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Abstract

The economic and fiscal outlook has recently improved for European economies, raising the odds that high public debts inherited from the crisis will be gradually wound down in line with EU fiscal rules. This will however take time and future debt trajectories remain exposed to significant uncertainties. In this context, this paper explores some implications of GDP-linked bonds (GLBs), an instrument for national debt management that has recently sparked growing interest. Based on the data and tools of the Commission Debt Sustainability Monitor, our results suggest significant potential benefits from GLBs in reducing debt uncertainties for all European economies. These benefits would be notably large in countries characterised by medium-to-high debt, high macroeconomic volatility and limited alternative tools to smoothen shocks. A risk premium would not eliminate the debt-stabilisation benefits brought by GLBs. The fall in the probability of explosive debt paths could also reduce the premium demanded by investors on conventional bonds in high-debt countries. The issuance of a fraction of GLBs can however be no substitute for pursuing sound economic and budgetary policies curbing national debts.

JEL Classification: H63, F34, E62.

Keywords: GDP-linked bonds, debt sustainability, sovereign risk.

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The paper does not attempt to discuss all relevant dimensions of GDP-linked bonds, notably as regards the financial market perspective. In particular, this paper does not examine the issue of banks as holders of sovereign debt and the ongoing discussion about how balance sheet diversification could be encouraged, for example via new bond-based instruments.

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1. INTRODUCTION

GDP-linked bonds (GLBs) spark growing interest in the community of economists. GLBs are sovereign bonds that link debt repayment obligations to the level or growth of GDP. Several influential academics have made a strong case for issuing GLBs over the past two and a half decades (Shiller, 1993; Borenzstein and Mauro, 2004; Blanchard et al., 2016). Their message is gradually filtering into policy circles. Some central banks such as the Bank of England have been active in exploring the potential for such instruments (Benford et al., 2016). International organisations, including recently the IMF, have provided a nuanced, but overall supportive assessment of the prospects for state-contingent debt instruments (International Monetary Fund, 2017). As a sign of rising interest, policy makers of the G20 countries held a discussion on a 'compass' for GLBs earlier this year (G20, 2017).

The common view on GLBs is that they combine attractive properties in principle with practical challenges that explain their limited take-up so far. GLBs offer an in-built mechanism to stabilise public debts in an environment of uncertainty. This is especially valuable where indebtedness is at sustainable, but high levels and winding down debt through conventional adjustment takes time. Investors, on their side, are interested in a reduction of the risk of outright default. In addition, some investors may find appealing an instrument guaranteeing returns linked to average growth, given their needs and the nature of their liabilities. However, GLBs have not been used so far in advanced economies and their occasional use in debt restructuring contributes to a perception that GLBs are an instrument for debt-distressed countries only. It is often assumed, in particular, that the issuance of GLBs would come with a significant premium overweighing the expected benefits.

Current times may slowly become more propitious to the notion of GLBs, including in advanced economies and notably European countries. The economic conditions and the fiscal outlook have recently improved across EU countries, in liaison with a broadening recovery. Nevertheless, public debt levels are high as a legacy of the crisis, while long-term growth prospects remain uncertain. Policy-makers must guarantee debt sustainability in that environment. GLBs can efficiently contribute to that objective by reducing risks of disruptive crises through smooth adjustments. GLBs may also increase short-run budget flexibility and cross-border risk sharing, especially when a significant share of debt is foreign-owned. These benefits in terms of long-run solvency and resilience to shocks have a particular relevance for euro area countries. In addition, GLBs may be an indirect, but effective means to incentivise economic reforms. In sum, in the post-crisis environment, the case for GLBs may be stronger than before, motivating further analysis of their implications.

Against this background, the purpose of this paper is to explore the consequences of issuing a fraction of national debts through GLBs in European countries. We rely on the data and tools of the *Debt Sustainability Monitor* framework (DSM, European Commission, 2017) to provide and extend the quantitative insights from previous studies. In particular, we investigate the reduction in uncertainty brought by GLBs on debt trajectories in the short and longer term. We also explore the trade-off between that reduced uncertainty and the assumed premium of GLBs over ordinary bonds. Our results suggest important potential benefits from GLBs, even in the presence of a premium, for all countries but especially those characterised by medium-to-high debt, high volatility, and limited alternative tools to smoothen shocks. At the same time, GLBs are no substitute for sound policies aiming at curbing excessive public debts, in line with EU rules. GLBs do not involve any mutualisation of national public debts.

The rest of the paper is organised as follows. Section 2 takes stock of the existing reflections over GLBs and summarises their main expected benefits and challenges. Sections 3-5 show how GLBs help reducing the impact on debt developments of macroeconomic shocks, firstly in the short-run, and secondly in the longer-run. We then explore to what extent the possible premium on GLBs outweighs its expected benefits (section 6). Section 7 provides conclusions. ([1])

2. THE CASE FOR GDP-LINKED BONDS: AN OVERVIEW

GDP-linked bonds are debt securities with repayments linked to the issuing country's GDP. This paper considers the general case where both the *principal* and the *coupon* of the sovereign bond are indexed to GDP ([2]). These GLBs belong to the wider class of state-contingent debt instruments, where debt service obligations are tied to a pre-defined state variable. GLBs bear an equity-like feature. They alleviate the service of debt for governments when economic activity weakens and increase it when output strengthens. Hence, as firms link dividends to corporate earnings, sovereigns issuing GLBs pay out a fraction of the "country earnings" (GDP) to investors.

Broadly speaking, three benefits of GDP-linked bonds are put forward (IMF, 2017; Benford et al., 2016; Blanchard et al., 2016):

- <u>*Debt-stabilising benefits*</u>: by neutralising shocks to the "snowball effect" (see section 3), GLBs reduce uncertainties on future debt dynamics. That diminishes the likelihood of explosive debt paths and sovereign debt crises. This is a particularly worthwhile feature as sharp adverse macroeconomic shocks appear to be the most frequent and second-most costly source of public debt increases (Bova et al., 2016). The reduction in governments' default risk may in turn induce a reduction of the risk premium on conventional debt ([3]).
- <u>*Improved cyclical management*</u>: GLBs may avoid the adoption of low-quality fiscal retrenchment in downturns by reducing interest payments in those circumstances, and symmetrically, they can attenuate pro-cyclical spending expansions by requiring higher interest payments in upturns. Moreover, GLBs foster international risk-sharing when they are cross-border held and business cycles differ. That feature may be attractive in a monetary union with limited adjustment mechanisms to asymmetric shocks.
- <u>*Diversification opportunities*</u>: From the perspective of investors, GLBs offer a natural hedge for institutions that carry long-term liabilities linked to the growth of earnings, such as pension funds with open defined benefit arrangements. More generally, GLBs provide a convenient asset giving a direct stake in the economy and they increase portfolio diversification opportunities, the more so if GLBs are issued by several sovereigns.

In addition, albeit less discussed in the literature, GDP-linked bonds could act as an indirect incentive to implement growth-enhancing reforms. To place their GLBs with a small premium, governments would need to convince investors that growth prospects are sufficiently solid. This holds especially for bonds emitted with long maturities, where the quality of policies matters the most. GLBs may similarly act as an efficient deterrent of growth-deteriorating policies, such as pension reform reversals, for fear of triggering an investor strike.

([1]) The paper does not attempt to discuss all relevant dimensions of GDP-linked bonds including from a financial market perspective.

([2]) That design is often named a "linker" (IMF, 2017). That is a simple approach, which mimics the one adopted for inflation-linked bonds. Some authors (Borensztein and Mauro, 2004) consider indexing only the *coupon* to GDP (a "floater"). A floater may be more attractive for emerging or low-income countries than for advanced economies where interest expenditure is comparatively small (5% of public revenues on average). "Extendible" bonds, of which sovereign CoCos are a particular kind, are another tool where redemption dates are postponed on a pre-defined trigger (Weber et al., 2011; Barkbu et al., 2011; Mody, 2013). Extendible bonds are primarily designed to tackle liquidity crises rather than solvency issues.

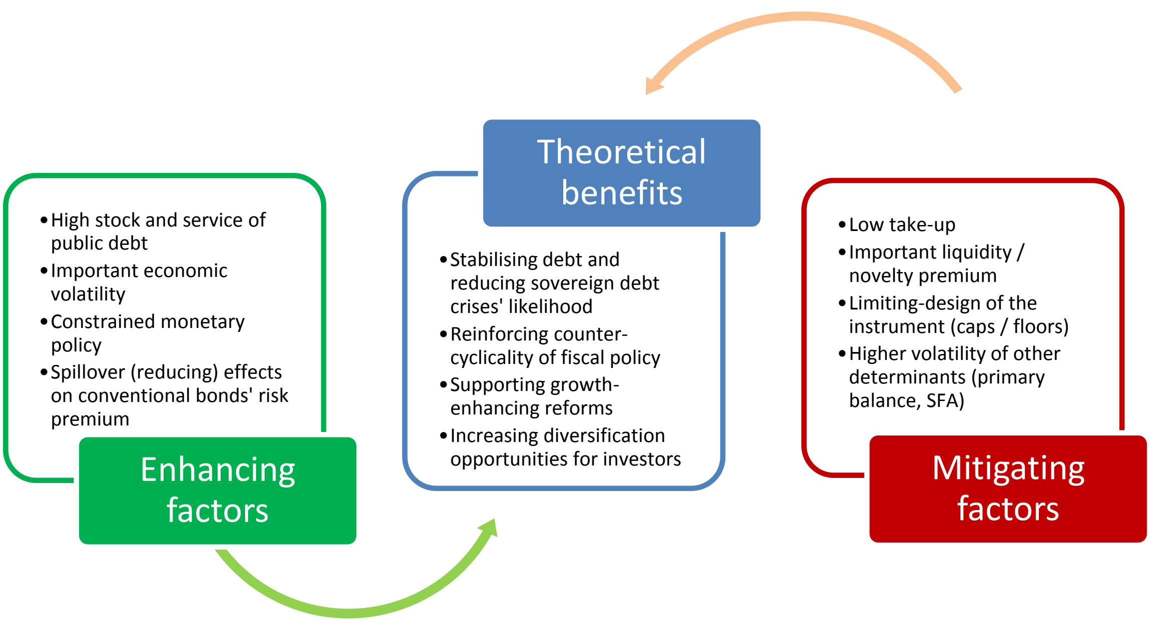
([3]) Bowman and Naylor (2016) argue that the lowered risk of default in one country would also have a beneficial spill-over effect on other countries given the presence of contagion effects of fiscal crises.

The extent of those benefits depends on several factors (Chart 3.1). These include the characteristics of the issuing country, notably its intrinsic volatility and policy settings, including the availability of monetary policy and other tools to address shocks. Obviously as well, the benefits depend on the degree of the take-up and on the precise design, e.g. the presence of caps / floors limiting interest rate adjustments. Moreover, the benefits can be mitigated or even reversed by counteracting factors, such as the size of the additional premium that is likely to be required on GLBs. Finally, GLBs do not address non-macroeconomic sources of shocks on public debt, such as banking sector bailouts. These must be tackled by other tools such as financial supervision or bail-in provisions.

GLBs have not been used so far in advanced economies. Elsewhere, there have been a few experiences mainly in the context of debt restructurings with instruments sharing some features of GLBs and primarily taking the shape of non-tradable instruments (see IMF, 2007 for a review of past experience). No sovereign has yet issued a GDP-linked bond with complete and symmetric risk-sharing between sovereigns and private investors - falling with lower GDP and rising with higher GDP (Benford et al., 2016; OECD, 2017). The most successful experience of state-contingent debt securities is inflation-linked bonds, which were first launched in the 1980's. Today these instruments represent 7% of government debt overall in OECD countries (OECD, 2017), but this share reaches a quarter of government debt in the UK, and above 10% in Italy and France.

Several implementation challenges explain the lack of development of GLBs to date. Arguably the largest concern is the presumption that GLBs would not be accepted by private investors without a significant premium over conventional bonds. That premium should compensate for the macroeconomic risk taken up by investors. It would combine with added liquidity and novelty premia, at least as the market for GLBs is in a developing phase. We examine in detail the implications of the GLB premium in the simulations and ask to what extent it offsets the expected benefits (see section 6). Other frequently mentioned concerns with GLBs pertain to risks of adverse selection and moral hazard (as only weak sovereigns may be interested in issuing GLBs) as well as measurement issues including GDP data revisions and data integrity (see Annex 3). Finally, the introduction of GLBs would raise questions regarding their treatment in financial regulation, in particular as compared to conventional bonds.

Graph 3.1. **GDP-linked bonds: theoretical benefits and enhancing / mitigating factors**



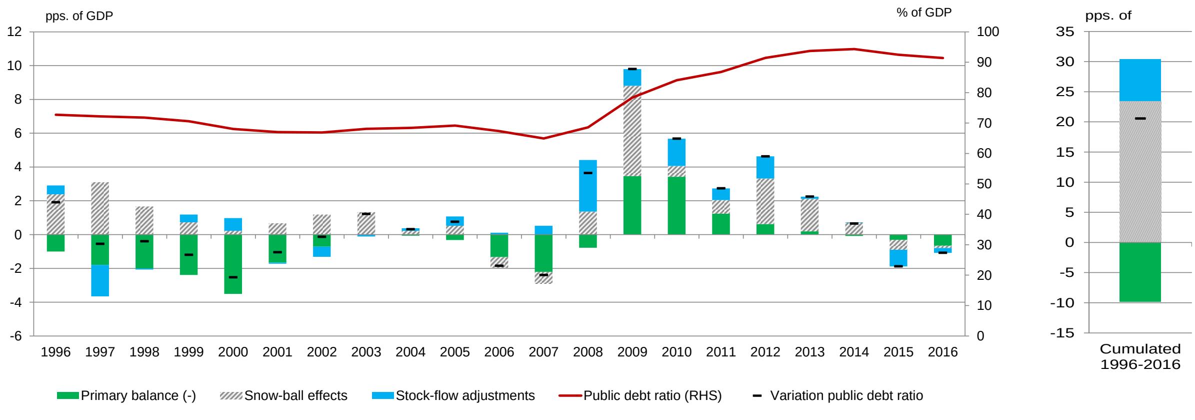
3. DEBT SUSTAINABILITY: SOME STYLISED FACTS

The growth of public debt in most European economies over the past two decades has multiple causes. The debt accumulation equation (see Box 4.1) is a simple accounting framework that breaks down the change in the debt to GDP ratio into three components: the primary balance, the so called snowball effect, and other factors subsumed under stock flow adjustments. The snowball effect is equal to the stock of past debt times the differential between the average (implicit) interest rate on debt and the nominal growth rate. GLBs essentially aim at eliminating or at least reducing the uncertainty over the snowball effect.

Past debt developments across European countries exhibit two features (Chart 3.2 and Table 3.1):

- First, the change in the debt ratio is quite volatile from one year to the next. This reflects a significant volatility in all three components of the debt equation, the primary balance, the snowball effect, and the stock flow adjustments. Business cycles, changes in policy and the realisation of contingent claims, such as banking sector support interventions, are major underlying causes of these movements.
- Second, the debt ratio has increased by over 20 pps. of GDP overall over the past two decades, with large cross-country differences. About one third of that average increase originates in stock-flow adjustments that are concentrated on the period of the financial crisis. The remaining two thirds reflect a contribution from the snowball effect that is only partially offset by the contribution of the primary balance. As is well known, it is necessary that the primary balance at least matches the snowball effect for debt to stabilise.

Graph 3.2. **Decomposition of the variation of the public debt ratio in the EA, by year** (pps. of GDP)



Reading note: In 2009, the EA public debt ratio increased by 9.8 pps. of GDP due to unfavourable snow-ball effects (5.3 pps. of GDP), driven by a substantial contraction of GDP (-3.5%), to a large primary deficit (3.5 pps. of GDP), and to a lower extent stock-flow adjustments (1 pp. of GDP).

Source: Ameco, Authors' calculations

These elementary facts illustrate both the volatility of the debt ratio and its overall upward trend in the recent past, notwithstanding considerable country differences. They also highlight the importance of the "snowball effect" in these movements. And they contrast with the scenarios of debt reduction generally expected on a forward-looking basis. One central motivation for GLBs is to help bridge the gap between ex ante expectations of debt reduction/stabilisation and real outcomes. GLBs cannot substitute for the sound policies that are needed to ensure solvency. However, they reduce the degree of uncertainty over future debt developments related to macroeconomic factors. GLBs limit the expected volatility of the debt ratio, both over a short-run horizon and on the longer-run. The following sections illustrate these possibilities.

Table 3.1. **Decomposition of the change in the public debt ratio (pps. of GDP): selected EU countries**

	Variation public debt ratio	Primary balance (-)	Snow-ball effects	Stock-flow adjustments
		1996-2007		
Euro area	**-5.9**	**-17.0**	**10.7**	**0.4**
Germany	**8.9**	-6.2	18.9	-3.8
Ireland	**-54.7**	-41.3	-31.8	18.5
Spain	**-26.1**	-24.3	-9.7	7.9
France	**8.5**	-1.9	6.7	3.8
Italy	**-17.1**	-36.9	23.7	-3.9
Portugal	**10.1**	14.3	-0.6	-3.5
		2008-2016		
Euro area	**26.4**	**7.1**	**12.8**	**6.5**
Germany	**4.6**	-12.2	2.6	14.2
Ireland	**51.6**	58.8	-10.9	3.7
Spain	**63.8**	44.1	19.3	0.4
France	**32.0**	20.9	9.5	1.6
Italy	**32.8**	-11.1	36.0	8.0
Portugal	**61.9**	19.4	30.0	12.5
		1996-2016		
Euro area	**20.6**	**-9.8**	**23.5**	**6.9**
Germany	**13.5**	-18.4	21.6	10.4
Ireland	**-3.1**	17.5	-42.7	22.1
Spain	**37.7**	19.8	9.6	8.3
France	**40.5**	19.0	16.2	5.4
Italy	**15.7**	-48.0	59.7	4.1
Portugal	**72.0**	33.7	29.4	9.0

Source: Ameco, Authors' calculations

4. GDP-LINKED BONDS AND DEBT STABILISATION IN THE SHORT RUN

Several European countries feature a high volatility of the interest – growth rate differential (Table 4.1 and Chart 4.1). At an annual frequency, the median standard deviation of that variable stands at over 300 percentage points. There are important cross-country differences in this respect. A higher than average standard deviation of the interest – growth rate differential is observed in the Baltic countries, Ireland, and to a lesser extent in Slovenia, Slovakia and Spain. High volatility seems partly related to the size of economies and their exposure to idiosyncratic shocks. Participation to the monetary union is arguably also a factor. A positive correlation between sovereign rates and growth is more likely when monetary policy responds to national shocks and the sovereign acts as a safe haven. But for a number of EU countries and mostly euro area countries, a weak or even negative correlation can be observed between sovereign bonds rates and output growth, a fact reminiscent of the Walters' critique. (4) That contributes to bigger time variations in the snowball effect. (5)

The fluctuations in the snowball effect together with the volatility in primary balances induce large variations in the dynamics of public debts (see Box 4.1). The volatility of primary balances, itself partly due to the business cycle and partly policy-driven, also contributes to raising the short-term uncertainty on debt trajectories. A larger volatility is logically observed in countries where business cycles are more pronounced and in economies most hit by the financial crisis such as Cyprus, Ireland and Spain. A negative correlation between the interest – growth rate differential and the primary balance, meaning that a higher interest rate (adjusted for growth) is associated with a lower primary balance, is observed in most countries. This further increases debt variability.

Table 4.1. **Interest – growth rate differential (i-g, %) and primary balance (pb, % of GDP) in selected EU countries: key statistics (1999-2016)**

	standard-deviation (i-g, %)	standard deviation pb (% of GDP)	Coef. of correl. i and g	Coef. of correl. Δi and Δg	Coef. of correl. (i-g) and pb	Coef. of correl. Δ(i-g) and Δpb
BE	1.6	2.8	0.4	0.1	0.0	-0.6
DE	2.5	1.6	-0.2	0.0	-0.4	-0.1
EE	7.5	1.6	0.3	-0.1	-0.8	-0.7
IE	9.0	8.1	-0.1	0.0	-0.6	-0.1
ES	3.8	4.2	0.5	-0.4	-0.9	-0.8
FR	1.6	1.7	0.5	0.2	-0.4	-0.5
IT	1.9	1.4	0.6	0.1	-0.3	-0.4
CY	4.1	2.9	0.7	-0.1	-0.6	-0.4
LV	11.9	2.4	-0.1	-0.4	-0.7	-0.8
LT	8.6	2.6	-0.4	-0.7	-0.5	-0.5
LU	3.7	2.1	0.4	0.1	0.0	0.0
MT	2.9	1.9	-0.2	0.2	-0.4	0.1
NL	2.0	2.4	0.7	0.5	-0.7	-0.7
AT	1.7	1.3	0.3	-0.2	-0.2	-0.3
PT	2.7	2.5	0.6	-0.3	-0.3	0.1
SI	3.8	3.1	0.7	-0.1	-0.6	-0.3
SK	4.2	2.3	0.4	-0.3	-0.4	-0.3
FI	2.8	3.7	0.4	0.1	-0.3	-0.6
EA-19	**1.9**	**1.7**	**0.5**	**0.1**	**-0.6**	**-0.6**
HR	4.5	1.7	0.3	-0.2	-0.3	-0.4
HU	3.3	2.4	0.8	0.1	0.2	0.1
UK	1.8	3.1	0.5	0.8	-0.3	-0.6
Median	**3.3**	**2.4**	**0.4**	**0.0**	**-0.4**	**-0.4**

Note: i) The simple statistics presented in these tables are based on annual data, covering the period 1999-2016, and are not corrected for 'outlier' values. ii) The table includes all (non-programme) euro area countries, as well as other EU countries exhibiting a debt to GDP ratio in 2016 greater than 60% of GDP (i.e. HR, HU and UK). iii) The interest rate corresponds to the implicit interest rate on public debt. iv) Correlations are calculated over the period 1999 – 2016 on series in level and in first difference – in this latter case, in order to control for time trends.

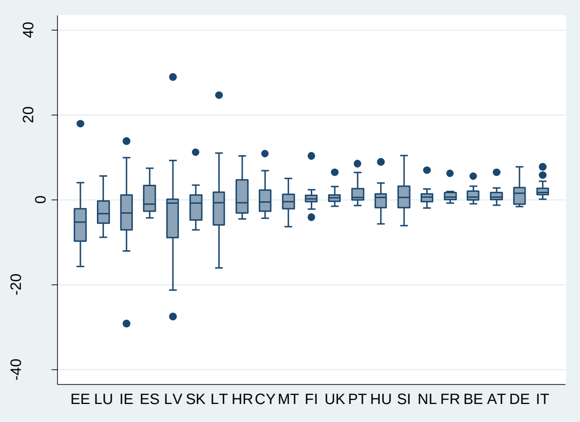
Source: AMECO, Authors' calculations

(4) According to Walters (1990), a member of a monetary union experiencing excessive inflation (e.g. because of a booming demand) will, because it is unable to change interest rates, have low real interest rates, further increasing demand. Similarly a member with weak demand and low inflation will have high real interest rates, exacerbating recessive pressures.

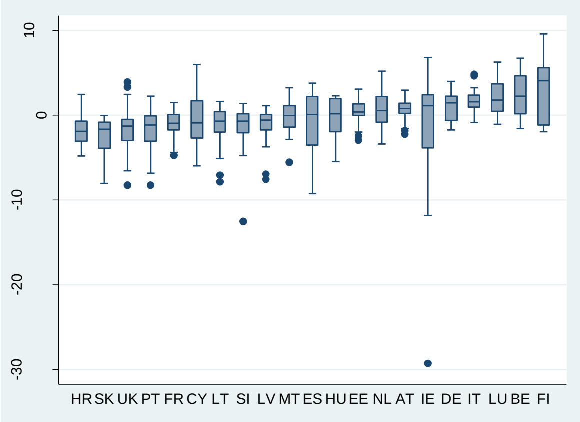
(5) Given that $V(i_t - g_t) = V(i_t) + V(g_t) - 2.Cov(i_t, g_t)$.

Graph 4.1. **Interest – growth rate differential and primary balance in selected EU countries: summary distribution (1999-2016) - ordered by median values**

Interest-growth rate differential summary distribution, by country



Primary balance summary distribution, by country



Note: Each box plot is a representation of the distribution of the variable of interest (interest-growth rate differential and primary balance) over the period 1999-2016 (by country). The middle line represents the median value, the top and bottom of the box correspond to the 75th and 25th percentile values; the top and bottom branches represent the upper / lower adjacent values (maximum / minimum excluding outliers); finally, the dots correspond to outlier values (more / less than 3/2 times of upper / lower quartile)). The longer the box (and branches) is, the higher the volatility of the variable is.

Source: AMECO, Authors' calculations

Box 4.1. **DEBT DYNAMICS UNCERTAINTY: CONVENTIONAL BONDS VERSUS GDP-LINKED BONDS**

In the conventional case, the debt dynamic is described as follows, omitting for the sake of simplicity stock-flow adjustments: $\Delta d_t = (i_t - g_t).d_{t-1} - pb_t$ where d_t is the public debt to GDP ratio, i_t is the nominal effective interest rate on public debt, g_t the nominal GDP growth and pb_t is the primary balance to GDP ratio. The uncertainty over the change in the debt ratio reflects the shocks affecting the interest growth rate differential and the primary balance. Formally, the variance of the change in the debt ratio is:

$$V(\Delta d_t) = d_{t-1}^2.V(i_t - g_t) + V(pb_t) - 2.d_{t-1}.Cov(i_t - g_t, pb_t) \quad (1)$$

GDP-linked bonds are considered, where both the principal and the coupon are indexed to growth. In a multi-period setting, this means that both principals and coupons are indexed to cumulated growth since the date of issuance. Assuming a one-for-one direct link, this can simply be written as $i_t^{gdp} = g_t + c$ where i_t^{gdp} is the return on (GDP-linked) public debt and c is a constant. The constant may incorporate a premium over conventional bonds. The debt equation then becomes $\Delta d_t^{gdp} = c.d_{t-1}^{gdp} - pb_t$ and the variability of public debt collapses to the one stemming from the primary balance:

$$V\left(\Delta d_t^{gdp}\right) = V(pb_t) \quad (1)'$$

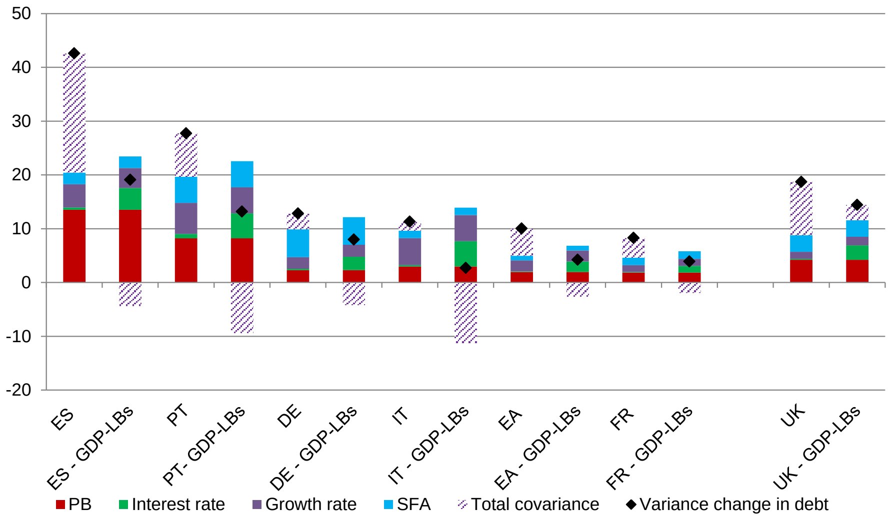
Comparing (1') with (1), the sources of uncertainty are clearly fewer with GLBs. Whether the variance is actually smaller holds when:

$$d_{t-1}.V(i_t - g_t) > 2.Cov(i_t - g_t, pb_t) \quad (2)$$

Condition (2) is likely to hold in most cases. This is notably because $Cov(i_t - g_t, pb_t)$ is likely to be either negative or at best mildly positive, notably because of the negative cyclical impact of growth on the primary balance through lower revenues. Even if the right hand side term of (2) were to be positive, it is likely to be somewhat lower than the term on the left hand side, in particular when debt is high (high d_{t-1}) and where the interest growth rate differential is volatile (high $V(i_t - g_t)$).

This unsteadiness of the debt ratio in the short run could be considerably reduced with GLBs. With current debt instruments, there is no 'natural' hedge of macroeconomic volatility. A thought experiment where conventional debt is entirely replaced with GLBs over the period 2001-2016 shows that a substantial reduction of the variance of the change in the debt ratio would have been observed (see Chart 4.2). The reason is that the co-movements between the various variables (primary balance, interest rate, growth rate and stock flow adjustments) brings a positive contribution with conventional bonds, which turns into a negative or just mildly positive contribution with GLBs. ([6]) The difference is particularly large in some countries such as Italy given the size of public debt and of interest payments (see Annex 1).

Graph 4.2. **Decomposition of the variance of the change in the debt ratio over the period 2001-2016 in selected EU countries: conventional versus GDP-linked public debt**



Note: This chart is based on a slightly more complex decomposition of the debt dynamic than in Box 4.1 taking into account stock-flow adjustments. The total co-variance takes into account co-movements between the interest rate, growth rate, primary balance and stock-flow adjustments (see Annex 2). In Spain, the large contribution of the total covariance in the conventional case is mainly driven by the high negative correlation between the interest – growth rate differential and primary balance (see Table 4.1).

Source: AMECO, Authors' calculations

From a macroeconomic perspective, GLBs would automatically reduce debt service payments in economic downturns and increase those in economic upswings. As illustrated in Table 4.2, a negative 1 % shock on growth would reduce the interest bill by around 0.8 percent of GDP on average, assuming that all public bonds are GDP-linked bonds, and by an average 0.3 percent of GDP in a more realistic case where one third of public debt is shifted to GDP-linked debt (see also Box 6.1). ([7]) This increases (reduces) fiscal room in downturns (upturns) and facilitates the conduct of sound fiscal policies throughout the cycle ([8]). For example, the savings achieved on interest payments in a recession may spare the adoption of low quality retrenchments that would otherwise be necessary to

([6]) These results are based on stylised assumptions, notably that all debt is GDP-linked.
([7]) The impact on public gross financing needs, which include debt amortisations, would be even higher.
([8]) For the euro area, Hughes Hallett (2017) sees it as a way to institute 'monetary federalism'.

control deficits. The precise implications of GLBs for aggregate fiscal policy would nevertheless depend on the specific budgetary arrangements and fiscal rules that prevail ([9]).

The benefits in terms of domestic stability should be higher when a higher proportion of GLBs is held by foreigners. To the extent that sovereign bonds are held cross-border, GLBs *de facto* constitute a system of international risk sharing. This can be helpful in particular in a monetary union such as the euro area where there are limited means to smooth the impact of asymmetric shocks, given imperfect financial integration and the lack of common budgetary instruments (see e.g. Furceri and Zdzienicka, 2015; Alcidi, 2017). When GLBs are held by domestic agents, there is still a stabilising benefit if the saving (in a downturn) on debt service is used to finance transfers to agents with a higher marginal propensity to consume than bond holders. This works well if the private agents that are affected by the lower government debt service, such as banks holding GLBs, have the means to smoothly absorb it.

Table 4.2. **Relative impact of a negative growth shock (-1 pp.) on interest payments (pps. of GDP, relative difference with the baseline scenario and with the conventional debt case)** ([10])

	Level in 2017	Impact (pps. of GDP)	
	Interest payments (% of GDP)	All GDP-linked bonds	One third GDP-linked bonds
BE	2.4	-1.1	-0.3
DE	1.2	-0.7	-0.2
IE	2.2	-0.8	-0.3
ES	2.6	-1.0	-0.3
FR	1.8	-1.0	-0.3
IT	3.8	-1.3	-0.4
CY	2.5	-1.0	-0.3
LV	1.0	-0.4	-0.1
LT	1.4	-0.4	-0.1
LU	0.4	-0.2	-0.1
MT	2.1	-0.6	-0.2
NL	1.0	-0.7	-0.2
AT	2.2	-0.8	-0.3
PT	4.4	-1.3	-0.5
SI	2.6	-0.8	-0.3
SK	1.4	-0.5	-0.2
FI	1.1	-0.7	-0.2
average	**2.0**	**-0.8**	**-0.3**
HR	3.4	-0.9	-0.3
HU	2.9	-0.7	-0.2
UK	2.4	-0.8	-0.3

Reading note: In case of a negative shock on GDP growth (-1 pp. compared to the baseline), interest payments would be reduced by 1.3 pps. of GDP in Italy – if all debt was GDP-linked - compared to the baseline and to the conventional debt case). The data used are those of each country in 2017. The simulations report the impacts in the 'steady-state', once all (respectively one third) bonds are GLBs.

Source: Debt Sustainability Monitor, Authors' calculations

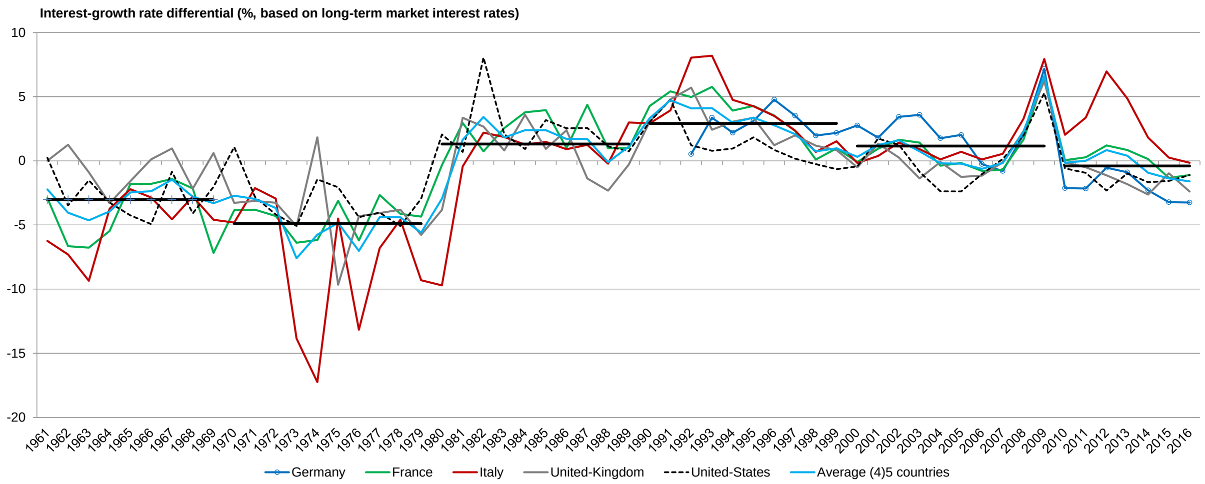
([9]) For example, if the prevailing rule targets the headline budget balance, a recession will necessitate the adoption of budget savings measures to offset the lower tax revenues and higher unemployment spending induced by the recession. In this case, the existence of GLBs reduces the amount of needed savings measures. However, if the prevailing rule targets a cyclically-adjusted budget balance, a recession in principle does not require the adoption of savings measures with conventional bonds. In that case, the presence of GLBs would in fact give room to support the economy with measures substituting lower interest payments.

([10]) The simulations with GDP-linked bonds are based on the DSM 2016 assumptions and the equations in Boxes 4.1 and 5.1 where the value of c has been determined in a way to equalise the public debt ratio in 2030, in the baseline scenario, with the level reached in the conventional debt case (as in Benford et al., 2016). This value is held constant (the shock being considered as temporary and unexpected). The simulation with one third GDP-linked bonds assumes by simplicity that the interest rate is an average of the conventional bonds' interest rate and the GDP-linked bonds' interest rate.

5. THE BENEFITS OF GLBS IN STABILISING DEBT TRAJECTORIES

GLBs also reduce the uncertainty over debt trajectories in the longer term. In a sense, this is more important than limiting short-term volatility. The long-term value of the interest-growth rate differential is a key source of macroeconomic uncertainty. Indeed, it has undergone substantial variations in the past, being generally low or negative in 1960s-70s, significantly positive in 1980s and up to mid-1990s and declining since then (see Chart 5.1). The post-crisis environment of the "new normal" is characterised by such uncertainty, as future trends of both interest rates and output growths are radically uncertain ([11]). To be sure, these trends are likely to be in part correlated, but not fully. Issuing a fraction of sovereign debt in GLBs attenuates that uncertainty on future debt paths. GLBs would not necessarily lower the expected cost of sovereign borrowing, but would make it more predictable, in relation to the growth of the economy.

Graph 5.1. **Interest-growth rate differential in selected countries since the 1960's**



Source: Ameco, Authors' calculations

The stochastic simulation framework of the European Commission is used to quantify the effects of the introduction of GLBs on the long-term debt distribution. We compare the debt distribution under the baseline scenario of conventional bonds and a GLBs scenario. As in other studies (IMF, 2017; Blanchard et al., 2016; Benford et al., 2016), a stochastic simulation framework is used. In comparison with other papers, we rely on the detailed data and methodological assumptions of the Debt Sustainability Monitor (European Commission, 2017), which are available for EU countries. Box 5.1 details the assumptions underlying the projections. To provide stylised results highlighting the differences with the conventional case, it is assumed that all bonds are GDP-linked from the start of the simulation, or only one third in a variant.

The introduction of GLBs reduces the size of the interval between the upper and the lower tails of the debt ratio distribution in all countries (see Table 5.1 and Chart 5.2). Under the assumption of a zero risk-premium, this reduction reaches around -30 pps. of GDP at the euro area aggregate level, ranging from -4 pps. of GDP (Luxembourg) to -55 pps. of GDP (Portugal). It would be particularly important in absolute and / or relative terms in Portugal, Italy, Lithuania, Ireland and Spain, given a

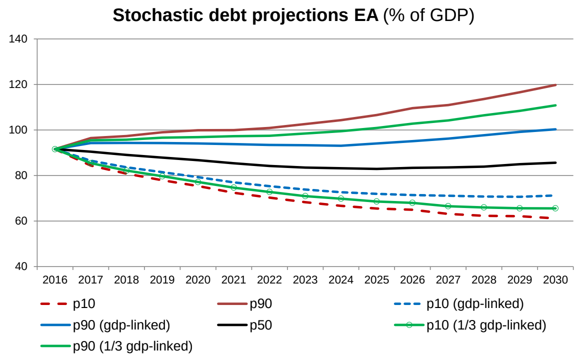
([11]) Hamilton et al. (2015) argue that there is much uncertainty about the value of future interest rates, their determinants being manifold and time-varying. Crafts and Mills (2017), looking at the US case, point that medium-term total factor productivity growth (a major determinant of future economic growth) is very unpredictable.

high volatility of the interest – growth rate differential (e.g. Lithuania and Ireland) and / or the large stock of public debt (e.g. Portugal, Italy and Spain). Hence, some highly indebted countries would greatly benefit from such instruments. Other highly indebted countries (such as Cyprus) would see a more moderate reduction of the debt ratio distribution cone, notably because of the (remaining) important primary balance volatility. Even in more stable economies (e.g. Germany, France and the Netherlands), there would a case for GDP-linked bonds, albeit more limited debt-stabilising effects.

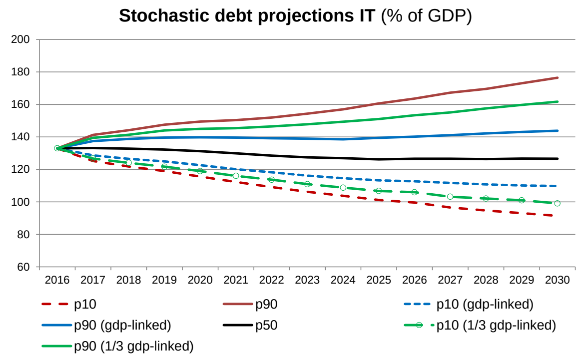
Overall, the benefits are especially large where: i) there is higher uncertainty on future interest rates and future growth rates, and ii) debt levels are medium to high, i.e. when there is limited degree of fiscal space and uncertainty on exactly how much fiscal space there is. These results are in line with the literature (e.g. stronger benefits in Spain and Italy than Germany found in Blanchard et al., 2016). ([12]) Debt-stabilising benefits would nevertheless be more limited in case of a reduced take-up of GDP-linked bonds (for instance assuming shifting a third of the debt portfolio to GDP-linked debt). In this last case, the width of the projected debt ratio distribution would be narrowed by around -13 pps. of GDP at the euro area aggregated level.

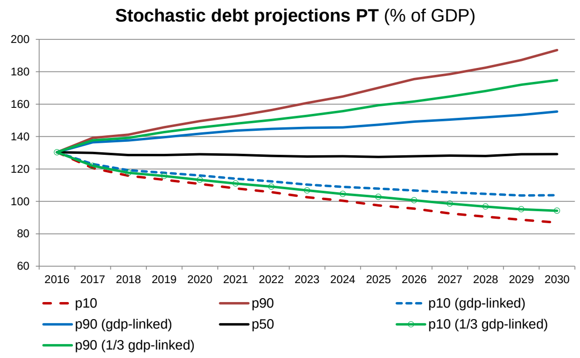
Graph 5.2. **Stochastic debt projections: conventional versus GDP-linked bonds – EA and selected case studies**

Euro area



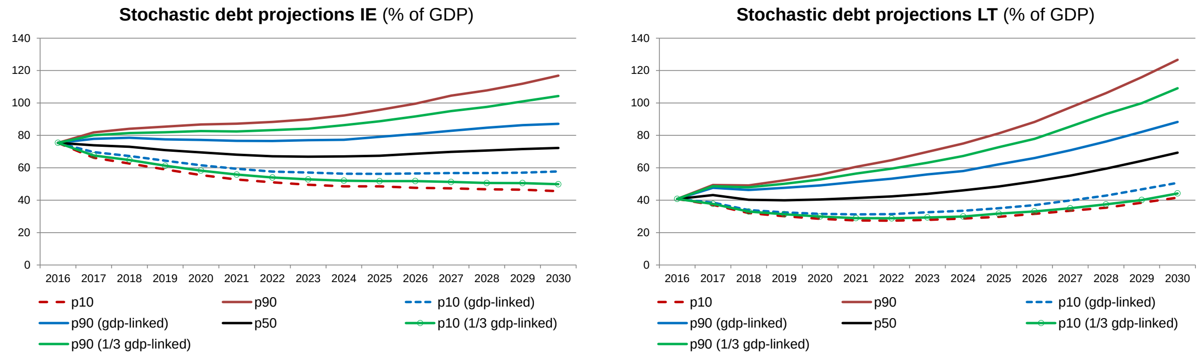
Large benefits due to high debt





([12]) There are however some moderate discrepancies in the results linked to some differences (e.g. horizon: 2030 versus 2035; percentile ranks considered: more extreme in some studies; and historical variance – covariance matrix used). In other papers, stylised or aggregate case studies are considered (an 'highly indebted advanced economy' in Bendford et al. (2016) and the euro area in the IMF (2007)).

Large benefits due to volatile r-g



Source: Debt Sustainability Monitor, Authors' calculations

Table 5.1. **Stochastic projections: conventional versus GDP-linked bonds in selected EU countries (% of GDP)**

Country	Debt ratio in 2016 (1)	Proj. diff. btw. percentiles 90th and 10th of debt ratio distribution in 2030				r-g volatility above EU median	Public debt above EU average in 2016
		All GDP-linked bonds (2)	Conventional bonds (3)	Difference (4) = (2) - (3)	Relative difference (5) = (4) / (1)		
BE	107	39.3	74.5	-35.2	-33%		x
DE	68.1	33.3	46.7	-13.4	-20%		
IE	75.4	29.4	71.4	-41.9	-56%	x	
ES	99.5	31.5	72.0	-40.5	-41%		x
FR	96.4	28.6	65.2	-36.6	-38%		x
IT	133	34.0	85.1	-51.0	-38%		x
CY	107.1	55.8	80.8	-25.0	-23%		x
LV	40	35.0	51.1	-16.1	-40%	x	
LT	40.8	37.7	85.0	-47.3	-116%	x	
LU	23.2	28.7	32.4	-3.7	-16%	x	
MT	62.1	36.6	53.4	-16.9	-27%	x	
NL	63	32.6	45.4	-12.8	-20%		
AT	83.5	42.2	61.1	-18.9	-23%		
PT	130.3	51.6	106.4	-54.8	-42%		x
SI	80.2	37.1	63.0	-25.9	-32%		
SK	53.3	38.6	49.2	-10.6	-20%	x	
FI	65.4	31.2	56.0	-24.9	-38%		
EA-19	91.6	29.1	58.6	-29.5	-32%		x
HU	73.4	45.3	65.9	-20.6	-28%	x	
UK	89.2	32.9	63.6	-30.7	-34%		x

Note: See Annex I for the results when only one third of public debt is GDP-linked.

Source: Debt Sustainability Monitor, Authors' calculations

Box 5.1. **STOCHASTIC SIMULATIONS WITH GDP-LINKED BONDS – MAIN ASSUMPTIONS**

In order to construct a range of plausible alternative paths around the baseline scenario, in each year of the projection period (up until 2030), we run stochastic simulations according to the standard methodology used in the Commission Debt Sustainability Monitor (see European Commission, 2017; Berti, 2013). Taking explicitly into account uncertainties, an amended equation for debt dynamics **with conventional public bonds** is:

$$\Delta d_t = \left[(i_t + \varepsilon_{i,t}) - (g_t + \varepsilon_{g,t})\right]. d_{t-1} - (pb_t + \varepsilon_{pb,t})$$

With GDP-linked bonds, it becomes:

$$\Delta d_t^{gdp} = c. d_{t-1}^{gdp} - (pb_t + \varepsilon_{pb,t})$$

The baseline scenario is based on the following assumptions: no-fiscal policy change (in practice, this means that the structural primary balance is assumed to remain constant over time, notwithstanding the projected costs of ageing), the closure of the output gap by t+5 (in 2021), with the economy growing at its potential from then onwards (as estimated by Commission services) and the convergence of the inflation rate and the real long-term interest rate to 2% (the year of the output gap closure) and 3% (by t+10) respectively. The constant is set at a level that ensure that, in the absence of shocks, the debt ratio after 15 years is the same for GLBs as it is for conventional bonds (arbitrage condition).

Stochastic projections consist in applying shocks to baseline values of the main variables driving the public debt dynamic, hence capturing in a more comprehensive way (than standard deterministic projections) uncertainty in macroeconomic conditions. The advantages of this method are three-fold: 1) running a very large number of sensitivity tests; 2) calibrating the shocks so that they reflect past observed uncertainty (size of the volatility); 3) capturing the correlation between the different variables.

More precisely, with conventional public debt: we allow the baseline values for interest rates, nominal growth and the primary balance (as well as exchange rate - not shown in the equations above for simplicity - for non-EA countries) to be subject to shocks, drawn from a joint normal distribution. The joint normal distribution has a zero mean and variances / co-variances calculated *based on historical shocks* (using quarterly data starting (in most cases) from the late 1990's – early 2000's until mid-2016, and eliminating outlier values). ([13]) In the simulations, we assume for each country that half of the variances / co-variances correspond to the country-specific values and half to the EU average.

With GDP-linked public debt: under the assumption of a fully GDP-linked debt stock, debt dynamics are generated through random draws from the distribution of the nominal growth and the primary balance only (as well as exchange rate for non-EA countries), taking into account, as for the conventional public debt case, the correlation between shocks. Under the assumption of a partial shift of the debt portfolio to GDP-linked bonds (one third in the simulations), we use a weighted average (in due proportion) of the interest rates on conventional bonds and on GDP-linked bonds.

Fans charts are constructed by taking draws from the joint normal distribution to produce 2000 simulations of the debt to GDP ratio over a 15 year window (2016 to 2030). We then plot the 10th and 90th percentiles of these simulations at each point in time.

The increased resilience of debt trajectories could reduce the probability of debt crises and indirectly reduce the cost of borrowing on conventional bonds. The recent literature connects the occurrence of debt crises with reaching the so-called "debt limit", broadly speaking the point at which investors become convinced that the country will not be able to sustain the primary surpluses needed to honour its obligations (Ghosh et al., 2011). By narrowing the cone of expected debt outcomes, GLBs

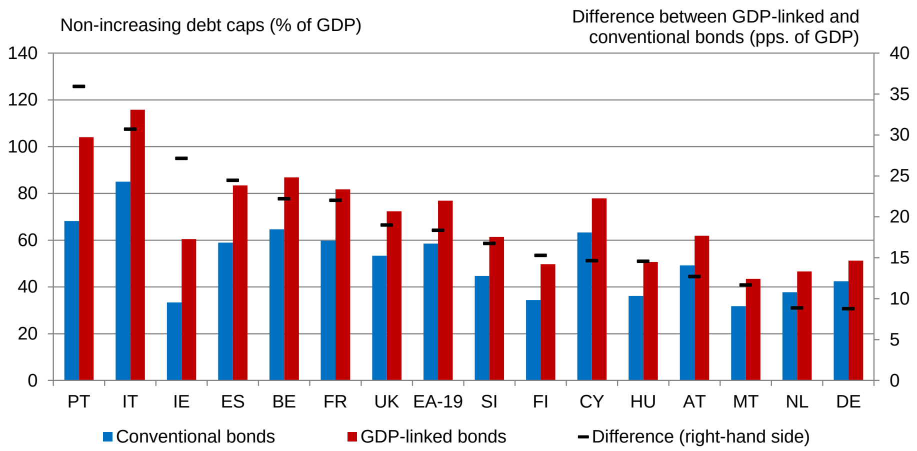
([13]) It is also assumed that there is no serial time-correlation of shocks.

lower the probability of hitting the debt limit and therefore of fiscal crises. ([14]) In turn, this may lower the credit spread on conventional bonds, especially for indebted countries of the EU and the euro area where that spread is relatively large *vis-à-vis* risk-free assets. GLBs therefore offer a 'safety valve' contributing to reduce the likelihood of unsustainable debt trajectories. In place of dramatic debt restructuring ex-post, they offer a smooth and automatic adjustment mechanism ex-ante when growth falls below expectations on a lasting basis. In this respect, GLBs may be an interesting tool to consider for fostering the resilience of the EU and of the euro area in particular.

Another indirect possible benefit is to facilitate a realistic strategy for gradually unwinding high public debts. There is some intellectual agreement that debt should serve as the anchor of a rules-based fiscal framework. But there is a lingering debate on the long-term level that is reasonable to target and the speed of reverting to that target. GLBs are interesting in this perspective, because they permit to target *ex ante* a realistic pace of debt reduction while providing guarantees that the debt ratio is less likely to explode *ex-post*. The advantage of GLBs can be illustrated using the notion of so called "non-increasing debt caps" (Chart 5.3). Those are defined as the median level of public debt to target in 2030 to ensure that, even in the case of adverse shocks, public debt ratio will not increase relative to its current value with a 90% probability. ([15])

With GDP-linked bonds, the non-increasing debt caps are higher. This means that countries can adopt a more gradual pace of debt unwinding without incurring a bigger risk of debt increase in the event of adverse shocks. Alternatively, they increase the chances that debt will be effectively reduced ex-post for a given target path of debt ex-ante. In line with previous results, the difference would be particularly noticeable in highly indebted countries (e.g. Portugal, Italy, Spain, Belgium, France and the United-Kingdom) and in those where macroeconomic volatility is particularly high (e.g. Ireland). However, while it may be useful to target more realistic debt objectives, GLBs should clearly not be understood as exempting governments from necessary consolidation, especially in vulnerable euro area Member States.

Graph 5.3. **Non-increasing public debt caps in 2030 – selected countries**



Note: 1) Non-increasing debt caps are defined as the level that should be targeted in 2030 (in terms of median public debt) to ensure that in case of adverse shocks, public debt in 2030 would not be greater than the level observed in 2016 with a probability of 90%. 2) Selected countries are those with a public debt ratio greater than 60% of GDP in 2016.

Source: Debt Sustainability Monitor, Authors' calculations

([14]) Pienkowski (2017) develops a calibrated model in which the emission of 20% (50%) of sovereign debt with GLBs reduces the debt limit by 15 (40) percent of GDP in advanced economies.
([15]) See European Commission (2016) for a more detailed presentation of'non-increasing debt caps'.

Finally, GLBs could also act as an indirect incentive to implement growth-enhancing reforms boosting potential growth and raising sustainability. To place their GLBs at a low price, governments would need to convince investors that growth prospects are solid, especially for bonds issued with long maturities (for which the horizon is such that actual growth coincides with potential growth, which in turn is driven by the quality of economic policies). Perhaps even more clearly, growth-deteriorating reforms (e.g. pension reform reversals) would be dis-incentivised, for fear of an investor flight. There is nevertheless a counter-argument that by sharing risks over future growth, the insurance provided by the GLBs would raise moral hazard. However, this moral hazard risk should be limited to the extent that only a fraction of debt will be GDP-linked, and governments are unlikely to dis-regard their growth objectives simply for the sake of saving on debt payments.

6. GDP-LINKED BONDS AND THE RISK PREMIUM

The benefits brought by GLBs could be undercut in case a high risk premium, *relative to conventional bonds*, is demanded by investors. This premium would be composed of several sub-premiums (Consiglio and Zenios, 2017; Cabrillac et al., 2017; Bowman and Naylor, 2016): a liquidity premium, given the narrow size of the GLBs market in its early stage of development; a novelty premium, reflecting the new / unfamiliar nature of the investment product; a growth risk (or indexation) premium, compensating investors for taking on some of a country's economic growth risk; a default risk premium, which could actually play a mitigating role.

However, as there is no clear historical precedent, the size of the risk premium on GLBs is empirically unknown:

- *Liquidity and novelty premium*: the liquidity and novelty premium could be initially high, but would be likely to decrease over time (as seen for other products like inflation-linked bonds). Potential investors believe that creating a well-defined, standardised instrument would help containing such a premium (IMF, 2017). ([16]) It could even become negligible if the market for GLBs were to develop sufficiently. Box 6.1 gives some insights on the horizon at which we could expect a significant proportion of GLBs issuances, given the current structure of public debt in European countries and the projected trends of financing needs.

- *Growth risk premium*: the quantification of the growth risk premium associated with GLBs is critical. Some attempts have been made in the literature to estimate such premium. Kamstra and Shiller (2009) estimate a risk premium of 150 basis points (bps) on a GDP-linked bond for the US (based on a capital asset pricing model). Pienkowski (2017) arrives at a similar estimate for advanced economies (based on a different framework). ([17]) Bowman and Naylor (2016) argue that, as can be expected, the estimates are sensitive to the model used, the underlying assumptions (regarding the benchmark portfolio) and the choice of the sample period. Consiglio and Zenios (2017) conclude that - on the basis of estimations for the UK and the US - the size of the premium critically depends on the design of the instrument (e.g. coupon versus principal-indexation, target growth rate, maturity).

- *Default risk premium*: In case of a significant proportion of GLBs issuance, public debt would be more sustainable (see section 5), and an important reduction in the default premium of all sovereign bonds, including conventional ones, could be observed, in particular in highly indebted countries. This effect would reduce the cost of issuing GLBs as compared with ordinary bonds and reduce the default risk premium affecting all bonds. It should increase with the share of GLBs issued.

([16]) The survey carried in this study amongst potential issuers and investors suggests that according to some participants, the GBLs premium over conventional bonds could be around 20 – 30 bps with a standardised product. In this study, it is unclear however whether this figure refers to the liquidity and novelty premium only, or to the overall premium.
([17]) A higher premium (or around 200 bps.) is estimated for emerging countries.

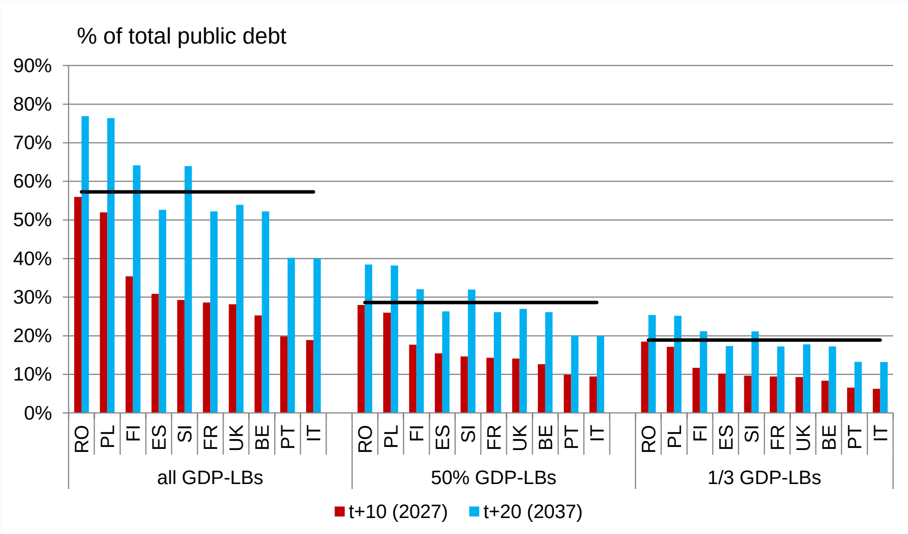
Box 6.1. **AT WHICH HORIZON COULD A SIGNIFICANT SHARE OF PUBLIC DEBT BE CONVERTED IN GLBS?**

A critical point regarding GLBs is the potential 'long-term' volume of issuance and the horizon at which this market could reach a mature phase. This question matters for the size of the potential benefits brought by this instrument, for how fast these benefits would accrue through time, and relatedly for the risk premium that would be demanded by investors.

Some simulations can illustrate what can be reasonably expected in terms of phasing-in of GLBs. The speed and magnitude at which public debt portfolio could be shifted to GLBs depend on three factors: 1) the share of new debt issued in GLBs, 2) the debt maturity structure, and 3) the projected financing needs. In our simulations, we assume that as from 2017, respectively all, half and one-third of new long-term public debt (whether it is issued to finance a budgetary deficit or roll-over maturing debt) would be issued in GLBs. The current debt maturity structure of debt is used, and assumed to remain broadly constant through time. Finally, for the sake of the exercise, we focus the analysis on countries projected to see an increase in their public gross financing needs in the medium to long-term (according to the Commission DSM 2016 projections).

Overall, an average share of about 20-30% of the debt stock could be in GLBs after two decades, under the scenarios of partial issuance in GLBs from now on (Chart 6.1). The shift to GLBs could be relatively rapid in some countries such as Romania and Poland, where the average maturity of public debt is less than 5 years ( ) and public debt is projected to substantially increase over the next two decades. On the other hand, in the case of the UK, the public debt portfolio would be shifted more gradually to GLBs due to the high maturity of debt (above 14 years on average). In Italy and Portugal, the conversion of public debt would also be relatively slow given the milder increase of projected financing needs over the period considered (even decrease until 2027). However, in those countries as more generally, a conversion to GLBs could be speeded up with buyback operations if deemed useful.

Graph 6.1. **Share of GLBs in the stock of public debt in t+10 and t+20 in selected EU countries - based on the DSM 2016 baseline scenario**



Note: 1) It is assumed that as from 2017, respectively all, half and one-third of new long-term public debt (to cover new financing needs or principal repayments) would be issued in GDP-linked bonds, and that it would then mature with the same maturity structure as conventional bonds (based on Eurostat and ECB historical data). 2) The selected countries are those where an increase of public debt is projected in the baseline scenario, starting from a ratio above 60% of GDP. Romania and Poland have also been included (although the debt ratio in 2016 was below 60% of GDP), given the high projected increase, and the low average maturity of debt (less than 5 years against a euro area average of close to 7 years).

Source: Debt Sustainability Monitor, Author's calculations

Overall, there is considerable uncertainty on the total premium that could affect GLBs over ordinary bonds. In practice, the size of the premium will depend on the conditions of issuance and is likely to evolve over time. Simulations in the literature that incorporate a risk premium rely on informed conventional choices: for example, the premium is set at 100 bps in Blanchard et al. (2016) and Benford et al. (2016), while values ranging from 100 bps to 350 bps are tested in Pisani-Ferry et al. (2013). Barr et al. (2014) use risk premia in the range of 35 bps - 370 bps, based on estimated values for different levels of investor risk aversion. In our simulations, we use a value of 150 basis points for the overall premium which we consider as a 'prudent' (i.e. high) value. If the premium turned out to be smaller, the simulations would be more advantageous to GLBs.

A total premium of 150 basis points would reduce, but not eliminate the debt-stabilisation benefits brought by GLBs. In the 'central scenario', the debt level would be in this case higher with GLBs than in the conventional bond case, given the increased cost of borrowing ('everything else being equal' meaning assuming no indirect effect on ordinary bonds' yields, see Chart 6.2). However, a series of unfavourable shocks would still leave the debt ratio at a lower level than with conventional bonds. This is illustrated by the fact that the debt path corresponding to the 90th percentile is still below the one with ordinary bonds – albeit higher than without a risk premium. Therefore, despite the premium, the risk of explosive debt would remain lower with GLBs (see Table 6.1). Furthermore, this simulation assumes that the default premium on conventional bonds is unchanged from the baseline. Tentative calibrations of the impact of the issuance of GLBs on the default premium suggest that when taking into account the lower default risk, the overall cost of borrowing on public bonds could in fact be lower than assumed in these projections, specifically for highly-indebted sovereigns (see Box 6.2).

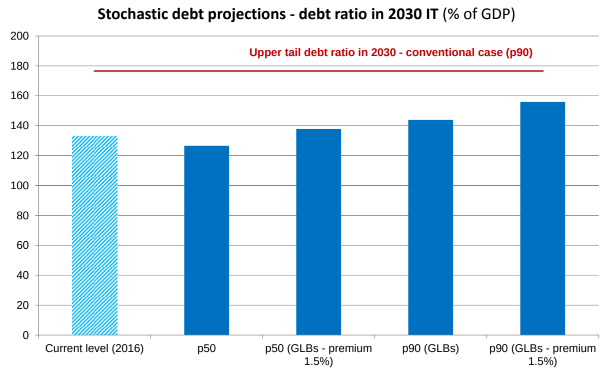
Table 6.1. **Comparing stochastic simulations with conventional bonds versus GDP-linked bonds, and depending on the presence of a premium**

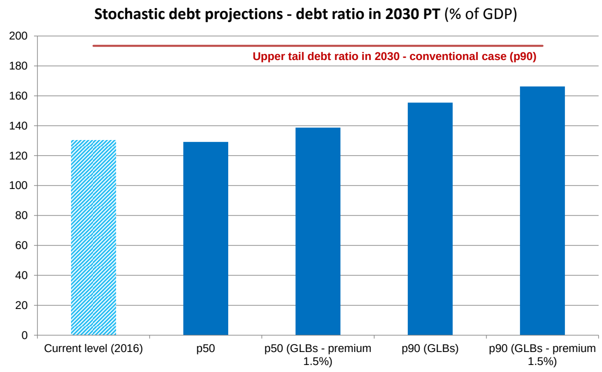
Country	Debt ratio in 2016 (1)	Proj. diff. btw. percentiles 90th and 10th of debt ratio distribution in 2030					90th percentile of debt ratio distribution in 2030				
		GDP-linked bonds		Conventional bonds (4)	Difference with conventional bonds		GDP-linked bonds		Conventional bonds (7)	Difference with conventional bonds	
		No premium (2)	Premium 1.5% (3)		(2) - (4)	(3) - (4)	No premium (5)	Premium 1.5% (6)		(5) - (7)	(6) - (7)
BE	107	39.3	41.1	74.5	-35.2	-33.4	124.9	133.2	148.7	-23.8	-15.6
DE	68.1	33.3	35.2	46.7	-13.4	-11.5	76.6	82.6	86.1	-9.6	-3.6
IE	75.4	29.4	30.5	71.4	-41.9	-40.8	87.2	90.5	116.9	-29.7	-26.4
ES	99.5	31.5	33.3	72.0	-40.5	-38.7	121.4	131.5	147.8	-26.3	-16.2
FR	96.4	28.6	30.0	65.2	-36.6	-35.2	121.2	129.2	145.2	-24.0	-16.0
IT	133	34.0	36.1	85.1	-51.0	-49.0	143.9	155.9	176.5	-32.6	-20.6
CY	107.1	55.8	58.7	80.8	-25.0	-22.1	115.1	123.4	133.0	-17.8	-9.6
LV	40	35.0	36.6	51.1	-16.1	-14.5	52.4	55.7	65.9	-13.4	-10.2
LT	40.8	37.7	39.6	85.0	-47.3	-45.4	88.3	93.5	126.6	-38.3	-33.2
LU	23.2	28.7	29.7	32.4	-3.7	-2.7	38.0	39.5	41.5	-3.5	-2.0
MT	62.1	36.6	38.0	53.4	-16.9	-15.5	64.3	67.5	76.3	-12.1	-8.9
NL	63	32.6	34.0	45.4	-12.8	-11.3	59.6	63.9	69.0	-9.4	-5.1
AT	83.5	42.2	44.1	61.1	-18.9	-17.0	89.0	95.1	103.0	-13.9	-7.9
PT	130.3	51.6	54.1	106.4	-54.8	-52.3	155.4	166.2	193.4	-38.0	-27.2
SI	80.2	37.1	39.1	63.0	-25.9	-23.9	101.1	108.1	119.1	-18.0	-11.1
SK	53.3	38.6	40.5	49.2	-10.6	-8.7	56.4	60.8	65.2	-8.8	-4.4
FI	65.4	31.2	32.6	56.0	-24.9	-23.4	110.4	117.2	127.0	-16.7	-9.8
EA-19	91.6	29.1	30.7	58.6	-29.5	-27.9	100.3	107.8	119.8	-19.5	-12.0
HU	73.4	45.3	47.5	65.9	-20.6	-18.4	84.7	90.9	100.0	-15.3	-9.2
UK	89.2	32.9	34.2	63.6	-30.7	-29.4	112.4	118.5	131.6	-19.2	-13.1

Source: Debt Sustainability Monitor, Author's calculations

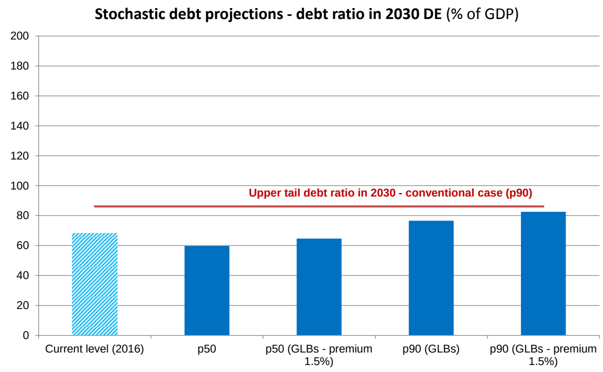
Graph 6.2. **Stochastic projections with conventional versus GDP-linked bonds depending on the risk premium, selected countries**

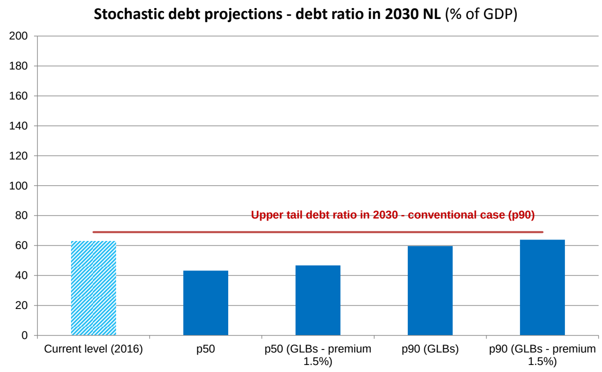
Still large benefits from GDP-linked bonds with a premium





Still benefits with GDP-linked bonds with premium, but upper tail of the distribution gets closer to standard case





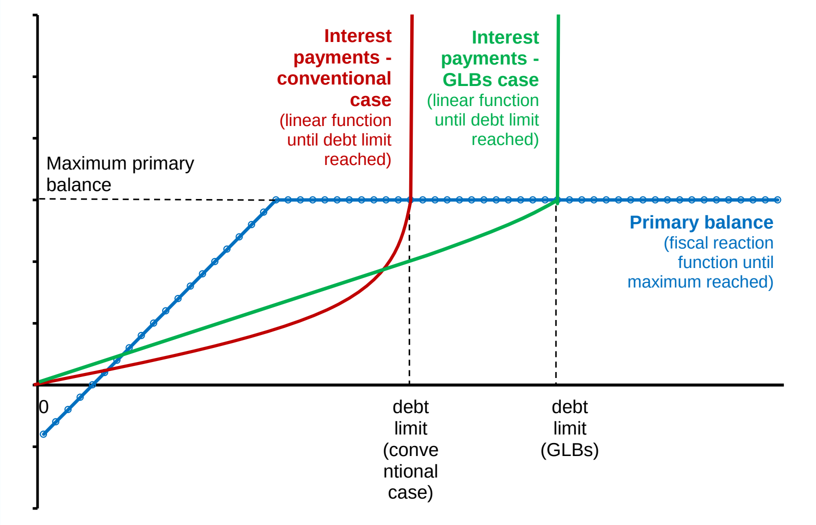
Note: without a risk premium, the simulated debt level in 2030 is equal in the conventional case and in the GLBs case in the baseline scenario (p50). P90 refers to the 90th decile of the debt stochastic simulations.

Source: Debt Sustainability Monitor, Author's calculations

Box 6.2. **COULD THE REDUCTION IN DEFAULT RISK OFFSET THE GDP-RISK PREMIUM? SOME TENTATIVE CALIBRATIONS**

Providing that GLBs reach a critical share in public debt, they could substantially reduce the default premium, hence limiting the overall cost of borrowing. Most papers point that risk-averse investors are likely to demand a premium to hold GLBs, on top of the premium on conventional bonds. Leaving aside the liquidity and novelty premium, this premium would essentially remunerate investors for holding bonds that have an uncertain return due to GDP volatility (growth risk or indexation premium). At the same time, several authors highlight that the issuance of GLBs could have an indirect favourable effect on the default premium demanded on all bonds, including conventional bonds. Indeed, if a sovereign's debt stock was (partially) made up of GLBs, the debt limit, i.e. the maximum sustainable debt level before default occurs (as defined in Ghosh et al., 2011), could be significantly increased. The reason is that macroeconomic shocks are less likely to push the economy towards explosive debt paths. This entails a reduction in the likelihood of default, which in turns lowers the spread demanded by investors (see Barr et al., 2014 and Chart 6.3). Even if the empirical evidence on the magnitude of these effects appears sketchy (see Table 6.2), the expected impact could be sizeable, compensating to some extent for the GDP-risk premium.

Graph 6.3. **Debt dynamic diagram with conventional bonds and GLBs**



Note: primary balance responds to debt increases up until it reaches a maximum value; interest payments (adjusted for growth) increase linearly with debt until debt limit is reached. Beyond this limit, interest rates are explosive, meaning that the sovereign cannot finance itself and default. With GLBs, the interest rate demanded by investors could be reduced beyond a certain level of debt, given the reduced likelihood of default. This would entail a higher debt limit before default occurs.

Table 6.2. **Debt limits with different assumptions: selected results**

	Barr et al. (2014) – representative county	Pienkowski (2017)	
		All countries	Advanced economies
Conventional bonds - no risk-aversion	93	-	-
Conventional bonds - risk-aversion	63	52	137
100% GLBs - no risk-aversion	195	-	-
100% GLBs - risk-aversion & premium = 35 bps	114	-	-
100% GLBs - risk-aversion & premium = 150 bps	84	84	238
100% GLBs - risk-aversion & premium = 370 bps	63	-	-
20% GLBs - risk-aversion & premium = 150 bps	-	80	152

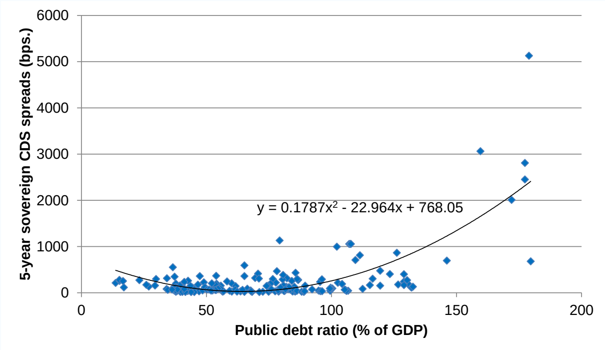
Source: above-mentioned papers

The reduction of the size of the default premium is likely to be substantial for highly indebted sovereigns. Different strands of the literature and simple empirical analysis support this assumption. Hilscher and Nosbusch (2010) show that default risk accounts for a large share of overall borrowing costs in low-rated sovereigns (while this share is small in others). Hence, the benefits of GLBs in reducing default premium should be larger in these countries. Roeger and in't Veld (2013), based on other research, note that below a debt ratio of 60% of GDP, CDS spreads are not very sensitive to variations in public debt, while between 60% and 90% of GDP, a 10 pps. of GDP increase in public debt would lead to a 25 bps rise in CDS spreads. Beyond this level, non-linearities are strong and the literature little conclusive. Performing a simple statistical analysis over EU countries and the period 2009-2016, it appears that at debt levels of 90% of GDP (respectively 120% of GDP), a 10 pps. of GDP increase of government debt can be associated with an increase of around 110 bps. in CDS spreads (respectively around 220 bps.) and 40 bps. in actual bond spreads (respectively around 80 bps.). ([18])

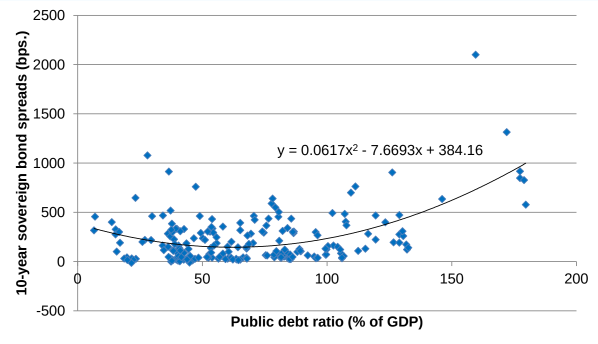
([18]) These rough estimates are based on the co-efficients reported in Chart 6.4. The sensitivity to a few observations (in particular Greece) is acknowledged.

Graph 6.4. **Empirical relationship between sovereign spreads and public debt - EU countries, 2009-16**

5-year sovereign CDS spreads and public debt level (EU countries, 2009-2016)



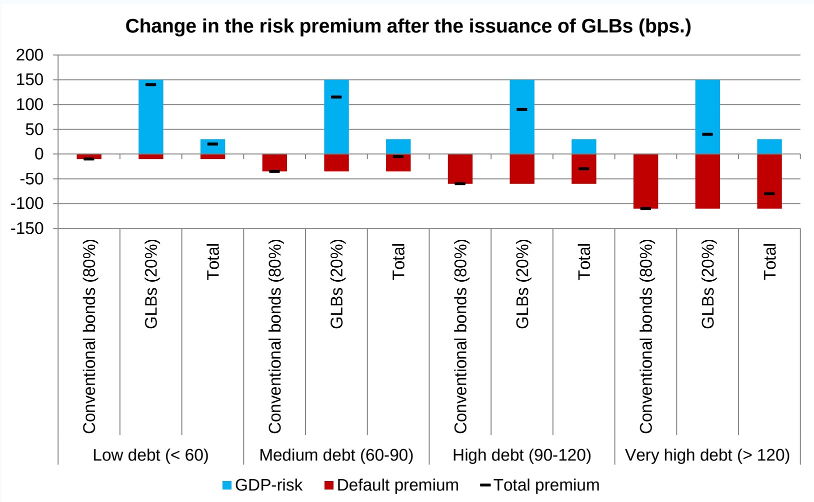
10-year government bond yield spreads (vis-à-vis German yield) and public debt level (EU countries, 2009-2016)



Source: Bloomberg, AMECO (updated from Roeger and in't Veld (2013))

Based on these elasticities, a reduction in default premium could broadly neutralise the GDP-risk premium in medium- and high debt countries, assuming a 'prudent' (i.e. high) level of 150 bps for the latter. As shown in Box 6.1, the issuance of one third of GLBs would allow converging to a share of growth-indexed debt of around 20% after two decades. Based on Pienkowski (2017), this would result in an increase of 15 pps. of GDP of the debt limit in advanced economies (see Table 6.2). As an illustration, we calibrate, based on the relation from Chart 6.4 above, an induced fall in the risk premium (Chart 6.5). In low- to medium-debt countries, there would be no or only a mild reduction of the default premium; however, in medium- to high-debt countries, the fall in the default premium could more than compensate the GDP-risk premium.

Graph 6.5. **Change in the risk premium after the issuance of GLBs depending on the debt level**



Note: These estimates are based on the following assumptions: GLBs represent 20% of total debt; GDP-risk premium is set at 150 bps; the default premium is little affected for low-debt countries (-10 bps.); it is reduced (for both conventional and GBLs bonds) by 35 bps. for medium-debt countries, by 60 bps. for high-debt countries and by 110 bps. for very high-debt countries.

Source: Author's calculations

7. CONCLUSION

In many advanced economies, public debt has reached unprecedented levels as a legacy of the past crisis. The economic conditions and the fiscal outlook have recently improved across EU countries, in liaison with a recovery that has broadened and gathered some speed. Nevertheless, public debt levels remain high and long-term growth prospects uncertain. Progress in stabilising and significantly reducing debt in line with fiscal rules takes time. In the interval, debt vulnerabilities to macroeconomic shocks remain important.

GDP-linked bonds (GLBs) present attractive properties in that context, by providing automatic buffers against macroeconomic shocks and increasing the predictability of debt paths. These financial instruments may have a particular relevance where monetary policy imperfectly responds to national shocks such as in monetary unions. However, GLBs cannot dispense from pursuing sound policies to ensure fiscal solvency, and there is also a view that the increased risk-sharing with investors could raise moral hazard. Moreover, GLBs have not been used so far in advanced economies, and an important practical challenge lies in their pricing. This issue is critical as a high risk premium (including a growth risk premium) could undercut the expected benefits.

Based on the data and tools of the Commission Debt Sustainability Monitor, this paper explores the consequences of issuing a fraction of GLBs in European countries. Our results suggest important potential benefits from GLBs, both in the short- and the long-run, for all European economies. These benefits would be particularly large in countries characterised by medium-to-high debt, high macroeconomic volatility and limited alternative tools to smoothen shocks. A risk premium, even if significant, would not eliminate the debt-stabilisation benefits brought by GLBs. In addition, by reducing the probability of explosive debt paths, GLBs could reduce the default premium of all sovereign bonds, including conventional ones. In highly indebted countries, this effect could broadly compensate for the growth risk premium. The paper also shows that a critical issue in terms of effective benefits and pricing is the magnitude and pace at which a GLBs market could develop.

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ANNEX I

Additional tables and charts

Interest – growth rate differential (%) in euro area countries

	1999-2016				yearly values since 2008								
	average (1)	standard-deviation (2)	coef. of variation (2) / (1)	Coef. of correl. Δr and Δg	2008	2009	2010	2011	2012	2013	2014	2015	2016
BE	1.1	1.6	1.4	0.1	2.0	5.6	-0.9	-0.1	1.4	2.1	0.9	0.6	0.0
DE	1.4	2.5	1.8	0.0	2.3	7.9	-1.3	-1.5	0.9	0.1	-1.1	-1.6	-1.3
EE	-4.9	7.5	-1.5	-0.1	4.1	18.0	-2.1	-11.0	-5.0	-4.1	-3.5	-1.6	-2.5
IE	-3.1	9.0	-2.9	0.0	10.0	13.9	6.1	0.4	2.3	1.1	-3.7	-29.1	-0.8
ES	0.3	3.8	12.2	-0.4	1.2	7.5	3.4	5.0	7.0	5.4	2.6	-0.5	-0.6
FR	1.0	1.6	1.6	0.2	1.9	6.3	0.0	0.2	1.7	1.2	0.9	0.0	0.4
IT	2.4	1.9	0.8	0.1	3.6	7.8	1.9	2.1	5.9	4.4	2.5	1.7	1.4
CY	0.7	4.1	5.7	-0.1	-3.3	6.9	0.6	1.8	6.1	10.8	5.7	2.3	1.0
LV	-3.6	11.9	-3.3	-0.4	-0.7	29.0	9.3	-8.9	-3.7	-0.4	0.1	0.2	0.5
LT	-1.0	8.6	-8.8	-0.7	-7.9	24.6	2.7	-5.9	-1.0	-0.3	-0.2	1.8	-0.2
LU	-2.7	3.7	-1.4	0.1	2.5	5.6	-5.8	-4.9	0.7	-2.9	-5.4	-3.2	-1.9
MT	-0.4	2.9	-7.7	0.2	-0.7	5.1	-2.6	1.3	-0.3	-2.1	-6.3	-5.6	-2.8
NL	0.7	2.0	2.8	0.5	0.7	6.9	0.9	1.2	2.3	1.1	0.6	-0.2	-1.3
AT	1.1	1.7	1.6	-0.2	1.3	6.5	0.8	-1.2	0.6	1.5	0.6	0.0	-0.3
PT	1.7	2.7	1.6	-0.3	2.7	6.0	1.0	6.5	8.6	2.8	2.2	-0.1	0.4
SI	0.9	3.8	4.5	-0.1	-2.8	10.4	4.5	3.2	6.7	5.0	0.9	0.9	0.9
SK	-1.0	4.2	-4.1	-0.3	-3.9	11.2	-1.8	-0.6	1.2	1.6	1.2	-0.2	0.4
FI	0.6	2.8	4.3	0.1	0.5	10.4	0.0	-2.1	1.5	0.6	1.1	0.0	-0.5
EA-19	**1.2**	**1.9**	**1.5**	**0.1**	**2.2**	**7.5**	**0.8**	**1.0**	**3.1**	**2.1**	**0.8**	**-0.6**	**-0.2**
HR*	0.8	4.5	5.7	-0.2	-2.3	10.4	6.1	3.9	5.9	4.8	4.7	1.9	1.0
HU	0.1	3.3	35.4	0.1	0.7	9.0	2.4	1.4	4.0	1.0	-1.9	0.0	1.4
UK	0.9	1.8	2.0	0.8	3.1	6.5	1.1	0.8	0.8	-0.4	-1.5	0.0	-0.7

Note: The interest – growth rate differential is the difference between the nominal implicit interest rate on public debt and the nominal GDP growth.

Source: AMECO, Authors' calculations

Primary balance (% of GDP) in euro area countries

	1999-2016				yearly values since 2008								
	average (1)	standard-deviation (2)	coef. of variation (2) / (1)	Coef. of correl. Δr and Δpb	2008	2009	2010	2011	2012	2013	2014	2015	2016
BE	2.5	2.8	1.1	0.4	2.9	-1.6	-0.4	-0.5	-0.6	0.2	0.2	0.5	0.2
DE	1.0	1.6	1.7	0.2	2.5	-0.6	-1.7	1.5	2.3	1.8	2.1	2.2	2.1
EE	0.5	1.6	3.4	-0.3	-2.5	-2.0	0.3	1.3	-0.1	-0.1	0.8	0.2	0.3
IE	-1.8	8.1	-4.6	-0.3	-5.7	-11.8	-29.3	-9.3	-3.9	-1.4	0.2	0.7	1.7
ES	-1.2	4.2	-3.6	-0.2	-2.9	-9.3	-7.5	-7.2	-7.5	-3.5	-2.5	-2.0	-1.7
FR	-1.1	1.7	-1.6	0.5	-0.4	-4.8	-4.4	-2.5	-2.2	-1.8	-1.8	-1.6	-1.5
IT	1.8	1.4	0.8	0.4	2.2	-0.9	0.0	1.0	2.3	1.9	1.6	1.5	1.5
CY	-0.3	2.9	-8.3	0.3	3.4	-3.1	-2.7	-3.5	-2.4	-1.8	-6.0	1.7	3.0
LV	-1.5	2.4	-1.6	-0.2	-3.7	-7.6	-7.0	-1.5	0.6	0.5	-0.1	0.1	1.1
LT	-1.4	2.6	-1.8	-0.3	-2.4	-7.9	-5.1	-7.1	-1.2	-0.9	0.9	1.3	1.6
LU	2.1	2.1	1.0	0.7	3.7	-0.3	-0.2	1.0	0.9	1.5	1.8	1.8	1.9
MT	-0.4	1.9	-5.4	0.3	-0.9	0.0	-0.1	0.7	-0.7	0.3	0.8	1.2	3.2
NL	0.5	2.4	5.1	0.6	2.3	-3.4	-3.2	-2.5	-2.2	-0.9	-0.8	-0.8	1.5
AT	0.6	1.3	2.2	0.3	1.4	-2.2	-1.6	0.2	0.5	1.2	-0.3	1.3	0.5
PT	-1.8	2.5	-1.4	0.5	-0.7	-6.8	-8.2	-3.1	-0.8	0.0	-2.3	0.2	2.2
SI	-1.8	3.1	-1.8	-0.3	-0.3	-4.6	-4.0	-4.8	-2.1	-12.5	-2.1	0.4	1.4
SK	-2.5	2.3	-0.9	-0.2	-1.1	-6.4	-6.2	-2.7	-2.6	-0.8	-0.8	-1.0	0.0
FI	2.7	3.7	1.3	0.4	5.6	-1.2	-1.3	0.3	-0.8	-1.4	-1.9	-1.6	-0.9
EA-19	**0.3**	**1.7**	**6.1**	**0.3**	**0.8**	**-3.5**	**-3.4**	**-1.2**	**-0.6**	**-0.2**	**0.1**	**0.3**	**0.7**
HR	-1.8	1.7	-1.0	-0.2	-0.8	-3.7	-3.6	-4.8	-1.9	-2.1	-1.9	0.2	2.4
HU	-0.4	2.4	-5.8	0.3	0.4	-0.1	-0.4	-1.3	2.3	2.0	1.9	2.0	1.3
UK	-1.7	3.1	-1.8	0.6	-3.0	-8.2	-6.6	-4.3	-5.3	-2.7	-3.0	-2.0	-0.5

Source: AMECO, Authors' calculations

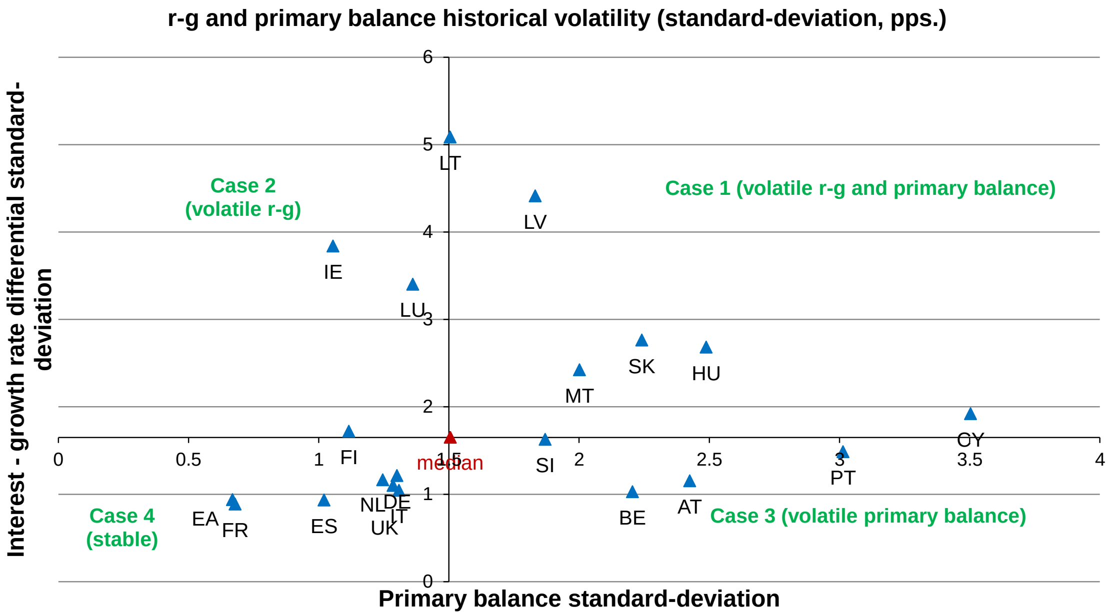
Interest payments and public debt service (% of GDP)

	2001		2008		2016	
	Interest payments	Debt service	Interest payments	Debt service	Interest payments	Debt service
BE	6.5	29.3	4.0	22.5	2.6	18.5
DE	3.0	13.2	2.7	15.6	1.4	16.9
IE	1.4	5.9	1.3	7.0	2.3	8.1
ES	3.0	12.2	1.5	8.5	2.8	21.5
FR	2.9	11.5	2.8	14.0	1.9	19.1
IT	6.1	25.3	4.9	24.8	4.0	27.0
CY	3.1	18.7	2.6	6.2	2.6	25.0
LV	0.9	2.5	0.5	1.4	1.1	2.6
LT	1.5	3.6	0.6	1.1	1.5	6.7
LU	0.4	0.7	0.4	1.4	0.4	1.3
MT	3.7	15.9	3.3	12.6	2.3	9.1
NL	2.9	10.8	2.0	10.7	1.1	12.3
AT	3.6	11.0	2.9	9.2	2.2	11.3
PT	3.0	8.8	3.1	17.0	4.3	21.3
SI	2.4	5.7	1.1	3.4	2.8	16.1
SK	4.0	13.2	1.2	4.7	1.5	7.6
FI	2.6	10.3	1.4	8.4	1.1	11.5

Note: Public debt service is the sum of interest payments and debt amortisation (see DSM 2016 for more explanations).

Source: AMECO, Estat, ECB, Authors' calculations

Historical standard-deviations of the interest-growth rate differential and the primary balance used in the stochastic projections



Note: These values are based on quarterly data starting (in most cases) from the late 1990's – early 2000's until mid-2016, and corrected for outlier values. The series are considered in first difference (quarterly variations).

Source: AMECO, Authors' calculations

Stochastic projections: conventional versus GDP-linked bonds in selected EU countries - all GDP-linked versus one third GDP-linked bonds (% of GDP)

Country	Debt ratio in 2016 (1)	Proj. diff. btw. percentiles 90th and 10th of debt ratio distribution in 2030							r-g volatility above EU average	Public debt above EU average in 2016
		All GDP-linked bonds (2)	1/3 GDP-linked bonds (3)	Conventional bonds (4)	Difference (5) = (2) - (4)	Difference (6) = (3) - (4)	Relative difference (6) = (5) / (1)	Relative difference (7) = (6) / (1)		
BE	107	39.3	58.4	74.5	-35.2	-16.1	-33%	-15%		x
DE	68.1	33.3	40.1	46.7	-13.4	-6.6	-20%	-10%		
IE	75.4	29.4	54.4	71.4	-41.9	-17.0	-56%	-22%	x	
ES	99.5	31.5	53.7	72.0	-40.5	-18.3	-41%	-18%		x
FR	96.4	28.6	48.5	65.2	-36.6	-16.7	-38%	-17%		x
IT	133	34.0	62.6	85.1	-51.0	-22.4	-38%	-17%		x
CY	107.1	55.8	68.3	80.8	-25.0	-12.5	-23%	-12%		x
LV	40	35.0	44.2	51.1	-16.1	-6.9	-40%	-17%	x	
LT	40.8	37.7	64.9	85.0	-47.3	-20.1	-116%	-49%	x	
LU	23.2	28.7	30.7	32.4	-3.7	-1.7	-16%	-7%	x	
MT	62.1	36.6	45.8	53.4	-16.9	-7.7	-27%	-12%	x	
NL	63	32.6	38.4	45.4	-12.8	-6.9	-20%	-11%		
AT	83.5	42.2	51.8	61.1	-18.9	-9.3	-23%	-11%		
PT	130.3	51.6	80.6	106.4	-54.8	-25.8	-42%	-20%		x
SI	80.2	37.1	51.6	63.0	-25.9	-11.4	-32%	-14%		
SK	53.3	38.6	43.3	49.2	-10.6	-6.0	-20%	-11%	x	
FI	65.4	31.2	45.7	56.0	-24.9	-10.3	-38%	-16%		
EA-19	91.6	29.1	45.3	58.6	-29.5	-13.3	-32%	-15%		x
HU	73.4	45.3	56.5	65.9	-20.6	-9.4	-28%	-13%	x	
UK	89.2	32.9	49.8	63.6	-30.7	-13.8	-34%	-15%		x

Source: Debt Sustainability Monitor, Authors' calculations

ANNEX II

Decomposition of the variance of the debt dynamics

When taking into account stock-flow adjustments, the decomposition of the variance of the debt dynamics is more complex than equation (1). The complete formula used to calculate the different contributions in Chart 4.2 is the following:

$$V(\Delta d_t) = V(i_t.d_{t-1}) + V(g_t.d_{t-1}) + V(pb_t) + +V(sfa_t) - 2.Cov((i_t - g_t).d_{t-1}, pb_t)$$

$$+2.Cov\big((i_t - g_t).d_{t-1}, sfa_t\big) - 2.Cov(pb_t, sfa_t) - 2.Cov(i_t.d_{t-1}, g_t.d_{t-1})$$

ANNEX III

GLBs and data revisions

Measurement issues: some over-estimated problems. Several papers and institutions point to the risk of misreporting GDP figures. This relates to concerns regarding both the quality and the integrity of GDP estimates. In this latter case, it is argued that governments may be tempted to understate their growth rate (or even be less willing to carry growth-friendly policies, a typical moral hazard problem). These risks seem limited in the European case for several reasons: first, the estimations and reporting of national account statistics are made by independent national statistical institutes, within the frame of the European Statistical System. In fact, the independence of these institutions, and the role of Eurostat in monitoring national data have been recently reinforced following the Greek crisis. Moreover, the quality and the level of credibility of these statistics are deemed high (see for example Cabrillac et al. (2017) based on the World Bank government effectiveness indicator). Given the political advantages of achieving high growth, it seems also unlikely that governments will dis-regard their growth objectives simply for the sake of saving on debt payments.

Measurement issues: some true challenges. Data revisions, also often pointed in papers (IMF, 2017; Brooke et al., 2013; Borenzstein and Mauro, 2004), seem on the other hand a more serious challenge. Indeed, GDP revisions are more frequent and larger than for the consumer price index (used for inflation-linked bonds). This concern could be more problematic for issuers than investors to the extent that there is a clear method established *ex-ante* for dealing with revisions (within the design of the instrument). ([19]) For issuers on the other hand, GLBs could lose some of their automatic debt stabilisation properties in case of important initial inaccurate estimations of GDP - not reflecting the 'true' state of the economy. However, Borensztein and Mauro (2004) suggest that over a 10-year horizon (which is the one generally assumed for such instruments) yearly revisions may even each other out, ending up being relatively small on a cumulative basis. Moreover, based on the OECD revision analysis dataset, ([20]) it appears that quarterly GDP revisions have been fairly limited at the European level since 2002, except in atypical cases (e.g. Ireland).

([19]) For example, Borenzstein and Mauro (2004) propose to include a clear method for dealing with potential data revisions in the bond contract, stipulating that data revisions will be ignored after a certain point. The BoE (see London Term Sheet 2016) proposes to index the bond payments to a chain-linked nominal GDP index that freezes the base quarter and subsequent quarterly growth rates at the third estimate of the latest available vintage of data. The IMF (2017) points at the necessity of introducing caps / floors to payments.

([20]) See http://www.oecd.org/std/36876629.pdf

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