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Euro area inflation linked debt: An evaluation

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ABSTRACT

How would the fiscal burden of Euro area (EA) countries have evolved without the issuance of inflation linked bonds (ILBs)? Could debt management through ILBs have decreased their sovereign debt-to-GDP ratio? By exploiting a new dataset on ILBs and the market value of debt in Germany, France, Italy and Spain in 2014–2022, I calculate the holding period return for investors in both nominal and real debt. Based on the government budget constraint, I conduct simulations that demonstrate the significant first-order effects of debt structure choices. Without ILBs the fiscal burden of the largest EA economies would have decreased by around 1% of GDP but in the case of Italy, it would have increased. Timing was also a relevant factor. Germany effectively controlled the cost of funds by managing its share of real debt, while Spain increased it by issuing ILBs when it was expensive. Slight ILB share adjustments could have alleviated their fiscal burden: Germany by 0.9%, France by 3%, Italy by 7%, and Spain by 1.8%.

1. Introduction

The COVID-19 pandemic resulted in a swift escalation of the fiscal burden of Euro area (EA) countries. This was followed by a remarkable surge in inflation, rising from an annual rate of 1.1% during 2015–2019 to 4.6% in 2020–2022. Concurrently, the Treasuries of the four largest EA economies partially relied on eurozone inflation-linked bonds (ILBs) to fund their budgets. ILBs protect investors from EA inflation risk, as both principal and coupon payments fluctuate with EA HICP inflation. Undoubtedly, this choice influenced the fiscal burden of EA countries due to differences in the cost of funds between real bonds and nominal securities. How would then the fiscal burden of the leading EA economies have evolved in the absence of ILBs? Could debt management through ILBs have lowered the sovereign debt-to-GDP ratio for these countries? To what extent?

Broadly, issuing ILBs is cheaper for borrowers than nominal bonds when inflation is lower than expected, but more expensive otherwise. In this article, I do not examine this choice ex-ante. Instead, I present a set of stylized facts on ex-post bond return differentials and demonstrate that, quantitatively, debt structure choices have first order effects. Additionally, I make two secondary contributions. First, I explain how a new dataset on ILBs, combined with aggregate fiscal data from Eurostat, can be used to simulate counterfactual debt dynamics. Note that presenting novel applications for readily accessible data is relevant for researchers, particularly when the expense of constructing detailed bond databases is large. Second, I show that utilizing face debt values instead of market values would yield different outcomes in the simulations.

To assess the fiscal burden of countries considering nominal and real bonds, it is crucial to focus on the market value of debt rather than its face value. This is because the liabilities implied by real bonds depend on future inflation, and their price incorporate inflation expectations. Additionally, standard economic theory dictates that the market value of debt must be financed with anticipated future discounted budget surpluses (the intertemporal budget constraint). Therefore, I employ the one-period budget constraint to simulate the evolution of the market value of debt under varying debt management strategies. To achieve this, I exploit a newly compiled quarterly dataset on quantities and prices of ILBs in Germany, France, Italy and Spain spanning from 2014Q4 to 2022Q4. This dataset, combined with aggregate Eurostat data on debt and deficits, enables me to simulate their market debt values across scenarios involving different shares of ILBs within total securities.

If these countries had no debt in ILBs (i.e. all their bonds were nominal) their reduction in their fiscal burden would have been only about 1% of GDP. Italy, however, would have experienced a 2.6% increase in its debt-to-GDP ratio. The four governments could have eased their debt burden notably by relying on real debt between 2018Q1 and 2020Q1, transitioning away from it thereafter. Surprisingly, borrowing in ILBs during the first half of 2022 lessened their fiscal burden. Germany stands out as it both increased and decreased its real debt share at opportune times for more affordable funding. In contrast, Spain heightened its real debt share during two periods of notably higher costs.

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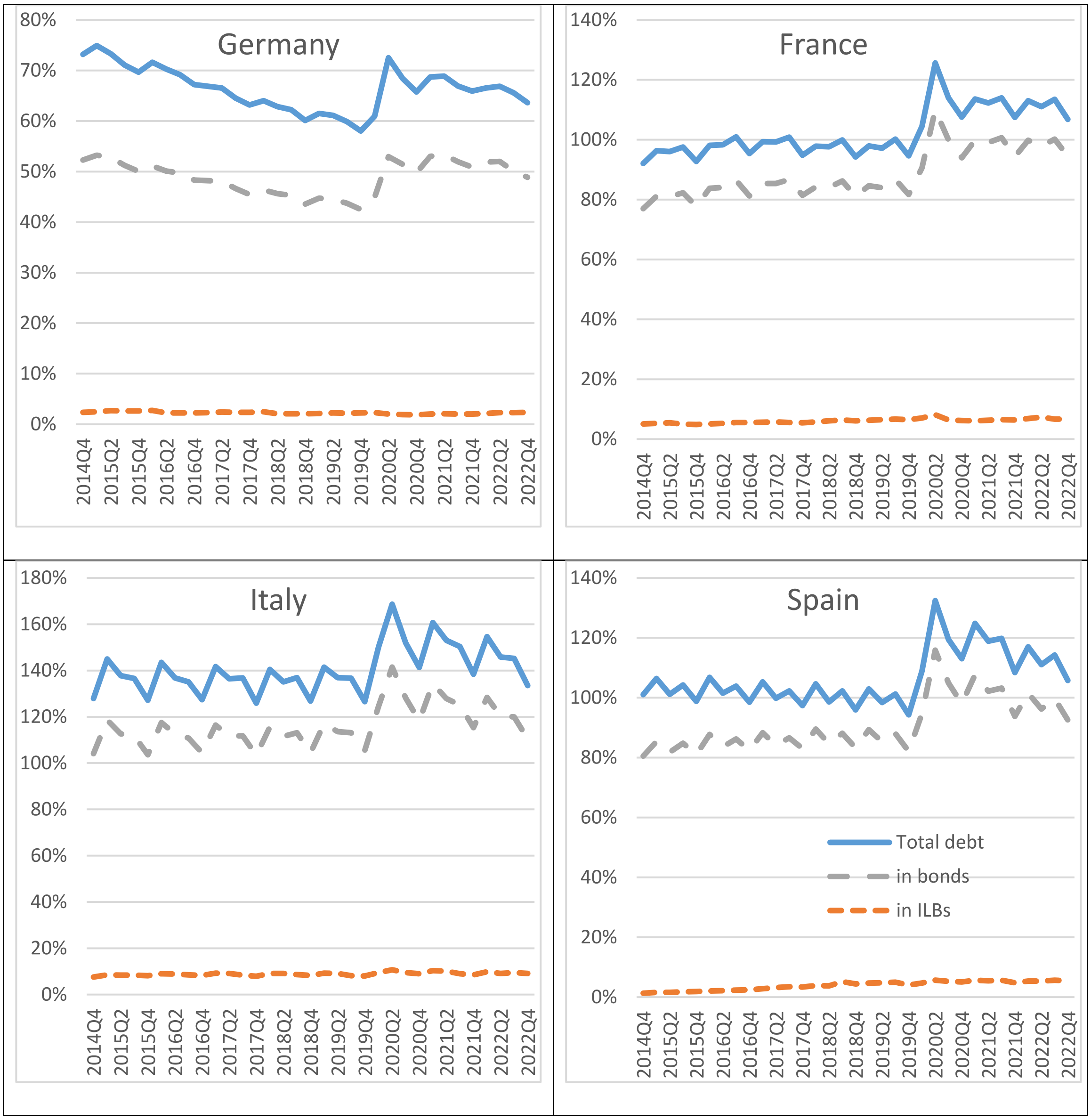

Fig. 1. Evolution of outstanding sovereign debt (face value, as a percentage of GDP) by instrument.
Source: Eurostat, Treasuries' websites and author's calculations.

Within the bounds of not deviating too far from observed real debt shares, an enhanced debt management strategy would have decreased the fiscal burden by 0.9% in Germany, 3% in France, 7% in Italy, and 1.8% in Spain.

Moreover, focusing on the market value of debt is key to consider for the role that the debt maturity structure plays in debt dynamics. Long-maturity debt is shielded against interest rate risk and can serve for fiscal insurance purposes (Faraglia et al., 2008). As yields increase, holders of long-term bonds encounter capital losses. This translates to a gain for the government, reflecting the need to refinance only a portion of the debt at higher interest rates. The one period budget constraint includes returns to bondholders, encompassing coupon payments and these capital gains and losses. I document that neglecting the latter would erroneously lead to the belief that, for instance, the Italian debt outstanding (face value) would have decreased if the Italian Treasury had abstained from ILBs. In reality, however, the Italian debt ratio would have risen at both face and market values.

Many papers have exploited the information provided by the markets for ILBs (called TIPS in the US): see Gürkaynak et al. (2010), Fleckenstein et al. (2014), Farrugia et al. (2018) or Kang (2022), for example. However, there is little theory on their optimal management. Previous work has explored the role of ILBs as a tool for inflation-monitoring by central banks (Garcia and van Rixtel, 2007). Schmid et al. (2022) propose their use as a commitment device against higher inflation. Velandia-Rubiano et al. (2022) analyze their contribution to developing capital markets in emerging economies. Equiza-Goni et al. (2023) studied their benefits for risk-sharing in a monetary union. My paper approaches the study of ILBs empirically, though.

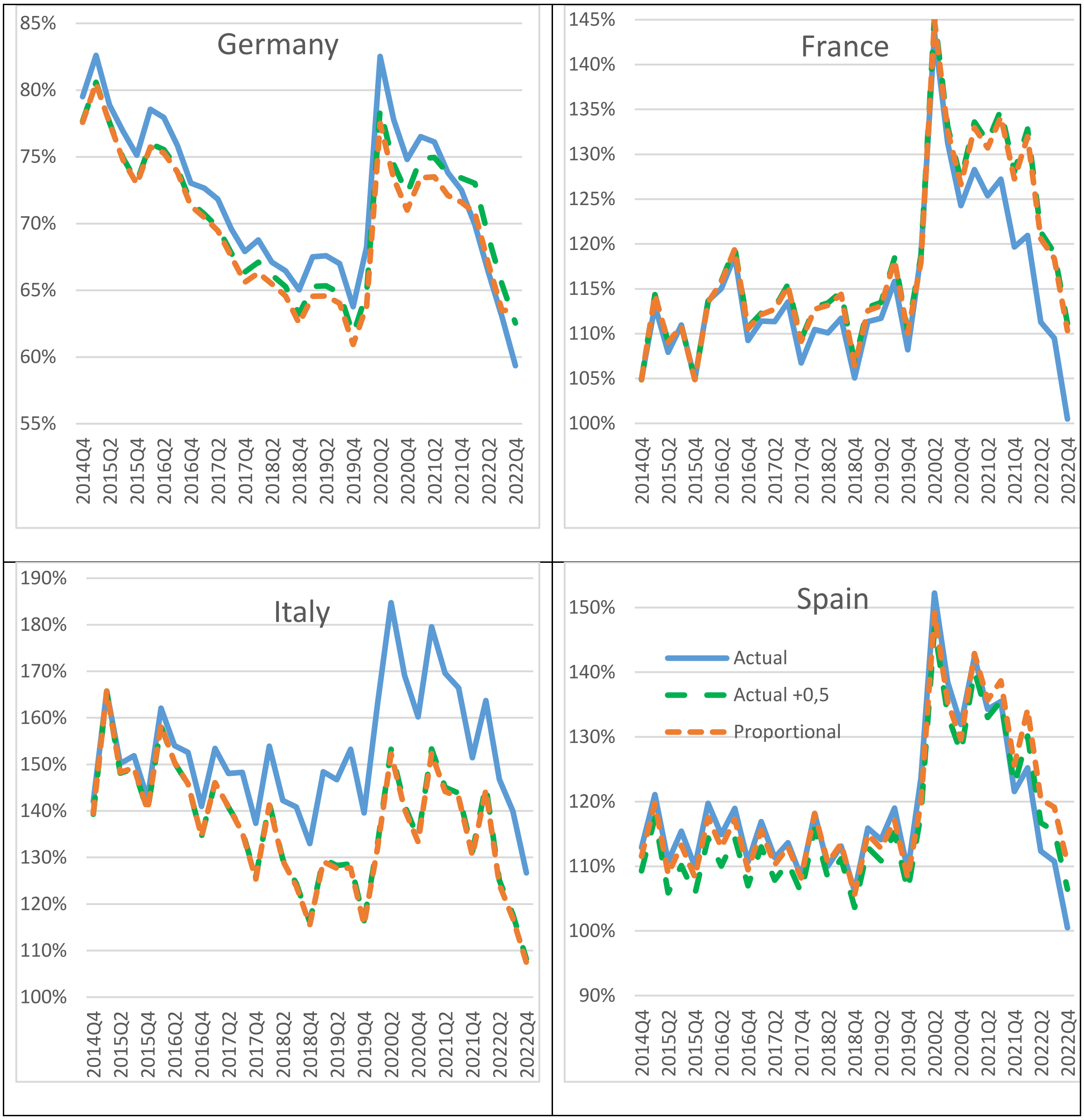

Fig. 2. Actual and simulated market values of debt (as a percentage of GDP)
Source: Eurostat and author's calculations. "Actual +0.5" is the simulated market value of debt when the counterfactual $\alpha_t^* = \alpha_t + 0.5$ in each of the 33 quarters, where α_t is the actually observed share of ILBs on securities. "Proportional" results from setting $\alpha_t^* = \alpha_t(33{\cdot}0.5)(\alpha_t/\sum_{t=1}^{33}\alpha_t)$.

This paper is closely related to the work of Hall and Sargent (2011) for the US, Equiza-Goñi (2016) for the EA, and Ellison and Scott (2020) for the UK. These studies analyze the main factors pushing up the (market value of) debt-to-GDP ratios in these economies and stress the importance of investors' capital gains and losses for debt dynamics.[1] Another approach that focuses on the evolution of the (face value) debt-to-GDP ratio is followed by the European Commission in their Fiscal Sustainability Report 2021 (European Commission, 2022), as well as in previous editions, whose statistics are available in Eurostat. Some related work focuses on specific policies that allowed inflation to erode the fiscal burden: pegged interest rates and other measures of financial repression (Reinhart and Sbrancia, 2015; Acalin and Ball, 2022). Finally, it is related with recent work studying the fiscal consequences of failures to meet the inflation target (Andreolli and Rey, 2023) or changing the target (Krause and Moyen, 2016; Hilscher et al., 2022).

[1] Hall and Sargent (2011) showed that investors' suffered important losses around Volcker's intervention to bring down inflation in the 1970s and 1980s in the US. Equiza-Goñi (2016) documented capital gains in the period preceding the establishment of the monetary union in Europe. Ellison and Scott (2020) showed that long bonds implied capital gains for the government at times of higher military expenditures but also losses during financial crises.

2. Data and methodology

This study focuses on the four largest economies of the Euro area in 2015–2022: Germany, France, Italy and Spain. These governments financed their budgets issuing nominal bonds and ILBs with different maturities and coupon rates, as well as non-marketable debt (mainly, loans). Fig. 1 shows the quarterly outstanding (face) value of their debt (divided by GDP) by instrument. Clearly, most debt is issued in bonds, among which only a small fraction is linked to European inflation (on average, 4.6% in Germany, 6.8% in France, 7.7% in Italy, and 4.2% in Spain).[2] The debt-to-GDP ratios were stable until the COVID-19 crisis hit Europe resulting in an increase of around 20%. Germany exhibited a similar pattern, with its debt ratio decreasing steadily until 2020 when it rose by 7.5%. All the data was retrieved from Eurostat's Quarterly Government Finance Statistics database with the exception of the outstanding ILBs. Importantly, the information about ILBs was retrieved by the author. The source was the monthly reports published by the Treasuries of these countries. This is a contribution of this study: exploiting detailed quarterly data on the inflation adjusted outstanding amount of debt in ILBs and their coupons.

As mentioned, Eurostat also publishes the main factors behind changes in the face value of these governments' debt, mainly interest payments, the primary deficit, and a residual stock-flow adjustment term. I complemented this Eurostat data with my new dataset on ILBs and their coupons. Assuming (due to lack of more detailed information) that nominal bonds and loans pay the same interest rate,[3] I can describe changes in the face value of debt, denoted $F_t = \left(\sum_{i=1}^{I} q_t^i + Q_t + L_t\right)$ as:

$$\Delta F_t = \sum_{i=1}^{I}\left[\left(1+c_t^i\right)\Pi_t - 1\right]q_{t-1}^i + i_t(Q_{t-1} + L_{t-1}) + D_t + SF_t \tag{1}$$

where $\left[\left(1+c_t^i\right)\Pi_t - 1\right]$ is the coupon and principal capitalization of inflation for each ILB,[4] Q_{t-1} and L_{t-1} are nominal bonds and loans carried from $t-1$ to t respectively, D_t is the primary (budget) deficit, and SF_t is the residual stock-flow adjustment factor. Note that i_t is derived from

$$\frac{int_t}{F_{t-1}} = \frac{Q_{t-1} + L_{t-1}}{F_{t-1}} i_t + \frac{1}{F_{t-1}} \sum_{i=1}^{I}\left[\Pi_t\left(1+c_t^i\right) - 1\right]q_{t-1}^i \tag{2}$$

where int_t are the interest payments reported by Eurostat in quarter t.

However, Eq. (1) does not correspond to the theoretical government budget constraint that describes changes in the market (instead of the face) value of debt. Eurostat's Quarterly Government Finance Statistics database also provides information about the market value of total debt in securities (that I denote S_t) and Eikon-Datastream contains data about the prices of ILBs. Thus, I could actually describe changes in the market value of total debt, $M_t = (S_t + L_t)$, as:

$$\Delta M_t = \sum_{i=1}^{I}\left[\left(p_t^i + c_t^i\right)\Pi_t - p_{t-1}^i\right]q_{t-1}^i + \left(P_{t-1,t} + c_{t-1,t} - P_{t-1}\right)Q_{t-1} + i_t L_{t-1} + D_t + SF_t \tag{3}$$

where $\left[\left(p_t^i + c_t^i\right)\Pi_t - p_{t-1}^i\right]q_{t-1}^i$ is the net holding period return on each ILB, including the coupon and principal incremented by inflation in addition to the capital gain for investors; $\left(P_{t-1,t} + c_{t-1,t} - P_{t-1}\right)Q_{t-1}$ is the capital gain and coupon paid to investors in nominal bonds; $i_t L_{t-1}$ is the interest paid on loans. Note that $P_t Q_t$ is obtained as $S_t - \sum_{i=1}^{I} p_t^i q_t^i$, thus I can compute $P_{t-1} = \left(S_{t-1} - \sum_{i=1}^{I} p_{t-1}^i q_{t-1}^i\right) \Big/ Q_{t-1}$. Recall that I imposed $c_{t-1,t}$ to be equal to the i_t derived from Eq. (2). The SF_t was already computed in Eq. (1). Thus, the average price of nominal bonds across previous quarter quantities, $P_{t-1,t} = \sum_{j=1}^{J} p_t^j q_{t-1}^j / Q_{t-1}$, can be derived as the only unknown element in Eq. (3).[5]

Define the total face value of ILBs, $Q_t^{'} = \sum_{i=1}^{I} q_t^i$, and of all bonds, $\widetilde{Q}_t = Q_t + Q_t^{'}$, and $\alpha_t = \sum_{i=1}^{I} q_t^i / \widetilde{Q}_t$, the share of ILBs over the total of debt in securities. Define also the average prices and coupon rates of ILBs across previous quarter quantities, $P_{t-1,t}^{'} = \sum_{i=1}^{I} p_t^i q_{t-1}^i / Q_{t-1}^{'}$ and $c_{t-1,t}^{'} = \sum_{i=1}^{I} c_t^i q_t^i / Q_t^{'}$. Similarly, based now on current quarter quantities, we can compute the average price of ILBs, $P_t^{'} = \sum_{i=1}^{I} p_t^i q_t^i / Q_t^{'}$, the average price across all securities, $\widetilde{P}_t = P_t(1-\alpha_t) + \alpha_t P_t^{'}$, and the average price of debt across all instruments (including loans), $\overline{P}_t = \frac{\widetilde{Q}_t}{F_t}\widetilde{P}_t + \frac{L_t}{F_t}$. Then, some algebra allows me to rewrite (3) like:

$$M_t = \frac{M_{t-1}}{\overline{P}_{t-1}}\left[\frac{\widetilde{Q}_{t-1}}{F_{t-1}}\left(\alpha_{t-1}\left(P_{t-1,t}^{'} + c_{t-1,t}^{'}\right)\Pi_t + (1-\alpha_{t-1})\left(P_{t-1,t} + i_t\right)\right) + \frac{L_{t-1}}{F_{t-1}}(1+i_t)\right] + D_t + SF_t \tag{4}$$

In this way, I can iterate M_t changing α_{t-1} – also included inside $\widetilde{P}_{t-1}$ and $\overline{P}_{t-1}$ in Eq. (4) – while keeping the rest of shares constant, including the ratios $\left(\frac{\widetilde{Q}_t}{F_t}\right)$ and $\left(\frac{L_t}{F_t}\right)$. In other words, if the counterfactual α_{t-1} implies higher borrowing M_t in the next quarter, the face value of the new debt is borrowed in the proportions of loans and securities actually observed (but in a altered share of real bonds, α_t, of course).

3. Simulations

In this section, I exploit the law of motion for the market value of debt in Eq. (4) to simulate the debt path under an altered share of ILBs in securities. To make this visible, Fig. 2 compares the actual debt-to-GDP ratios (blue solid line) with those obtained by adding 50% (0.5) to all α_t values (green dashed line). Alternatively, I also simulate the evolution of debt for the case where the sum of changes in all α_t values (50% over 33 quarters) is distributed proportionally to the actual values of α_t. In other words, I increased the proportion of debt in ILBs more significantly in those quarters when these governments had a relatively higher ratio of real debt (orange dotted line).[6]

In general, I find that following these policies the debt burden would have increased in all countries. The exception is Italy where it would have fallen by around 16 percent points. Having a larger share of ILBs

[2] Italy and France also issued a few bonds linked to their country-specific inflation that are not included among the ILBs of this study.

[3] This assumption is a simplification. In the case of Germany, the author collected extra data on coupons paid to nominal bondholders and reproduced the simulations in this paper allowing for interest rates on nominal securities and loans to be different. The results were very similar.

[4] Π_t is the relative change between the applied indexation coefficients in t and t−1. This coefficient is predetermined at t−2 and reflects fluctuations in Euro Area HICP inflation. However, it is applied with a floor value equal to 1. In other words, the outstanding quantities of ILBs cannot be lower than their issued face value.

[5] Algebraically, $P_{t-1,t} = \sum_{j=1}^{J} p_t^j q_{t-1}^j / Q_{t-1}$. Because granular data for p_t^j and q_{t-1}^j is not easily accessible, I computed $P_{t-1,t}$ by separating the only element in the sovereign budget constraint for which I do not have data.

[6] The formula for the counterfactual shares of ILBs over all securities increased proportionally is the following: $\alpha_t^* = \alpha_t(33{\cdot}0.5)(\alpha_t/\sum_{t=1}^{33}\alpha_t)$. Fig. A.2 in the Appendix shows actual and the counterfactual values of α_t implied by level and proportional increases in the shares of ILBs over all securities.

Table 1
Effect on market debt-to-GDP ratios ($\Delta\frac{M}{Y}$) due to increases in the share ILBs on bonds.

Country	POLICY	Simulated	Simulated
(actual $\Delta\frac{M}{Y}$)	α increases:	$\Delta\frac{M}{Y}$	- actual
Germany	+ 50% in level	−15.9%	4.3%
(−20.2%)	proportionally	−16.9%	3.3%
France	+ 50% in level	4.3%	8.8%
(−4.4%)	proportionally	3.5%	7.9%
Italy	+ 50% in level	−34.1%	−18.8%
(−15.3%)	proportionally	−35.0%	−19.7%
Spain	+ 50% in level	−4.4%	8.0%
(−12.4%)	proportionally	−2.6%	9.9%

The observed change in the market value of debt (as a percentage of GDP) from 2014 to 2022 is shown in brackets under each countries' name. The third column shows the simulated change in the market value of debt (over GDP) in each country for different polices: the first rows result from a counterfactual $\alpha_t + 0.5$ in each of the 33 quarters while the rows below come from distributing 33×0.5 across all quarters proportionally to the observed α_t.
Source: author's calculations.

Table 3
Simulated effects on the face value of debt-to-GDP ratios ($\Delta\frac{F}{Y}$).

Country	POLICY	Based on Eq. (4)		Based on Eq. (5)	
(actual $\Delta\frac{F}{Y}$)	α is	Simulated $\Delta\frac{F}{Y}$	Difference	Simulated $\Delta\frac{F}{Y}$	Difference
Germany	set equal to 0%	−9.5%	−0.1%	−9.8%	−0.27%
(−9.6%)	on average 0%	−9.6%	0.0%	−9.8%	−0.29%
France	set equal to 0%	14.3%	−0.5%	13.7%	−1.10%
(14.8%)	on average 0%	14.2%	−0.6%	13.7%	−1.11%
Italy	set equal to 0%	9.3%	3.7%	4.3%	−1.23%
(5.6%)	on average 0%	9.2%	3.6%	4.3%	−1.24%
Spain	set equal to 0%	4.3%	−0.5%	4.2%	−0.54%
(4.7%)	on average 0%	4.5%	−0.2%	4.4%	−0.36%

The observed change in the face value of debt (as a percentage of GDP) from 2014 to 2022 is shown in brackets under each countries' name. The third column reports the face value of debt (over GDP) implied by the paths simulated for the market debt values based on Eq. (4). The simulated polices consist of a reduction in the share of ILBs over securities: the first rows result from a counterfactual $\alpha_t = 0$ while the rows below come from demeaning the α_t. The fifth column shows the same for simulations based on Eq. (5), that is, simulating directly the face debt values.

Table 2
Effect on market debt-to-GDP ratios ($\Delta\frac{M}{Y}$) due to reductions in the share ILBs on bonds.

Country	POLICY	Simulated	Simulated
(actual $\Delta\frac{M}{Y}$)	α is	$\Delta\frac{M}{Y}$	- actual
Germany	set equal to 0%	−20.6%	−0.4%
(−20.2%)	on average 0%	−20.7%	−0.5%
France	set equal to 0%	−5.5%	−1.1%
(−4.4%)	on average 0%	−5.7%	−1.2%
Italy	set equal to 0%	−12.3%	3.0%
(−15.3%)	on average 0%	−12.4%	2.9%
Spain	set equal to 0%	−13.3%	−0.8%
(−12.4%)	on average 0%	−13.1%	−0.7%

The observed change in the market value of debt (as a percentage of GDP) from 2014 to 2022 is shown in brackets under each countries' name. The third column shows the simulated change in the market value of debt (over GDP) in each country for different polices: the first rows result from a counterfactual $\alpha_t = 0$ while the rows below come from demeaning the α_t.
Source: author's calculations.

would have decreased the fiscal burden of the German and Spanish governments until mid-2021, but raised it thereafter. France would have benefited from a larger α_t in 2018Q1–2020Q1. Note that the market value of the debt is the best measure of the fiscal burden of these countries, as it not only reflects the effect of realized past and current inflation but also the liabilities implied by expected future inflation. Moreover, it accounts for the maturity structure of all debt payment obligations.

Table 1 shows the effect on the market value of debt (divided by GDP) of changes in α_t, the share of ILBs over the total of debt in securities. The first column reports in parentheses the actual changes observed over the timespan 2014Q4–2022Q4 in these ratios. Consistently with the graphs in Fig. 2, the actual fiscal burden of all governments fell during this period. The next column reports the effect of the policies shown in Fig. 2: a level increase of 50 percentage points in all shares of real debt, or the same total change in these shares distributed proportionally to the observed ones. The third column shows the difference between the simulated and actual changes in the debt ratios.

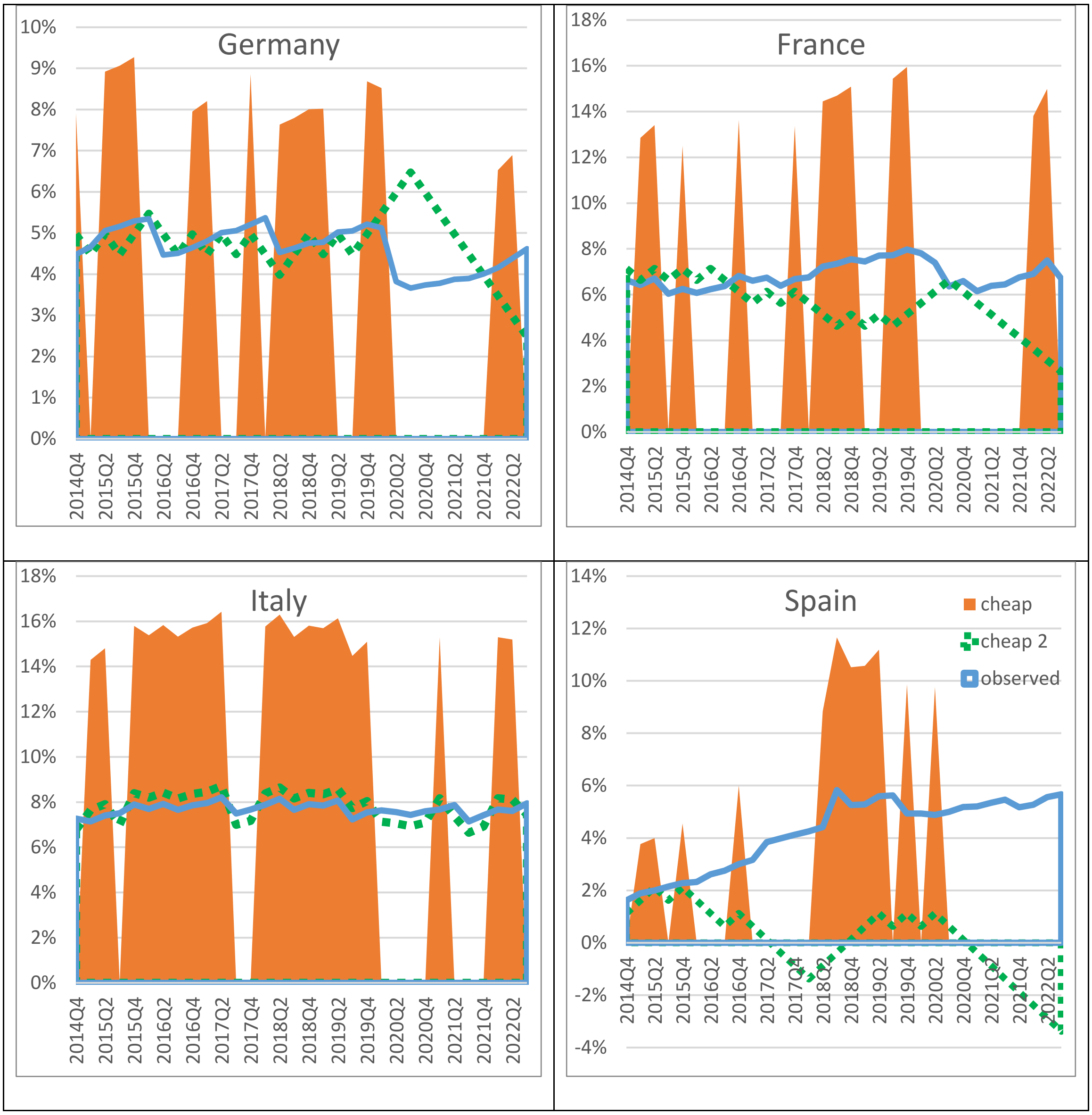

Fig. 3. Restricted shares of outstanding bonds in ILBs that minimize the fiscal burden.
Source: author's calculations. The "observed" series is the actual share of ILBs on securities α_t. The shaded area "cheap" is the counterfactual $\alpha_t^{'} \in (0, 2\alpha_t)$ that minimize ex-post the government financing cost. And "cheap 2" is restricted so that $\Delta\alpha_t^{''} \in (-0.5\%, 0.5\%)$.
Source: author's calculations.

With the simulated policies, the fiscal burden in France and Germany decreases less. In other words, a higher α_t implied a larger fiscal burden, especially when α_t was not raised proportionally, suggesting that these Treasuries generally issued more real debt when it was cheaper. As mentioned, in the case of Italy, a higher α_t implied a more pronounced decline in the fiscal burden, especially when the share of real debt is increased proportionally. This shows that Italy tended to have more debt in ILBs when it was cheaper. Finally, the government of Spain, whose debt burden actually fell during this period, would have lowered it less with a higher α_t (as in the case of Germany). However, this relative increase in the fiscal burden would be larger if α_t was raised proportionally in each period instead of equally. This can be interpreted as evidence that Spain did not generally issue real debt in the cheapest moment.

In Table 2, I study the effect of similar policies of the opposite sign. The first policy sets α_t to zero (no debt issued in ILBs). The second policy consists of a level reduction in α_t that puts its average equal to zero (i.e. demeaning the actual α_t).[7] Thus, the second policy preserves the timing of higher or lower α_t observed, while the first does not and sets them equal to zero in all periods. Not surprisingly, reducing the share of ILBs over total securities would have reduced the fiscal burden of these countries, with the exception of Italy. Consistent with the previous comments, this reduction is stronger (and the rise of Italy is lower) when the observed timing in the α_t is preserved (second policy). The exception is Spain where erasing this timing would yield a further reduction in the fiscal burden.

Table 3 reports the effect of these policies on the face value of debt (divided by GDP) instead of its market value. The first column shows

[7] If the counterfactual α_t has mean equal to zero, then it is positive in some quarters and negative in others. A negative α_t means that the government is selling nominal bonds and buying ILBs as assets.

Fig. A.1. Real one-quarter holding returns of nominal (solid blue) and inflation-linked (dashed orange) bonds.

that the observed face values increased for all countries, except Germany, consistent with Fig. 1. In all cases, the change of the debt-to-GDP ratio for face values is bigger than for market values. The reason behind this is the increase in interest rates within these economies, transitioning from exceptionally low levels in 2014Q4, which marked the aftermath of the sovereign debt crises, to elevated rates by 2022Q4 in an effort to curb inflation. Thus, bond prices fell and, since these governments had long-term debt that was shielded against interest rate risk, they experienced capital gains that alleviated their fiscal burden. The next columns show the simulated effects of the policies that reduce α_t (again, either set it to zero or demean it) in the debt-to-GDP ratio of these countries in face values. In other words, I simulate the debt path for the market value of debt with Eq. (4) but then report changes in their implied face values (divided by GDP).

$$F_t = F_{t-1}\left[\frac{\widetilde{Q}_{t-1}}{F_{t-1}}\left(\alpha_{t-1}\left(1+c'_{t-1,t}\right)\Pi_t + (1-\alpha_{t-1})(1+i_t)\right) \quad + \frac{L_{t-1}}{F_{t-1}}(1+i_t)\right] + D_t + SF_t \tag{5}$$

Why reporting the effects on the face values when the market value of debt better represents the fiscal burden of these countries? The reason is that Eq. (5) could be an alternative approach to estimate the effects of debt management policies. Eq. (5) is simply Eq. (1) rewritten so that the altered α_{t-1} are more visible. Admittedly, this procedure would ignore the role played by capital gains and losses for bondholders (and, thus, interest risk protection) in debt dynamics. I find that this approach could

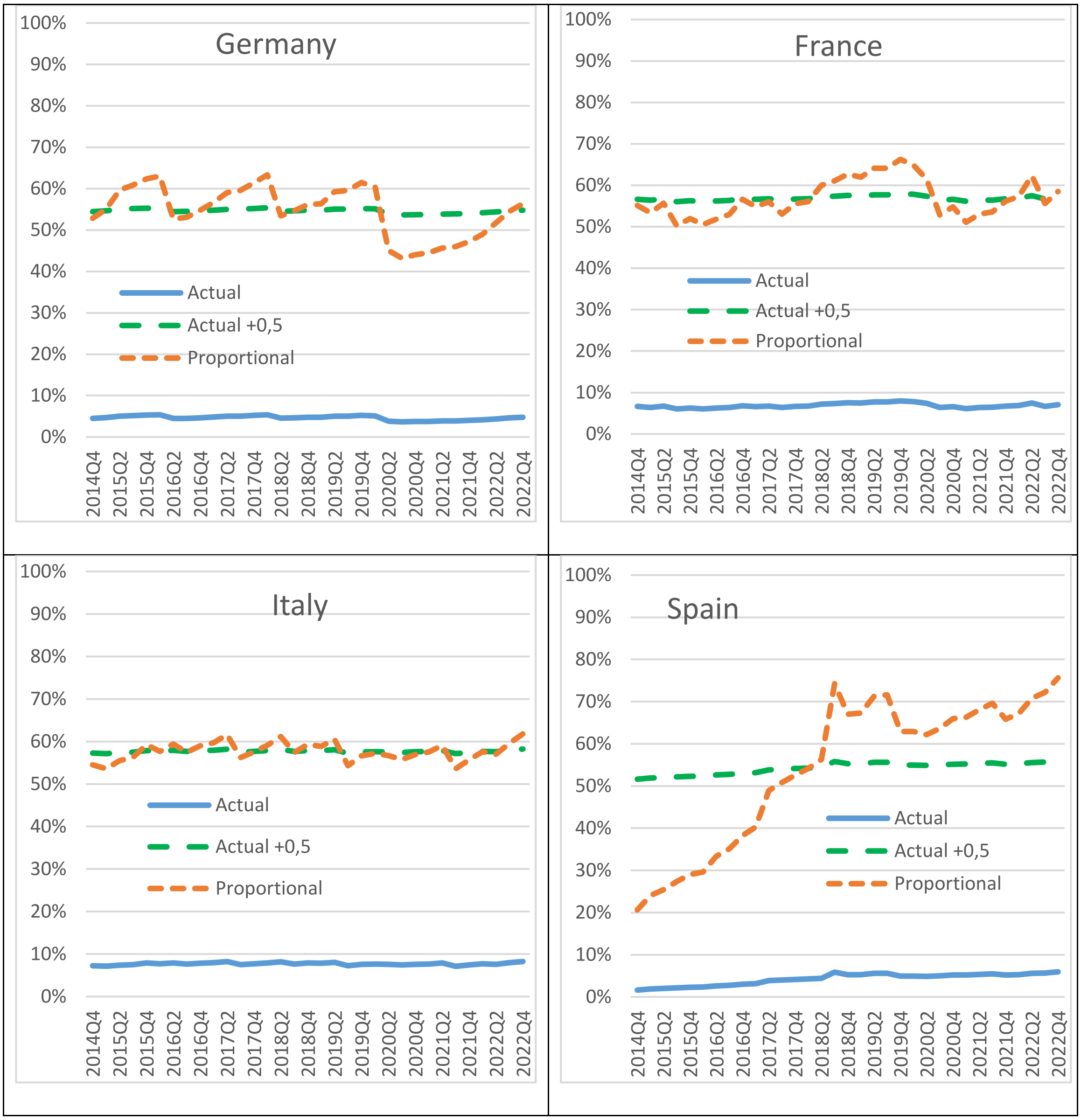

Fig. A.2. Counterfactual values of α_t adding 50% per quarter in levels or proportional increases.

be misleading, especially in the case of Italy. I would expect the face value of Italian debt to decrease by slightly more than 1.2% according to Eq. (5). However, the simulation based on Eq. (4) shows that the face value of Italian sovereign debt (as a percentage of GDP) would rise by around 3.6 percentage points (in line with the approximate 3% increase in the market value reported in Table 2). In the other three countries, using Eq. (5) as a shortcut would lead to overestimate the strength of the reductions in the fiscal burden implied by leaving out real debt.

Finally, I use Eq. (4) to find the sequence of α_t (denoted $\alpha_t^{'}$) that would achieve the lowest fiscal burden in 2022Q4 (that I henceforth call "cheap" strategy). I constrain the cheap strategy to a set of possible values of α_t between 0 and twice the value of the observed ILB share on total bonds, i.e.: $\alpha_t^{'} \in (0, 2\alpha_t)$. This way, I can also quantify the benefits of following an alternative policy that does not deviate much from the implemented one. Fig. 3 shows the observed (blue solid line) and cheap (orange shaded area) ILB shares. Of course, these judgements are made with hindsight. The "cheap" strategy consists of having ILBs whenever their ex-post next-period rate of return to investors is lower than that on nominal debt. Fig. 3 indicates that all countries benefited from having some outstanding ILBs from 2018Q1 to 2020Q1. Thereafter, the recommended policy is to not have real debt until 2021Q4; however, all governments incurred a higher cost of funds by having some outstanding ILBs in that period.

Countrywise, we notice that Germany's observed α_t seems to follow the increments and reductions of the cheap strategy, although more steadily. France made a timely reduction in their share of ILBs after COVID-19. Italy had beneficial outstanding ILBs most of the time since it was almost always cheaper to issue real debt. Finally, Spain increased α_t in 2017 and after the COVID-19 shock, during periods when ILBs provided ex-post higher returns to investors than nominal bonds. With these bounded optimized values of α_t, the "cheap" strategies, Germany would have decreased the market value of debt (over GDP) in 0.9 percentage points, France in 3 points, Italy in 7, and Spain in 1.8 points (compared to the observed α_t). Admittedly, the cheap strategy implies massive buybacks from one quarter to the next in all countries, followed by swift reversals. A more implementable alternative cheap strategy (denoted $\alpha_t^{''}$) would be one that can only deviate steadily from the observed α_t because changes are restricted to be small, for instance:

$\Delta\alpha_t'' \in (-0.5\%, 0.5\%)$. The latter is shown as the "cheap 2" strategy (green dashed line) in Fig. 3. In Spain, this strategy implies the position where the Treasury issues nominal bonds and invests in inflation-linked assets. With this alternative strategy Germany would have increased the fiscal burden (as a percentage of GDP) by 0.1 percentage points, but France would have reduced it in 0.2 points, Italy in 0.5, and Spain in 1.2 points (in comparison with the debt burden implied by the observed values of α_t).

4. Conclusion

Despite the recent increase in inflation, I documented that ILBs since 2015 did not imply a significantly larger fiscal burden for Germany, France, and Spain; and, in fact, Italy would have benefited from having more real debt. However, I document that debt structure choices had significant first-order effects. In fact, a slightly different debt management strategy would have reduced debt-to-GDP ratios in these sovereigns. In producing these stylized facts, it was essential: (1) that I combined new data on ILBs with Eurostat fiscal statistics to compute the quarterly holding period return to investors in both nominal and real debt; and (2) that, following Hall and Sargent (2011), I simulated the counterfactual paths of the market value of debt by iterating the government budget constraint.

A limitation of my analysis is the assumption that I made that an altered proportion of real debt to the total debt in securities would not have impacted yields and the primary budget balances in the simulations. Although this assumption is not uncommon in the literature (e.g., Hall and Sargent, 2011; or Ellison and Scott, 2020), it is not entirely realistic. For this reason, I studied some counterfactual scenarios that do not deviate excessively from the observed policies. Future work could further explore the impact of differences in the maturity structure of nominal and inflation-linked bonds on debt dynamics. This is particularly relevant as the maturity structure of sovereign debt is being studied to play an important role in the effectiveness and design of monetary policy (e.g., Andreolli, 2021, and Chafwehé et al., 2021).

Data availability

Data will be made available on request.

Appendix

See Figs. A.1 and A.2.

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