Debt Stocks Meet Gross Financing Needs: A Flow Perspective into Sustainability

This paper shows that changes in gross financing needs have a significant effect on borrowing costs when debt stocks are high

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Abstract

It is well known that no single metric can provide reliable cross-country risk assessments of debt sustainability. While approaches to understanding sustainability have traditionally relied heavily on stock metrics, a consensus is emerging that debt sustainability should be linked to both stock and flow features of underlying public debt. This paper informs this debate by analysing the ability of gross financing needs, the preferred flow metric in current debt sustainability analyses by official institutions, to provide additional information to that provided by standard stock metrics of a sovereign's likelihood of distress. Our main contribution is to document a significant negative effect from changes in gross financing needs when debt stocks are high. These results support the intuition that countries can sustain very large debt stocks if these do not generate unmanageable flow needs. Additionally, we show that sovereign roll-over needs are a critical element driving this effect. Given the role of official lending in taming the dynamics of this component, our findings also inform the literature on the role of official lending in crises resolution.

Keywords: Sovereign sustainability, debt stocks, financing needs, maturity

JEL codes: H62, H63, F34

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It is well known that no single metric can provide reliable cross-country risk assessments of debt sustainability. While approaches to understanding sustainability have traditionally relied heavily on stock metrics, a consensus is emerging that debt sustainability should be linked to both stock and flow features of underlying public debt. This paper informs this debate by analysing the ability of gross financing needs, the preferred flow metric in current debt sustainability analyses by official institutions, to provide additional information to that provided by standard stock metrics of a sovereign's likelihood of distress. Our main contribution is to document a significant negative effect from changes in gross financing needs when debt stocks are high. These results support the intuition that countries can sustain very large debt stocks if these do not generate unmanageable flow needs. Additionally, we show that sovereign roll-over needs are a critical element driving this effect. Given the role of official lending in taming the dynamics of this component, our findings also inform the literature on the role of official lending in crises resolution.

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1. Introduction

An integral element of any official support program is the analysis of public debt sustainability (DSA). As it is well known that no single metric, either stock or flow, can provide a reliable country-specific risk assessment of debt sustainability on a cross-country basis, this is often done by combining DSA and risk thresholds.[1] Unfortunately, there is no single comprehensive front-to-back formal model that can consistently explain default events. Each default event emerges from a unique set of root causes and country-specific factors and evolves in a distinct manner. Traditional approaches to debt sustainability have paid most attention to the level and dynamics of debt stocks.[2] This approach, although it touches upon economic growth and roll-over risks, has in practice articulated around the concept of debt levels leading to policy recommendations along the lines of *for debt to be sustainable, the stock of debt should decline to level X by year Y.*[3]

In our view, the key question when assessing a country's debt sustainability is whether the country can secure the necessary funds to cover its financing needs over the medium and long term. The stock of debt only accurately represents the amount of money *borrowed*, and not the flow of obligations that are required thereafter. Different term-to-maturity structures and roll-over risk, amortisation schedules for principal, and varying interest rates, can give a stock of debt a very different significance. A given level of debt can impose very different repayment flows and refinancing risks.

These arguments came into sharp focus when the IMF engaged in the euro area. As described in Corsetti et al. (2017), the measures taken to forestall the euro area crisis showed the limitations of the *stock approach* to sustainability. By deploying significantly back-loaded and affordable loans, the euro-area safety net (articulated around the European Stability Mechanism) significantly reduced both the cost of financing the debt stock and the need to roll it over, reducing the risk of a disordered default for a given debt level. In fact, as voices emerged that debt sustainability should also be linked to flow measures describing the underlying debt stock, an institutional change occurred.[4] In reaction to the discomfort with the stock approach, the way DSA is conducted has changed. Along the lines of the IMF's *acceptably low rollover risk,* so far the debate has settled upon incorporating an additional flow metric and controlling that its value does not exceed a risky threshold. That measure is gross financing needs (GFN), a flow metric that captures the forthcoming financing needs of

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[1] The IMF guidelines dictate a "risk-based approach". The approach involves first categorizing countries as "lower-scrutiny" or "higher-scrutiny", based on at least one of the following benchmarks being exceeded: (i) current or projected public debt above 60% (50%) of GDP in advanced (emerging) economies, (ii) current or projected GFN exceed 20 (15) percent of GDP, and (iii) seeking or having exceptional access to IMF resources.

[2] The IMF defines a forward-looking view of sustainability (IMF, 2013): *"In general terms, 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 and with preserving potential growth at a satisfactory level. Conversely, if no realistic adjustment in the primary balance – i.e., one that is both economically and politically feasible – can bring debt to below such a level, public debt would be considered unsustainable*."

[3] As an example, according to the 2012 Eurogroup framework reaching a debt-to-GDP ratio of 124% in 2020 and remaining substantially lower than 110% in 2022 would ensure Greece's debt sustainability.

[4] See Dias et al. 2014, Schumacher & Weder di Mauro 2016, or Bassanetti et al. 2016.

a country. GFN add up the following elements: interest payments, principal repayments, and the primary deficit (see Schumacher & Weder di Mauro 2016 or Zettelmeyer et al. 2017).

The rationale for using this comprehensive flow metric is that funding shortages occur when there is a mismatch between GFN and financing sources. As a result, one would suspect that, the larger the GFN, the harder for the sovereign to fill the gap. Thus, while a too large debt stock could signal solvency problems, excessive GFN may indicate liquidity pressures, and an increased likelihood the sovereign cannot cover upcoming obligations. As in the case of stock metrics, trying to find a one-size-fits-all concrete threshold for this alternative metric can prove difficult.[5]

While linking solvency and liquidity to the concept of stock and flow metrics sounds logical, it also seems important to understand what combinations of debt stocks and flow features can negatively affect debt sustainability. In this paper we take a first step toward answering this question. Using a newly built annual dataset that spans 1998 to 2016 and includes 23 European Union countries, we apply panel regression techniques to tie the joint behaviour of gross financing needs and the generally accepted stock measure of solvency, debt to GDP, to a country's perceived solvency, as measured by its sovereign spreads.

There is a vast amount of research that has focused on the linkage between debt stocks and sovereign risk.[6] Similarly, a significant number of contributions have focused on the linkage between some specific flow measures and sovereign spreads, even though most of them only include the primary deficit as a flow measure (or alternatively, as in Ardagna et al. (2004), they do account for the debt service, but they study the determinants of yields instead of spreads).[7] Remarkably, there is an absence of empirical work combining stock and flow debt features (let alone supporting the use of this latter measure) and their implications for sovereign solvency. Two exceptions are Dias et al. (2014) and Bassanetti et al. (2016). Dias et al. (2014) study NPV measures of debt, embedding in the calculation both interest and principal payments. Bassanetti et al. (2016) expand an otherwise standard spread regression to show that just as important as the level of debt is whether that debt is increasing or decreasing.

Our analysis complements these papers by showing that jointly considering flow and stock measures related to a country debt profile delivers a more accurate picture of impending risks to sustainability. We find that the effect of the debt stock on sovereign financing costs is dependent on the level of gross financing needs that such debt stock generates. Countries whose GFN levels are already large face more intense pressure if debt increases than countries whose debt remains unchanged (or is decreasing). Analogously, we observe that when debt is above 60% of GDP, a one percentage point increase in GFN leads to a five basis point increase in spreads. Additionally, when we decompose the effect of GFN, we observe that the main driver of this effect is the sovereign's roll-over needs. We also study the ability of flow and stock variables to work as an early warning, by studying their relation to a crisis

[5] Looking only at GFN has further limitations, as it only captures information one year in advance.

[6] See, for instance, Afonso et al. (2015) or Bernoth & Erdogan (2010).

[7] See, for instance, Bassanetti et al. (2016), Ardagna et al. (2004) or Attinasi et al. (2009).

indicator. According to our estimates, when public debt is around 110% of GDP, a one percentage point increase in GFN increases the probability of a fiscal crisis by one percent.

These findings have two important implications. First, they reinforce the idea that assessing sovereign solvency requires a simultaneous consideration of both flow and stock features of the underlying public debt. In fact, our results confirm that focusing only on stock metrics is likely to lead to the wrong conclusion. Second, our results on the remarkably destabilising effect that large debt redemptions and debt stocks can have underline one channel through which official lending can enhance market access. Given the role of official lending in taming the dynamics of this component, our findings also inform a flourishing literature on the role of official financing in the resolution of sovereign stress.[8]

The rest of this paper is organised as follows. Section 2 gives an overview of the data and some stylised facts. Our methodology is described in section 3, while section 4 shows the main results. Section 5 concludes.

2. Data

We gathered a panel of General Government gross financing needs and debt stock series for 23 European Union countries ranging from 1995 to 2016.[9] Using data from the ECB, we built our GFN indicator as the sum of upcoming interest and principal debt payments, and the primary deficit.[10] This is a natural benchmark for measuring the extent of upcoming dues, including those related to debt stock, as by construction the variable measures sovereign gross financing needs in the year ahead.

We built the GFN series by combining information on the primary balance, interest payable (on accrual basis), and outstanding Maastricht debt (of any original maturities) maturing in the short term (amortisations). We obtained the series from the ECB's Statistical Data Warehouse. Using them, we obtained country-specific GFN series:

$$\mathrm{GFN}_t = \mathrm{PB}_t + \mathrm{IP}_t + PR_{t-1} = Deficit_t + PR_{t-1}$$

where PB_t stands for the primary balance at time t, and is defined such that a positive value refers to a deficit, IP_t stands for the interest payments in the corresponding year, and PR_{t-1} represents the amount of principal repayment due in one year at the end of year t-1. PR_{t-1} includes all the outstanding debt at the end of the previous year (securities, loans and any debt under Maastricht rules) with all types of original maturities, which have short-term residual maturity.[11] Figure 1 shows the evolution of the breakdown of the GFN ratio for a selection of our sample countries.

[Figure 1]

[8] See Sandri (2015), Muller et al. (2016), Corsetti et al. (2017), Abraham et al. (2017).

[9] The countries are: Austria, Belgium, Finland, France, Greece, Italy, Portugal, Spain, Denmark, Poland, Romania, Slovenia, Slovakia, Sweden, Czech Republic, Croatia, Hungary, Malta, Cyprus, Bulgaria, Latvia, Lithuania and Netherlands. Other EU countries were not included for data availability issues.

[10] More specifically, we collected the following variables: primary balance, interest payable (accrual basis), and outstanding Maastricht debt with any original maturities, maturing in the coming year.

[11] We note that both the time span and frequency of the dataset were limited by the availability of debt redemption data.

With the inception of the global crisis, GFN increased significantly for most countries, in part driven by increasing deficits, and in part by the increased roll-over needs that the increasing debt stocks were generating. Since 2012, GFN has decreased everywhere. Figure 1 shows that in Romania, Portugal, and Cyprus, although debt stocks kept increasing, these dynamics decoupled from GFN dynamics.

We measure the combined effect of flow and stock properties of debt by constructing a Stock-Flow Pressure (SFP) Index. We do this by multiplying, for each country/year pair, debt stock (as % of GDP) and GFN (also as % of GDP). Figure 2 plots the SFP index, re-scaled between 0 and 1, against the debt stock. The explosive path the data cloud reveals is telling. Within our sample, as debt stocks increase, GFN increases more than proportionally, implying that the potential to deliver sustainability problems can compound.

[Figure 2]

As common in the literature, our measure of sovereign risk is drawn from sovereign bond markets.[12] We use data on 10-year sovereign bond yields as a proxy for sovereign risk. We gather these data series for each country in the sample and for Germany, and compute sovereign spreads against the German Bund. We use a set of variables to control for both country and global features. Table A1 in the Appendix enumerates all the variables we use and the sources from which we obtained them. Figure 3 summarizes, using all countries in the sample, simple OLS-based correlations between sovereign spreads and our three debt metrics: debt-to-GDP, GFN to GDP, and the SFP Index.

[Figure 3]

Panel A shows that both debt and GFN (both lagged by one year) explain some of the variation in spreads and that they both contribute positively to the increase in spreads. Remarkably, the interaction of debt and flow measures (SFP Index) correlate yet more strongly with spreads. Moreover, as shown in Panel B, when we focus on a 2006 to 2015 sub-sample, when spreads supposedly became more reactive to fiscal events, the relationships are even clearer. For all the three debt metrics, R-squared doubles up in the sub-sample.

With these stylised facts in mind, in the next section we apply various econometric methods to explore these relations further and to find evidence of the necessity of complementing stock measures with other types of metrics describing debt dynamics in order to analyse the sustainability of public debt.

3. Econometric analysis

In line with the literature on the measurement of sovereign risk in a cross-section of countries (see Lee et al. 2013), we make use of panel data techniques to tie our flow variable (GFN) and the generally accepted stock measure of solvency (Debt/GDP) to the sovereign spreads (risk). We estimate the relationship between GFN/GDP, Debt/GDP, and these

[12] Intuitively, the private market uses information on a country's GFN, among other things, when it decides at what price to trade the sovereign's debt securities in secondary markets.

spreads using panel data modelling.[13] We begin with a simple specification in which stock and flow measures are entered independently:

$$Spread_{it} = \alpha + \beta \cdot \frac{Debt}{GDP}_{it-1} + \gamma \cdot \frac{GFN}{GDP}_{it-1} + \theta \cdot Controls_{it-1} + \mu_i + \varepsilon_{it}$$

Within our econometric specification, in addition to our stock and flow measures of debt stock, we include control variables such as real GDP growth, change in debt (as % of GDP), and three global factors (VIX, world growth, and the US 10-year yield). Within our panel regressions, the key coefficients are those quantifying how stock and flow debt metrics, including the compounding SFP Index, translate into risks to sustainability, as measured by sovereign spreads.

To assess the extent to which combining flow and stock metrics improve our understanding of the dynamics of sovereign risk, we augment the model with an interaction between GFN/GDP and Debt/GDP, the SFP Index:

$$Spread_{it} = \alpha + \beta \cdot \frac{Debt}{GDP}_{it-1} + \gamma \cdot \frac{GFN}{GDP}_{it-1} + \delta \cdot SFP_{it-1} + \theta \cdot Controls_{it-1} + \mu_i + \varepsilon_{it}$$

We estimate these models using both the standard correction for serial correlation and heteroscedasticity, as well as by using the Driscoll-Kraay (1998) estimator that also corrects for the presence of cross-sectional correlation. Our main interest is in δ. If the flow argument is right, δ should be positive and significant.[14] According to our argument, for a given debt stock, countries with lower GFN should suffer less from sustainability concerns ($\delta > 0$).

We assess the robustness of our results in various ways. First, we extend our model with a large number of additional controls, and use different specifications for the error terms. We also use a state-dependent approach, similar to Bassanetti et al. (2016), and measure the effect of GFN in sub-samples with high and low debt.

The role of maturing debt

Additionally, given the different nature of the three elements composing our GFN indicator, we allow for the model to deliver a differential effect for each of them. We do so by estimating the following model:

$$Spread_{it} = \alpha + \beta \cdot \frac{Debt}{GDP}_{it-1} + \sum_{X=\{PB,IT,DA\}} \gamma^X \cdot X_{t-1} + \sum_{X=\{PB,IT,DA\}} \delta^X \cdot \frac{Debt}{GDP}_{t-1} \cdot X_{t-1} + \theta \cdot GDP\ Growth_{it-1} + \mu_i + \varepsilon_{it}$$

The results from this model allow us to disentangle the channels through which changes in GFN affect sovereign risk. The coefficient δ^{DA}, for example, informs us about the extent to which, at a given debt level, increases in debt amortisation (roll-over needs) affect sovereign spreads. The larger the underlying debt stock, if $\delta^{DA} > 0$, the more the increases in roll-over needs will effect perceived sustainability.

[13] In order to attenuate simultaneous determination issues, we lag all our independent variables by one year.

[14] In this working paper version, we use the fixed-effect method. As a further extension we will implement the same estimations using the random effects method. In fact, among our control variables we use a quite complete set of global variables (World real GDP growth rate, US 10-year bond yields, and the VIX), and by using random effects we will be able to reduce the chance that we miss some country-specific effects.

Crisis indicator analysis

As the last step of our analysis, we assess whether our framework is able to tell us what the determinants of fiscal crisis events are. To do so, we use a different approach, and define our dependent variable as a binary indicator taking value one when a country is seen as suffering a sovereign risk crisis. We apply the plain vanilla definition of fiscal stress by defining our dependent variable as a 1 if the annual average sovereign spread for a country/year pair is larger than 350 basis points and it went above 500 basis points at least for a month during the year, and zero otherwise. Using our new dependent variable and the same set of controls, we run both linear probability and logit models.

4. Results

While we find evidence that both flow and stock metrics are relevant, our results indicate that what is critical is their interaction. We observe that changes in the SFP Index lead to significant and economically sizeable movements on sovereign spreads.

The results are presented in Tables 1 through 3. We start our analysis by looking within our sample for correlations between sovereign spreads and GFN. As shown in the first column of Table 1, by using panel regression with fixed effect, we find that this correlation exists and is positive. In fact, an increase in GFN is correlated with an increase in spreads. In columns 2 and 3 we add as controls real GDP growth and world GDP growth, and still find that the correlation exists and is positive, although at a smaller magnitude. As a next step we add a stock metric to the same specification, the debt-to-GDP ratio. The results in column 4 demonstrate that both debt and GFN are positively correlated with sovereign spreads and are significant, suggesting that they could explain different features of it. As in Bassanetti et al. (2016), in order to include an alternative measure to describe a different feature of debt, we add to the specification the change in public debt to (constant) GDP. As shown in column 5, now neither GFN nor the change in debt are significant. This might be the result of the relatively high correlation between GFN and change in debt, as they are both flow measures. Although GFN and the change in debt might look like alternative measures, we believe that they are not. Instead, we believe that GFN explains a part of sovereign spreads variation that is not possible to disentangle by using just the change in debt, i.e. the rollover risk.

[Table 1]

Armed with the intuition supplied by Figure 2, which suggests that there is a compounding effect (and therefore some non-linearity) between GFN and debt in explaining sovereign spreads, we investigate more deeply and add to the previous specification a variable which tries to capture this non-linear feature, the interaction between debt and GFN. In turn, columns 5 through 8 of Table 1 show the results of this new specification. At first glance, it seems that the results are completely different as debt is not significant and GFN now has a negative sign. But a closer look at these results makes clear that the interaction term is fundamental to understanding sovereign spreads. In fact, the way GFN affects spreads now depends on the level of debt. Conversely, to understand what happens to spreads when debt levels change we need to know the GFN level. One implication of this finding is that both GFN and debt stocks become increasingly relevant in determining sovereign risk as the other grows. Figure 5 quantifies this finding graphically. Panel A in Figure 5 plots the effect of increasing GFN by 1% of GDP (marginal effect) on spreads at different debt levels. Analogously, in Panel B we compute the marginal effect on spreads of increasing the debt stock by 1% of GDP.

We observe that, for low debt stocks, increases in GFN have no significant effect on spreads (and are thus not a concern). When debt ratios go above 60%, however, increases in GFN lead to larger sovereign spreads.[15] As shown in Panel A of Figure 5, if a country has a debt-to-GDP ratio of 100%, an increase of 1% in GFN translates, all else being equal, into a 10-basis point spread increase. Analogously, the same increase in GFN when the debt stock is at 80% would translate into a five basis point increase in spreads. On the other hand, Panel B shows that when GFN is low, debt stock increases do not affect spreads. But if GFN is above 20%, each percentage point of increase in the debt stock can lead to spread widening by more than four basis points.[16]

In Figure 4, we use the estimated parameters for the debt-to-GDP ratio, GFN, and their interaction to create a visual representation of the non-linear relation between spreads, debt stocks, and GFN. The steepness of the curve highlights the importance of combined large debt stocks and flow measures in generating stress in sovereign bond markets.

Breaking down GFN

Given that GFN derives from three different sources, in this section we break it down into these components to learn which of the three drives the results we obtained in the previous section.

Table 2 shows all the results. From the first three columns, we can see that it is the debt amortisation component of GFN whose correlation holds throughout the three specifications. After adding debt to GDP and the change in debt to the first specification as shown in columns 4 and 5, none of the GFN component results are significant.

[Table 2]

To explore which component of GFN drives the earlier results we examine the interaction of each of them with the debt-to-GDP ratio. Columns 6 through 9 in Table 2 confirm our initial intuition. The need to roll over government debt is important in explaining sovereign spreads. Moreover, it is the element of GFN whose effect is compounded when it interacts with the level of debt.

Threshold effects

Using the previous estimates, we can identify a threshold for debt above which increases of GFN add to a country's perceived solvency risk.[17] We find that the threshold is around 58.3%

[15] We note that this endogenous turning point for the debt stock, obtained from our analysis, coincides with threshold for high scrutiny used by the IMF or that provided by the Maastricht rules.

[16] Note again that the threshold for GFN coincides with those currently used by the IMF and the ESM.

[17] In the Appendix we also use the signalling approach to identify the debt threshold which best splits stress events and normal periods (with stress events defined in the same way we define them in the paper). It suggests us that a good threshold for debt is given by 69.4% of GDP. As it is close enough we will use the endogenous threshold generated by the regression model. For robustness, we have implemented the "Discrete model" using the 69.4% threshold and the results were qualitatively similar, and also in line with the results from our continuous model,

of GDP (using the results from Table 1, column 6).[18] In this section, we use this threshold to perform another experiment. Specifically, we study the effect of GFN on spreads in two sub-samples: when debt is above 60% of GDP and when it is below. The results of this alternative model are presented in Table 3. Additionally, Figure 6 gives a visual sense of the economic significance of these results.

In Table 3 we show the results obtained by using our *favourite*[19] specification in column 1. We observe that if the debt stock is above 60% of GDP, sovereign spreads may increase by five to six basis points for every 1% increase in GFN. If debt is below that threshold, the results indicate a change in spread that ranges from between zero to 4 basis points for every 1% increase in GFN. The negative marginal effect is, however, not significant. These results also hold when we add time-fixed effects (column 2), whereas, when we correct for the presence of cross-sectional correlation (columns 3 and 4), the coefficients keep the same magnitudes and signs, but the coefficients on GFN are not significant now.

[Table 3]

Figure 6 shows the marginal effect of GFN on the sovereign spreads, when the debt-to-GDP ratio is below and above 60%, computed from the specification in column 1 of Table 3. The graph presents 10% error bands.

GFN and crisis likelihood

In studying the effects of GFN on a binary indicator of sovereign distress, we implement a panel linear probability model to estimate the contribution of our variables of interest to the increase in the probability of an event of sovereign stress. In Table 4 we show the results of the estimations. For these models, we show only the most complete specifications as the sequence of results is qualitatively similar to the previous models. Columns 1 through 3 show that, as in the previous sections, once we add the debt-to-GDP and the change in debt (column 1), the GFN loses significance. Column 2 shows our *favourite* specification, where we include the interaction between debt to GDP and GFN. Now the GFN has a negative and significant coefficient, but, as in the previous case, we can see that the coefficient on the interaction term is positive and large enough to offset the negative effect of GFN once the debt-to-GDP ratio becomes large enough. Column 3 shows very similar results when we correct for the presence of cross-sectional correlation. From these results we can enrich our previous results by inferring that when public debt is "too high" an increase in GFN widens the sovereign spreads and raises the probability of a fiscal stress episode.

[Table 4]

To attempt to quantify the contribution of GFN in increasing the probability of a fiscal stress event, we estimate a panel logit model. Columns 4 and 5 in Table 4 show the results of the panel logit model (with random effects). We show only the most complete specifications as the sequence of results is qualitatively similar to the previous models. In column 4 we show

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with a higher marginal effect of GFN on spread when debt is above the threshold and with the same marginal effect when debt is below the threshold being non-significant.

[18] Henceforth, in the text we will round up the threshold to 60% for convenience.

[19] We will refer to it as our "*favourite*" specification.

that adding the debt-to-GDP ratio and the change in debt make GFN non-significant. In column 5, we include the interaction term between sovereign debt and GFN and we observe that the marginal effect of GFN on the probability of entering a period of fiscal stress becomes positive when debt is higher than 90% of GDP. For instance, as shown in Figure 7, a country with public debt of around 110% of GDP whose GFN increases by one percentage point of GDP, will increase its probability of going into a period of fiscal stress by one percentage points.

5. Conclusions

In this paper we use 20 years of data for 23 European Union countries to study the relationship between stock (debt to GDP) and flow (gross financing needs to GDP) metrics of public debt and a sovereign's borrowing costs. We show that jointly considering these flow and stock measures delivers a more accurate picture of impending risks. We find that the effects of both stock and flow measures reinforce each other above a certain critical threshold. Moreover, we show that sovereign roll-over needs are a critical element driving this effect. Finally, we also document that the combination of stock and flow measures is an important driver of the probability of experiencing a fiscal stress event.

These findings have two important implications. First, they reinforce the idea that DSA needs to simultaneously consider both flow and stock features of the underlying public debt. Our results confirm that focusing only on stock metrics is likely to lead to the wrong conclusion.[20] Second, our results regarding the reinforcing negative effect of debt redemptions and debt stocks underline one channel through which official lending can be beneficial for countries' market access. For countries with a high stock of debt, intervening on the redemption profile can reduce sovereign stress, allowing the country to access financial markets at smoother conditions while working on debt reduction. Given the role of official lending in taming the dynamics of this component, our findings also inform a flourishing literature on the role of official financing in the resolution of sovereign stress.

[20] Moreover, assessing sustainability in countries receiving financial assistance provided by the EFSF/ESM requires a longer perspective than the traditional one decade used by the IMF.

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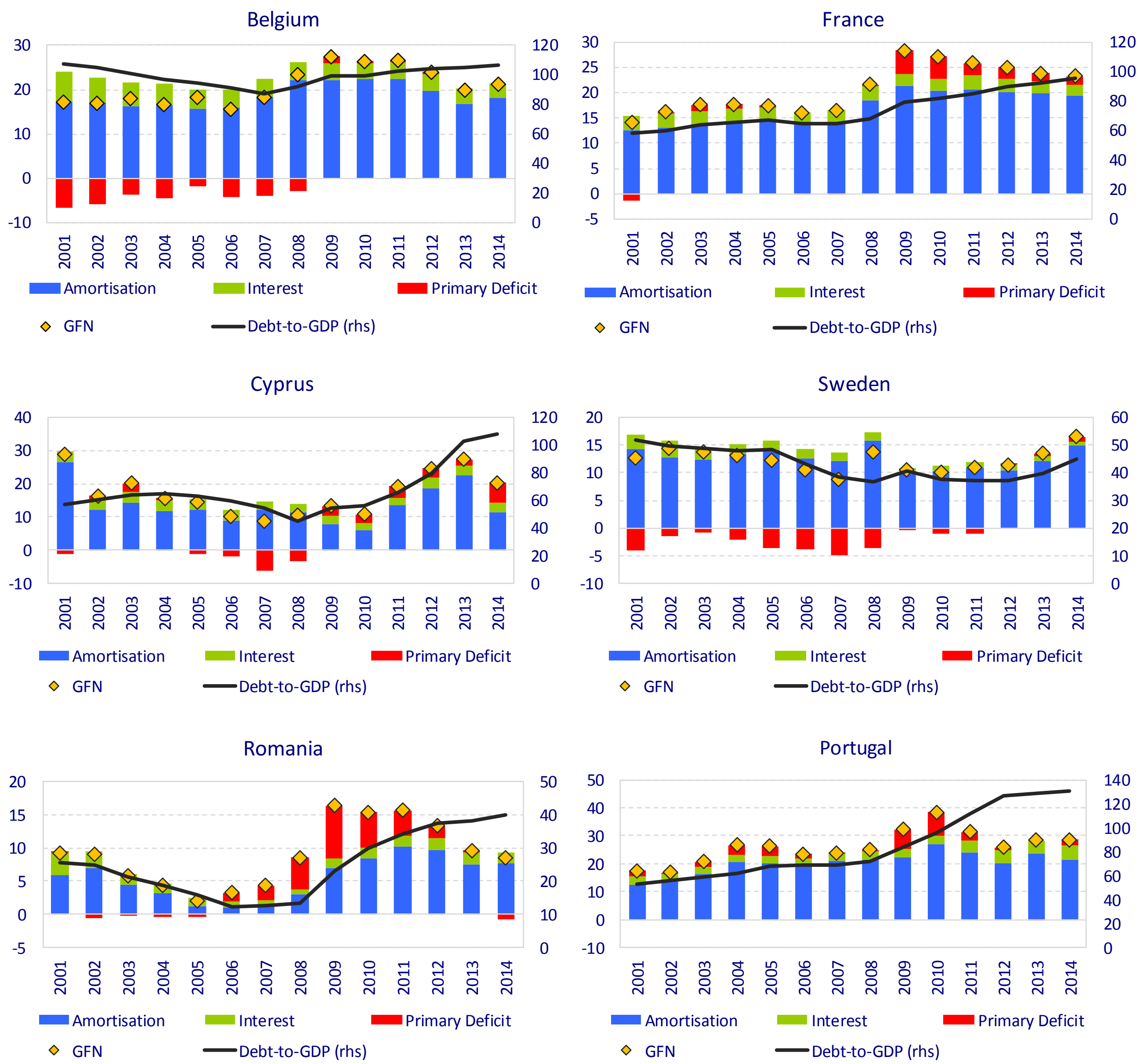
Sandri, D (2015), Dealing with Systemic Sovereign Debt Crises: Fiscal Consolidation, Bail-ins or Official Transfers?. IMF Working Paper No. 15/233.

J. Zettelmeyer, E. Kreplin and U. Panizza (2017). Does Greece Need More Official Debt Relief? If So, How Much?. Peterson Institute for International Economics, Working paper 17-6.

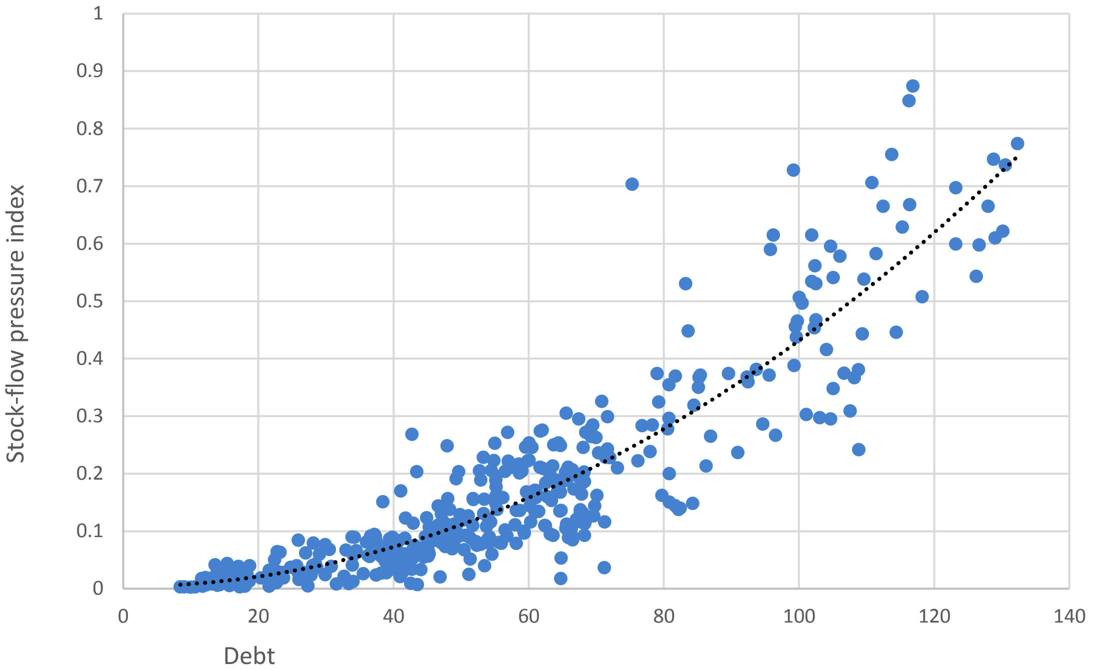
Annex 1. Data

Figure 1: Breakdown of GFN in a selection of EU countries



Source: Authors' calculations based on ECB data. GFN, its sub-components and debt are in percent of GDP. GFN and its sub-components are measured on the left-hand axis, while the debt-to-GDP ratio is measured on the right-hand axis.

Figure 2: SFP Index and debt stocks



Source: Authors' calculations based on ECB data. Debt is in percent of GDP.

Table A1: Coverage

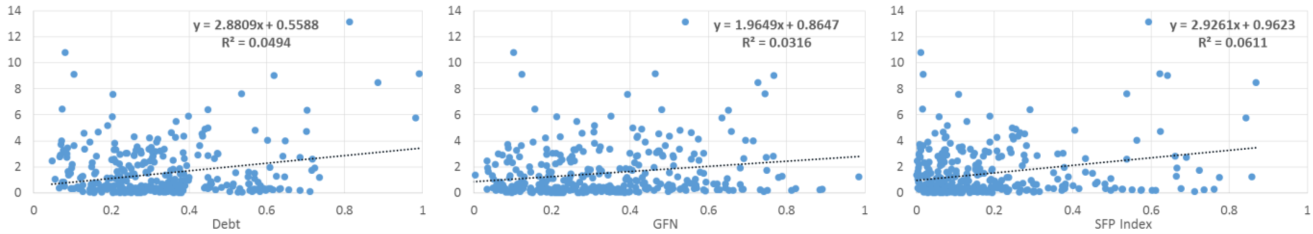
Country	Range	
Austria	1995	2015
Belgium	1995	2015
Denmark	1995	2015
France	1995	2015
Italy	1995	2015
Netherands	1995	2015
Sweden	1995	2015
Finland	1995	2015
Greece	1995	2015
Malta	1998	2015
Portugal	1995	2015
Spain	1995	2015
Cyprus	1998	2015
Bulgaria	2000	2015
Czechia	1999	2015
Slovakia	1998	2015
Latvia	1998	2015
Hungary	1998	2015
Lithuania	1998	2015
Croatia	2003	2015
Slovenia	2000	2015
Poland	1998	2015
Romania	2002	2015

Table A2: Sources

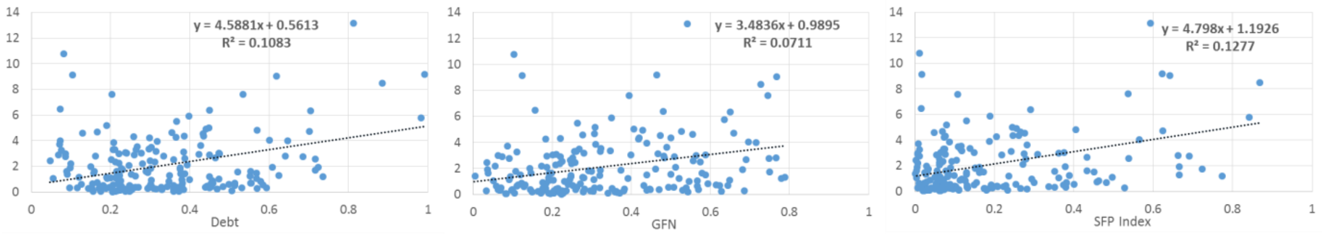
Variable	Source
Sovereign yields	Eurostat
Amortisations	ECB
Primary deficit	Eurostat
Interest expenditures	Eurostat
Debt to GDP	ECB
Change in debt to constant GDP	ECB (debt) and Eurostat (GDP)
Real GDP growth	Eurostat
World GDP growth	World Bank
US 10 year yields	Federal Reserve Board
VIX	Wall Street Journal

Figure 3

Panel A: Sample 1996-2015



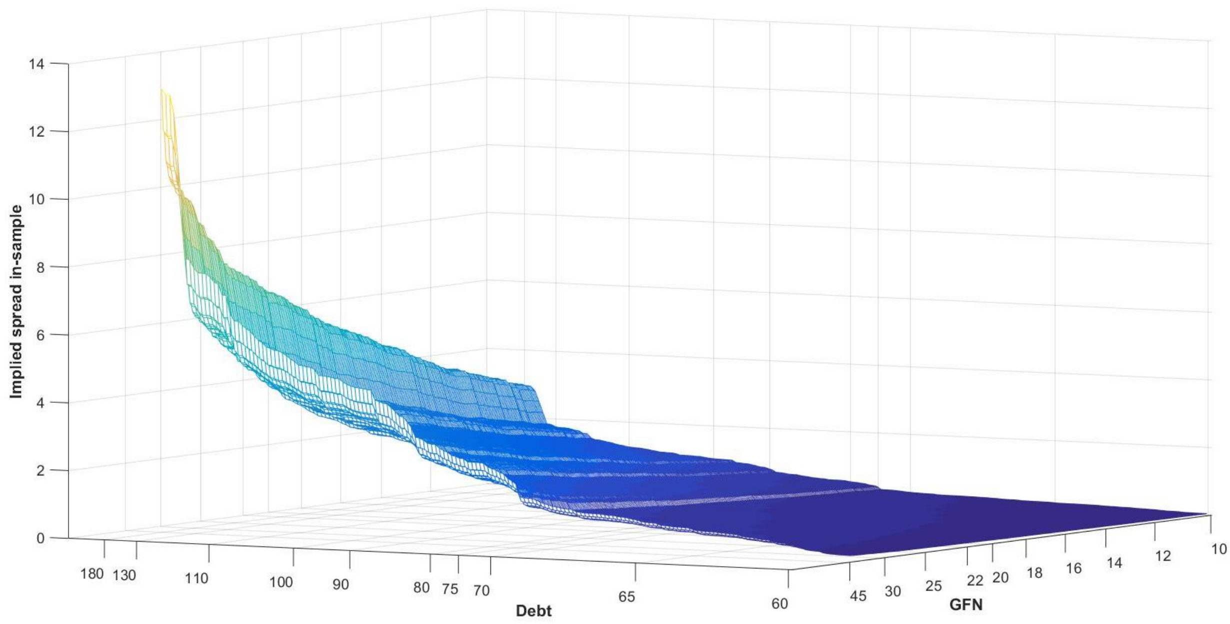
Panel B: Sample 2006-2016



Source: Authors' calculations based on ECB data. The vertical axis measure spreads (in percent). Debt stands for the Government's debt-to-GDP ratio, and GFN for the gross financing needs, as percentage of GDP).

Annex 2. Results

Figure 4: Spreads implied by debt, GFN, and the SFP Index



Source: Authors' calculations based on ECB data

Legend:

Debt and GFN are in % of GDP. Implied spreads are in percent. This 3D plot is produced in Matlab by using in-sample data and the coefficients estimated in Table 1, column 6. Each point in the chart is composed of three coordinates: (X, Y, Z).

X: Debt-to-GDP;

Y: GFN-to-GDP;

*Z: (-0.142 * Y) + (-0.012 * X) + (0.00245 * X * Y).*

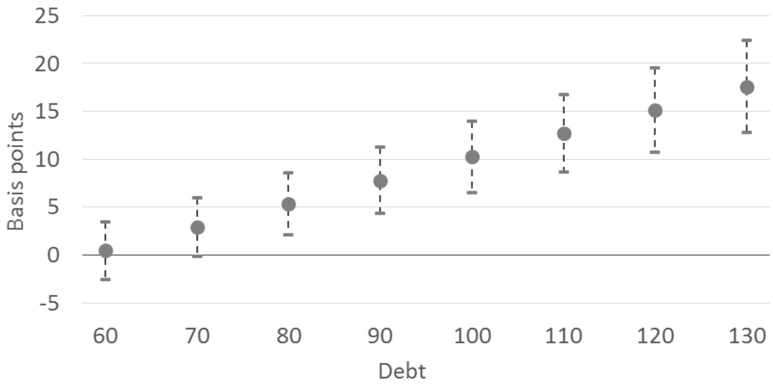
Table 1: Stock-Flow Combinations and Sovereign Spreads

Dependent variable: 10y Spread	1	2	3	4	5	6	7	8	9
GFN	0.112***	0.074***	0.071***	0.041**	0.026	-0.142***	-0.142***	-0.142**	-0.142**
	(0.016)	(0.017)	(0.017)	(0.019)	(0.022)	(0.026)	(0.027)	(0.059)	(0.061)
Debt				0.0211***	0.0228***	-0.012	-0.0135	-0.012	-0.0135
				(0.007)	(0.007)	(0.009)	(0.010)	(0.014)	(0.016)
Change in Debt					0.0294	0.0212	0.0236	0.0212	0.0236
					(0.022)	(0.019)	(0.019)	(0.015)	(0.021)
Debt · GFN						0.00245***	0.00239***	0.00245**	0.00239**
						(0.0003)	(0.0003)	(0.001)	(0.001)
Real GDP Growth		-0.150***	-0.233***	-0.214***	-0.209***	-0.240***	-0.255***	-0.240***	-0.255***
		(0.026)	(0.032)	(0.032)	(0.033)	(0.029)	(0.032)	(0.028)	(0.039)
World GDP growth			0.262***	0.229***	0.229***	0.593***	1.518	0.593***	0.445***
			(0.064)	(0.064)	(0.064)	(0.065)	(1.680)	(0.079)	(0.052)
US 10 year yield						-0.157**	-0.178	-0.157**	-0.0222
						(0.065)	(0.343)	(0.055)	(0.087)
VIX						0.127***	0.129	0.127***	0.0520***
						(0.014)	(0.089)	(0.015)	(0.012)
Constant	-0.167	0.721**	0.178	-0.559	-0.543	-1.665**	-3.85	-1.665***	0.000
	(0.243)	(0.287)	(0.310)	(0.382)	(0.387)	(0.657)	(3.116)	(0.435)	(0.000)
Observations	373	360	360	360	357	357	357	357	357
R-squared	0.129	0.214	0.252	0.274	0.278	0.498	0.536	-	-
Number of countries	23	23	23	23	23	23	23	23	23
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	NO	NO	NO	NO	YES	NO	YES

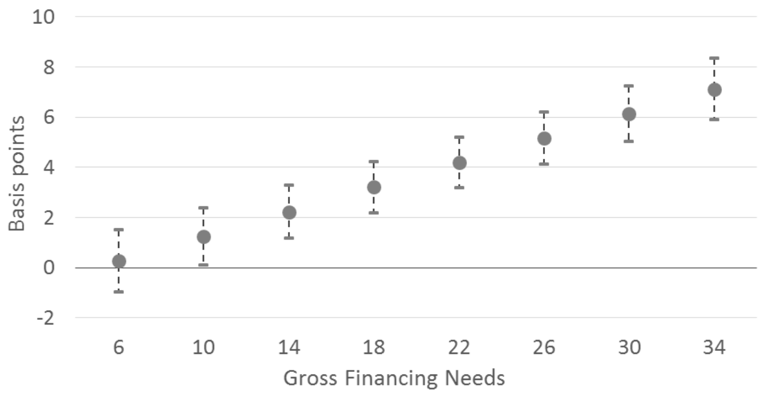
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
GFN and Debt are in percent of GDP. Change in Debt is the difference between Debt in t and Debt in (t-1), divided by GDP in (t-1). Columns 1 through 7 are estimated with standard panel regression techniques. Columns 8 and 9 are estimated using Driscoll-Kraay estimator.

Figure 5: Debt stocks meet gross financing needs: the role of non-linearities

Panel A: Impact of gross financing needs on spreads, by debt levels



Panel B: Impact of debt on spreads, by gross financing need levels



Source: ECB and authors computations. GFN and debt are in percent of GDP. The graph presents 10% error bands.

Legend: Panel A shows the estimated marginal effect of gross financing needs on spreads, using estimates from Table 1, column 6. The figure reports how spreads react to 1% increases in gross financing needs by debt-to-GDP levels. Panel A shows the estimated marginal effect of the debt-to-GDP ratio on spreads, using estimates from Table 1, column 6. The figure reports how spreads react to 1% increases in debt-to-GDP gross financing needs by gross financing need levels.

Table 2: Combining Stocks and Flows - Breakdown of GFN

Dependent variable: 10y Spread	1	2	3	4	5	6	7	8	9
Amortisation	0.094***	0.075***	0.069**	0.037	0.031	-0.126**	-0.128**	-0.126***	-0.128**
	(0.028)	(0.028)	(0.027)	(0.029)	(0.030)	(0.049)	(0.050)	(0.044)	(0.049)
Interest	0.116	0.134	0.137	0.022	0.003	-0.561**	-0.700**	-0.561	-0.700
	(0.088)	(0.097)	(0.095)	(0.101)	(0.105)	(0.258)	(0.292)	(0.516)	(0.607)
Primary deficit	0.143***	0.057	0.058*	0.048	0.018	-0.055	-0.050	-0.055	-0.050
	(0.033)	(0.036)	(0.035)	(0.035)	(0.040)	(0.059)	(0.062)	(0.135)	(0.124)
Amortisation · Debt						0.0019***	0.0018***	0.0019**	0.0018*
						(0.001)	(0.001)	(0.001)	(0.001)
Deficit · Debt						0.0015*	0.0015*	0.0015	0.0015
						(0.001)	(0.001)	(0.002)	(0.002)
Interest · Debt						0.0062**	0.0062**	0.0062	0.0062
						(0.003)	(0.003)	(0.006)	(0.006)
Debt				0.022***	0.023***	-0.004	0.001	-0.004	0.001
				(0.007)	(0.007)	(0.012)	(0.013)	(0.022)	(0.025)
Change in Debt					0.030	0.018	0.021	0.018	0.021
					(0.023)	(0.019)	(0.02)	(0.021)	(0.027)
Real GDP Growth		-0.158***	-0.240***	-0.210***	-0.210***	-0.221***	-0.241***	-0.221***	-0.241***
		(0.027)	(0.033)	(0.034)	(0.035)	(0.031)	(0.033)	(0.026)	(0.034)
World GDP Growth			0.262***	0.228***	0.229***	0.574***	0.670	0.574***	0.397***
			(0.064)	(0.064)	(0.064)	(0.066)	(1.708)	(0.073)	(0.078)
US 10 year yield						-0.069	0.162	-0.069	0.175
						(0.100)	(0.382)	(0.164)	(0.214)
VIX						0.127***	0.210**	0.127***	0.032
						(0.014)	(0.098)	(0.013)	(0.034)
Constant	0.039	0.567*	0.039	-0.534	-0.548	-1.775**	-3.752	-1.775*	0,000
	(0.305)	(0.329)	(0.346)	(0.389)	(0.395)	(0.78)	(3.152)	(0.923)	(0.000)
Observations	373	360	360	360	357	357	357	357	357
R-squared	0.132	0.216	0.254	0.275	0.278	0.376	0.548	-	-
Number of countries	23	23	23	23	23	23	23	23	23
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	NO	NO	NO	NO	YES	NO	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Amortisation, Interest, Primary deficit and Debt are all in percent of GDP. Change in Debt is the difference between Debt in t and Debt in (t-1), divided by GDP in (t-1). Columns 1 through 7 are estimated with standard panel regression techniques. Columns 8 and 9 are estimated using Driscoll-Kraay estimator.

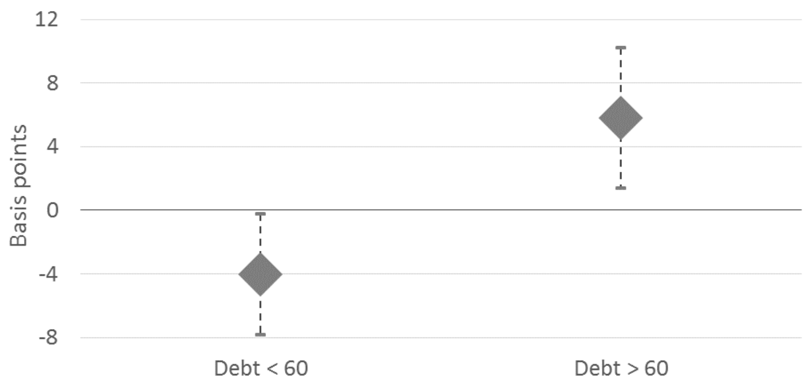
Table 3: Threshold Model - Spreads and Flows when Debt is Above or Below 60%

Dependent variable: 10y Spread	1	2	3	4
GFN · High Debt Dummy	0.058**	0.052*	0.058	0.052
	(0.027)	(0.028)	(0.042)	(0.046)
GFN · Low Debt Dummy	-0.040*	-0.036	-0.040	-0.036
	(0.023)	(0.025)	(0.027)	(0.029)
High Debt Dummy	-1.805***	-1.791***	-1.805	-1.791
	(0.564)	(0.584)	(1.179)	(1.305)
Debt	0.037***	0.039***	0.037***	0.039***
	(0.007)	(0.008)	(0.010)	(0.013)
Change in Debt	0.024	0.026	0.024	0.026
	(0.020)	(0.021)	(0.019)	(0.026)
Real GDP Growth	-0.221***	-0.232***	-0.221***	-0.232***
	(0.031)	(0.034)	(0.031)	(0.046)
World GDP growth	0.576***	0.649	0.576***	0.324***
	(0.070)	(1.792)	(0.088)	(0.049)
US 10 year yield	-0.128*	0.019	-0.128**	-0.140
	(0.071)	(0.365)	(0.059)	(0.087)
VIX	0.127***	0.160*	0.127***	-0.008
	(0.015)	(0.095)	(0.016)	(0.022)
Constant	-3.668***	-4.871	-3.668***	0.000
	(0.639)	(3.327)	(0.816)	(0.000)
Observations	357	357	357	357
R-squared	0.430	0.475	-	-
Number of countries	23	23	23	23
Country FE	YES	YES	YES	YES
Year FE	NO	YES	NO	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

GFN and Debt are in percent of GDP. Change in Debt is the difference between Debt in t and Debt in (t-1), divided by GDP in (t-1). Columns 1 and 2 are estimated with standard panel regression techniques. Columns 3 and 4 are estimated using Driscoll-Kraay estimator. High Debt Dummy equals 1 when the Debt to GDP ratio is larger than 60%. Low Debt Dummy equals 1 when the Debt to GDP ratio is smaller than 60%.

Figure 6: Marginal effects: gross financing needs and spreads when debt is high/low



Source: ECB and authors computations. Debt is in percent of GDP. The graph presents 10% error bands.

Legend:

Figure 6 shows the computed marginal effect of gross financing needs on spreads using estimates from Table 3, column 1. The two points in the figure report how the spreads would change if gross financing needs change by 1% of GDP, when the debt-to-GDP ratio is below and above 60%.

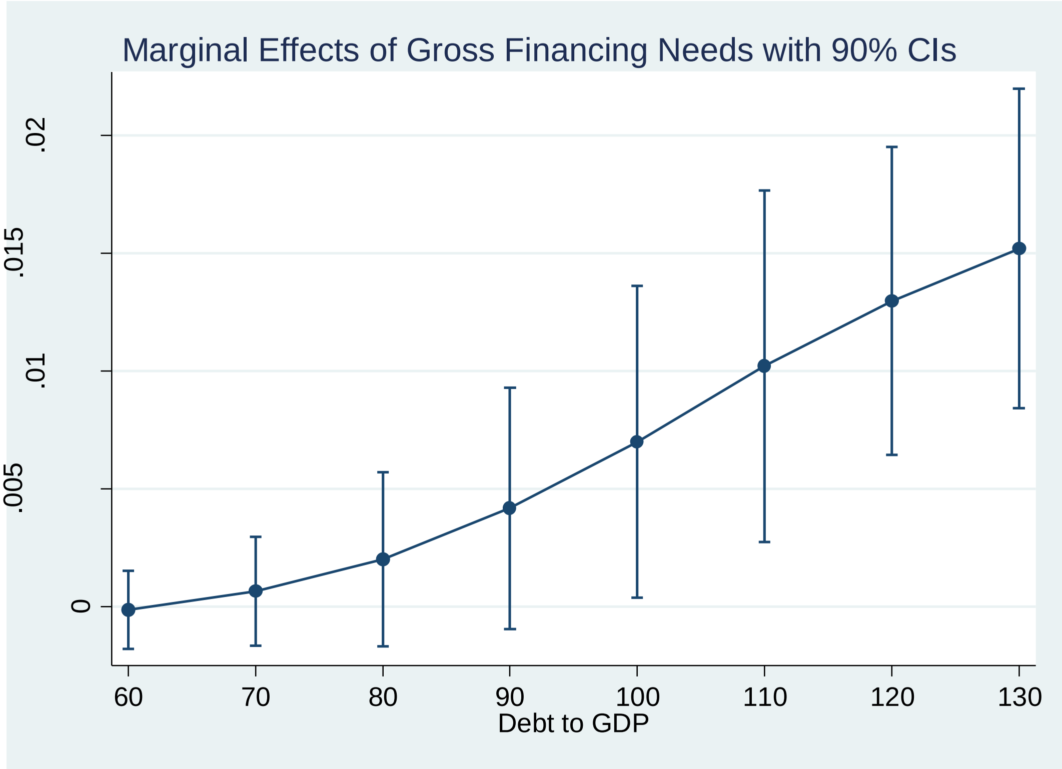
Table 4: Binary Dependent Variable

Dependent variable: Fiscal Stress Events	1	2	3	4	5
GFN	-0.005	-0.017***	-0.017***	-0.019	-0.349**
	(0.004)	(0.005)	(0.005)	(0.078)	(0.148)
Debt	0.005***	0.0003	0.0003	0.039	-0.067
	(0.001)	(0.002)	(0.001)	(0.024)	(0.043)
Change in Debt	-0.001	-0.001	-0.001	0.011	0.008
	(0.004)	(0.004)	(0.002)	(0.073)	(0.089)
Debt · GFN		0.0002***	0.0002***		0.006***
		(0.0001)	(0.0001)		(0.002)
Real GDP Growth	-0.029***	-0.031***	-0.031***	-0.269***	-0.348***
	(0.006)	(0.006)	(0.008)	(0.104)	(0.120)
World GDP growth	0.063***	0.065***	0.065***	0.865***	1.040***
	(0.014)	(0.014)	(0.016)	(0.260)	(0.303)
US 10 year yield	-0.022	-0.021	-0.021*	-1.005***	-1.238***
	(0.014)	(0.014)	(0.012)	(0.380)	(0.453)
VIX	0.015***	0.015***	0.015***	0.294***	0.350***
	(0.003)	(0.003)	(0.002)	(0.075)	(0.095)
Constant	-0.440***	-0.239*	-0.239**	-10.750***	-7.272*
	(0.122)	(0.137)	(0.084)	(3.336)	(3.884)
Observations	357	357	357	357	357
R-squared	0.197	0.221	-	-	-
Number of countries	23	23	23	23	23
Random Effects	NO	NO	NO	YES	YES
Country FE	YES	YES	YES	NO	NO

Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

GFN and Debt are in percent of GDP. Change in Debt is the difference between Debt in t and Debt in (t-1), divided by GDP in (t-1). Columns 1 and 2 are estimated with standard panel regression techniques. Column 3 is estimated using Driscoll-Kraay estimator. Columns 1 through 3 are Linear Probability models. Columns 4 and 5 are estimated using Logit panel regression technique.

Figure 7



Source: Authors' calculations based on ECB data. Debt is in percent of GDP. The graph presents 10% error bands.

Legend:

Figure 7 shows the marginal effect of gross financing needs on the increase in the probability of being in a fiscal stress event (as defined in the paper). Every point in this figure shows how the probability of a fiscal stress event would change given a change in gross financing needs of 1% at different levels of the debt-to-GDP ratio (all else being equal). In order to draw this figure, we used estimates from Table 4, column 5.

Finding the optimal GFN threshold

The signalling approach allows us to identify the threshold in the debt/GDP ratio that best separates stress events from non-stress events, for each specification of stress. The algorithm that implements this method recursively sets each value of the debt/GDP present in the sample as a possible threshold and uses it as signal of a stress event for the next period (one-year ahead): above the threshold it signals stress; below it does not.

For each threshold that the algorithm tries, there are four possible outcomes. The debt/GDP may: signal a stress event and it is right (A), fail to issue a signal in a stress period (missed crisis) (B), issue a signal that is wrong (false alarm) (C), fail to issue a signal in a calm period (D). These four outcomes fill what is called the confusion matrix (Figure 8).

Figure 8

	Crisis	**No crisis**
Signal	A	C
No signal	B	D

For every possible threshold, the algorithm computes the so-called Policy Maker Loss Function (PMLF henceforth), which is defined as follows:

$$\text{PMLF} = \Theta\left(\frac{B}{A+B}\right) + (1-\Theta)\left(\frac{C}{C+D}\right)$$

The PMLF is the weighted sum of the type-I and type-II errors, where the weighting parameter (Θ) reflects the policy maker preferences between the two types of error. This means that a $\Theta > 0.5$ means that the policy maker cares more about not missing a stress event, a $\Theta < 0.5$ means that the policy maker cares more about the potential loss of output given by taking too many pre-emptive measures, while a $\Theta = 0.5$ means that the policy maker is indifferent between the two types of error.

An extended version of the PMLF formula includes weights given by relative frequencies of crises and non-crises events, in order to give the right weight to the two events. We do not multiply the first and the second element in the PMLF by their relative frequencies. The rationale is that we leave the theta parameter free to change. So, excluding the relative frequencies from the formula automatically assigns to the crises events a weight higher than it was supposed to be in the extended PMLF, as it has a lower relative frequency in the sample as compared to the non-crises events.

Finally, in order to choose the relevant threshold, we maximise the following Usefulness measure:

$$\text{max Usefulness} = \min\{\Theta; (1-\Theta)\} - PMLF(\Theta)$$

We apply the plain vanilla definition of fiscal stress by defining our dependent variable as a 1 if the annual average sovereign spread for a country/year pair is greater than 350 basis points, it exceeded 500 basis points for at least one month during the year, and was otherwise at zero.

The relevant threshold for the debt-to-GDP ratio resulting from splitting the normal periods from the stress events is 69.4%.

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