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Sovereign risk, debt composition and exchange rate regimes☆

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ABSTRACT

Domestic and foreign debt risks, like exchange rate fluctuations and defaults, are influenced by the exchange rate regime. Analyzing data from 2004 to 2021 for 46 economies, we find that risk increases with higher public debt-to-GDP ratios (size effect), and a larger proportion of foreign debt (composition effect). However, the effects vary based on exchange rate regimes: composition effect is strong in floating, ambiguous in managed, and absent in monetary unions. The size effect is strong in monetary unions, weak in floating, and absent in managed regimes.

1. Introduction

How the size of public debt affects its riskiness has been a topic of extensive studies in both theoretical and empirical literature. Although the consensus states that increasing the size of public debt leads to increased riskiness, there are several caveats.[1] This paper starts with an observation that foreign public debt and domestic public debt are two very different instruments. Foreign debt issuance constitutes a net transfer into the economy and its repayment is a transfer out of the economy, therefore its size should directly increase its risk. However, domestic debt issuance and repayment is mostly a redistribution within the economy, so its riskiness should be less dependent on the size (Paczos and Shakhnov 2016, 2022).

Secondly, we observe that domestic public debt (debt owed to domestic residents), is mostly denominated in local currency, while foreign public debt (debt owed to foreign residents) is mostly denominated in foreign currency.[2] Thus, the relationships between the composition and size of the public debt and its riskiness could also crucially depend on the exchange rate regime adopted by the economy. The goal of this paper is to study these relationships empirically.

The role of public debt composition is most clearly visible in economies with a floating exchange rate regime. Their foreign public debt, when denominated in foreign currency, is subject to currency fluctuations, which feed into its perceived riskiness. On the other

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[1] That increased size of public debt leads to increased riskiness is a benchmark result in all quantitative sovereign default models, starting with Aguiar and Gopinath (2006) and Arellano (2008). Yet, empirically, the picture is less clear as later evidenced in the literature review.

[2] Although there is an increased entry of foreign investors into domestic currency debt markets, this has been only a very recent phenomenon and is still limited in size, see e.g. Arslanalp and Tsuda (2014) and Du and Schreger (2022).

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hand, they are also the monopoly supplier of their currencies and thus cannot be forced into default on debt denominated in local currency (De Grauwe 2013). Defaulting on this debt could only be a policy choice. Thus, we hypothesize that in economies with floating exchange rates, the size of public debt, and the share of foreign debt in total public debt, would increase its riskiness. However, the composition effect could be mitigated by the fact, that, via currency sovereignty, those economies have an option to inflate their domestic debt away. Hence, the size of domestic debt should still affect its riskiness.

A polar opposite example is economies in a monetary union. An economy entering a monetary union ceases its control over the currency in which it issues debt. Thus, we hypothesize that the sovereign risk associated with domestic and foreign public debt should be similar. While the size of public debt should affect its riskiness, its composition should not. On the other hand, the size effect could be mitigated by the fact, that entering a monetary union increases an economy's credibility, allowing the government to borrow more.

Similarly to members of a monetary union, economies with managed exchange rates also face real constraints on their domestic debt. An economy with a managed exchange rate promises to convert its currency to a reserve asset at a prearranged rate. To maintain this conversion rate, their central banks must hold a certain amount of the reserve asset. Hence, these governments' spending (and thus debt repayment) is restrained by their holdings of the reserve asset, which they neither control nor supply. Therefore, we hypothesize that the composition of public debt should not influence its riskiness. However, an economy may abandon (or be forced to abandon) its peg to repay any domestic debt. Therefore, the composition of public debt may still be important for its riskiness if the credibility of the peg is low.

The goal of this paper is to empirically test the above hypotheses and quantify the effects that the size and composition of public debt have on its riskiness. We collect publicly available data on government bond spreads (debt riskiness), public debt-to-GDP ratios (debt size) and foreign debt-to-public debt ratios (debt composition) and a set of controls for 46 economies in different exchange rate regimes in the years 2004–2021.

We find that, on average, the size of public debt increases its riskiness, while the effect of debt composition is U-shaped (riskiness decreases at low shares and increases at high shares of foreign debt). When controlling for the exchange rate regime, we find that, in floating regimes, the composition effect, in line with our hypothesis, is positive, but the size effect is very weak (statistically and economically). In a monetary union, in line with our theoretical premises, the size effect is positive and strong, and the composition effect is absent. In managed exchange rate regimes, contrary to our theoretical premise, the size effect is absent, and the composition effect is very weak. To the best of our knowledge, this is the first study that empirically relates public debt size and composition to its riskiness controlling for an exchange rate regime.

2. Literature review

The theoretical premise of this study is based on the sovereign debt and default model of domestic and foreign debt in Paczos and Shakhnov (2016, 2022). In their model, domestic and foreign public debt are different instruments and carry different risks. We study empirically their conclusions, extending the approach to acknowledge that exchange rate regimes may affect policy trade-offs and debt riskiness.

Ours is not the first empirical approach to study the relationship between the size and composition of public debt and its riskiness. However, the literature to date has mostly concentrated on drawing distinctions between advanced and emerging economies Dell'Erba et al. (2013). look at the effect of the size and composition of public debt on sovereign risk, comparing advanced, Euro Area, and emerging economies. Using a data sample of 26 emerging and 15 advanced economies between 1993 and 2012 and measuring sovereign risk with spreads they find that a larger share of public debt to GDP increases the debt riskiness (positive size effect). This size effect is the largest in emerging economies, the next largest in the eurozone economies, and the smallest impact in advanced non-eurozone economies Baldacci and Kumar (2010). also find a positive size effect in a sample of 31 economies between 1980 and 2008 using long-term yields as a direct measure of risk. Their setup uses a variety of control variables and, similarly to us, they study the non-linear effects of debt, but unlike us, do not study whether the average effects are different in different subsets of economies Dell'Erba et al. (2013). also look at the relationship between foreign government debt and sovereign risk. The largest positive effect was found in emerging economies, the second largest in eurozone economies and no significant effect was found in advanced economies.

Several studies look at a selected group of economies, usually advanced economies that include economies with floating exchange rates and eurozone countries. In particular, Afonso and Jalles (2020), Arslanalp and Poghosyan (2016), Gruber and Kamin (2012), Hauner and Kumar (2006), Ichiue and Shimizu (2015), Kinoshita (2006), and Poghosyan (2014) all assess the relationship between public debt and long-term interest rates in different subsets of the OECD economies. All find a positive size effect (public debt increases yields), while Ichiue and Shimizu (2015) also study debt composition and find a positive effect (foreign debt increases yields). Ardagna et al. (2007) find a positive size effect, and its strength is found to depend on the level of government debt. All these studies, except Poghosyan (2014), use ten-year government bond yields as the dependent variable. Instead, Poghosyan (2014) uses a change in real yields. We improve upon this literature by collecting carefully calculated data on spreads. Also, for the clarity of comparison, we extend our approach and provide robustness results, where we follow the literature closely and use 10-year bond yields as the dependent variable.

However, some contributions find the opposite effect: that increasing public debt reduces sovereign risk in advanced economies Andritzky (2012). finds a negative effect of the government budget balance on sovereign risk for G20 countries. They also find a greater negative impact of the budget balance on sovereign risk in the Euro Area, compared to non-Euro Area countries. They attribute this finding to markets underestimating the risk of default in the Eurozone before the financial crisis. Similarly, some studies find a negative composition effect. In their sample, Andritzky (2012) and Arslanalp and Poghosyan (2014) also find that increasing the share of

foreign debt decreases sovereign yields.

This paper adds to the literature by, to the best of our knowledge, being the first to explicitly separate economies according to their exchange rate regimes.

3. Data

We compile a panel dataset of 46 economies for the period 2004–2021. First, we collect the data on sovereign spreads that reflect the probability and expected extent of sovereign default and minimize the possible effects of inflation expectations or duration. The data comes from an updated dataset accompanying Born et al. (2020). The spread data is constructed in the following way. For a subset of emerging economies, the data comes from J.P. Morgan's Emerging Markets Bond Index (EMBI) spreads. For a subset of the euro area economies, the data is based on the "long-term interest rate for convergence purposes" and CDS spreads. For the subset of non-eurozone advanced economies, the data is based on foreign-currency-denominated bonds and CDS spreads (as in Chan-Lau and Kim 2004; Ang and Longstaff 2013). All the spreads are calculated on similar-maturity foreign-currency bonds. The details of the spread construction with illustrative examples are laid out in Born et al. (2020).

We categorize every economy-year observation into one of the three separate groups based on the economy's exchange rate regime, using the IMF exchange regime classification.[3] The data availability dictates the data sample, including sample economies and time period. The spread data is available until 2017, so, as robustness, we substitute the spread data with the data on long-term yields on government bonds from the IMF International Financial Statistics Database, which currently runs until 2021. The geographical coverage is broad, compared to the studies cited above. Table A1 in the Appendix lists all the countries and areas included in our sample, together with the years the economies followed one of the three exchange regimes, and with the availability of spread and long-term yield data.

Two government debt variables are our key regressors. The first debt variable, representing size, is total public debt as a percentage of GDP. The second debt variable, representing composition, is the percentage of total public debt owned by foreigners.[4] We use the resident definition of foreign public debt as opposed to the currency definition due to the Eurozone being multiple countries with the same currency. We complement our dataset with four control variables: the annual percentage change in real GDP growth, inflation, defined as the annual percentage change in average consumer prices, the average central bank policy rate over each year controls for short-term interest rates, and national saving, defined as gross national saving as a percentage of GDP.

GDP growth, inflation and gross government debt data were obtained from the IMF Data Mapper, World Economic Outlook database. Data on national saving is from the IMF's AFR Regional Economic Outlook database and The World Bank's national accounts database. The definition of national saving was the same for both databases. Ten-year government bond yields and the central bank policy rate data are from the IMF's International Financial Statistics databases. We also had to supplement data on the central bank policy rate with data found from individual economies' central bank websites. Finally, external government debt data was obtained from the IMF's sovereign debt investor database. The data on debt composition comes in yearly intervals, and the data on all control variables have been obtained in yearly frequency. The data on spreads come in quarterly frequency and has been averaged to yearly observations. Details of data description and sources are provided in Table A2 in the Appendix.

Table 1 presents descriptive statistics for all variables for the full sample of countries and areas, over the period 2004–2021. Table 2 gives descriptive statistics for the dependent variable and two key regressors across the three exchange rate regimes. Euro Area economies have the highest riskiness on average, followed by managed regimes, and floating regimes. Public debt as percent of GDP is the highest in the Euro Area economies, followed by floating regimes, and managed regimes. The fraction of foreign debt to total public debt is the highest in Eurozone, followed by managed regimes, and floating regimes Table 3. presents the cross-correlations of all independent variables, showing that this set of independent variables does not suffer from potential multicollinearity issues.

4. Methodology and results

4.1. Methodology

In this section, we estimate different versions of the regression model of sovereign risk in economy i, in year t:

[3] The first group is comprised of economies with floating exchange rate regimes. These economies are all developed, middle- and high-income economies. The second group is made up of the eurozone countries. The third group is economies with a form of managed exchange rate regime. These regimes include pegged currencies, composite anchors, and crawling pegs, mainly with the dollar or euro. The economies in this group are generally developing, middle- and low-income economies.

[4] We use the economic definition of foreign public debt (residency of debt holder), as this is consistent with our theoretical premise: debt repayment to foreign residents constitutes an outflow from the economy, while debt repayment to domestic residents does not. The currency definition is irrelevant to the Eurozone countries, since neither of them holds sovereignty over the euro, which would imply that all their public debt is foreign. Yet, for developing economies currency and economic definition are quite close, as most of the debt held by foreign residents is issued in foreign currency. For more discussion on economic, currency and legal definitions of foreign public debt see: Panizza et al. (2009), Paczos and Shakhnov (2016).

Table 1
Descriptive statistics.

	Obvs	Mean	Sd	Min	Max
Spread	350	1.239	1.945	0.00595	18.26
Public Debt	464	65.30	36.16	8.100	213.1
Foreign Debt	439	48.31	18.19	5.250	89.14
GDP growth	464	1.945	3.712	−14.80	25.30
Inflation	464	1.903	1.782	−1.700	15.30
Saving	413	22.75	5.717	4.661	38.80
Policy Rate	411	1.444	1.440	−0.500	6.500

Notes: This table shows the number of observations, the mean, the standard deviation, the minimum and the maximum of all variables. Observations from all economies over the full time period 2004–2017.
Sources: Born et al. (2020), IMF International Financial Statistics, IMF World Economic Outlook, IMF Sovereign Debt Investor Database, and IMF AFR Regional Economic Outlook.

Table 2
Descriptive statistics – controlling for exchange rate regimes.

	Mean	Sd	Min	Max
Spread (%)				
Float	0.568	0.568	0.0200	2.642
Euro	1.525	2.412	0.00595	18.26
Managed	1.017	0.809	0.0429	3.928
Public debt (as% of GDP)				
Float	58.28	28.38	9.700	132.8
Euro	76.49	39.11	8.100	213.1
Managed	42.30	16.80	14.10	87.20
Foreign debt (as% of public debt)				
Float	33.71	9.147	16.17	54.08
Euro	58.88	14.23	25.89	89.14
Managed	33.61	13.71	5.250	65.85

Notes: This table shows the mean, standard deviation, minimum and maximum of ten-year government bond yields, public debt and foreign debt, separately for each group of economies: economies with floating exchange rates, eurozone countries and economies with managed exchange rates over the full period 2004–2017.
Sources: Born et al. (2020), IMF World Economic Outlook, IMF Sovereign Debt Investor Database.

Table 3
Matrix of correlations.

Variables	(1) PublicDebt	(2) ForeignDebt	(3) GDPgrowth	(4) Inflation	(5) Saving	(6) PolicyRate
(1) PublicDebt	1.000					
(2) ForeignDebt	0.199	1.000				
(3) GDPgrowth	−0.317	−0.163	1.000			
(4) Inflation	−0.328	−0.107	0.164	1.000		
(5) Saving	−0.434	−0.207	0.293	−0.043	1.000	
(6) PolicyRate	−0.334	−0.192	0.257	0.511	0.079	1.000

Notes: this table shows the correlation coefficients for each pair of independent variables.
Sources: IMF International Financial Statistics, IMF World Economic Outlook, IMF Sovereign Debt Investor Database, and IMF AFR Regional Economic Outlook.

$$\begin{aligned} Spread_{it} &= \beta_{it} + \beta_1 PublicDebt_{it-1} + \beta_2 ForeignDebt_{it-1} \\ &+\beta_3 Euro_{it-1} + \beta_4 Manage_{it-1} \\ &+\beta_5 PublicDebt_{it-1} * Euro_{it-1} + \beta_6 PublicDebt_{it-1} * Managed_{it-1} \\ &+\beta_7 ForeignDebt_{it-1} * Euro_{it-1} + \beta_8 ForeignDebt_{it-1} * Managed_{it-1} \\ &+\beta_9 GDP_{it-1} + \beta_{10} Inflation_{it-1} + \beta_{11} Saving_{it-1} + \beta_{12} PolicyRate_{it-1} \\ &+\beta_{13} PublicDebt^2_{it-1} + \beta_{14} ForeignDebt^2_{it-1} + \mu_{it} \end{aligned} \tag{1}$$

Where the dependent variable, *Spread* is the sovereign default premium. Among the key independent variables: *PublicDebt* is the total public debt-to-GDP ratio, *ForeignDebt* is the percentage share of foreign public debt in total public debt (public debt composition), *Euro* and *Manage* are exchange rate regime dummies taking value 1 if, in a given year, the economy was a member of the eurozone or followed a managed exchange rate regime, respectively. We use interaction terms of *PublicDebt* and *ForeignDebt* with exchange rate regime dummies to assess whether changes in public debt size and composition affect sovereign default premiums differently under different exchange rate regimes. We complement our regression model with four control variables: *GDP* is the GDP growth rate,

Inflation, Saving is the national saving-to-GDP ratio, and *PolicyRate* is the economy's central bank short-term policy rate. In some specifications, we additionally include square terms of *PublicDebt* and *ForeignDebt* to control for non-linear effects of debt size and composition on sovereign risk. Finally, μ_{it} is the residual error term.

The sample consists of 46 economies over the period 2004–2021. We estimate three different versions of regression (1): an ordinary least squares model (OLS, technically $\beta_{it}=\beta_0$) with control variables, a one-way fixed-effects (FE) model with economy-fixed effects ($\beta_{it}= \beta_i + \beta_0$) and control variables, and a two-way fixed-effects model with economy- and time-fixed effects ($\beta_{it}=\beta_i + \beta_t$) without control variables. The first two specifications are common in the literature. The third specification follows Dell'Erba et al. (2013). Although the two-way FE model abstracts from time-and-economy-varying determinants of sovereign spread, it has two strong advantages. First, it allows for a clear interpretation of debt and interaction coefficients, and second, it still controls for a large share of unobserved heterogeneity with the two-way fixed effects. In fact, quantitatively, in our regressions, this specification outperforms the other two in terms of explaining the observed data.

We recognize that there is a strong possibility of reverse causality: interest rates on government bonds may causally affect the size and composition of public debt (as well as GDP growth or other macro controls). To mitigate the endogeneity problem, we use the lag (of one year) of all independent variables throughout all regressions.

4.2. Benchmark results

First, to quantify the average effect of public debt size and composition, in Table 4 we present the results of the estimation of model (1) without exchange rate regime controls. We run six specifications: OLS, economy-fixed, and time- and economy-fixed effects, with and without square terms for debt.

The estimate of the linear term of public debt is positive and significant in all three linear models (columns 1–3). On average, across all economies, a 1 percentage point increase in public debt-to-GDP debt causes a 2–6 basis point increase in spreads. Interestingly, results from columns 4–6 also show that the size effect of public debt is U shaped: the estimates of the linear term of foreign debt are negative, while estimates of the square term are positive. This means that the riskiness of debt decreases with total public debt when total public debt is low and increases with total public debt when it is high. This echoes the results found in Ardagna et al. (2007) and Baldacci and Kumar (2010), where the effect of the size of public debt on risk riskiness is found to be non-linear.

Looking at foreign debt, in two out of three linear specifications, the estimates are significant and both show a positive effect of debt composition on spreads. A 1 percentage point increase in the share foreign debt in total public debt, causes on average a 1.2–3.3 basis point increase in spreads. The results from non-linear specifications in columns 4–6 show that the effect of debt composition is also U-

Table 4
Benchmark regression results - without exchange rate regime controls.

	(1) OLS	(2) FE	(3) FE	(4) OLS	(5) FE	(6) FE
PublicDebt	0.0204***	0.0600***	0.0309***	−0.0664***	−0.0130	−0.0557***
	(0.00336)	(0.0163)	(0.00282)	(0.00825)	(0.0160)	(0.00818)
ForeginDebt	0.0123**	−0.00326	0.0325***	−0.0386*	−0.0108	0.00854
	(0.00515)	(0.0145)	(0.00544)	(0.0204)	(0.0294)	(0.0217)
GDP	−0.144***	−0.188***		−0.145***	−0.184***	
	(0.0282)	(0.0473)		(0.0232)	(0.0452)	
Inflation	0.214***	0.197***		0.141***	0.182***	
	(0.0586)	(0.0580)		(0.0488)	(0.0551)	
Saving	−0.0409**	0.0182		−0.0130	−0.00281	
	(0.0186)	(0.0282)		(0.0160)	(0.0313)	
PolicyRate	−0.0676	0.141		−0.0704	0.0460	
	(0.0793)	(0.119)		(0.0656)	(0.0712)	
PublicDebt^2				0.000548***	0.000407***	0.000517***
				(4.99e-05)	(9.97e-05)	(4.72e-05)
ForeignDebt^2				0.000477**	0.000145	0.000105
				(0.000206)	(0.000261)	(0.000210)
Constant	0.291	−2.992		3.657***	0.142	
	(0.669)	(1.925)		(0.731)	(1.292)	
Observations	315	315	357	315	315	357
R-squared	0.348	0.473	0.507	0.566	0.553	0.637
Economy-time controls	YES	YES	NO	YES	YES	NO
Economy FE	NO	YES	YES	NO	YES	YES
Time FE	NO	NO	YES	NO	NO	YES

Notes: The dependent variable is the spread in percentage points. Results are from pooled OLS and fixed effects regressions using the full sample of 26 economies over the period 2004–2017. All variables are expressed as percentages and their details, and all data sources are outlined in the "Data" section. Standard errors are in parentheses. Models (1)-(3) do not include square terms of PublicDebt and ForeignDebt variables, models (4)-(6) include square terms. Models (1)-(2), and (5)-(6) include macro (economy-time specific) controls and no time-fixed effects, while models (3) and (6) include time-fixed effects and no macro controls. Models (1) and (4) are estimated by OLS, while models (2)-(3) and (5)-(6) are estimated using economy-fixed effects. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

shaped: the estimates of the linear term of foreign debt are negative, while estimates of the square term are positive. The riskiness of debt decreases with foreign debt when the share of foreign debt is low and increases with foreign debt when the share is high.

GDP growth has a negative effect on spreads ranging from a 14.4–18.8 basis point decrease in spreads with a 1 percentage point increase in GDP growth. Inflation has a positive effect on spreads. A 1 percentage point increase in inflation, on average, causes a 14.1–21.4 basis point increase in spreads. Saving is only significant in one specification and the central bank policy rate is insignificant. This last finding validates our choice of the dependent variable, as it shows that spreads have been cleared from the influence of the short-term rate. Interestingly, in the robustness checks, where we use long-term yields on government bonds as the dependent variable, the effect of short-term policy rate are significant and positive.

Next, we present the results of the estimation of the model (1) controlling for exchange rate regimes. The results are presented in Table 5. We employ dummy variables for the years when countries were members of a monetary union (*Euro*), followed managed exchange rate regime (*Managed*) and their interaction with debt variables. Thus, the estimates of debt variables should be interpreted for the control group: the economies with floating exchange rate regimes. An assessment of debt size and debt composition effects on sovereign spreads in the Eurozone and managed exchange-rate economies requires the statistical summation of debt and interaction coefficients. A correct interpretation of coefficients is only possible when no square terms are present, therefore here we only extend specifications (1)-(3) from Table 5. Again, we estimate the model using OLS (column 1), economy-fixed effects (2) and economy- and time-fixed effects with no macro controls (column 3).

In economies with floating exchange rates, the size effect is weak economically and statistically. The estimate is statistically insignificant in two out of three estimations and only weakly significant (at 10% level) and positive only in one-way FE estimation. This finding, similar to Andritzky (2012), is new and challenges existing knowledge, although is not as strong as theirs: they find a negative size effect in advanced economies (a mix of floating and monetary union economies), while we find an economically and statistically weak size effect in floating exchange rate regimes. In economies with floating exchange rates, the composition effect is positive. A 1

Table 5
Benchmark regression results – including exchange rate regimes controls.

	(1) OLS	(2) FE	(3) FE
PublicDebt	−0.00897	0.0156*	6.75e-05
	(0.00706)	(0.00776)	(0.00578)
ForeginDebt	0.0360*	0.0240**	0.0362***
	(0.0187)	(0.0100)	(0.0116)
GDP	−0.139***	−0.191***	
	(0.0250)	(0.0484)	
Inflation	0.152***	0.195***	
	(0.0553)	(0.0482)	
Saving	−0.0552***	0.0217	
	(0.0191)	(0.0280)	
PolicyRate	−0.0875	0.0967	
	(0.0738)	(0.0912)	
PublicDebt * Euro	0.0475***	0.0515***	0.0442***
	(0.00733)	(0.0123)	(0.00642)
PublicDebt * Managed	0.00826	0.0128	−0.00847
	(0.0141)	(0.0141)	(0.00945)
ForeignDebt * Euro	−0.00398	−0.0345***	−0.0304***
	(0.0204)	(0.00912)	(0.0105)
ForeignDebt * Managed	−0.0372*	−0.00242	0.00814
	(0.0204)	(0.0161)	(0.0114)
Euro	−3.327***		
	(0.968)		
Managed	1.887*		
	(1.021)		
Constant	1.151	−2.695	
	(0.992)	(1.758)	
Observations	315	315	357
R-squared	0.517	0.514	0.589
Economy-time controls	YES	YES	NO
Economy FE	NO	YES	YES
Time FE	NO	NO	YES
P(PublicDebt+PublicDebt*Euro=0)	0.00	0.00	0.00
P(PublicDebt+PublicDebt*Managed=0)	0.95	0.05	0.35
P(ForeignDebt+ForeignDebt*Euro=0)	0.00	0.46	0.34
P(ForeignDebt+ForeignDebt*Manage=0)	0.89	0.29	0.00

Notes: The dependent variable is the spread in percentage points. Results are from pooled OLS and fixed effects regressions using the full sample of 26 economies over the period 2004–2017. All variables are expressed as percentages and their details, and all data sources are outlined in the "Data" section. Standard errors are in parentheses. Models (1)-(2) include macro (economy-time specific) controls and no time-fixed effect, while model (3) includes time-fixed effects and no macro controls. Model (1) is estimated using OLS, while models (2)-(3) are estimated using economy-fixed effects. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

percentage point increase in foreign public debt share causes a 2.4–3.6 basis point increase in spreads. This is in line with our initial hypothesis that the composition of debt should matter for its riskiness in economies with floating exchange rate regimes.

In the Euro Area, the size effect is positive and significant. The summation of the coefficient on total public debt and its interaction with the Euro dummy suggests that a 1 percentage point increase in total public debt causes a 3.8–6.7 basis point increase in spreads. This result is in line with our hypothesis. Here, an important observation is necessary: in the Euro Area debt is, *ceteris paribus*, safer than in floating exchange rate regimes. This is evidenced by the estimates of the dummy variable *Euro*. For two hypothetical economies with identical public and foreign debt levels, GDP growth, inflation, saving rate, and policy rate, spreads are 333 basis points lower in the Euro Area than in floating regimes (significant at 1%). This level effect is larger than marginal debt effects discussed before, by far. If we take a hypothetical economy with a floating exchange rate with no foreign debt and compare it to a hypothetical Eurozone economy with the same level of public debt, but entirely owed to foreigners, then, the spread would still be lower in the Eurozone economy.

In the Euro Area, the composition effect is absent in the two FE specifications and is only significant and positive in the OLS specification. We interpret this result as weakly confirming our theoretical hypothesis, that, because of the lack of monetary sovereignty, in a monetary union domestic and foreign debt are similar instruments and carry similar risks.

In economies with managed exchange rates, the size effect is absent in OLS and two-way FE specification and is only significant and positive in the one-way FE specification. This result suggests that a 1 percentage point increase in total public debt to GDP causes a 2.8 basis point increase in spreads. We conclude that our initial hypothesis, that the size effect in managed exchange rate regimes should be positive, does not find strong support in the data.

In economies with managed exchange rate regimes, the composition effect is absent in the OLS and one-way FE specification and is significant and positive in the two-way FE specification. A 1 percentage point increase in foreign debt share causes a 4.4 basis point increase in spreads. Here, our theoretical hypothesis was not clear-cut, as two effects are working in opposite directions: pre-arranged conversion rate would render the composition effect absent, but the risk of abandoning the peg may bring in a positive composition effect. The empirical evidence here is non-decisive whether one effect strictly dominates the other.

4.3. Robustness analysis

We find that the results obtained in the two benchmark estimations presented in Table 4 and Table 5 are robust to a battery of alternative specifications. We find that the choice of macro controls does not matter for the results: we have estimated model specifications with economy-fixed effects instead of macro controls (columns 3 and 6 in Table 4 and column 3 in Table 5) and found similar results. Further, we conduct two separate robustness exercises.

First, we re-estimate model (1) using the long-term government bond yields instead of sovereign spreads as the dependent variable. The data on long-term spreads comes from the IMF's International Financial Statistics Database. On the one hand, the advantage of using spreads, as discussed in Section 3, is that they have been constructed to isolate the effect of sovereign risk premiums and to minimize the effects of other factors (like inflation, short-term yields, or duration). On the other hand, the advantage of long-term yield data is broader data coverage, as evidenced in Table A1 in the Appendix. The results of this analysis are found in Tables A3 and A4 in the Appendix.

In Table A3 we repeat the analysis from Table 4 and confirm that the size and composition effects are positive on average and that the size effect is U-shaped (negative at low and positive at high debt levels). In Table A4 we repeat the analysis from Table 5 and interact the debt variables with exchange rate regime dummies. The robustness analysis confirms that the size effect is positive in a monetary union and that it is inconclusive in managed regimes. Interestingly, here we find that the size effect is negative in the floating exchange rate regimes. This finding is similar to Andritzky (2012), who also uses long-term bond yields as the dependent variable. This robustness analysis also confirms a positive composition effect in the managed regimes and the lack of composition effect in a monetary union. Here again, like in Andritzky (2012), we find a negative composition effect in floating regimes.

The second robustness exercise accounts for the special role of the financial crisis period. We repeat the analysis from Table 4, accounting for exchange rate regimes, but split the dataset into two parts, by years: 2008–2012, and after 2012. The results are available in Tables A5 and A6 in the Appendix. We confirm a strong composition effect in a monetary union both during and after Financial Crisis. We also find evidence for the positive composition effect in floating and managed regimes after Financial Crisis and positive effects in managed regimes during Financial Crisis.

5. Conclusions

We find new evidence regarding the relationship between the size of public debt, its composition and sovereign risk. Specifically, we find evidence that this relationship does indeed change according to the exchange rate regime employed by the economy. In economies with floating exchange rate regimes, increasing the total share of foreign public debt increases its riskiness, but the results for the size effect are ambiguous. In Eurozone countries, increasing total public debt increases its riskiness, while increasing the share of foreign debt does not affect its riskiness. Yet, Eurozone countries have lower sovereign risk on average than floating exchange rate regimes. Finally, in economies with managed exchange rates, the size effect is inconclusive, while there is evidence that an increasing share of foreign debt increases sovereign risk.

In the empirical research on the determinants of sovereign debt riskiness, a commonly used measure of risk is the long-term yield on government bonds. The shortcomings of this measure are the limited comparability of yields, and the contamination of yields by factors other than pure default risk (inflation expectations, duration, short-term yields). The spread data minimizes these shortcomings

but offers somewhat lower coverage. In this paper, we have tried to mitigate these shortcomings by using both measures interchangeably.

The results regarding the managed regimes are particularly interesting and warrant further research. There is a broad spectrum of arrangements found in this group, from hard pegs (eg. economies in the two years before the euro adoption) to managed floats that allow for substantial exchange rate movements (like Malaysia before 2016). The finding that the composition effect in the managed regimes is ambiguous is consistent with the theory and empirical findings: managed regimes sit between free-floating regimes (where the composition effect is strong) and monetary union (where the composition effect is absent). However, the absence of size effect in managed regimes (and in floating regimes) requires further effort to reconcile theory with empirics.

Declaration of Competing Interest

The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

Data availability

Data will be made available on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.frl.2023.104396.

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