non-first auctions from January 1st 2016 to December 31st 2019 of 3 types of BTPs, i.e. 3-, 7-, 10-year original maturity, for a total of 103 events of interest and a sample of 27 BTPs.[12] Auctions' results are publicly available on the website of the Treasury and contain many information that we included in our dataset. First, the auction day that we used to create two dummy variables: the *auction dummy* that is one on the auction day and zero otherwise; and the *post-auction dummy* that is one in the days following the auction and zero on the auction day and the days before. Second, the *auction reopening dummy* that is equal to one in case there is a supplementary offering from the Treasury and in case Primary Dealers bids are at least 25% the offered amount. Third, the *bid-to-cover ratio* (BC) that is the ratio between the total amount bid by primary dealers and the total amount supplied by the Italian Treasury, and is already available in auction results data. Fourth, the net-of-fees allotment price. We use this price to compute a novel index of auction performance, the *overpricing indicator* (OP). The OP index aims as a proxy of "good news" of the auction, and it is calculated in two steps:

[9] Adrian et al. (2017) confirm a similar relationship for US corporate bonds.
[10] Similarly, expected after-market liquidity determines how much corporate bonds are underpriced at Initial Public Offerings (Corwin et al., 2004; Ellul and Pagani, 2006).
[11] All high-frequency data were provided by the Italian Ministry of Economics and Finance, in the framework of an institutional collaboration with CRIEP and MTS Italy.
[12] See Section 5.2 in the Appendix for the list of ISIN codes of the securities included in the analysis. The dates shown in the tables refer to the on-the-run period from beginning 2016 until end 2019.

1. we compute the difference between the net-of-fees allotment price and the secondary market mid-price for the same security, that is obtained from the limit order book five-minutes before the auction time;
2. Then, we divide the difference that we obtained in step 1 by the original maturity of the security - i.e., 3, 7 or 10 years - that proxies the duration of the title and is intended to compensate for the tendency to overestimate the good news effect for bonds with longer duration. The OP index should capture the impact of the auction's overpricing on the liquidity discovery process on the secondary market and, as argued, it is a novelty we introduce in the literature as auctions' performance have always been based on bid-to-cover ratios (Beetsma et al., 2016, 2018a; Fuhrer and Giese, 2019).

However, the overpricing of auctions is a concern for the Italian Treasury. While in the short run higher overpricing determines an opportunity for the issuer in terms of lower interests cost, in the long run it may discourage final investors to participate in the auctions if they are not willing to pay much more than the secondary market fair value. For this reason, the Italian Treasury has set specific rules in the Primary Dealers' monitoring criteria in order to limit a too aggressive bids from PDs in the auctions.[13]

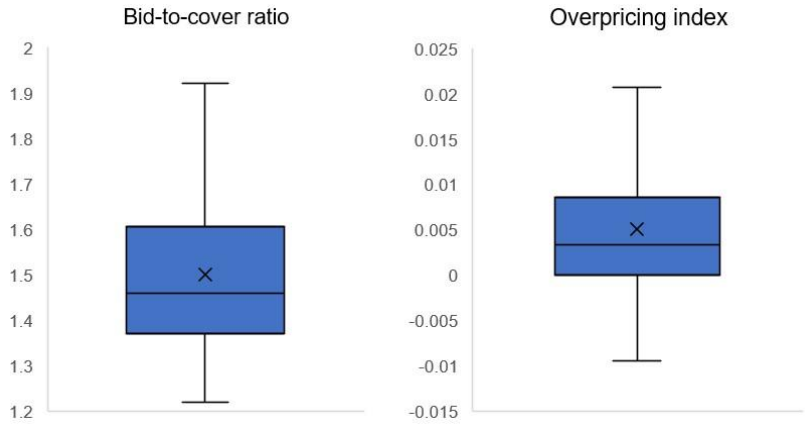
Table 1 presents some descriptive statistics of the two indicators, while figure 1 shows graphically the two measures. Overall, since we consider 103 auctions, we have 103 values for both BC and OP.

Table 1 Descriptive statistics of auction's performance indicators

	Mean	Min	25th	Median	75th	Max
BC	1.5	1.22	1.37	1.46	1.61	1.96
OP	0.005	-0.002	0	0.003	0.01	0.055

Source: MEF, MTS data and authors' calculation.

Figure 1 Bid-to-cover ratio and overpricing index distribution throughout the sample



Source: MEF Italy, MTS data and authors' calculation
Notes: The box plots show the distribution of the two indicators of auction's performance used in the analysis
The boxes represent the 25th-75th interquartile range, the horizontal line inside both boxes shows the median and the cross represents the mean. Whiskers show extreme values excluding the outliers

[13] See Decree no. 107484 as of 21st of December 2018. This market regulation has not been modified in the period 2015-2019, providing a consistent period on which to conduct the analysis.

Liquidity measures

MTS Italy is an electronic quote-driven market. The dataset used contains all the quoted bid and ask prices in the book, with the relative volumes and the number of dealers quoting at each price on both sides of the market. We study the liquidity development of three segments of the Italian government bonds (BTPs): 3-year BTP, 7-year BTP, and 10-year BTP. All prices and volumes are observed at a 5-minute frequency, from 9am to 5pm for each trading day.[14] For each 5-minute snapshot, we calculated liquidity measures and then we took daily averages.[15] Moreover, as we considered only on-the-run BTPs, we analysed different BTPs of the same segment, identified by different ISIN codes. A BTP is considered as on-the-run from its first day of issuance until the day before the auction of a BTP with a new ISIN code.[16] The sample period goes from January 1st 2016 to December 31st 2019, however we consider only snapshots of 11 days each to analyse the auction cycle. The width of the window was chosen to avoid overlaps between two consecutive auctions and also to be in line with other studies using a 5-day time window around the auction day (e.g., Beetsma et al., 2016).

The most widely used liquidity measure is the best bid-ask spread (BA_{it}), i.e. the difference between the best bid-price and the best ask-price of the book as a percentage of the mid-price. However, using a unique liquidity metric may be misleading (Schneider et al., 2018). Therefore, we follow a more comprehensive approach (as, among others, Sarr and Lybek, 2002, but also Mormando and Greco (2020)) and we compute the following additional liquidity measures from the limit order book:

1. $VWBA_{it}$ the *volume-weighted bid-ask spread*: the difference between the average of prices on both sides of the book, weighted by the respective quoted quantity and in percentage of the mid-price;
2. PI_{it} the *price impact of 20mm*: the difference between the mid-price and the realizable execution price of a deal of 20 million of euros;
3. QS_{it} the *quote slope*: the bid-ask spread divided by the sum of the logarithmic bid and ask quoted quantities at the best prices of the book (Hasbrouck and Sepp, 2001);
4. BD_{it} the *best quoted depth*: the quoted amount at the best bid and ask prices; ND_{it} the *number of dealers*: the average amount of dealers quoting at the best prices; AQQ_{it} the *average quoted quantity*: the average quoted amount at the best prices of the book.

Considering multiple measures allows us not to lose important information, as some liquidity variables are price-related, some quantity-related and some multidimensional (i.e. they consider both prices and volumes). These liquidity measures are considered for all 103 time windows of 11 days each, for a total of 1133 observations as a result of daily averages of 5-minute frequency data. Table 2 shows the descriptive statistics of the liquidity measures in our sample.

[14] MTS Italy is open from 8am to 5:30pm, however outside the interval we chose the trading activity is low.
[15] In order to clean the data and get rid of outliers, we considered prices (and related quantities and number of dealers quoting at those prices) that were at most 0.5 ticks further from the best price of the market, on both sides of the book.
[16] See section 5.2 of the Appendix for the list of ISIN codes of the securities included in the analysis. The dates shown in the tables refer to the on-the-run period from beginning 2016 until end 2019.

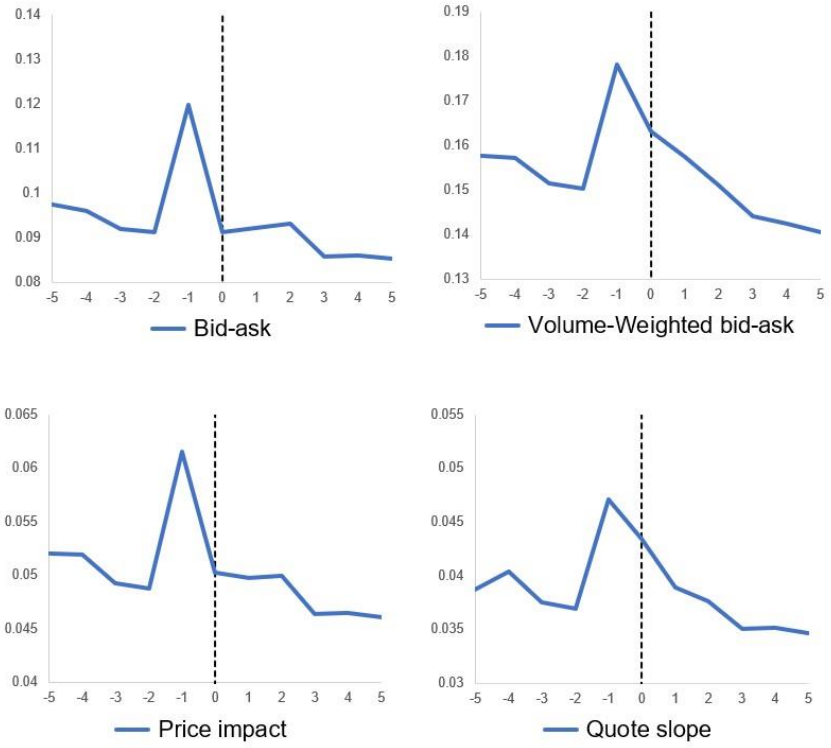
Table 1 Descriptive statistics of liquidity measures

	Mean	25th	Median	75th
BA	0.09	0.052	0.074	0.103
VWBA	0.15	0.096	0.131	0.173
PI	0.05	0.028	0.041	0.055
QS	0.04	0.021	0.029	0.042
BD	22.09	14.87	19.08	26.29
ND	3.54	2.61	3.2	4.23
AQQ	5.73	5.35	5.9	6.59

Source: MTS data and authors' calculation

Figures 2 and 3 display the average development of the analysed liquidity measures throughout the 11-day time window. With auction day being on t=0, we clearly see a systematic pattern around auctions. Namely, price-based and multidimensional metrics are lower on the day of the main event at time t=0 compared to before the auction. Lower values of these measures indicate better liquidity conditions. The latter, keep getting better also afterwards as, on average, the lines of the relevant indicators continue decreasing. On the other hand, as Figure 3 shows, the reduction of quantity-based measures suggests a lower willingness of market makers and other market participants to trade large quantities around the auction. Nevertheless, this effect seems to be limited to the auction day only.

Figure 2 Price-based and multidimensional liquidity measures evolution around auctions



Source: MTS data and authors' calculations
Note: The figure shows the dynamics of the bid-ask spread in percentage of the mid-price (BA), the volume-weighted bid-ask spread in percentage of the mid-price (VWBA) the price impact of a 20 mn deal (PI) and the quote-slope (QS)

Figure 3 Quantity-based liquidity measures throughout the sample

Source: MTS data and authors' calculations. Notes: The figure shows the dynamics of the depth at the best available quotes (BD), the average number of dealers quoting at the best prices (ND) and the average quoted quantity by a single dealer at the best prices (AQQ)

Table 3 confirms these first descriptive results by showing what happens in the five days before and five days after the auction. On average, in line with what discussed above, liquidity is worse before the auction than after the event: price-related and multidimensional liquidity measures are smaller.[17] A remarkable exception concerns quantity-based only liquidity metrics, i.e. best depth, number of dealers,

[17] The bid-ask spread is 1 tick tighter in the five days after the auction. Likewise, the volume weighted bid-ask spread decreases by 1.2 tick meaning that also the entire book is more liquid. In addition, the price impact decreases by 0.5 tick and the quote slope is flatter.

average quoted quantity, which decrease in the 5-day time window after the auction. This reduction might be related to the fact that market makers hedge the risk associated to tighter bid-ask spreads, by quoting smaller quantities (decrease in best depth) overall (Mormando and Greco, 2020), or because more risk-averse dealers will no longer quote at more competitive prices (decrease in the number of dealers, even if small). This also explains the slight increase in the average quoted quantity.

Table 2 Average values of liquidity metrics before and after the auction in an 11-day time window

	Before	After
BA	0.099	0.089
VWBA	0.159	0.147
PI	0.053	0.048
QS	0.040	0.036
BD	22.709	21.918
ND	3.64	3.53
AQQ	5.987	5.964

Source: MEF, MTS data and authors' calculation
Notes: The values before the auction are averages of the 5 days before the auction. The values after the auction are averages of the 5 days next to the auction

3.2 Econometric model

To test our main predictions about the relationship between auction performance and market liquidity on the auction day, we regress alternative liquidity measures on the auction event, the post-auction event, the two indicators of auction performance, controlling for market volatility and financial markets condition. The empirical strategy consists in performing several panel regressions with fixed-effects.

Baseline regression

The baseline model is the following:

$$LIQ_{i,t} = \alpha_0 + \beta_1 AUC_t^i + \beta_2 postAUC_t^i + \sum_{m=1}^{2} \gamma_m X_m + \varepsilon_t, \qquad (1)$$

where LIQ_{it} is the liquidity metric for auction *i* on day *t*, α_0 is the constant term, β and γ_m specify the effect of the auction indicators and the control variables used. *AUC* is the auction indicator, a dummy variable that equals to 1 when the auction takes place on day *t*, 0 otherwise. *postAUC* is another dummy variable that equals to 1 in the days after the auction. The time variable *t* of the panel consists of an 11-day time window around the auction of the bond. Therefore, the auction dummy *AUC* will be equal 1

when *t=6*, while the dummy *postAUC* when *t>6.*[18] Moreover, we control for two variables describing market conditions X_m, where *m* stands for the specific control variable, whose effect is captured by γ_m. Specifically, we control for funding liquidity risk measured by the difference between the 3-month Euro Area Inter-Bank Offered Rate (EURIBOR) and the 3-month Euro OverNight Index Average (EONIA) and for market volatility, which in our case it is constructed as the inter-daily range of the mid-price of the bond in that specific auction cycle on day *t*.

Table 3 Baseline regression

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.018***	-0.011*	-0.008**	-0.002	2.634***	0.524***	1.24
postAUC	-0.015**	-0.019**	-0.007*	-0.006**	-0.176	-0.021	7.61

Source: MEF, MTS data and authors' calculation

*Notes: The table shows the coefficients of auction's performance indicators of the panel estimation with individual fixed effects of the baseline regression (equation 1). The effect of the auction event and of market conditions is estimated on seven liquidity measures: the best bid-ask spread (BA); the volume weighted bid-ask spread (VWBA); the price impact of a deal of 20 million euro on the total quoting book (PI); the quote slope (QS); the best depth (BD); the average number of dealers quoting at the best prices (ND); the average quoted quantity by dealers at the best prices (AQQ). The P-value of the F-test rejects always the null hypothesis that coefficients are not significant. * marks significance at 10%, ** marks significance at 5%, *** marks significance at 1%.*

From Table 4, we see that auctions have a significant effect on liquidity metrics on the auction day. Indeed, the only fact that there is an auction, irrespective of its outcome, affects liquidity conditions. However this effect is uneven. On the one hand, auctions have a significant negative effect on the bid-ask spread (*BA*) which decreases by 0.018 basis points on the auction day. This negative impact, which translates into better liquidity conditions, significantly affects also two of the multidimensional liquidity measures (i.e. *VWBA* and *PI*) that are also smaller when the auction takes place. Particularly, the negative impact of the auction on *VWBA* means that the whole book, even if slightly, is more liquid on the day of the auction. With respect to the price impact (*PI*), a 0.008 basis points decrease means that for an investor it is less costly to submit an order of 20 million. This effect persists over time as it is captured by the significant and negative impact of the post-auction dummy which captures the impact of the issuance in the 5 days after. Furthermore, the whole book is affected to a stronger extent given both the higher significance and the coefficient in absolute values with respect to *VWBA* and QS, which cannot significantly be explained by the auction event alone. These results suggest the existence of heterogeneous quoting behaviour among market makers both on auction day and over time. The

[18] As highlighted by Beetsma et al. (2018b), these dummies do not suffer of any potential endogeneity issue, as the auction calendar is published at the beginning of each year by the Treasury.

heterogeneity is captured by the difference in the coefficient for *BA* and *VWBA*. On auction day, indeed, the most competitive dealers quote a tighter bid-ask spread on auction day compared to less competitive market makers, which tighten the spread of their quoting prices less (i.e. larger coefficient, in absolute terms, of the auction dummy on *BA* compared to *VWBA*). However, those dealers that are less competitive on the day of the issuance tighten their spreads more on the day after the auction - as suggested by the higher absolute coefficient of *postAUC* when regressed on *VWBA* than when used as a covariate for *BA*.

On the other hand, the quantity measures of liquidity that are related to the best prices are also significantly influenced by the auction event - though without a persistent effect - in the opposite direction. Particularly, the depth quoted at the best prices (*BD*) and the number of dealers quoting at those prices (*ND*) decrease, respectively by 2.63 million and 0.52. This decrease might be explained by the fact that a tighter bid-ask spread is tantamount to more competitive quoting prices, thus market makers tend to reduce their risk exposure by quoting smaller amounts at the best quotes (Mormando and Greco, 2020). Hence, the number of dealers quoting at the best prices shrinks as only the more competitive ones submit orders. As a consequence, the total quoted amount at the best prices will decrease too. However, there is no significant impact on the average quoted quantity (*AQQ*).

In general, we find empirical evidence that auctions have an impact on liquidity conditions. Above all, after the auction, the (price-related) liquidity measures improve and this positive impact tend to persist in the days after the issuance.

Auction reopening

Additionally to the main auction, in the Italian government bonds case and similarly to the other European sovereigns, there is the option of supplementary placement that are reserved for Government bond Specialists - or primary dealers - that took part in the main auction. The *auction reopening* takes place on the day that follows the auction and usually consists of an offer of the Treasury equal to 15% of the amount offered. This tap is sold at the same price that is determined in the main auction, so in this case there is not a price discovery process but only an opportunity offered by the Treasury to the specialists to subscribe an additional amount of the bond. Since the main auction event has a significant impact on the liquidity discovery process around and after the auction, this section investigates whether auction reopenings are also a determinant in the liquidity conditions of specific Italian BTPs. Therefore, the empirical model considers a further dummy which is equal to 1 when there is a reopening and the amount allotted by the Treasury is at least 25% of the one offered. Note that given the efficient market conditions, this option is typically exercised by all dealers for the 100% of the amount offered by the Italian Treasury when the bond well performs in the day after the auction. Otherwise, if the price falls below the auction price (that is the strike price of the option) dealers do not bid any amount.

Table 4 Baseline regression with supplementary placement dummy

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.018***	-0.011*	-0.008**	-0.002	-2.63***	-0.52***	1.22
postAUC	-0.015*	-0.019**	-0.009*	-0.006*	-0.21	-0.0001	8.57
reopening	-0.001	0.003	-0.005	0.002	0.303	-0.13	-8.88

Source: MEF, MTS data and authors' calculation
*The table shows the coefficients of auction's performance indicators of the panel estimation with individual fixed effects of the baseline regression (equation 1). The effects of the (post) auction event, the reopening and of market conditions are estimated on seven liquidity measures: the best bid-ask spread (BA); the volume weighted bid-ask spread (VWBA); the price impact of a deal of 20 million on the total quoting book (PI); the quote slope (QS); the best depth (BD); the average number of dealers quoting at the best prices (ND); the average quoted quantity by dealers at the best prices (AQQ). The P-value of the F-test rejects always the null hypothesis that coefficients are not significant. * marks significance at 10%, ** marks significance at 5%, *** marks significance at 1%.*

As table 5 shows, the fact that the Treasury allots a supplementary amount the day after the auction, and that the final amount offered to allowed dealers is at least 25% of the supplied quantity, does not affect market liquidity conditions. Therefore, the market is more interested in the main auction event and not in whether a reopening takes place or not. Our interpretation is that this difference can be determined by the absence of a price discovery process in the reopening auction. In this sense, differently from the standard auction, the reopening does not offer any additional information to market participants on the bond fair value. Also in this case, the heterogeneity among dealers is confirmed as in the baseline regression (see Section 3.2.1).

Indicators of performance

As the baseline specification shows that auctions have an important effect on liquidity on the auction day, and that this effect persists in the 5 days after the issuance in some cases, we intend to investigate whether this effect is due to the auction event only or (also) to its performance. We therefore introduce a new variable in our specification to control for auction performance. The new empirical model is the following:

$$LIQ_{i,t} = \alpha_0 + \beta_1 AUC_t^i + \beta_2 postAUC_t^i + \beta_3 I_t^i + \sum_{m=1}^{2} \gamma_m X_m + \varepsilon_t \qquad (2)$$

Where, in addition to the baseline model, we have also the variable $\boldsymbol{I_t^i}$, which defines the indicator of performance of the auction. Its effect is given by the coefficient $\boldsymbol{\beta_3}$. In terms of indicators, we adopt the two measures introduced and described in Section 3.1.1, i.e. the bid-to-cover ratio (BC) and the overpricing index (OP). The motivation of this further check is to investigate whether there is an impact of the outcome of the auction, and if one of the two measures has a stronger informative power on market liquidity.

Since wholesale secondary markets - specifically on sovereign debt securities - are highly efficient, we expect that market participants define a proper liquidity premium that may lead to a biased estimates when we consider the OP specification. However, we assume that the liquidity premium is constant within a specific auction cycle and its pricing does not diverge in the primary and secondary market at the auction cut-off. In other words, we assume that Primary Dealers define the same pricing for liquidity premium both for their quotes on MTS and for their bids in the auction.

Table 5 Baseline regression with auction's indicators of performance

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.013**	-0.04	-0.005**	0.006	-2.69***	-0.53***	-3.45
postAUC	-0.015*	-0.019**	-0.007*	-0.006**	-0.17	-0.02	7.61
OP	-1.069	-1.3*	-0.582	-0.046**	12.45	1.34	917.5

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.03	-0.005	-0.01	-0.004	0.27	0.16	-8.48
postAUC	-0.015*	-0.019**	-0.01*	-0.006**	-0.17	-0.02	7.61
BC	-0.01	-0.01	-0.001	-0.004	-1.94	-0.45	6.49

Source: MEF, MTS data and authors' calculation

*The table shows the coefficients of auction's performance indicators of the panel estimation with individual fixed effects of the baseline regression with the addition of the indicators of performance as in equation 2. The effects of the (post) auction event, the outcome and the market conditions are estimated on seven liquidity measures: best bid-ask spread (BA); volume weighted bid-ask spread (VWBA); price impact of a deal of 20 million euro on the total quoting book (PI); quote slope (QS); best depth (BD); average number of dealers quoting at the best prices (ND); average quoted quantity by dealers at the best prices (AQQ). The P-value of the F-test rejects always the null hypothesis that coefficients are not significant. * marks significance at 10%, ** marks significance at 5%, *** marks significance at 1%.*

As we can notice from Table 6, OP improves liquidity conditions significantly only in specific cases. Namely when liquidity measures that consider the whole order book, i.e. VWBA and QS, are analysed. Moreover, when OP is significant, the auction dummy has no longer an effect on liquidity. This might be explained by the fact that all dealers that quote on the order book (and, more generally, all market operators) are more concerned by the auction's outcome than by the event itself, while more competitive market makers are focused on the main event. The other important findings is that the usual measure of auction's performance, i.e. BC, has never a significant impact on liquidity measures. These findings corroborate the initial ones (see Section 3.2.1) and add that more informed market makers contribute more to market liquidity.[19]

4. Conclusion

In this paper, we analysed the impact of auctions on secondary market liquidity of Italian government bonds. Relying on data from the Italian primary and secondary markets of specific government bonds, we empirically assessed the effect of auctions on the liquidity of these debt securities in an 11-day time window. Our empirical strategy consisted of using auctions and specific auction's performance indicators (i.e. the bid-to-cover ratio and the overpricing index) to infer their effect on several liquidity measures on auction day together with other market variables. Firstly, we find significant evidence that auctions have a positive effect on the liquidity discovery process, that this effect is positive on specific metrics, i.e. price-based liquidity indicators are better on auction day, and long-lasting as found out from the statistically significance of the post-auction dummy. Secondly, indicators of auction's performance

[19] However, a robust empirical argument in this direction necessarily requires a richer dataset, which could allow the analysis of individual behaviours of market makers.

are good predictors of liquidity conditions of the secondary market. With respect to the Italian government bond market, the overpricing index - specifically designed on that market - has a significant role in the liquidity discovery process. Therefore, we can conclude that, though the bid-to-cover ratio might be a significant predictor of the price-discovery process of Italian government debt securities in the secondary market around auctions, it is not a good measure to predict liquidity, while the overpricing index is.

Finally, our results suggest the existence of heterogeneity among dealers and over time with more competitive dealers tightening more their bid-ask spread on auction day, while less competitive dealer close more their spreads on the days after the auction. However, more granular, dealer-level data are needed to confirm this final result.

Overall, our findings allow us to conclude that there is a new channel through which the primary market is linked to the secondary one. Further investigation can be implemented in this framework in order to infer better how liquidity of secondary market of government bonds may change when interacting with the primary market, particularly focusing on the contribution of individual market makers to market liquidity.

Appendix

I. Institutional framework

a. Functioning of the Primary Market and Instruments Issued by the Treasury

In the primary market, the sovereign issuer, that in Italy is the Ministry of Economics and Finance (henceforth Treasury, or Italian Treasury), places different type of securities depending on the liquidity needed to finance its spending. [20]

Depending on the kind of instrument, we can distinguish two different auction protocols: competitive yield auction and marginal price auction. The former involves Buoni Ordinari Del Tesoro (BOTs)'s issuance and it is in yield terms. With this protocol, each bid placed by the dealers is awarded at the yield rate proposed.[21] The latter regards all the other instruments issued by the Treasury and it is in terms of price. The winning bids are all settled at the same price, the lowest winning one, also called stop-out price.[22] Usually, auctions concern on-the-run bonds, the latest issued bond until a new one is issued and takes the place of the old one that obtains the off-the-run status. Off-the-run bonds can be issued as well, depending on the liquidity needs of the Treasury and on the market shortage of these specific bonds. Sometimes, tranches of off-the-run bonds can be placed on the market together with on-the-run ones. In this case, we talk about joint auction and the range of the offered amount must be considered for the two securities together. This choice of the Treasury is adopted when the securities to be issued are perceived to be highly requested by the market, but also to be more flexible in the issue distribution (MEF, 2017).

Irrespective of the auction format, the process starts some days before the auction. During these days, the debt management office of the Treasury announces the auction in a press statement. The announcement for all auctions is issued three business days prior to the placement date. The statement confirms the auction date, the maturity of the bond(s) to be auctioned and provides a target range for the volume (the minimum and the maximum amounts offered to the market). The to-be issued bond starts trading before the proper issue - i.e. grey market - precisely the day after the announcement has been published. On auction day, primary dealers submit their bids during the pre-announced time window.

Each primary dealer has at most five bids to place (the quantities and the correspondent prices at which they are willing to buy the bond) and they are sent electronically and anonymously to the Bank of Italy within 11 a.m. of the auction day. After the Bank of Italy receives all the bids from the market makers, a decrypting procedure starts and send the list of bids to the Treasury.

The results are published as soon as possible after the cut-off of the auction, typically within 11:30 a.m. In the announcement of the results, the Treasury publishes all relevant information of the process. Concerning securities issued through a uniform price auction, we can find the ISIN code, the tranche of issuance, the coupon, the issue date, the maturity date, the date of the auction, the settlement date, the interval of the amount to be offered, the amount requested and the amount allotted, which usually

[20] Among Italian government bonds we can distinguish 17 segments of emission: 6-, 12-month BOTs, 24-month CTZ, 3-, 5-, 7-, 10-, 15-, 20-, 30, 50-year BTPs, 5-, 10-, 15-, 30-year BTP-I, CCTeu and the retail bond BTP Italia. Every year the Treasury publish a calendar where dealers can find the date of interest of the auction process (announcement, issuance and settlement dates).

[21] The maximum numbers of bids that can be placed by a singular bidder are five, with yield differing one from the other by one thousandth of one percent. The minimum quantity to be bid is 1.5 million euros. The first bids to be allocated are those with the lowest yields. In order to avoid misbehaviour from primary dealers in placing the bids in terms of yields, a range from a minimum acceptable yield to a maximum one is calculated.

[22] For marginal price auction, primary dealers can place at most always 5 bids, but the minimum bidding amount is 500,000€ and less than the amount being issued. Prices must vary by at least one tick, which is one hundredth. Concerning our three segments of BTPs, the 10-year maturity is issued at the end of the month and the 3- and 7-year BTPs at the middle.

corresponds to the top amount of the range disclosed (full allotment), the allotment price and the placement fee[23] which has to be scaled down from the allotment price in order to know the real bid price, and the bid-to-cover ratio. Settlements take place on the second working day after the auction.

There are two main periods for auctions, one takes place at the middle of the month and concerns, regarding medium-long term allocation, 3-, 7-, higher than 10-year BTPs and the second one at the end of the month which involves 5- and 10-year BTPs.[24]

For a more efficient placement of bonds to properly satisfy the aggregate investor demand and cut the borrowing cost, the Public Debt Management meets the Specialists (a subset of primary dealers) before the announcement date. These meetings are very important for the Public Debt Management as in this way it is more informed about secondary market developments.

Moreover, there are other informative documents, published by the Treasury, that overcome the information asymmetry problem between issuer and dealer. These are, mainly, the Annual Calendar (published at the beginning of each year, it contains information about the dates of announcement size, issuance/re-opening and settlement of each security), the Guidelines on Public Debt Management (yearly documents that provide qualitative and quantitative information on the issuance and management of the government securities in the following year) and the Quarterly Issuance Program (where information about new bonds to be issued and re-openings of on-the-run bonds for the next quarter of the year are released). These documents, together with other information such as Public Debt Reports, are available on the website of the Italian Treasury.

b. Specialists' Evaluation Criteria

In order to be classified as a Specialist, and benefit from some privileges,25 a primary dealer must meet several requirements and accomplishments as outlined in the Decree no. 993039 of November the 11th 2011.[26]

With the aim of being sure about Specialists' compliance with their obligations, the Italian Treasury continuously monitors their behaviour both in the primary and secondary markets. The main evaluation criteria give the possibility to Specialists to gain points to better compete and be placed at the top of the final ranking. The final purpose of the Treasury is to foster demand at auctions, increase secondary market liquidity and receive advice from the Specialist on debt management policy issue. The points granted depend on the behaviour of Specialists in the primary and secondary markets. Different factors are at the heart of the evaluation: the quantity allocated by each bidder at auctions, the measure to which the specialists contribute to overpricing and over demanding, the regularity of participation to all the auctions, the quality of bid and ask price proposals on the secondary market and the associated quantities, the type of bonds and volumes traded with other investors, the number of bonds quoted and the number of those traded, the activity in the repo market, the market share in the special operations (i.e., exchange transactions and buyback operations), the overall contribution to the management of public debt (i.e., advisory and research activity). The most important index (that gives 33 out of 100 in

[23] The amount of the placement fee depends on the type of security issued. Considering the four BTPs object of the analysis, we can find placement fees for 0.15%, 0.25%, 0.30%, and 0.35% for the 3-, 5-, 7-, 10-year maturities, respectively.
[24] The reference is to on-the-run bonds. Off-the-run BTPs can be issued also in slots that do not concern their initial maturity.
[25] For example, only Government Bond Specialists that took part in the main auction can participate in the re-openings of the same bond. The maximum amount offered in the re-opening depends on the type of security, i.e. re-openings are equal to 15% of the ordinary issue (10% for BOTs), 30% for medium- and long-term bonds if newly issued.
[26] Among all the criteria, they must participate efficiently at the auctions in terms of quality, quantity and continuity of bidding, with a minimum allocation higher, or equal, than 3% of the overall amount auctioned, considering the characteristics of the subscribed securities. Furthermore, they have secondary market commitments in terms of contribution to the volumes traded, to liquidity and to the depth of the market.

2019) concerns the primary market and it is a quantitative indicator that involves the share allocated obtained in the reference period.

Moreover, to make Specialists more compliant with the regulations, the Treasury makes, at the end of each year, a ranking and the top five is made public.[27]

c. MTS Italy

A more efficient placement of bonds for sovereign issuers, in terms of lower borrowing costs and lower risk premia demanded by investors, is guaranteed by a good functioning of the secondary market, the market where primary dealers act as market makers, i.e. they trade to provide liquidity to other investors that cannot access the primary market. MTS is an interdealer platform with a high level of pre- and post-trade transparency established in 1988 by the Italian Treasury. The MTS trading system is quote-driven, electronic limit-order interdealer market, in which market makers' quotes can be hit or lifted by other market participants via market orders.

MTS Italy is a branch of the entire MTS trading system and it is the secondary market where Specialists are monitored by the Italian Treasury. It is regulated by the Italian Treasury, the Bank of Italy and Consob. Here, there are two types of participants: market makers and market takers. The former are primary dealers that act on the basis of the Market Making Commitments, which establish the rule that market makers have to provide liquidity continuously by quoting two proposals (one for the bid side and one for the ask side) during the trading hours. They can place quote anonymously, at least until one of the two counterparties settles bilaterally. They issue standing quotes but are not obliged to display the maximum quantity they want to bid, but only a non-negative fraction of the quantity they are willing to trade. Quotes must be at least of 2 million on both ask- and bid side. The latter, market takers, act as price takers, by hitting or lifting market makers' quotes by market orders.

Finally, MTS Italy is divided into two segments: Cash and Repo. In the former, only Italian government debt securities are traded. In the latter we can find also government bonds of different Governments and non-government bonds, e.g. Asset-backed securities.[28]

If the secondary market is not functioning in an orderly manner and is not liquid as it should be, the primary market suffers in terms of placements and buy-back operations carried out by the Treasury. If this situation exists, the Italian Treasury, together with the technical assistance of both the Bank of Italy and the main Specialists,[29] can change the debt management and issuance choices to improve the overall level of efficiency and ensure a sufficient liquidity and breadth of trading in the secondary market.

[27] A placement at the top five of the ranking can signal the Specialist in the financial market as it gives a higher reputation (Mormando and Greco, 2020).

[28] These two markets differ also in terms of market opening hours. For the Cash Market, we can find the following hours: Pre-Market: 7:30am - 8:00am; Trading Hours: 8:00am - 5:30pm; Market Closed: from 5:30pm until the next morning. For the Repo Market, instead: Pre-Market: 7:30am - 7:45am; Market Open: 7:45am - 6:30pm; General Collateral allocation window: 6:30pm - 6:45pm; Market Closed: 6:45pm.

[29] As stated in the Specialists Decree (MEF, 2011): The enrolment of the Candidate Specialist in the List of Specialists is dependent upon the satisfaction, during the observation period, of a series of requirements as Assistance in choosing how to improve the overall efficiency of debt management, also by proposing useful contributions to issuance and debt management choices.

II. On-the-run BTP description

Table 1 - 3-year BTP

ISIN code	Description	From (dd/mm/yyyy)	To (dd/mm/yyyy)
IT0005139099	BTP 0.3% 15Ott18	01/01/2016	08/04/2016
IT0005177271	BTP 0.1% 15Apr19	09/04/2016	10/10/2016
IT0005217929	BTP 0.05% 15Ott19	11/10/2016	07/04/2017
IT0005250946	BTP 0.35% 15Giu20	08/04/2017	09/10/2017
IT0005285041	BTP 0.2% 15Ott20	10/10/2017	09/04/2018
IT0005330961	BTP 0.05% 15Apr21	10/04/2018	08/10/2018
IT0005348443	BTP 2.3% 15Ott21	09/10/2018	08/03/2019
IT0005366007	BTP 1% 15Lug22	09/03/2019	09/09/2019
IT0005384497	BTP 0.05% 15/01/2023	10/09/2019	31/12/2019

Source: MEF

Notes: The description includes the type of government debt securities (BTP), the yield at issuance and the maturity date in DDMMMYY format

Table 2 - 7-year BTP

ISIN code	Description	From (dd/mm/yyyy)	To (dd/mm/yyyy)
IT0005135840	BTP 1.45% 15Sep22	01/01/2016	08/03/2016
IT0005172322	BTP 0.95% 15Mar23	09/03/2016	08/09/2016
IT0005215246	BTP 0.65% 15Ott23	09/09/2016	08/03/2017
IT0005246340	BTP 1.85% 15May24	09/03/2017	08/09/2017
IT0005282527	BTP 1.45% 15Nov24	09/09/2017	08/03/2018
IT0005327306	BTP 1.45% 15May25	09/03/2018	10/09/2018
IT0005345183	BTP 2.5% 15Nov25	11/09/2018	08/04/2019
IT0005370306	BTP 2.1% 15Jul26	09/04/2019	12/11/2019
IT0005390874	BTP 0.85% 15Jan27	13/11/2019	31/12/2019

Source: MEF

Notes: The description includes the type of government debt securities (BTP), the yield at issuance and the maturity date in DDMMMYY format

Table 3 - 10-year BTP

ISIN code	Description	From (dd/mm/yyyy)	To (dd/mm/yyyy)
IT0005127086	BTP 2% 01Dec25	01/01/2016	23/02/2016
IT0005170839	BTP 1.6% 01Jun26	24/02/2016	25/01/2017
IT0005210650	BTP 1.25% 01Dec26	26/07/2016	25/01/2017
IT0005240830	BTP 2.2% 01Jun27	26/01/2017	27/06/2017
IT0005274805	BTP 2.05% 01Aug27	28/06/2017	25/01/2018
IT0005323032	BTP 2% 01Feb28	26/01/2018	25/07/2018
IT0005340929	BTP 2.8% 01Dec28	26/07/2018	22/02/2019
IT0005365165	BTP 3% 01Aug29	23/02/2019	26/08/2019
IT0005383309	BTP 1.35% 01Apr30	27/08/2019	31/12/2019

Source: MEF

Notes: The description includes the type of government debt securities (BTP), the yield at issuance and the maturity date in DDMMMYY format

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Debt Management, Liquidity, and Yields: Evidence from the Eurobond Market

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Abstract

Market liquidity is of value to both investors and issuers of securities, and is therefore a crucial factor in asset pricing. For the important asset class of Eurobonds, it is shown that bid-ask spreads (a proxy for market liquidity) and yields are closely related to bond characteristics such as issue volume, time to maturity, the inclusion of an adhanced collective action clauses, and the jurisdiction of issuance. Debt management offices can choose these characteristics in a way that has economically significant and persistent effects on both liquidity and pricing.

Keywords: Eurobond yields, bid-ask spread, liquidity, debt management, instrument design.

JEL Classification Numbers: F34, G12, G15, H63

1. Introduction

Eurobonds constitute an important asset class. They provide a means of international diversification for investors that offer not only an attractive risk-return trade-off but also relative liquidity and transparency. They allow borrowers in emerging market and developing countries (EMDCs), and especially EMDC sovereigns, to access a wide investor base and to manage their debt portfolios flexibly. Eurobonds are of macro-finance importance as a channel for debt capital flows to and from EMDCs. Eurobond pricing is followed closely as an indicator of the market participants' perception of risk and used as a benchmark for pricing other products, while substantial investment portfolios are tied to Eurobond indices.

Eurobonds are unusual in that they are characterized by being issued in a jurisdiction (typically New York or England) and a currency (predominantly the US dollar) distinct from those of the issuer. They are sold "over the counter" but transactions are normally recorded in one of the major international central securities depositories.[2] Those characteristics make Eurobonds more homogeneous than sovereign bonds issued

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[2] Choudhry (2008) provides more institutional details. Van der Wansen et al. (2019) provides information on operational matters.

under myriad national laws and in local currencies; reduces concern that, in case of dispute, either investors or issuers will be unduly favored by courts; and facilitate trading.

By 2020 there were about US$1.5 trillion in rated sovereign EMDC Eurobonds outstanding—up from under US$1 trillion in 2015-with about 70 new issues per year over the past decade (International Debt Statistics, 2021). As of 2017, 82 countries had issued Eurobonds, ranging from major issuers such as Mexico and Turkey to occasional and small-scale issuers such as Gabon, Surinam, or Uzbekistan. In addition, about US$500 billion in non-sovereign Eurobonds, issued for example by major EMDC banks and enterprises, were outstanding. These volumes have continued to rise, and ever more issuers have been tempted to raise funds through these instruments.

In this context, a fuller understand of Eurobond pricing and the functioning of the Eurobond market is of value to investors and borrowers alike, and for policy determination. It may be possible to identify certain bond characteristics and debt management practices that do not cost the issuer much but are of substantial benefit to the investors. A borrower, that is, a sovereign issuer, can provide these characteristics and be rewarded by lower financing costs.

Moreover, the Eurobond market, with its homogeneity in some dimensions and heterogeneity in others, can be a source of evidence on the functioning of financial markets generally. The central issue relates to the determinants of pricing, market liquidity, and thus efficiency (O'Hara, 2003). Relevant determinants may include the tenor of the security; issue size; legal provisions relating in particular to restructuring; features of the issuer, including creditworthiness but also the issue's overall market presence and debt management strategy.

This paper, which is based on Hardy (2022), is a contribution to that understanding. It is structured to yield results relevant to market participants, especially debt management offices (DMOs) and new issuers in EMDCs, as well as academics. Also, focus rests on the largest and most homogeneous part of market, namely U.S. dollar-denominated sovereign bonds. Specifically, the yields on, and bid-ask spreads of individual US$ EMDC sovereign Eurobonds are related to bond and issuer characteristics that theory and evidence from other empirical studies suggest should be relevant. These relationships are assessed using a large panel of observations and flexible functional forms.

The connection between yields and market liquidity is worth elaborating. The market for a security is said to be liquid if it is possible to buy or sell a reasonable amount of that security, reasonably quickly, with a minimal effect on the price. The concept of market liquidity is multi-faceted and several metrics are relevant. A modest bid-ask spread—that is, the difference between the price at which participants offer to buy the security and that at which they offer to sell it—is necessary but not sufficient for a market to be considered liquid.

Liquidity is of value to both investors and issuers because it promotes "price discovery" (the timely aggregation of information into market prices) and facilitates market transactions. An investor in a liquid asset can readily increase or decrease the stake in reaction to shifting beliefs about risk or expected return, or to meet liquidity needs. On the issuer side, the DMO's job is easier if the market in its securities is liquid, so that it can quickly sell more securities, or sell more than anticipated, without a sharp adverse movement

in prices. Moreover, DMOs often engage in "liability management operations" buying in certain bonds in order to maintain a desired duration of its overall portfolio or to reduce roll-over risk as the redemption date of a major issue approaches—which depend on market liquidity.

The findings presented here on the determinants of bid-ask spreads should therefore be of interest to both sides of the market. Moreover, they will provide one explanation of why certain bond characteristics affect yields: the characteristics that promote greater liquidity in the form of lower bid-ask spreads should be "rewarded" by the market in the form of lower yields.

The next section reviews theoretical and empirical research on securities market liquidity and its connection to pricing. From this a series of testable hypotheses applicable to the Eurobond market are derived, albeit informally. The sources and main characteristics of the data set are explained. The section thereafter presents and discusses the main results for the regressions on bid-ask spreads and yields, and the associated hypothesis tests. The estimated coefficient from the bid-ask spreads and yields regressions are then used to project the magnitude of the effects, before the paper concludes with a summary and suggestions for future research.

2. Background

2.1.Theory

Investors can be expected to place a higher price, and thus accept a lower yield, on securities for which there is a liquid market. In the first instance, liquidity is valuable because it allows an investor to adjust positions in timely fashion and at little cost; it generates a "convenience yield." An investor may see an opportunity to transact in a way that offers higher returns or the avoidance of losses, but without market liquidity the opportunity may be missed. Also, an investor whose aim is consumption smoothing will be discouraged from purchasing an asset that is difficult to realize when funds are needed in a hurry (Garbade and Silber, 1979; Amihud and Mendelson, 1986).

Furthermore, illiquidity raises the cost of acting on (small) informational advantages, and therefore reduces informational efficiency. On the one hand, illiquidity makes it less worthwhile to invest in the acquisition of information, and especially granular information that would affect asset valuation modestly (Crabbe and Turner, 1995). Less information is generated. On the other, prices do not react to small differences in valuation, so they reveal less of the information that is available.

Generally, one would expect the market for an asset to be liquid if there is a large and diverse base of investors for that asset who are potentially willing to trade. An asset is unlikely to be liquid if there is little demand for it, or if investors are very homogeneous in terms of their investment horizons and expectations—if they are all "on the same side of the market." Investors must also be willing to trade; buy-and-hold investors may be plentiful and diverse, but they do not contribute to market liquidity. An asset characterized by a substantial issuance volume; limited credit and market risk; moderate duration; and with standard features is likely to attract such a large and diverse investor base.

Liquidity and strong demand for an asset may be mutually reinforcing, and feedback may run from relative yields to market liquidity. Liquidity should make an asset more attractive and reduce its yield. But an asset that offers good relative returns should, for given characteristics, generate strong and widespread demand,

and thus generate better market liquidity. There is ample evidence, for example, that low interest rates in advanced economies encourages capital flows into EMDC financial markets and specifically Eurobonds. Disentangling the underlying connections may be difficult because many of the conditions listed above that support high liquidity also imply strong demand.

Liquidity is closely related to the bid-ask spread, which can be viewed as generating a return to making the market. The dealer (whether or not officially designated as such) incurs certain costs and risks in holding an inventory and posting bid and ask prices at which it is willing to buy or sell on demand (at least for small quantities); incurring these costs and risks is compensating through earnings on the bid-ask spread (Amihud and Mendelson, 1980; Glosten and Milgrom, 1985; Easley and O'Hara, 1987). The bid-ask spread may reflect market power on the part of the dealer(s) (Dutta and Madhavan, 1997; Chacko et al, 2008).

2.2. Securities market pricing and liquidity

These considerations have given rise to numerous empirical studies of how market liquidity is related to pricing and of the determinant of market liquidity. The evidence corroborates the hypotheses outlined above: the liquidity premium is generally an important component of asset pricing, and variations in market liquidity across securities and time can largely be explained.

Only a few studies have looked at the interaction of liquidity and pricing in international bond markets. Alquist (2008) draws conclusions from data on the late nineteenth century London market data on sovereign bonds; then too, a high bid-ask spread was associated with significantly higher yields, as was small issue size. Duffie et al. (2003) document how liquidity was priced into Russian domestic bond and Eurobond yields, and how the liquidity premium varied over time and depending on the exact terms and conditions of various bond series. Chamon et al. (2018) focus on whether issuance in a foreign rather than the domestic jurisdiction affects yields, but also find a positive relationship between bid-ask spreads and yields (and specifically that the higher bid-ask spreads on foreign jurisdiction bonds makes then less attractive). They emphasize that effects become much more pronounced during stress times, that is, when credit risk is elevated.

The results of Hund and Lesmond (2008) are relatively closely related to those presented here. They look at sovereign and corporate emerging market bonds, and find that liquidity is statistically and economically highly significant in explaining differences in yield spreads.[1] Yields are found to be affected also by macroeconomic conditions; political conditions; credit rating; and bond features such as maturity (negative effect); age (negative effect); and coupon rate (positive effect). According to their evidence, the bid-ask spread is well correlated with, and as powerful as, other measures of market liquidity (namely, the percentage of zero returns, and a measure based on a limited dependent variable model known proposed in Lesmond et al., 1999). The bid-ask spread is positively related to other liquidity measures, and affected also by the amount outstanding (positive); credit rating (negative); bond price volatility (positive); bond age (negative but insignificant for sovereign bonds); and maturity (positive but insignificant). The authors undertake joint estimation of yields and the liquidity measures using three-stage least squares; an instrumental variables approach, where macroeconomic variables and indicators of financial market

[1] They focus on annual average yields in excess of a comparable U.S. government bond yield of similar maturity, and annual averages of their liquidity measures.

development are the main instruments; and regressions based on year-to-year changes. The relationship between yields and liquidity remains positive and significant.

Bid-ask spreads on international bonds, including sovereign bonds, are examined also in Ap Gwilym et al. (2002). They find that the spread is negatively related to credit rating and issue size, and positively related to price volatility, but the effects of coupon rate and maturity are statistically insignificant.

A sub-literature looks at the effects on pricing of certain features in Eurobond terms and conditions on their pricing, and in particular whether the inclusion of a collective action clause (CAC) is rewarded or penalized.[2] A CAC enables a qualified majority of bondholders to bind the minority to the terms of a restructuring, making it more difficult to block a restructuring.[3] The weight of evidence suggests that the effect is a small but significant reduction in yields, especially for countries with worse credit ratings. Chung and Papaioannou (2020) is a recent example of such a study. They find that the inclusion of an "original" CAC (with only series-by-series voting) has a statistically significant negative effect on bond yields, and that the effect is stronger for countries with lower credit ratings during stress periods. The inclusion of an enhanced CAC had a negative but statistically insignificant effect on yields of bonds issued by lower-rated countries. Broadly similar results were obtained by Becker et al. (2003), Richards and Gugiatti (2003), Bardozzetti and Dottori (2014).

Ratha et al. (2016) suggest that the choice of jurisdiction is distinct from, and at least as important as inclusion of a CAC. According to their analysis, initial yields on bonds issued under New York law being substantially lower than those issued under English law—a result suggested already in Tsatsaronis (1999).

3. Testable hypotheses

Theory and the existing literature suggest that the bid-ask spread on a Eurobond should reflect the costs of transacting and holding the security in the trading book (including the costs of bearing the associated risks), and also the market liquidity of the instrument. The establishment and maintenance of a large and diverse investor base, eager to trade, is likely to be the product of many factors:

1. The security should be issued in sufficient size that it is worthwhile for many investors to undertake initial research into the security's likely performance, and then to undertake on-going monitoring. Moreover, the distinction needs to be made between initial issue size and the stock outstanding; the latter may be much less than the former where the issuer has undertaken liability management operations.

2. The issuer's overall market presence and its typical debt management strategy may matter. A large and frequent issuer of Eurobonds may have built up an investor base that has already invested in the analysis of potential risk and returns and is relatively eager to hold individual securities issued by that sovereign.

[2] Conditions include also so-called pari-passu clauses, which protects a creditor from legal subordination of its claims in favor of another creditor. CACs and pari-passu clauses almost always go together, so it is difficult to separate their effects econometrically. Therefore, attention here focuses on CACs.

3 The original CACs operated on a series-by-series basis, and therefore a group of creditors could relatively easily obtain a "blocking position," thus delaying overall agreement. In response, CACs have been enhanced to allow for "two limb" aggregation (requiring agreement by series and in aggregate) or "single limb" aggregation (requiring just a supermajority of the aggregate holders of all bonds).

3. The return on an asset relative to that on alternatives may affect the breath of the investor base and thus market liquidity. In particular, low yields on advanced economy securities such as U.S. Treasury bonds may induce investors to "search for yield" in emerging market Eurobonds.

4. Duration will matter to investors. Duration is a function of remaining time to maturity, but initial time to maturity may be important in establishing the initial investor base. Moreover, a high coupon yield reduces duration. Plausibly, the relationship between duration and the bid-ask spread is non-linear and even non-monotonic: the market may be most active for bonds that are neither very close to maturity nor of very long tenor.

5. Evidence from other markets suggests that "age" or "seasoning"—that is, the time elapsed since issuance—could be negatively related to market liquidity because the share of a bond in buy-and-hold portfolios tends to increase.

6. The degree of sovereign risk will affect the size and diversity of the investor base: fewer investors will be interested in relatively risky sovereign assets. Sovereign risk can be reflected in the respective country's credit rating, where both the initial and the current rating may matter. However, it is possible that very highly rated EMDC sovereign bonds are largely held by buy-and-hold investors, and these countries may generate relatively little "news" that provokes trading. Hence, market liquidity may be relatively weak for highly rated bonds. In addition to the rating, the coupon rate is a signal of riskiness.

7. Inclusion of a bond in an index is reportedly important for many investors.[4] It is common for investment intermediaries to offer vehicles such as mutual funds that invest only in instruments included in a recognized index; the JP Morgan "Emerging Market Bond Index Global" (EMBIG) is representative.

8. Sovereign risk may depend on contractual features of the respective bond, and in particular whether the terms include a CAC or enhance CAC. Possibly, the costs of restructuring, and the distribution of those costs among the sovereign and different classes of investors, will depend also on the jurisdiction under whose law the bond is issued (typically New York or English law). However, the effects of these provisions may depend on the riskiness of the sovereigns.

9. The investor base may have evolved over time in terms of size, diversity and familiarity with the Eurobond market, and there may have been structural breaks not captured elsewhere. Hence, it is worth including as an explanatory variable that captures when a bond was issued.

10. The currency denomination of the bond may matter. Here, for the sake of parsimony, attention focuses on U.S. dollar-denominated Eurobonds, which constitute well over three quarters of the asset class.

It should already be apparent that several challenges to the empirical investigation relate to collinearity and identification, for example, because some effects are captured by several variables (e.g., the credit rating and the coupon rate signal credit risk), and some variables reflect several effects (e.g., the coupon rate signals credit risk but also affects duration; the initial maturity and the remaining time to maturity are relevant to investors' investment horizon, but also imply how long the bond has been in the market and the share that has landed in buy-and-hold portfolios).

[4] See Calomiris et al. (op. cit.) for a discussion.

Furthermore, many of the factors described above that affect liquidity affect also overall demand for the bond, and thus a bond's yield. For example, a large issue, with a large volume still outstanding, is more likely to overcome the fixed costs of assessing the bond's risks and expected returns, and thus enjoy a large investor base. Repeated large issuers are more likely to have built up a stable investor base. However, demand may be price elastic: yields may have to be higher in order to mobilize demand to take up a larger-volume issue or an issue by a country with a large total volume of bonds outstanding. That price elasticity may reflect concerns over credit or roll-over risk, so again volume and credit-risk factors may interact.

4. Estimation framework

4.1 Data sources

The estimates focus on the explanatory power of financial and institutional variables that are under control of relevant agents, and specifically the country DMO that sets the volume (initial and outstanding), initial maturity, coupon rate, jurisdiction of issuance, and inclusion of CACs. Moreover, these variables are precisely measured and dateable. Hence, they are certainly all predetermined; the values of many are determined years before the observation period.[5]

The data used in the analysis are downloaded from multiple sources and capture issue-specific as well as country-specific information. Bloomberg Generic provides market data on listed bonds, such as prices, yields, and sovereign credit rating. Dealogic provides individual bond characteristic at the time of issue, including issued volume, coupon rates, and past credit rating. The Perfect Information data are used to assess the presence of contractual clauses and the governing laws of securities in the sample. JPMorgan is the source on the EMBIG Index constituents. The FRED Economic Database made available by the St. Louis Federal Reserve provides data on U.S. Treasury bond yields.

The data are end quarterly and the sample covers securities listed during March 2017 to March 2019. Eurobonds were identified as securities issued in a currency other than that of the issuer and listed in a major jurisdiction. For the sake of comparability, the dataset is limited to fixed-rate straight bonds, issued by EMDCs, denominated in US dollars.

4.2 Definitions

The various variables are defined as follows:

- The main variables to be explained are the yield to maturity (YLD) of each bond, based on the midpoint of the bid and ask prices, in basis points; and the spread between the ask and bid prices relative to the mid-price (BAS), again in basis points;

- The initial issuance volume (VOL_ISS) and the volume currently outstanding (VOL_NOW) are measured in US$ billions. In addition, to capture possible "threshold" effects, certain volume dummies were defined. For example, the variable D500 takes the value of unity if the initial volume equals or exceeds US$500 million and zero otherwise; other volume dummies are defined analogously;

[5] Consider issue volume: a country may have an opportunistic issuance strategy, issuing more when conditions are favorable. Nonetheless, the initial issue volume is set for the life of the bond and in particular for the observation period.

- Also measured in US$ billions is the total volume of a country's issues outstanding (CTY_VOL), as captured in this sample. Since the number of issues (CTY_I_NUM) is available, the average issue size (AVG_VOL) can be estimated;

- Initial time to maturity (MAT_ISS) and remaining time to maturity (MAT_NOW) are measured in years;

- The point on the U.S. dollar risk-free yield curve (MAT_NOW_DYC) corresponding to the remaining maturity of a specific bond is measured in basis points. It was approximated with a suitably tuned convex combination of the 1-year and 20-year U.S. Treasury yields.[6] The approximation worked well for most maturities of the Eurobonds in the sample and for the period covered;

- As the main measure of sovereign risk, Standard & Poor's and Moody's issuer rating were obtained (a Fitch rating was used when an S&P rating was not available). The average score of the available ratings was then translated into a numerical code (from 22 for the highest possible rating of AAA to 1 for the lowest possible rating of D). Both the rating at time of issue (CRR_ISS) and the current rating (CRR_NOW) are considered;

- The coupon rate (CPN_RT) is measured in percentage points;

- Whether a bond is included in the EMBIG is captured by a dummy variable (D_EMBIG) that takes the value of unity in case of inclusion;

- Dummy terms are used to indicate the inclusion of relevant contractual provisions such as an original CAC (D_O_CAC) or an enhanced CAC (D_E_CAC), and whether a bond is issued under New York law (D_NY_LAW);

- Cross-products with log credit ratings and squared log credit ratings are constructed. D_E_CAC_LCRR_I and D_E_CAC_LCRR_I_SQ, for example designate the product of the enhanced CAC dummy and the log of the relevant country's credit rating at the time off issuance and the square thereof, respectively. These terms allow for the possibility that effects of explanatory variables may differ in complex ways depending on the country's riskiness.; and

- A dummy variable is constructed for all but one quarterly observation date (designated D_MMMYY). Dummy variables are constructed also for each possible issue year in the sample, namely, for 1996 through 2019. On occasion it is useful to include country variables, which are designated by D_(country code), where the country code is the three-digit indicator from used in International Financial Statistics.

Various modifiers are used. The prefix "L" indicates the natural logarithm of the relevant variable. The suffix "_SQ" indicates the square of the variable. A term such as "CHG_A" denotes the difference between the current value of variable A_NOW and the value at time of issue A_ISS. A prefix "R_" indicates the residual from an auxiliary regression. Also included is a variable DAVG_LVOL defined as the difference between the log average bond size for the respective country and the log issuance volume of the relevant bond; the variable captures whether or not the size of a particular bond is typical for that country's issuance program.

[6] Let 1YR (20YR) denote the one-year (20-year) U.S. Treasury yield. Define a weight $w=(1+\tau)/(\text{MAT\_NOW}+\tau)$, where τ is a tuning parameter. Thus, $w=1$ if MAT_NOW=1, and converges to 0 as MAT_NOW increases. Then MAT_NOW_DYC ≡ w.1YR + (1–w).20YR.
For this sample, $\tau=3$ was chosen to achieve a close approximation to the actual dollar yield curve.

4.3 Summary statistics

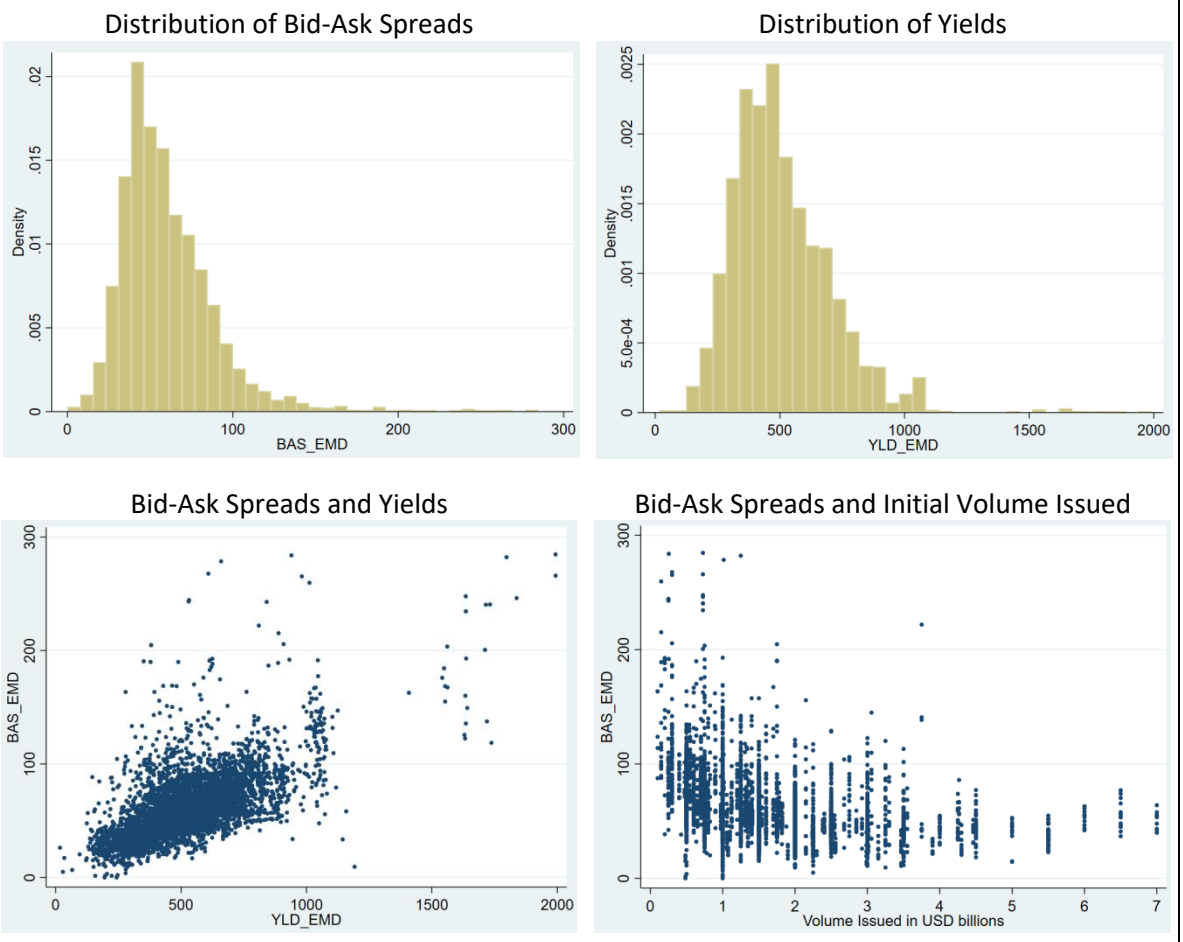
The dataset includes over 4750 observations of yields and bid-ask spreads on EMDC US$ Eurobonds, implying about 500 observations per observation period. The number of observations per quarter increases slowly over the sample period as new bonds are issued faster than old bonds mature.

The wide ranges of most exogenous and endogenous variables offer the prospect that tests will be powerful and results relevant to many countries and periods. For example, most initial issue volumes are below US$3 billion, but some are double that. The modal initial maturity is ten years, but there are substantial numbers of shorter-term bonds and a cluster of bonds with initial maturity around 30 years. The credit ratings in the data sample range from AA (=20) to CCC+ (=6). The modal value is BBB- (=13), with just a few observations with ratings of CCC+ and only about a fifth of the sample had a credit rating above BBB (=14).

The summary statistics and charts show that the distributions of the variables are typically skewed (Figure 1). Most variables (before taking logarithms) are bounded from below. In particular, bid-ask spreads are always positive. In this sample, the US$ yields are all positive. The distributions display long “tails” of relatively high value observations.

The scatter plots for the bid-ask spread against other variables suggest that certain correlations are strong. Most striking is the positive relationship between bid-ask spreads and yields. The bid-ask spread is distinctly negatively correlated with issue size, but the relationship may be non-linear.

Figure 1. Selected Variable Distributions and Scatter Plots



Source: see text

A preliminary examination of the data suggests the presence of extreme outliers (mostly with very large bid-ask spreads or yields). These outliers are almost all for bonds from countries that had undertaken restructurings or were in or close to default. Most of the outlier bonds are Venezuelan or Argentine.

Given the large dataset, outliers are treated conservatively: for estimation purposes, all Venezuelan bonds are excluded, as are bonds with characteristics likely associated with exceptional illiquidity (e.g., a residual maturity of less than one month or a yield above 15 percent). That trimming (plus a handful of missing values for explanatory variables) brings the sample size of US$ Eurobonds down to 4,363. As will be shown, results are not sensitive to the severity of outlier exclusion. Issues from 61 countries are included in the sample, and all regions are represented.

4.4 Regression specification

The dependent variables are the logarithms of the bid-ask spread and the yield on individual EMDC U.S. dollar-denominated Eurobonds (*LBAS* and *LYLD*, respectively). Taking logarithms is essential to achieve error

terms that are symmetrically and at least approximately normally distributed.[7] Otherwise, standard tests of significance are inapplicable and possibly very misleading.

Attention focuses on the reduced form specification, relating *LBAS* and *LYLD* to the explanatory variables, which are clearly predetermined.[8] The reduced form is sufficient for the purposes of market participants, be they investors or DMO, and is econometrically more straightforward. In particularly, the reduced forms can be estimated by OLS.[9]

A flexible functional form and the inclusion of cross-products among explanatory variables distinguish this approach from that taken in past literature. A translog functional form, which includes both logs and squares of logs of the explanatory variables, allows for non-linear and possibly non-monotonic relationships. Cross-products with credit rating terms are included, motivated by the theoretical arguments for expecting that the effect of an explanatory variable depends on the respective country's credit rating. For example, bond yields and liquidity may be largely independent of issuance volume for a highly rated country, but sensitivity may be greater for a lower-rated country. The cross-products of the dummies for "contractual terms" with the credit rating variable may be especially relevant given the theoretical argument and empirical evidence cited above to suggest that the contractual variables are disproportionately important for bonds issued by low rated countries. Each regression includes explicit quarterly dummy variables to capture common quarterly shocks and variations in explanatory variables that are not available in the sample, and thus global macro-financial conditions. Since many of the right-hand-side variables are correlated with each other, attention focuses on overall effects and joint (Wald) tests of related groups of variables (e.g., all terms related to the issue volume).

The principal specification for the dependent variable Y (the bid-ask spread or the yield) is thus[10]

$$LY = \sum_{h}^{H}(\alpha_{1h}LX_h + \alpha_{2h}LX\_SQ_h + \alpha_{3h}LX\_LCRR\_I_h + \alpha_{4h}LX\_LCRR\_I\_SQ_h) + \sum_{i}^{I}(\beta_{1i}DV_i + \beta_{2i}DV\_LCRR\_I_i + \beta_{3i}DV\_LCRR\_I\_SQ_i) + + \sum_{j}^{J-1}(\gamma_j D\_period\_j) + \sum_{k}^{K-1}(\gamma_k D\_ISSUE\_YR\_k) + CONSTANT$$

where *LW* denotes the log of variable *W*; LX_SQ_h denotes the square of the log of explanatory variable X_h (such as issue volume); $LX\_LCRR\_I_h$ denotes the normalized cross product of LX_h and the log initial credit rating *LCRR_ISS* for that observation (see below); $LX\_LCRR\_I\_SQ_h$ denotes the normalized cross product of LX_h and the squared log initial credit rating *LCRR_ISS_SQ* for that observation; DV_i denotes a dummy variable indicating a contractual or institutional feature of the bond (such as jurisdiction of issue or presence of an enhanced CAC); $DV\_LCRR\_I_i$ denotes the normalized cross product of DV_i and the log initial credit rating *LCRR_ISS*; $DV\_LCRR\_I\_SQ_i$ denotes the normalized cross product of DV_i and the squared log initial credit rating *LCRR_ISS_SQ*; *D_period_j* denotes a dummy variable taking a value of 1 for observations from quarter

[7] The support of the distribution of the bid-ask spread, and that of the yield, are narrow and certainly non-negative. Hence, a regression of levels on levels cannot give rise to normally distributed residuals.
[8] Many explanatory variables indeed are determined years in advance at the time of issuance.
[9] Stata Version 16 was used for all estimation.
[10] The observation index is suppressed for the sake of concision.

j and zero otherwise; and *D_ISSUE_YR_k* denotes a dummy taking a value of 1 in for bonds issued in year *k* and zero otherwise.

Robustness was assessed by various means, such as repeating the regressions using the robust regression procedure available in Stata;[11] trimming or expanding the sample; using a sample of just those bonds that were issued after 2009; using country dummies and dropping variables that therefore become unidentified (i.e., total country volume and credit rating level); after dividing the sample by country issue size or by rating groups. Dividing the sample into lower and higher rated bonds seems worthwhile even though, since the credit rating is an important explanatory variable, doing so in effect creates sample selection bias. A battery of diagnostic test was performed.

5. Regression results

The regressions were able to explain a large proportion of the variation in the dependent variables, with estimated parameters being statistically significant (individually or as groups) and economically plausible. Details and further results are provided in Hardy, op. cit. Results were broadly robust, and the distributions of residuals close to normal. The results are reasonably robust.

Due to the large number of estimates and the complex translog specification, the effects of the various explanatory variables are presented here graphically. The graphs are constructed to show how the level of a dependent variable varies as the level of the respective explanatory variable varies, as appropriate taking into effect the interaction with the credit rating variable. The graphs are normalized such that the curve goes through the mean value of the dependent variable when the respective explanatory variable is (close to) its mean.[12]

5.1 Bid-ask spreads

The regressions for the log bid-ask spreads explain over two thirds of its variation. There are many individually highly significant parameter estimates, and most groups of parameter estimates (e.g., for all issued volume variables) are significant at beyond the 1 percent level. The typical effects of the various explanatory variables are illustrated in Figure 2.

Looking at the effects of the various explanatory variables, it can be seen from the top left chart in Figure 2 that issue volume has a strong and negative effect on the bid-ask spread. Reducing the volume from US$1.5 billion (just above the sample average) to US$750 million raises the bid-ask spread from about 55 bps. to over 80 bps. for a typical bond with rating of BBB-. The relationship tapers off after issue size exceeds US$1.5 billion but is seen even at higher volumes.[13] There are distinct threshold effects at US$500 million, US$1 billion, and US$1.5 billion, but they tend to reinforce the overall relationship. Credit ratings matters: the

[11] This procedure works iteratively to down-weight outliers.

[12] The regressions yield results that can be represented in stylized form as ln(*y*)=a0+a1ln(*x*), where y and x are respectively the dependent variable and the (group of) explanatory variable(s); a1 is the parameter estimate for the variable ln(*x*); and a0 captures the other remainder of the specification. The predicted value of the level of *y* is therefore given by $\hat{y} = e^{a0}.x^{a1}$. To construct the graphs, the term a0 is chosen such that $\bar{y} = e^{a0}.\bar{x}^{a1}$, where the top bar indicates the mean of the respective variable. For ease of presentation, the normalization used a "rounded" value of the respective explanatory variable at a benchmark value close to its mean (e.g., an issue volume of US$1.5 billion, when the sample mean is about US$1.3 billion). For a dummy variable (such as the indicator of whether a bond includes an enhanced CAC), the projection is scaled by the inverse of the sample average value of the dummy variable, so that the projection for the whole sample goes through the mean of *y*, but the curve shows the effect when the dummy takes the value of unity.

[13] It is worth noting that yield and liquidity are not the only considerations facing a debt manager. Concentrating issuance in a few large issues increases roll-over risk.

volume effect is somewhat less important for bonds with the low credit ratings; perhaps they have a narrower investor base, so, on the margin, a smaller volume is enough to generate as much market liquidity as they ever enjoy. The relationship between issue volume and the bid-ask spread is positive for very low rated bonds. The explanation could be that the issuance volume itself signals higher creditworthiness more strongly than what is indicated by the rating. Qualitatively similar results are found, for example, in Ap Gwilym et al. (op. cit.), and Bildersee (1980).

Undertaking an LMO that reduce the amount outstanding does reduce liquidity as measured by the bid-ask spread, but the effect is not very pronounced until only a third or less of the initial volume remains (top right chart in Figure 2). Highly-rated bonds are less affected, possibly because they enjoy strong demand among "buy and hold" investors, who do not much care about market liquidity. One implication is that choice of the initial volume has a distinct and persistent effect on liquidity; once the investor base is established, the market remains fairly stable. The current volume outstanding is significant but less important.

Based on estimates for the whole sample, the total volume of issuance by a country is not a powerful determinant of the bid-ask spread, at least once the total exceeds US$5 billion (second row left-hand chart).[14] A smaller, lower-rated issuer can achieve a somewhat narrower bid-ask spread when the total volume increases. A medium- to highly-rated issuer does not need to be much concerned about this aspect of market presence. The parameter estimates are individually statistically insignificant, but collectively they differ significantly from zero.

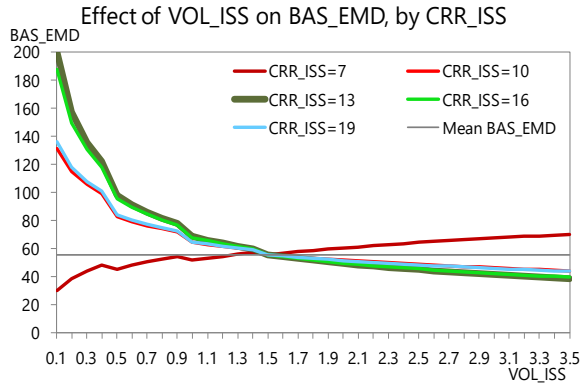
This result is perhaps surprising: one might expect that more investors would be prepared to cover the fixed costs of analyzing the risk-return characteristics of an issuer when that issuer has a large volume of securities outstanding, and especially when the issuer is regularly in the market. Hence, the Eurobonds of frequent, large-volume issuers should be more liquid than those of sporadic, small-volume issuers, and have correspondingly narrower bid-ask spreads.[15]

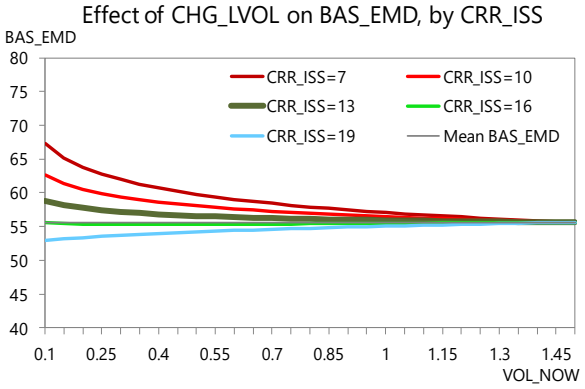
The modest estimated importance of a country's total issuance volume may be a statistical artifice, or reflect underlying differences the situation facing small versus large issuers. The result may reflect collinearity: the correlation between total country volume and individual issue volume is about 0.6 (but is lower for large issuers); possibly the estimated coefficient on the latter captures the effects of both. However, some additional regression results (see Hardy, op. cit.) based on splitting the sample suggest that increasing total country volume does decrease bid-ask spreads substantially for small issuers, but not for large issuers.

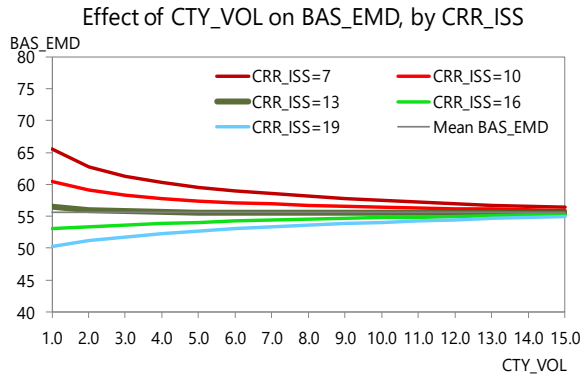
[14] The existing literature concentrates on individual issue size, neglecting the total outstanding by issuer or number of issues.

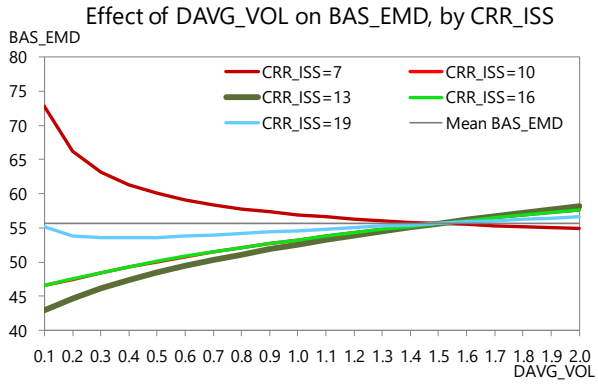
[15] However, Tanner and Kochin (1971) and Bildersee (1979 and 1980) find that individual issue size matters for the bid-ask spread even on Canadian, agency, or U.S. government bonds, respectively.

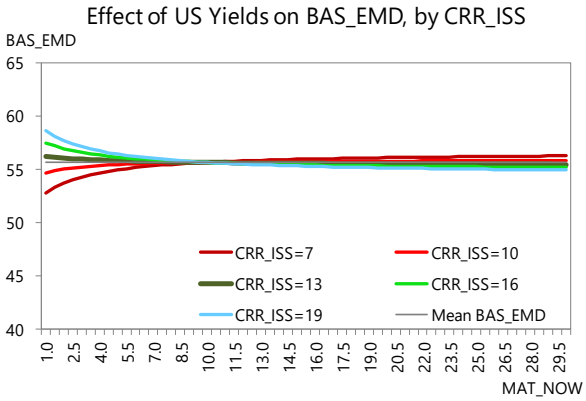
Figure 2. Bid-Ask Spread Determinants; Reduced Form Regressions

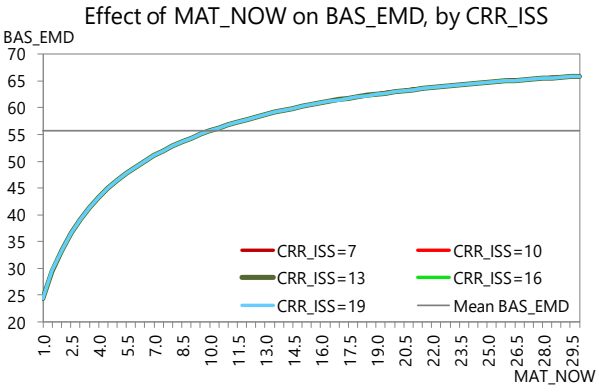


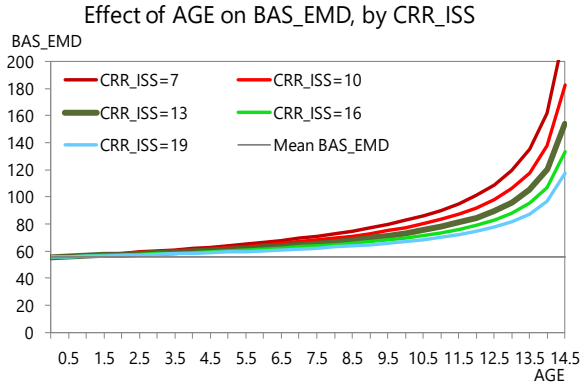












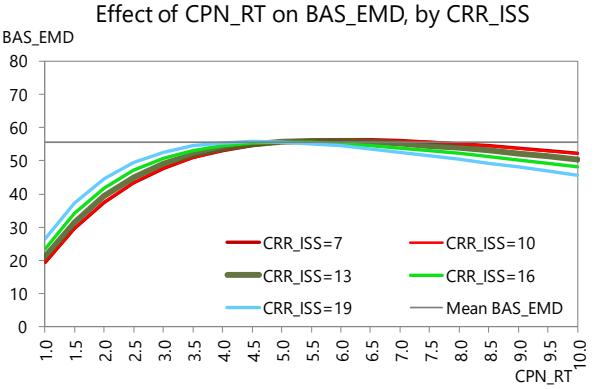
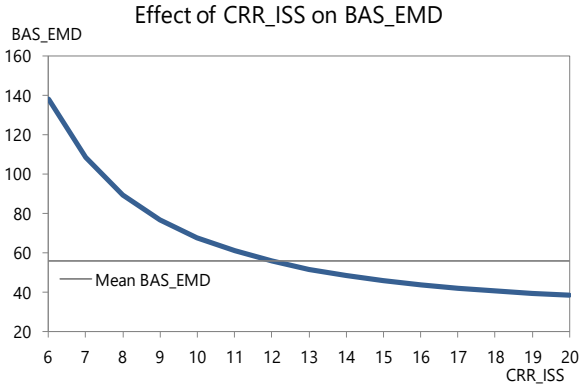
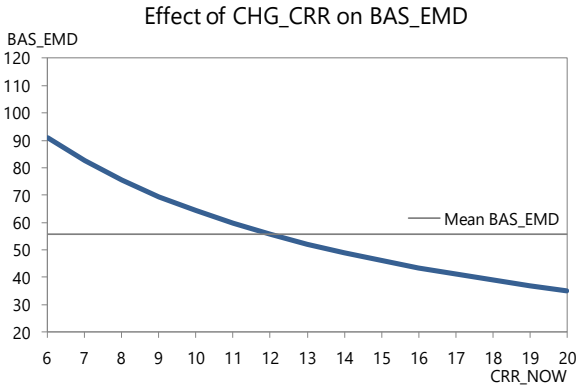
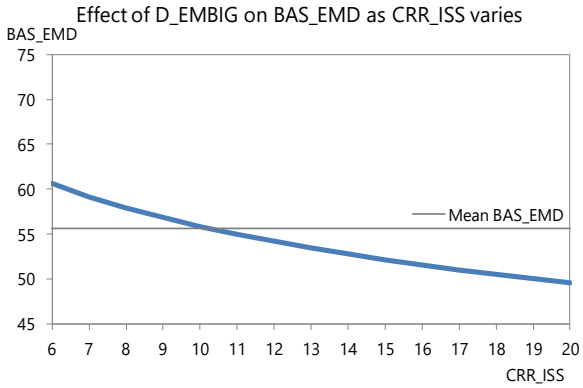
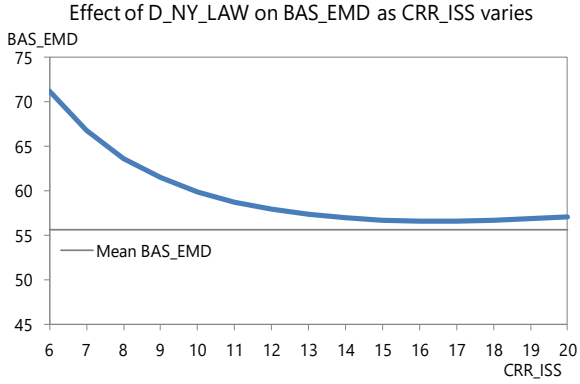


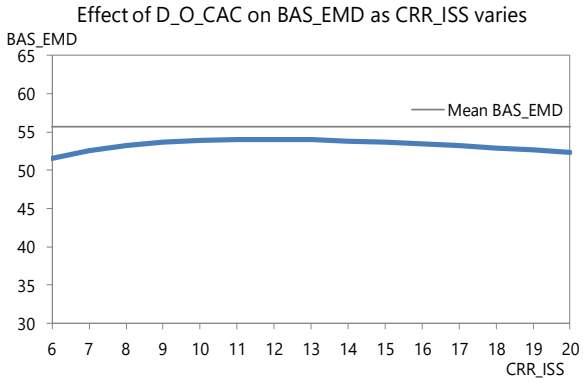
Figure 2. Bid-Ask Spread Determinants; Reduced Form Regressions (Continued)

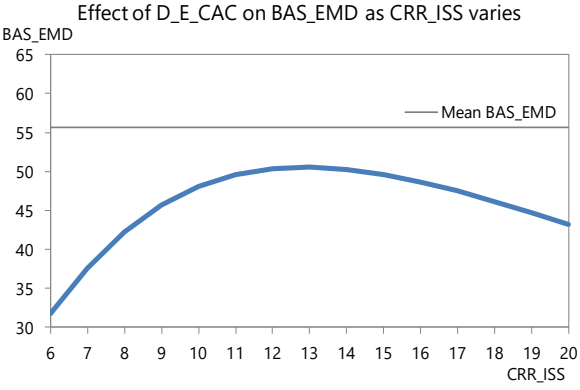


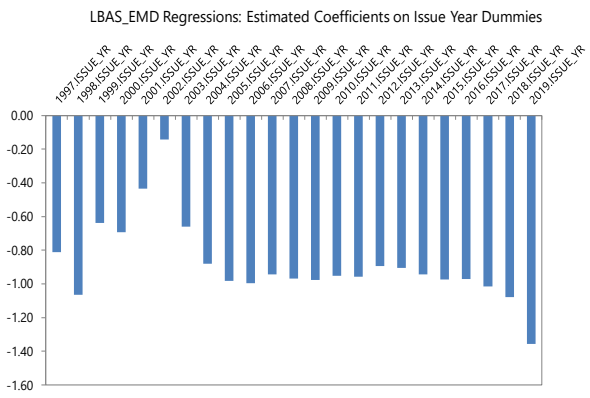












Source: see text

For a country with a credit rating in the range of 9 to 15, issuing somewhat less than its average issue size can slightly narrow the bid-ask spread, but a very large issuance will be penalized (second row right-hand chart). Consistency is more important for a country with a low credit rating: issuing an unusually small amount may be taken as an adverse signal, and being able to issue an unusually large amount may expand the investor base and generate much price discovery through trading in the initial allocation.

The estimated parameters on current yield curve variables are individually insignificant, and the overall effect is very small (third row, left-hand chart). The estimated coefficients on the log-level and its square are jointly insignificant. Possibly, U.S. interest rates and especially longer-term rates were sufficiently stable during the sample period that changes in "search for yield" behavior were not pronounced.

An examination of the parameter estimates and the results of various Wald tests reveals that the initial maturity significantly affects the bid-ask spread.[16] The effect of initial maturity on the bid-ask spread is well-captured by the quadratic terms, with almost no difference by credit rating (third row right-hand chart). The estimated parameters on the linear terms and the cross-products with the credit rating are insignificant individually and collectively.

As seen in results from other markets summarized above, age (time elapsed since issuance) does affect the bid-ask spread, but in a highly non-linear way (fourth row left-hand chart). Once only about a quarter of the initial maturity remains, spreads increase sharply. The effect is much more pronounced for bonds with a low credit rating. For top-rated bonds, liquidity dries up when only about a tenth of initial maturity remains.

The overall effect of the initial credit rating on the bid-ask spread is represented in the top left-hand chart on the second page of Figure 2. This projection takes into account the indirect effect of the credit rating working through cross-product terms, where the other explanatory variables are assumed to take typical values (e.g., an issue volume of US$1.5 billion). Again, the relationship is non-linear: a low rating has a disproportionate effect on the spread. Spreads are not much affected by the credit rating in the range 9 to 18. A slight uptick can be seen in the spread for top-rated issues. Possibly, the typical investor for Eurobonds focuses on issuers with medium ratings, and is less interested in Eurobonds that are very close substitutes for advanced economy bonds.

The distinct effects of the initial and current ratings are both economically significant, and therefore the change in the rating since issuance has a strong effect (top right-hand chart on the second page of Figure 2).[17] The initial rating matters for countries with below-average credit ratings; once that mid-point is reached, the effect is minimal. A deteriorating credit rating may reduce demand and shrink the investor base, resulting in wide bid-ask spreads, and likewise an upgrade may make a bond attractive to many more investors. Interestingly, this relationship has little convexity: the initial rating matters most for low-rated issuers, but the change affects all bond roughly equally.

The coupon rate has a distinctly positive but nonlinear relationship with the bid-ask spread, largely independent of the credit rating (bottom row right-hand chart). A coupon rate of 1.5 percent is associated with a bid-ask spread about 25 basis points lower than in the case of a coupon rate of 5 percent. Thus, the greater duration implied by a low coupon rate does not translate into reduced market liquidity—unlike

[16] Analogous results for other markets or other samples are found in Amihud and Mendelsohn (1991), Chakravarty and Sarkar (2003), and Hund and Lesmond (op. cit.), for example.

[17] The relevant F tests need to be interpreted with care because LCRR_ISS enters as a cross-product with many other explanatory variables.

what was found in other markets in the studies cited above. The coupon rate on a Eurobond strongly may signal creditworthiness in a way that goes beyond the credit rating; perhaps only a very well-regarded issuer can offer a low coupon rate.

Inclusion of a bond in the EMBIG has a small effect on the bid-ask spread, positive for low-rated issuers and negative for medium- to high-rated issuers (middle left-hand chart on the second page of Figure 2). The estimated parameters are not individually significantly different from zero, but they are jointly significant.

Rather more important is choice of jurisdiction: issuance under New York is found to increase the bid-ask spread for low-rated bonds, that is, those for whom restructuring and court involvement is relatively likely. The prevalence of trust arrangements under New York law and experience during the Argentine and Greek restructurings (see Box 1 above) may encourage existing investors to hold on to risky bonds even in the face of news events, and thus reduce market liquidity, ceteris paribus. Lower market liquidity is reflected in wider spreads. Issuance jurisdiction has no significant effect on the bid-ask spread of medium- to high-rated bonds, which are presumably remote from restructuring.

Inclusion of an original CAC seems to have only a slight negative effect on bid-asks spreads, and indeed the estimated parameters are insignificant. However, the effect of inclusion of an enhanced CAC is highly significant and in line with the prediction: an enhanced CAC seems to make a low-rated bond attractive to a wider investment base, thus increasing its liquidity and narrowing the bid-ask spread. In case of very low rating, the bid-ask spread can be reduced by about 20 basis points, compared to a sample average spread of 55 basis points. Even spreads on medium-rated bonds are reduced by about 5 basis points. Thus, the influence of CAC inclusion on the yields of lower rated bonds is complicated by the effect on bid-ask spreads found here.

Most estimated parameters on the issue year dummies are at roughly the same level across the sample, but there seems to have been some better and worse “vintages” (bottom row). Bonds issued in 1999-2003 seem to have unusually large bid-ask spreads, but 1998 seems to have been a good year to issue. The stability of the estimated parameters from 2004—even during the global financial crisis—may reflect the maturation of the market.

The results for the full sample and those for bonds with a credit rating below BBB+ (=15) are quite similar, but the estimates for bonds with higher ratings are often rather different. Often pairs of variables will have parameter estimates that are large in absolute terms but of opposite sign (such as in the case of LVOL_ISS and LVOL_ISS_LCRR_I). It seems that less weight is attached to the exact specification of a bond’s design when that bond is very highly rated; idiosyncratic characteristics matter less—a result similar to that in Schultz (2001).

5.2 Yields

The regressions for log yields achieve R^2 statistics of around 0.85, even higher than those achieved in the regressions for the log bid-ask spreads. Many parameter estimates and groups of estimates are highly significant, and they are economically consistent with those obtained from the bid-ask spread regression.

The issue volume is an important determinant of the yield, especially for bonds with middle range ratings and for volumes below US$1 billion (Figure 3, top left-hand chart). Reducing the volume from US$1.5 billion to US$750 billion raises the yield by over 60 basis points for a mid-rating bond. Threshold effects can be

seen, the most pronounced being at the US$500 million mark; there is a small penalty for very large issue sizes. Issue volume is not important for bonds with very high ratings, and yields on the lowest-rated rise with volume; the price elasticity effect predominates for the riskiest issuers. A modest reduction in the volume outstanding (relative to the initial volume) has a minor effect, but once the remaining volume falls below a third or a quarter of the initial amount, rates rise steeply. All these results are consistent with the hypothesis that restricted liquidity (as signaled by a higher bid-ask spread) reduces demand and thus causes yields to rise.

For most countries, the yield tends to increase with the total amount of bonds outstanding, but the effect is not very large and the individual relevant coefficient estimates mostly do not differ significantly from zero (Figure 3, second row left-hand chart). Possibly, any liquidity effect is offset by the price elasticity effect, and the credit rating variable captures any influence of higher total volume on credit risk. When the sample is split between small and large issuers, the positive relationship is maintained, except in for smaller, lower-rated issuers, where an increase in the aggregate volume from very low levels is associated with a marked decrease in yields, possibly because of interest from a wider investor base and thus improved market liquidity.

A bond issue that is small (large) relative to the amount that a country typically issues can achieve a somewhat lower (higher) yield. The relevant coefficient estimates are highly significant, but the overall effect is modest, especially for highly rated bonds. Again, the relationship is very different for bonds with very low ratings, where the signaling effect of deviating from the country average is very prominent. For example, an exceptionally large issue may be interpreted as a sign of a desperate need for financing.

The effect of current U.S. bond yields is very pronounced, as expected, and independent of credit rating. Even after allowing for the current yield curve, remaining maturity affects the yield monotonically and largely independent of credit rating, as was seen for the bid-ask spread. The effect of seasoning is non-monotonic: for a bond with an initial term of 15 years, for example, the yield tends to fall for the first decade or so, suggesting that the supply effect predominates, and then rises sharply as the maturity date approaches, suggesting that diminishing market liquidity gains influence (Figure 3, fourth row left-hand chart).

Unsurprisingly, a lower credit rating is associated with a higher yield (Figure 3 continued, top row). Looking more closely at the parameter estimates for the when-issued rating variables (LCRR_ISS, etc.) and the change in the rating (CHG_LCRR, etc.), it is clear that the current rating matters most. The F tests indicate that the estimated coefficients on the two when-issued credit rating variables are jointly insignificantly different from zero in the yields regression, but that test does not allow for the influence working through cross-products.

A low coupon rate is associated with low yields, whereas the effect working through longer duration is not prominent (Figure 3, bottom row, right-hand chart). The sharp curvature of the effect shape—rising steeply then almost flat for coupon rates above 4.5 percent for most rating levels—mirrors that seen in the bid-ask spread regressions. Possibly, causation runs from the coupon rate to the bid-ask spread, and then to the yield.

Figure 3. Yield Determinants; Reduced Form Regressions

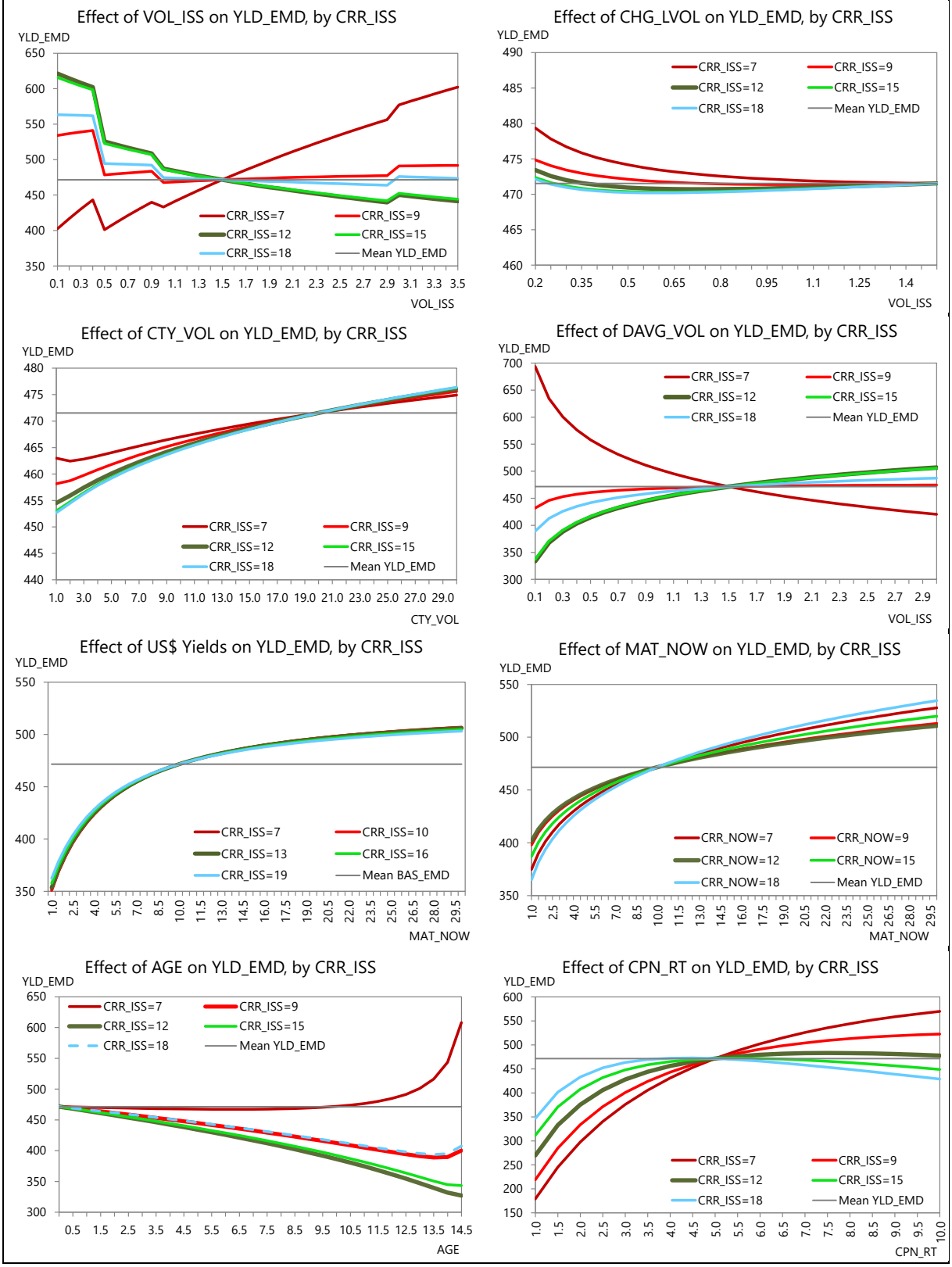
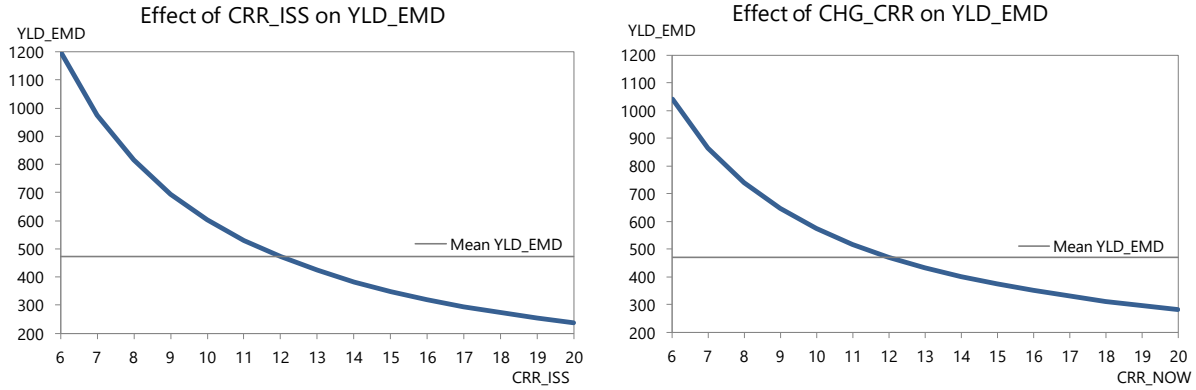
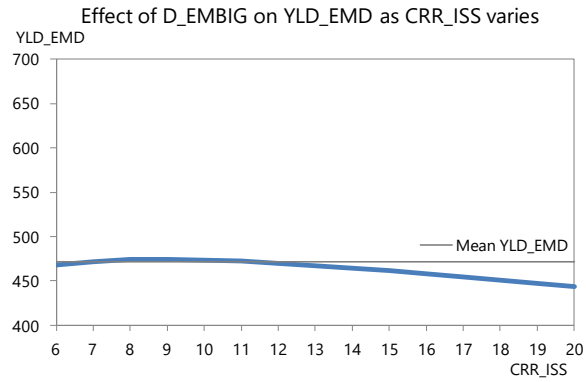
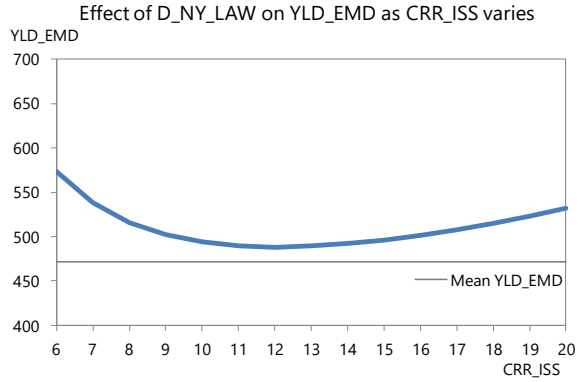
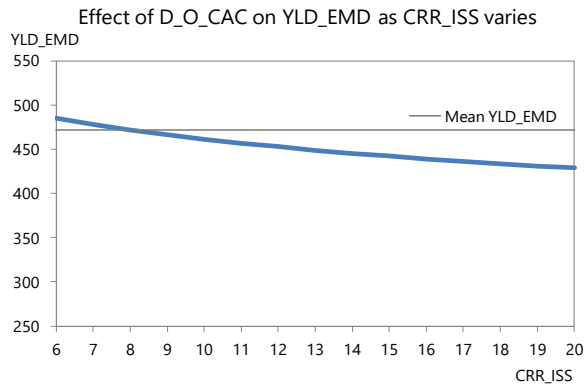


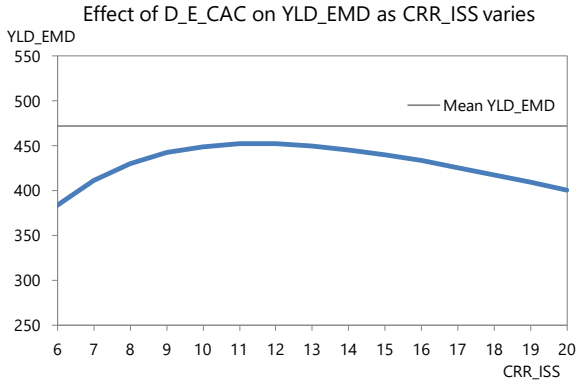
Figure 3. Yield Determinants; Reduced Form Regressions (Continued)

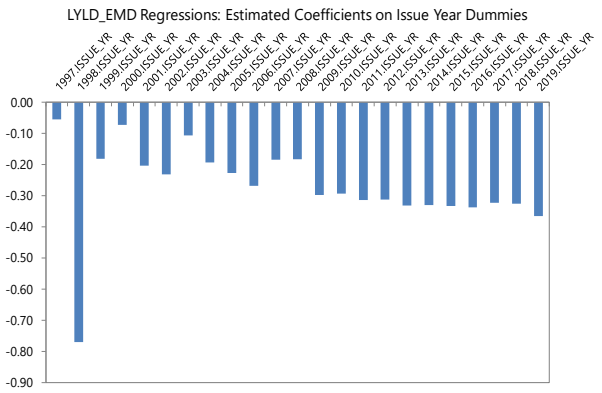












Source: see text

Inclusion in the EMBIG has a significant but modest overall effect on yields. The estimated effect has the same sign but is smaller than that found by Calomiris et al (2019), who looked though at corporate Eurobonds and employed a simpler specification.

Issuance under New York law raises yields markedly, especially for low-rated bonds, possibly to compensate for the higher bid-ask spreads projected above but also possibly because, should it come to restructuring, resolution under New York law is expected to be relatively expensive for most investors.[18] Ratha et. Al 2016) finds that issuance under New York law lowers yields, but that study employs fewer controls for other effects, such as differences in volume and credit rating.

Parallel to what was seen for bid-ask spreads, inclusion of an original CAC seems to have only a small but negative effect on yields, though the estimated parameters are jointly significant. In contrast, an enhanced CAC markedly reduces yields, especially on low-rated bonds (Figure 3 continued, third row); depending on the rating, yields can be reduced by tens of basis points.

The good and bad "vintages" of issue, as captured by the year dummies, largely coincide with those seen for the bid-ask spread (Figure 3 continued, last row). Bonds issued in 1999-2003 seem to have both large bid-ask spreads and high yields.

6. Summary and conclusions

The results presented here show that, for the globally important asset class of Eurobonds, instrument design significantly influence yields and liquidity risk, as captured by bid-ask spreads. In particular, the choice of issue size; maturity; jurisdiction of issuance; and inclusion of an enhanced CAC, are important. Table 1 summarizes the magnitudes of the main effects, separating the marginal effects of continuous variables (such as a bond's remaining maturity) from the step effects of dummy variables (such as whether or not a CAC is included in a bond's terms). However, characteristics of very highly rates bonds are less reliably related to their yields and spreads.

The results are of both academic and practical interest. They broadly corroborate the predictions of models of market liquidity and the relationship between market liquidity and yields: yields reflect not only duration and credit risk, but also liquidity risk. This empirical study, using a novel panel dataset, complements others that have looked at the determinants of market liquidity and the relationship to yields. The estimation approach is distinguished by the special attention paid to the inter-dependence of yields and bid-ask spreads; interactions with credit ratings and issuer size; and the influence of numerous control variables. The flexible function form allows for nonlinear and even non-monotonic relationships, which turn out to be prevalent, while giving rise to approximately normally distributed residuals.

One implication of the revealed relationships is that good debt management—both at initial issuance and through subsequent intervention—can reduce funding costs by tens of basis points, achieving savings of millions of dollars even for a small issuer. The results suggest how an initial investor can predict how long a bond is likely to retain market liquidity. The results also allow an assessment of whether current pricing is

[18] The extra cost may reflect a lower final recovery rate or a lengthier process.

in line with market liquidity; divergence may give rise to investment opportunities or occasions for liquidity management operations by the DMO.

The approach used here could be extended to investigate whether bid-ask spreads vary depending on the degree of global and country-specific stress and volatility, as captured perhaps by risk premia and macro-financial indicator variables. It is at least possible that market liquidity at first improves when there is more "news," until increased risk erodes the investor base. Alternatively, one could investigate country by country how market liquidity varies across issues, focusing on large issuers who each generate enough observations to achieve useable degrees of freedom; or refine the estimates based on a narrow sub-sample of highly comparable countries, which approach may be appropriate for research by an investor or DMO.

Interesting extensions of this research could include looking at the determinants of the bid-ask spreads and yields of corporate Eurobonds; those of Eurobonds denominated in other currencies; and those of advanced countries issued both domestically and abroad. The approach of this paper could usefully be applied to an investigation of the pricing and liquidity of domestic sovereign securities in emerging markets, an asset class that is of growing importance, and for which the achievement of sustained market liquidity can be a crucial challenge.

Table 1. Summary of Main Effects 1/

Explanatory Variable	Marginal Effect	
	Decrease BAS by 10 bps. requires	Decrease YLD by 30 bps. requites
Issuance volume	Increase in issue volume from US$1.1bn. to US$1.5bn.	Increase in issue volume from US$1.3bn. to US$1.5bn.
Total country volume	Increase in country volume from US$1bn. to US$10bn.	Increase in country volume from US$4bn. to US$7bn.
U.S. T-bond yield curve	…	Decrease in maturity from 10 to 5.5 years
Time to maturity	Decrease in maturity from 10 years to 4.5 years	Decrease in maturity from 10 to 4.0 years
Credit rating at time of issue	Increase in rating from BB- to BB+	Increase in rating from BB (positive outlook) to BB+ 2/
Change in credit rating since time of issue	Increase in rating from BB- to BB+	Increase in rating from BB (positive outlook) to BB+ 3/
Coupon rate	Decrease in coupon rate from 5.0 percent to 2.5 percent	Decrease in coupon rate from 5.0 percent to 3.5 percent
Dummy Variable	Fixed Effect	
	Effect on BAS_EMD	Effect on YLD_EMD
Issue volume ≥US$0.5 bn.	-9.0 bps.	-70 bps.
Issue volume ≥US$1.0 bn.	-5.0 bps.	-18 bps.
Issue volume ≥US$1.5 bn.	-3.0 bps.	-23 bps.
Issue volume ≥US$3.0 bn.	-0.5 bps.	+13 bps.
Included in EMBI Global	-1.5 bps. when CRR=BB+; +3.0 bps. when CRR= B-	-1.5 bps. when CRR= BB+ +0.5 bps. when CRR= B-
Issued under NY law	+2.0 bps. at CRR= BB+ +11.0 bps. when CRR= B-	+17.0 bps. at CRR= BB+ +67.0 bps. when CRR=B-
Inclusion of an original CAC	-1.5 bps. at CRR= BB+ -3.0 bps. when CRR= B-	-19.0 bps. at CRR= BB+ +6.5 bps. when CRR= B-
Inclusion of an enhanced CAC	-5.5 bps. at CRR= BB+ -18.0 bps. when CRR= B-	-19.5 bps. at CRR= BB+ -61.0 bps. when CRR= B-

Source: See text.

1/ Credit rating assumed to be BB+ unless stated otherwise.
2/ One rating grade improvement reduces yield approximately 60 bps.
3/ One rating grade improvement reduces yield approximately 45 bps.

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SESSION III

DEVELOPMENT OF LOCAL CURRENCIES BOND MARKETS

Endogenous Market Development for Government Securities in Lower-Income Economies[1]

Tadashi Endo[2]

Abstract

Many lower-income economies have difficulty developing government securities markets (GSMs). A "Two-Dimensional Policy Framework for GSM Development" offers a solution to improve upon the twenty-year-old World Bank/IMF's conventional policy framework. It differentiates GSMs by their development phases and presents endogenously phase-coherent policy sets. This research found that the endogenous variables explained 40 percent of trading volume growth in the early phase of India's GSM development and that utilities played a dominant role in increasing trade volumes in the early-phase market. The framework is worth test-applying to GSM development in lower-income economies.

Keywords: Government security; Market development; Low-income economy; Phase-differentiation; Endogenous variable; Utility

JEL classification: H63, O16, O21, and P43

1. Introduction

The government securities market (GSM) is a core economic infrastructure for modern economic management. Hence, the international development community (IDC), including the World Bank and IMF, established a comprehensive policy framework for GSM development in the early 2000s (the conventional policy framework–CPF) and undertook GSM development initiatives for more than two decades. However, the results are disappointing for lower-income economies (LIEs).[3] The secondary markets of most LIEs remain illiquid or considerably low liquid. (Endo, 2020) The effectiveness of the CPF for LIEs has yet to be reviewed.

This research questions what policy set for GSM development in LIEs is implementable at a low cost and what framework lays out different policy sets for different market development phases. These questions aim at finding a new way for a LIE to facilitate and reinforce its macroeconomic and social achievements through its GSM development. In answer to these questions, I propose a "Two-Dimensional Policy

[1] This paper is abridged and modified as necessary from Endo, T. (2022). Endogenous market development for government securities in lower-income economies. Emerging Markets Review, 50, 100844 https://doi.org/10.1016/j.ememar.2021.100844.

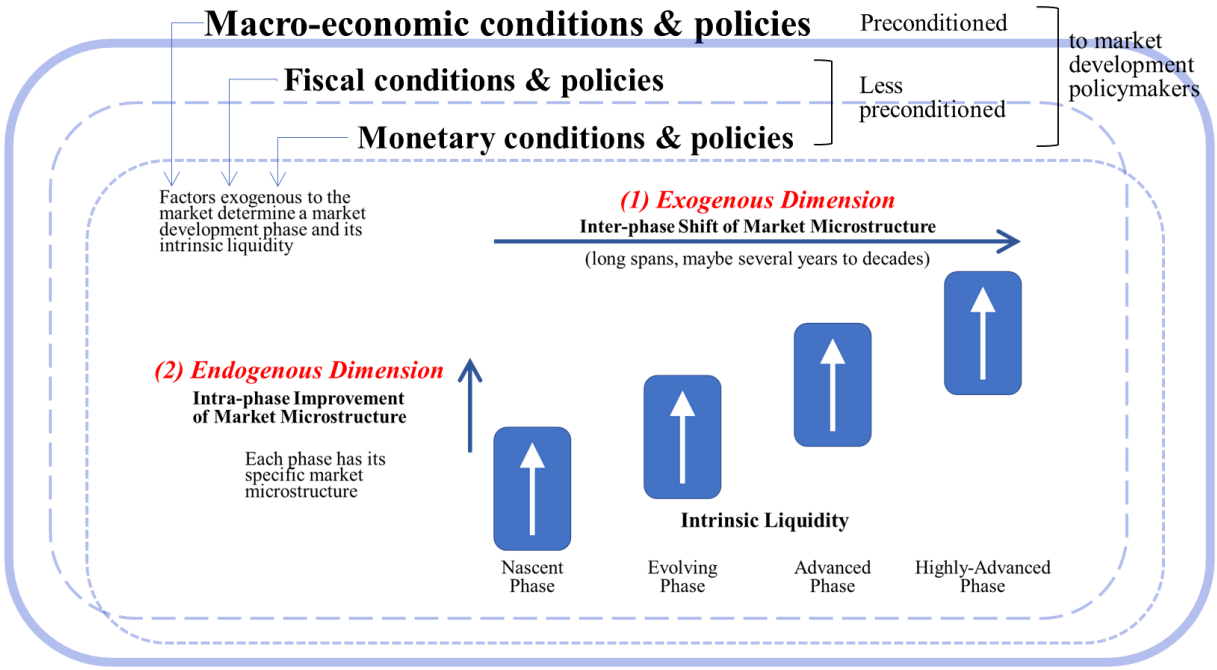
[2] Consultant, Japan

[3] This study defines the World-Bank-defined low-income economies (LIEs) and many lower-middle income economies (LMEs) as "lower-income economies" unless otherwise specified. The World Bank defines low-income economies and lower-middle-income economies as those with a GNI per capita of $1,025 or less in 2018 and those with a GNI per capita between $1,026 and $3,995, respectively. (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups) "Emerging economies" in common parlance include not only "lower-income economies" but also higher-income economies that are not included in "advanced economies."

Framework for GSM Development" (TDPF) (Figure 1 and Table 1) to enable the GSM policymaker to focus on endogenous GSM development systematically.

Endogenous market development works on policy variables endogenous to a GSM rather than exogenous. The TDPF is a tool to identify and work on the best set of endogenous policy variables.

Figure 1: Two-Dimensional Market Development



Source: Author

Table 1 Two-Dimensional Policy Framework for Government Securities Market Development

June 4, 2022

Market Developmental phase		**1** **Nascent**	**2** **Evolving**	**3** **Advanced**	**4** **Highly-Advanced**
Investor base (minor investors)		Mainly captive/state Commercial banks State pension fund State insurance companies (Retail investors) (Corporate investors)	Less captive/state Commercial banks Pension funds Insurance companies (Retail investors) (Corporate investors)	Private sector dominant Yield-seeking Pension funds Life insurance companies Cooperatives Foreign investors Mutual funds Commercial banks	More private sector dominant Competitive performance Pension funds Life insurance companies Cooperatives Foreign investors Mutual funds Hedge funds Commercial banks
Policy principles	Policy Measures	Simple Minimum Low cost	Focused Efficiency-seeking, Local Scalable	Competitive Efficient Beyond the banking sector Equal footing	Sophisticated Internationally competitive Prudential Resilient
	Goals	Visibly fundamental and functional	Essential to a national economy	Influential across the yield curve	Internationally compatible
Functioning Market Functions*					
Accounting	Policy Measures	Disclosure and governance of institutional investors and intermediaries	Amortization	Mark-to-market (Fair value)	Hedge accounting
	Goals	Trust building in financial intermediation	Reduced price distortion,	Better performance evaluation of asset management Better risk management Competition for better asset management performance More active trading	Derivatives for risk management
Legal affairs	Policy Measures	Modern business law Modern banking law Public debt law Securities Law Immobilization or depository regulation	Trade failure Trade finality Netting arrangements Dematerialization Code of conduct	Payment system law Novation Securities lending Liquidation of collateral and pledged assets Master repo agreement	International harmonization Jurisdictional (re)alignment Legal and jurisdictional coordination regulators

Market Developmental phase		1 Nascent	2 Evolving	3 Advanced	4 Highly-Advanced
				Enhanced prudential supervision and regulation	
	Goals	Legal basis for debt securities issuance and trading	Certainty and efficiency of trading	International comparability, Legal basis for trading efficiency, settlement certainty, and risk management Enhanced resilience to shocks	International comparability and connectivity
Primary market	Policy Measures	Preannounced auctions Non-competitive bidding Designated/prequalified bidders Treasury bills Short-term maturities	Issue calendar Reopening or buy-back or switching Tap issuance Bidding open to the public Short- to medium-term maturities	Larger issue amounts Syndicate underwriting Long-term maturities Treasury bills for sterilization	Product innovation (like STRIPS)
	Goals	Introduction of market-based public finance	Lower debt cost by pooling liquidity Lower secondary market prices by consolidating issues Broadening of the investor base	Adaptation to institutional investors Liquidity enhancement Extending the benchmark yield curve	A more reliable yield curve (a zero-coupon yield curve)
Debt and cash management**	Policy Measures	Cleanup of public or quasi-public arrears Public debt issuance legislation DM office Timely & accurate debt record keeping The separation between front- and back-office activities	Increase in domestic borrowing DM strategy and reporting Consolidation of DM functions Sensible balancing or separation between DM and monetary policy operation (e.g., agency agreement) Partial risk management Sovereign credit rating	Treasury single account Cash flow forecasting Integrated debt recording system with the rest of the public financial management system Middle office (integrated sovereign risk management, etc.)	Assets and liabilities management framework (integrated approach)

Market Developmental phase		1 Nascent	2 Evolving	3 Advanced	4 Highly-Advanced
	Goals	Explicit authorization to borrow Clear delegation of responsibilities Confidence building in public finance Timely debt service	Mitigation of the "original sin." Reduced refinance or liquidity risks Enhanced accountability of public debt Transparency	Better controlled refinance or liquidity risks	Increased natural hedging of the state's balance sheet
Secondary market	Policy Measures	Negotiated (dealers' "Club") market Telephone voice trading	Screen-based electronic trading platform Call auction or continuous order-driven Market convention Market surveillance	Electronic OTC market (quote-driven) Continuous trading Partial PD market making Market transparency rules Interdealer brokers	Full-scale PD market-making Connectivity Interdealer brokers
	Goals	Occasional trading	Trade transparency Periodic/regular price discovery Centralized marketplace	Liquid trading Extend price discovery to the medium- and long-term segments	Continuous price discovery across the yield curve High-volume trading
Monetary policy framework***		Reliance on rules-based instruments	Introducing money market instruments	Increasing open market operations	Full reliance on money market operations
Money market	Policy Measures	Treasury bills Call market Reserve averaging	Standing facilities (Central bank repos) Interest rate corridor Bank repos Sporadic open market repos	Repos among financial and non-financial institutions (open repo market) Commercial papers	Forward-rate agreements
	Goals	Reduced volatility of money market rates	Reduced volatility of money market rates Even distribution of fund liquidity Anchoring the yield curve at the short end Introduction of market-based monetary operations	Lower and more stable inventory holding costs for non-bank intermediaries Facilitating a shift from direct instruments to indirect ones	Enhanced hedging function
Derivatives or futures	Policy Measures			Interest rate swaps	Interest futures and options Currency futures and options
	Goals			Interest rate hedging	Higher price discovery and

Market Developmental phase		1 Nascent	2 Evolving	3 Advanced	4 Highly-Advanced
					liquidity Reinforced price discovery (yield curve)
Clearing and settlement	Policy Measures	Book-entry CSD	Dematerialization DVP Rolling settlement Multiple-net settlement SWIFT Automation	Integration of payment and securities settlement systems RTGS Central bank money STP	CCP Link to international CSDs Special collateral repos
	Goals	No physical delivery Ownership management	Enhanced Backoffice efficiency Closer market monitoring	Systemic risk reduction	Globalization

Source: Modified from Endo (2022)

Notes:
* Market functions (previously termed "market components") are the categories of policy measures enabling the market structure to function.
** Policy measures for debt management in this Table are those for domestic government debt market development. Emerging economies often resort to external debt before or while their domestic government debt markets develop. Their external debt issuance may require the debt issuing economies to put in place more advanced debt management systems in earlier stages than their domestic debt does.
*** Based on the author's interpretation of Laurens, J. Bernard.2005. Monetary policy implementation at different stages of market development. IMF Occasional paper No. 244. Washington, D.C.: International Monetary Fund, 2005. Available at http://www.imf.org/external/pubs/nft/op/244/op244.pdf

Remarks:
(1) A country's market may shift from a developmental phase to another as its economy goes through a major structural change (inter-phase transition), while most market development likely occurs in a single developmental phase (intra-phase market improvement).
(2) Listed policy measures are, in principle, new policy measures that should be considered in a particular developmental phase. The four phases and their policy measures and goals are ballpark guidelines. They should be flexibly applied in the local context. A country's market may be implementing some policy measures that the two-dimensional Table specifies for the next or previous phase.
(3) The table does not base its developmental phase classification on numerical parameters. A market's developmental phase can be determined by comparing its functioning policy measures and institutional settings horizontally or vertically.
(4) Countries can have different developmental goals. Every economy may not always want to advance to higher market developmental stages.
(5) The pace of policy implementation may vary depending on actual market development and unfolding circumstances.
(6) Some policy measures listed in a developmental phase may conflict.

Acronyms:
CCP = central counterparty; CSD = central securities depository; DM = debt management; DVP = delivery vs. payment; OTC = over-the-counter (market); PD = primary *dealer*; RTGS = real-time gross settlement; STP = straight-through processing; STRIPS =Separate Trading of Registered Interest and Principal of Securities; SWIFT =Society for Worldwide Interbank Financial Telecommunication.

The framework divides emerging GSMs into four groups by market development phases (phase-differentiation). It reorganizes CPF-based policies[1] by market development phases (phase-coherency) to form a two-dimensional matrix table. The framework's phase-differentiation helps policymakers and practitioners bundle GSM development policies coherently and friendly to the local context. It is practical for the GSM policymaker to work on the bundle to make the most of given exogenous variables

[1] Policies formulated, advised and implemented under various CPF programs. Most of them are found in World Bank and IMF (2001), World Bank (2007a, 2007b) and the World Bank/IMF's financial sector program documents, such as Financial Sector Assessment Program (FSAP) reports.

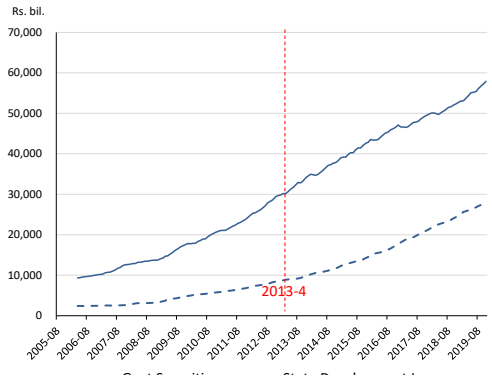
for GSM development. The new framework would help readjust the extant policy set to a GSM's economic or social environment, if any.

In contrast, the CPF was derived primarily from gap analyses between advanced and emerging markets. Policy assessors typically compare their target emerging markets with "best practices" or "global standards" to identify gaps that they think impede market development. The gaps tend to be too wide for LIEs, and the targets too ambitious. Nonetheless, they advise their client governments to fulfill or narrow those gaps. Advised governments usually attempt to implement the advice but end up implementing it only halfway. Their CPF-trapped GSMs remain illiquid or low-illiquid.

The CPF conflates GSMs in different development phases. As such, a CPF-based GSM development initiative is prone to mismatches between policies and realities, which often mislead GSM development in LIEs. The blind reliance on a PD system is an example. Many LIEs have PD systems in place, but the systems are barely functioning (Endo, 2020). The phase-differentiated and phase-coherent TDPF would mitigate this kind of mismatch risk.

India showcases the effectiveness of phase-fit and locally-fit policies in its early GSM development phases. The introduction of innovative market infrastructure and practical market microstructure (collectively "market structure") in the early 2000s accentuated the effectiveness. The new market structure achieved the "transparency and ease" of trading, as Indian PDs described. India built a market structure electronically integrating trading processes from order display to trade settlement to meet local and timely needs. Before a series of GSM reform initiatives that began in 2001 (the GSM Reform), the Indian GSM was a negotiated market (dealers club market), even though it was locally called an "OTC market" and had primary dealers (PDs). In a negotiated market, dealers generally match orders with counterparts for themselves or their customers over the phone. In reforming the GSM, the Reserve Bank of India (RBI) did not adopt a quote-driven market-making PD system, which the CPF-based advisors typically recommend to emerging GSMs. Instead, first, the RBI developed a screen-based order-driven trading platform or the Negotiated Dealing System-Order Matching (NDS-OM) in 2005 with local IT technology. Second, the central bank imposed a continuous two-way firm quote (market-making) obligation for order-driven trading on PDs but has left the two-parameter (the spread and volume) obligation not strictly enforced.

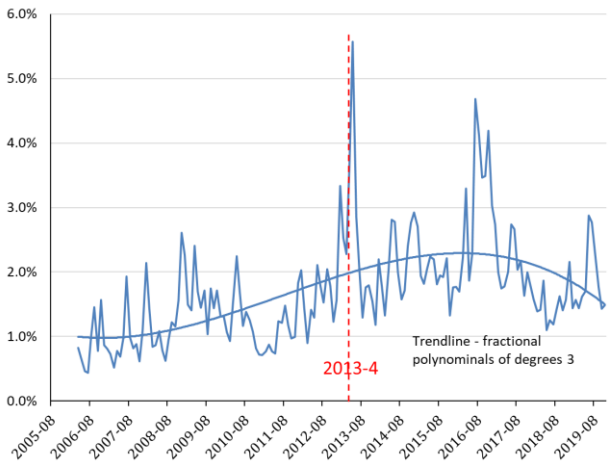
Figure 2: Outstanding Balance of Indian Government Securities and State Development Loans



Earlier, the RBI organized state-owned financial institutions and private banks to streamline the market infrastructure. It set up the Clearing Corporation of India (CCIL) in 2001, built the Negotiated Dealing System (NDS) in 2002, and assigned its operation to the CCIL (RBI, 2013). The NDS, equipped with a central counterparty (CCP) function, was designed to automate the clearing and settlement of government securities trades. The CCIL linked the NDS-OM to the NDS to achieve straight-through processing (STP). This new market structure enabled the growing GSM (Figure 2) to increase turnover until 2015 (Figure 3).

Thus, the South Asian country adeptly caught the momentum of its increasingly favorable macroeconomic, fiscal, and monetary settings for GSM development with phase-fit and locally-fit policy sets. The government launched an economic transformation from a socialistic regime to a market-based one in 1991. The factors exogenous to the market became increasingly favorable for GSM development by the early 2000s. Its GDP growth sustained between 5.24 percent and 8.49 percent (except for 3.09 percent in 2008), with an average of 7.09 percent, from 2003 to 2018. The national consensus for fiscal discipline resulted in the Fiscal Responsibility and Budget Management Act of 2003. The country's public debt[2] to GDP peaked at 84.2 percent in 2003 and stayed between 66.0 percent and 68.8 percent from 2010 to 2018. Since the GSM Reform started in 2001, the inflation rate[3] had been reasonably low before it climbed from 6.7 percent in 2006 to 12.3 percent in 2009. Subsequently, the rate decelerated below 5 percent in 2015 and below 4 percent in 2017.

Figure 3: Monthly Average Daily Turnover of Indian Government Securities



After its remarkable success in market growth, the initial policy sets have been running out of steam in recent years. For instance, the turnover growth rate appears to have peaked (Table 3). Trading in the GSM does not spread across maturities but concentrates on one or two ten-year issues and the interbank market.

A utility is another essential concept to capture the development dynamics of an early-phase market. In this study, a utility refers to the trader's or the investor's preference or value recognition in trading or market structure relative to alternatives regarding trading objects, quantities, qualities, timings, modes, counterparts, and other trading behavior attributes. Its preference criteria involve non-monetary or psychological values, such as reliability, functionality, and convenience in consuming trading services. Usually, it is not directly measurable. This study refers to it as utility value, utility amount, or utility quantity when its measurement matters.

The rest of the paper is structured as follows: Section 2 surveys literature about GSM development theories, case studies, and consumer theories. Section 3 overviews the Indian GSM. Section 4 presents a descriptive analysis of the CPF in the light of emerging economies. Section 5 lays out the TDPF. Section 6 explores the causalities of phase-fit and locally fit policy variables to the market development of the Indian GSM. Section 7 discusses the TDPF's implications and India's experience as regards GSM development in LIEs. Section 8 concludes this work.

2. Literature review

Following studies on GSM microstructure in the 1990s, the World Bank and IMF jointly took the lead in

[2] General government gross debt as defined by IMF.
[3] Average consumer prices.

formulating the policy framework for GSM development in emerging economies through their monumental publication. World Bank and IMF (2001) overviewed theories, market structure, and market practices. They laid out policy measures to advance essential components of GSMs. Subsequently, World Bank (2007a, 2007b) assessed 12 emerging markets[4] against the "sound practices" established in their previous publication. As for the dynamics of market development, World Bank (2007b) points out the "chicken and egg" problems in market development (pp. 54 and 92) but stops short of elucidating their mechanism and policy solutions.

A growing body of literature showcased the efforts that emerging economies made for local currency bond market development (Aguilar, 2006; Arif, 2007; Arvai and Heenan, 2008; BIS, 2002; Castellanos & Martinez, 2006; de Brun, Gandelman, Kamil, & Porzecanski, 2006; De la Torre and Schmukler, 2007; Jiang & McCauley, 2004; Leal and Carvalhal-da-Silva, 2006; Sophastienphong, Mu, and Saporito, 2008; Sy, 2007; Szilagyi, Batten & Fetherston, 2003). Some other studies outline how markets have improved (Amante, Araujo, & Jeanneau, 2007; Silva, 2008; Sophastienphong et al., 2008). AfDB (2007, 2010) provides data on African government debt markets' structures. Meanwhile, Blommestein and Horman (2007) and Berensmann, Dafe, and Volz (2015) also overview African debt markets and their debt management practices. IMF and World Bank (2021) compiled recent GSM development experiences and technical issues of middle-income economies.

Macro-level cross-section studies increasingly searched for determinants of local currency bond market development but stopped short of sorting out issues associated with development phases or development dynamics (Abbas & Christensen, 2007; Adelegan & Radzewicz-Bak, 2009; Akamatsu & Puongsophol, 2017; Claessens, Klingebiel, & Schmukler, 2007; Hanson, 2007; IMF & World Bank, 2016; IMF, World Bank, EBRD, & OECD, 2013; Kumhof & Tanner, 2005; Panizza & Urgo, 2008; Smaoui, Grandes & Akindele, 2017; Warnock & Burger, 2006). Consequently, market microstructure approaches were rare until Endo (2020) questioned the validity of the PD system in LIEs.

The prior literature rarely sees GSMs as consumer markets where investors buy trading services to consume. It is observed and theorized in consumer markets that the values, such as functionality, reliability, and convenience, often come before prices (Christensen, 1997a, 1997b; Gurowitz, 2012; Horton, n.d.; Moore, 2014). A life cycle also operates for new products, services, or technologies. The diffusion of innovation theory portrays consumers' technology adoption behaviors with a logistic curve (Roger, 2003). The technology adoption cycle model comprises four adoption stages characterized by consumers' unique psychographic profiles (Moore, 2014).[5]

India's GSM development path is well documented. Patil (2001) vividly blueprints the reform of the Indian GSM that the RBI subsequently followedt. Reddy (2002) discusses the issues and dilemmas faced by the Indian debt market until the GSM Reform. Mohan (2004, 2006) reviews the steady developmental path of the Indian GSM relative to its corporate debt market and presents prospective issues for the next leap. Mohan and Ray (2009) analyze the Indian debt market development in three phases. The first phase (1992-95) created the enabling environment, the second phase (1995-2000) built the market and institutional infrastructure, and the third phase (2001-) enhanced the market liquidity and safety. Mohan and Ray (2017) briefly refer to the bond market but discuss more the financial market settings in which the bond market developed.

[4] Bulgaria, Colombia, Costa Rica, Croatia, Indonesia, Kenya, Lebanon, Nicaragua, Pakistan, Sri Lanka, Tunisia, and Zambia (p. ix, World Bank 2007b).

[5] "a combination of psychology and demographics that makes its marketing responses different from those of the other groups" (Moore, 2014, p. 15).

The literature on the functional improvement of the Indian GSM is growing. Shankar and Bose (2008) confirm the efficiency of the auction system in the Indian GSM. Nath (2013) shows that the Turnover Ratio and the Amihud Illiquidity Ratio indicate the Indian GSM market liquidity well, but impact cost does not. Rajaram and Ghose (2015) review the evolution and explore primary dealers' functions in the Indian GSM. Fleming, Sareen, and Saggar (2015, 2016) show the highly positive impact of the NDS-OM on the secondary as well as primary markets. Deuskar and Johnson (2016) find that Indian government securities' price dynamics are substantially attributable to the RBI's liquidity provision dynamics.

3. The Indian market

3.1. Primary Market

The RBI, on behalf of the central government or state governments, issues government securities through auctions and underwriting. In consultation with the central government, the central bank issues indicative half-yearly auction calendars, which it subsequently updates. Auctions take place for Treasury bills and government bonds on Wednesdays and Fridays. Accepted bids settle on a T+1 basis. Auctions are open to all investors. Commercial banks, PDs, insurance companies, and other institutions that have funds and securities accounts (Subsidiary General Ledger (SGL) accounts) with the RBI bid on the E-Kuber, that is, the RBI's Core Banking Solution platform. Other investors or intermediaries bid through commercial banks or PDs called Aggregators/Facilitators (Fleming, Sareen & Saggar, 2015, 2016; RBI, 2019).

The total government debt outstood at 68.1 percent of the 2018 GDP.[6] Government securities, Treasury bills, and state development loans outstanding amounted to INR[7] 57,913 billion, INR 5,410 billion, and INR 28,158 billion, respectively, at the end of November 2019.[8] They accounted for 28.85 percent, 2.88 percent, and 14.40 percent of 2018-19 GDP, respectively. The outstanding balance of state development loans also grew fast (Figure 2).

3.2. Secondary Market

The great majority of the outstanding government securities trade on the NDS-OM. Other trading platforms include the "OTC market"[9] and stock exchange platforms such as BSE Direct[10] and the NSE's Negotiated Trade Reporting Platform[11] and Order Matching Platform.[12] The NDS-OM quickly overtook the "OTC market" from 49.64 percent of trades in 2004-05 to 91.21 percent in 2012-13, and 93.29 percent in 2019-20 (up to November 2019). Outright trades increased from 77,060 trades and INR 5,134 billion in 2004-5 to 804,146 trades and INR 93,410 billion in 2018-19 at average compound annual rates of 18.24 percent and 23.03 percent, respectively. Meanwhile, the OTC tends to trade larger-sized orders than the NDS-OM. In 2019-20 (up to November 2019), the OTC's average order size was INR 423.9 million compared to INR 113.6 million for the ND22S-OM.[13]

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[6] IMF. "total government debt" is "General government gross debt" as IMF defines at https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/IND?year=2020.

[7] The Indian Rupee. Spot rate: INR 71.73 per USD at the close of November 29, 2019. Retrieved from https://www.rbi.org.in/scripts/WSSView.aspx?Id=23407.

[8] Table 5: Outstanding-Government Securities, Treasury Bills, and State Development Loans. (CCIL, 2019a)

[9] See Footnote 2.

[10] https://www.bseIndia.com/stastic/markets/debt/ncbGsec.html.

[11] https://www.nseIndia.com/products/content/debt/wdm/reporting_system.htm.

[12] https://www1.nseIndia.com/products/content/equities/slbs/trading.htm.

[13] Calculated from the data in Table 27: Trading Platform Analysis of Outright Trades. (CCIL, 2019a).

The clearing and settlement in the Indian GSM are secured and efficient. The NDS-OM is STP-connected with the NDS. The RBI requires traders to report trades executed on other platforms to the NDS within 15 minutes of their execution and clear and settle them on the NDS (RBI, 2015, Articles 8.4 and 15.1).

3.3. Primary Dealer System

The RBI introduced PDs in 1996 following auctions for primary issuance that began in 1992. The RBI licensed nine PDs, subject to asset and performance criteria. Since the interest rate reverted upward in 2003-4 after consecutive eight years of decline, severe losses made most PDs financially unsustainable. They had been highly leveraged. The FRBM Act of 2003 ended the RBI's intervention in auctions and made the issuance of government securities fully market-based in 2006. Subsequently, the RBI strengthened the PD system by reorganizing it under dual business models in 2006: three standalone PDs and ten bank PDs (Rajaram & Ghose, 2015). As of the end of December 2019, the GSM has seven standalone PDs (three foreign-owned PDs and four domestic PDs) and fourteen bank PDs (six foreign banks, three domestic private banks, and five public sector banks) (Table 2).

The PD system in India's primary market is a hybrid of underwriting and competitive bidding. The issuance procedure of government securities is in two steps. First, the RBI sets and announces a "minimum underwriting commitment (MUC)" amount equal to 50 percent of the issue amount or more.[14] The RBI's Master Direction requires each PD to underwrite the MUC amount equally (a twenty-first of the MUC amount, at present). Second, the RBI auctions the remaining amount or additional competitive underwriting (AUC) amount. The Master Direction requires each PD to bid for at least its MUC amount (a twenty-first of the MUC amount) up to thirty percent of the AUC amount and an "underwriting commission" rate for its AUC bid amount. Bidding can be in uniform- or multiple-price form or on a price- or yield basis, as the RBI determines for each issuance. The RBI pays an "underwriting commission" to successful AUC bidders. The RBI also pays the AUC bidders who have won four percent or more of the issue amount a commission on their underwritten MUC amounts. The commission is at the average rate of auctioned AUC "underwriting commission" rates weighted by accepted AUC bid amounts (RBI, 2019).

India's selective enforcement of the PD's market-making obligations is sensible and effective in exploiting the primary market and simultaneously activating the secondary market (Endo, 2020).-The RBI entices PDs into bidding or underwriting with fees and competitive pressures. The central bank enforces the trading volume norm for the secondary market but not the continuous firm bid-ask quoting obligation. The RBI's Master Direction requires each PD to offer two-way firm quotes (market-making) and trade government securities outright five times or more than its average month-end stock annually (RBI, 2019). PDs' market-making through two-way firm quoting is meant to help non-PD dealers, brokers, and end-investors trade with trading immediacy to meet their diverse needs. However, the RBI has not enforced the obligation on PDs unnecessarily[15].

4. Conventional Policy Framework (CPF)

The CPF that the World Bank and IMF jointly developed in the early 2000s considerably disseminated knowledge about GSMs to emerging economies. However, it is subject to some shortcomings for GSM development in LIEs. Firstly, it does not differentiate GSMs by macroeconomic settings. This shortcoming may be called the single-universe problem. Secondly, it disregards the distinction between

[14] Currently, the RBI sets the MUC at 50 percent of the issue amount.
[15] In the Evolving Phase, it is often observed that the market regulator does not fully enforce the PD's market-making in the secondary market.

market components (endogenous factors) and fiscal and monetary preconditions (exogenous factors). This shortcoming may be called the indistinction problem. Thirdly, it fails to identify the coherent groups of interconnected market components. That is the incoherence problem. Fourthly, it overlooks dynamic feedback loops of inter-connected market development processes. This shortcoming may be called the standalone-component problem**.**

The single-universe problem prevents heeding a policy's local specificity, such as the level, size, or properties of an economy. The government's rather limited capacities and resources in an LIE would understandably compel GSM development to share the capacities and resources with other political, economic, and social objectives. Since the development of an LIE GSM is thus dependent on the rest of the local economy[16], locally-tailored approaches would be indispensable.

The indistinction problem makes it hard for the GSM policymaker to focus on endogenous market development issues. This problem blurs the boundaries of responsibilities among fiscal, monetary, and GSM development authorities.

The incoherence problem likely comes from the practice that market development efforts are often piecemealed or assigned discretely to individual specialists without overall coordination. This practice would risk market components being frictional, disorderly, or inefficient as a system, even if they are individually legitimate. A market component's workings are often bound by or pre-conditional to other market components. For example, an electronic trading platform needs dematerialization. A central counterparty function requires novation.

The standalone-component problem may ignore the dynamic nature of market development processes. The processes are interdependent and looped, and they are likely to have different carrying capacities. Accordingly, they have to be managed so that no structural breaks occur in market development. A precedent process in interconnected processes must produce only as much output as its dependent process or processes can absorb economically and operationally. Inversely, a dependent process can accept only as much input as its precedent process or processes can produce economically and operationally. Excessive output or input may be wasteful or harmful to a connected process. Therefore, market development simultaneously involves multiple market components and is endogenously multi-constrained and dynamic. The constrains could be transtemporal. Its progress would be incremental, gradual, and non-linear.

5. The analytical framework

5.1. GSM Development in two-dimensions

GSM development can be viewed in two dimensions. The horizontal dimension in Figure 1 and Table 1 represents the Exogenous Dimension, consisting of factors exogenous to a GSM. Those factors include macroeconomic, fiscal, and monetary policies or conditions. This Exogenous Dimension broadly divides the universe of emerging markets into four development phases: the Nascent, Evolving, Advanced, and Highly-advanced Phases. GSMs in most LIEs fall in the Nascent or Evolving Phase. Each development phase forms a policy set paradigm[17] for market operations and development.

[16] A GSM and the rest of its local economy are mutually dependent, forming feedback loops. However, the GMS's feedback effect takes time to show up.

[17] An operational framework of coherent policies set and its associated activities.

By contrast, the vertical dimension is the Endogenous Dimension and comprises factors endogenous to a GSM. The GSM policymaker can usually manage these endogenous factors. They are market components, such as accounting rules, legal rules, primary market, secondary market, money market, debt and cash management, clearing and settlement, and derivative and futures market. Thus, the two dimensions form a matrix of market components by market development phases.

A development phase on the Exogenous Dimension gives the GSM policymaker a realistic perspective on its development horizon. The GSM policymaker can hardly upgrade its economy for GSM development in its capacity and during its tenure. Conversely, an economy's position on the Exogenous Dimension sets the exogenous conditions of a GSM. Fiscal and monetary policies or conditions are also exogenous but could be flexible for the GSM policymaker relative to macroeconomic ones. These exogenous factors shape a policy paradigm for a set of market components.

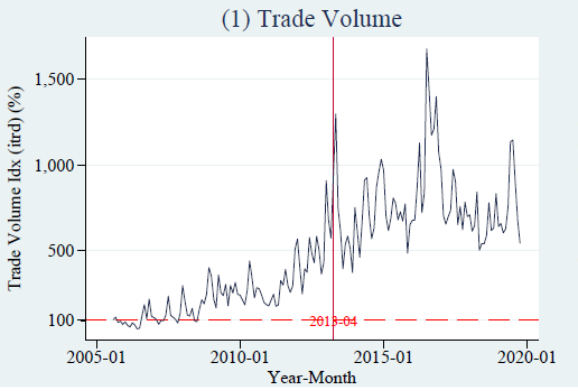
The TDPF determines a market's development phase by comparing its functioning policies and institutional settings horizontally and vertically. A country can develop a GSM in a single development phase (intra-phase market improvement). A country's market may rarely shift from one development phase to another unless its economy undergoes a structural change (inter-phase transition). The policy selection and implementation should be flexible in the local context. Economies can also have different developmental goals and paces.

5.2. The Indian GSM in the Two-Dimensional Framework

The Indian GSM was in the Nascent Phase before starting the financial market deregulation in 1991 (the Deregulation) and entering the Evolving Phase. The launch of the GSM Reform in the early 2000s enabled the GSM to leap. The strategic focus was a market infrastructure reinforcement. Meanwhile, the World Bank recategorized the country from a lower-income country to a lower-middle-income one in 2007.

India's GSM has been in the Evolving Phase since then. The country systematically improved the GSM in the new phase, though its market development did not follow the CPF. Instead, it implemented the policy goals and measures that were broadly consistent with those prescribed for the Evolving Phase in the TDPF. In the early 2000s, the RBI revamped its policy goals and measures to meet the economy's imminent needs and set realistic goals. Like many other emerging markets, India's financial market was bank-centric, and public sector banks were predominant. Yet, the RBI needed to ensure market-based issuance of government securities and enhance secondary market liquidity.

Figure 4: Trade Volume Index in the First-half and Second-half Periods



The core programs for the market infrastructure reinforcement were the NDS, the automated clearing and settlement system with a CCP function, and the NDS-OM, the screen-based order-driven trading platform. They came into operation in 2001 and 2005 under the CCIL's management. The country supplemented a telephone-voiced, quote-driven OTC market with a screen-based order-driven market as government securities' principal marketplace. Continuous order-driven order-matching, which is

typical on stock exchanges, fits well with the market features of a GSM in the late Evolving or early Advanced Phase. The turnover and trading volume of the Indian GSM rose remarkably from 2005 to 2013 (Figures 3 and 4).

The relatively simple trading strategies in the Indian GSM allowed the RBI to capitalize on the order-driven trading platform model that the National Stock Exchange (NSE) successfully deployed in the 1990s.[18] The narrow trading choice largely balanced the supply and demand for immediacy (Grossman & Miller, 1988) and lessened the necessity of two-way quoting. Thus, the NDS and the NDS-OM may be viewed as an extension of the NSE market structure (Patil, 2001).

India has developed a GSM on its bank-centricity rather than on a capital market. Neither was its investor base broad and deep, nor its non-bank intermediaries were well-capitalized. Even if desirable, it would have been impractical to transform India's financial market structure for GSM development in a matter of years. Bank-centricity is common in the Nascent and Evolving Phases. The PD reform in 2006 further reinforced the bank-centricity by reducing standalone PDs and creating bank PDs. Of 21 licensed PDs, seven and fourteen PDs are standalone and banks, respectively, as of the end of December 2019 (Table 2).

Table 2: PD Interviews & Surveys Statistics

	Licensed	Interviewed	Answered to survey
PDs	**21**	**17**	**10**
Standalone	**7**	**5**	**3**
Domestic	4	3	2
Foreign	3	2	1
Banks	**14**	**12**	**7**
Domestic	8	8	6
Public	3	3	3
Private	5	5	3
Foreign	6	4	1

India's GSM developmental path occasionally deviated from the Framework model favorably or unfavorably. The country equipped its NDS with a CCP function when the market was still in the Evolving Phase. Given India's market development history, the CCP was integral to its strategic market structure. Many other countries may consider installing a CCP in the Highly-Advanced Phase. On the other hand, the Indian market has not fully adopted a mark-to-market accounting rule that the framework places as a policy measure of accounting in the Advanced Phase. Its attempt to run STRIPS and When-Issued on the market has not gained momentum.

6. Causality analyses

6.1. The target variable

This section investigates endogenous market factors' causality to the trade volume growth in the Evolving Phase of the Indian GSM. As such, the trade volume is the target variable or dependent variable in this analysis.

6.2. Trading costs

The analysis indicates that the central bank appropriately employed the market growth policies from 2005 to 2013. The RBI's policies brought about trading "transparency and ease," repo market development, and competitive bid-ask spreads, among other things. The NDS and the NDS-OM have made GSM trading transparent and easy. Repo market development has provided PDs with additional money management tools. Notably, the trading volume requirement the RBI imposed on PDs and linked

[18] The NSE's market structure pointedly addressed the concern of the Indian investment community in the 1990s in the advent of the Harshad Mehta scandal in 1992. The concern centered on the certainty, reliability, and safety of their trading and settlement.

to auction and underwriting privileges pressured and incentivized PDs to narrow bid-ask spreads. The reduction of trading costs resulting from these policies appears to have substantially increased trade volumes. Trading costs are inversely correlated to market liquidity (Madhavan,1992). Chaumont (2018) points to "a trade-off between the transaction costs and the trading probability" in the secondary market

Table 3: PD Surveys about Market Making – Questions and Aggregated Answers

Survey Questions	Aggregated Answers
(1) Do you calculate the cost of market-making to determine the spread?	Six PDs follow "market trend." Four PDs look to repos or market liquidity.
(2) Do you build up and hold an inventory of bonds for market-making purposes?	Seven PDs hold an inventory. By contrast, two PDs deny holding any inventory and instead rely on the repo market.
(3) If you take into account the inventory holding costs, do you include: • Interest expenses (funding cost) of the inventory • Market risk costs of the inventory	Five PDs take into account funding costs and market risk. Two foreign PDs look to repo rates.
(4) When the market volatility increases, what do you do? • Widen the spread • Withdraw your orders from the market, or • Others.	Five PDs withdraw their quotes. Four PDs widen their quotes.
How often do you withdraw your offers?	Two of them frequently (multiple times a day) and another rarely withdraw their quotes.
Do you withdraw your orders for: • RBI-predetermined benchmark issues, • Normally, most liquid issues, or • Both?	Of five PDs withdrawing quotes, three withdraw both RBI-designated benchmark issues and most liquid issues. Two withdraw quotes from most liquid issues only
(5) What is the distribution of trades between interbank and non-interbank customers? • 90:10 • 80:20 • 70:30 • 60:40 • Other.	The ratio of interbank trades ranges from 60 to 95 percent. Active PDs tend to be more interbank-oriented. Public bank PDs tend to have more customer transactions than others.

for sovereign bonds. This trading property is observed in advanced markets where utilities necessary for trading are available - non-pecuniary trade frictions are minimal. In early phase markets, however, trading costs contain unavailable utilities. Accounting usually does not recognize the elusive utility elements of trading costs. However, they significantly affect trading decisions in India's case.

Indian PDs' trading behavior reflects this broader concept of trading costs. I conducted semi-structured interviews with PDs in the Indian GSM and surveyed their market-making practices in September and October 2019. The interviewees were trading heads and traders of 17 out of 21 PDs. The written survey followed the interviews, and ten PDs voluntarily answered the survey. Table 3 summarizes their responses.

The interviewed traders unanimously attributed their preference for the NDS-OM over the telephone-voiced OTC market to "ease and transparency." Table 4 decomposes the trader's "ease and transparency" and relates its utility elements to the various trading cost elements that the NDS-OM and the NDS are considered to have reduced. Quantifying these utilities and the new market infrastructure building in monetary terms is not straightforward, mainly because their benefits and costs scatter across the economy. However, the trader's increased use of the NDS-OM suggests that the benefits from the utilities or the spread savings or both exceeded the overall costs of the automated platform (market centralizing costs). Accordingly, my causality analyses proxy for the degrees of trading "transparency and ease" using NDS-OM trading percentages.

Table 4: The Trader's Utilities of the NDS-OM

Traders' expressions	Facilitated Functions	Positive Effects	Reduced Costs
"Ease"	Standardized order format	Standardized trade execution, settlement, clearing, depository, and reporting	Order processing costs
	Electronic connectivity (vertically integration)	• Reduced human intermediation • Straight-through processing	
	Shorter execution time	Enhanced trade immediacy	Opportunity costs
	Central counterparty	No fails, no counterparty risk, settlement certainty	Information (credit) search costs Order processing costs Opportunity costs
"Transparency"	Centralized marketplace	Ensured best execution	Information search costs
	Displayed pre-trade information (limited order book)		Dealers' oligopoly rents
	Immediately reported post-trade information	Shorter trading cycle	Opportunity costs

6.3. Data

This causality analysis sourced the raw market data of the Indian GSM mainly from the CCIL. The CCIL published the time series data from August 2005 to March 2019 in CCIL (2019a, 2019b), and the CCIL individually provided the same time series from April 2013 and October 2019. All the sample variables were monthly averages of their daily values that the CCIL observed on its system.

I took the following two steps to analyze the data. First, I examined my time series variables for autocorrelations to choose the most appropriate model from the vector autoregression (VAR), vector error correction (VEC), and autoregressive distributed lags (ARDL) models. Second, I specified the chosen model by examining the sample variables' properties and determining their order of integration. To this end, I tested the sample variables for multicollinearity, autocorrelation, optimal lag orders, and unit roots.

Table 5: Summary of Variables

Variable	Variable Label	Obs	Mean	Std. Dev.	Min	Max
Raw Variables						
trd	Av Daily Trades	75	1,447.11	809.66	383	4,689
gsec	G-securities Balance (INR bil)	75	18,671.38	5,899.67	10,203.50	30,173
ndsom_pct	Av Daily NDS-OM Percentages (%)	75	85.96	5.62	58.63	92
trdsize	Trade Value Size	75	0.09	0.01	0.07	0
oldsprd	Av Old Bid-Ask Spreads (%)	75	0.24	0.18	0.04	0
repo	Av Daily Repos	75	204.48	46.66	113	
Normalized Variables						
itrd	Trade Volume indx (%)	75	248.64	139.12	65.81	805
igsec	G-securities Balance indx (%)	75	182.99	57.82	100	295
indsom_pct	NDS share indx (%)	75	112.41	7.35	76.67	121
itrdsize	Trade Value Size indx (%)	75	125.61	13.7	100	167
ioldsprd	Old spread indx (%)	75	151.9	115.95	28.06	46
irepo	Repo indx (%)	75	116.85	26.66	64.57	181

(2) The Second-half Period

Variable	Variable Label	Obs	Mean	Std. Dev.	Min	Max
Raw Variables						
trd	Av Daily Trades	79	4,004.66	1,235.44	1,936.00	8,647
gsec	G-securities Balance (INR bil)	79	44,215.38	7,248.60	30,623.60	57,227
ndsom_pct	Av Daily NDS-OM Percentages (%)	79	93.11	1.52	87.46	95
trdsize	Trade Value Size	79	0.12	0.01	0.1	0
newsprd	New Bid-Ask Spread (%)	79	0.03	0.03	0.01	0
Normalized Variables						
itrd	Trade Volume indx (%)	79	82.81	25.55	40.03	17
igsec	G-securities Balance indx (%)	79	144.38	23.67	100	186
indsom_pct	NDS share indx (%)	79	98.2	1.6	92.25	100
itrdsize	Trade Value Size indx (%)	79	98.77	10.8	81.84	123
inewsprd	new spread indx (%)	79	85.51	67.16	26.05	438

To begin with, I normalized the sample values of the variables relative to 100 at the beginning of each of the two subperiods, January 2007 and April 2013. The normalization (indexation) made their behaviors directly comparable. Table 5 provides the summary statistics of the raw as well as normalized data.

I split the sample period from August 2005 and October 2019 into two subperiods: January 2007 to March 2013 (the first-half period) and April 2013 to October 2019 (the second-half period) for a suspected structural change in the market and a data inconsistency problem. Also, I dropped the 17 months from August 2005 to December 2006 since the period lacks bid-ask spread data. I labeled the variable *ioldsprd* and *inewsprd* for the first- and second-half periods, respectively.

I checked the independent variables' multicollinearity since I estimated regression models with the trade volume (*itrd*) as the dependent variable. Consequently, I dropped the repo trade (*irepo*) for modeling for the second-half period. As a result, I had the independent variables of *igsec, indsom_pct, irepo, itrdsize,* and *ioldsprd* for the first-half period, and *igsec, indsom_pct, itrdsize,* and *inewsprd* for the second half period.

My investigation of the sample variables' properties started by testing them for autocorrelation.[19] I ran Durbin's alternative test. The majority of the level and first difference variables were autocorrelated, so AR(1) models – VAR and VEC models - could not be estimated to fit the variables. Hence, I chose the ARDL model.

I selected optimal lag orders of the level variables for the causality models by the Vector Auto-Regressive Specification Order Criterion (varsoc). Since the sample sizes of the time series were not large (75 and 79 for the first-half and second-half subperiods, respectively), I focused on the SBIC for optimal lag order selections (Ventzislav & Lutz, 2005). I performed the Augmented Dickey-Fuller test and the DF-GLS test (the modified Dickey-Fuller *t*-test) for unit root in the level and first difference variable time series. Finally, I performed the HEGY test on the *itrd* and *indsom_pct* variables for a seasonal unit root.

[19] My statistical software for these analyses was Stata version 16.

6.4. Methodologies

I estimated the ARDL model and its error correction (EC) process (ARDL/EC model) to assess the variables' causality to the target variable. At first, I identified the likely lag order combinations for the valid ARDL/EC model. Then, the likely lag order combinations underwent the bounds tests to determine the possible presence of cointegration (long-run regressive relationship among the level variabtransteles) as well as their post-estimation tests for the satisfaction of the assumptions underlying the ARDL/EC model (the integration conditions of I(0) and I(1) but not I(2)).[20] The post-estimation tests included the Durbin-Watson test (code: estat dwatson) and the Breusch-Godfrey test (code: estat bgodfrey) for autocorrelation in the residuals, White's test for homoskedasticity (code: estat imtest, white), and the cumulative sum test for parameter stability (code: estat sbcusum).

To model my datasets, I expanded a general representation of an ARDL(p, q) model and its ARDL/EC model. The dependent variable for the first-half period was *itrd*. Its independent variables were *igsec*, *indsom_pct, irepo, itrdsize*, and *ioldsprd*. I denoted them by *itr*, *ig*, *in*, *ir, its,* and *ios* for simple representation and prefixed their summation index i with "." to distinguish them from those variable indices. The ARDL/EC model for the first-half period was:

$$\Delta itr = c_0 + c_1 t - \alpha(itr_{t-1} - \boldsymbol{\theta x}_t) + \sum_{i=1}^{p-1} \psi_{itr.i}\, \Delta \boldsymbol{itr}_{t-i} + \sum_{i=0}^{q_{ig}-1} \psi'_{ig.i}\, \Delta \boldsymbol{ig}_{t-i} + \sum_{i=0}^{q_{in}-1} \psi'_{in.i}\, \Delta \boldsymbol{in}_{t-i} + \sum_{i=0}^{q_{ir}-1} \psi'_{ir.i}\, \Delta \boldsymbol{ir}_{t-i} + \sum_{i=0}^{q_{its}-1} \psi'_{its.i} \Delta\, \boldsymbol{its}_{t-i} + \sum_{i=0}^{q_{ios-1}} \psi'_{ios.i}\, \Delta \boldsymbol{ios}_{t-i} + u_t\,. \quad (1)$$

For the second-half period, by omitting *irepo* and replacing *ioldsprd* (*ios*) with *inewsprd* (*ins*), I obtained the following ARLD/EC model:

$$\Delta itr = c_0 + c_1 t - \alpha(itr_{t-1} - \boldsymbol{\theta x}_t) + \sum_{i=1}^{p-1} \psi_{itr.i}\, \Delta \boldsymbol{itr}_{t-i} + \sum_{i=0}^{q_{ig}-1} \psi'_{ig.i}\, \Delta \boldsymbol{ig}_{t-i} + \sum_{i=0}^{q_{in}-1} \psi'_{in.i}\, \Delta \boldsymbol{in}_{t-i} + \sum_{i=0}^{q_{its}-1} \psi'_{its.i} \Delta\, \boldsymbol{its}_{t-i} + \sum_{i=0}^{q_{ins-1}} \psi'_{ins.i}\, \Delta \boldsymbol{ins}_{t-i}\; u_t\,. \quad (2)$$

I ran Equations (1) and (2) on the sample variables with selected lag order combinations to estimate the model's long-run and short-run parameters.

The ARDL/EC model's specification sensitivity centered on selecting lag orders for the sample variables or lags(p q_{ig} q_{in} q_{its} q_{ir} q_{ios}) for the first-half period and lags(p q_{ig} q_{in} q_{its} q_{ins}) for the second-half period. Stata's ARDL software module automatically assigned lag orders for each dependent and independent variable.

[20] The residuals of the ARDL/EC model are homoscedastic, serially uncorrelated, and stable over time (no structural change). (Kripfganz & Schneider, 2018, and others)

Finally, I estimated the impact of the *igec* and *indsom_pct* variables on the ARDL/EC regression's explanatory power by dropping them in sequence and verifying lag order combinations with post-estimation tests. The differences that dropping a variable from the regression makes in R-squared were expected to measure the variable's impact on the *itrd* variable or the trade volume (stepwise method).

6.5. Results

The results of Durbin's alternative test for Autocorrelation and the Autocorrelation Plots confirm my sample variables' autoregressiveness either in level or in first difference or both. Notably, the *indsom_pct* variable was non-autoregressive in level but autoregressive in first difference for the first-half period.

The results of the DF-GLS test and the Augmented Dickey-Fuller for unit root confirm that the sample variables were integrated of order 0 (I(0)) or order 1 (I(1)).

Table 6: Stata output - Cointegration Relationship of itrd and independent variables for the First-half Period (2007-01 - 2013-03)

The First-half Period (2007-01 - 2013-03)

Sample: 2007-03 -				Number of obs =		73
				R-squared =		0.5107
				Adj R-squared =		0.4128
Log likelihood = -				Root MSE =		74.3172
D.*itrd*	Coef.	Std. Err.	t	P>|t|	[95%	Interval]
ADJ						
itrd						
L1.	-0.963828	0.1596048	-6.04	0.000	-1.283085	-0.64457
LR						
igsec	1.238424	0.3184949	3.89	0.000	0.6013392	1.875508
indsom_pct	4.71427	2.321337	2.03	0.047	0.070905	9.357634
irepo	0.9855633	0.6519742	1.51	0.136	-	2.289706
itrdsize	1.90578	1.046627	1.82	0.074	-	3.999347
ioldsprd	0.0476454	0.1083383	0.44	0.662	-	0.264354
SR						
itrd						
LD.	0.2718715	0.12608	2.16	0.035	0.0196739	0.524069
igsec						
D1.	-9.161366	6.217188	-1.47	0.146	-21.59759	3.274862
indsom_pct						
D1.	0.5674625	1.729826	0.33	0.744	-2.892704	4.027629
irepo						
D1.	0.2449174	0.7173015	0.34	0.734	-1.189899	1.679734
itrdsize						
D1.	-0.744683	0.9562347	-0.78	0.439	-2.657437	1.168071
ioldsprd						
D1.	-	0.1183265	-0.04	0.966	-	0.231694
_cons	-817.1547	252.2628	-3.24	0.002	-1321.755	-312.554

Source: The Author's calculation

The HEGY test results for seasonal root indicate they had unit roots individually but not jointly and had non-seasonal unit roots (unit roots at the zero-frequency). The results are not entirely consistent with those of the Augmented Dickey-Fuller test. The dubious monthly seasonality in the variables does not seem as significant as it may affect the long-run causality.

The above findings are consistent with the ARDL/EC modeling assumptions subject to the post-estimation tests. The confirmed mixed presence of unit roots disqualifies either a VAR model or a VEC model for modeling my data.

The estimation of the ARDL/EC model parameters with likely lag order combinations was subjected to the post-estimation tests. All the results suggest that the best-fit lag combinations were lags(2 1 1 1 1 1) and lags(1 1 0 1 0) for the first- and second-half periods, respectively.

Tables 6 and 7 present the ARDL/EC's parameters estimated with the best-fit lag combinations for the first-half and second-half periods. The impacts of the government securities balance and the NDS-OM variables are summarized in Tables 8 and 9. Excluding the *igec* variable from the regression lowered the R-squared from 51 percent to 40 percent for the first half period and from 49 percent to 42 percent for the second-half period (Tables 8(1) and 9(1)). Further, ignoring the *indsom_pct* variable reduced the R-squared from 40 percent to 18 percent[21] for the first half period and from 40 percent to 25 percent for the second-half period (Tables 8(2) and 9(2)).

[21] At 18% for the R-squared, the bounds test failed against the 1% critical value of the t-statistic (Table 7).

7. Discussion

The CPF has so far failed to deliver expected results to LIEs. This research aimed to improve upon the CPF. It questioned how the GSM policymaker could develop practical policy sets for GSM development in LIEs and if any policy framework could help formulate them.

Table 7: Stata output - Cointegration Relationship of itrd and independent variables for the Second-half Period (2013-04 - 2019-10)

The Second-half Period (2013-04 - 2019-10)
ARDL(1,1,0,1,0)
Sample: 2013-05 - 2019-10 Number of obs = 78
R-squared = 0.4876
Adj R-squared = 0.4363
Log likelihood = - Root MSE = 16.6783

D.*itrd*	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADJ						
itrd						
L1.	-0.6381263	0.095634	-6.67	0.000	-	-0.44739
LR						
igsec	-0.3353774	0.1787872	-1.88	0.065	-	0.021202
indsom_pct	10.81974	2.306342	4.69	0.000	6.219886	15.4196
itrdsize	1.168602	0.4117613	2.84	0.006	0.3473701	1.989834
inewsprd	-0.0286854	0.0512199	-0.56	0.577	-	0.07347
SR						
igsec						
D1.	-2.892274	2.199252	-1.32	0.193	-7.278543	1.493996
itrdsize						
D1.	0.5225009	0.3435998	1.52	0.133	-	1.207789
_cons	-663.3685	142.0962	-4.67	0.000	-946.7704	-379.967

Source: The Author's calculation

The results evidence endogenous market factors' significant contribution to market development in its early phases. This study measured the contribution of an independent variable in terms of differences in R-squared values calculated by stepwise methods. In India's case, all the independent variables explained 51 percent of the trade volume (*itrd*) growth in the first-half period (Table 6). The balance of government securities (*igsec*) was a fiscal policy variable. Excluding it, the endogenous variables explained 40 percent (Table 7(1)). The 51 percent can be broken down into 10 percent for the government securities' balances (*igsec*), 22 percent for the market infrastructure innovation (the NDS-OM percentages) (*indsom_pct*), and 18 percent for the rest of the variables (Table 7(2)). These weights should not be taken as independent since they are cointegrated. Also, more precisely, they contributed to changes but not necessarily growth in the trade volume. Nonetheless, I view their positive changes as contributions to growth.

By contrast, the second half period manifested a fiscal policy variable's limitation. The trade volume could not keep up with the continued growth of government securities balance, and the turnover declined. All the independent variables explained 49 percent of the trade volume changes when its growth was almost flat (Table 7). The NDS-OM percentages and the other endogenous variables accounted for 42 percent, separately 16 percent and 26 percent (Table 9). The balance of government securities was no longer statistically significant at a p-value of 0.065, and its coefficient was negative (Table 7).

The NDS-OM in India's context had two implications: a locally-fit and phase-fit market structure and hidden utility exploitation. Firstly, adopting the new market structure was timely for the Indian GSM in the Evolving Phase. The Indian GSM adopted an order-driven model for its automated trading platform instead of a quote-driven one, which most advanced markets adopt and the IDC usually recommends. In an early development phase, the trading choice is relatively narrow since liquid issues are limited in number, the investor base is small or homogeneous, and trading and investment techniques are simple. The relative simplicity more likely balances the supply and demand for immediacy (Grossman & Miller, 1988). India could extend its locally developed and successfully implemented stock market model to the GSM in the 1990s.

Secondly, the NDS-OM also meant uncovering hidden "universal" utilities embedded in the Indian GSM's reformed market structure. Utilities are economic agents' perceptions, and they are not directly measurable. They can be grouped into universal utilities and trader-specific ones. The former affects all traders across the market as the trading "transparency and ease" did. The NDS-OM as a component of

a market structure generates "universal" utility values. A utility may also eliminate or reduce a negative market structure component, such as social or political rent in a GSM. They are more apparent in the early stages than the later ones of a market development phase in which most traders become price-takers.[22]

Consumption theories developed in the real economy suggest the dominant role of utilities in the early development phases of the Indian GSM. The observed role of utilities in motivating the investor to trade in the early phases of the Indian GSM is typical of industrial and retail consumers' buying behaviors in imperfect markets. It is known that non-pecuniary values, such as functionality, reliability, or convenience, dominate industrial or retail consumers' buying decisions in the early phases of their product life cycles or imperfect markets (Christensen, 1997a, 1997b; Gurowitz, 2012; Horton, n.d.; Moore, 2014). The Indian investor's behavioral evolution over time in the Evolving Phase has also been consistent with consumption theories. Its utility consumption was gradual, accelerated, decelerated, and stalled in the NDS-OM's capacity life cycle. This pattern fits Roger's innovation-decision process model (Roger, 2003, pp. 168-218) and Moore's technology adoption cycle model (Moore, 2014, pp. 11-17).

The observed bid-ask spread's insignificance suggests that a trade causality analysis should consider utility values before the spread. The bid-ask spread narrowing to as narrow as three basis points did not significantly increase the trade volume throughout the observation period (Table 3). The bid-ask spread is inversely correlated with the trading volume in advanced securities markets (Chaumont, 2018; Madhavan,1992). The trade causality in LIE GSMs, as the Indian GSM exemplifies, is not that straightforward.

These findings indicate that effective GSM development policies are phase-fit. Therefore, the policymaker likely finds high-leverage policies in the column of its development phase in the TDPF table. India's introduction of a screen-based automated trading platform in 2005 typifies a phase-fit policy measure after the country fostered market environments in the 1990s and the early 2000s. Relevance, timeliness, sequence, and coherence are crucial to overall policy effectiveness in the local context. Table 10 shows the general alignment of India's policy measures and the TDPF, though they were independently formulated.

A high-leverage policy's strength would be temporal and conditional, like India's NDS-OM. The high-leverage policy may shift, even in the same development phase. Then, the policymaker may have to reset market development targets or policies to keep up with the changes. The NDS-OM that had saturated the market structure's carrying capacity could no longer raise the turnover ratio in the second half period, even though the government securities balance kept growing (Figure 3).

Some market environments are not always rigidly exogenous to the market. Fiscal and monetary settings could be somewhat manageable for the GSM policymaker compared to macroeconomic ones. The legal or working relationships among market development, fiscal, and monetary authorities can make fiscal and monetary environments less rigid. An example is India's Fiscal Responsibility and Budget Management Act of 2003 (Table 10).

Policy consistency pays off. Policies prescribed for a development phase in the TDPF assure policy consistency over the mid- to long-term. Even endogenous market improvement in a development phase may take a few decades. The Indian GSM took 22 years to level off in 2013 and 28 years to reach this

[22] The trader-specific utilities are what Harris (2003) analyzes as utilitarian trading benefits (pp. 178-194).

research point in 2019. It appears too early to say that the Indian GSM has fully graduated from the Evolving Phase to the Advanced Phase.

Table 8: R-squared and Post-estimation Tests with Variables Excluded

Lag order combination*	Bounds testing for cointegration (estat ectest) F	t	Durbin-Watson test for autocorrelation (estat dwatson)	Breusch–Godfrey test for autocorrelation (estat bgodfrey, lags(1)) Ho: No autocorrelation	White's test for homoskedasticity (estat imtest, white) Ho: homoskedasity	R-squared	Ho: var = 0 *indsom_pct*	*irepo*
	Reject Ho (no level relationship) at		Normal 1.5 -2.5					
(1) ARDL/EC model controlling for *igsec* for the First-half Period (2007-01 - 2013-03)								
1 0 0 0 0	10%, 5%, 1%	10%, 5%, 1%	1.965487	0.8438	0.0936	**0.4022**	#0.000	#0.023
1 1 0 0 0	10%, 5%	10%, 5%, 1%	1.980802	0.8762	0.3032	0.4024	#0.000	#0.027
1 1 1 0 0	10%, 5%	10%, 5%, 1%	1.972868	0.7909	0.1520	0.4027	#0.000	#0.038
1 1 1 1 0	10%, 5%	10%, 5%, 1%	1.925314	0.4517	0.1804	0.4083	#0.000	0.063
1 1 1 1 1	10%, 5%	10%, 5%	1.922488	0.4358	0.2543	0.4128	#0.000	0.068
2 0 0 0 0	10%, 5%, 1%	10%, 5%, 1%	1.964340	0.8041	0.0075	0.4058	#0.000	#0.018
2 1 1 0 0	10%, 5%	10%, 5%	1.959265	0.5055	0.0658	0.4065	#0.000	#0.028
2 1 1 1 0	10%, 5%	10%, 5%	1.910631	0.5679	0.1678	0.4132	#0.000	#0.049
2 1 1 1 1	10%, 5%	10%, 5%	1.904224	0.4511	0.4512	0.4171	#0.000	0.054
(2) ARDL/EC model controlling for *igsec* and *indsom_pct* for the First-half Period (2007-01 - 2013-03)								
1 0 0 0	10%, 5%, 1%	10%, 5%	1.964616	0.8341	0.4852	**0.1814**	Excluded	#0.015
1 1 0 0	10%	10%, 5%	1.980802	0.8762	0.3032	0.1839	Excluded	#0.016
1 1 1 0	10%	10%, 5%	1.899729	0.4570	0.0873	0.2132	Excluded	0.051
1 1 1 1	10%	10%, 5%	1.900370	0.4606	0.1283	0.2137	Excluded	0.053
2 0 0 0	10%	10%	1.964340	0.8041	#0.0075	0.1894	Excluded	#0.008
2 1 0 0	None	10%	1.988918	0.9343	#0.0183	0.1934	Excluded	#0.007
2 1 1 0	None	10%	1.946091	0.3714	#0.0266	0.2214	Excluded	#0.025
2 1 1 1	None	10%	1.945987	0.3681	0.0955	0.2217	Excluded	0.488

* In the order of *itrd, indsom_pct, irepo, itrdsize,* and i*oldsprd* for (1); and *itrd, irepo, itrdsize,* and *ioldsprd* for (2)
# Reject Ho
Source: The Author's calculation

Table 9: R-squared and Post-estimation Tests with Variables Excluded

Lag order combination*	Bounds testing for cointegration (estat ectest) F	t	Durbin-Watson test for autocorrelation (estat dwatson)	Breusch–Godfrey test for autocorrelation (estat bgodfrey, lags(1)) Ho: No autocorrelation	White's test for homoskedasticity (estat imtest, white) Ho: homoscedasity	R-squared	Ho: var = 0 *indsom_pct*	*irepo*
	Reject Ho (no level relationship) at		Normal 1.5 -2.5					
(1) ARDL/EC model excluding *igsec* for the Second-half Period (2013-04 - 2019-10)								
1 0 0 0	10%, 5%, 1%	10%, 5%, 1%	1.553040	0.0175	0.7832	**0.4213**	#0.000	#0.008
1 1 0 0	10%, 5%	10%, 5%, 1%	1.801236	0.2873	0.8576	0.4511	#0.022	#0.041
1 1 1 0	10%, 5%	10%, 5%	1.991256	0.7260	0.9733	0.4893	#0.022	0.336
1 1 1 1	10%, 5%	10%, 5%	2.023292	0.5191	0.9601	0.4935	#0.048	0.441
2 0 0 0	10%, 5%, 1%	10%, 5%, 1%	#1.483217	#0.0005	0.8401	0.4230	#0.000	#0.010
2 1 0 0	10%, 5%	10%, 5%	1.725438	#0.024	0.9057	0.4590	0.089	0.067
2 1 1 0	10%, 5%	10%, 5%	1.902557	0.6923	0.9604	0.4879	0.077	0.371
2 1 1 1	10%, 5%	10%, 5%	1.943499	0.9288	0.9321	0.4972	0.190	0.526
1 0 0 0	10%, 5%, 1%	10%, 5%, 1%	1.553040	0.0175	0.7832	0.4213	#0.000	#0.008
(2) ARDL/EC model excluding *igsec* and *indsom_pct* for the Second-half Period (2013-04 - 2019-10)								
1 0 0	10%, 5%, 1%	10%, 5%, 1%	1.774259	0.2959	0.6403	**0.2564**	0.135	#0.043
1 1 0	10%, 5%, 1%	10%, 5%, 1%	1.890391	0.7663	0.9461	0.2927	0.549	#0.046
1 1 1	10%, 5%, 1%	10%, 5%, 1%	1.890085	0.7513	0.9623	0.2927	0.555	0.069
2 0 0	10%, 5%, 1%	10%, 5%, 1%	1.766014	#0.0312	0.8115	0.2870	0.117	0.050
2 1 0	10%, 5%, 1%	10%, 5%, 1%	1.867795	0.3191	0.9786	0.3098	0.416	0.055
2 1 1	10%, 5%, 1%	10%, 5%, 1%	1.862177	0.2415	0.8682	0.3112	0.437	0.054
2 2 0	10%, 5%, 1%	10%, 5%, 1%	1.814740	0.0720	0.9857	0.3184	0.634	0.078
2 2 1	10%, 5%, 1%	10%, 5%, 1%	1.805833	#0.0294	0.8820	0.3206	0.673	0.068

* In the order of *itrd, indsom_pct, itrdsize,* and i*newsprd* for (1); and *itrd, itrdsize,* and *inewsprd* for (2)
# Reject Ho
Source: The Author's calculation

India's successful GSM development has left some problems unresolved or given rise to unintended consequences for the next phase. The quality of liquidity is an issue facing the Indian GSM, often the case with other GSMs in the Nascent or Evolving Phases. The three most actively traded issues accounted for 67 to 87 percent of all trades in 2019. This concentration is presumably responsible for unusually narrow bid-ask spreads by emerging market standards. The liquidity-centric trading in a bank-centric market, unlike yield-seeking trading, tends to converge on a few GS issues through a feedback (self-reinforcing) effect and consequently keep the liquidity inside the interbank market.

Though familiar with the Nascent and Evolving Phases, these concentrations are undesirable for a GSM

Table 10: Policy Measures in Two-Dimensional Framework and India's Implementation

	1		2	
	Nascent		Evolving	
Market Component	**Policy measures in Two-Dimensional Framework**	**Policy measures in India's implementation**	**Policy measures in Two-Dimensional Framework**	**Policy measures in India's implementation**
Accounting	Disclosure and governance of institutional investors and intermediaries		Amortization	
Legal affairs	Modern business law Modern banking law Public debt law Securities Law Immobilization or depository regulation	The Constitution (Articles 202 and 293) The Reserve Bank of India Act (Articles 21(2) and 21A(1)(b)) SEBI Act 1992	Trade failure Trade finality Netting arrangements Dematerialization Code of conduct	The Payment and Settlement Systems (Amendment) Act, 2015 Dematerialization of Government Securities (1998) DVP-III (2004)
Primary market	Preannounced auctions Non-competitive bidding Designated/prequalified bidders Treasury bills Short-term maturities	Auction of government securities and Treasury bills (1992 and 1993) Non-competitive bidding (2009) PDs (1995)	Issue calendar Reopening or buy-back or switching Tap issuance Bidding open to the public Short- to medium-term maturities	Issuance Calendar for Marketable Dated Securities (2015) Buy-Back (2003) Conversion (Switch)(2019)
Debt and cash management*	Cleanup of public or quasi-public arrears Public debt issuance legislation DM office Timely & accurate debt record keeping The separation between front- and back-office activities	Restricted and prohibited ad-hoc T-Bills (1994 and 1997). Commonwealth Debt Recording and Management System (1986)	Increase in domestic borrowing DM strategy and reporting Consolidation of DM functions Sensible balancing or separation between DM and monetary policy operation (e.g., agency agreement) Partial risk management Sovereign credit rating	Fiscal Responsibility and Budget Management Act (FRBM) (2003) requiring the govt to report to the parliament Medium-term debt management strategy (2015)
Secondary market	Negotiated (dealers' "Club") market Telephone voice trading	Securities Trading Corporation of India (STCI) (1994)	Screen-based electronic trading platform Call auction or continuous order-driven Market convention Market surveillance	NDS-OM (2005) The Fixed Income Money Market and Derivatives Association of India (FIMMDA) (1998)
Monetary policy framework**	Reliance on rules-based instruments		Introducing money market instruments	CP (2017)
Money market	Treasury bills Call market Reserve averaging	Auction of T-bills bills (1993)	Standing facilities (Central bank repos) Interest rate corridor Bank repos Sporadic open market repos	Liquidity Adjustment Facility (LAF) (2000) Repos permitted to SGL a/c holders (1997)
Derivatives or futures				
Clearing and settlement	Book-entry CSD	Subsidiary General Ledger at RBI National Securities Depository Ltd (1995) Depositories Ordinance (1995) Depositories Act (1996)	Dematerialization DVP Rolling settlement Multiple-net settlement SWIFT Automation	Dematerialization of Government Securities (1998) A dematerialized form made mandatory for RBI-regulated entities (2003) DVP I (1995), II (2002), III (2004)

Notes: Desirable policy measures were taken from Table 1. India's Implemented policy measures are not exclusive. The years are those in which the measures were initially undertaken.
Source: the Author compiled data from CCIL (2017), Fleming et al. (2015), Mohan and Ray (2009), Rajaram and Ghosh (2015), RBI (2019), and the websites of NSDL, CCIL, the Department of Economic Affairs

of capital market type. First, the concentration may cause non-PD and non-bank traders to perceive adverse selection and information asymmetry problems. Accordingly, these problems may discourage them from actively trading in the GSM, though their participation would bring in heterogeneous views and improve the GSM's price discovery efficiency. Second, the liquidity concentration and the spread squeeze form an "entry barrier" in the GSM. The entry barrier would make it challenging for non-PD institutions to enter and extend financial efficiency beyond the interbank market in the economy. Third, it may also segment the term structure of interest rates and prevent the transmission mechanism from developing.

The next leap of India's GSM may have to wait for its financial market structure to deepen, broaden, and diversify further. A financial market structure is a long-term set of institutions, policies, laws, and regulations aligned for financial transactions or how they are organized. A government builds and maintains a particular financial market structure to achieve its policy or political goals in the long run. India's current financial market structure is bank-centric. The TDPF suggests broadening the investor base and deepening the financial market structure, among other things, for the next phase.

This research has several limitations. First, it could test the TDPF on an ex-post basis only with the Indian GSM's development path. Empirical studies of other lower-income markets may present different perspectives. Second, my observed endogenous variables may not be exhaustive enough. Third, endogenous factors' interactions with exogenous ones were not addressed. Fourth, most of my data were monthly averages of daily observed values. Nevertheless, since my focus is on long-run relationships, I assume that the monthly averaging had no significant impact on my research results.

Another caution is that India might have had some luck with GSM development. Its luck includes a successful stock market reform experience just before the GSM reform, a pool of local IT talents, and traditional intellectual independence. Other LIEs may not have such luck.

8. Conclusion

This research has explored the endogenous policy sets and their framework for GSM development in LIEs and proposed the TDPF. It is also expected to help the academic and policy advisor conceptualize market development programs for the policymaker more practically than before.

LIEs need a practical framework of policy sets to translate their economic and social achievements into implementable GSM development policies. The key concepts underlying the proposed TDPF are sensible differentiation of GSMs by their development phases (phase-differentiation) and endogenously coherent policy sets for phase-differentiated GSMs (phase-coherency).

The Indian GSM showcased that endogenous market factors explained about 40 percent of the trade volume growth. India's leading variable was an automated market structure, which released embedded universal utility values to the trader. Its contribution is estimated at 22 percent of the trade volume growth. These laudable contributions of endogenous market factors compel us to organize GSM development policy sets for LIEs into the TDPF. A phase-fit, locally-fit approach and endogenously phase-coherent policy sets would make LIEs financially more efficient.

An agenda for further research could include ex-ante testing of the TDPF with various LIEs, the role of utilities in market structure's evolution and market phase transition, and the interactions between exogenous and endogenous GSM development factors.

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A Road to Efficiency in Emerging Local Debt Markets: the Mexican Experience

María del Carmen Bonilla, Omar Mendizabal, Gabriel Yorio[1]

Abstract

This paper describes a road to improve the efficiency of the Mexican debt market. It specifies the steps undertaken by Mexico between 2020-2022 to develop an efficient Overnight Indexed Swap (OIS) curve in local currency to allow national debt market participants to price a debt product in different time horizons. The Ministry of Finance is implementing a threefold strategy to accomplish this: i) consolidating the use of new Mexican Risk-Free Reference Rate (RFR), the Funding Interbank Equilibrium Interest Rate (TIIEF, for its acronym in Spanish) through the sovereign debt market; ii) incentivizing sustainable debt issuance in Mexico through a sustainable sovereign bond with TIIEF as the reference rate and, iii) issuing longer maturities in sovereign and sustainable debt market to robustness TIIEF curve and encourage the creation of derivative contracts. The expected outcome is that derivatives on the TIIEF will structure a sufficient number of nodes to obtain an efficient OIS curve in local currency.

Keywords: public policy, financial market, public debt management, sustainable debt
JEL: G15, G18, H63, Q01

ACRONYMS

ARRC Alternative Reference Rates Committee
AUM Asset Under Management
BIS Bank for International Settlements.
CCFV Green Finance Advisory Council (*Consejo Consultivo de las Finanzas Verdes*)
CONSAR National Commission of the Savings System for the Retirement (*Comisión Nacional del Sistema de Ahorro para el Retiro*)
FED The Federal Reserve of United States
FSB Financial Stability Board
GAAP Generaly Accepted Accounting principles.
IAS International Accounting Standards
IBOR Interbank Offered Rate
IMF International Monetary Fund
IOSCO International Organization of Securities Commissions
IRS Interest Rate Swap
ISDA International Swaps and Derivatives Association
LIBOR London Interbank Offered Rate
MoF Ministry of Finance and Public Credit
OIS Overnight Indexed Swap
RFR Risk Free Reference Rate
SDG Sustainable Development Goals of the United Nations

[1] Ministry of Finance and Public Credit of Mexico

SOFR Secured Overnight Financing Rate
TIIE Interbank Equilibrium Interest Rate (*Tasa de Interés Interbancario de Equilibrio*)
TIIEF Funding Interbank Equilibrium Interest Rate (*Tasa de Interés Interbancario de Equilibrio De Fondeo*)

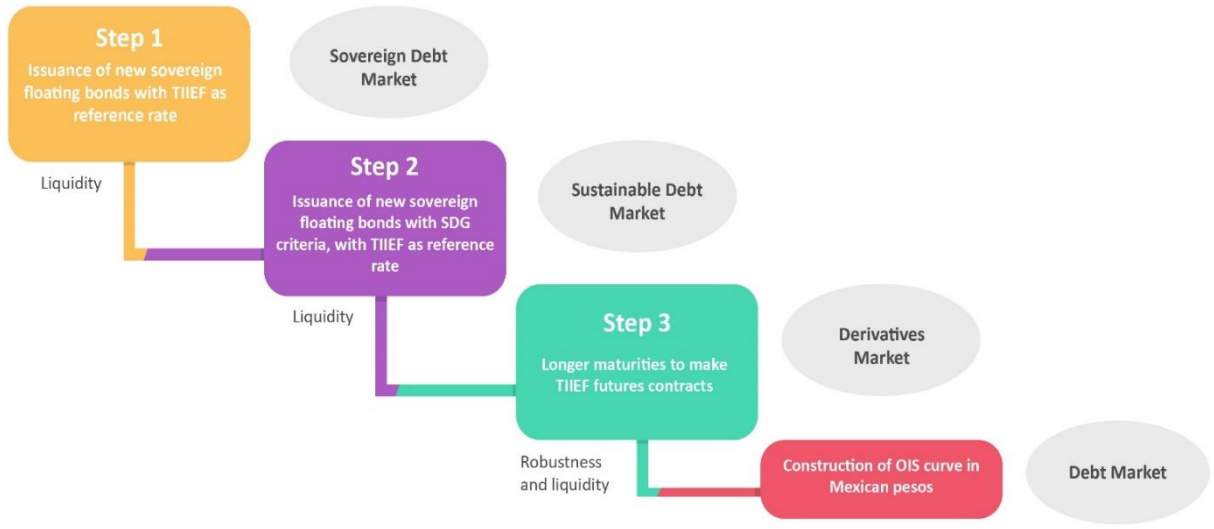
1. Introduction

The Ministry of Finance and Public Credit of Mexico (MoF) prioritizes the implementation of high international standards in its local and foreign debt market, following the latest trends, and driving innovations for all participants in the local fixed income market.

One key to achieve this goal is the development of an efficient Overnight Indexed Swap (OIS) curve in Mexican pesos. This curve will improve efficiency in the local debt market by providing a benchmark for financial operations, using the new Mexican Risk-Free Reference Rate (RFR) denominated as Funding Interbank Equilibrium Interest Rate (*Tasa de Interés Interbancaria de Equilibrio de Fondeo ,* TIIEF).

The MoF has designed a road to an efficient debt market for public and private issuers, through a threefold strategy, involving the sovereign debt market, the sustainable debt market and the derivatives market. See Figure 1.

Figure 1. Road to Efficient Debt Market



In summary, the threefold strategy consists in accelerating the adoption of RFR and strengthening the sustainable local market that will foster the national and international derivatives market based on the TIIEF, resulting in sufficient nodes to be able to construct an OIS curve in Mexican pesos.

The paper is organized as follows:

- **Section I: Transitioning to alternative Risk-Free Reference Rates in Mexico** summarizes Mexico's experience implementing their migration to Alternative Risk-Free Reference Rates (RFR) and the main inefficiency problems in the current local market.

- **Section II: Threefold Strategy, First Step: Issuance of New BONDES F** describes the creation of a new sovereign floating bond linked to the new local RFR and its adaptation on the local debt market.

- **Section III: Threefold Strategy, Second Step: Issuance of New Sustainable Sovereign Bonds in Local Currency** comprises relevant aspects of the local sustainable debt market. It analyzes the key factors involving the decision making process for the appropriate format of the new bond, which would be essential to develop more than one market.

- **Section IV: Threefold Strategy, Third Step: Integrating Curves and Expanding Maturities** will include the following steps expected to achieve the efficiency goal.

- **Section V: Final Remarks** brings together all the involved elements of the threefold strategy and explains the MoF expectations for the future.

1.1 Transitioning To Alternative Risk-Free Reference Rates In Mexico

In February 2013, the Financial Stability Board (FSB) took the mandate entrusted by G20 to review and reform major reference rates introducing the acronym RFR which refers to nearly risk-free reference rates. In July 2013, the International Organization of Securities Commissions (IOSCO) published a broader framework for the principles for financial benchmarks (Schrimpf & Sushko, 2019); these principles seek to homogenize international standards, resulting in the new RFR worldwide and supporting a successful benchmark transition. In response, Mexico started the adoption of this framework with the creation of its TIIEF.

The implementation of alternative RFRs is the starting point for the threefold strategy. Mexico is a pioneer among the emerging economies, in developing the TIIEF. The process to calculate and publish is explained below.

1.2. The New Mexican RFR: the TIIEF

In Mexico, the benchmark rate is the Interbank Equilibrium Interest Rate (TIIE), which is the equivalent of the LIBOR (Box 1). Since 1995, the TIIE has represented the rate at which banking institutions fund each other at different tenors (28, 90 and 180 days), and it is calculated as the weighted average of bank quotes every business day by the Mexican Central Bank.

One of the main problems with the use of TIIE is that it does not reflect the real daily cost of the interbank loan operations[1] of executed quotes as it only shows a survey of selected participants, allowing for potential market manipulation. In addition, there is no interbank loan market for tenors greater than one year for bank loans and derivative products.

In contrast, the new TIIEF reflects the wholesale funding conditions in interbank transactions, by weighting the average of overnight loan operations collateralized in sovereign securities.

Inefficiencies exist in the balance sheets of local and foreign banks. On one hand, most of the banks are foreign and their balance sheets are mainly in USD. In order to buy sovereign bonds in local currency, they need overnight loans in Mexican pesos to exchange their dollars using the TIIE. On the other hand, since local banks do not have a Mexican peso discount curve for their daily operations, the common practice is to use the TIIE, which means they are discounting their cash flows in USD.

In January 2020, Mexican Central Bank, started to calculate and publish the TIIEF, employing the standards developed by the FSB, IOSCO and the BIS. This effort constituted the first milestone to transition to an efficient OIS curve based on RFR in Mexican pesos. Faced with these inefficiencies, the MoF decided to take advantage of the new TIIEF and designed a new market instrument tied to it.

[1] Also known as Repo operations.

Box 1. Migration to Alternative Risk-Free Reference Rates (RFR)

Internationally, the main reference rates in money markets are denominated as Interbank Offered Rate (IBOR). The London Interbank Offered Rate (LIBOR) was one of the most widely used at which large banks could borrow in the short term from one another on an unsecured basis. LIBOR originated in the late 1960s in the syndicated loan market, but in 1986, the British Bankers Association began to publish interbank offered rate quotes from a panel of banks, exemplifying the rates at which banks could borrow from other banks (Schrimpf & Sushko, 2019).

In June 2012, LIBOR came under public scrutiny due to controversy over individual panel bank submissions during the height of the financial crisis (Hou & Skeie, 2014). Therefore, in 2013, the Financial Stability Board (FSB) took the mandate, entrusted by G20 to review and reform major reference rates introducing the acronym RFR that refers to nearly risk-free reference rates. FSB began to monitor the efforts to implement proposals and convened a Market Participants Group to represent the private sector. Furthermore, in July 2013, the IOSCO published a broader framework on principles underlying benchmarks to use in the finance sector (Schrimpf & Sushko, 2019).

With an established framework, the next step was to achieve a smooth and swift transition from LIBOR to the alternative RFR. In the United States, the Alternative Reference Rates Committee (ARRC), established in 2014, is composed of a select group of private-market participants convened by the Federal Reserve Board and the New York Fed. Its main objective is to support a successful transition from USD LIBOR to a more robust reference rate, in this case, the Secured Overnight Financing Rate (SOFR). The SOFR rate was launched in the mid-2018 and its implementation in new derivative contracts is mandatory from December 31, 2021. The SOFR measures the cost of borrowing cash overnight, collateralized by Treasuries. The United States is using a 2-year implementation plan to achieve the liquidity necessary in the derivative markets for the creation of a term reference rate based on SOFR. In the first year of implementation, ARRC released new LIBOR fallback terms for use in new cash products.

Furthermore, the International Swaps and Derivatives Association (ISDA) published the new Interbank Offered Rates fallback terms such as the credit adjustment calculation (ISDA, 2020).

1.3 TIIEF Adoption: Derivatives Market at a Glance

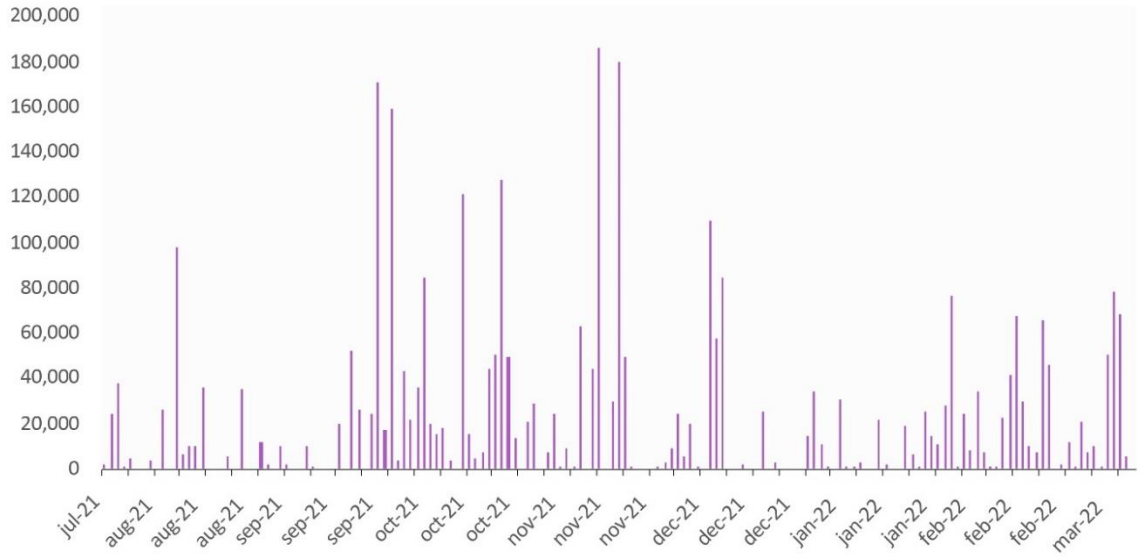
The TIIEF is intended to develop a curve linked to sovereign risk. Since the sovereign has lower risk than interbank, the new TIIEF curve is expected to be below the TIIE curve. Currently, investors hedge Mexican sovereign debt positions with a TIIE Interest Rate Swap[2] (IRS), which generates distortions

[2] An interest rate swap is a forward contract in which one stream of future interest payments is exchanged for another based on a specified principal amount. Interest rate swaps usually involve the exchange of a fixed interest rate for a floating rate, or vice versa.

due to the fact that IRS contracts have an interbank risk implied in the OIS curve in contrast to the underlying asset, which is sovereign risk.[3]

To illustrate this inefficiency, assume an investor buys a 10-year sovereign bond at a yield rate of 8.40 percent and seeks to hedge this position through a IRS contract. In the market, the 10-year TIIE IRS is at 8.60 percent. This transaction results in a difference of 20 basis points (interbank versus sovereign risk spread), given that historically the spread between the TIIEF and the TIIE is between 20-25 basis points. If there had been a TIIEF curve, the difference would be close to zero.

Figure 2. TIIE IRS Contracts
(Daily Volume)



Source: MEXDER

Volume is the main challenge since the difference in liquidity between the two rates has been the main impediment to speed up migration in an orderly manner, even though investors are aware of the benefits of the transition. At the moment, TIIEF futures remain significantly low, for instance, TIIEF futures contracts in the derivatives market have a daily average of approximately 4,000 contracts. In contrast, TIIE IRS contracts (Figure 2) have a daily average of nearly 40,000 (CME, 2022; MEXDER, 2022). The highest peak of TIIEF futures contracts was 300,000 in a single day, due to the hiking cycle of the local monetary policy. The second highest peak was the issuance of the new sovereign floating bond in October 2021, which will be explained in the next section. Since then, the volume has decreased significantly. To address low liquidity on the new TIIEF, the MoF began issuing new floater bonds with the TIIEF as reference.

2. Threefold strategy, first step: issuance of new bondes

To encourage the adoption of TIIEF and enable the expansion of the OIS curve maturities in Mexican pesos, the MoF decided to cease the issuance of the previous sovereign floating bond[4] with TIIE (cost of

[3] In addition, IRS contracts involve different currencies because most of the participants in the local debt market collaterlize in USD.
[4] Issued in Mexican pesos.

interbank funding) as the reference rate and replaced with a new one with TIIEF. This new sovereign floating bond is the BONDES F and represents the first step in the threefold strategy.

2.1. A New Sovereign Bond: Bondes F

The BONDES F keeps most of the characteristics of the previous sovereign floating bond, except for the use of the TIIEF as the reference rate. The first BONDES F auction took place in October 2021 for the equivalent of USD$537 million and, since then, Mexico has auctioned maturities of 1, 2, 3, 5, 7, and 10 years.

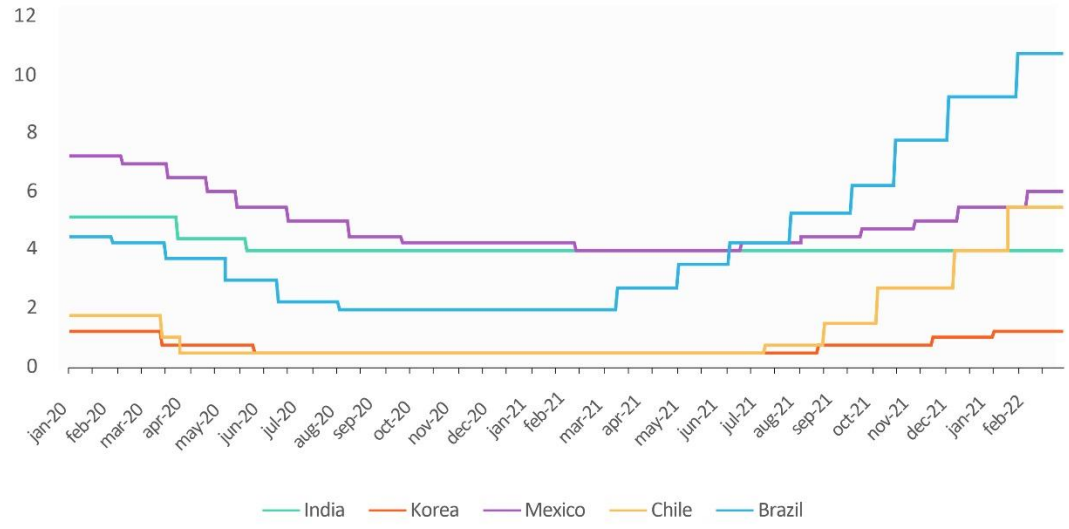
At the same time, to acelerate migration between the past floating bonds to the new ones, the MoF has conducted exchange operations. The first transaction was carried out in December 2021 and consisted of an exchange between the previous floating bond with maturities between 2022 and 2026 and BONDES F with similar maturities. The result was a repurchase of approximately USD$8.4 billion and a placement with BONDES F of a similar amount. This transaction represented approximately four times the average weekly amount of an auction with all sovereign securities.

Box 2. The End of the Low-Interest Rates Environment

The global economy is facing a longer than expected period of high inflation. An assessment from the International Monetary Fund (IMF) considers that two of the main factors for such persistence stem from global value chain disruptions and the rise of energy prices, which caused the global economic growth forecast to reach 4.4 percent in 2022 (Gopinath, 2022).

At first, inflationary pressures were considered transitory, but current information indicates that these circumstances might persist longer than expected. Hence, central banks have entered a rate tightening cycle of their monetary policy, aimed at maintaining the inflation rate on their target ranges (Dodd, 2021). At the end of 2021, Canada and the United Kingdom have begun a restrictive period caused by inflation. While in the United States, the Federal Reserve (FED) began rate hikes in 2022 (Cox, 2022).

Figure 3. Monetary Policy Rate in Selected Emerging Economies



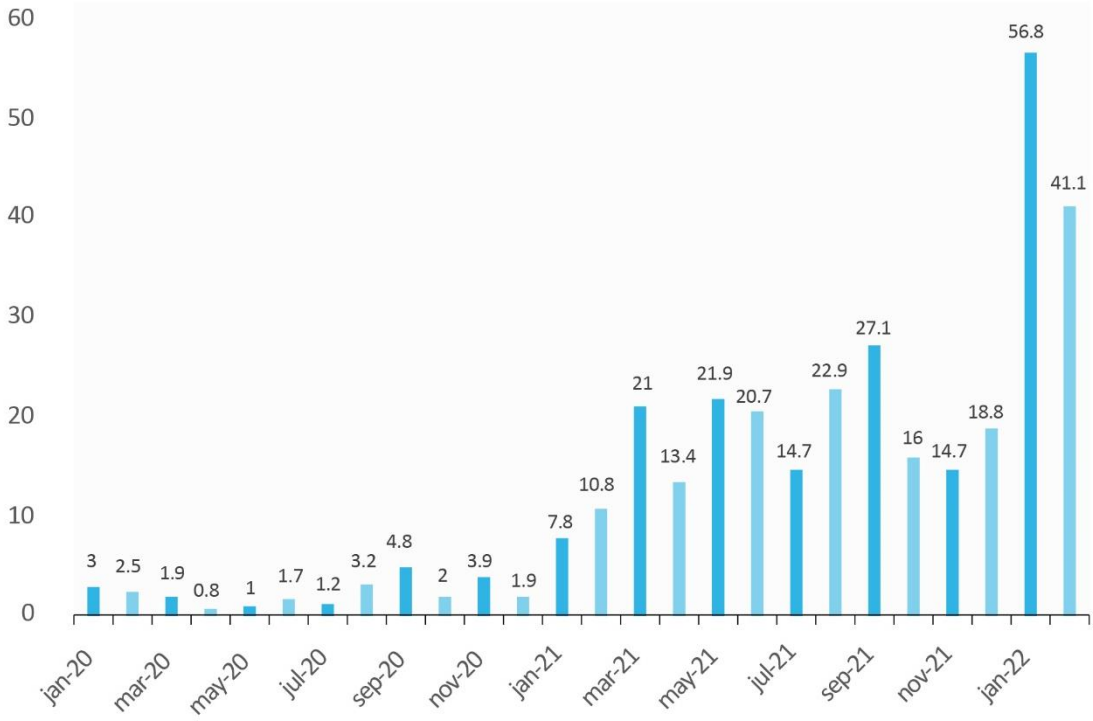
Source: Bloomberg Finance L.P.

In emerging economies, the inflationary phenomenon has been more pernicious; consequently, central banks have had to speed up their hike cycle in mid-2021, as shown in Figure 3. Brazil is one of the countries that had a more reactive position, with hikes of 100 basis points in a single meeting (Capurro, 2021). The Mexican Central Bank began its cycle of hikes in August 2021, with hikes of 25 basis points, increasing it to 50 base points in the most recent decision (Banco de Mexico, 2022).

The world is currently in an inflationary period (See Box 2) and central banks have entered a cycle of monetary policy hikes. This has led to an increase in the demand for floating bonds referenced to short-term interest rates (Figure 4). High demand is expected to continue as long as expectations for further rate hikes are sustained. In addition, in emerging economies, capital inflows and outflows builds intermittent demand between fixed and floating rate bonds depending on the monetary policy cycle. Therefore, high demand is enhanced for floating bonds in these economies due to investors's preferences in a new rate hiking cycle.

Source: Bloomberg

Figure 4. Issuance of Floating Rate Bonds
(USD billions)

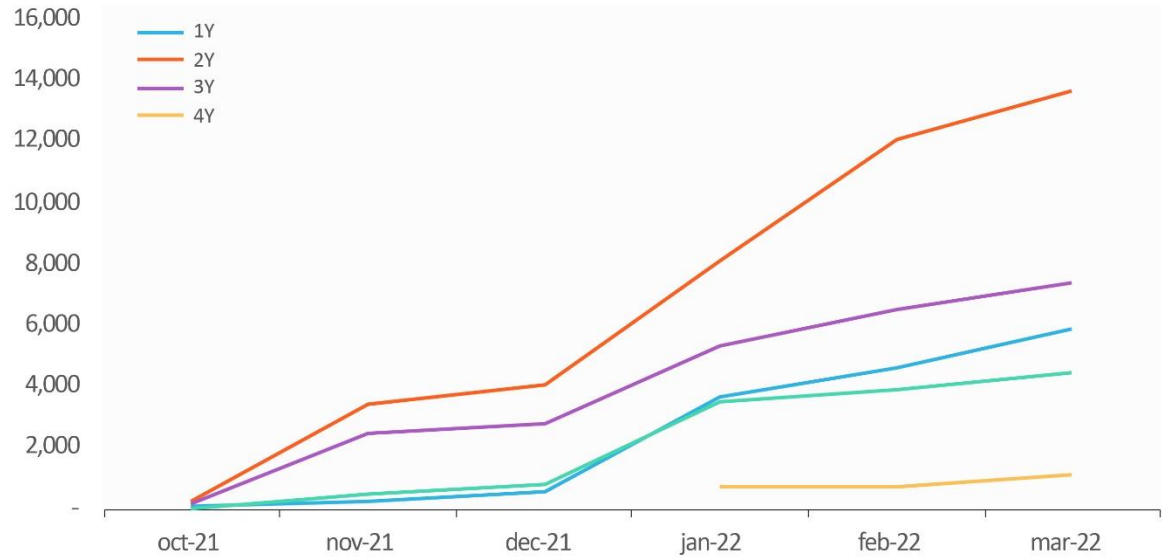


Note: Issuance by companies domiciled in USA

Monetary policy is expected to be fully normalized within a range of one to three years. Figure 5 shows the evolution of the outstanding of BONDES F according to different maturities. The evolution ilustrates that almost six months after their first auction, their growth has been exceptional, especially for the 2 and 3-year maturities, in line with the current cycle of monetary policy hikes. Prior to 2020, the auction calendar only contemplated the 5-year floating bond with an average amount of USD$230

million allocation. In recent auctions of BONDES F, the total amount allocated was approximately USD$600 million.

Figure 5. Outstanding of BONDES F by Maturity
(USD millions)



Source: Banco de Mexico

The creation of the BONDES F was a milestone for the local debt market development, as it has proven to be an efficient instrument to boost the adoption of the TIIEF and promote the development of an OIS curve in Mexican pesos.

3. Threefold strategy, second step: issuance of new sustainable sovereign bonds in local currency

The second step of the threefold strategy is issuing new sovereign sustainable bonds linked to Sustainable Development Goals (SDG)[5] , in local currency. The new sustainable sovereign bonds will be floaters, with the TIIEF as the reference rate, thus encouraging both the adoption of the new RFR and sustainable issuance in the domestic market (See Box 3). The expected result is to adhere more maturities to the TIIEF curve while establishing a benchmark for participants that incorporate sustainable criteria into their financing plans.

The aforementioned bond was named BONDES G. It preserves the same characteristics as BONDES F but with sustainability criteria and, therefore, a "greenium"[6] spread, i.e. the premium on green bonds.

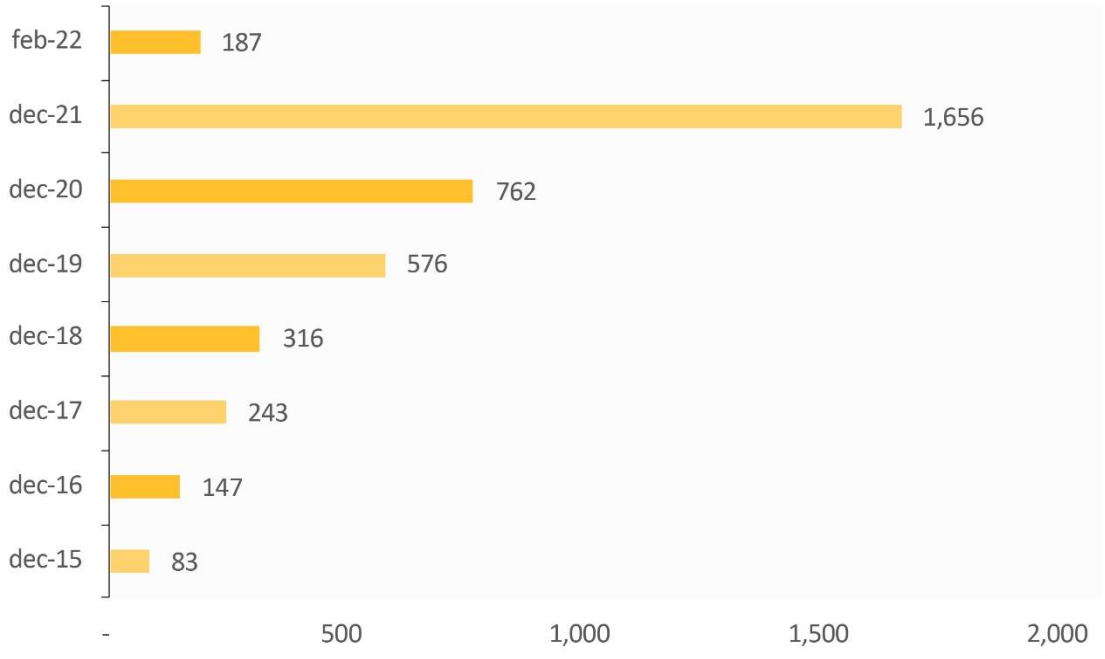
5 Mexico has been issuing sustainable SDG-linked sovering bonds under its Sovering Sustainable Bond Framework available for inverstors in the MoF website.
6 The greenium is a premium to the issuer for having sustainable criteria in its issuance and it is expected to reflect a lower premium than a traditional bond for the incorporation of sustainable impacts in the valuation of the sustainable bonds.

Box 3. The Sustainable Debt Market

World wide the sustainable debt market, also referred as Environmental, Social and Governance (ESG), has considerably grown in recent years. In 2021, sustainable assets grew 76 percent versus 2020, with a record of USD$441 billion. Mexico positioned itself in 25th place globally by allocating USD$13.5 billion. The top three countries were: the United States (USD$302 billion), France (USD$177 billion) and Germany (USD$109 billion). Regarding emerging markets, China led the top 3 with USD$74.2 billion, followed by Chile with USD$25.8 billion and then Mexico (Bloomberg Intelligence, 2022).

According to studies carried out by Bloomberg, global sustainable assets on track are expected to exceed USD$41 trillion by 2022 and USD$50 trillion by 2025, which represents a third of the projected 140 trillion Assets Under Management (AUM). The sustainable debt market is expected to raise USD$15 billion by 2025 (Bloomberg Intelligence, 2012). Figure 6 shows that the growth between 2020 and 2021 was very significant and that expectations for this year are equally positive. Relevant institutions around the world have modified their prospects and investment regime for these instruments. Similarly, the rating agencies have included special methodologies and considered important the involvement in sustainable investments for the final rating of the company or country. The world is migrating investment assets to sustainable assets, and the growing international demand is still at peak.

Figure 6. ESG Total Amount Issued
(USD billion)



Source: Bloomberg Intelligence

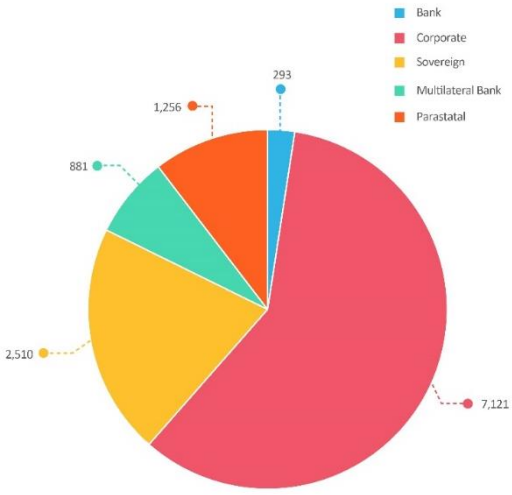
3.1.The Importance of Developing the Sustainable Local Debt Market

Since 2020, the Mexican sustainable debt market began to expand. Nonetheless given the issuance of the first sustainable sovereign bond in euros, this rate was considerably boosted in 2021 (See Figure 7).

Figure 7. Sustainable Amount Issued and Issuances total number
(USD million)

Source: CCFV

Figure 8. Sustainable Amount Issued by Issuer
(USD million)



In 2021, 42 bonds were issued by the private sector, with the corporate sector accounting for 34 issues, representing an outstanding of around USD$7 billion (Figure 8).

It is important to highlight that these bond issues have been placed in the market using quasi-sovereign benchmarks of the Mexican development banks[7]. Thus, introducing sovereign sustainable benchmarks denominated in Mexican pesos is expected to ease sustainable issuance in the local market.

Source: CCFV

7 Mexico has eight local development banks devoted to different sectors such as infrastructure, subnational financing, housing and mortgages, financial inclusion, small and medium enterprises, and international commerce, among others.

To address this opportunity, the Mexico's new sustainable sovereign issuance will facilitate price discovery and greenium to contribute to the development of the local sustainable corporate debt market. For many companies, the sustainable issuances are just as fundamental as their traditional financing strategies. Companies today may be pressured to comply and report their sustainable disclosures, but they also understand the long-term benefits, such as expanding investors's base to open sources of financing, lowering financial risk management and diminish financing costs.

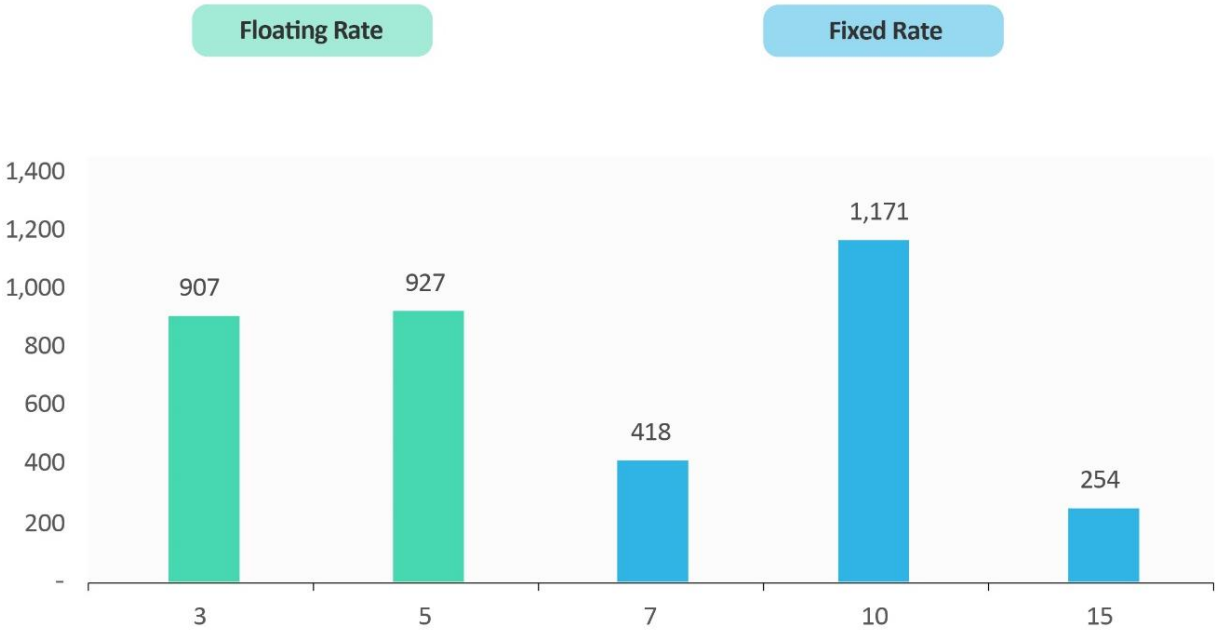
One of the main participants in the local sustainable market are the development banks, which complement the sovereign with quasi-sovereign asset class. Development banks are recurrent issuers in the local debt market with a floating rate issuance preference that responds to the nature of their balance sheet, where the actual reference rate of those bonds is TIIE.

The MoF has encouraged the development banks to issue debt instruments under a floating rate scheme with the TIIEF as reference rate.

In addition, the development banks have pioneered issuing sustainable issuances because of their development mandates and due to their alignment to SDG criteria. Figure 9 shows that the 57 percent of outstandings bonds under a 10-year maturity are floaters, and 81 percent under a 7-year maturity.

The aspects described above were incorporated into the decision that the first sustainable sovereign bond in local currency should be a floater, given that there is already an incipient curve. Sovereign issuances will be placed in longer maturities allowing development banks to have more space to issue their bonds at different maturities, adding market depth with new references and tenors for the local sustainable curve.

Figure 9. Outstanding of ESG issuances from Development Banks by tenor
(USD millions)



Source: CCFV

Mexico has shown a strong commitment to comply with the 2030 Agenda since its launch in 2015. The country was the first one to issue a sovereign bond linked to the SDG. Currently, 78 percent of the Federal Government budget programs are linked to at least one SDG, this allows: I) recurrent issuance of sustainable sovereign bonds, II) access to a new investor base focused on sustainable impact of their investments; and, III) development of reference curves for other national sustainable issuers.

To date, Mexico has issued two sustainable bonds for a total of 2 billion euros. Now, the MoF is on track to develop its sustainable curve in the local market. In addition to the benefits that the MoF has in terms of innovation and better refinancing possibilities, it is essential to build a local curve at different rates (fixed, variable, floating, and other instruments in addition to bonds) in order to give all participants a risk-free sovereign benchmark. Through these actions, the MoF will encourage greater efficiency and transparency for the whole debt market.

On the demand side, Mexican pension funds still have a long road to rebalance their portfolios to include sustainable assets. In 2021, only 4 of the 11 pension funds in the country adopted sustainable investment principles. As of 2022, in a joint effort by Mexican financial authorities in collaboration with the National Commission of the Savings System for the Retirement (CONSAR, by its acronym in Spanish), pension fund regulation was introduced in which all Pension Fund Administrators must consider sustainable criteria in their investment portfolios (Consar, 2022).

Pension Funds AUM represented approximately 22 percent in 2021 and the MoF estimates that this will grow up to 40 percent in a few years. There is a substantial opportunity for the most important asset managers in Mexico to invest in sustainable debt.

3.2. BONDES G and Greenium Discovery

The Mexican MoF took the initiative to study the different issuance mechanisms that other countries have used and the coexistence of a sustainable curve with the *brown curve, i.e. a sovereign curve without sustainable criteria.* The countries have experienced greenium discovery, when placing Sustainable Bonds in the primary market.

One of the most widely used strategies is the Twin Bond Structure. This structure issues sustainable bonds with the same maturity and a coupon rate as a brown bond. An important fact is that the sustainable bond typically has a smaller issue volume than the conventional bond. The main objective is to ensure that the issuance of sustainable bonds does not have a negative impact on the overall liquidity, for instance, in sovereign bonds. At the same time, it is easier for investors to diversify between conventional and sustainable bond allocation. The issuing procedure differs in each country. For example, while some countries issued sustainable and brown bonds at the same time, others did it on different days. Some other sovereign issuers seek to issue separate sustainable labels which could be attached to any conventional government bond.

The MoF considered an alternative that would integrate three markets simultaneously given the Mexican context described in past sections.

To sum up, four fundamental factors were considered to design the new sustainable sovereign bond:

I. The transition to alternative reference rates, this is the new TIIEF. Only a few emerging markets have started this transition, while the changes in advanced economies have been gradual. This transition has been limited due to the lack of derivatives market liquidity between TIIEF and TIIE.

II. In October 2021 BONDES F were first issued to promote the gradual transition to this new rate. This action will encourage other issuers (especially Development Banks) to reference their issuances to the TIIEF.
III. The fact that Development Banks have a strong preference for sustainable bonds and floaters opening the opportunity for a market instrument comprising this features.
IV. The new cycle of hiking rates makes floating bonds preferred by investors.

Hence, in 2022, the MoF will issue a new sustainable floating bond in Mexican pesos named BONDES G using TIIEF as the reference rate. This will be priced through the BONDES F (brown bonds) with similar maturities, allowing the market to define a greenium reflected in the spread of the brown bond. As BONDES F already has the TIIEF as a reference rate, the creation of an efficient sustainable floating curve it is expected to have a natural adoption by the market.

Furthermore, the floating rate curve referred to TIIEF will contribute to build fixed-rate curve by: i) providing liquidity for the new OIS curve based on TIIEF, and ii) targeting both the non-sustainable and sustainable local debt market.

3.3. Local Market Coordination

Currently, the Central Bank of Mexico uses sovereign securities to articulate monetary policy. This generated that, by the end of 2021, the Central Bank will be responsible for approximately 50% of the outstanding of BONDES D, for monetary policy purposes.

Open market operations are one of the main instrument used by the Central Bank to manage short-term liquidity, either through credit auctions or the purchase of securities. For this, instruments used as monetary regulation are essential to achieve the Central Bank's operational objectives. In order to accelerate the adoption of BONDES F, the Central Bank and the MoF developed a new liability management tool, through a process of coordination and active communication between both institutions.

The result was the creation of a new legal framework on the purchase of BONDES D for monetary policy and the sale of BONDES F by the Federal Government. This also implied the development of operating systems within the Central Bank and within the MoF.

To date, three exchange operations have been carried out for an approximate amount of USD$9.7 billion, providing more liquidity to the BONDES F market, in addition to the operations described in previous sections. In these operations, the Central Bank repurchases previously auctioned BONDES F and liquidates the securities. In exchange, it delivers to the holders of the debt a BONDES F that is in charge of the Federal Government. Since this transaction involves a crossing of balance sheets, the Federal Government receives Mexican pesos for the issuance of the BONDES F. A second cross-balance sheet swap program is currently being studied by the Ministry of Finance and the Board of Governors of Banco de México.

For new BONDES G, the MoF, in coordination with Central Bank, chose syndicated auctions[8] over the traditional primary auction to provide volume and guarantee the success of BONDES G issuance. To complement the volume, the Central Bank will also use BONDES G for monetary regulation.

8 The syndicated auction mechanism consists of sovereign securities sold to a group or syndicate of financial institutions who, for a commission, commit to purchase a certain volume of securities at a market price. The securities are then sold by the members of the syndicate to the rest of the market.

In Mexico, syndicated auctions have been carried out since 2010 only for fixed and inflation-linked rate bonds. In these operations, the "Distributors" are appointed among the members of the Market Makers program. The adoption of this mechanism has allowed Mexico to have access to a larger investor base compared to what is commonly achieved through a traditional primary auction, due to it is feasible to place a relevant outstanding in a single auction in order to adequate liquidity conditions in the secondary market (Acosta y Álvarez, 2014).

4. Threefold strategy, third step: integrating curves and expanding maturities

In order to smooth the redemption profile, BONDES G will have different tenors compared to the BONDES F. Hence, the MoF expects to start the issuance of BONDES G in 4 and 6 years maturities in 2022, reaching up to 9 years.

The MoF will develop a fixed sustainable curve through the derivatives based on the TIIEF once sufficient liquidity and maturities in the floating curve are achieved. The market will be able to extrapolate the fixed rate from the floating rates. In summary, the fixed rate will be derived from the floating rates (BONDES F and BONDES G) and the futures rates (OIS curve based on TIIEF), allowing to match flows (SWAPS) at a desired term.

Fixed rate maturities are expected to have a curve up to 10-year maturity to also meet the duration required for long horizon investors, such as pension funds and insurance companies.

The MoF is aiming to provide investors with an efficient floating and fixed sustainable curve for allowing the deployment of investment strategies wrapped with the hedging strategies. The MoF expects that issuing instruments on the new curves will enhance efficiency and benefit for all market participants, including banks.

5. Final remarks

The threefold strategy is a key to enhancing efficiency in the debt market for public and private issuers, allowing for greater flexibility for all issuers in their financing programs, both sustainable and traditional. Setting up the local debt market for financial innovation should attract a broader investor base and foster efficiencies both in the liquidity and depth of the local market. At the same time, it will further promote transparency on the price discovery process.

The integration of the local sustainable market with the TIIEF derivatives market is essential to achieve efficiency. Therefore, the MoF expects to increase the dynamism in both markets in order to hedge sovereign assets. Furthermore, the creation of the local OIS curve will ensure correc pricing in Mexican pesos, benefiting all participants.

Moreover, the structure of the fixed income market and international capital flows are expected to transform the debt instruments ecosystem demanded by investors. Another positive effect is transiting to sustainable financing and RFR to reduce future refinancing risk.

The MoF is convinced that the road to efficiency in the local debt market will be achieved through the route of financial innovation. The sustainable floating and fixed-rate curve should boost the derivative market. Inter- and intra-market dynamics should also cascade to the rest of the entire Mexican financial ecosystem.

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SESSION IV

ACTIVE DEBT MANAGEMENT

Making a Market: on the Diffiusion, Benefits, and Risks of the Primary Dealer Model in Advanced Economies

Charlotte Rommerskirchen[1]

Abstract

In today's sovereign bond markets, primary dealers take on a key role in financing government debt. Primary dealership reforms which originated in the US in the early 1960s, had far reaching implications for not only debt sustainability and interest rates, but also for the relationship of governments and their agencies with financial and non-financial institutions. This paper examines the diffusion of the primary dealer model across 32 rich economies. In so doing, it provides a cross-national political-economy analysis of primary dealership creation and of its consequences. The results suggest that the costs of public debt have been a central driver of reform. Turning to the consequences of primary dealer introduction, there is strong evidence that primary dealer systems reduced governments' borrowing costs substantially. At the same time, the growing role of repo finance within the primary dealer model, points to inherent risks emerging from cyclical effects and systemic fragilities.

Keywords: debt management; primary dealers; public debt; financial markets; repo markets; monetary-fiscal coordination
JEL classification: H63

1. Introduction

The transformation of public debt management has started to draw increasing interest, and for good reason. Even before the ongoing Covid-19 pandemic triggered a surge of debt levels unprecedented in peace times, questions around public debt and its management spoke to wider macro-finance themes within economics and political economy. With governments issuing trillions of debt instruments to foot the pandemic bill, central bankers were hailed as the main life support. Central banks across advanced economies have facilitated the fiscal response by directly or indirectly financing large portions of public debt. In so doing, central banks were keen to respect existing bond market boundaries distinguishing between the primary market (largely off limits) and the secondary market. This means that before central banks bought government bonds, these had to be placed in the primary market, a market that is dominated by so-called primary dealers (PD). By the turn of this century the majority of OECD countries have introduced a primary dealership model (PDM). Yet we know relatively little about a system that acts as cornerstone of today's financial markets. This study examines the origins, determinants and consequences of the primary dealer model across the OECD. Ultimately, this paper seeks to contribute to an informed dialogue on the macro-financial merits and risks of the current primary dealer system. This study proceeds in 4 main sections. The first section presents a

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broad overview of the origins of the PDM starting in the 19th century and focusing on the wave of post-Bretton Woods reforms. The second section analyses the drivers of PD reform using hazard models. Findings suggest that above all the cost of servicing debt and the debt burden of a country were key factors in introducing the PDM. These findings are further contextualised with brief country case studies on the US, the UK, Italy and Germany. The third section turns to the impact of PD adoption. Results from a pooled cross-sectional time-series analysis suggest that countries with a PD system in placed saw a decline in sovereign bond yields. Primary dealership introduction seems to have been a more important factor in this decline than central bank independence or the creation of 'modern' debt management agencies. The fourth section, discusses the role of repo finance in de-risking the PD system. The paper closes by considering the implications and future of the primary dealer model.

2. A short history of the primary dealer model

By the 19th century, large investment houses in charge of underwriting and issuance dominated the bond market of advanced economies, while market makers provided secondary market liquidity. Between the end of the Gold Standard in 1914 and the end of the Bretton Woods era in the 1970s, sovereign bond markets were a predominantly domestic affair. Domestic investor, frequently portrayed as 'financially repressed' formed the core of bond holders who in turn 'typically received compensation through protective regulation and implicit lender-of-last-resort or deposit insurance subsidies' (Kroszner 1998: 88). What is more, there are instances where 'captive' financiers were able to profit from the closed system notably by demanding (by today's standards) high interest rates. Most bonds were held to maturity and often not marketable. Financial sector liberalization more broadly, and capital account liberalization specifically, gave rise to the development of a range of new financial products that were aimed at managing the growing volatility in interest rates, exchange rates, and commodity prices of the post-Bretton Woods world (Wheeler 2004). These financial market reforms set off the starter gun for the transformation of public debt management. With surging debt levels and funding demands, governments set out to improve their abilities to finance deficits. In so doing, they formalised and institutionalized market structures introducing new debt management practices (e.g. the use of increasingly complex derivatives), with most countries converging on a financialised model of debt management (Fastenrath et al. 2017). This model typically relies on the issuance of marketable debt through a primary dealer system, where a select number of primary dealer banks are given privileged access to debt auctions in exchange for a commitment to 'make' a secondary market in sovereign debt.

The division of the government bond market into primary and secondary segments is not new. And yet the introduction of the primary dealer system is qualitatively different. This system refers to a 'nexus of designation criteria and performance requirements that stem from the decision to execute open market operations through primary dealers' (Garbade 2006). This nexus can be described by its obligations and its perks. Regarding the first, primary dealer institutions obtain the exclusive right to submit (competitive) bids in auctions for government bonds and are required to do so in 'substantial', predefined ways. Furthermore, dealers usually need to contribute to market liquidity by quoting executable two-way prices for government bonds on secondary markets according to set rules about the maximum spread or turnover requirements. Regarding the perks of the system, primary dealers enjoy the right to participate in (usually profit generating) syndications, often have access to special (repo) financing facilities, and may benefit from any reputational gain stemming from their PD status as well as from informational advantages due as a result of the ongoing dialogue between primary dealers and public bodies.

The introduction of the PD system enabled the financialization of debt management. Primary dealers made the switch from direct issuance and syndication to competitive auctions possible. Auctions mean that prices of government securities are determined through arm's length, competitive bidding by (international) investors. This shift is widely credited with bringing debt servicing costs down. By the turn of the century, syndicated bond issuance was the exception rather than the rule in advanced economies. According to Bröker (1993: 17), the use of auction techniques is 'perhaps the most typical indication of market governance in public debt management'. It is arguably their activity in the secondary market, however where primary dealers had the biggest impact on the government bond market. Primary dealers are market makers. This obligation to quote prices two-ways transformed sovereign bond markets from illiquid, slow and domestic markets to liquid, international markets with both high speed and high turnover. As so often with (financial) market innovation, technological advanced played a crucial role in this transformation. The wave of PD reforms (see Figure 1) needs to be appraised not just in the context of accelerated internationalisation of capital markets, but also in the context of tremendous developments in telecommunications and information networks. In the UK, for instance, the Big Bang switch in 1986 from traditional face-to-face share dealing to electronic trading, is unthinkable without the concomitant IT revolution.

Since the advent of state borrowing, sovereign debt managers have sought to access capital markets at home and abroad with the help of (often foreign) underwriting banks (Flandreau and Flores 2009). The role of today's primary dealers is not primarily to signal the 'sound reputation' of a sovereign government – although reputational gains continue to work both ways both for the sovereign and for primary dealer banks. Already prior to the wave of PD reforms, sovereign bond underwriters have lost this role to rating agencies, and at times happily so. Compared to bond underwriters in the 19th century, the risks of primary dealers continue to fall. In modern bond markets, bonds are cleared and settled through a clearing system. This takes away the clearing risk of a counterparty in the secondary market missing their payment. What remains, is the underwriting risk of disposing of the purchased bonds at uncertain prices in the secondary market. In principle, any bond acquisition could turn loss making due to a lack of demand at a certain price point. The rise of repo finance demand, with sovereign bonds the main asset, as well as the increased willingness of central bankers to act not only as lenders of last resort, but also market maker of last resort, has substantially de-risked primary dealer activity in rich economies.

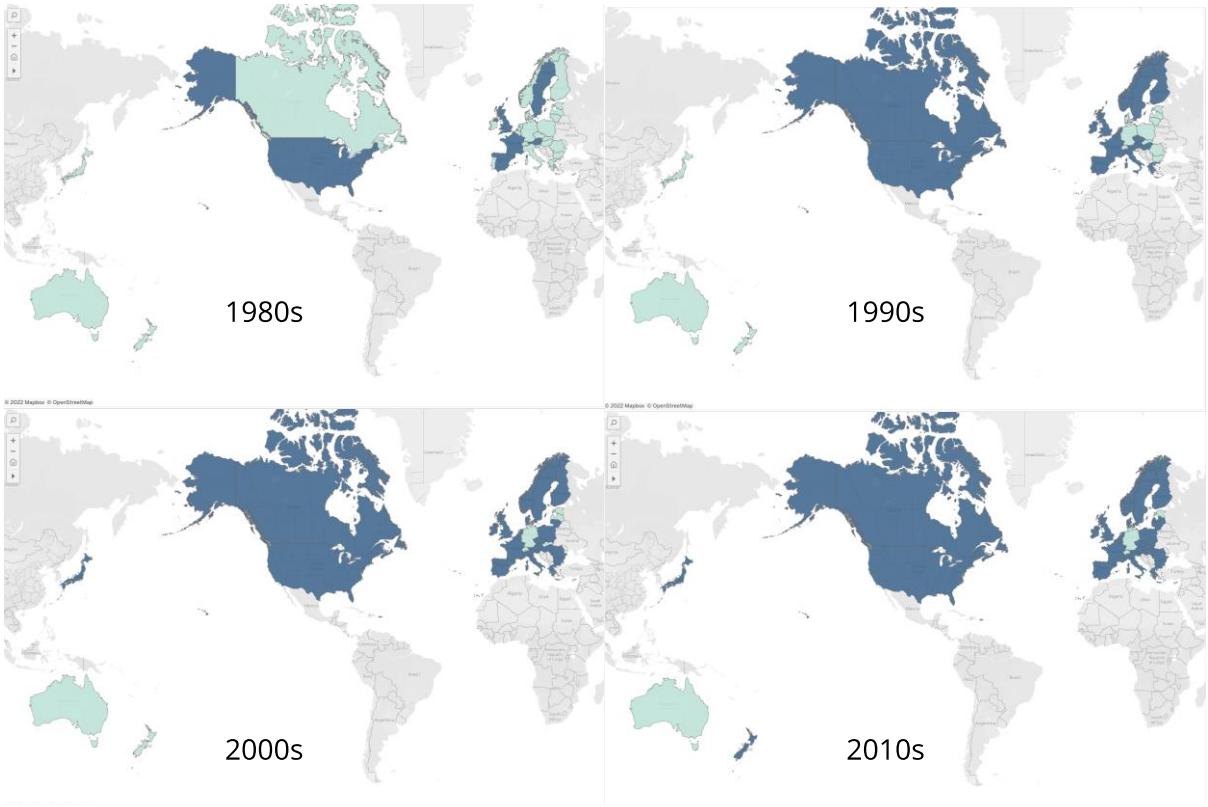
The creation of primary dealership systems is closely link with monetary policy at large and independent central banking specifically. On the fiscal policy side, the main motive for the establishment of the PD system provided in the economics literature is to bring down government's financing costs (e.g. Breuer 1999). Primary dealers would be responsible for raising stable, low-cost funding and for maintaining a well-functioning secondary market. This makes intuitively sense, but does not get us very far. After all, why would governments introduce reforms that would increase the costs of borrowing? The question is rather *why* governments identified the PD system as the best way to achieve this aim *when* they did, and indeed why some did *not*. The appeal of debt management reform, of which the PD system is a key and usually the first component, can be understood as a shift in thinking about debt (Fastenrath et al. 2017). Namely, public officials began considering debt as a portfolio in line with financial economics. Debt management thus became focused on portfolio optimisation which relied on a heightened role for liquidity and diversity of bond investors. Liquidity in debt management was to be boosted by primary dealers acting as ready market makers willing to continuously quote prices at which they will trade on demand. As financial deregulation brought down the costs of trading, changes to the microstructure of the government securities markets have contributed to the increase in liquidity (Kroszner 1998: 89).

Diversity was to be increased by explicitly inviting foreign banks to participate in the PD system. So doing, would not only increase the number of players and introduce competition in primary debt auctions between primary dealers, but also open up channels to tap into diverse pools of foreign buyers in the secondary bond market. The UK is representative in this regard, where 'the more the merrier was broadly the attitude of the Bank, which felt the depth and liquidity of the market - its capacity to be active and smooth-working - could only benefit from new competition and capital' (Reid 1988: 64). Sylvain de Forges (interviewed in Lemoine 2013), director of the French debt agency between 2000 and 2003, considers the globalization of bond investors thus: 'We are internationalizing the market, with non-residents, Japanese, American, or whatever pension funds. People who would never have imagined, for a quarter of a second, buying a paper issued by a socialist government. And French to bout! One of the worst possible references in this field!' The introduction of the PD system was thought to also support financial market development more broadly by both inviting foreign financial institutions and by assigning a 'special' status[1]. Deepening the capitalization of the bond market and widening the networks of possible bond buyers, would ideally be beneficially for financial markets at large.

The arrival of the primary dealer model marks the 'shift from relationship financing to market-based techniques in the issuance of debt instruments' (Fastenrath et al. 2017: 282, see also Badurina and Svaljek 2012: 76). By the turn of the century, the consensus was that the primary dealer system was in most cases 'highly recommended' (Arnone and Ugolini 2005). Figure 1 shows the trend of PD model adoption. The rate at which governments adopted a PD model increase remarkably in the late 1990s. In most instances, primary dealerships preceded debt management office reforms. This is because 'modern' debt management required a liquid, well capitalized bond market which the PD model successfully enabled.

[1] Here especially the direct dealings with the central bank are worth mentioning with special facilities which can be transformed into monetary equivalents.

Figure 1. The spread of the primary dealer model



Source: see Appendix

This is not to say that the PD system cannot be abused. As Yadev (2016) argues: 'To be sure, tight-knit, cohesive, and similarly situated control by privileged dealers invites the risk of collusion, price-rigging, or a tolerance for risk-taking within the "ingroup."'. US primary dealers, for example have, on a number of occasions, incurred sanctions for attempting to manipulate the market in their favour. Indeed, abuse of the primary dealer position is not confined to US. A prominent example involved EuroMTS in 2004, when Citigroup took large positions against market-makers. Citi sold EUR 11 bn worth of government bonds (thus reducing prices) and bought some back later at a hefty profit (Gabor 2016). Specifically, the combination of PD special access and the adoption of auction systems has been linked to the opportunity for primary dealers to acquire a large fraction of new issues by aggressive bids. Cornering the market, dealers could then make profits by selling them on at a hefty margin to other primary dealers who have already sold 'when issued' securities to their customers and are now in want of said assets.

3. Drivers of PDM adoption

The specific design of the primary dealer system differs from country to country; indeed a few rich countries have no PD system or have never formalized PD obligations. How to explain individual countries' decisions to adopt the PD model and account for the possible variation in PD adoption? The following section reviews 3 domestic political-economy propositions about the drivers of reform.

3.1 Domestic economic factors

Proposition 1: PD reforms were determined by countries' economic profiles. Particularly, countries experiencing high debt costs would be more inclined to implement change that was thought to bring about a funding environment with stable and lower costs.

Macroeconomic explanations of policy change generally include variables such as debt levels, inflation, and per capita gross domestic product. The thinking behind their inclusion in models of economic policy decision is straightforward: economic policies address a particular policy challenge. Independent central banks were to enable a low inflation regime, fiscal rules were to tame runaway deficits, etc. Given that these reforms target economic outcomes, the existing domestic macroeconomic background should matter. Suleiman and Waterbury (2019) for example find that external debt levels and current account balance deficits matter for the adoption of structural reforms. Simmons and Elkin (2005), although their work overall emphasis the role of peer diffusion effects, present evidence that the domestic economic climate matters for capital account, exchange rate and current account liberalization. Garriga (2010) shows that domestic macroeconomic factors are important determinants of central bank reform. This is only a small snapshot of a rich literature that has established the macroeconomic determinants of economic policy making. In the context of this study, three variables are of particular interest:

1. the debt per capita to GDP ratio to measure the overall debt burden of a country
2. the interest payments that governments need to shoulder
3. the wealth of a country which is likely to also capture macroeconomic developments (incl. financial market development/maturity) more broadly

3.2 Domestic financial market factors

Proposition 2: Domestic financial markets mattered for the adoption of the PD model. In particular, more open and less concentrated financial markets should increase the likelihood of reform.

Ingoing financial market conditions should matter for financial market reform. Market conditions here not only link to the power of financial market actors in influencing a reform that has largely been viewed as market-friendly, but they should also speak to the prevailing winds of change within a given political economy. Capital account openness for instance denotes not only the competitive environment in a market with new entrants being able to come and go with relative ease, but should also be a broader indictor for market liberalization that might spill over to other financial market domains and would open the possibility for changes in public debt management. Open financial systems are also likely to be playing grounds where global investment banks like Baring, Merrill Lynch, J.P. Morgan, Salomon Brothers and UBS operated. These were US key players (and thus familiar with the primary dealer model pioneered in the US) at the turn of the century and have advanced financial sector innovation as they ventured abroad and arrived at newly liberalized markets. Some authors have indeed argued that PD reforms, and here notably the choice of auction technique, has been driven by the private interests of large financial institutions rather than cost-reducing public officials (cf. Peltzman, 1976). These rent-providing reforms, so the argument, were evidence of 'regulatory capture' of the US Treasury of by the dealers. The scandal ridden primary dealership history of the US further hints at such capture, as do accounts of well-documented close tie and revolving doors in international finance (on revolving doors in debt management see Silano 2022). The biography of William Simon may be viewed a case in point: sworn in as Secretary of the US Treasury in 1974, Simon was previously a senior partner at Salomon Brothers in charge of the government bond department and the first president of the Association of Primary Dealers. Measurements of banking concentration have been linked to the power of finance in steering government policy either via intentional lobbying or implicit pressure. Studies of banking concentration have so far focused on questions related to financial stability and other performance measures (e.g. Calice and Leonida 2018). Given that the PD reforms aimed at opening up and diversifying the sovereign bond market, we can expect that lower banking concentration would improve the

likelihood of reform. Alternatively, lower banking concentration might speak to the ability of concentrated domestic interest to put up resistance against PD reforms.

3.3 Domestic political factors

Proposition 3: Ultimately, PD reforms are political decisions and should be influenced by the political landscape of a country, chief among them the ability of governments to push through reforms.

Within political-economy scholarship on economic reform and liberalization, there are few who would dispute political factors frequently matter. Gourevitch's dictum (1986) 'policy needs politics' applies. The field of potential political sources of influence is wide. In this study, two of the most prominent political factors in the literature are considered. First, drawing on veto player theory (Tsebelis 2011), we can test how political factors influence the ability to push reform through. Specifically, is a strong executive in a better position to enact PD reforms? What is more, the partisan outlook of the executive, so the assumption in the literature, can under certain circumstances have an impact on macroeconomic policy making. Few studies have considered partisan effects in debt management (e.g. Trampusch 2019, Rommerskirchen and van der Heide 2021) and are overall sceptical of the claim that partisanship mattered in debt management reforms. The diverse evidence on fiscal policy or monetary policy in line with Douglas Hibbs ' seminal thesis (1977) on a causal relationship between political variables and policy outputs warrants further investigation.

3.4 Sampling, Estimation and Variables

The sample includes 32 rich economies with yearly observations from 1970 to 2012 using hazard models to analyse the determinants of PD system adoption. These models examine the risk, or hazard, that an event will occur. The 'hazard' here is whether a state decides to adopt a PD system or not. Once a state has adopted a PD system, it exits the data since it has already 'succumbed to the hazard' and should be considered no longer at risk. The main advantage of using hazard models is their explicit modelling of time effects — that is to say how the diffusion of a policy has swept the board over time. The main model presented in Table 1 uses a Weibull distribution to characterise the baseline hazard. Results are robust to different specifications, including Cox's Proportional Hazard (PH) event history model and logistic models that control for time dependence. A battery of further robustness checks was performed, which are not presented here to conserve space, but are available upon request.

Dependent variable/censoring event: The dependent variable takes on 1 when a country introduced the primary dealer system. If a country introduced the PD model in a year between 1970 and 2012 the country was thereafter excluded from the study beginning the following year. A dichotomous measure is warranted. Although there may well be nuances in the primary dealer model, its adoption is still a categorical event. The purpose of this investigation is to model a major shift in debt management practice and not to capture the nuances of organising the primary dealer market.

Independent variables:

1. Domestic economic variables: To capture a government's debt burden, we include both a measure of total debt (*debt*), Gross portfolio debt liabilities to GDP (%) as well as the interest payments as % of GDP (*interest*). In addition, we control for the wealth of a country by including the logged GDP per capita (*GDP*). These variables are taken from the Global Financial Development Database and Eurostat. The time lag (t-1) is used to avoid simultaneity.

2. Political domestic variables: We take the variable *majority* which measures the margin of majority enjoyed by the government. This is the fraction of seats held by the government. It is calculated

by dividing the number of government seats by total (government plus opposition plus non-aligned) seats and is based on the Database of Political Institutions (Clarke et al. 1999, updated 2020). The variable 'left' takes on the value 1 if a left-leaning government is in power and 0 otherwise, and is also taken from the Database of Political Institutions.

3. *Financial market variables:* The variable *concentration*, taken from Bankscope, measures the total of the 3 largest banks' share of assets in total assets of all banks in a country as concentration ratio. The variables *openness* is the index of capital account openness, or KAOPEN, by Chinn and Ito (2008). This de jure index is based on information regarding restrictions in the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions.

3.5 Results

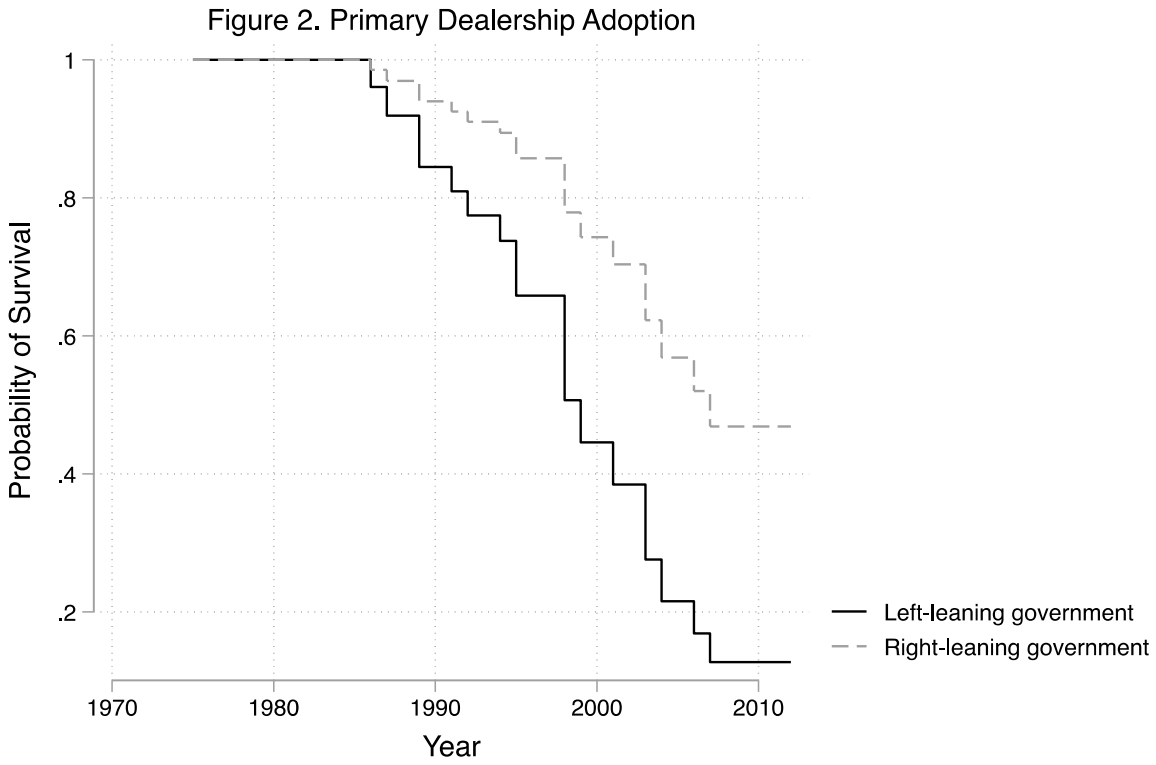
What conditions led to change in the microstructure of the government securities market? Table 1 presents the results from 3 different models with robust standard errors clustered by country. Model 1 presents the economic baseline. Model 2 includes financial market variables. Model 3 adds the political domestic variables. To ease interpretation, hazard ratios are reported. Hazard ratios are interpreted relative to 1 (greater than 1 implying an increase in the risk of PD adoption and hazard ratios less than 1 suggest a decrease). In the first model, the debt to GDP ratio is not found to be statistically significant. However, we find that both high interest payments and higher GDP-to-capita-ratios increase the hazard of PD adoption. Rich countries with costly debt burdens are more likely to implement the primary dealer system. This finding makes intuitively sense: PD reforms were a way to manage the costs of debt. This finding echoes Krippner 's argument (2011) that financial liberalization is fundamentally linked to the need for government funding in a changing international political and economic environment. We find no evidence in favour of proposition number 2. Neither capital account openness nor banking concentration seem to matter for the introduction of the PD model. It is widely assumed that countries pitted against each other in the competition for capital and investors face incentives to converge upon market preferred behaviour. It is however not conclusively settled weather financial market actors *actually welcomed* the PD reforms and if so, whether they did so uniformly. Arguably, domestic banks who acted as main primary market investors for government bonds might well have preferred the old system where business was often more profitable (particularly in syndicated deals). In the UK, it is not far-fetched to speculate that many existing market makers were not too keen on the Big Bang reforms. For Jean-François Pons, chief clerk at the French Treasury in 1988, the state 'has its own interest in this reform, which enables him to turn regularly and at a cheaper cost to the market' (quoted in Feiertag 2021: 125). Accordingly, the concentration or power of banks and openness of the financial system more broadly are not homogeneously related to PD reform.

Table 1. Survival Analysis of Primary Dealership Adoption

	(1) Model 1	(2) Model 2	(3) Model 3
Interest payments $_{t-1}$	1.276***	1.272***	1.231***
	(0.0681)	(0.0673)	(0.0704)
GDP per capita $_{t-1}$	1.413***	1.429***	1.499***
	(0.185)	(0.193)	(0.220)
Debt $_{t-1}$	0.984	0.982	0.987
	(0.0122)	(0.0125)	(0.0108)
Capital Account Openness		0.190	
		(0.198)	
Banking Concentration		0.624	
		(0.787)	
Right			0.419*
			(0.203)
Majority			1.033
			(0.0282)
Observations	653	646	579
AIC	-121.6	-119.4	-122.9
BIC	-99.18	-88.12	-92.36

*Notes: Standard errors clustered by country in parentheses. *p<.10; **p<.05; ***p<0.01*

Turning to proposition number 3, we find no evidence that an increase in the margin of majority enjoyed by governments also increases the likelihood of PD reform. One reason for this may be that debt management reforms were low salience, quiet reforms that did not meet parliamentary opposition (cf. Rommerskirchen and van der Heide 2021). Given the overall uncontroversial nature of PD introduction, the margin of majority did not matter. However, results suggest that partisanship matters. With a hazard ratio close to .5, the variable right more than halves the risk of PD adoption — in other words left-leaning governments were more likely to implement primary dealer systems. As a graphical illustration of the effect of partisanship, Figure 2. plots the survival curve for the adoption of PD systems and illustrates that left-leaning governments were at greater risk of PD adoption than right-leaning governments. Looking at descriptive statistics, we see that in our sample PD systems were established by 13 left-leaning and only 6 right-leaning governments. Possibly, left-leaning governments were more likely to champion debt management reform that was perceived to provide cheaper funding for an expansion in government spending. Relatedly, left-leaning governments may stand to win more in terms of market reputation for 'market-friendly' reforms (Shepsle 1991). Yet, calendars of macroeconomic reforms seldom map onto electoral calendars. That is to say, policy-makers and bureaucrats may be working on reform proposals whose implementation covers different cabinets. This makes blame or credit attribution murky and results should be interpreted with this caveat in mind.



3.6 Country Cases

The results of the survival model are able to offer insight into broader patterns of PD adoption. A closer look at the countries who adopted PD models suggests however that there are limits to a broad-brush analysis. This is perhaps most notable with respect to the outlier group: that is countries in our sample who decided to not go down the PD route: Australia, Germany, Switzerland, Estonia, Malta. Clearly there is more to the story than a rich-poor divide. Another interesting case would be New Zealand which introduces the PD system online in 2019 despite being considered a trailblazer in debt management reform at large. The following section, briefly discusses 4 country cases in order to paint a more detailed picture on the drivers of PD (non)-adoption.

a. US: Pioneering the PDM

The pre-history of the US primary dealer system can be traced back to the 1920s and, like in many other countries, is best understood in monetary policy terms. This monetary policy link persists to this day ('Primary dealers are trading counterparties of the New York Fed in its implementation of monetary policy'.) In the 1920s, the Federal Reserve System itself was still in flux, marked by a power struggle between Washington (Board) and New York, the later becoming quickly the market arm of the Fed due to Wall Street's presence. The NY Fed under Benjamin Strong set up an alternative monetary coordinating committee through which the NY bank started transacting with specific private sector counterparties - the early open market operations. By 1939, Fed officials realised that these dealer relationships existed but were not yet properly formalised. This led to the creation of 'recognised dealers', the precursor of today's primary dealers. The more contemporary story, chronicled in great detail by Garbade (2021), starts in the 1960s when the Fed and Treasury conducted a set of joint studies pushing for the creation of a Primary Dealer Association. A key motive for the establishment of the

association was a concern over a lack of effective regulatory oversight over the US-Treasuries market. A PD Association that would set common trading standards and could discourage undesirable practices. In short, this would offer a private sector solution to lack of regulatory rigour. The formation of such a group finally came to pass in the wake of adverse publicity about dealer behaviour. The PD charter stipulates dealers would aim 'To foster high standards of commercial honor and business conduct among its members and to promote just and equitable principles of trade'. Concerns over primary dealer behaviours and fragmented oversight continue to this day (Yadev 2016). At the same time, the Primary Dealer Association has been a crucial and effective partner from the beginning, notably during the 1970s when despite soaring government debt levels, the Treasury was able to finance its deficit at relatively favourable terms. Alongside a more predictable issuance calendar, a change in the auction format and the issuance types, the primary dealer model gained a positive reputation abroad for facilitating debt management.

b. The UK: the Big Bang and the PDM

The introduction of the primary dealer system in the UK in 1986 (the Gilt-edged market-makers, GEMMs) was explicitly modelled after the US — although the title 'Gilt-edged Market-makers' was chosen by the Bank of England 'in preference to the American term' (Phillips 1987: 15). Reforms were not driven by a cash-strapped Treasury, but spearheaded by the then executive director of the Bank of England, Eddie George (Reid 1988). The PD system was not only meant to raise finance on better terms, but to improve the Bank's capacity to conduct monetary policy. Dutta's excellent study on the UK Big Bang (2019) explains the PD reform thus: The 1986 reforms radically altered the division of labour between bond market participants due to the change from single- to dual-capacity trading. Under the old system, a stock exchange firm acted either in a jobbing or a brokering role, yet was not allowed to take on both. This division created a clear demarcation of interests, with jobbers trading their 'book' for profit and quoting two-way prices and brokers acting as agents for secondary-market investors. Prior to the Big Bang, jobbing firms were in short supply as few had the capital resources to provide the market with sufficient liquidity. By 1985, only eight jobbing firm traded in gilts, contrasted to 29 firms who were awarded the primary dealer franchise in 1986. Reforming this division of labour was meant to address problems in managing the pace of gilt sales which were hampered by jobbers limited market-making power. Specifically, during the UK's post-war period it had proved difficult to fund the debt at long maturities on the scale desired whereas short-maturity financing was thought to risk loosen monetary conditions (Goodhart 1998 : 56-61). The reforms united both jobber and broker roles with the creation of the Gilt-Edged Market Makers. This group of primary dealers commits to a pre-defined share of primary auctions as well as secondary market activity in exchange for privileged access to auctions in the primary market. After the Big Bang, if the Bank of England wanted to reduce liquidity in the financial system, it could sell gilts much more broadly to non-banks, and in this way gain control on broad money growth. The UK Treasury did welcome the introduction of GEMMs: Similar to France, the introduction of the PD system took place at a time when the national debt was rising.

c. Italy: the Euro and the PDM

The precursor of a primary dealer system in Italy can be traced back to broad reforms of 1981 (incl. central bank independence) after which **s**ales of government bonds were done via a private banking consortium that had to sell at market prices. These reforms also put an end to the Banca d'Italia large scale bond purchases. As a result, interest payments increased. Especially in light of tight Maastricht targets for entry into monetary union, the new primary dealership model promised to bring funding

costs down. The Italian primary dealership model was then established in 1994 and created an influential solution to the problem of PD monitoring. Although primary dealer models in the EU were first introduced in France and UK, reforms in Italy were among the technological most influential for Europe (van der Heide 2021). In Italy, the PD system is intrinsically linked with the Mercato dei Titoli di Stato, the so-called MTS platform. Set up in 1988, and thus predating the establishment of primary dealers, to improve the 'transparency' of the 'price discovery' process, MTS provided a platform where dealers (call Specialists) could stream prices to each other, and Treasury officials could monitor dealers' commitment to market making. The Italian Treasury periodically started publishing ranking of specialists' market making, as MTS allowed for a 'objectified' measure of performance. Today, league tables that rank the best performing PDs are widespread practice. MTS became 'almost part of the European *acquis*' (MacKenzie et al. 2020). The introduction of the common currency, which would strengthen the marketisation and transnationalisation of Europe's public debt markets proved to be an important catalyst for debt management reform. By removing currency risk and thus weakening the ties between governments and their domestic investor-base, Europe would see the rise of a 'pan-European government bond market', forcing member states to compete for investment capital. Within this context, liquidity was increasingly seen as an important policy objective to secure a steady and diversified demand for domestically issued securities. The primary dealer system was a key reform to boost liquidity. Eurozone governments, facing increased competition over investor demand, have come to rely on the interdealer trading platform MTS to improve their hold over large dealer banks and to foster competition among them.

d. Germany: *Marktpflege* as PD substitute

How come Germany has not embraced the PD system? Germany experimented with more formal primary dealership system at the turn of the century, but came to take 'the view that it is the cheaper option for the German taxpayer no to' (Gerhard Schleif then managing director of the Finanzagentur, quoted in Chambers 2006). The German *Finanzagentur* operates a quasi-primary dealer system, revolving around a group of dealer banks that face little to no hard commitments in exchange for access to auctions. All banks, that is currently 36, accepting a number of basic requirements may become a member of the *Bund Bietergruppe*. With the benefit of hindsight, it may seem unsurprising that Germany with a deep bond market, benchmark status and an extremely liquid bund futures market (which among other things facilitates price discovery of German bunds), could eschew the adoption of a PDM. Yet writing in 2022 with Germany's status as prime bond haven cemented, it would be wrong to suggest that the conditions we find today did make reforms less attractive at the time. In 1987, the year that France introduced its PD system (one year after the UK), debt servicing costs as % of GDP stood at 2.5 in France compared to 2.8 in Germany. By the time the common currency was introduced in 1999, both countries faced an identical interest payment ratio at 3.3 % of GDP. What is more, Germany's benchmark status was not assured for the majority of the period under investigation in this paper.

Instead, it is useful to consider first, that Germany has been relatively conservative in adopting debt management innovation compared to its immediate peers. Prior to the 1990 reforms, the main long term funding instrument, ten-year 'bunds,' were sold directly to a syndicate of banks, and before 1986, no foreign-owned banks were permitted to participate in the syndicate. The Bundesbank and Ministry of Finance typically would decide the maturity and size of the debt they wished to issue and negotiate with the syndicate members to determine the coupon and issue price. Once agreed upon, the terms would be announced and each member of the syndicate would receive a fixed portion of the issue,

with the shares determined by the Bundesbank. Impeding secondary market liquidity, the government used to give the syndicate members and primary market investors a strong incentive to hold their bonds for at least a year. The initial bond purchasers received a 'reallowance' - similar to a special selling commission - for committing not to sell the security for a year. What is more, the bund issues were in relatively small amounts, thereby leaving little room for an active secondary market to develop. Introducing a primary dealership model was discussed in the wake of EMU, but notably the Bundesbank in its role as 'fiscal advisor' spoke out against it. Essentially, the Bundesbank's reading of the origins of the primary dealer system was that this model was specific to the challenges of a splintered US banking system and thus not needed in the German context (Finanzagentur Newsletter 4/2004). This opposition is in line with the Bundesbank's negative view of US sovereign debt management more broadly (Trampusch 2015).

Secondly, Germany has identified another way to ensure and manage liquidity via *Marktpflege* (which roughly translates into 'care of the market'). The practice of Marktpflege predates the creation of the Finanzagentur and in the Bundesbank's Archive can be traced back to at least the 1970ies with price-management operations on the fragmented German stock exchanges. *Marktpflege* refers to a practice where the finance agency routinely keeps a share of the emission in its own books for the purpose of market making. This means that the Bundesbank (later on behalf of the German finance agency) continuously sells reserves or uses them for the repo market in consideration of secondary market condition averaging around 20% since 2006. In an online presentation to private investors the Finanzagentur (2021, author's translation) explains under the rubric 'liquidity risk': 'The risk of not being able to sell Bunds at any time before maturity is extremely low, as Bunds are the most heavily traded government bonds in the eurozone and the Finance Agency and the Bundesbank carry out *Marktpflege*.' The Bundesbank (2007) puts it thus: 'Through their trading activities, the Finance Agency and the Bundesbank are permanently present on the market and thus make an important contribution to securing liquidity in the market for German Government securities.' *Marktpflege* is a liquidity machine and enables the debt management agency to act as market maker if need be, without committing primary dealer banks.

4. On the benefits of PDM adoption

Having discussed the origins and drivers of PD adoption, the following section examines the consequences of having a PD in place. In particular, did the PDM help to bring down the costs of debt? Our estimation strategy relies on a pooled cross-sectional time-series analysis. We employ a generalized least squares estimator and include country fixed effects and a linear time trend to control for country and temporal dynamics not explicitly modelled in the data. We also correct for first-order serial correlation and heteroskedasticity in the errors. The main aim here is to examine whether this particular aspect of government securities markets mattered for the changes in long-term (10-year) interest rates on government bonds. In addition to a dummy (PD) that takes the value 1 if a primary dealership is in place and 0 otherwise, we also include a dummy for a newly reformed debt management office (DMO) and a measurement for central bank independence (CBI). These two controls aim to capture far-reaching macroeconomic policy reforms regarding monetary policy and debt management, which are likely to matter for the costs of debt. Controlling for key economic variables, we find that long-term interest rates are sticky, that is high interest rates in the previous year led to an increase in interest rates in the following year. Higher interest burdens are found to reduce long-term interest rates, possible as the countries in the sample with (very) high debt levels also have the more 'mature' economies. Financial

market liberalization in the form of capital account openness is found to reduce long-term interest rates, while inflation and global interest rates are found to lead to an increase. Turning to Table 2's main results, we see that in contrast to 'modern' debt management offices or central bank independence (coefficients here are statistically not significant), primary dealership systems contributed to a decrease in long-term interest rates. We also consider whether PDM adoption improved a country's sovereign credit rating (results are avaible upon reques). Further tests suggest that there is no direct association (although an indirect positive effect is likely as is a more favourable rating outlook due to a diversified investor base brought about by the PDM).

Table 2. Explaining Annual Changes in Long-term Interest Rates

	(1) Model 1	(2) Model 2	(3) Model 3
Interest $_{t-1}$	-0.266***	-0.271***	-0.262***
	(0.0251)	(0.0255)	(0.0254)
Debt$_{t-1}$	-0.00348*	-0.00409**	-0.00473**
	(0.00208)	(0.00205)	(0.00222)
∆Debt	0.00157	0.000783	0.000327
	(0.00623)	(0.00619)	(0.00633)
Openness$_{t-1}$	-0.885***	-0.919***	-1.003***
	(0.241)	(0.235)	(0.235)
Inflation $_{t-1}$	0.0971***	0.101***	0.0998***
	(0.0134)	(0.0134)	(0.0135)
Global Interest Rates$_{t-1}$	0.110***	0.117***	0.116***
	(0.0356)	(0.0359)	(0.0357)
PD $_{t-1}$	**-0.249***		
	(0.140)		
DMO $_{t-1}$		**-0.197**	
		(0.149)	
CBI $_{t-1}$			**0.0176**
			(0.161)
Constant	1.879***	1.846***	1.682***
	(0.366)	(0.377)	(0.353)
Observations	866	866	866

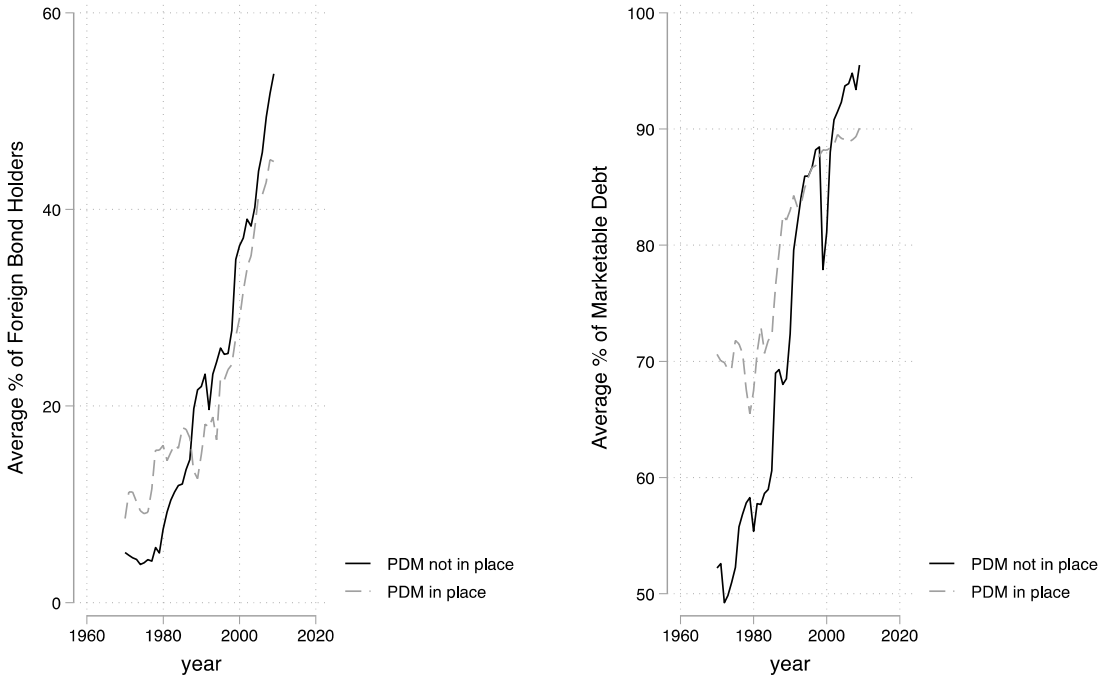
*Notes: *p<0.10; **p<0.05; ***p<0.01, FGLS error correction model of annual change in long-term interest rates. Estimates of country fixed effects not shown in table for ease of presentation*

As discussed above, the primary dealership system was thought to broaden the investor base, notably with investors from abroad. To consider this point, we take data on bond structure from Abbas et al. (2011). This reduces our sample to 14 countries from 1970 to 2009.[2] Looking at the average percentage of foreign bond holders in the group of PD countries vs. non-PD countries, we can see that it was only in the early years of PD adoption, that the primary dealer system went hand in hand with an internationalisation of bond holders. A similar trend is visible for the average share of marketable debt, where non-PD countries caught up and overtook PD countries, see Figure 3. Still, the difference during

[2] Australia (.), Belgium (1991), Canada (1998), France (1987), Germany (.), Greece (1998), Ireland (1995), Italy (1994), Japan (2004), Netherlands (1999), Sweden (1989), Switzerland (.), UK (1986), USA (1960).

the early years, suggests that the PD system likely contributed to an internationalisation of the investor base, and there is a statistically significant relationship between having a PD system in place and the share of foreign investors (Pearson's correlation coefficient is .36., N= 402). This association is not necessarily a causal one. That is to say, it could well be that countries who adopted a PDM already had a higher share of foreign investors and of marketable debt due to financial market liberalisation prior to PD adoption.

Figure 3. Primary Dealership Creation and Debt Struture



Source: For PDM creation see Appendix. Data on Foreign Bond Holders and % of Marketable Debt from Abbas et al. (2011)

5. The future of the PDM

Comparing the number of PD banks between 2021 and 2019 for a select number of European countries, it is striking that the Covid pandemic has not led to a collapse of PD numbers. Looking at a slightly larger period, we can see a slight decline from an average of 16 primary dealers in 2021 compared to an average of 19 PD banks per country in 2012.

Table 3 - Number of primary dealer banks in Europe

Country	2021	2019	2017	2015	2012
Austria	21	21	21	22	24
Belgium	13	11	19	22	19
Denmark	9	11	11	13	12
Spain	20	22	22	22	22
Finland	15	14	14	14	14
France	15	15	16	19	20
Greece	18	20	21	21	22
Ireland	17	15	16	18	16
Italy	16	16	18	20	20
Netherlands	13	13	16	21	16
Portugal	17	20	20	20	18
Sweden	7	7	7	6	8
Slovenia	15	14	14	15	14
Slovakia	12	11	11	10	22
UK	18	24	19	21	19

Source: AFME European Primary Dealers Handbook, various editions

In the past decades the primary dealer model has come under strain given historically low yields on government bonds and a more challenging regulatory environment. As one Head of Debt Capital Markets puts it bluntly: 'There is an awful lot of bullshit from the sovereign issuers about the value of their business. In reality it's really slim pickings' (Global Capital 2013). Recent regulatory changes have reduced primary dealers' opportunities to turn a profit. The new post-2008 regulation 'designed to curtail banks' leverage […] had the unintended consequence of also sharply reducing their ability and willingness to make markets in corporate and even government debt' (Lee , 2013). Moreover, targeted regulatory interventions made earning money from market making more difficult. MiFID II, for instance, also targeted 'front running', or dealers' opportunistic propositioning against incoming client orders to benefit from changes in price making the trade more expensive for clients. This is not to say that there is no money to be made in being a primary dealer. Existing studies suggest that the PD status is a valuable label for primary dealer banks, where relationship and reputational gains are harder to quantify (cf. Rato 2020). Carpinetti (2017) examines 147 primary dealer banks between 1988 and 2015 and finds that they enjoyed a boot to their stock price in the weeks following PD appointment.

The introduction of an incentive system dates back to the US origins of the primary dealerships. An incentive system, so the thinking, would reward 'good performance' and make it more profitable for PDs to compete with one another (and thus bring prices down) than to collude. In a less lucrative franchise, so the concern, primary dealers would have higher incentives to take risks and shirk self-discipline. The creation of MTS (see above) made the surveillance of 'good performance' both easier and more precise.

In the wake of the 2008 crisis, post-auction non-competitive subscriptions are becoming more important as compensation mechanisms, and in particular as compensation of best performing PDs. Furthermore, syndications have been a key incentive for primary dealers.In the UK for example, the DMO rewards its high-performing dealers by inviting them to participate in debt syndications that typically come with non-negligible fees (on average £1.8 million per £1 billion syndicated debt). The official reasoning of these syndications is to secure continued support from primary dealers. Critics may see the fees associated with debt syndication as a form of 'corporate welfare'. In December 2020 the Conservative MP Mel Stride raised questions about the system. Between 2011 and 2020, the DMO had conducted 58 debt syndications, each priced at the 'tight end' of an 'indicative range', the DMO claimed. In a letter to the DMO, Stride wondered: 'Is it surprising that you have achieved "the tight end" in such a consistent manner? Could this be a sign that sometimes you have potentially not priced keenly enough, to the taxpayers' detriment, especially given the seeming high levels of demand?' Stheeman replied that 'whilst the outcome of each individual operation must clearly be judged in terms of value for money for the taxpayer, the programme as a whole must also be resilient to exogenous shocks'[3]. Syndications should be placed in the context of the issuance operations as a whole. The syndication fees, Stheeman, suggested, were 'an important factor for primary dealers in their decisions to support the programme more generally and to invest in their gilt franchises'. It is difficult to say, in other words, how much is too much because pricing considerations need to be weighed against the willingness of primary dealers to continue to perform their infrastructural role as intermediaries in the government bond market and as part of the transmission mechanism for monetary policy. The opaque calculations of 'the right price' also mean that syndication fees have, with few exceptions, flew under the radar of public or parliamentary scrutiny. Questions around debt issuance strategies will however remain an important issue, not least given that the majority of OECD primary dealers reported a higher reliance on syndication in response to the pandemic (OECD 2020).

5.1 De-risking the PD system

In addition to often discussed material (e.g. fixed fees or access to syndication and non-competitive auctions) and immaterial (e.g reputational and relationship gains) incentives, the primary dealer system is supported by debt managers and central bankers. We will not discuss the key role of central banking in supporting sovereign debt markets here. Instead, this section will consider the role of debt management offices which now routinely act as de-risking partners.

The repo pitch[4] in debt management appeared at the turn of the century: developing a repo market, so the argument, would increase the demand for government debt and thereby bringing yields down. Repos enable banks without otherwise sufficient liquidity to engage in arbitrage and thus ensure that primary dealers' 'lack of money' does not reduce demand for bonds. Even where counterparties do not have the necessary reserves available, the repo trade helps debt agencies find buyers for their assets. Market makers ability to quote immediately-executable selling prices often requires them to hold a considerable bond inventory (the warehousing risk). This is where the repo market comes in for primary dealers: repo offers a way to finance and hedge this inventory. For example, interest rate risks on

[3] https://committees.parliament.uk/publications/3565/documents/34443/default/.

[4] The repurchase agreement, or repo, is a financial agreement in which the borrower agrees to buy back the security sold to the lender at a later date, usually for a higher price. If the counterparty is unable to meet the repurchasing obligation, the lender can liquidate (or simply keep) the assets serving as collateral. Repos are therefore considered 'secured'. This makes them attractive for the short-term funding needs of particularly institutional investors and market makers (usually banks) with short-term term liquidity requirements. Put differently, a repo is a short-term loan backed by high quality collateral (sovereign bonds).

inventory are frequently hedged by taking an off-setting short position in another security borrower in the repo market. This means that repo financing contributes to 'price discovery'. The repo market also plays a role where market-makers don't currently possess the bond issue demanded by an investor. Here market makers borrow that issue in the repo market. This repo hedging is meant to reduce the cost of borrowing for governments because it reduces risk for primary dealers. DMOs are well aware of the mutual interest with primary dealers in a functioning repo market. In the UK, for example, the gilt dealer sector is the largest net borrower in the overnight gilt repo market (Bank of England 2020).

However, despite repos appeal in de-risking market making, stability in repo finance cannot be taken for granted. Indeed, since the 2007 crisis the repo market has been increasingly recognised as a potential source of financial instability (cf. Gabor 2020). Sissoko (2020) highlights a tension within the repo liquidity system: The safety of repos depends on the premise that markets are reliable sources of liquidity. Yet past decades of repo trading provide ample evidence of 'collateral calls, collateral sales, liquidity events, and liquidity-driven losses for repo-borrowing funds and their end investors' (*ibid.* 315).

Across rich countries, DMOs have supported the market-making ability of their primary dealers by setting up repo lending facility. It is worth highlighting, that PD de-risking from the side of debt managers or central banks predates the ongoing Covid pandemic. In 2000, the UK DMO started an automatic non-discretionary standing repo facility. If the DMO considers that there is sufficient evidence of severe market dislocation or disruption, it may offer gilts for repo-ing to GEMM member. Similarly, primary dealers in the Netherlands and Belgium have access to a repo facility to be used to facilitate market making. Repo support for primary dealers has been increased and adjusted ever since, most recently during the early months of the Covid pandemic. A prominent example here is the US Federal Reserve's new Primary Dealer Credit Facility established in March 2020 to allow primary dealers to support smooth market functioning and facilitate the availability of credit, in the face of deteriorating conditions in the market for triparty repo financing. Other central banks followed with similar arrangements, such as the Bank of Canada's now suspended Term Repos and Contingent Term Repo Facilities or the Danmarks Nationalbank Extraordinary Lending Facility. Following recent bond purchasing programs, liquidity and cost motives aligned: central bank purchases of sovereign debt meant that there was a higher demand for government bonds than was supplied by the market and debt managers stepped in to supply collateral in what debt managers considered a win-win situation. As Tammo Diemer (quoted in Orchard 2020), head of the German Finanzagentur put it: 'We are not only supporting the security market, but also taking advantage of the funding.'

Table 3. Primary Dealer and repo market support, selected countries

	Primary dealer and repo market support	Authority
Belgium	Secondary government debt market smoothing through selective provision of government securities	Belgian Debt Agency
Denmark	Securities lending facility provides government securities to Primary Dealers to support the functioning of the repo market	Danish Central Bank
France	Securities repo facility provides government securities to Primary Dealers to enhance the liquidity of government debt	French Debt Agency
Germany	Liquidity support and planning via 'Marktpflege'	German Debt Agency
Italy	Repo facility open to potentially all secondary market participants, designed to enhance goals of cash management and address situations of scarcity in specific securities	Italian Treasury
Netherlands	Repo facility allows Primary Dealers to obtain part of an unsold government debt auction via a repo transaction to maximise efficiency in debt auctions	Dutch State Treasury Agency
Portugal	Repo facility of last resort supports market-making obligations of primary dealers in secondary markets	Portuguese Debt Agency
Sweden	A standing repo facility governed by demand and offered irrespective of the borrowing requirement	Swedish National Debt Office
UK	Standing and special repo facilities to support primary dealers in their ability to make two-way prices in secondary markets and counteract severe market dislocations	Debt Management Office
US	Primary Dealer Credit Facility as well as Repo facilities (introduced at various points since 2008)	Federal Reserve

Sources: various central bank and debt management office websites

6. Conclusion

The creation of primary dealerships was motived by the rising costs of servicing sovereign debt. Indeed, as one of the key findings of this paper suggests, the PDM is associated with a subsequent reduction in long-term interest rates. For OECD countries, having a primary dealer system has become the way to go, with a few notable exceptions. The PD model has arrived at the EU-level too. As part of the NextGenerationEU funding strategy, the European Commission has set up a Primary Dealer Network made up of currently 41 financial institutions 'to facilitate the efficient execution of auctions and syndicated transactions, support liquidity in the secondary markets, and ensure the placement of our debt with the widest possible investor base' (EU 2021). The EU primary dealer system also avails itself of a carrot system of syndication rewards. Emerging market economies have embraced the model too. Brazil was the first non-OECD country to adopt PD system in 1974, that is before the wave of reforms swept OECD countries starting in the late 1980s. The backstory to Brazil's early adoption is the 1973 oil price shock which pushed Ernesto Geisel's government to rely on external debt to support its industrialization program. China, to give another example, established a primary dealer system in 1993 (Bai et al. 2013). At the time of writing, Argentina, India, Chile, South Africa, Singapore, Thailand and Turkey all have primary dealer systems with an increasing number of developing countries in the process of adopting PD models. PD systems in emerging markets are similar to those in rich economies. The main difference is that the two-way quoting obligations for primary dealers in emerging markets is often less firm depending on trading conditions. Indeed, insufficient market liquidity (be it because of the size of the debt market or because of the composition and behaviour of the investor base) is a key reason why some emerging market economies decide not to adopt a PD system. What is more, as particularly the early years of the US system with numerous episodes of abuse suggest, a primary dealer system can prove detrimental in a country with a small or budding financial sector given the greater risk of collusion. Indeed, studies such Arnone and Ugolini 2005, cautioned against a blanket adoption of PDMs arguing that any adoption needs to be considered vis-à-vis a country's development strategy, market size, and market microstructure.

If the current trend of PD adoption were to continue, it seems likely that the number of countries with PD systems is to rise. This is not to say that the primary dealer model has not come under strains over the years. Yet, as this paper has discussed, public officials have responded to these challenges by de-risking and incentivising primary dealership roles. In this regard, rich countries, with capable central banks and favourable credit ratings, are clearly in a more advantageous position than most emerging or developing countries. And yet, peers from the Global South are taking note supported by the international debt management community and international organizations. The pandemic has confronted many poor and middle-income countries with a liquidity crisis that exceeded the low liquidity of illiquidity common across many emerging markets. Debt management reforms that are geared towards the provision of liquidity are thus unlikely to fall out of fashion soon.

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Appendix

Sources for primary dealership system and debt management reforms:

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Extraordinary Actions: the Use of Buyback and Spread Auctions – The Brazil National Treasury Experience

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Abstract

The paper reviews the use of extraordinary actions by the Brazil National Treasury (BNT), with special attention to the COVID-19 crisis. The approach encompass aspects related to Brazil macroeconomics, finances and institutional structure. We sought to understand the tools and contexts that gave rise to the extraordinary actions of the BNT, as well as the construction of the underlying factors that supported them. Using a probit model and a principal component analysis we verified that that important indicators of financial market volatility are relevant to explain the actions of the BNT in the public bond market.

Keywords: Debt, Debt Management, Government Bonds, National Debt, Treasury Securities
JEL classification: H630, C530.

1. Introduction

Over the last decades, several countries went through important changes in economic policy design as a consequence of financial and sovereign debt crisis and its impacts across different markets. The need to guarantee a functional financial system and, simultaneously, deal with macroeconomic shocks raised the interaction between fiscal and monetary policies and debt management. In this environment, despite important advances in bond markets structure and debt management, the Brazil National Treasury (BNT) identified events of significant market distortions as investors reacted to economic, financial and political concerns. In some of those events, BNT announced extraordinary buyback or spread auctions as a tool to support markets and provide market references.

The complete assessment of market conditions and the decision on wether the Treasury should make an extraordinary action requires a permanent follow-up on economic and financial conditions. The Treasury liquidity reserve and assertive communication with investors are examples of important elements that must be taken into account. This working paper was constructed in this background, with the goal to assess the main elements on BNT extraordinary actions in recent years. On this regard, we discuss public debt management in Brazil and its idiosyncrasies, such as raising concerns over the last decade on fiscal issues and the ability to push a reform agenda, the oficial credit policy and the framework that describes the flows between BNT and the Central Bank.

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These idiosyncrasies led Brazil to unusual conditions that guaranteed a very comfortable cash position in an environment of fiscal deterioration. Despite a positive situation in terms of solvency, the country had to deal with adversities resulted from more challenging debt forecasts. This fiscal deterioration had an immediate impact in bond markets, with more significant shocks in moments of higher uncertainties.

In the following sections we present relevant aspects that will help the reader to understand the public debt management framework in Brazil, such as the interaction between fiscal and monetary policies, liability management transactions and the importance of the liquidity reserve. In the following section the reader will have a brief description of BNT's extraordinary actions under an historical perspective. Next, we estimate an econometric model that provides evidence of the main financial variables for extraordinary actions. Finally, we present some concluding remarks.

2. Public debt management

This section aims to briefly describe the processes related to public debt management. In the macroeconomic sphere, the interaction between public debt, fiscal and monetary policy is highlighted, as well as the importance of coordinating these fronts for the efficiency of the economic-financial system. In the specific scope of debt management, the instruments available to achieving the objectives related to the financing process are explored. In this sense, it is worth mentioning the actions aimed at improving the government bond portfolio and manage the liquidity reserve, with a focus on the institutional arrangement, the composition of indexes, maturity structure and, mainly, risk mitigation.

2.1 Liability Management

Liability management is the process by which changes in the existing public debt outstanding are sought with the aim of improving the debt profile, given previously defined guidelines. These operations generally do not aim to provide additional short-term financing capacity, with emphasis on repurchase and exchange of government bonds with a focus prevailing over risk management. However, despite their strategic nature, liability management operations have increasingly been used for different purposes, such as market support in stress situations, cost reductions and diversification of the investor base [WB (2015)].

Given the spectrum of risk assessment, it is important to assess which ones inherent in the public financing process can affect the achievement of the debt manager's objectives. The literature usually groups these risks mainly into the following categories: a) market risk, related to movements in economic and financial indicators such as interest and exchange rates; b) rollover/refinancing risk, which refers to the ability to renew a certain debt exposure at maturity; c) liquidity risk, which refers to the availability of sufficient demand for a specific debt instrument, without generating price distortions; d) credit risk, which is associated with the ability to meet obligations; and e) operational risk, which includes technological aspects and settlement procedures [IMF and WB (2014)].

The public debt manager usually has a range of instruments available to mitigate these risks, so that the consideration of the economic scenario is very relevant for defining the liability management actions that will be adopted. In normal situations, the traditional instruments available to achieving specific debt management objectives are highlighted, especially repurchases and exchanges of securities. In case of crisis, in turn, a wide spectrum of actions may be necessary, including extraordinary actions with repurchases and exchanges of government bonds, simultaneous purchase and sale auctions, cancellation of auctions or, at the limit, debt restructuring. Papaoannou (2014) highlighted, for example,

the use of repurchase operations or securities exchanges as tools to deal with high levels and inadequate structures of public debt, as well as to reduce related vulnerabilities.

The process of implementing actions to achieve the debt manager's objectives usually allows for a distinction between planning activities[1] and operational management[2] which, despite being integrated, emphasize different time perspectives for the actions. In the set of planning activities, the analysis of the structural conditions of the economy gains relevance, highlighting the tools that emphasize the medium and long-term, which tend to be applied with the following purposes: to reduce the associated refinancing risk to the debt maturity structure, speed up the process of improving the debt composition, reducing the cost of financing, as well as projecting cash.

Within the scope of operational management activities those related to short-term actions tend to gain relevance, such as monitoring the market situation, evaluating price formation, fine-tuning the debt strategy and diagnosing timing of exceptional situations. In this case, the activities aimed at contributing to stimulating liquidity and correcting distortions in the secondary market for government bonds stand out[3]. Actions aimed at stabilizing the market and restoring transparency in price formation tend to be taken during periods of stress.

Considering this broad spectrum, the public debt planning framework developed by the BNT highlights the importance of intertemporal programming capable of providing transparency, predictability and timing. In fact, the objective, guidelines and optimal composition formalize the desired Federal Public Debt (FPD) structure of long-term cost and risk. The transition strategy between the present and the long term, called medium-term planning, emphasizes the macroeconomic scenarios and the degree of development of the debt market to determine the speed of transition. The short-term action, in turn, is guided by the Annual Borrowing Plan (ABP) and by the monthly tactical management of the Public Debt Management Committee (COGED)[4], with emphasis on the analysis of current market conditions and their implications for the financing process.

Despite the potential benefits of liability management operations, the execution of the financing process takes into account traditional actions through public offerings with competitive auctions, with predictability being an important attribute often promoted through the disclosure of an issuance calendar. Therefore, liability management tools tend to be used in a complementary way, as potential catalysts towards the optimal composition of debt in times of favorable economic conditions or as a buffer when unfavorable market conditions are observed.

Despite this consideration, the use of liability management tools has been increasingly frequent. Blommestein et al. (2012) report that, among OECD countries, repurchase operations are more frequent than exchange operations, being used by more than 80% of the debt managers consulted. In addition, almost 30% of managers stated that they use repurchases regularly[5]. The authors also identified that, after the 2008/09 financial crisis, many debt managers started to increase liquidity reserves, issuing

[1] Activities associated with the determination of general objectives and guidelines.
[2] Activities associated with the day-to-day operations with government bonds, related to the market and business.
[3] The ability to remove devalued bonds from the market and refinance high-coupon bonds, for example, allows for the correction of market distortions, also helping to ease the government's budget constraint.
[4] National Treasury Ordinance no. 426, dated june 25, 2019, sets the attibutions of the COGED.
[5] The form of action may differ among the thirty-three countries surveyed. The French government carries out operations in the secondary and primary market (reverse auction), while the German government operates daily buybacks in the secondary market, without informing the market and without disclosing operations statistics. The Japanese government, in turn, holds monthly auctions. There are also those countries that prefer to adopt an *ad hoc* methodology for carrying out repurchase operations, such as Italy, which carries out extraordinary auctions using resources from eventual fiscal surpluses and extraordinary revenues.

above the financing need in order to expand the flexibility of actions and reduce the risks associated with the refinancing capacity and any adverse shocks.

Therefore, extraordinary actions must be treated as auxiliary. The possibility of holding extraordinary auctions can bring greater stability and security to the government bond market, as long as it does not put at risk the regularity of the ordinary issuance process. It is also opportune to point out that the use of these tools tends to depend on the degree of development, particularities of each economy, sophistication of the public securities market and specialization of debt managers.

2.2 The Role of the Liquidity Reserve

Regardless of the size and development of local government bond markets, maintaining a liquidity reserve has been common practice among debt managers. The stated objective of liquidity reserve management is generally aimed at maintaining timely resources so as to ensure efficient fulfillment of obligations. Clearly, measures to ensure the availability of resources and the options exercised to invest or retain surplus resources have risk and cost implications, so that inappropriate practices and dysfunctional institutional arrangements can hamper the implementation of government policies.

The main approaches used to manage the liquidity reserve are traditional and modern. The first emphasizes the need to maintain a considerable amount of resources in order to guarantee payment in a timely manner, characterized by prudence, passive attitude and low emphasis on opportunity costs. In the modern view, in turn, the aim is to guarantee government obligations in light of the minimization of retained resources. In this case, the notion of efficiency is present due to the restriction of opportunity costs associated with the maintenance of the liquidity reserve.

Cruz and Koc (2018) carried out a survey with debt managers from OECD countries and identified that the liquidity reserve has the capacity to assist in the fulfillment of obligations, to mitigate refinancing risk, to increase market confidence, to allow dealing with possible volatility in demand in bond auctions or with the occurrence of temporary loss of market access. The authors pointed out some stylized facts among the countries surveyed: i) the main mechanisms for the accumulation of resources are issuances in volumes above maturities and positive primary fiscal results; ii) the reference for a liquidity reserve is defined in the number of months of debt service coverage; iii) the need for liquidity reserve is heterogeneous across countries, ranging from one week to one year; iv) the most common practice is to maintain a reserve level sufficient to cover budget expenses (including debt redemptions) for one month[6].

Regarding the Brazilian case, the National Treasury has an organizational structure for debt management that divides the attributions between back office (registration, control, payment and accounting activities), middle office (medium and long-term strategy activities) and front office (short-term strategy activities and operationalization of securities issues). In this perspective, the debt manager's mandate involves activities related to the indebtedness process and the cash flow to pay the debt, featuring a dual mandate, which has an important management instrument in the liquidity reserve.

However, part of the liquidity reserve of the Brazilian debt of more recent years did not necessarily result from the decision to use the traditional tools for accumulating resources, but mainly from the

[6] It is interesting to note that, in the case of Portugal, the reference value of the liquidity reserve was determined by analyzing the debt redemption profile and deviation expectations based on revenue and expenditure. The indicative level in 2018 was 40% of gross borrowing requirements in the following 12 months. The Turkish government, in turn, defines the liquidity reserve as the level of cash and other credit allocations readily available to withstand severe liquidity stresses for shorter periods. However, the actual reference level and the currency composition of the liquidity reserve are kept confidential, considering that the disclosure of its level could compromise the efficient functioning of the operations.

relationship structure between the National Treasury and the Brazil Central Bank (BCB)[7] and the partial reversal of the Federal Government's credit policy, especially early settlement of credit operations with BNDES[8]. This notion must be taken into account because the country has been living with relevant primary deficits since 2014 but has not experienced difficulties in honoring its obligations, even in more critical situations. The policy of accumulation of international reserves, established with the main objective of mitigating the vulnerability of the external sector, began to increasingly impact the results of the monetary authority from the end of the 2000s onwards. A distortion resulting from this new condition was contamination of the BCB's result by exchange rate volatility. In times of heightened uncertainty, in particular, the depreciation of the exchange rate contributed to the BCB's balance sheet showing positive results due to the marking to market of international reserves, which forced the monetary authority, as a result of the legal determination, to transfer the cash profits to the National Treasury. That is, a mechanism was established whereby the liquidity reserve tended to have an extra source of supply in adverse situations.

Additionally, it must be considered that the resources deposited in the Treasury Single Account (TSA) receive the average return on federal public securities held in the BCB portfolio. Although the allocation of this revenue is free, with no specific link to debt payments, it is a source that helps to mitigate the need for new issues or primary resources to finance the Federal Government Budget.

In this sense, the institutional arrangement of the fiscal and monetary authorities contributed to creating a condition of decoupling between the solvency capacity and the need for primary fiscal results, the latter being fundamental to guaranteeing debt sustainability. The adverse implications of this construction led to a change in the legal bases that define the relationship between the National Treasury and the BCB[9].

Despite the different implications that the existing institutional arrangement had on other dimensions of public finance, the volumes of the TSA destined to the liquidity reserve showed an increasing trend over the years, with the volumes reaching an honor capacity well above the three months of maturities of the internal debt on the market, a level that the BNT considers important to anticipate periods of greater concentration of maturities, mitigate risks and avoid putting pressure on the cost of debt.

Finally, it is important to highlight that, given the need to increase the transparency of debt management in the face of the fiscal challenges imposed by the Covid-19 crisis, the BNT included the maintenance of the liquidity reserve above its prudential level as a guideline and started the disclosure of the total resources of the liquidity reserve.

2.3. Extraordinary Interventions

The cost and risk dimensions are clearly noted in defining the objective function of debt management in most countries[10]. In the case of FPD management, the goal is:

“supply the Federal Government's financing needs in an efficient manner, at the lowest cost in the long term, respecting the maintenance of prudent levels of risk and, additionally, seeking to contribute to the smooth functioning of the Brazilian government bond market”. [STN (2018)]

[7] See Bacha, E. A Crise Fiscal e Monetária Brasileira. Rio de Janeiro: Civilização Brasileira, 1º ed., 2016.
[8] Banco Nacional de Desenvolvimento Econômico e Social (National Bank for Economic and Social Development).
[9] The Law No. 13.820/2019 brought important improvements to and reduces asymmetries in the regulatory framework governing the financial relationship between the National Treasury and BCB. A main premise is the improvement of the institutional arrangement regarding the distribution and coverage of the BCB’s balance results, with special attention to the reduction of exchange equalization flows, which will make both the liquidity/inflation management and the FPD management more efficient.
[10] See the Table in the Appendix.

This is the starting point for defining and analyzing the National Treasury's financing actions. The consideration of a contribution to the proper functioning of the securities market is an important consideration in the Brazilian case. When placing the public bond market within its objective function, the public debt manager must have instruments that help markets towards an efficient path. From this perspective, extraordinary debt operations should be interpreted when the dysfunctionalities of the government bond market become apparent. These moments are usually marked by significant price volatility, loss of reference rates, significant decrease in the number of daily trades, open spreads between buy and sell, etc. Under these conditions, the public debt authority can assess at its discretion the relevance of acting in order to re-establish the fundamentals and efficiency of the market.

From a legal point of view, the regulation that defines the powers of COGED[11] ensures the possibility of extraordinary meetings for the Committee to deliberate on matters within its competence in a timely manner, which brings flexibility to the process. In this way, during periods of high volatility in the financial market, the National Treasury can act in different ways to support the proper functioning of the market, without exerting excessive pressure on the cost of financing or abandoning the principles highlighted as good practices.

However, from a practical standpoint, one of the biggest challenges for the debt manager is to effectively characterize market conditions. Broadly, two situations can be considered: i) market re-pricing – when there is a permanent increase in the interest curve to a new level; and ii) loss of reference – moments when the interest curve temporarily gains level and/or inclination, but returns to levels compatible with the historical average or previously recorded. In practice, the debt manager cannot know ex-ante which of the two situations the market is in. However, in both situations, the presence of the debt authority can help to determine the market balance, either by helping to minimize the asymmetry of information between investors and savers in the price formation process, or by making use of reputation and/or signaling to give direction to the market.

Accurate diagnosis help to define the instruments and intensities of actions available to the debt manager. Table 1 lists the main tools that can be used for actions by the National Treasury.

[11] National Treadury Ordinance no. 426 - dated june 25, 2019, which defines COGED's attributions, indicates in Article 7 that the president of COGED may convene extraordinary meetings to deal with matters within the competence of the Committee, such as definition of the annual financing strategy for the FPD and limits for its indicators, schedule of auctions, establishment of the monthly strategy for the FPD and deliberation on other matters related to the management of the DPF.

Table 1 – Extraordinary Actions available for the Debt Manager[12]

Actions	Description
Reduction of Scheduled Auctions Size	A change in the level of issuances in relation to historical or programmed levels can help reduce pressure on the yield curve or on the premiums of fixed-rate bonds. This type of action tends not to significantly pressure the liquidity reserve level, if adopted in a timely manner.
Auction Cancellation	The cancellation of scheduled auctions as a result of risk aversion or the need for a more accurate diagnosis of economic fundamentals can avoid the possibility of distortions in the price formation process. The existence of a liquidity reserve is a necessary condition for this type of action.
Issuance of Floating Bonds	The characteristics of domestic demand favor the issuance of these bonds, which help to increase the liquidity reserve and debt maturity, in addition to mitigating pressures on the interest rate curves. This type of action helps manage the market's assets and liabilities, increasing the interest rate risk of the public debt, with the benefit of reducing debt refinancing risk.
Short Term Issuance	The characteristics of domestic demand favor the issuance of these bonds, which benefit the increase in the liquidity reserve in the short term. Although favor the management of market assets and liabilities, maintain pressure on market and debt refinancing risks.
Buy-backs	They can be useful in acute liquidity constraints, helping to provide liquidity to the security holder and to mitigate adverse impacts on the financial market. Holding a considerable volume of liquidity reserve is a necessary condition for this performance.
Spread Auctions	They can be useful in times of liquidity constraints in the secondary government bond market, helping to establish a price reference to the market. An adequate level of liquidity reserve is a necessary condition for this type of action.
Exchange Auctions	They can help tailor investors' portfolios to market conditions. The exchange of different bonds, whether term or index, can mitigate pressures on the public bond market. They do not exert pressure on the liquidity reserve level.

Source: Authors

Caution in using these market intervention tools is a desirable attribute. International practice does not recommend extraordinary actions to achieve short-term public debt cost objectives. Opportunistic use for this purpose can undermine the debt manager's credibility and undermine the integrity of the financing process, even hindering market development and raising costs in the long run. Attention to the participants' incentives is also relevant, as they can use the debt manager's presence to avoid market solutions. Therefore, despite the potential benefits of having some flexibility for extraordinary actions, there is the possibility of generating inadequate incentives for some investors and harming the general good functioning of the government bond market.

[12] The BNT issuances fixed-rate bonds (LTN and NTN-F), inflation-linked bonds (NTN-B) and floating bonds (LFT), which are indexed to the weighted average interest rate of the overnight interbank operations (SELIC).

In addition, as holding a significant volume of liquidity reserve is a necessary condition for many forms of extraordinary action and considering that there are not negligible uncertainties in the determination of scenarios, especially for longer terms, a preventive attitude is desirable in order to have this instrument. In the Brazilian case, despite the fiscal difficulties that have not weakened cash management throughout the decade of 2010, the change in the legislation of the relationship between the National Treasury and the BCB, as well as the anticipation of a large part of the BNDES' returns, should impose a new dynamic for the liquidity reserve, making its management more challenging in the coming years.

It is also worth pointing out that the Brazilian government bond market does not have an automatic safeguard system as observed in the stock and futures markets through the circuit break, which establishes a temporary price limit. When these markets fall below the threshold value, trading is stopped for a predetermined period of time. One of the reasons for using circuit brakers is credit risk and loss of financial confidence. The arguments in favor of this mechanism are based on the premise that significant variations in market prices may not be consistent with the fundamentals of the economy or market efficiency. However, circuit breakers can interfere with the price formation process and inhibit the portfolio's hedging strategy, thus reducing liquidity in other markets.

3. Overview of extraordinary actions

This section aims to analyze the economic and financial factors that were historically important for extraordinary actions in the Brazilian government bond market, especially during the COVID-19 crisis, which caused an unprecedented adverse shock to the Brazilian economy. Thus, the main qualitative elements that were behind the extraordinary actions are described in order to help identify the variables used in the quantitative model in the next section. In fact, the BNT constantly monitors general market conditions in order to maintain the soundness of the government bond market. In this sense, the analysis of different variables (such as asset volatility, liquidity, price reference, risk sentiment and asset repricing) allows a characterization of the main elements involved in debt management in Brazil.

In fact, from a historical perspective, it is possible to analyze some conditions and some challenges that have arisen over time for the Brazilian debt manager. For example, in the late 1990s, increased risk aversion towards emerging markets hit the Brazilian economy and generated a significant outflow of capital, in a context of high current account deficit. At that time, the structure for conducting the economic policy that ensured stabilization began to show clear signs of exhaustion in the face of the challenges imposed by the external environment. Thus, after an intense outflow of capital and a significant reduction in international reserves, the country faced difficulties in managing the debt. According to Carvalho et al. (2009) the crises of the late 1990s delayed the process of changing the public debt profile. The hostile environment made it difficult to increase the participation of fixed rate bonds, as well as the growing concentration of short-term debt. In this way, the National Treasury sought to reduce the refinancing risk and increase the participation of floating bonds (indexed to overnight interest rates). Difficulties were also observed in the early 2000s, notably in the period of exchange of governments. However, as the support for obtaining robust fiscal surpluses was consolidated, there was a gradual reduction in uncertainties regarding the necessary adjustments to the economy, which allowed for the construction of a favorable cycle for debt management.

Even in the face of gradually more favorable conditions, Pereira et al. (2009) report that, as a result of adverse impacts on the international market, the BNT carried out two simultaneous auctions of purchase and sale of shot term fixed rate bonds in May 2004. Similar operations were also carried out with floating

bonds in order to provide transparency and provide pricing parameters for the secondary market. The authors also highlighted that, later, in May 2006, uncertainties regarding the conduct of monetary policy in the US restricted Brazilian market liquidity, with a worsening in government bond prices. As a result, non-resident investors holding longer-term inflation-linked bonds did not find buyers in the secondary market, leading the BNT to act, through purchase and sale auctions, to minimize market imbalance. According to the authors, this action reduced the stress initially seen in the long-term inflation-linked market, which was contaminating other markets.

In the following years, debt management continued to improve in terms of profile. In 2008, Brazil's long-term external debt, for example, was rated investment grade by two of the main credit rating agencies – Standard and Poor's (S&P) and Fitch Rating –, reflecting its ability to honor obligations related to the debt, which helped to achieve better financing conditions by reducing funding costs and additional demand for government bonds from institutional investors that had regulatory restrictions for investments in countries without this sovereign rating reference.

However, the external economic and financial crisis in September 2008 brought excessive volatility to the markets and caused a retraction in global activity. During this period, the BNT carried out four simultaneous long-term fixed rate bonds spread auctions. These auctions were intended to give price references to investors, as well as to avoid opening premiums. The BCB, in turn, based on a diagnosis of lack of liquidity in the foreign exchange market, opted to provide liquidity through different instruments in foreign currency. Coordinated actions contributed to lower interest rates and allowed some investors to change positions without putting pressure on those interested in holding the position. This action involved a low financial volume in relation to the outstanding and was based on the objective of helping the soundness of the secondary market for government bonds.

After the initial shock of the Subprime crisis, perceptions about Brazil's performance evolved towards a vision of consistent recovery. This change was accompanied by an improvement in the external environment and had a direct impact on the reduction of financial volatility, helping to manage the public debt. Then, in the early 2010s, there was a deterioration in the domestic economy. As of 2013, some adverse economic aspects became acute (interventions on administered prices, increased public spending, reduced transparency in fiscal policy and a complex external environment) and began to have negative impacts on the domestic bond market, imposing difficulties for improve the public debt profile.

Due to the increase in risk aversion in 2013, when interest rates on government bonds proved to be excessively volatile given the prospect of anticipating the reduction of monetary stimuli in the US, the BNT returned to action through extraordinary purchase and sale auctions fixed rate bonds and inflation-linked bonds in June and August of that year. Still from the perspective of reducing global liquidity, the BNT carried out two extraordinary repurchase auctions in February 2014. At that time, there was a diagnosis of distortion in demand for fixed rate bonds and the extraordinary repurchase auctions helped to provide liquidity to holders of these bonds and indicate a price reference.

In 2015, in turn, the negative aspects related to the internal political environment still accumulated, so that there was deterioration in debt composition with increase share of floating interest bonds and reduction share of fixed rate and inflation-linked bonds, interrupting a long trend of advances in this direction. Furthermore, the trajectory of the FPD/GDP began to rise, revealing the fiscal difficulties that the country was facing. A remarkable fact of that year was the draft of the Annual Budget Law containing a primary deficit of BRL 30 billion in 2016, indicating the fiscal and political articulation difficulties, which led to the loss of investment grade in the classification from the S&P agency.

With deteriorating of economic conditions, BNT adopted measures between the end of September and the beginning of October 2016, canceling the auctions for the sale of fixed rate bonds and the exchange of inflation-linked bonds, followed by the announcement of one-off simultaneous auctions of purchase and sale of fixed rate bonds and inflation-linked bonds, as well as an extraordinary floating bonds sale auction. The sequence of actions adopted was possible thanks to the flexibility brought about by the liquidity reserve.

Although of political difficulties and intense recession in economic in 2016, there was a perspective of overcoming the deep crisis. Part of the favorable perspectives came from the progress in the fiscal agenda, especially with the approval of Constitutional Amendment No. 95 (Expending Cap). However, the last quarter of the year was marked by a resumption of risk aversion, given the frustration with internal activity, the result of the North American elections and uncertainties in the European and Chinese economy. In view of these adversities, in November 2016, the BNT announced a program of extraordinary auctions for long term fixed rate bonds buybacks, as well as the cancellation of an auction for the sale of short and long terms fixed rate bonds. At the time, the objective was to remove interest rate risk from the market in order to mitigate excess volatility in the fixed rate markets.

In 2017, concerns about the structural adjustments needed for the Brazilian economy, such as the delay in approving the Social Security reform, in addition to uncertainties related to political support for the reformist agenda of the executive branch pressured the market. The month of May was marked by a significant deterioration in the political environment and financial conditions. In this scenario, the BNT canceled two auctions of fixed rate and floating bonds, as well as extraordinary auctions for the purchase and sale of fixed rate and inflation-linked bonds (causing a total net redemption of approximately BRL 2.1 billion). On that occasion, the BNT sought not to change the trend of asset repricing, but to avoid sharp short-term fluctuations that could hamper the proper functioning of the bond market and other related markets.

The year 2018 brought the expectation of volatility as a result of the political issues of the election year. In May, the domestic financial market was affected by greater uncertainties. The conjunction of internal elements (truck drivers strike, elections, political difficulties, blocking the reform agenda, etc.) and external elements (tensions in international trade, Brexit, economic weakness of some countries in the Eurozone and Emergentes, etc.) put pressure on the yield curve's rates at the medium and long-term, with an increase in risk premiums. The short-term rates also rose in anticipation of a more restrictive monetary policy, mainly due to exchange rate depreciation.

In this context, the BNT carried out extraordinary auctions and canceled some of the scheduled auctions, with the objective of removing pressures on the supply side and guaranteeing the functionality of the public securities market, mitigating the impacts of excessive volatility. Between late May and early July 2018, extraordinary fixed rate and inflation-linked bonds auctions were held. Additionally, the following traditional auctions were cancelled: i) two auctions of fixed rate and inflation-linked bonds, scheduled for May; ii) the entire month of June, with the exception of one auction of floating bonds; and iii) auction of long term fixed ratd bond for early July. In total, seventeen extraordinary auctions were carried out, resulting in a net repurchase of approximately BRL 24.3 billion. On this occasion, there was an increase in the share of floating bonds to the detriment of fixed rate bonds. The actions of the BNT aimed at reducing interest rate risk (level of DV01) and the liquidity reserve position remained quite comfortable.

The BCB acted in a coordinated manner in this episode. Investor demand for shorter bonds and the monetary authority to carry out an extraordinary repurchase operation with a 9-month term, usually

the offered terms of repurchase agreements were between 3 and 6 months. The BCB also operated in the foreign exchange market through currency swaps, which correspond to the sale of dollars in the futures market. The coordinated actions were not intended to change the trend of asset repricing, but to avoid excessive fluctuations that would harm the functioning of the financial market.

3.1 Adverse Shock of the COVID-19 Pandemic

The year 2020 was marked by an unprecedented adverse shock to the Brazilian economy, resulting from the COVID-19 pandemic. The impacts of the spread of the virus were observed in different segments, with health, social and economic impacts that resulted in the decree of a state of public calamity throughout 2020. The intensity of the crisis impacted the financial markets and brought uncertainty and volatility. In this context, the BNT acted in an extraordinary manner in the government bond market with the objective of mitigating adverse risks on financing needs and financial system.

Between March 12th and 26th, 2020 extraordinary auctions were held for the purchase and sale of fixed rate and inflation-linked bonds. Additionally, the following traditional auctions were cancelled: i) fixed rate, inflation-linked and floating bonds scheduled for March 12, 17, 19 and 26; and ii) long term fixed rate scheduled for April 2, 9 and 16. All these auctions were on the annual schedule. In total, the net repurchase was approximately BRL 35.6 billion. Additionally, on March 25, it was defined that floating bonds auctions would have two vertices: a long one maturing on jan/2026 and a short one maturing on jan/2022. Subsequently, on April 1st, the decision was taken to make floating bonds auctions weekly rather than biweekly.

In view of the scale of the crisis, the National Congress approved Constitutional Amendment 106/2020 to support some economic policy actions while the situation of public calamity persisted. Within the scope of public debt management, emphasis is given to the authorization given to the BCB to trade in the secondary market for public and private securities. This provision eliminated the legal uncertainty for the monetary authority to act in the public bond market. Although not triggered, this instrument precaution was important given the strong increase in the financing needs, which were under pressure because the fiscal policy against the crisis.

Other challenge for debt management on the crisis was the increase of federal government borrowing requirements at a time of great uncertainty and risk aversion from investors, who raised precautionary demand for liquidity. Therefore, resources migrated from government bonds to repo operations, which have shorter maturities and virtually no price volatility.

During this period, liquidity reserves helped the BNT flexibility to adjust issuances according to market conditions and to increase bond issuances timely. With the increase in borrowing requirements, the financial volume raised through government bond issuances reached historical highs. While the financial volume monthly average in 2019 was BRL 58 billion, during the second half of 2020 it hit BRL 126.7 billion. Amidst a scenario of uncertainties, risk aversion and a steepening yield curve, the debt issuance average maturity declined, implying a shortening of the public debt maturity structure.

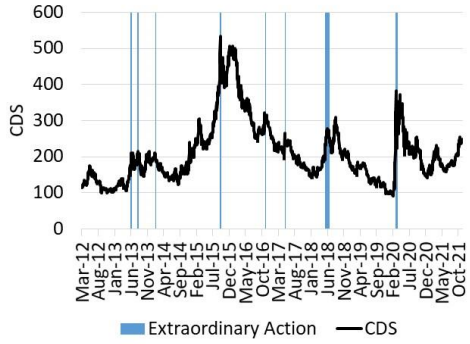
The BNT also promoted adjustments to its borrowing plan to meet the sudden rise of the borrowing requirements and to adapt the plan to the changing market conditions. The addition of certain on-the-run bonds throughout 2020 was a key factor to the success of the borrowing strategy, as it also provided flexibility to the debt management. With the market demand concentrated in short-term bonds, in particular, 6-and 12-month, and considering the steepening yield curve, the BNT increased the list of on-the-run bonds. With this measure, the Treasury intended to meet the sudden increase of borrowing requirements imposed by the pandemic while minimizing the consequences to the refinancing risk.

The financial volume raised through the issuance of domestic bonds in 2020 was BRL 1,298.6 billion. This amount was approximately 71.5% higher than the average of the previous four years. The sudden increase in government borrowing requirements explains the shock on government bonds offers. Furthermore, an environment of uncertainties and risk aversion explains the significant share of short-term maturities bonds in the borrowing strategy.

In 2021, the prospect of economic overcoming of the pandemic was consolidated with the spread of vaccination in the country. Internal uncertainties related to fiscal consolidation and the political environment are important challenges, but so far no extraordinary actions have been necessary in the public debt market. In this context, debt management has been gradually recovering its guidelines, mainly with the increase in the maturities of issues.

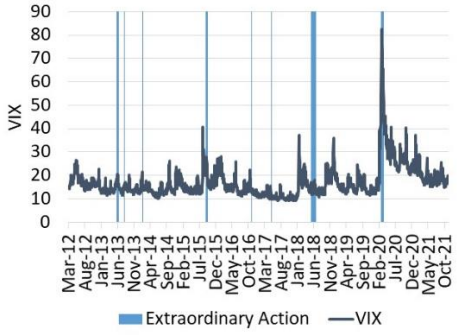
The crisis caused by the COVID-19 pandemic imposed unprecedented challenges for economies and global markets. In Brazil, the reaction caused a temporary increase in government expenditures. However, the timing and the magnitude of the measures succeed in mitigating the negative impacts over the main macroeconomic variables. In this context, the FPD management played its role in fulfilling the federal government borrowing requirements and guaranteeing the proper functioning of the federal government bond market. Aspects of the FPD management, such as the increase of a liquidity reserve, a mainly domestic debt composition and a developed and organized government bond market proved to be important mechanisms to mitigate the COVID-19 crisis effects.

Chart 1 – 5-Year CDS – Brazil



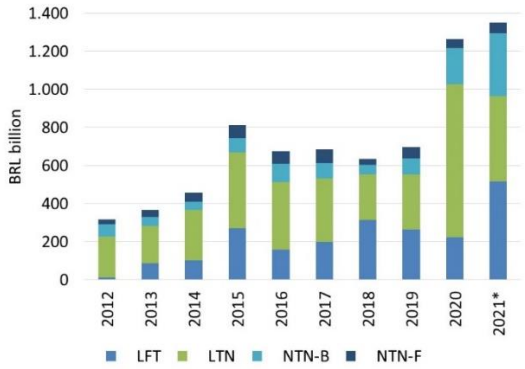
Source: Bloomberg and BNT

Chart 2 – VIX



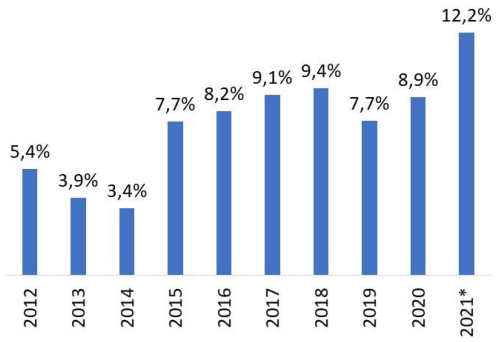
Source: Bloomberg and BNT

Chart 3 – Domestic FPD Bond Issuance



*Year to June
Source: BNT

Chart 4 – Liquidity Reserve/GDP



*Year to June.
Source: BNT

This historical analysis indicates that actions of BNT were associated with moments of risk aversion. It is also important to note that, although peaks in the BNT's actions are related to moments of stress, the action of economic authorities can mitigate abrupt movements in asset prices, whether government bonds or foreign currency. In other words, an event of extreme volatility may not have occurred as a result of the action of the economic authorities, despite the construction of an adverse scenario.

On the other hand, it is noteworthy that the constant presence of the debt manager tends to lead to strategic behavior on the part of financial market agents, which can increase the appetite for risk, confident that they will be able to count on the BNT's performance during scenarios of instability. Such behavior may result in an increase in volatility events and/or income transfer between agents with different positions in the market. Another possible problem with the premature or excessive use of extraordinary auctions is the loss of effectiveness of such a strategy and, consequently, difficulty in re-establishing normal business conditions.

4. Quantitative analysis

This section aims to develop statistical tools to assess the conditions of extraordinary actions by the BNT. For this purpose, we used two methods: i) an econometric model was used, which allows evaluating how and which financial indicators were important for the performance; and ii) the other metric used was principal component analysis, which allows an aggregated assessment of how financial volatility

behaved at the time of operation. It is important to emphasize that these quantitative exercises are incapable of evaluating the efficiency of the actions. For example, aspects such as gains/losses, incentives or reputation of the debt authority are not covered in this analysis. Furthermore, the model refers to the debt manager's past analysis and is not necessarily a guide for future actions

To assess the need for intervention by the BNT in the public bonds market, the following research strategy was adopted: i) survey of the moments of action; ii) definition of market variables that can give rise to extraordinary actions; iii) econometric analysis using extraordinary actions as a dependent variable and market indicators as independent variables; iv) definition of a volatility index based on the indicators and an *ad hoc* metric that can suggest moments of high volatility in the financial market, an environment that can give rise to extraordinary actions.

To assess the BNT's actions, binary models were chosen[13], which are frequently used in studies that assess agents' exclusive choices, suitable for situations in which the agent has only two alternatives. In the case in question, between acting or not in the government bond market. Additionally, based on the Principal Component Analysis (PCA)[14] of the series of indicators, a series of financial volatility was constructed from the 10 indicators evaluated and it was defined as a rule that results above the 95th percentile would be characterized as an extreme measure of risk.

The variables used in the evaluation are divided into 5 distinct categories, which demonstrate both domestic and external market conditions, namely: i) level of volatility; ii) lack of liquidity; iii) lack of price reference; iv) feeling of risk; and v) asset repricing. A total of 11 variables were analyzed and are described in Appendix I. The analysis period chosen comprised the interval between 08/01/2013 and 11/22/2021, with data on a daily basis. Econometric estimation using a Probit or Logit model requires that the series be stationary, a procedure that was verified in the variables used (Appendix I). The results of the econometric estimation are shown in Table 2. The estimates for the coefficients of the independent variables showed the expected signs and were statistically significant up to the 10% level in all models. Regarding statistics, in general, the Log-Likelihood, Akaike and Schwarz signaled a marginally superior adjustment of the Probit in relation to the Logit model. The Ordinary Least Squares (MQO) model was estimated for comparison purposes only. It is noteworthy that Table 2 only reports the model with the best test statistics.

[13] According to the methodological description in Appendix I.

[14] Principal Component Analysis (PCA) is a method used to reduce the dimensionality of multivariate data, that is, it allows the expression of available information in fewer variables. The principal components are able to extract the variability of the original variables, allowing data analysis to be simplified. The purpose of PCA is to combine the variables (X1,..., Xi) and create index (Z1,..., Zi) that are uncorrelated and that explain the variation in the data.

Table 2 – Regression Results

	PROBIT	LOGIT	MQO
C	-	-	-
	0.30	0.68	0.02
AMPLITUDE_DI(-3)	37.47**	72.16**	5.57**
	6.81	14.33	1.16
VOLUME_DI(-3)	1.83***	3.74**	0.07
	0.00	0.00	0.00
CDS_BRAZIL(-3)	2.37***	15.38**	0.76**
	2.37	5.47	0.28
IMPLICIT_VOL_EXCHANGE_RATE(-3)	3.61***	8.39***	0.006
	0.01	0.03	0.00
Akaike info criterion	0.19	0.20	-0.88
Schwarz criterion	0.21	0.21	-0.87
Log likelihood	106.27	103.61	
H-L Statistic	4.94	4.06	
Obs with Dep=0	1430	1430	1430
Obs with Dep=1	42	42	42
Obs Total	1472	1472	1472

*Notes: Standard deviations are in parentheses. Akaike and Schwarz indicate the model's fit information criteria. LL stands for Log Likelihood. H-L Statistic of fit adequacy evaluation for binary specification. The p-value of the t-statistic is given by: * if p < 0.10, ** if p < 0.05 and *** if p < 0.01.*
Source: Authors

The fit of binary choice models is usually assessed in the form of a comparison between predicted values and realized values. Wooldridge (2010) suggests that using the success fraction of the complete sample as a limit or cut-off point is the most adequate way to assess the correctly predicted percentage of the model. That is, if the total of extraordinary actions corresponded to 3.0%, every time the model indicates a probability greater than 3.0%, there will be an indication of extraordinary action. In this perspective, the total forecast accuracy (acting and not acting) was 83.6% = (1,197+34)/1,472. Type II Error (not predicting action when it occurs) of 0.7% = 8/1,205. The estimated series considered 42 BNT actions, of which the model predicted 34, that is, 81.0%. A pertinent criticism of the model is that it accuses many possibilities of actions, 233. In other words, there are many indications of actions, an aspect that is counterintuitive to the practice of public debt management, since they must have an exceptional character.

Table 3 – Choosen Model (*cut-off* - 3,0%)

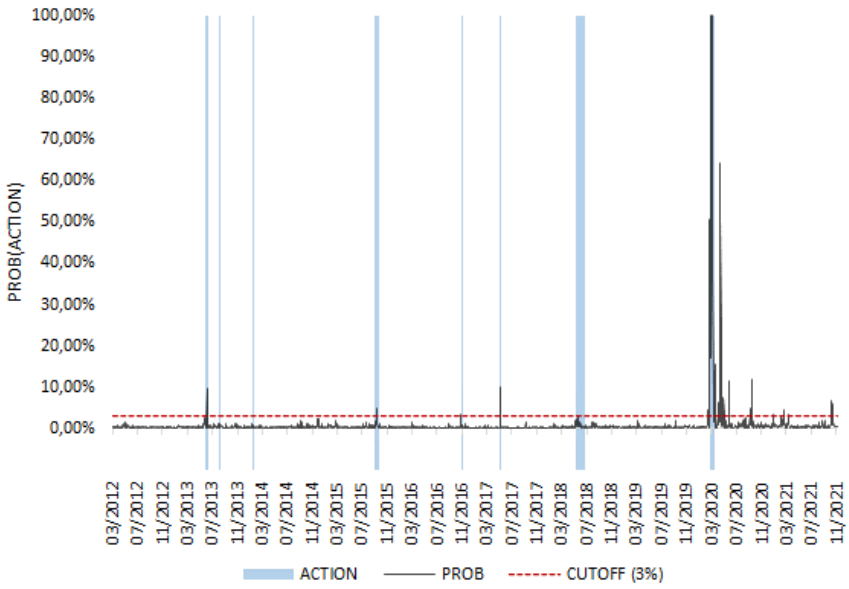
		Estimated		
		0	1	Total
Observed	0	1,197	233	1,430
	1	8	34	42
	Total	1,205	267	1,472

		Estimated (%)		
		0	1	Total
Observed	0	81.3	15.8	97.1
	1	0.5	2.3	2.9
	Total	81.9	18.1	100.0

Source: Authors

The graph below shows the BNT's probability of action (black line), as well as the dates of operations (blue bar) and the historical cutoff (red dashed line). In a simple reading, whenever the indicator of probability of action exceeds the historical cutoff, there is a relevant probability that the BNT will adopt extraordinary actions. As can be seen from the visual analysis, most of the BNT's actions coincide with the estimated indications.

Chart 5 – Probability of Extraordinary Actions

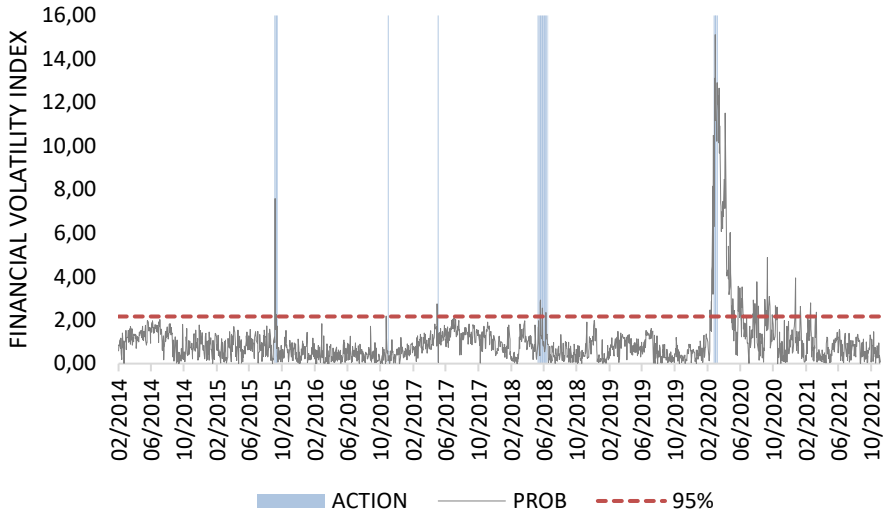


Source: Authors

The second method that we used also considers the group of 11 variables whose common behavior corresponds to the conditions of the financial market, in this case the extraction of the main components was considered to construct a financial volatility index. With this, it was possible to propose a metric for evaluating stressful situations in the financial market. Adopting variations above two standard deviations (percentil of 95%) as an ad hoc criterion of high volatility, 70 moments were indicated during the period of analysis. During this period, the BNT performed special operations 44 times, and all actions, with the exception of those that took place in 2014, were located at least in the same week as the

financial volatility index stress indication with 10 actions coinciding exactly with the indicated day by the index. Chart 7 shows the financial volatility index.

Chart 6 – Volatility Index



Source: Authors

Obtaining indications that the actions of the BNT remained within moments of volatility was an expected result. However, these indications are insufficient to determine the form of action, whether in instruments, time or intensity. In other words, the tool is able to indicate only one vector of the set of information that involves a debt manager's reaction.

It is also important to note that, although peaks in the financial volatility index indicate moments of stress or the precedence of a crisis, the action of economic authorities can mitigate abrupt movements in asset prices, whether government bonds or foreign currency. In other words, an event of extreme volatility may not have occurred as a result of the action of the economic authorities, despite the construction of an adverse scenario.

5. Concluding remarks

The approach to evaluate extraordinary actions of the public debt manager must encompass not only aspects that are intrinsic to debt management but also those related to the country's macroeconomics, public finances and institutional structure. In this sense, some tools have been consolidated as strategic among debt managers, with liability management operations being used for different purposes, such as supporting the government bond market in stressful situations.

In Brazil, this perception is present, and the National Treasury has acted several times over the last few years with the purpose of contributing to the good functioning of the public securities market. Therefore, we sought to understand the tools and contexts that gave rise to the extraordinary actions of the BNT, as well as the construction of the underlying factors that supported them. In this sense, an attempt was made to highlight the role played by the official credit policy and the institutional

arrangement of the relationship between the National Treasury and the BCB over the last few years as a source of financing for the TSA and for the liquidity reserve.

The results of the quantitative analysis showed that important indicators of financial market volatility are relevant for forecasting the actions of the BNT in the public bond market. The models tested showed a high predictive capacity of the BNT's actions and were robust to different sets of independent variables and statistical tests. Furthermore, the analysis of principal components confirms the perception that moments of financial volatility were important for the decision to act of the public debt authority. The construction of an *ad hoc* metric of extreme volatility moments based on the financial volatility index also confirms the debt manager's performance system.

Therefore, the results suggest a performance of the BNT associated with volatility peaks over time, based on criteria and indicators that reflect the financial situation of the public bond market. Furthermore, they indicate that the selected model and the financial volatility index can be used to monitor the government bond market and to support the formulation of strategic actions aimed at improving the functionality of the government bond market.

However, it is worth noting that the use of indicators or mechanical metrics represents only one dimension in the light of the broad spectrum related to the BNT's actions and the financing process. The relationship between debt management and fiscal, exchange and monetary policy, as well as the interaction with different market participants, are essential conditions for decision making, and financial indicators should not be the only variable analyzed. Advancing the understanding of metrics that help in diagnosing public bond market conditions and that can help the debt manager in the decision-making process must be a constant exercise.

In the case of extraordinary actions, the interaction between analytical techniques and the debt manager's experience, as well as the idiosyncratic institutions of each country, is fundamental for debt management. The manager's technical tools and experience are, therefore, complementary and not substitutive.

Quoting Bolder and Deelei (2011), it could be said that economic-financial indicators are available tools that should be used together (not as a substitute for) of the manager's judgment. Thus, indicators are necessary because intuition cannot be fully trusted. However, intuition is necessary because indicators cannot be fully trusted. It is the controlled interaction between these two elements that contributes to a good debt management policy.

Finally, it should be emphasized that the actions of the National Treasury must be primarily focused on the development and preservation of a competitive and efficient public bond market, with the maintenance of the debt manager's reputation being necessary to decide whether or not to act at times of uncertainty or information asymmetry, since their actions have the potential to change the behavior of market participants and, consequently, the process of price formation of government bonds.

Appendix I

Table 4 – Debt Management Objectives by Country

	Cost and Risk Minimization	Cash Flow Optimization	Market Efficiency	Diversification of Investor Base	Economic Coordination
Brazil	X		X		
Colombia	X				
Denmark	X		X		
Finland	X				
Ireland	X				
Jamaica	X				
Japan	X				
Mexico	X		X	X	
New Zealand	X			X	
Poland	X				
Portugal	X		X		
UK	X	X			
Turkey	X		X		X

Source: Authors

Appendix II - Description of indicators

The indicators analyzed to support decision making regarding the execution of extraordinary auctions of public debt securities of this National Treasury Secretariat were grouped into 5 categories, namely: **Volatility indicators; Indicators of lack of liquidity; Indicators of Absence of Price References; Risk sentiment indicators; Asset repricing indicators.** Below is a brief description of the indicators.

1) Volatility Indicators

Moments of uncertainty and/or risk aversion in the markets tend to be accompanied by an increase in asset price volatility, which in turn can impact the correct functioning of markets and even generate problems for public debt management. The indicators selected to indicate financial market volatility are:

1.1 DI Amplitude

The DI amplitude indicator is calculated from the maximum and minimum trading rates of DI contracts throughout the day, and measures the percentage of the rate variation of such contracts in basis points in relation to the average of the maximum and minimum rates, the final indicator is obtained in this way:

AmpDI% = (Tx.max% - Tx.min%) / [(Tx.max% + Tx.min%)/2]

Where: **AmpDI%** = DI Amplitude as a percentage of the average of the maximum and minimum rates; **Tx.max%** = Maximum DI rate traded throughout the day; **Tx.min%** = Minimum DI rate traded throughout the day. For the elaboration of this indicator, the maturity of January 2021 was initially chosen due to its great liquidity. It is understood that in times of stress, the market will show an increase in volatility, which may be reflected in greater intraday variation in the rates traded in DI contracts. Trading data is registered by the Stock Exchange - B3, and obtained from the Bloomberg platform.

1.2 VIX

The VIX volatility indicator was created by the Chicago Board Options Exchange (CBOE) and is an indicator of the volatility of stock options traded on the Standard & Poor's 500 (S&P 500), the main composite US stock market index.

1.3 Implied volatility of exchange options

The implied volatility indicator for exchange options (FX vol) prospectively measures the uncertainty of the future exchange rate that is embedded in the trading of US dollar options on the BM&F. Implied volatility is an undetermined variable in the Black-Scholes option pricing model and as it cannot be observed, it must be calculated using the other inputs of the model, namely: Option market price; Target share price; Exercise price; Time to maturity; and Risk-free interest rate. With the option's current price, the Black-Scholes formula can be solved by obtaining the implied volatility value. The FX vol index is published daily in the BM&F's daily bulletin

2) Absence of Liquidity Indicators

Lack of liquidity is another good metric to check moments of great risk aversion in the financial market, as the lack of reference prices, caused by high volatility, can make agents feel insecure about doing business, taking away liquidity from the market. In moments like this, the performance of this National Treasury Secretariat, offering extraordinary auctions and acting in the purchase and sale of selected securities, can help the market to return to its normal operation by increasing liquidity. The indicators selected for checking market liquidity are:

2.1 Daily Volume of Reference DI Contracts

The daily contract volume indicator of the reference DI is constructed from the sum of the total intraday volume of a specific DI contract maturity. Initially, we chose to follow the January 2023, January 2025, January 2027 and January 2029 maturities due to their liquidity. However, for the regression we used a series consisting of the trading volume of the January 2017 DI ranging from 01/01/2013 to 8/25/2014 and the January 2021 DI ranging from 8/25/2014 to 12/07/2018. The trading data of DI contracts are registered by the Stock Exchange - B3, and obtained from the Bloomberg platform.

2.2 Total Daily Volume of Public Securities

The total daily volume of government bonds indicator seeks to have an overview of liquidity in the secondary market for government bonds, and monitors the aggregate daily trading volume of each category of government bonds (Letra Financeira do Tesouro - LFT, Letras do Tesouro Nacional - LTN , Notas do Tesouro Nacional série B - NTN-B and Notas do Tesouro Nacional série F - NTN-F). NTN-F were further subdivided into two categories, the first covering the volume of the NTN-F market as a whole and the second the volume of maturities 01/2025, 01/2027 and 01/2029. Data on government securities trading are registered in the Special System for Settlement and Custody - SELIC, and obtained from the Bloomberg platform.

3) Absence of Price Reference Indicators

During times of turmoil, it is very common for markets to lose the relative price reference for financial assets, whether due to the drop in liquidity of these assets or other factors, which can generate a vicious cycle, further reducing market liquidity and making it difficult to return to a balanced situation. In times like this, a performance by this STN offering extraordinary auctions, and acting on the buying and selling points of selected securities, can help the market to return to its normal operation by providing different players with a fair buy and sell spread. The indicator selected for checking the absence of a price reference is:

3.1 Public Securities Spread (Purchase Rate - Sell Rate)

The government bond spread indicator measures the relationship between the spread and the reference rate for buying and selling the bond, as follows:

Spread% = (Rate.purchase% - Rate.Sale%) / [(Rate.purchase% + Rate.sale%)/2]

Where: **Spread%** = Spread in percentage of the average of the reference rates for the purchase and sale of the security; **Rate.purchase%** = Referral rate for purchase; **Rate.sale%** = Referral rate for sale. For this study, it was decided to limit the maturity of the analyzed government bonds. The criteria for selecting the maturities to be monitored was liquidity in the secondary market, which at this time resulted in the following maturities: NTN-F 2023 and 2025.

4) Risk Feeling Indicators

Risk sentiment indicators bring aggregate market data that may indicate moments of great stress in the global or local financial market. In this way, the risk spread charged to the private sector, the risk spread of Brazil against selected countries, among other data, are analyzed. The indicators selected for checking market risk sentiment are:

4.1 TED Spread

The TED Spread measures the spread between the US government's 3-month Treasuries and the 3-month interbank rate of the international market (Libor) in US dollars, and aims to measure the difference in the cost of short-term financing in the States States and the Libor rate. Given that Treasuries are considered one of the least risky assets in the market, it is expected that, during times of stress, the spread charged by financial agents to finance banks will rise, in other words, the greater the risk of liquidity or solvency banks, the greater the spread between Treasuries rates and Libor. This indicator is taken from Bloomberg data.

4.2 Libor OIS

Libor OIS measures the spread between the interbank rate on the international market (Libor) and the Overnight Indexed Swap rate (OIS), which measures the cost of exchanging a pre-fixed flow for a floating rate flow of the same period in the American market. Thus, the Libor OIS spread measures the difference in the cost of interbank loans in the international market, which have solvency risk, with the risk-free interest rate of the American market. Similar to the TED spread, it is expected that, during times of tension, the rate of remuneration charged by financial agents to finance banks will rise, in other words, the greater the liquidity or solvency risk of banks, the greater the spread between the free interest rate and the Libor. This indicator is taken from the Bloomberg database.

4.3 CDS Brazil

The Credit Default Swap - CDS is the premium charged to the investor by the seller to guarantee the payment of a specific issuer's bond, that is, it works as a kind of insurance, ensuring that the investor receives the amount owed to him by the issuer. CDS works as a measure of the issuer's credit risk. For regression estimation purposes, it was used the the CDS variation rate compared to the previous day.

5) Asset repricing indicators

5.1 Exchange Regression x DXY

The U.S. Dollar Index or DXY is a measure of the strength of the US dollar against a pre-defined basket of foreign currencies. Its linear regression against the real can show whether the real is undergoing a devaluation/appreciation process that is not explained by the gain/loss of strength in the dollar. The indicator is calculated from the difference between the effective exchange rate in reais and the rate predicted by the linear regression of the exchange rate in reais against the DXY index. Such regression in turn is obtained through the excel "linear prediction" function, which performs a simple linear regression in order to predict future values and is calculated as follows: $a = y^* - bx^*$ and: $b = \Sigma (x-x^*)(y-y^*) / \Sigma (x-x^*)^2$

where x and y are the arithmetic means of the DXY and Real/Dollar series respectively.

5.2 Linear Regression FX x DI

The Linear Regression of exchange rate x DI interest rate is used to find out if changes in the exchange rate can be explained by changes in the level of the interest rate. Initially, the 10-year DI rate was chosen as reference because it is less affected by short-term changes in the SELIC rate. The index is obtained from the difference between the effective exchange rate in reais and the rate predicted by the linear regression of the exchange rate in reais against the 10-year DI rate. Such regression in turn is obtained through the excel "linear prediction" function, which performs a simple linear regression in order to

predict future values and is calculated as follows: $a = y' - bx'$ and: $b = \Sigma (x-x')(y-y') / \Sigma (x-x')^2$

where x and y are the arithmetic means of the 10-year DI and Real/Dollar series respectively.

Appendix III – Stationarity tests

Table 5 – Stationarity tests

SERIES	CONSTANT	CONST. and TREND	NONE	STATUS
AMPLITUDE_DI*	-9.42	-9.43	-2.95	Stationary
VOLUME_DI	-5.06	-5.06	-1.63	Stationary
SPREAD NTN-F*	-5.17	-10.88	-3.79	Stationary
CDS_BRAZIL*	-30.50	-30.52	-30.49	Stationary
EXCHANGE_REGRESSION	-14.12	-14.14	-14.14	Stationary
DXY_REGRESSION	-11.79	-11.79	-11.59	Stationary
IMPLICIT_VOL_EXCHANGE_RATE	-3.61	-3.63	-0.84	Stationary
VIX	-6.75	-6.74	-1.47	Stationary
LIBOR OIS	**-1.53**	**-1.13**	**-1.02**	**Non Stationary**
TED SPREAD	**-2.40**	**-2.23**	**-1.17**	**Non Stationary**

** The AMPLITUDE_DI, SPREAD NTN-F and CDS_BRAZIL series used in the regression were constructed from non-stationary data. See Appendix I for more details*

Table 6 – Stationarity test – 1º difference

SERIES	CONSTANT	CONST. and TREND	NONE	STATUS
AMPLITUDE_DI*	-	-	-	-
VOLUME_DI	-	-	-	-
SPREAD NTN-F*	-	-	-	-
CDS_BRAZIL*	-	-	-	-
EXCHANGE_REGRESSION	-	-	-	-
DXY_REGRESSION	-	-	-	-
IMPLICIT_VOL_EXCHANGE_RATE	-	-	-	-
VIX	-	-	-	-
LIBOR OIS	-12.31095	-12.31928	12.3047	Stationary
TED SPREAD	-17.08874	-17.11308	17.0892	Stationary

Appendix IV –Econometric results

Table 7 – Estimation results

	PROBIT	LOGIT	MQO
C	-3.48****	-6.89***	-0.07***
	0.36	0.889	0.02
AMPLITUDE_DI(-3)	33.67***	63.98***	5.27***
	8.25	20.1	1.24
VOLUME_DI(-3)	1.64**	3.39	0.078
	0.82	2.11	0.07
CDS_BRAZIL(-3)	5.23**	11.85**	0.61**
	2.65	5.98	0.27
RESIDUE_EXCHANGE RATE – DXY(-3)	3.57***	6.62***	0.40***
	1.04	2.15	0.11
RESIDUE_EXCHANGE RATE – DI(-3)	-5.16***	-10.86***	-0.57***
	1.77	3.72	0.14
EXCHANGE RATE IMPLICITY VOL(-3)	0.01	0.04	0.00
	0.01	0.03	0.00
VIX(-3)	0.01	0.02	0.00
	0.02	0.04	0.00
SPREAD_LIBOR_OIS(-3)	5.80	19.64	0.19
	12.12	31.50	0.52
TED_SPREAD(-3)	-2.43	-4.94	-0.19
	5.76	12.30	0.29
Akaike	0.20	0.20	-0.88
Schwarz	0.24	0.24	-0.84
LL	-130.21	-132.02	644.37
H-L Statistic	11.01	7.10	-
LR Statistic	119.02	115.39	-
Obs with Dep=0	1,394	1,394	1,394
Obs with Dep=1	42	42	42
Obs Total	1,436	1,436	1,436

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Closing Remarks

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Dear colleagues,

The past two days have been fascinating and exciting as we heard from the best specialists, academics and practitioners, about the current debates and questions on public debt management. We could have continued for a few more days given the richness of information and analyses, but we need to close the 2022 event and maybe leave some questions for the next conference?

Let me thank the organizers, in particular our colleagues from the Italian Treasury who hosted the conference this year and made it effective, convenient and very interactive despite the hybrid format. I would like to thank the moderators, the presenters and their co-authors who could not join us, and all the participants. This was a very fine forum of public debt specialists and 'afficionados', as was reflected in the quality of the discussions and questions.

As a member of the original team of the 2019 PDM with colleagues from the OECD and the Italian Ministry of Finance, I'm really impressed by what was achieved in creating a regular forum to discuss the latest topics on debt development from a theoretical and operational perspective. This is also a testimony of the success of the PDM network led by the Italian Treasury that allows the public debt management community to stay up-to-date and exchange ideas. We thought the 2019 PDM would be a one-off event and it seems we now have a regular forum.

This year, 17 papers were presented and discussed in 6 sessions, but we had more than twice as many submitted papers, most of them of very high quality. I can testify that the selection process has been tough with long discussions to make the final selection. This reflects the importance of public debt management as a topic of analysis and discussion, and the relevance of our conference.

This week's event has also seen an increase in terms of diversity for the papers and their authors, in terms of professional experience, institution, geography and gender. Amongst the authors of the papers presented, I noticed a very good balance between universities [40%], ministries of finance/central banks [28%] and international organizations [24%]. The gender balance was almost even, which is a good progress compared to 2019. Overall, this is a positive trend that I hope will be sustained and strengthened. I think that private sector experts and even some researchers from civil society organizations/NGOs could the future contribute and benefit to the conference, so that may be a path to explore in the future.

Turning to the topics covered over the past two days, it is clear that the core questions around public debt management remain relevant even though a few new issues emerge. This balance is important because the value added of our event is not in commenting the news or reacting to recent developments. We clearly didn't want another conference on 'COVID and public debt' – which doesn't

mean the pandemic should not be included in the discussion: the paper on debt sustainability after the pandemic in the first session was highly relevant. But I'm convinced of the value of confronting on traditional debt topics the results of robust research, preferably backed by quantitative analysis, with the experience of practitioners. The practitioners benefit as they have better rationale for their action and can expand their toolkit to address traditional or new problems. The academics and researchers benefit from the reality check to confirm or revise their assumptions and open new paths for their work.

As such, the traditional issues of debt sustainability, market liquidity, local currency market development, among others, were discussed but often with a different angle, linked to the experience of a particular country, leveraging a different methodology, highlighted by a particular recent trend or looking at the long-term perspective, as illustrated by the sovereign defaults on domestic law public debt. I'm not sure active debt management, environmental sustainability or sovereign asset and liability management are 'new' topics anymore, but there is still a lot to explore and analyze in these areas, so they are less 'traditional' than the ones mentioned earlier. Research and practices on the topics do contribute to a regular flow of new papers and new concrete experiments by the public and private sectors. As an example, the discussion on disaster risks and sovereign ALM offered a very interesting view of our current reflections at the World Bank and how to assist our client countries. One area that could be explored in a future PDM conference concerns the use of Fintech and Digital Ledger Technology (DLT) in government securities markets, whether their contribution is expected to remain marginal or whether they could have a more transformative impact, for example on linking local markets to the global scene.

But I will not comment all the papers discussed. I reckon all sessions provided me with new information, new perspective, new ideas and food for thoughts. I hope that it was the case for everyone of you.

Thanks to all of you and see you all for the next PDM conference!

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