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Debt sustainability analysis for euro area sovereigns: a methodological framework

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Abstract

The euro area sovereign debt crisis has highlighted the importance of reducing public debt levels and building up sufficient fiscal buffers during normal and good times. It has also reaffirmed the need for a thorough debt sustainability analysis (DSA) to act as a warning system for national policies. This paper introduces a comprehensive DSA framework for euro area sovereigns that could be used for analysis of fiscal risks and vulnerabilities. Specifically, this framework consists of three main building blocks: (i) a deterministic DSA, which embeds debt simulations under a benchmark and various narrative shock scenarios; (ii) a stochastic DSA, providing for a probabilistic approach to debt sustainability; and (iii) other relevant indicators capturing liquidity and solvency risks. The information embedded in the three main DSA blocks can be summarised in a heat map, which can provide guidance on the overall assessment of risks to debt sustainability. This method reflects the need to have a broad-based assessment, cross-checking information and perspectives from various sources with a view to deriving a robust debt sustainability assessment.

Keywords: sovereign debt sustainability analysis, fiscal policy, public debt; euro area, fiscal risks.

JEL classification: E62, H62, H63, H68

Non-technical summary

A debt sustainability analysis (DSA) framework is an important tool for the assessment of sovereign vulnerabilities and can provide national authorities with policy warnings. Most international organisations and financial institutions use debt sustainability analyses in their surveillance procedures. The assessment of Member States' general government debt developments is also a key component of fiscal surveillance under the Stability and Growth Pact (SGP).

This paper introduces an enhanced DSA framework for euro area sovereigns. With a focus on the assessment of risks to debt sustainability, the framework is largely based on a practical definition of sustainability. One such definition, as proposed by the IMF (2013), includes debt dynamics, the level of debt, and the feasibility to achieve or maintain primary balance surpluses, as follows: "In general terms, public debt can be regarded as sustainable when the primary balance needed to at least stabilise 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 […] The higher the level of public debt, the more likely it is that fiscal policy and public debt are unsustainable […]" (IMF, 2013, pp. 4). In addition, any debt sustainability analysis for the euro area countries should take the minimum requirements of the EU fiscal governance framework into account when assessing the needed adjustment in the primary balance and the sustainable debt level. Finally, a broad range of other indicators, including a shorter-run liquidity indicator encompassing gross financing needs, as well as institutional factors, should be considered in order to assess risks to debt sustainability.

More specifically, the DSA framework outlined in this paper is derived based on three main building blocks: (i) a deterministic DSA; (ii) a stochastic DSA; and (iii) other relevant short and medium to long-term indicators. First, under the deterministic DSA block, debt projections in a central benchmark, as well as in adverse narrative shock scenarios, are evaluated based on three criteria, namely the debt level, debt dynamics and the feasibility of sustaining primary surpluses. The adverse narrative shock scenarios are used to stress test the resilience of the benchmark (central) debt path. The simulation horizon for the deterministic DSA is ten years. Second, the framework provides a quantitative assessment of uncertainty surrounding the debt projections (stochastic DSA) for three indicators: the probability of the future debt level being above a certain threshold, the probability of debt not stabilising, and the dispersion of simulated debt paths as a measurement of the overall uncertainty. Third, the DSA framework includes various other indicators to capture both short-run liquidity risks and medium to longer-run solvency risks, which cannot be directly captured in the deterministic DSA. The short-run liquidity risks take into account net financing needs and a composite index of the ease of refinancing. The medium to longer-run risks include four categories of indicators: the public debt maturity structure, scope for contingent liabilities, the net financial position of the economy and governance and political risk.

The information embedded in the three main DSA blocks can be summarised in a heat map, which can provide guidance on the overall assessment of risks to debt sustainability. The advantage of this method is that it offers a comprehensive, yet concrete and easy-to-grasp, quantitative risk assessment for euro area countries.

1 Introduction

Sustainable public finances are a prerequisite for the proper functioning of Economic and Monetary Union (EMU). Sound fiscal and economic policies at the national level are crucial in a monetary union in which the member countries share a single currency and the responsibility for monetary policy is assigned to an independent institution, namely the European Central Bank (ECB).[1] This also implies that national policies are a matter of common concern and should not be allowed to impose disproportionate costs on other EMU participants. As regards fiscal policies, the basic requirements for the proper functioning of EMU, in particular the need to avoid excessive government deficit and debt ratios, are well enshrined in the Treaty and the secondary EU legislation.[2] If fiscal and macroeconomic imbalances are not corrected in a timely manner, the materialisation of country-specific risks to sovereign debt sustainability would not only have adverse implications for the country concerned, but could also lead to negative spillovers to other Member States. The stabilisation function of fiscal policies in the euro area can only operate if risks to debt sustainability remain contained.

A DSA framework is an important tool for the assessment of sovereign vulnerabilities and can provide national authorities with policy warnings. Most international organisations and financial institutions use debt sustainability analyses in their surveillance procedures. Under the Treaty establishing the European Stability Mechanism, consideration of financial assistance to euro area Member States experiencing financing problems requires, inter alia, a debt sustainability assessment by the European Commission, in liaison with the ECB, and possibly also the International Monetary Fund (IMF) as part of the procedure.[3] A DSA is also required for the design of policy conditionality in EU-IMF financial assistance programmes. Finally, the assessment of Member States' general government debt developments is a key component of fiscal surveillance under the Stability and Growth Pact (SGP)[4].

So far, many euro area countries have not sufficiently redressed their fiscal and macroeconomic imbalances. Many governments did not build up sufficient fiscal buffers before the crisis. While general government debt-to-GDP ratios declined in many euro area countries in the years ahead of the crisis, this decline fell

1 For earlier discussions on the relationship between fiscal policies and monetary policy in the euro area, see, inter alia, ECB (2008) and ECB (2012b).

2 See Article 121 of the Treaty on the Functioning of the European Union, which states that "Member States shall regard their economic policies as a matter of common concern and shall coordinate them with the Council" and Article 126, which stipulates that "Member States shall avoid excessive government deficits" and that compliance with budgetary discipline shall be examined on the basis of two criteria, the deficit and the debt ratio in relation to specific reference values (defined as 3% and 60% of GDP respectively in Protocol (No 12) on the excessive deficit procedure). The debt criterion was operationalised by the introduction of the debt rule in the 2011 reform of the Stability and Growth Pact ("six-pack").

3 See Article 13 ("Procedure for granting stability support"), paragraph 1(b), of the Treaty establishing the European Stability Mechanism.

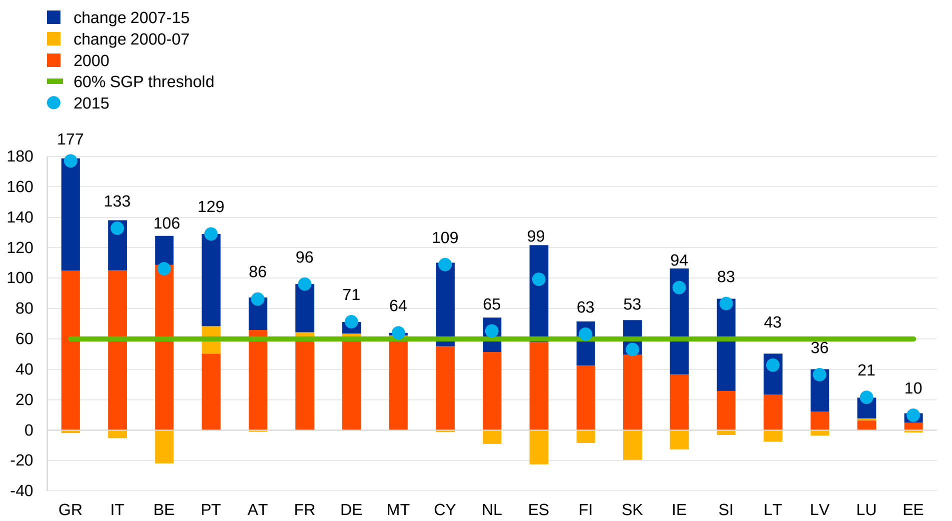
4 In addition to assessing risks for individual countries, sustainability frameworks have been used as inputs in the assessment of policies at aggregate level, such as the appropriate fiscal stance in the euro area. For a discussion, see Bankowski and Ferdinandusse (2016).

significantly short of what would have been desirable under the favourable economic circumstances at that time. In 2007 a number of countries recorded government debt-to-GDP ratios well in excess of the Maastricht Treaty's 60% reference value. Despite progress since the crisis, some countries have fallen short of their commitments under the SGP. Debt ratios in 2015, while on a declining path in several countries, remain in many at high and very high levels (see Chart 1). Several Member States have also failed to implement the necessary structural reforms to boost long-term growth and support real convergence within EMU.[5] In the run-up to the crisis, competitiveness deteriorated significantly in several countries, some of which also experienced unsustainable credit-financed domestic demand booms and housing bubbles. Given, among other things, the adverse sovereign-bank feedback loops at work during the crisis, the ensuing real economic and financial downturn implied significant fiscal costs and the materialisation of contingent liabilities for governments. As a consequence, risks to public debt sustainability increased substantially in several euro area countries, which came under heightened market pressure. Against this background, the key purpose of a DSA is to identify public debt sustainability risks. This, in turn, serves as an important warning tool to guide economic policy.

Chart 1

General government debt-to-GDP ratio: developments in euro area countries

(% of GDP)



Sources: Ameco (as per the European Commission Spring 2016 forecast database) and own calculations.
Notes: countries are shown in the descending order of their government debt-to-GDP ratios in 2007.

This paper introduces an enhanced DSA framework for euro area sovereigns, targeting non-programme countries in particular. The next section summarises the main theoretical underpinnings of conventional debt sustainability analysis. Section 3 outlines a conceptual framework for an enhanced debt sustainability analysis for euro area sovereigns. The main building blocks of this framework are introduced in

5 For a discussion of the factors behind the lack of sustainability in the process of real convergence across the EMU countries, see ECB (2015a).

sections 4-7, which present, by way of example, results for the euro area aggregate, where feasible. Section 8 concludes.

2 Relevant DSA concepts

This section briefly reviews the theoretical underpinnings of conventional debt sustainability analysis and the various metrics and approaches used in the literature to assess whether a government's debt is sustainable or not. It also sets out a practical definition of sustainability in line with proposals of other international institutions, in particular the IMF.

There is no simple rule for determining whether a government's debt is, in practice, sustainable or not. Any sovereign debt sustainability analysis is inherently difficult and sensitive to the assumptions used. Box 1 below provides some of the relevant definitions and metrics used in the literature. A DSA involves projections of, and judgement on, fiscal as well as macroeconomic and financial variables over a long-term horizon. The important task of gauging contingent and other implicit liabilities for the government sector and creating meaningful sensitivity scenarios is inherently complex. Past examples show how difficult it may be, in practice, to reliably project debt paths.[6]

Box 1
Debt sustainability concepts

Sustainability of government debt means that the accumulated debt has to be serviced at any point in time. This requires governments to be both solvent and liquid.[7]

"Solvency" is a medium to long-term concept and requires that the government's budget constraint is fulfilled, meaning that the net present value (NPV) of the government's future primary balances must be at least as high as the NPV of outstanding government debt ("flow concept").[8] An equivalent criterion ("stock concept") states that the present value of liabilities should not be greater than the present value of assets. In more concrete terms, a government is solvent if it is seen to be able to generate sufficient primary budget surpluses in the future to repay its outstanding debt.

"Liquidity" is a short-term concept and refers to a government's ability to maintain access to financial markets (whenever it does not have sufficient cash or other liquid assets), ensuring its ability to service all upcoming obligations in the short term.

Liquidity and solvency are linked. If the market suspects that there is a significant risk that a government may no longer be solvent – or, while in principle being solvent, may no longer be willing

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6 A review of IMF Article IV staff reports for the advanced economies found that in most cases the magnitude of public debt increases over the recent global crisis was not anticipated, even under the most extreme shock scenarios. See Cottarelli and Moghadam (2011).

7 See also ECB (2012a)

8 Policy conclusions based on this theoretical definition are complicated by the uncertainty associated with calculations at very long time horizons (infinity) and the choice of discount rates to calculate NPVs (such discount rates should also differ between classes of liabilities and assets held by governments). Although the views in the literature differ, the NPV of debt needs to be calculated assuming that the government fully honours its debt obligations, implying that the discount factor does not include any default risk premia.

to fully service its debt – the liquidity situation will tighten. At the same time, a liquidity crisis may cause a deterioration in the conditions underpinning sustainability.

Analytical studies on debt sustainability typically rely on long-term projections of gross debt. This is primarily because of high uncertainty related to estimates of the NPV of assets held by the government and, especially, to whether these assets can actually be used to repay debt. That being said, financial assets and net debt should be considered as components of a comprehensive DSA framework.

As pointed out in IMF (2013), in assessing debt sustainability in practice, the pure solvency criterion outlined above is not very practical or demanding, as it would allow a government to run large primary deficits for an extended period of time if it could credibly commit to running sufficiently high primary surpluses thereafter. Therefore, a practical definition of sustainability, to capture both solvency and liquidity in a measurable, policy-relevant way, would be needed (see the main text). In practice, debt sustainability analysis typically sets out from the following debt accumulation equation:

$$\Delta b_t = \frac{i_t - g_t}{1 + g_t} b_{t-1} - pb_t + dda_t \qquad [1]$$

which provides for a simple accounting framework to decompose the change in the government gross debt-to-GDP ratio ($\Delta \mathrm{b_t}$) into its key drivers, consisting of: (i) the "snowball effect", i.e. the impact from the difference between the average nominal interest rate charged on government debt ($\mathrm{i_t}$) and the nominal GDP growth rate ($\mathrm{g_t}$) multiplied by the debt-to-GDP ratio in the previous period ($\mathrm{b_{t-1}}$); (ii) the primary budget balance ratio ($\mathrm{pb_t}$); and (iii) the deficit-debt adjustment as a share of GDP ($\mathrm{dda_t}$) comprising factors that affect debt but are not included in the budget balance (such as acquisitions or sales of financial assets, valuation effects, etc.).

With $\mathrm{dda} = 0$, the debt ratio will stabilise when $pb_t \approx (i_t - g_t) b_{t-1}$.Thus, if $i > g$, as has been commonly the case for advanced economies over extended periods in the past, a primary surplus is needed to stop the debt burden from rising and an ever larger surplus is needed to reduce the debt burden. That primary surplus will need to be larger, the higher the initial debt level.

While it has been a common practice for DSA to focus on long-term debt dynamics, given the inherent risks associated with high debt, debt sustainability also depends on the level at which a specific debt path evolves. In this respect, DSA frameworks may embed prudent cross-country thresholds (in particular the 60% of GDP debt ratio enshrined in the Treaty) and further upper thresholds derived from the literature on early warning indicators (e.g. the IMF's DSA framework uses an upper threshold of 85% of GDP for advanced economies). Such debt ratios (particularly the 60% of GDP ratio) are also used in some instances in national fiscal frameworks as debt ceilings.

Other theoretical and empirical approaches to sustainability

Stochastic DSA

The stochastic DSA captures the uncertainty surrounding deterministic debt paths. This probabilistic tool has become part of fiscal policy assessments in many international institutions. Most often, it employs the historical volatility and co-movement of the macroeconomic variables entering into the debt accumulation equation and produces a fan chart around the deterministic debt path. Such fan charts can be used to calculate probabilities attached to certain sustainability indicators.

(Sustainable) Debt limits

Given the perils of high debt, the literature has so far identified several approaches to derive (sustainable) debt limits and propose debt benchmarking to such thresholds in order to assess sustainability. While many of the metrics used in the literature are empirically useful to gauge the capacity of a country to sustain a certain debt burden, they are surrounded by high uncertainty. This uncertainty stems from various sources, such as the historical time period chosen, the country sample used or the model specification. There is thus a very large dispersion of results across various models. For an overview and a description of uncertainties associated with some of these approaches, see also IMF (2013) and European Commission (2016). Among the most known approaches to derive debt limits and assess sustainability on this basis are:

(i) The “steady-state debt ratio”, formalised by Blanchard et al. (1990), that is, the debt-to-GDP ratio to which the economy would tend to converge in the long run (implying debt stabilisation in the steady-state). In other words, this is the public debt ratio beyond which a government does not meet the inter-temporal budget constraint any longer. Some studies (e.g., IMF 2003) propose to operationalise this concept by approximating expected primary balances, future interest rates and future growth on the basis of their long-run historical averages. Others (e.g., European Commission, 2016) derive the primary balance from estimated country-specific fiscal reaction functions (see below) and use various assumptions for the *i-g* differential. The "steady-state" debt ratios are generally more prudent than the "debt limits" (see below).

(ii) The “natural debt limit” introduced by Mendoza and Oviedo (2004) for emerging economies is the maximum debt ratio that the government would be able to service with certainty, i.e. even in the worst-case scenario for its fiscal position. The authors introduce short-run (liquidity) aspects in the long-run sustainability model, in an attempt to account for financial markets’ default concerns in cases of high macroeconomic volatility or fiscal fatigue after large adjustment programmes.

(iii) The “fiscal space” proposed by Ghosh et al. (2013) or the “fiscal limit” proposed by Bi and Leeper (2013). The common aim of these approaches is to determine a “debt limit” beyond which fiscal solvency is seriously in doubt or to give a probabilistic view on the debt limits, depending on the state of the economy.

“Fiscal space” seeks to determine a “debt limit” beyond which the government would default. At this point, fiscal fatigue impedes a higher adjustment of the primary balance and the *i-g* differential could explode given an endogenous market risk premium and default probability. It is derived empirically, starting from a fiscal reaction function estimated for a certain group of countries (in Ghosh et al (2013), for a group of 23 advanced economies over the period 1970-2007), in which fiscal fatigue is identified at a high debt level. On this basis, estimates of fiscal space for individual countries are derived. For instance, for most euro area countries, estimates of “fiscal space” at the height of the crisis were rather generous and surrounded by significant uncertainty, with the debt limit going well above 150% of GDP, leading the authors, therefore, to argue that countries should stay well below such dangerous limits. At the same time, the model incorporates a stable debt ratio – much lower than the debt limit – to which the economy converges in the steady-state (see above).

“Fiscal limit” is a DSGE (Dynamic Stochastic General Equilibrium) model of sovereign default in essence stating that there is a maximum government debt-to-GDP ratio that can be sustained without appreciable risk of default or higher inflation. Yet, this is not a point estimate, it is a probability distribution. The maximum primary surplus and the discount rates *(i-g)* vary over time and according to the state of the economy. The fiscal limit is linked to the government ability to raise revenue (or to its position on the *Laffer curve*).

Other statistical and empirical approaches

A number of approaches investigate past behaviour of governments in coping with debt sustainability constraints. Such approaches, in particular the fiscal reaction functions, are relevant for drawing lessons for future behaviour and to distinguish the channels through which governments can achieve sustainable fiscal policies. From a practical point of view, in terms of debt sustainability analysis, the major downside of these methods is their backward orientation.

"Fiscal reaction function" (FRF) is the concept of debt sustainability grounded in the works of Bohn (1998, 2008), and shows that a sufficient condition for sustainability is that the government reacts systematically to increases in government debt by adjusting the primary balance (reducing the deficit or increasing the surplus net of interest payments). In empirical analyses, this condition is usually tested by regressing the primary balance on lagged debt. In case of a linear relationship, a positive and significant debt coefficient denotes weak evidence of sustainability.[9]

Statistical approaches: alternative empirical approaches to assessing fiscal sustainability from a backward-looking perspective are based on econometric tests of time series behaviour of fiscal variables. In particular under certain assumptions regarding the behaviour of GDP growth and interest rates, stationarity and cointegration tests can be used to assess fiscal policy sustainability. One approach focuses on the stationarity properties of public debt. Another approach looks at the behaviour of the determinants of the deficit ratio, i.e. the growth rates of expenditure and revenue. If the two variables are cointegrated, the fiscal deficit is stationary and fiscal policies are deemed sustainable. Finally, cointegration between the primary balance and public debt has been proposed as an alternative statistical approach of the FRF. The disadvantages of these approaches relate mainly to data constraints, as well as the very simple nature of usually bivariate relations.

For such methods and other alternative approaches, including the balance sheet method (focused on a balance sheet view of the government, similar to that of corporations, which is extremely data intensive and country-specific), see Giammarioli et al. (2007).

The enhanced framework for sustainability risk assessment outlined in this paper is largely based on a practical definition of sustainability. One such definition, proposed by the IMF (2013), includes debt dynamics, the level of debt, and the feasibility of achieving or maintaining primary balance surpluses, as follows: "In general terms, public debt can be regarded as sustainable when the primary balance needed to at least stabilise 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 […] The higher the level of public debt, the more likely it is that fiscal policy and public debt are unsustainable […]"(IMF 2013, p. 4). In addition, any debt sustainability analysis for the euro area countries should integrate (at least) the

9 As shown in Ghosh et al. (2013), in the presence of fiscal fatigue (bounded surpluses), this condition provides only weak evidence of sustainability.

minimum requirements of the EU fiscal governance framework when assessing the needed adjustment in the primary balance and the sustainable debt level. Finally, a broad range of other indicators, including a shorter-run liquidity indicator encompassing gross financing needs as well as institutional factors, should be considered in order to assess risks to debt sustainability.

Owing to various sources of uncertainty in the assessment of debt sustainability, it is necessary to conduct a broad-based analysis. This analysis should account for sustainability factors along at least three dimensions. First, notwithstanding the usual medium to long-term solvency perspective of the DSA, the country's ability to maintain market access in the short term is also important. This is because liquidity risks in terms of difficulties in accessing financial markets in the short term could imply debt sustainability problems over the medium term, as higher sovereign bond yields will gradually increase the cost of servicing debt. Second, government debt can only be considered sustainable if the fiscal and structural reform policies required to bring debt firmly onto a downward path towards prudent levels are feasible and realistic in both political and economic terms. Third, apart from the "ability to pay", a basic prerequisite or guarantor for fiscal sustainability is the government's "willingness" to pay the obligations to its creditors in full. The following section outlines the various components of the enhanced DSA framework.

3 Overview of an enhanced DSA methodology

In line with other institutions' practices and given the high relevance of debt sustainability analysis for country surveillance, this paper presents an enhanced DSA framework. This framework builds on previous work within the ECB and also reflects aspects of the IMF (2013) and the European Commission (2014) DSA methods. Compared with the IMF, this paper's method takes a longer time perspective (ten years for debt simulations, as in the Commission's approach, as opposed to five in the IMF's approach). Other differences stem, inter alia, from the short-term approach to liquidity risk and from a larger set of indicators included in the heat map. In line with the IMF procedure, this paper's method embeds various shock scenarios directly into the heat map. Some aspects similar to our methodology, including the evaluation of the benchmark and adverse shock scenario, according to debt level, dynamics and fiscal effort, have recently been introduced into the Commission's enhanced DSA methodology of the 2015 Fiscal Sustainability Report (see European Commission, 2016). Owing to the inherent difficulties and uncertainties in assessing sovereign debt sustainability, a broad range of indicators is necessary for a robust analysis.

Table 1

Overview of the enhanced DSA framework

	Deterministic DSA		Stochastic DSA	Other indicators
	Benchmark scenario	**Shock scenarios**		
DSA building blocks	Mechanical and rule-based central scenario	Narrative shocks around benchmark: i) No fiscal policy change with ageing costs ii) Historical iii) Macro (bank) stress test iv) Inflation shock v) Structural shock	Probabilistic way to assess uncertainty around benchmark based on VAR model	For short- and medium-term risks i) Liquidity risk ii) Debt structure iii) Contingent liabilities iv) Net financial position of the economy v) Governance and political risk
Evaluation criteria for traffic-light heat map	i) Debt level in t+10 ii) Debt dynamics (year of debt peak) iii) Fiscal fatigue (capacity to maintain primary surpluses; only in benchmark)		i) Probability debt ratio in t+5 > 90% ii) Probability debt ratio not stabilising by t+5 iii) Dispersion debt path in t+5	Thresholds (empirical literature) or Percentile of indicator distribution
Overall aggregation	4-colour heat map (green, yellow, orange, red)			

Source: own representation.

The country-specific DSA is derived based on three main building blocks: (i) a deterministic DSA, (ii) a stochastic DSA and (iii) other relevant short and medium to long-term indicators (see Table 1). First, under the deterministic DSA block, debt simulations in a benchmark (central scenario) and adverse narrative shock scenarios are evaluated based on three criteria: debt level, debt dynamics and fiscal fatigue (the feasibility of sustaining primary surpluses, used for the benchmark only). The simulation horizon for the deterministic DSA is ten years (i.e. 2016-25 in this paper). Second, the framework provides an empirical assessment of the uncertainty surrounding the debt simulations, captured by the stochastic DSA. Three indicators (criteria) are used as input for the heat map in this block, namely: (i) the dispersion of simulated debt paths as a measurement of overall uncertainty, (ii) the probability of the debt projection being above a certain threshold, (iii) the probability of debt not stabilising. All criteria are evaluated at the end of the stochastic DSA horizon, which is five years. Third, the debt sustainability analysis includes various other indicators to capture both short-run liquidity risks and medium to longer-run solvency risks, which cannot be directly captured in the deterministic DSA. The short-run liquidity risks take into account net financing needs, as well as a composite index of the ease of refinancing. The medium to longer-run risks include four categories of indicators: the public debt maturity structure; contingent liabilities; net financial position of the economy; and governance and political risk. These indicators are assessed based on thresholds identified in the empirical literature and, where such thresholds are not available, based on in-sample distribution. The information contained in each of the three DSA building blocks can be summarised in a traffic light colour heat map (green-yellow-red) according to the above-described criteria. Finally, the individual heat map entries can be further condensed into an overall four-colour heat map of debt sustainability risks (red for very high risk, orange for high risk, yellow for medium risk and green for contained risk). For an overview of the framework, see Table 1.

4 The deterministic DSA block

The deterministic DSA block comprises a central benchmark debt path scenario and several adverse shock scenarios. It is called “deterministic” because the debt path is determined on the basis of explicit assumptions for the underlying variables (GDP growth, interest rates, fiscal position). Various adverse shock scenarios are constructed around the benchmark scenario in order to gauge the resilience of sovereign debt to such developments.

Specific metrics are introduced to evaluate the risks surrounding the debt paths in both the benchmark and the adverse shock scenarios. First, the level of debt at the end of the simulation period is assessed. The motivation for this criterion is justified because high levels of debt are associated, inter alia, with a high debt servicing burden and a higher sensitivity to adverse shocks. Second, the dynamics of the debt path are evaluated in terms of the projected time required to stabilise the debt-to-GDP ratio. Longer horizons to stabilise the debt ratio imply higher uncertainty and higher debt sustainability risks. Third, a fiscal fatigue criterion is used (only in the benchmark) to assess the likelihood of maintaining sustained primary balances. More precisely, the political feasibility of the cumulative primary surpluses inherent in the respective debt paths is assessed against the country’s own historical track record as well as common benchmarks. For illustrative purposes, the euro area aggregate is shown in this section.

4.1 The benchmark scenario

The benchmark aims at providing a plausible, internally consistent and rule-based scenario. It assumes that governments will take additional fiscal measures as necessary to broadly meet the minimum requirements under the SGP to avoid potential financial sanctions. Interest rate assumptions are derived from market expectations, extrapolated over the medium term. For the purpose of consistency with the fiscal rule embedded in the DSA benchmark, real GDP growth assumptions ensure convergence to potential growth estimates. On the nominal side, inflation rates based on the GDP deflator are assumed to converge to a rate consistent with the ECB’s objective of price stability. The precise assumptions underlying the benchmark scenario are summarised in Box 2 below.

Box 2
Assumptions underlying the benchmark scenario

The benchmark simulations are conducted for a period of ten years (e.g. 2016-25), reflecting the medium to longer-term focus of the DSA. This horizon constitutes a compromise between, on the one hand, the requirement of a long-term orientation and, on the other hand, the increasing uncertainty associated with it. For illustrative purposes, the euro area simulations shown in this paper take the latest European Commission (EC) projections as a starting point for the shorter term (the EC Spring 2016 projections are used as a basis for the period 2016-17, with the cut-off date for simulations 22 April 2016). Potential growth estimates are also based on the EC Spring 2016 forecast and the disaggregation between the cyclical component and the structural position is done based on the EC's methodology to ensure consistency with the fiscal effort path under SGP requirements. In more detail, the following assumptions apply in this framework taking the EC Spring 2016 forecast as a basis.

Fiscal assumptions

The fiscal consolidation path

The benchmark assumes that governments broadly comply with the minimum fiscal requirements to avoid significant deviations and, potentially, sanctions under the SGP. Such assumptions are implemented as follows. When a draft budgetary plan is available (2016 plans in this paper), then the nominal budget balance projection for the respective year is taken into account (as reflected in the EC Spring 2016 forecast). For the following year (2017), if the minimum SGP requirements are above the structural effort planned by governments, then the (less ambitious) government's target is incorporated into the benchmark to ensure prudence. The governments' fiscal effort (from 2017 onwards), proxied through changes in the structural primary balance, is calculated as follows:

(i) *for countries subject to an excessive deficit procedure (EDP)* – the annual structural effort required under the latest (2016) EDP recommendation, unless this is above the government plan in its Stability Programme. Any shortfall compared to the required effort in the previous years (before 2017) covered by the EDP recommendation is disregarded, i.e. it is assumed that governments will not compensate such shortfalls by additional consolidation in the following years. If a government commits in its Stability Programme to correcting the excessive deficit by the given deadline, but this is not reflected in the simulated DSA path for the nominal balance, a minimum effort of 0.5% of GDP is added. After the end of the EDP period (or before if so suggested by the DSA simulations), the additional consolidation effort follows the assumptions under the preventive arm (see below).

(ii) *for countries under the preventive arm of the SGP* – the minimum annual adjustment towards reaching the medium-term objective (MTO) needed to avoid significant deviations under the SGP. To start with, this paper takes the adjustment requirements according to the 2015 Commission's communication on flexibility[10] (see the Chart below), unless these are higher than provided in the governments' plans for 2017, in which case the latter (lower) are taken into account. For modelling simplicity, the adjustment requirement regimes are evaluated based on one-year lagged thresholds (debt-to-GDP ratio, output gap and real GDP growth). For reasons of prudence, the required consolidation effort is adjusted downwards with the maximum deviation allowed to avoid sanctions under the SGP, that is, 0.25 percentage point per year. Due to enforcement uncertainty, the additional fiscal effort required in some countries under the debt rule is not reflected in the benchmark.

[10] See European Commission (2015a).

Table

Annual fiscal adjustment towards the MTO under the preventive arm according to the Commission's 2015 communication on flexibility

		Required annual fiscal adjustment*	
	Condition	Debt below 60% and no sustainability risk	Debt above 60% or sustainability risk
Exceptionally bad times	Real growth < 0 or output gap < -4	No adjustment needed	
Very bad times	-4 ≤ output gap < -3	0	0.25
Bad times	-3 ≤ output gap < -1.5	0 if growth below potential, 0.25 if growth above potential	0.25 if growth below potential, 0.5 if growth above potential
Normal times	-1.5 ≤ output gap < 1.5	0.5	> 0.5
Good times	output gap ≥ 1.5%	> 0.5 if growth below potential, ≥ 0.75 if growth above potential	≥ 0.75 if growth below potential, ≥ 1 if growth above potential

Source: European Commission (2015a)

(iii) *for countries at or above the MTO* – zero additional consolidation and, respectively, a (gradual) fiscal stimulus is assumed so that countries remain at, or go back to, their MTOs. More specifically, the assumed fiscal stimulus is limited to a maximum of 1% of GDP per year, with more than one year thus needed for convergence for countries further above their MTOs. This also implies that any interest payment savings from debt reduction – only once the MTO has been reached (in many cases towards the end of the simulation horizon) – are used in the benchmark as a fiscal stimulus (and not towards further debt reduction).

Headline budget balance and components

The cyclical budgetary component is derived endogenously based on the Commission's methodology (output gap times budgetary semi-elasticity) and the assumptions underlying real and potential growth (see below). After adjustment for temporary measures, the structural primary balance is then calculated as a residual for 2016 (when the draft budgetary plan is available). Thereafter, the additional fiscal consolidation or stimulus is added based on the fiscal rule explained above. The headline balance is derived by adding interest payments in line with the financial assumptions (see below).

Deficit-debt adjustment (DDA)

As a default assumption, DDA is set to zero for the simulation period beyond the current (EC Spring 2016) forecasting horizon. Exceptions are those countries which had historically large debt-increasing DDAs related, for example, to surpluses run by public pension funds that cannot be used for central government financing.

Real GDP growth assumptions

For the current (EC Spring 2016) forecasting horizon: 2016-17

Under no further required structural effort, real GDP growth assumptions remain in line with the most recent short-term forecast horizon (in this paper, EC Spring 2016 projections until 2017). In addition, any further consolidation effort (or stimulus) considered as of 2017 relative to the EC baseline forecast is assumed to have short-term negative (or positive) effects on real GDP growth.

The corresponding fiscal multiplier is set at -0.55 on impact, in line with simulation results obtained with the ECB's New Area Wide Model for balanced-composition fiscal consolidation packages.[11]

Beyond the current (EC Spring 2016) forecasting horizon: 2018-25

Beyond 2017, the medium-term growth projections are derived based on a simple stylised model used for debt simulations.[12] Accordingly, real GDP growth is driven by its potential growth, as well as by persistence effects (through an autoregressive process), and affected by any additional fiscal consolidation (or stimulus) considered in the benchmark (through the fiscal multiplier). See equation 1 below:

$$y_t = c_1 y_{t-1} + (1 - c_1)\, y_t^p + c_2 \Delta SPB_t - c_3 OG_{t-1} \qquad [1]$$

where y_t is the annual real GDP growth rate (as of 2018); y_{t-1} is the previous year's real GDP growth rate; y_t^p is the growth rate of potential output (in this paper taken exogenously to the model in line with the EC Spring 2016 projections, T+10 methodology); ΔSPB_t is the change in the structural primary balance, which denotes the additional consolidation (or stimulus, where relevant).

C1 is the autoregressive coefficient denoting persistence effects, set at 0.5. To ensure desirable long-term properties of the growth equation (i.e. convergence of output to its potential), the real output growth is a weighted average of its lag and the contemporaneous potential output growth.

C2 is the short-term fiscal multiplier, set at -0.55, as described above.

C3 is the elasticity with respect to the (lagged) output gap (OG), set at 0.4. In the absence of additional consolidation and given persistence effects, this coefficient would ensure a closure of the output gap in around five years. However, the pace of output gap closure could differ by country, mainly depending on how far from their MTO individual countries are.

GDP deflator assumptions

The GDP deflator growth rates for the euro area and individual countries are assumed to converge gradually to 1.9 in line with the ECB objective for price stability.

Financial assumptions

The sovereign yields beyond the short-term (EC) forecast horizon can be derived from the implied forward rates from national yield curves for the available countries. For these countries, the country-specific long-term interest rate assumption can be defined as the ten-year (five-year, one-year) benchmark bond extended with the forward par yields derived on the cut-off date from the corresponding country-specific spot yield curves. For the other countries, the interest rate projections can be computed by assuming certain dynamics of spreads to the first group of countries.

For the three-month T-bill yields, the benchmark assumes a linear convergence to the EURIBOR projections in three years, a choice justified by the expected gradual normalisation of the European government securities market.

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[11] See ECB (2014).

[12] See ECB (2014) and Warmedinger et al. (2015).

An Average Market Interest Rate (AMIR) is derived from the available yields at various maturities as representative of the market interest conditions for the newly issued debt. Interest payments (and the corresponding implicit interest rate) are then calculated taking the maturity structure into account. The maturity structure of debt (which is not held by official creditors) is assumed to gradually converge (over about 20 years) to the euro area average (20% of debt maturing within one year, 40% between one and five years and 40% in more than five years). For more details on the interest payment equation, see Appendix 1.

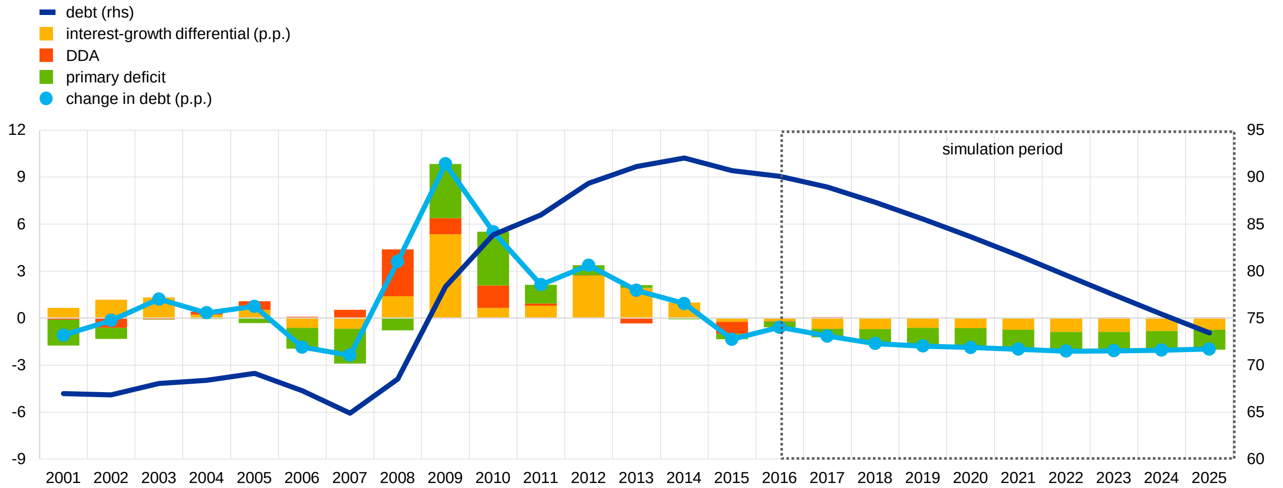
In line with the above assumptions, Chart 2 depicts for illustrative purposes the simulated debt path and its main driving variables for the euro area aggregate. In the absence of shocks, the main factors contributing to the decline in the debt ratio are the primary surplus and, to a lesser extent, the favourable "snowball effect" (interest rate-growth differential), while the DDA is assumed to be zero after 2017.

Chart 2

Benchmark debt path and its decomposition

Euro area aggregate

(% of GDP, percentage points)



Sources: Own calculations. The euro area aggregate debt and its components are adjusted for the support to EU/IMF programme countries via bilateral loans or EFSF/EFSM/ESM. A positive sign (+) implies an increase in the general government gross debt ratio (also a primary deficit), a negative sign (-) a reduction in debt ratio (and a primary surplus). The squares denote the simulation period. The dotted frame captures the simulation period.

The robustness of the debt paths in the benchmark scenario can be assessed through various checks of the main macroeconomic and fiscal assumptions. Several categories of cross-checks can be performed. First, in basic robustness check scenarios, the paths of some macroeconomic variables can be altered in terms of source of data forecast, pace of convergence, and size of fiscal multipliers. These factors induce relatively modest changes in the debt paths, in part due to the endogenous relationship of the basic model (e.g. the assumption that governments broadly comply with the minimum requirements of the SGP). In general, the effects would be marginally higher for countries with larger consolidation needs (far away from their MTOs) and/or with a high debt level. Second, as standard in the DSA, various deterministic shock scenarios are implemented (see Section 4.2). Third, a VAR-based stochastic DSA (discussed in Section 5) is used to assess the uncertainty surrounding the benchmark. The latter allows evaluation of whether the historical distributions of the macroeconomic variables indicate upside or downside risks to the benchmark debt path.

4.2 Shock scenarios

Given that any sovereign debt sustainability analysis is inherently difficult and sensitive to the assumptions used, a rather wide range of shock scenarios may be considered to assess the resilience of countries' debt paths. The adverse shock scenarios discussed below represent one reasonable selection for such sensitivity analysis. They show the effects of one or more shocks – applied as of the first year of simulations (2016 in this paper) – on key fiscal and macroeconomic variables. The adverse shock scenarios are based on a "narrative" interpretation, in contrast to a standardised shock size (e.g. 1% of GDP). This narrative aims at redressing some of the arbitrariness inherent in this type of analysis. Narrative shock scenarios allow the reflection of actually perceived risks at a given point in time. However, empirical volatilities are also considered to be important and can be reflected, inter alia, in the stochastic DSA. The narrative scenarios are designed as country-specific shocks, but follow a harmonised methodological approach. The shocks propagate to debt following the endogenous reactions of the model. The primary balance deteriorates in the presence of negative real growth shocks through the cyclical component (automatic stabilisers) in line with the country-specific budgetary elasticities. All shock scenarios incorporate a risk premium channel, i.e. the impact of shocks to interest payments is captured through the sovereign bond spreads' reaction to fiscal fundamentals. Numerically, this impact is implemented through a 25 basis point increase in spreads for every 1 percentage point increase in the deficit-to-GDP ratio, and a 4 basis point increase in spreads for every 1 percentage point increase in the debt-to-GDP ratio.[13] The narrative scenarios considered in the DSA framework are briefly described below.

The "No fiscal policy change with ageing costs" scenario: this scenario (adverse for most countries) assumes that governments will not take any additional (structural) consolidation measures compared with the baseline assumptions (in this paper under the EC Spring 2016 Forecast). This is done by assuming that the structural primary balance remains constant at the 2017 level. This assumption entails rather sizeable adverse shocks for countries that still have large consolidation needs, that is, those in EDP and/or far below their MTOs. In addition, the projected change in total ageing costs according to the risk scenario of the 2015 Ageing Report,[14] updated to capture any more recent reforms, is included in this shock. Overall, this scenario should underline DSA risks in countries with still large fiscal needs resulting from fiscal imbalances and high ageing costs.

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13 Broadly in line with results in Laubach (2009).

14 Report prepared by the Ageing Working Group of the Economic Policy Committee (see European Commission, 2015b).

The “historical” scenario: this scenario assumes that real growth rates and primary balance ratios (net of support to the financial sector) return within three years to their long-run (mostly lower) historical average (here considered over 2001-13). The other main assumptions of the benchmark are kept unchanged. This scenario gauges risks to the forward-looking assumptions of the benchmark, in particular the variables that are “unobserved” in practice (potential growth and the structural balance).

The “macro (bank) stress test" scenario: real GDP growth rates, GDP deflator and ten-year sovereign bond spreads are subject to adverse shocks over the period 2016-18 in line with the country-specific assumptions under the EBA 2016 EU-wide bank stress testing exercise.[15] In addition, the (large) negative shocks to real growth are assumed to have a lasting impact on potential GDP (half of the shock is translated into potential GDP as a hysteresis effect). The lower potential GDP translates into a deterioration of the structural fiscal position. The shocks to the GDP deflator are modelled as in the country-specific inflation shock below.

The “inflation shock” scenario: the path of the GDP deflator assumed in the benchmark is subject to a negative (disinflation) shock according to a measure of past empirical uncertainty, defined as the standard deviation of estimated errors from an autoregressive representation (calculated over the period 2001-15). The shock feeds one to one into the nominal GDP growth rate. In addition to the direct impact on the nominal GDP level and thus on the debt ratio, the lower inflation rate is assumed to negatively affect the structural primary balance. Indeed, due to rigidities in expenditure setting, the indexed public spending, approximated by public wages and social payments, could disconnect in the short run from the actual price developments in case of an unexpected disinflation shock. On the other hand, the lower inflation rate is assumed to reduce the nominal (marginal) interest rate for new government debt. This impact is partly offset by the rise of sovereign spreads in reaction to worsened fiscal fundamentals, so that on balance the real (marginal) interest rate tends to rise.

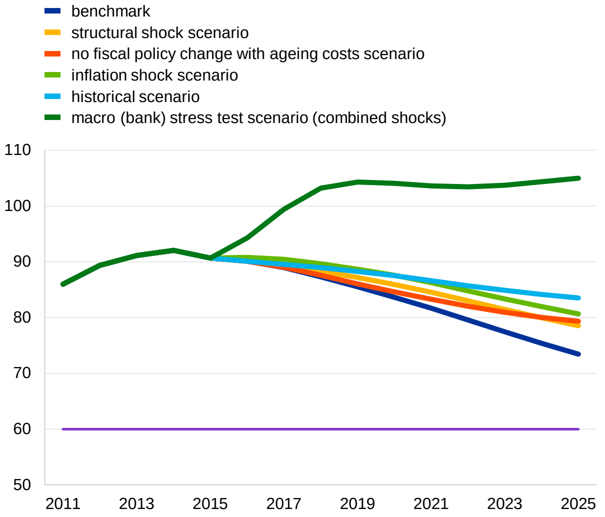
The “structural shock” scenario: the potential growth path underlying the benchmark is subject to a negative shock (decrease) according to a measure of past empirical uncertainty (calculated in line with the inflation shock). The lower potential GDP translates into a deterioration of the structural fiscal position. This shock scenario aims to capture possible adverse effects on potential growth estimates (according to the EC’s common method) stemming from past uncertainty. Such a shock could also reflect the lack of further structural reforms to enable euro area economies to grow further (even if the rate of potential output growth is now estimated to be much lower than in the past).

[15] See ESRB (2016).

Chart 3

Government debt simulations under the benchmark and shock scenarios:
Euro area aggregate

(Debt-to-GDP ratio, % of GDP)



Source: Own calculations
Notes: The shocks are applied as of 2016. The horizontal line indicates the 60% debt threshold.

Chart 3 provides an illustration of the shock scenarios for the euro area aggregate. In most of these adverse scenarios, the debt ratio would reach around 80-85% of GDP at the end of the simulation horizon, but it would remain on a downward path. The most adverse scenario is the macro (bank) stress-test scenario, a combined shock scenario, which would put the debt ratio on an upward, much higher path over the simulation horizon.

4.3 Quantitative evaluation of the deterministic DSA

In the next step, a metric for a heat map is introduced to numerically evaluate the various debt path scenarios according to three criteria. These criteria are the debt level, debt dynamics and, for the benchmark scenario only, the risks of fiscal fatigue, as defined below. A traffic light heat map indication of "green", "yellow" or "red" is derived for each of these sub-indicators. A red light implies high risk for the debt path under the deterministic DSA, yellow points to medium risk and green signals low risk.

The debt level criterion

A higher debt level entails higher risk for debt sustainability. A high level of debt increases refinancing concerns, restricts the room for counter-cyclical fiscal policy and thereby makes the economy more vulnerable to macroeconomic shocks. Depending on the maturity structure, it generally entails high gross financing needs, which can make a country more prone to liquidity crises and defaults. A high level of debt also implies the need to sustain high primary surpluses, which may be difficult under political or economic uncertainty. Investors may thus be more likely to question the sustainability of fiscal policies of a sovereign with a high debt burden, particularly when its fiscal track record is poor. There is also theoretical and empirical evidence that high and/or increasing debt levels may ultimately impede long-term growth, with the relationship going in both directions.[16]

In this DSA framework, the debt level criterion is evaluated at the end of the simulation horizon with debt thresholds at 60% and 90% of GDP. A green assessment is given if the debt ratio in 2025 is 60% or lower. The assessment is yellow if the debt ratio in 2025 is between 61% and 90%. A red assessment reflects a debt ratio above 90%. The debt ratio thresholds of 60% and 90% are consistent with institutional and empirical considerations.[17] In the calculation of an overall sustainability risk score, higher debt levels (above 120% or 150% of GDP) could receive an additional penalty.

Debt dynamics

A continuously rising debt path is usually taken as a clear sign of unsustainability. Conversely, falling debt levels may reassure investors even if the debt level is still high. In the current exercise, the debt dynamics are captured in the heat map as follows: (i) a green light if a country's debt ratio has already peaked (by 2015 in this paper)[18]; (ii) a yellow light if debt stabilisation is expected in the next three years (by the end of the EC forecast horizon + one year, implying stabilisation no later than 2018); and (iii) a red light if stabilisation occurs only afterwards (as of 2019) or not at all over the simulation horizon.

Risk of fiscal fatigue

The benchmark scenario aims at providing a plausible, internally consistent and rule-based scenario. However, this scenario can face challenges, particularly in those cases where fiscal policy risks prevent additional consolidation efforts or even the maintenance of the favourable starting position. A corresponding criterion gauges the ability of governments to maintain high primary surpluses for a sustained period based both on their own historical track record and common thresholds across all euro area countries. Hence, heat map traffic lights can be assigned by comparing the simulated primary balance ratio in the benchmark scenario with country-specific best historical performance since 1999 (reference primary balance) and with a debt-adjusted reference. The latter (derived from a fiscal reaction function for the euro area) is intended to correct the historical reference, reflecting the fact that some countries did not need to sustain (high) primary surpluses in the past due to much lower debt levels. Finally, the simulated primary balance under the benchmark

16 For a review, see Reinhart, Reinhart and Rogoff (2012), Dieppe, A. and Guarda, P. (eds.) (2015), and ECB (2016).

17 Debt ratios above 60% of GDP exceed the prudent threshold embedded in the SGP. Debt ratios between 80% and 100% of GDP are found in the literature to signal fiscal stress (see IMF, 2013; EC 2014) and to be associated with lower growth. See, inter alia, Checherita and Rother (2012); Cecchetti et al. (2011); Baum et al. (2013) and the reviews in footnote 18.

18 To avoid penalising countries with very low debt levels and slightly upward dynamics, the green category is also assigned if the debt is constantly below 20% of GDP over the simulation horizon.

scenario is also compared with common thresholds derived from the literature.[19] These thresholds are set at 3.1% of GDP (the floor for the yellow risk category) and 4% of GDP (the floor for the red risk category). The two common thresholds do not imply that countries should not strive to maintain high primary surpluses over long periods of time if needed for sustainability purposes. They just highlight potential difficulties and risks based on experiences of advanced economies in the past.

For an overview of the heat map criteria under the deterministic DSA block, see Table 2.

Table 2

Heat map criteria for the deterministic DSA block

Criteria	Additional description	Heat map		
Deterministic DSA				
Debt level	Debt ratio (% of GDP) at the end of the simulation horizon (2025)	≤ 60	60 < debt ratio ≤ 90	> 90
Debt stabilisation	Peak in the debt ratio	In the past (by 2015)	Between T+1 (2016) and T+3 (2018)	As of T+4 (2019) or no stabilisation
Fiscal fatigue (capacity to maintain primary surpluses)	Comparison of primary balance (PB) over the simulation period (based on 5 or 10 year moving average) with a historical country-specific threshold or EA common-threshold	PB simulations (5-year moving average) < historical PB threshold	PB simulations (5-year MA) between historical PB threshold and debt-adjusted historical PB threshold OR 3.1 < PB simulations (10-year average) < 4	PB simulations (5-year MA) above debt-adjusted historical PB OR PB simulations (10-year average) ≥ 4

Source: Own representation.
Notes: In the example taken in this paper (see Box 2), the relevant period (year) for the heat map assessment is shown in parentheses. "T" represents the latest historical year in terms of data availability.

[19] For the overall methodology underpinning this paper's fiscal fatigue criterion, see Checherita-Westphal and Zdarek (2015). For the literature on bounds to primary surpluses (common thresholds), see Abbas et al. (2013) and Eichengreen and Panizza (2014).

5 The stochastic DSA block

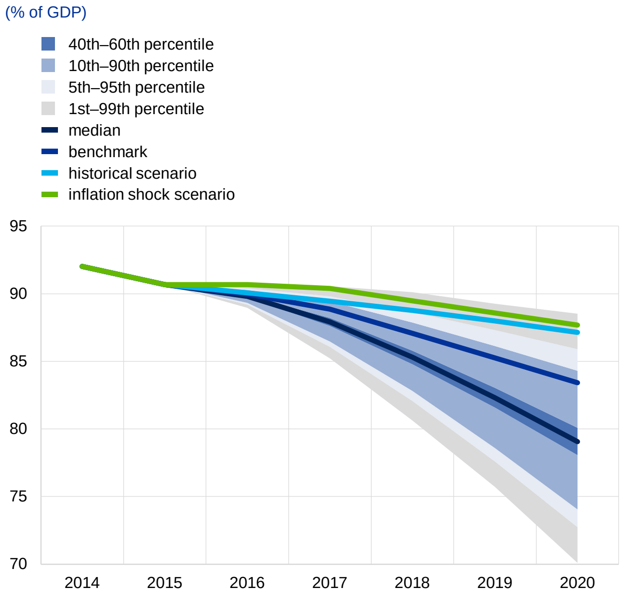
The stochastic DSA (SDSA) provides an empirical rather than a narrative analysis of macroeconomic uncertainty surrounding the simulated debt path. The SDSA is thus a tool that complements the deterministic debt sustainability analysis. It allows for a very large number of simulated shocks (beyond what would be conceivable in the deterministic sensitivity analysis), which are based on the historical behaviour of the relevant macroeconomic variables. The SDSA in the DSA toolkit is based on a quarterly VAR framework, with four variables (real short-term and long-term interest rates, real GDP growth and growth of the GDP deflator). The simulation exercise uses a "bootstrap" method with 5,000 simulations to obtain a stable distribution of future debt paths.[20]

The key driving variables are forecasted and annualised using the generated time series of random shocks for each quarter of projection and the estimated coefficients. Future debt paths are consequently calculated using the same debt aggregation model as in the deterministic benchmark scenario. Therefore, even though the VAR itself does not include a fiscal reaction function, the change in the cyclical developments implied by each simulated GDP path influence the path of the structural balance according to the fiscal effort matrix described in Box 2.

[20] There are two different approaches regarding stochastic projections using VAR. First, the estimation of an unrestricted VAR model is used to produce a variance-covariance matrix of shocks for key driving variables of debt dynamics (real GDP growth, rate of inflation, real interest rates and also (real) exchange rate if utilized). This approach relies on Cholesky decomposition of residuals and depends on the assumption of normality (see for example Celasun et al., 2006), which may be considered too restrictive. In order to avoid the normality assumption, bootstrapping techniques are applied to VAR residuals (see, for example, Medeiros, 2012).

Chart 4

Fan chart for debt ratio: the euro area aggregate



Source: Own calculations.

Since a large number of simulations are carried out to guarantee robustness of results (5000 draws), the resulting distribution of public debt paths for the forecast horizon can be concisely summarised by calculating statistical characteristics of the empirical distribution (for example, various moment statistics, see below). The SDSA can also be used to cross-check the plausibility of the benchmark and of selected shock scenarios from the perspective of past macroeconomic volatility. See Chart 5 for the example of the euro area aggregate. In this case, the benchmark debt-to-GDP ratio appears to be rather conservative as it lies in the upper part of the distribution, below but close to the 90th percentile. Two macro shock scenarios (historical and inflation shock) lie broadly between the 95th and 99th percentile. The macro (bank) stress test scenario would be unusually severe from the perspective of past macroeconomic volatility (lying outside the fan-chart).

The SDSA is evaluated using three indicators over a five-year simulation horizon: (i) the uncertainty surrounding simulated debt paths, measured as the dispersion, i.e. the difference between the 5th and the 95th percentile debt ratio as of T+5 (2020 in this paper); the larger the dispersion, the more uncertain the debt path is considered to be; (ii) the probability of debt not stabilising by 2020; and (iii) the probability of debt going above the 90% of GDP threshold in 2020. A three-colour heat map is used for the SDSA as follows: for the first criterion, euro area countries with the highest uncertainty regarding their debt paths (above the 66th percentile of the country distribution) receive red in the heat map; medium uncertainty (between the 33rd and the 66th percentile) is assigned yellow; and the lowest uncertainty (below the 33rd percentile) is assigned green. For the second and third criteria, countries with a probability of debt not stabilising, and of debt being above 90% of GDP, which is higher than 0.66 receive red, between 0.33 and 0.66 yellow, and below 0.33 green. See Table 3 for an overview.

Table 3

Heat map criteria for the stochastic DSA

Indicators	Additional description	Reference period	Criteria	Heat map		
Stochastic DSA						
Indicator 1 (debt dispersion)	Simulated difference 95th-5th percentiles of debt ratio distribution	T+5 (2020)	Percentiles EA sample	≤ 33rd percentile	33rd < percentile ≤ 66th	> 66th percentile
Indicator 2 (Probability of debt above 90% in T+5)	Debt level criterion	T+5 (2020)	Threshold probability	probability ≤ 0.33	0.33 < probability ≤ 0.66	probability > 0.66
Indicator 3 (Probability of debt not stabilizing by T+5)	Stabilisation criterion	T+5 (2020)	Threshold probability			

Source: Own representation.
Notes: "T" represents the latest historical year in terms of data availability (in the example taken in this paper, end of SDSA simulation horizon is 2020).

6 Other indicators and their evaluation

Owing to various sources of uncertainty in the assessment of debt sustainability, it is necessary to conduct a broad-based analysis, including as much relevant information as possible. A broad-based analysis should account for reasonable and appropriate sustainability factors along multiple dimensions and should therefore be less sensitive to individual components. With the benefit of hindsight, most of these indicators would have helped to signal liquidity and solvency risks prior to the euro area sovereign debt crisis.

A number of other indicators can provide additional signals or simple cross-checks with regard to specific debt-related vulnerabilities and risks. They capture debt sustainability risks arising from both short-run liquidity risks and medium to longer-run solvency risks. Moreover, some of these indicators are intended to capture, as far as possible, the government's "willingness" to pay its creditors in full. Since a clear-cut and comprehensive indicator for this source of risk is not available, it is necessary to include relevant information from a rather wide range of indicators and thus to complement the more extensive analysis on the "ability" to pay. The short-run liquidity risk takes into account net financing needs, as well as a composite index of the ease of refinancing. The medium to longer-term sustainability risks include four categories of indicators: (i) the public debt structure; (ii) the scope for contingent liabilities; (iii) the net financial position of the economy; and (iv) governance and political risk. Since there are no clear-cut thresholds for the indicators, any analysis is inherently sensitive to the assumptions used. In this DSA framework, risks stemming from the additional indicators are reflected in a three-colour heat map, based on two types of criteria: (i) thresholds available/derived from the empirical literature, in particular based on the early warning indicator, S0, calculated by the European Commission[21]; and (ii) the percentile distribution of the indicator, where such thresholds are not available (using the 66th percentile to denote the threshold for the "red" risk category and the 33rd percentile to denote the low threshold for "yellow", with countries in the bottom risk category receiving a "green" colour). For details on the individual variables and the exact thresholds used in the heat map, see Tables 3-7 below.

The short-term "liquidity" indicator captures both the short-term financing needs (usually to be calculated for the first projection year T+1; in the example taken in this paper, for 2016) and an index for the ease of refinancing government debt. The financing needs are calculated in net terms, as gross financing needs (budget deficit and maturing debt) less the liquid financial assets (mostly currency and deposits), on an annual basis. The ease of refinancing index takes into account the market perception of the respective sovereign's risk, as captured by the current sovereign credit rating and the credit and liquidity risk premia embedded in the ten-year government bond market (approximated by the yield spread vis-à-vis the German

[21] See Berti et al. (2012) and European Commission (2016).

Bund in the past quarter and the bid-ask spreads over the past year for the same maturity bond). The larger the net financing needs and the worse the market conditions (benchmarked against S0-based thresholds and three sovereign rating categories), the higher the short-term liquidity risks. For an overview of the indicator and its sub-components, see Table 4.

Table 4

Heat map criteria for the liquidity risk indicators

Indicators	Additional description	Reference period	Criteria	Heat map		
Liquidity risk						
Net financing needs T+1 (% GDP)	Deficit forecast and ESCB Centralised Securities Database (CSDB) (deficit + maturing official loans + maturing securities adjusted by cash deposit)	T+1 (2016)	Threshold (gross financing needs IMF-based threshold for red 20%) adjusted by average cash reserve stock (6%)	≤ 4	4 < value ≤ 14	> 14
10-year government bond spreads	Thomson Reuters and ECB	Average of latest available quarter (Q1-2016)	Thresholds (EC S0-based, FSR)	≤ 185	185 < value ≤ 231	> 231
Bid-ask spread, 10 year-government benchmark bond	Thomson Reuters	Average of latest available quarter (Q1-2016)	Percentile EA Sample	≤ 33rd percentile	33rd < percentile ≤ 66th	> 66th percentile
Current sovereign rating (long-term)	Moody's	Latest rating	Thresholds	Higher than Aa3	A1 ≤ value ≤ Baa3	Lower than Ba1

Source: Own representation. Notes: In the example taken in this paper, the latest available period for each indicator is shown in parentheses. "T" represents the latest historical year in terms of data availability. Gross and net financing needs are to be calculated for the year 2016 as the sum of the 2016 headline deficit (in this paper, EC spring 2016 forecast), long-term maturing securities issued by the cut-off date (CSDB), stock of short-term debt outstanding at the end of the previous year, and repayment of official loans (for programme and post-programme countries). Net financing needs are adjusted for cash deposits (at the end of the previous year plus any net issuance at the cut-off date). Caveats in the aggregated data from CSDB used to estimate maturing marketable debt: (i) loans are not included in the calculations; (ii) the coverage of securities across countries is heterogeneous; (iii) the estimates do not take account of the fact that some maturing government securities are held within the government sector (and would be consolidated for the purpose of measuring EDP government debt).

The "public debt structure" indicators aim to capture risks related to the structure of government debt in terms of maturity, currency composition and type of interest rate. Four indicators are currently included, i.e. the share of short-term debt and its year-on-year change, the share of debt in foreign currency and the share of debt with a variable interest rate. The larger the share of short-term debt and/or the more it increases, the higher, ceteris paribus, the risks to debt sustainability as refinancing risk increases. In the same vein, the larger the share of public debt denominated in foreign currency and/or with a variable interest rate, the higher the sustainability risk as sovereigns are more exposed to foreign exchange and interest rate movements.[22] For an overview of the indicators, see Table 5.

[22] Another important source of risk is investor ownership. In principle, the foreign investor base is more volatile and prone to sudden stops in situations of heightened uncertainty. However, some caveats apply to this assessment. A relatively large or increasing share of debt held by non-residents can also reflect a high degree of trust in the respective sovereign. It may also be beneficial for financial and macroeconomic stability as a higher share of foreign investors reduces the risks of adverse loops between the sovereign and the national banking systems.

Table 5

Heat map criteria for the structure of debt indicators

Indicators	Additional description	Reference period	Criteria	Heat map		
Structure of debt						
Share of short-term debt (% of GDP)	ESCB	Latest available year (end-2015)	Threshold (EC S0-based)	≤ 8.16	8.16 < value ≤ 16	> 16
Change (y-on-y) in the share of short-term debt	ESCB	Latest available year (end-2015)	Threshold (EC S0-based, FSR)	≤ 2.2	2.2 < value ≤ 2.76	> 2.76
Share of public debt in foreign currency (% of GDP)	ESCB	Latest available year (end-2015)	Threshold (EC S0-based, FSR)	≤ 24	24< value ≤ 29.82	> 29.82
Share of debt with variable interest rate (% of total debt)	ESCB	Latest available year (end-2015)	Percentile EA Sample (2001-2015)	≤ 33rd percentile	33rd < percentile ≤ 66th	> 66th percentile

Source: Own representation. Notes: In the example taken in this paper, the latest available year for the indicators' evaluation is end-2015.

The "contingent liabilities" indicators refer to future government liabilities that arise only if a particular event materialises. The financial crisis has shown that the distinction between public and private debt became blurred for many countries. Fiscal costs can stem from contingent liabilities[23] (explicit or implicit, directly or indirectly) related to the financial sector, other sectors' indebtedness, official financial assistance to other EU countries as well as demographic changes. To capture such potential costs, the DSA framework takes the following four indicators into account. The first indicator refers to the estimated change in ageing costs over the very long term (in 2060 compared with 2025[24]) as per the risk scenario of the 2015 Ageing Report, adjusted with latest available peer-reviewed estimates. The second is a "synthetic" contingent liability indicator, calculated based on data reported by Member States to Eurostat.[25] It includes the total amount of general government guarantees, contractual amounts under private public partnerships (PPPs) and loans extended by government units and classified as non-performing. Due to country-specific and incomplete data coverage for all Member States, the new database currently gives only a limited overview of reported contingent liabilities. The third and fourth indicators in this category refer to the share of non-performing loans (NPLs) in the banking sector (latest harmonised data available from the ESCB Consolidated Banking Data) and their year-on-year change. For an overview of the indicators, see Table 6.

[23] For an earlier discussion on the topic, see van Riet (ed.) (2010).

[24] This is, therefore, beyond the horizon considered in the "No fiscal policy change with ageing costs" scenario.

[25] See the Eurostat data on contingent liabilities and non-performing loans in EU Member States (release dated 27 January 2016, which reports data with a lag). Adjustments for more recent developments related to government support to the financial sector are implemented in the DSA indicator.

Table 6

Heat map criteria - scope for contingent liabilities indicators

Indicators	Additional description/ source of data	Reference period	Criteria	Heat map		
Scope for contingent liabilities						
Cumulative increase in ageing costs (p.p. of GDP)	2015 Ageing Cost Report, AWG risk scenario	Ageing report available period after T+10 (2026-2060)	Thresholds (EC S0-based)	≤ 2.25	2.25 < value ≤ 6.5	> 6.5
Synthetic contingent liabilities indicator (general gov. guarantees + PPPs + NPLs gov) (% of GDP)	Eurostat	Latest available year (2014*)	Thresholds (EC S0-based)	≤ 2.25	2.25 < value ≤ 6.5	> 6.5
Share of NPLs banking sector (% of total debt instruments, loans and advances)	ESCB CBD (Consolidated Banking Data)	Latest available quarter (Q3-2015)	Thresholds (EC S0-based, FSR)	≤ 1.8	1.8 < value ≤ 2.3	> 2.3
Change in share of NPL (%)	ESCB CBD (Consolidated Banking Data)	Latest available y-o-y change (Q3 2015/end-2014*)	Thresholds (EC S0-based, FSR)	≤ 0.2	0.2 < value ≤ 0.3	> 0.3

Source: Own representation. Notes: In the example taken in this paper, the latest available period for each indicator is shown in parentheses. For the synthetic contingent liabilities indicator from Eurostat, only 66% of the total reported amount is considered relative to the thresholds for the derivation of the heat map. *For this indicator, data is adjusted with the latest available information for the change in contingent liabilities related to government support to the financial sector. The thresholds used for this indicator and for the cumulative change in ageing costs are derived based on the signalling approach for the variable *change in debt*. For the NPLs share, the latest available harmonised data (ESCB, CDB) are used. Data from national sources or for more recent periods may indicate a different tendency of NPLs.** In the example taken in this paper, the period shown for the change in share NPLs is restricted due to a methodological change in the time series as of Q3 2014.

The DSA also includes **risk indicators stemming from the “economy-wide net financial position and external competitiveness”.** They capture risks arising from the external indebtedness of the economy, including the net financial position of the government and other economic sectors. Moreover, they include the various indicators of external competitiveness captured under the external block of the macroeconomic imbalance procedure (MIP). Overall, such indicators are among the external vulnerability indicators with the highest predictive power for sovereign crises, as identified by the Commission’s early warning framework, namely: (i) the net international investment position (NIIP), (ii) net savings of corporations, (iii) net savings of households, (iv) net government debt, and (v) a composite index of the four MIP external block indicators, namely: the change over the past three years in unit labour costs, the effective exchange rate, the three-year average of the current account balance and the five-year percentage change in the export market share. For an overview of this category of indicators, see Table 7.

Table 7

Heat map criteria for the financial position and competitiveness indicators

Indicators	Additional description/source of data	Reference period	Criteria	Heat map		
Financial position and Competitiveness						
Net international investment position (% of GDP)	ECB (BPM6 database)	Latest available year (end-2015)	Thresholds (MIP/ECB)	> -35	-35 ≥ value > -50	≤ -50
Net government debt (% of GDP)	European Commission (AMECO)	Latest available year (end-2014)	Thresholds (EC S0-based)	≤ 15.9	15.9 < value ≤ 58.1	> 58.1
Net savings corporations (% of GDP)	European Commission (AMECO)	Latest available year (2014)	Percentile EA Sample (2001-2014)	> 66th percentile	66th ≥ percentile > 33rd	≤ 33rd percentile
Net savings households (% of GDP)	European Commission (AMECO)	Latest available year (2014)	Thresholds (EC S0-based)	> 6.04	6.04 ≥ value > 0.96	≤ 0.96
Macroeconomic Imbalance Procedure (External)	Average of sub-indicators, Various sources					
of which: Unit Labour Costs (% change)	Eurostat	% change over 3 years (2015/2013)	Thresholds (MIP and EC S0-based)	≤ 4.1	4.1 < value ≤ 9	> 9
of which: Real Effective Exchange Rate (% change)	European Commission (AMECO)	% change over 3 years (2015/2013)	Thresholds (MIP and EC S0-based)	≥ -0.8 & ≤ 0.8	> -0.8 value ≥ -5 & 0.8 < value ≤ 5	< -5 & > 5
of which: Current Account Balance (% of GDP)	ECB (BPM6 database)	3 year average (2013-2015)	Thresholds (MIP and EC S0-based)	> 2.65	2.65 ≥ value > -4	≤ -4
of which: Export Market Shares (% change)	IMF	% change over 5 years (2015/2011)	Thresholds (MIP-based)	> 0	0 ≥ value > -6	≤ -6

Source: Own representation. Notes: In the example taken in this paper, the latest available period for each indicator is shown in parentheses. For the sub-category "Macroeconomic Imbalance Procedure (External)", an aggregated score will be first calculated as a simple average of the four individual components (for each individual indicators, 1 is given for green, 2 for yellow and 3 for red according to the set thresholds or percentiles). The heat map is then derived as follows: green for a score in the range [1; 1.667); yellow for [1.667; 2.334) and red for [2.334, 3).

Regarding **the "governance and political risk" indicators,** several empirical studies have shown that weak governance and institutions are often closely linked to sovereign debt distress, i.e. that the quality of institutions is an important predictor of crises, even after controlling for economic variables.[26] Similarly, other studies show that a country's default history is an important determinant of the creditworthiness of sovereign borrowers.[27] To be regarded as creditworthy, countries with histories of default and poor institutional quality are forced to keep their debt-to-GDP ratio at much lower levels than countries that have stronger institutions and/or have never defaulted. Credit rating agencies also analyse the institutional framework when assigning sovereign ratings. The importance of institutional factors means that improvements in policy and institutional environment can lower the likelihood of debt distress for any given level of debt. This category of indicators includes: the World Bank's worldwide governance indicators, Transparency International's corruption perception index, the European Commission's fiscal rule index for the quality of fiscal

[26] See, inter alia, Kraay and Nehru (2006), Van Rijckeghem and Weder (2009) and Papaioannou (2015).

[27] See, for instance, Reinhart et al. (2003).

frameworks including fiscal institutions, and the political risk indicator of the Political Risk Services (PRS) Group, Inc. For an overview of the indicators, see Table 8.

Table 8

Heat map criteria for the governance and political risk indicators

Indicators	Additional description/source of data	Reference period	Criteria	Heat map		
Governance and political risks						
Worldwide Governance Indicators (World Bank)	Consists of Voice and Accountability, Government Effectiveness, Regulatory Quality and Rule of Law	Latest available year (2014)	percentile world sample truncated by OECD min-max	> 66th percentile	66th ≥ percentile > 33rd	≤ 33rd percentile
Corruption Perceptions Index (Transparency International)	Transparency International	Latest available year (2015)	percentile world sample truncated by OECD min-max	> 66th percentile	66th ≥ percentile > 33rd	≤ 33rd percentile
EC's Fiscal rule index	European Commission	Latest available year (2014)	percentile EU countries (1990-2014)	> 66th percentile	66th ≥ percentile > 33rd	≤ 33rd percentile
Political risk indicator (PRSG database)	The PRS Group	Latest available month (March 2016)	percentile world sample truncated by OECD min-max	> 66th percentile	66th ≥ percentile > 33rd	≤ 33rd percentile

Source: Own representation. Notes: In the example taken in this paper, the latest available period for each indicator is shown in parentheses. For the governance and political risk indicators (except the EC fiscal rule index for the EU countries), the heat map benchmarking is done according to the 33rd-66th percentiles of the world sample truncated by the maximum and minimum indicator values for more advanced economies (the OECD sample).

7 Overview of the sovereign debt sustainability assessment

The information embedded in the three main DSA blocks can be summarised in a heat map to provide guidance on the overall assessment of risks to debt sustainability. These vulnerability signals could be further refined and quantified into a single score for debt sustainability risk according to given weights for various criteria, indicators and DSA blocks. Such weights could be derived based on past relevance for debt sustainability assessment (i.e. back-testing the method to past data and developments) and/or based on (expert) judgement. The advantage of this method is that it offers a comprehensive, yet concrete and easy-to-grasp risk assessment. Caveats of any heat map approach relate to the underlying assumptions, threshold ("cliff") effects, possible further non-linear interactions between the various indicators influencing debt sustainability and the potential absence of other sources of risk at the country level or cases where the latest policy measures to reduce the stock of imbalances are not fully reflected. In general, to the extent that governments enhance the design and implementation of fiscal, structural and financial reform policies, debt sustainability risks will tend to decline.

8 Conclusions

This paper presents a broad-based methodology for an enhanced debt sustainability analysis for euro area sovereigns. In line with other institutions' practices and given the high relevance of debt sustainability analysis for country surveillance, this framework builds on a broad range of indicators to underpin the analysis. It provides for a harmonised quantitative assessment, captured in a DSA heat map. For final assessments, the quantitative results of the framework could be further aggregated in debt sustainability scores and complemented by expert judgement. At the same time, this DSA framework is not designed to provide guidance on sovereign risk premia or the overall country risk, especially in the shorter term. The advantage of this method is that it offers a comprehensive, yet concrete and easy-to-grasp quantitative risk assessment.

Appendix
The interest payment equation

Interest payments on government debt used in the context of the debt sustainability analysis are projected as the sum of interest payments on the following components:

(i) Non-maturing debt (i.e. debt with a residual maturity of more than one year in the previous period[28]). The interest rate is assumed to be the implicit interest rate (as defined below) in the previous year.

(ii) Maturing debt (i.e. debt with a residual maturity of less than one year in the previous period. All this debt is assumed to mature each year end-June and to be financed by new issuances at market conditions. In the first half of the year, the interest rate paid on that debt is the implicit interest rate in the previous year. In the second half, the interest rate on the rolled-over debt is an average of the market interest rates (see below).

(iii) The net borrowing requirement (computed as the sum of the primary deficit, the deficit-debt adjustment and interest payments). This part is assumed to be financed at market conditions (average of the market interest rates, see below).

Formally, the interest payment equation is as follows:

(1) $inp_t = nmd_{t-1}iir_{t-1} + md_{t-1}\frac{1}{2}(iir_{t-1} + amir_t) + \frac{1}{2}(-pb_t + dda_t + inp_t)amir_t$

or, moving all expressions involving inp_t to the left hand side and factoring out:

(2) $inp_t = \frac{nmd_{t-1}iir_{t-1}+\frac{1}{2}md_{t-1}iir_{t-1}+\frac{1}{2}(-pb_t+dda_t+md_{t-1})amir_t}{1-\frac{1}{2}amir_t}$

where (all country-specific variables):

inp = interest payments

nmd = debt with a residual maturity of more than one year

iir = implicit interest rate (see below).

md = debt with a residual maturity of one year or less

amir = “Average Market Interest Rate” (defined as below)

pb = general government primary balance

dda = deficit-debt adjustment,

[28] The non-maturing debt of the year t is considered to be the debt with a residual maturity above one year in t-1, as the latter is measured at the end of the year in ESCB’s Government Finance Statistics data.

The implicit interest rate *iir* is defined as: $irr_t = \frac{inp_t}{D_{t-1}}$, where *D* is the general government gross debt (EDP).[29]

For (former) programme countries, interest payments should be calculated as the sum of interest paid on market debt and interest paid on the official loans granted. The interaction between the two components is captured via the financing needs of the general government. Indeed, in year t the general government will issue debt on the market to cover its gross financing needs (deficit + dda + maturing debt to be rolled over), net of the new official loans granted this year $(\mathrm{D}_{\mathrm{t}}^{\mathrm{of}} - \mathrm{D}_{\mathrm{t-1}}^{\mathrm{of}})$. Thus, equation (2) could be rewritten as follows:

$$(2')\ inp_t = \frac{nmd_{t-1}iir_{t-1} + \frac{1}{2}md_{t-1}iir_{t-1} + \frac{1}{2}(-pb_t + dda_t + md_{t-1} + inp_t^{of} - \Delta D_t^{of})amir_t}{1 - \frac{1}{2}amir_t}$$

where only positive net financing needs are taken into account.

The Average Market Interest Rate (amir) should be representative of the market interest conditions for the debt to be issued in period t. For the structure of this debt, we use as a proxy the structure of the residual maturity of the stock of debt available in the ESCB's Government Finance Statistics (GFS) data, that is, debt with residual maturity below one year, between one and five years, and above five years.

The Average Market Interest Rate (amir) is calculated as follows:

$$(3)\ amir = \frac{1}{2}(stn + stn\_12m) * sd1 + \frac{1}{2}(stn\_12m + ltn\_5y) * sd1\_5 + \frac{1}{2}(ltn\_5y + ltn\_10y) * sd5$$

where (all country-specific variables):

stn = 3-month government security yield

stn_12m = 12-month government security yield

sd1 = share of debt with residual maturity below 1 year

ltn_5y = 5-year government bond yield

sd1_5 = share of debt with residual maturity between 1 and 5 years

ltn_10y = 10-year government bond yield

sd5 = share of debt with residual maturity above 5 years

The interest rate assumptions should be country-specific. For several countries, the country-specific long-term interest rate assumption can be defined as the ten-year (five-year, one-year) benchmark bond extended with the forward par yields derived on the cut-off date from the corresponding country-specific spot yield curves.[30] [31] For

[29] Interest payments in period *t* are actually the interest paid on an average debt during the period *t*. Since the reported EDP debt is the stock of debt at the end of each year, the average debt of period *t* could be approximated by the simple average stock of debt between *t-1* and *t.*

[30] See Svensson, L.E.O. (1994).

[31] For longer projection horizons, term premiums are not allowed to be negative, avoiding unjustified inversion of the forward yield curve.

other countries, the interest rate projections can be computed by assuming certain dynamics of spreads to the first group of countries.

The path of the country-specific three-month government security yields assumes a linear convergence to the EURIBOR projections in 3 years.

Interest payments as of 2016 (and the corresponding implicit interest rate) are then calculated based on the equation presented above.

As the maturity structure provided by GFS data is only available for past years, the country-specific debt maturity structure is assumed to gradually converge to (roughly) the euro area average beyond the simulation horizon.

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