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Currency Redenomination Risk

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Abstract

A eurozone exit or breakup exposes bondholders to currency redenomination risk. I quantify redenomination risk since the sovereign debt crisis: It contributes substantially to credit spreads around changes in government in France and Italy. Bond prices suggest that markets have priced a potential Italian exit as isolated, and a French one as a breakup. Unlike conventional default risk, redenomination risk can be negative depending on the strength of the national "shadow" currency. Countries with strong shadow currencies earn breakup-insurance premia from the eurozone analog of "exorbitant privilege." Yield effects are quantitatively large for implied exit probabilities as low as 1%.

> "Will our debt be paid in euros or francs? … You will devalue the new franc by 20–30%." "Every [country] will pay with its own currency. … We will gain competitiveness, because the mark will appreciate and it is Germany who will suffer." (Presidential candidates Macron and Le Pen (TV debate, May 3, 2017))

I. Introduction

How likely are exits from the eurozone? Or an altogether breakup? Public debate about an exit or a breakup has been around since the sovereign debt crisis but has recently received more attention in the context of rising "euro-skeptic" sentiment. Financial markets have paid close attention: Abandoning the euro in favor of a national currency exposes sovereign bondholders to the risk of redenomination, that is, repayments in a new and potentially less valuable currency. This article outlines how this risk can be measured from asset prices, its evolution since the sovereign debt crisis, and which lessons periods of heightened risk convey about the implications of a potential exit or breakup. I show that quantifying redenomination

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risk has implications for understanding sovereign borrowing costs beyond risk-free rates and default risk.

Like conventional default risk, redenomination risk can raise sovereign yields above risk-free rates. However, by quantifying the evolution of redenomination risk in France and Italy in recent years, I show that such risk exists independently from better-studied default risk and is driven by entirely different forces.[1] By assessing its correlation with bond yields across the eurozone, I also document *eurozone-wide* breakup risk.

Unlike conventional default risk, it can lower sovereign yields below risk-free rates. I find that German, Austrian, and Dutch bonds are hedges for a eurozone breakup scenario. Market participants expect these countries to return to stronger national currencies, or form a stronger miniature union. Redenomination risk in these countries is *negative* and translates into sizeable "convenience yields." Thus, redenomination risk provides a novel perspective on "safety" in "safe" euro assets.

Analogous to a credit spread, I express redenomination risk in "yield terms," rather than an event probability, that is, as the annualized compensation demanded by bondholders for exposure. The measure is forward-looking and based solely on asset prices. I start with the difference between premiums on two types of sovereign credit default swaps (CDSs), only one of which covers the redenomination event. This so-called "ISDA basis" has been used by practitioners as a redenomination risk measure (e.g., Minenna (2017)). I show that it is an upward-biased measure of redenomination risk. I use synthetically matched controls to create a novel measure with a quantitatively interpretable magnitude. In comparison, the raw ISDA basis is typically off by a factor of 2. Since 2014, redenomination risk in French sovereign yields has long been close to 0, indicating a *mostly* stable monetary union. In the run-up to the presidential election in 2017, however, it reaches 26 bps, accounting for 40% of the total French credit spread. Using the term structure of redenomination risk, I estimate that this premium translates into a 1.08% risk-neutral probability of a French eurozone exit on the eve of the first election round, with an associated 18% depreciation of the new currency. The same decomposition using the raw ISDA basis yields an implausibly high event probability (68%) and close to zero depreciation. During the COVID-19 crisis, default and exit risk rise slightly, but exit risk remains at less than half the level seen in 2017.

For Italy, exit risk compensation rises to 85 bps (around 30% of the total credit spread) in 2018 around the formation of a "euro-skeptic" government. I estimate an implied depreciation of 29.7% and a redenomination probability of 2.6%. Exit risk remains at elevated levels, like default risk, until the fall of the coalition government in mid-2019. The quantitative measure also provides an estimate of the direct fiscal benefit to Italian taxpayers of commitment to the euro: The exit-driven rise in ex ante borrowing costs during the time of the first Conte government translates into a present-value debt service cost of €7.7 billion. French exit risk at the time is low,

[1]The headline results in Section III quantify redenomination risk from exits *in the absence of default*. Such exits are typically unlikely but can be as relevant for sovereign yields as the risk of default. The alternative measure in Section V captures exits with and without default. It covaries strongly with the baseline measure, suggesting that redenomination risk has been largely "political" rather than "debt-driven" since the sovereign debt crisis.

consistent with markets pricing the hypothetical Italian exit as an isolated event rather than a eurozone breakup. Indeed, sovereign yields across the eurozone are uncorrelated with Italian exit risk at the time.

The French election period paints an entirely different picture: Yields in Germany, Austria, and the Netherlands correlate negatively with French exit risk, whereas yields in Portugal, Italy, or Ireland rise with it. This pattern is consistent with markets pricing a French redenomination at the time as a *breakup* scenario in which all countries return to national currencies of heterogeneous value.

The results for German, Austrian, and Dutch bonds reveal sizeable convenience yields. In U.S. treasuries, these are often associated with money-like safety derived from "absolute security of nominal repayment" (Krishnamurthy and Vissing-Jorgensen (2012), p. 234). In contrast, redenomination-based convenience yields stem directly from the *state-contingent nominal* properties of affected bonds. Indeed, they are reminiscent of another explanation for the premium on safe dollar assets: the "exorbitant privilege" of the United States in international financial markets, which Gourinchas, Rey, and Govillot (2010) interpret as an insurance premium derived from dollar appreciation in bad times. Breakup-contingent redenomination into a strong shadow currency creates a similar effect for *some* euro assets. The estimated present value of these insurance premia to German taxpayers from as few as 11 bond issuances in Mar. and Apr. 2017 exceeds €100 million. Redenomination risk separates "convenience" from "insurance," thus informing the study of eurozone convenience yields (e.g., Jiang, Lustig, van Nieuwerburgh, and Xiaolan (2021)).

As a result, broadly defined convenience yields may serve as an alternative proxy for eurozone breakup risk that does not rely on "off-the-run" CDS. Indeed, the average convenience yield in Austrian, Dutch, and German bonds closely tracks French redenomination risk post 2014. A backward extension of this measure indicates that breakup risk during the sovereign debt crisis exceeded that around the French election by a factor of 3–4. A forward extension provides a useful proxy for ongoing real-time analysis.

Redenomination-based convenience yields vary across eurozone countries and touch several other questions in financial economics. Covered-interest-parity (CIP) violations, for instance, indicate that interest differentials from bond markets differ from those implied by currency swaps. These deviations from "arbitrage-free" prices are often used to quantify shadow prices on regulatory and other intermediary constraints (e.g., Du, Tepper, and Verdelhan (2018)). However, the CIP "arbitrage" is not redenomination proof: Redenomination-based convenience yields produce time-varying CIP deviations that are distinct from intermediation constraints and instead reflect a currency mismatch of the arbitrage trade in the breakup scenario.

Redenomination risk extends beyond sovereign and quasi-sovereign debt to deposits, household debt, and potentially corporate debt. Hence, it creates dispersion in the general interest environment within the eurozone. Intermediaries whose liabilities are subject to redenomination in their home country (e.g., deposits, insurance, or pension claims) either become home-biased (Battistini, Pagano, and Simonelli (2014)) or load up on redenomination risk. Home bias reinforces the sovereign-bank feedback loop (Acharya, Drechsler, and Schnabl (2014), Brunnermeier, Garicano, Lane, Pagano, Reis, Santos, Thesmar, van Nieuwerburgh, and Vayanos (2016a), and Farhi and Tirole (2018)) and implies dispersion in net interest margins earned by banks across the eurozone: Due to an effective lower bound on deposit rates, low-interest environments hurt bank profitability and dynamically weaken balance sheets, such that policy rate cuts can become contractionary (the "reversal rate" of Abadi, Brunnermeier, and Koby (2023)). Large manifestations of breakup risk therefore imply a spectrum of country-specific effective lower bounds on ECB policy.

Some intermediaries in countries with negative redenomination risk may instead limit home bias and "reach for yield" (Becker and Ivashina (2015)). Investing in higher-rate, foreign eurozone bonds exposes households to a pernicious form of foreign currency risk. Negative redenomination risk drives the profitability cost of home bias and, thus, the incentive to reach for yields.

The closest precedent to a eurozone exit is the dissolution of Czechoslovakia in 1992. Both countries subsequently kept the Czechoslovak crown for a period of 6 months. Anticipating an eventual depreciation of the new Slovak crown relative to the new Czech crown, deposits moved to Czech banks, prompting capital scarcity in the Slovak banking sector (Brocek (2018)), eventual capital controls, and an increasingly unsustainable transitory union. In Feb. 1993, existing Czechoslovak crowns became Czech or Slovak crowns at a 1-to-1 rate. The Slovak crown depreciated against the Czech crown by around 10% in 1993 (Lopatka (2011)).

Few other articles attempt to measure redenomination risk. De Santis (2019) studies the so-called quanto CDS spreads. These quanto spreads reveal the (risk-neutral) expectation of euro–dollar depreciation in the event of a *default.* The approach therefore does not disentangle the default event from the exit event and contains no information on the value of the national shadow currencies (see Appendix A for details). Krishnamurthy, Nagel, and Vissing-Jorgensen (2018) decompose eurozone sovereign yields into three components corresponding to default, redenomination, and market segmentation. In a related approach, Bayer, Kim, and Kriwoluzky (2018) measure redenomination risk by comparing the "CDS-bond basis" of foreign-law corporate bonds and domestic-law sovereign bonds. Both approaches differ starkly from mine in the identifying assumptions they rely on. In the interest of brevity, I defer a detailed comparison to Appendix IA.B of the Supplementary Material.[2]

I contribute to the literature on sovereign CDS and sovereign risk including Pan and Singleton (PS) (2008), Longstaff, Pan, Pedersen, and Singleton (2011), Reinhart and Rogoff (2011), Augustin (2014), Fontana and Scheicher (2016), Du and Schreger (2016), and Bahaj (2020). Like some of these articles, I use sovereign CDSs to learn about variations in sovereign risk. Unlike these articles, which study

[2]Two other articles follow my approach of using the ISDA basis: Cherubini (2021) estimates the redenomination–default correlation; Bonaccolto, Borri, and Consiglio (2023) focus on market-implied euro–dollar depreciation in the event of a eurozone exit during the COVID-19 crisis. Neither provides a quantitatively interpretable measure, but both corroborate the correlation-based result that French exit risk observed in 2017 was deemed breakup risk. Balduzzi, Brancati, Brianti, and Schiantarelli (2023) use CDS to study political risk without separating default from exit risk.

default risk, I find that the proximate drivers of redenomination risk are political events, rather than macroeconomic shocks or financial crises. The eurozone setting implies an increasingly relevant, political dimension of sovereign risk beyond the conventional decisions of default or devaluation. This new dimension links to the literature on populism and political risk (Pástor and Veronesi (2021), Guiso, Herrera, Morelli, and Sonno (2019)). Compared to political uncertainty indices (e.g., Baker, Bloom, and Davis (2016)), the market-based redenomination risk measure targets a specific policy action and has a quantitative economic interpretation.

Section II outlines when and how CDS can be used to measure redenomination risk. Section III describes the synthetic-control approach and quantifies redenomination risk in France and Italy. Section IV infers market-implied lessons on the potential exit scenarios from asset–price comovements with redenomination risk. Section V quantifies convenience yields for countries with strong "shadow currencies" and proposes an alternative real-time proxy of breakup risk.

II. Redenomination and Credit Default Swaps

A CDS is a bilateral contract wherein one party, in exchange for a periodic premium, provides insurance to the other against losses incurred by creditors of a particular borrower. Investors trade CDS contracts with different degrees of protection, that is, triggered by different credit events. For redenomination, the relevant contracts are those triggered by restructuring events, that is, with the so-called CR/CR14 doc clauses. Identifying redenomination risk starts with the difference between two simultaneously traded CDS contracts, one of which pays out in the event of redenomination, whereas the other does not. That difference is called the "ISDA basis."

For simplicity, consider a single-period (ending at T) CDS. Denote by $R_T \leq 1$ the recovery rate from a credit event at T, by q_T its (risk-neutral) probability, and by the indicator function its occurrence at T. Today's premium, $S_{0,T}$, is given by

$$S_{0,T} = e^{-rT}\mathbb{E}_0^{\mathbb{Q}}(\mathbb{1}_T(1-R_T)) = e^{-rT}q_T\mathbb{E}_0^{\mathbb{Q}}(1-R_T|\mathbb{1}_T=1). \tag{1}$$

To facilitate trading, CDSs use standardized terms, governed by the International Swaps and Derivatives Association (ISDA), which specify what exactly constitutes a credit event. ISDA periodically updates the standardized definitions (most recently in Sept. 2014). Contracts issued under the newer definitions are denoted by their restructuring clause as "CR14" (vs. "CR").

Most sovereign "defaults" are restructurings. One change in the 2014 ISDA definitions refers to the set of events that constitute a restructuring. Section 4.7(a) (v) of the ISDA definitions specifies "permitted currencies" into which debt can be redenominated without constituting a restructuring, that is, without triggering a CDS payout. In the 2003 version of the clause (CR),

> "Permitted Currency" means (1) the legal tender of any Group of 7 country […] or (2) the legal tender of any country which, as of the date of such change, is a member of the [OECD] and has a local currency long-term debt rating of AAA or higher […]. (ISDA (2003), pp. 32–33)

Instead, CDSs with the newer CR14 clause are triggered by

> … any change in the currency of any payment […] to any currency other than the lawful currency of Canada, Japan, Switzerland, the United Kingdom and the United States of America and the euro and any successor currency to any of the aforementioned currencies (which in the case of the euro, shall mean the currency which succeeds to and replaces the euro in whole). (ISDA (2014), p. 42)

The G7 includes France, Germany, and Italy. Redenominations of existing debt into new national currencies by these countries would therefore *not* trigger CDS payouts for CR contracts, but could for CR14 contracts. The second exemption in the 2003 definitions applies to OECD countries rated AAA *at redenomination.* The credit rating is endogenous to changes in redenomination risk (just like default risk), so this exemption does not imply that the ISDA basis of *currently* AAA-rated OECD countries captures redenomination risk (see Appendix B for a discussion).

To illustrate, suppose France and Spain were to leave the eurozone and redenominate outstanding bonds into new francs and new pesetas, respectively, with an (arbitrary) conversion rate of 1-to-1. This initial conversion rate is not, and cannot generally be, a market exchange rate: Since quantities in redenominated contracts scale with the conversion rate, this rate preserves the fixed exchange rate previously enforced by the currency union, scaled by an arbitrary constant. Yet the split of the currency union means each new currency has its own interest rate, inflation, and risk premium. If the expected real interest rate path is lower and/or the risk premium higher, the new currency has to depreciate relative to the initial conversion rate. In the absence of capital controls, it will do so immediately after the split. In an incarnation of the "Mundell–Fleming trilemma," redenomination therefore implies exchange rate gains or losses on redenominated contracts, unless the new currency's fundamental properties coincide with those of the common currency it replaces.

Suppose that the freely determined market exchange rates after the exit are 0.8€ per franc and 0.75€ per peseta and that the bonds trade at par in the new currencies. French CR14 contracts pay out 20% of the notional value, but CR contracts pay nothing, as the new currency (the franc) is that of a G7 country (France). For Spain, both contracts pay 25% of the notional. If the market exchange rate for either country is 1-to-1 or above, contracts on that country do not pay out.

Paying bondholders in a depreciated numéraire is economically equivalent to a nominal haircut (e.g., the Greek restructuring of 2012).[3] For the purposes of this article, however, the distinction is paramount, since the CDSs used for measurement treat the two events differently. Between default and redenomination, there are three mutually exclusive events: i) default without redenomination, ii) default with redenomination, and iii) redenomination without default. Since all CR contracts are triggered by events i) and ii), the ISDA basis can only distinguish event iii) from

[3]Legally, neither redenomination nor the Greek restructuring constitutes "default" since (amended) contractual obligations are met. For brevity, I will use the term "default" loosely to refer to a restructuring that changes the nominal quantity of payment rather than "only" the numéraire.

the union of i) and ii). If redenomination and default tend to coincide, this limits the informativeness of redenomination risk measures based on the ISDA basis. Precedent suggests that they do not coincide: Greece did not leave the eurozone following its default, and neither Slovakia nor the Czech Republic defaulted in the 1990s. However, Slovakia and the Czech Republic had little external debt to default on at the time of their split, and speculation about a Greek eurozone exit was widespread during the sovereign debt crisis. To put more structure on this question, consider two potential proximate causes of an exit: excessive debt versus dissatisfaction with the political union.

"Debt-driven" exit: A country may exit the EMU after a sovereign default causes its home-biased banking system to collapse, necessitating bailouts financed through seignorage. This scenario may be an apt characterization of redenomination risk during the sovereign debt crisis, or in Greece in the summer of 2015. The approach in Section III does not capture risks of this type of exit, since all CDSs are triggered by the initial default. Yet the approach *does* measure economically large instances of redenomination risk, so market participants must entertain other scenarios.

"Political" exit: "Euro-skeptic" sentiment in European electorates mirrors a global shift in political preferences away from multilateralism (Guiso et al. (2019)), often motivated by concerns about trade or immigration. These are not addressed by sovereign default. The opening quote suggests that monetary sovereignty can also improve domestic competitiveness at the expense of others. A country leaving the eurozone and the EU can abandon its rules on competition, fiscal deficits, or labor mobility, or (in the words of former UK Prime Minister Johnson) "*take back control of our laws, our money, and our borders.*" This type of exit is not necessarily linked to default, and the political preference may arise under weak or strong economic conditions (Pástor and Veronesi (2021)). It may further obviate the need for default by restoring the option of debt monetization as a historically popular substitute to default (Reinhart and Rogoff (2011)).

To streamline terminology, I will refer to default with or without redenomination as "default" (i.e., the union of events i) and ii) above) and to redenomination without default (i.e., event iii)) as "redenomination" or "stand-alone redenomination" when comparing directly to event ii). Denoting "default" and "redenomination" by respective superscripts D and R, the ISDA basis (in the absence of other frictions) reflects redenomination risk for eurozone-G7 countries:

$$\text{(2)} \quad \text{CR14}_{i,0,T} = e^{-rT}\left[q_{i,T}^{R}\mathbb{E}_0^{\mathbb{Q}}\left(1-R_{i,T}^{R}|\mathbb{1}_T^{R}=1\right)+q_{i,T}^{D}\mathbb{E}_0^{\mathbb{Q}}\left(1-R_{i,T}^{D}|\mathbb{1}_T^{D}=1\right)\right],$$

$$\text{(3)} \quad \text{CR}_{i,0,T} = e^{-rT}\left[\mathbb{1}_{i\notin G7}q_{i,T}^{R}\mathbb{E}_0^{\mathbb{Q}}(1-R_{i,T}^{R}|\mathbb{1}_T^{R}=1)+q_{i,T}^{D}\mathbb{E}_0^{\mathbb{Q}}(1-R_{i,T}^{D}|\mathbb{1}_T^{D}=1)\right],$$

$$\text{(4)} \quad ISDA_{i,0,T} := \text{CR14}_{i,0,T}-\text{CR}_{i,0,T} = e^{-rT}\,\mathbb{1}_{i\in G7}q_{i,T}^{R}\mathbb{E}_0^{\mathbb{Q}}\left(1-R_{i,T}^{R}|\mathbb{1}_T^{R}=1\right).$$

CDS payouts are nonnegative according to both sets of ISDA definitions. For redenomination, this means that the new currency depreciates from the arbitrary conversion rate. If markets expect, say, a new German mark to appreciate upon introduction, the frictionless ISDA basis is 0 and does not reflect negative redenomination risk in German bonds.

Equation (4) assumes that the clause on permitted currencies is the only difference between CR and CR14 contracts. It is not: Most notably, the CR14 also includes a clause known as "Asset Package Delivery" (or "APD"). This clause sets out the recovery computation for a restructured bond that is exchanged into a "package" of new securities, as was the case for Greece in 2012. Unlike the permitted currencies clause, the APD clause does not distinguish countries based on G7 membership. Section III lays out a synthetic control approach to disentangle the redenomination component of the ISDA basis from those related to other contractual changes or frictions.

III. The Redenomination Spread

A. Data

I collect daily CDS premia for dollar- and euro-denominated contracts with CR or CR14 doc clauses and maturities of 1, 5, and 10 years for Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Portugal, Spain, and the United Kingdom. This set of countries spans all eurozone and/or G7 members for which comprehensive time series are available, and adds Denmark due to its peg to the euro. The approach proposed in this section only allows for *direct* measurement of redenomination risk in Germany, France, and Italy. Measurement in these countries does not limit the *sources* of exit risk: The resulting time series capture whichever shocks, domestic or foreign, make redenomination in these countries more likely. Other eurozone and G7 countries provide a useful control for other drivers of CDS premia and help extract the redenomination component. Section IV further studies bond yields across the eurozone to infer variation in redenomination risk outside the three G7 countries. The sample starts in Sept. 2014 when the CR14 contracts were launched and ends in Nov. 2020. I focus on the 5-year maturity and dollar denomination as the most liquid benchmark contracts. Hence, the measure is interpretable as a dollar investor's cost of insuring against redenomination losses. Appendix A and Appendix IA.C of the Supplementary Material provide more detail on the role of currency denomination in CDS.

Since CDSs are traded over-the-counter, transaction prices are difficult to observe. However, Markit collects quotes from a range of dealers and reports consensus measures, which are widely used by market participants as an external valuation of their positions and for regulatory purposes. Data on particularly illiquid contracts are therefore akin to a survey among sophisticated intermediaries. Markit also reports the number of submitted quotes ("depth"). The average depth varies across countries from under 4 (Cyprus/Finland) to over 6 (Italy), with minor differences between the CR and CR14 contracts for any given country. Table 1 reports summary statistics for CR and CR14. Figure 1 plots 5-year CR14 premia (left) and ISDA bases (right) for a subset of countries (for readability). Figure IA.3 in the Supplementary Material shows all countries.

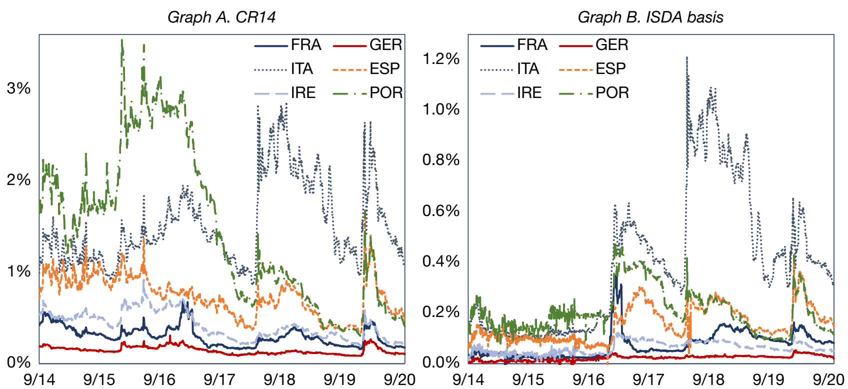
TABLE 1
CDS Premia: Sample Averages

Table 1 reports averages of CDS premia with 5-year maturity, the term structure slope (10y − 1y), and depth (number of submitted quotes), all collected from Markit. Premia for contracts under 2014 ISDA definitions are denoted by CR14. The ISDA basis is computed as CR14 − CR; the last column accordingly reports the difference in depth. The daily data run from Sept. 2014 to Nov. 2020. All numbers are expressed in percentage points. The first set of countries are the three eurozone G7 members, followed by other eurozone countries, Denmark (pegged to the euro), and the United Kingdom and Japan whose currencies are exempt from the redenomination clause in CR and CR14 contracts.

	CR14				CR14 − CR			
Country	USD 5y	USD 10y − 1y	EUR 5y	USD Depth	USD 5y	USD 10y − 1y	EUR 5y	ΔDepth
FRA	0.302	0.493	0.212	5.233	0.074	0.090	0.051	0.080
GER	0.146	0.275	0.095	4.346	0.023	0.032	0.017	0.077
ITA	1.517	1.353	1.234	6.679	0.394	0.231	0.317	0.426
AUT	0.195	0.336	0.134	4.732	0.025	0.023	0.020	−0.342
BEL	0.298	0.482	0.216	4.604	0.051	0.051	0.029	0.125
CYP	2.174	0.936	2.034	3.584	0.209	0.058	0.177	−0.063
ESP	0.742	0.875	0.571	6.082	0.156	0.145	0.111	0.054
FIN	0.180	0.309	0.134	3.790	0.017	0.019	0.014	−0.554
GRE	7.469	−4.854	6.665	4.534	0.680	−0.632	0.555	0.062
IRE	0.421	0.591	0.332	4.573	0.063	0.077	0.046	−0.281
NED	0.173	0.302	0.119	4.199	0.020	0.014	0.021	−0.202
POR	1.458	1.404	1.247	5.745	0.209	0.161	0.165	−0.777
DEN	0.156	0.277	0.115	4.181	0.018	0.020	0.014	−0.153
GBR	0.263	0.407	0.263	4.541	0.028	0.034	0.028	−0.287
JPN	0.312	0.498	0.304	5.211	0.024	0.033	0.029	−0.358

FIGURE 1
CR14 Premia and ISDA Bases

Figure 1 plots the 5-year USD-denominated CR14 CDS premia (Graph A) and ISDA bases (Graph B) for sampled countries, omitting some countries for readability. The ISDA basis is defined as $ISDA_{i,t} = CR14_{i,t} - CR_{i,t}$.



B. Synthetic Control: Cleaning Up the ISDA Basis

Graph B of Figure 1 suggests that the ISDA basis is an upward-biased measure of redenomination risk. Redenomination realistically only affects the ISDA basis for G7-eurozone countries (see Appendix B), but the basis is positive and volatile for many other countries, especially those with higher levels of credit risk, such as Spain or Portugal.

Other drivers of the ISDA basis include i) liquidity differences between the newer CR14 and the superseded CR contracts and ii) other differences in the two sets of ISDA definitions, like the APD clause. I discuss these confounders and more institutional detail in the introduction of the 2014 definitions in Appendix IA.A of the Supplementary Material. Unlike the clause on redenomination, none of these confounders distinguishes issuers based on G7 and eurozone membership. I therefore control for them by subtracting from each G7-eurozone ISDA basis the average ISDA basis of a matched set of control countries whose ISDA bases are not affected by redenomination.

1. Synthetic Matching

To isolate the redenomination-driven component of the ISDA basis in Germany, France, and Italy from components due to other differences between the two contracts, I construct synthetic matches for the three G7-eurozone countries from control countries in the spirit of Abadie and Gardeazabal (2003): On each day and for each treated country, the synthetic control is a weighted average of the ISDA bases of control countries such that the weights i) minimize the squared distance in four matching variables between treated country and synthetic control, ii) sum to 1, and iii) are nonnegative. Denote the sets of control countries and matching variables by J and Z, respectively. For treated country i, the synthetic control weights $w^i_{j,t}$ solve

$$\text{(5)} \qquad \min_{w^i_{j,t}} \sum_{z\in Z}\left[\left(\sum_{j\in J} w^i_{j,t} z_{j,t}\right) - z_{i,t}\right]^2$$

$$\text{(6)} \qquad \text{such that} \sum_{j\in J} w^i_{j,t} = 1 \text{ and } w^i_{j,t} \geq 0 \forall i,j,t.$$

Abadie, Diamond, and Hainmueller (2015) describe the synthetic control method and its mapping to the regression approach. The setting differs from conventional synthetic-control settings in one practical dimension. In the conventional setting, the difference in differences is across entities (e.g., countries) and *time*. My setting is purely cross-sectional, across countries and *contracts* (CR vs. CR14): One contract always insures against redenomination, whereas the other does not, but both are simultaneously observable. I can therefore match on *contemporaneous* variables (other than the CR contract), and form a time-varying match. Appendix IA.E of the Supplementary Material provides a more detailed mapping of concepts and tests used in conventional (i.e., pre-vs-post) diff-in-diff contexts.

What are the matching variables? The impact of the APD clause varies with overall default risk, since the clause affects the calculation of loss-given-default. The liquidity-driven component of the ISDA basis may instead correlate with a country's overall bond or CDS liquidity. The matching variables capture these dimensions: i) the CR14 premium, ii) the number of dealers quoting the CR14 ("depth"), iii) the 5-year sovereign bond yield, and iv) the bid–ask spread of this bond yield. I obtain daily time series for the two latter variables from Bloomberg. Since especially the bid–ask spread and depth occasionally exhibit erratic or weekday-related movements, I match a trailing 20-day average of variables

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(ii)–(iv). Just like pre-treatment variables in conventional settings, all of these variables are untreated in the sense that they are unaffected by the redenomination clause in the CR definitions. Compared to analogous exercises using a single benchmark country to account for market frictions (e.g., as in De Santis (2019)), this approach accounts for the natural cross-sectional and time-series variation of these frictions with country characteristics.

2. Identifying Assumption

The identifying assumption is that the impact of confounders on the ISDA basis is similar for the "treated" countries (G7 *and* eurozone), for which only one contract covers redenomination, and the synthetic control (G7 *or* eurozone, but not both), matched to the treated country on covariates.

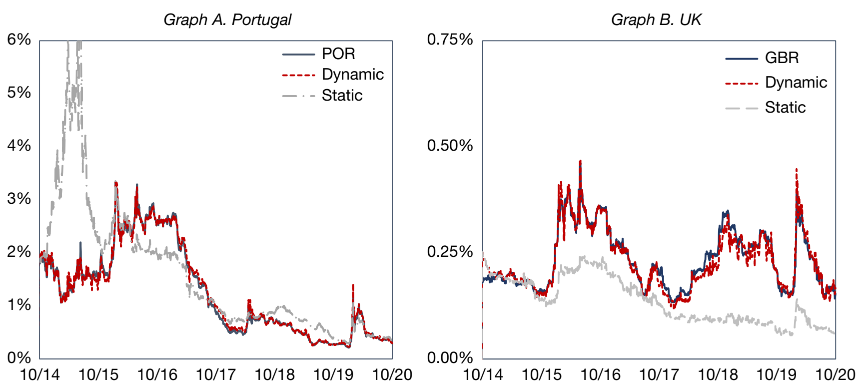
Naturally, this is untestable. What *is* testable, however, is whether the impact of those confounders is similar across control countries. Following Abadie and Gardeazabal (2003), I run a placebo test of whether the CR premium of one control country can be closely approximated by a synthetic control matched to that country. Recall that redenomination plays no role in the ISDA basis of any of these countries. Graph A of Figure 2 plots the observed CR premium and its synthetic counterpart for Portugal: The procedure produces a close fit, meaning that whatever drives the ISDA basis beyond redenomination risk does so in a way that is quantitatively similar across countries with similar levels of credit risk and liquidity as measured by the matching variables.

Treated countries are, by definition, G7 members, and perhaps non-G7 eurozone countries are an imperfect match, because G7 countries are systematically larger, which may produce differences in the ISDA basis. But since the ISDA bases of *some* G7 countries (those outside the eurozone) are not affected by redenomination risk, a part of the identifying assumption (that the ISDA basis does not vary systematically with G7 membership after conditioning on the matching covariates) is explicitly testable: Graph B of Figure 2 shows the same exercise for the United

FIGURE 2

Observed and Synthetic CR Premia

Figure 2 plots the 5-year CR CDS premia for Portugal (Graph A) and the United Kingdom (Graph B) along with two synthetic counterparts from the synthetic control procedure: using i) a dynamic match and ii) a static match formed at the start of the sample.



Kingdom. Again, the procedure accurately replicates the United Kingdom's CR premium from the CR premia of other control countries matched to the United Kingdom on the chosen covariates. Hence, these covariates evidently capture the relevant variation in the non-redenomination components of the ISDA basis.

The plots also show that dynamically adjusting the match is crucial for a close fit. Changing country characteristics translate into a changing ISDA basis for reasons other than redenomination risk: For instance, the APD clause makes the ISDA basis a function of the default probability. To isolate the redenomination component, the synthetic control has to resemble the targeted treatment country on those dimensions dynamically. The placebo tests in Figure 2 indicate that the approach accurately accounts for confounders in the ISDA basis. I define the *redenomination spread (RS)* as the following difference in differences:

$$(7)\quad \mathrm{RS}_{i,t} \equiv \mathrm{CR14}_{i,t} - \mathrm{CR}_{i,t} - \sum_{j \in J} w^{i}_{j,t}\left(\mathrm{CR14}_{j,t} - \mathrm{CR}_{j,t}\right) \approx \sum_{j \in J} w^{i}_{j,t}\mathrm{CR}_{j,t} - \mathrm{CR}_{i,t}.$$

For G7-eurozone member i, this is the gap between the synthetic, counterfactual CR contract which covers redenomination and the observed CR contract which does not. The approximation in equation (7) arises only on days t for countries i where the nonnegativity constraint in (6) prevents an exact matching, such that $\mathrm{CR14}_{i,t}$ is only approximately equal to $\sum_{j \in J} w^{i}_{j,t}\mathrm{CR14}_{j,t}$.

C. Redenomination Risk over Time

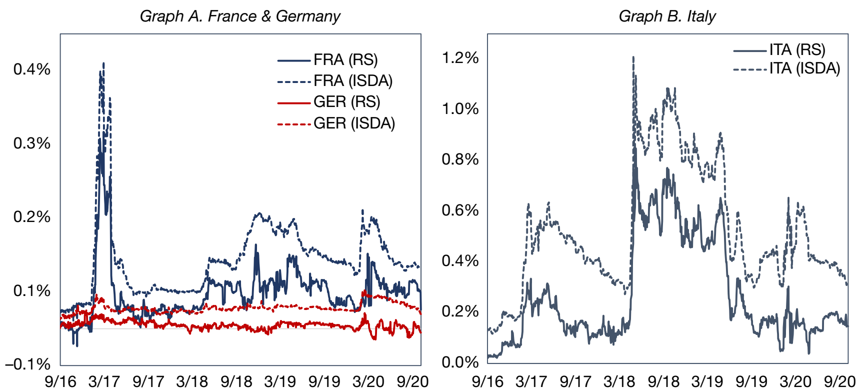
Figure 3 plots the redenomination spreads and ISDA bases for the three G7 eurozone members.

The synthetic control adjustment is quantitatively important: On average, the ISDA basis exceeds the redenomination spread by a factor of more than 2 for each country. Nonetheless, the adjusted quantities are economically large: French

FIGURE 3

Redenomination Spreads

Figure 3 plots the 5-year redenomination spreads for France, Germany (Graph A), and Italy (Graph B), along with their "raw" ISDA bases. For readability, I omit the first 2 sample years over which the three redenomination spreads are noisy but close to 0.



redenomination risk rises to 26 bps in Mar. 2017, at which point it accounts for 40% of the total French CR14 CDS premium. That is, in the run-up to the French presidential election, 40% of total sovereign risk priced in French CDS stems from the risk of a redenomination, not from conventional default risk. It is worth noting that the rise in observed redenomination risk coincides with a *cheapening* of CR contracts (Figure IA.3 in the Supplementary Material): Not only are markets pricing a scenario in which redenomination occurs without default (i.e., rising RS), the driver of this risk is *not* simultaneously linked to rising default risk (i.e., no rise in CR premia), thus signaling the risk of a "political exit" outside of a debt crisis.

For Germany, the measure is close to 0 throughout the sample, consistent with i) a zero probability of redenomination and/or ii) the expectation that the new currency would appreciate upon exit. Using CDS alone, the two are indistinguishable. Section IV outlines why bond prices instead point toward the latter explanation.

The Italian redenomination spread rises in 2017 around the French election, but spikes more substantially in May of 2018 to 85 bps, accounting for roughly one third of the total CR14 premium at the time.[4] Along with the spike in the redenomination spread, default risk (as measured by the CR premium) rises by around 1 percentage point, indicating an increased probability of both default (CR) and exit without default (RS). The redenomination spread remains above 50 bps until mid-2019 when it plummets to around 20 bps. The large spike in CDS premia during the COVID-19 crisis in Mar. 2020 is associated with some volatility but no sustained rise in redenomination risk.

Redenomination risk arises around political events, and these *happen to unfold* in France and Italy. This is not due to the focus on G7 eurozone members: If events like the Brexit referendum or the COVID-19 crisis drove eurozone breakup risk, it would show in the French and Italian redenomination spreads. The finding that neither, unlike elections, is associated with economically large exit risk separates this recent dimension of sovereign risk from the better-studied risk of default.

D. Separating Probabilities from Depreciation

Next, I disentangle probability and loss-given-event in the redenomination-specific insurance premium, similarly to PS (2008), separating default probabilities from loss-given-default. The following equation prices an M-year swap with semi-annual premium payments $\frac{1}{2}S$, recovery $R^{\mathbb{Q}}$, and arrival intensity $\lambda^{\mathbb{Q}}$ as

$$(8)\quad \frac{1}{2}S_{t,M}\sum_{j=1}^{2M}\mathbb{E}_t^{\mathbb{Q}}\left[e^{-\int_t^{t+j/2}\left(r_s+\lambda_s^{\mathbb{Q}}\right)ds}\right] = \left(1-R^{\mathbb{Q}}\right)\int_t^{t+M}\mathbb{E}_t^{\mathbb{Q}}\left[\lambda_u^{\mathbb{Q}}e^{-\int_t^{t+j/2}\left(r_s+\lambda_s^{\mathbb{Q}}\right)ds}\right]du.$$

[4]Coalition negotiations in May raised the question of a eurozone exit, and a draft coalition agreement was leaked to the media, citing as objectives the "introduction of specific technical procedures for single states to leave the eurozone and regain monetary sovereignty." A draft "Contract for the Government of Change" was published on May 15, 2018, available (in Italian) at https://www.huffingtonpost.it/2018/05/15/un-comitato-di-conciliazione-parallelo-al-consiglio-dei-ministri_a_23435353/.

The left-hand side of equation (8) is the present value of the expected premium payments received by the protection seller. The right-hand side is the present value of the expected payout received by the protection buyer, equal to 1 minus the recovery conditional on a credit event occurring before the expiration of the swap. The annualized premium S that solves equation (8) corresponds to the quoted swap premium. In PS (2008), this is a standard CDS premium, but the equation applies equally to a hypothetical contract that is triggered *only* by the redenomination event. In that case, the recovery is equal to the euro value of the redenominated bond divided by its original euro principal, driven by the depreciation of the new currency versus the euro. (This recovery is for a redenomination in the absence of default, so it is not affected by the APD clause nor by depreciation-upon-default.) S is the redenomination spread and $\lambda^{\mathbb{Q}}$ is the arrival intensity of the redenomination event.

To estimate the relevant parameters and link risk-neutral quantities to their counterparts under the physical measure, PS (2008) assume that the default intensity follows a log-normal process. Given the limited but heavy-tailed variation in observed redenomination risk, this approach is ill-suited for this particular setting. Instead, I separate probabilities from implied depreciation-upon-redenomination under the (dollar) risk-neutral measure.[5]

Like PS (2008), I use the term structure: I construct 10-year redenomination spreads using the same procedure as for the baseline 5-year measure. 5- and 10-year maturities are among the most liquid contracts and well suited to capture variation driven by the 5-year election cycles of Italy and France. Unlike PS (2008), I focus the estimation on variation across only 2 days (e.g., immediately before and after the French election) and assume that changes are driven by the event probability.

Redenomination spreads for two maturities on two dates pin down four unknown parameters. The key variables of interest are the event probabilities on each of the two dates and the depreciation of the new currency $(1-R^{\mathbb{Q}})$. As per the standard assumption, the recovery is constant. Expected interest rates are proxied by observable dollar OIS rates. I use the last degree of freedom to model the term structure of exit probabilities in the form of a proportional change in arrival intensities over the second 5-year period, using a factor κ such that $\lambda_{5\to10}=\kappa\lambda_{1\to5}$; $\kappa>1$ signals higher redenomination probabilities at horizons beyond 5 years.[6]

Starting with France, on Friday, Apr. 21, and Monday, Apr. 24, the 5 (10)-year RS are 20 (26) and 7 (9) bps, respectively. On the eve of the French election, I estimate a risk-neutral arrival intensity of $\lambda^{\mathbb{Q}}_{1\to5}=1.08\%$, which drops to $\lambda^{\mathbb{Q}}_{1\to5}=0.39\%$ after the election result is known. The implied (risk-neutral) depreciation of the new franc is 18.2%. I estimate $\kappa=1.671$, indicating that the annualized redenomination probability rises for horizons above 5 years (i.e., horizons including

[5]Quantities under different currency-specific $\mathbb{Q}$-measures are linked by the expected excess return in euros on the dollar-risk-free asset in the respective state: For example, if the dollar appreciates against the euro by $x\%$ in the exit event, the ratio of dollar-to-euro risk-neutral probabilities equals $(1+x\%)$ times the ratio of the two gross risk-free rates. See Appendix IA.C of the Supplementary Material for a formal exposition.

[6]To solve equation (8), I discretize the integral in semi-annual increments and then apply a nonlinear programming solver (`fmincon`) to obtain the four parameters of interest ($\lambda^{\mathbb{Q}}_t$, $\lambda^{\mathbb{Q}}_u$, $R^{\mathbb{Q}}$, and κ) from the observable inputs for dates t and u (four redenomination spreads $\text{RS}_{s,M}$, and four interest rates $r_{s,M}$ for $s=\{t,u\}$ and $M=\{5,10\}$).

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the subsequent election in 2022). For comparison, using the better-known raw ISDA basis, the same exercise yields an intensity of 67.73% with an implied depreciation of only 0.38%. These latter (implausible) results directly highlight the value of my novel measure and its quantitatively interpretable level. A similar exercise for Italy between the formations of the two Conte governments yields a depreciation-upon-exit of 29.7%. As of May 2018, the implied short-run arrival intensity is 2.6%, with a long-run intensity of 4.7%. At the formation of the successor government in Sept. 2019, the estimated short-term intensity is 0.81%.[7]

IV. Breakup Versus Isolated Exit

A eurozone breakup implies correlated risk across countries. Can we observe this risk for other countries than the G7-eurozone members? Appendix IA.F of the Supplementary Material lays out a simple model of the equilibrium comovements of different assets in response to breakup risk or isolated exit risk.

Equilibrium yield correlations with *breakup* risk are country-specific. As exemplified by the Czechoslovakian experience, anticipated depreciations of new national currencies induce capital flight out of fiscally and economically weaker countries and into stronger ones. The distinctive feature of a currency union is that there is no exchange rate to adjust, but only bond prices. Investors demand higher nominal yields on bonds which are likely to repay in a weaker numéraire.[8] The signature of breakup risk is that correlations of eurozone bonds depend on the expected relative value of the new national currencies. Instead, an isolated exit implies no such heterogeneity for the remaining eurozone bonds, which all repay in euros. This section considers asset–price comovements with observable redenomination risk to distinguish breakups from isolated exits.

A. Sovereign Bond Yields

This section studies cross-country correlation in redenomination risk. While redenomination risk is directly observable for only a few countries, it will manifest itself in the bond yields of all eurozone countries. Loosely speaking, yields contain three components:

$$(9) \qquad y_{j,T,t} \approx \text{RISK\_FREE\_RATE}_{,T,t} + \text{DEFAULT\_RISK}_{j,T,t} + \text{REDENOMINATION\_RISK}_{j,T,t},$$

where default risk includes the risk of joint default and redenomination. The risk-free rate component includes all euro-wide return components (e.g., a term

[7]On May 29, 2018, the attempt to form a technocratic caretaker government under former IMF-director Cottarelli fails; M5S and Lega resume negotiations for a populist government. The 5 (10)-year redenomination spread is 77 bps (1.04%). On Sept. 3, 2019, M5S members approve a new coalition with the pro-EU Democratic Party (PD); the redenomination spread is 24 bps (33 bps).

[8]And vice versa for strong numéraires: Brunnermeier, James, and Landau (2016b) argue that “a Greek euro will necessarily be worth less than a German euro. As long as Greek euros can be converted 1-to-1 into German euros, Greeks may […] withdraw their deposits […] and buy German Bunds” (p. 226).

premium and a currency premium). The redenomination spreads presented in Section III measure *positive* redenomination risk. If the last term is negative, it is not picked up by RS, but instead generates a "convenience yield" in countries for which market participants expect the new national currency to appreciate (see Section V).

I regress daily changes in sovereign yields (net of maturity- and currency-matched swap rates) on the changes in the 5-year redenomination spreads of France and Italy. Since default risk in France or Italy may correlate with redenomination risk, and default risk in other countries may correlate with French and Italian default risk, I control for the French and Italian 5-year CR CDS which reflect default but not redenomination risk.

The estimation of redenomination risk correlations focuses on event windows, in which political events coincide with large variation in redenomination risk, specifically before and after the first-round election in France and during the formation of the first Conte government in Italy. During these periods, the redenomination spreads exhibit large level changes and this focus avoids attenuation bias from the long periods with low risk but noise in daily changes. To this end, I interact the French and Italian redenomination spreads with an event dummy, which restricts the estimation of this coefficient to those periods while allowing for a separate estimation of the coefficients on the default risk controls over the whole sample. This implementation is analogous to standard practice in event studies on abnormal stock returns which use factor loadings estimated over a wider sample to separate "abnormal" returns from "normal" returns:

$$\Delta(y_{i,t} - \text{OIS}_{i,t}) = \alpha_i + \beta_{i,j} \times \Delta\text{RS}_{j,t} \times \mathbb{1}_{j,t} + \gamma_i \times \Delta\text{CR}_{j,t}^{\text{EUR}} + \varepsilon_{i,t} \quad (10)$$

for $j = \{\text{FRA}, \text{ITA}\}$. This exercise targets cross-country correlation in redenomination risk, which is directly observable for France and Italy. For these two countries, I therefore use these observable RS rather than bond yields to regress on the other country's RS. The comovements of different bond yields with observed redenomination risk in France and Italy reveal a striking pattern (Figure 4 and Table 2).

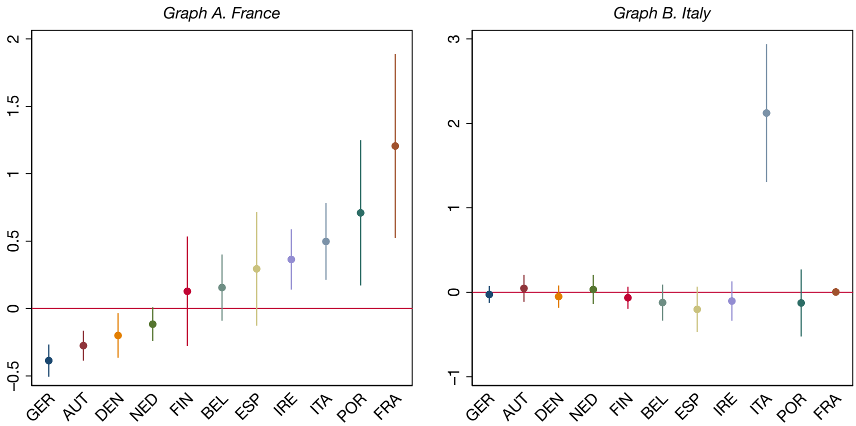
French redenomination risk is associated with significantly *lower* yields on German, Austrian, Danish, and Dutch bonds, but higher yields on Irish, Portuguese, and (unsurprisingly) French ones. For France and Italy, this exercise does not require bond yields as redenomination risk is directly observable. Regressing changes in RS_{ITA} on changes in RS_{FRA} reveals that Italian redenomination risk comoves positively with French risk during the election period. This result is consistent with the expectation of a breakup in the event of a French redenomination, after which the new currencies of Germany, Austria, or the Netherlands, as well as the then-depegged Danish krone appreciate against those of other eurozone members.

The range of coefficients multiplied by the level of RS_{FRA} (around 0.25%) indicates that redenomination risk creates cross-country yield dispersion of 0.4%. Since redenomination risk (especially that of a breakup scenario where the euro ceases to exist) extends to all redenominatable assets (e.g., mortgages, small-business loans, and potentially also corporate bonds), more persistent risk levels also translate into cross-country dispersion in net interest margins earned by banks

FIGURE 4

Sovereign Yields

Figure 4 plots slope coefficients $\widehat{\beta}_{i,j}$ from regression (10). The dependent variable for i = ITA (i = FRA) in Graph A (B) is $\mathbf{RS}_{\text{ITA}}$ ($\mathbf{RS}_{\text{FRA}}$). $\mathbb{1}_{\text{FRA}} = 1$ during Feb. 15 to Mar. 9 and Apr. 19–27, 2017, $\mathbb{1}_{\text{ITA}} = 1$ during May 11 to June 9, 2018 for Italy. Ninety-five percent confidence intervals are based on heteroskedasticity-robust standard errors. The full results are reported in Panels A and B of Table 2.



and, consequently, into dispersion in the expansionary effects of policy rate cuts (Abadi et al. (2023)).

No such pattern exists for Italy. Only Italian yields comove with Italian redenomination risk during the formation of the first Conte government. Other bond yields and directly observable French redenomination risk are uncorrelated with Italian redenomination risk during the government formation period. Since Italian default risk is moving at the same time, this exercise accounts for the correlation of yields with the Italian CR premium, which can be estimated over the full sample. This result bears the signature of an exit that market participants expect to be isolated, while all other bonds still repay in euros. There may nonetheless be a common effect on yields in other countries from portfolio substitution (cf. the model in Appendix IA.F of the Supplementary Material). In the case of an isolated exit by Italy, investors in eurozone bonds may shift investments out of Italian into, say, Spanish bonds, thus lowering Spanish yields. While none of the negative coefficients in Figure 4 are statistically significant, the largest magnitudes are those in Spanish and Portuguese yields.[9]

The sign and magnitude of sensitivities to breakup risk are determined by market expectations about the value of a country's national currency in a post-eurozone world. Figure IA.4 in the Supplementary Material plots the slope coefficients from Graph A of Figure 4 against various macroeconomic and fiscal

[9]Table IA.2 in the Supplementary Material shows that the takeaways from Figure 4 are robust to wider event windows and, in the French case, to the omission of the default risk control. This control is more relevant for Italy, where default risk and redenomination risk rise together. The results are similar using the unadjusted ISDA basis as a redenomination proxy, as daily variation is highly correlated between the ISDA basis and the redenomination spread. For the other exercises in this article, however, the level of bias in the ISDA basis makes it a poor measure of redenomination risk.

TABLE 2

Regression of Eurozone Sovereign Yields on RS and CR Premia

Table 2 reports the results for time-series regressions of eurozone (plus Denmark) 5-year sovereign bond yields net of swap rates on French and Italian redenomination spreads and default risk (Panels A and B). Panels C and D repeat the exercise with CR14 CDS premia as the dependent variable:

$$\Delta(y_{i,t} - \text{OIS}_{i,t}) = \alpha_i + \beta_{i,j} \times \Delta\text{RS}_{j,t} \times \mathbb{1}_{j,t} + \gamma_{i,j} \times \Delta\text{CR}_{j,t}^{\text{EUR}} + \varepsilon_{i,t}, \tag{10}$$

$$\Delta\text{CR14}_{i,t}^{\text{EUR}} = \alpha_i + \beta_{i,j} \times \Delta\text{RS}_{j,t} \times \mathbb{1}_{j,t} + \gamma_{i,j} \times \Delta\text{CR}_{j,t}^{\text{EUR}} + \varepsilon_{i,t}. \tag{11}$$

In Panel A, the dependent variable for i = ITA is $\text{RS}_{\text{ITA},t}$, and in Panel B, it is $\text{RS}_{\text{FRA},t}$ for i = FRA. The indicator equals 1 during the following event windows: Feb. 15 to Mar. 19 and Apr. 19–27, 2017 for France, and May 11 to June 9, 2018 for Italy. The parentheses contain t-statistics based on heteroskedasticity-robust standard errors. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The daily data run from Sept. 2014 to Nov. 2020.

	GER	AUT	DEN	NED	FIN	BEL	ESP	IRE	ITA	POR	FRA
Panel A. Yields and French Redenomination Risk, Regression (10))											
$\hat{\beta}_i$	−0.386***	−0.275**	−0.200*	−0.116	0.128	0.156	0.294	0.364***	0.497***	0.710***	1.205***
	(−6.33)	(−4.85)	(−2.37)	(−1.82)	(0.62)	(1.24)	(1.37)	(3.20)	(3.44)	(2.59)	(3.46)
$\hat{\gamma}_i$	−0.223***	0.271**	−0.090	0.098	0.250**	0.534***	1.843***	0.695***	0.544***	2.939***	0.609***
	(−2.82)	(2.51)	(−0.99)	(1.44)	(2.44)	(6.94)	(9.96)	(7.60)	(2.83)	(9.18)	(7.41)
N	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,585	1,604	1,604
Panel B. Yields and Italian Redenomination Risk, Regression (10))											
$\hat{\beta}_i$	−0.026	0.047	−0.051	0.033	−0.064	−0.122	−0.202	−0.103	2.122***	−0.126	0.004
	(−0.51)	(0.58)	(−0.76)	(0.37)	(−0.96)	(−1.12)	(−1.47)	(−0.87)	(5.10)	(−0.62)	(0.33)
$\hat{\gamma}_i$	−0.086***	0.023	−0.067***	−0.014	0.006	0.095***	0.496***	0.140***	1.242***	0.736***	0.012
	(−5.50)	(0.98)	(−3.91)	(−0.85)	(0.41)	(5.53)	(13.96)	(6.36)	(14.00)	(12.94)	(1.31)
N	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,587
Panel C. CDS Premia and French Redenomination Risk, Regression (11)											
$\hat{\beta}_i$	0.006	0.088**	0.002	0.010	−0.034	0.040	0.246	0.205***	0.882***	0.562	0.959***
	(0.15)	(1.82)	(0.10)	(0.40)	(−1.59)	(0.51)	(1.31)	(2.71)	(3.89)	(1.32)	(8.79)
$\hat{\gamma}_i$	0.191***	0.270***	0.124***	0.165***	0.128***	0.630***	2.184***	0.869***	3.792***	3.229***	0.872***
	(6.39)	(4.59)	(4.41)	(4.02)	(3.80)	(4.89)	(9.59)	(6.24)	(7.02)	(9.47)	(14.36)
N	1,598	1,602	1,604	1,604	1,582	1,604	1,604	1,604	1,604	1,604	1,600
Panel D. CDS Premia and Italian Redenomination Risk, Regression (11)											
$\hat{\beta}_i$	−0.016*	−0.017	−0.020*	0.000	−0.080*	−0.028	−0.141	−0.049	1.163***	0.005	0.006
	(−1.84)	(−1.53)	(−1.71)	(0.01)	(−1.73)	(−1.01)	(−1.11)	(−1.42)	(3.63)	(0.07)	(0.28)
$\hat{\gamma}_i$	0.029***	0.042***	0.021***	0.023***	0.022***	0.109***	0.524***	0.151***	1.177***	0.779***	0.113***
	(6.59)	(4.87)	(4.24)	(3.47)	(3.62)	(5.29)	(14.50)	(6.87)	(27.46)	(14.92)	(7.74)
N	1,600	1,604	1,606	1,606	1,584	1,606	1,606	1,606	1,606	1,606	1,600

fundamentals. Sovereign debt, current account balance, and budget surplus (all scaled by GDP) each linearly account for meaningful shares of the cross-country variation in $\widehat{\beta}_{\mathrm{FRA}}$.

B. The Value of the Euro in an Exit Scenario

While the most liquid CDSs on European sovereigns are denominated in dollars, CDSs are also traded in euros. The relative difference between the dollar and euro premia directly reveals the risk-neutral expectation of the euro–dollar depreciation conditional on a credit event, as well as the time-series covariance between the event risk and the exchange rate (Lando and Nielsen (2018)). For the default event, Mano (2013), Augustin, Chernov, and Song (2020), Della Corte, Jeanneret, and Patelli (2023), and others use this so-called quanto spread to study the interaction between default and currency risk.[10] Denoting the value of a euro in dollars by e_t, single-period quanto redenomination spreads reveal implied euro–dollar depreciation-upon-redenomination (cf. Appendix A):

$$\text{(12)} \qquad \frac{\mathrm{RS}_{i,t}^{\$} - \mathrm{RS}_{i,t}^{\mathrm{EUR}}}{\mathrm{RS}_{i,t}^{\$}} = \mathbb{E}^{\$}\left(1 - e_{t+1}/e_t \,|\, \mathbb{1}_{i,t+1}^{R} = 1\right),$$

where the indicator denotes redenomination in G7 country i at $t+1$. This number differs from the recovery rates estimated earlier as it relates to a different exchange rate. The earlier recoveries depend on the depreciation of the *new, national* currency against the euro at the exit (precisely: between the redenomination and the bond auction conducted by ISDA to determine recoveries). Instead, the quanto spread reflects the covariance of the *euro–dollar* exchange rate with redenomination risk. Backed-out from multi-period CDSs, the quanto spread does not translate cleanly into a euro–dollar depreciation at redenomination: If future changes in redenomination risk are correlated with the exchange rate, the quanto spread will be nonzero even if the expected euro–dollar depreciation *at* redenomination is 0 (see Lando and Nielsen (2018) for details).

With this caveat, the average relative quanto spread (the left-hand side of equation (12)) for France during the election period is 36%, with low time-series variance. On the eve of the first round, the quanto spread is 33%. In comparison, the average over the Italian event period is 17%. In the spring of 2017, the quanto measure fluctuates substantially, indicating noise in the measurement of particularly the euro-based redenomination spread, which is based on the less liquid euro-CDS contracts. Taken at face value, these numbers loosely indicate that the market-implied euro–dollar depreciation in the event of a French exit is around twice that in the event of an Italian one.

To complement the CDS-based, direct measure of euro–dollar depreciation, I perform a similar event study as for sovereign yields, using changes in the log euro–dollar exchange rate as the dependent variable. Formally, I estimate

[10]Unrelated to sovereign CDSs, Kremens and Martin (2019) show how expected currency movements under the *physical* measure can be inferred from quanto derivatives on *equity indices.*

TABLE 3

Regression of €/$ FX Rates on French and Italian Redenomination Spreads

Table 3 reports the results for time-series regressions of log exchange rate changes on French and Italian redenomination spreads, controlling for default risk and 10-year OIS swap rates:

$$(13) \quad \Delta\log(e_t) = \alpha + \sum_i \beta_i \Delta RS_{i,t} \mathbb{1}_{i,t} + \sum_i \gamma_i \Delta CR_{i,t}^{EUR} + \sum_j \delta_j \Delta OIS_{j,t}^{10y} + \varepsilon_t.$$

The exchange rate is defined such that increases reflect an appreciation of the euro. I report *t*-statistics in parentheses, based on heteroskedasticity-robust standard errors. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Column 1 omits the control for default risk, and column 3 uses the following wider event windows for the indicator: For France, the event window now spans the whole pre-election period from Feb. 15, 2017 to Apr. 27, 2017 after the first round. For Italy, it spans the entire first Conte government, from May 11, 2018 to Sept. 3, 2019.

	1	2	3
$\Delta RS_{FRA,t} \mathbb{1}_{FRA,t}$	−0.077***	−0.077***	−0.058**
	(−3.69)	(−3.87)	(−2.32)
$\Delta RS_{ITA,t} \mathbb{1}_{ITA,t}$	−0.034***	−0.041***	−0.026***
	(−4.31)	(−3.62)	(−2.82)
$\Delta CR_{FRA,t}^{EUR}$		−0.052*	−0.052
		(−1.70)	(−1.66)
$\Delta CR_{ITA,t}^{EUR}$		0.012**	0.012**
		(1.98)	(2.01)
ΔOIS_t^{EUR}	0.055***	0.057***	0.057***
	(7.03)	(7.25)	(7.21)
ΔOIS_t	−0.042***	−0.041***	−0.041***
	(−8.77)	(−8.81)	(−8.74)
N	1,606	1,604	1,604

$$(13) \qquad \Delta\log(e_t) = \alpha + \sum_i \beta_i \Delta RS_{i,t} \mathbb{1}_{i,t} + \sum_i \gamma_i \Delta CR_{i,t}^{EUR} + \sum_j \delta_j \Delta OIS_{j,t}^{10y} + \varepsilon_t,$$

for $i \in \{FRA, ITA\}$, $j \in \{EUR, \$\}$, and the same indicators as in regression (10). Table 3 reports the results. The euro depreciates with increases in both French and Italian redenomination risk, consistent with the positive quanto spreads. Further, the relative magnitudes of the β-coefficients are in line with those of the quanto spreads, with a ratio close to 2:1. While this result does not directly point to a breakup or an isolated exit, it indicates that the French election in 2017 posed a more severe threat to the value of the euro than the Italian government formation in 2018.

Strictly speaking, the empirical results in this section do not identify whether the breakup that is priced around the French election is *caused* by France, or whether France would only ever exit in a general breakup. The importance of the question nonetheless invites a speculative discussion, which I defer to Appendix IA.H of the Supplementary Material. To summarize, the setting from which these results are obtained points toward a cautious interpretation that causality runs from the French election to the breakup.

The results show unambiguously, however, that the event of a French redenomination is priced as coinciding with a eurozone breakup. For Italy, I find no evidence of a similar relationship regardless of causality. They also show that other events in the sample, like the Brexit referendum or COVID-19, did *not* translate into redenomination risks of comparable magnitudes. The type of political risk reflected in my measure is a recent phenomenon, and exits have so far remained unprecedented and unlikely. My results provide a rare window into the perception of these tail events by financial markets.

V. Negative Redenomination Risk

A long literature following Krishnamurthy and Vissing-Jorgensen (2012) studies convenience yields in U.S. treasuries. These are typically associated with money-like safety, collateral quality, or liquidity. A country whose national shadow currency is deemed stronger than the euro earns a similar convenience yield, albeit derived from the bonds' hedging properties for the breakup event rather than money-like convenience. These premia mirror the insurance interpretation of the "exorbitant privilege" derived by the United States from the safe haven properties of the U.S. dollar in the global financial system (Gourinchas et al. (2010)). This section examines redenomination-driven convenience yields. When these become economically large, they distort the measurement of risk-free rates from default-free sovereign yields. This insight is relevant to monetary policy transmission and the interpretation of negative sovereign yields in the eurozone. On the fiscal side (in the absence of an exit), these premia represent a benefit to taxpayers, while positive redenomination risk implies incremental debt service costs.

A. Redenomination Risk and Convenience Yields

Jiang et al. (2021) study the cross section of convenience yields in eurozone sovereign bonds using spreads between bond yields and CDS, the so-called CDS-bond basis. Redenomination exposure of some eurozone sovereigns translates into changes in the CDS-bond basis. Identifying and studying redenomination risk, therefore, complements the study of eurozone convenience yields à la Jiang et al. (2021) as it separates hedging from convenience as the source of the yield reduction.

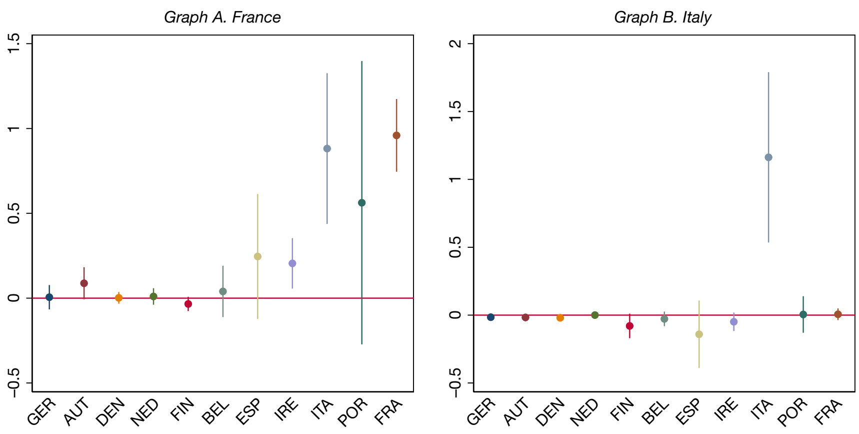
I repeat regression (10) with euro-denominated CR14 CDS premia as the dependent variable. For all countries, these premia measure the sum of default risk and the positive part of redenomination risk, that is, $\text{CR14}_{j,t} \approx \text{DEFAULT\_RISK}_{j,t} + [\text{REDENOMINATION\_RISK}_{j,t}]^{+}$. Figure 5 plots the slope coefficients, which show that the negative relationship between French redenomination risk and German, Austrian, Dutch, and Danish *bond yields* is absent from their *CDS premia.* (The estimates for Germany, Austria, and Denmark are statistically different from those in Figure 4, but the 95% confidence intervals overlap for the Netherlands.) For Italy, on the other hand, the cross section of CDS premia is just as uncorrelated with redenomination risk as the yields in Figure 4.

Convenience yields arising from negative redenomination risk offer a potential alternative in measuring eurozone breakup risk. Figure IA.4 in the Supplementary Material shows that debt to GDP, fiscal surplus, and current account balance are closely related to the sensitivity of a country's yields to breakup risk. An additional country characteristic that may play a role is geography: Austrian yields respond similarly to Dutch and German ones, despite the higher debt-to-GDP ratio and lower fiscal and trade surpluses. It is conceivable that the implied strength of the Austrian shadow currency reflects the expectation of a miniature currency union of the three contiguous countries following a eurozone breakup. The variables in Figure IA.4 in the Supplementary Material are highly persistent, as is geography,

FIGURE 5

CDS Premia

Figure 5 mirrors Figure 4, plotting coefficients of daily changes in CR14 premia, rather than yields, on changes in French (Graph A) and Italian (Graph B) redenomination spreads along with heteroskedasticity-robust 95% confidence intervals. The full results are reported in Panels C and D of Table 2.



suggesting that the cross-country distribution of exposures to breakup risk may be extrapolated from my sample to the sovereign debt crisis in the past, and to hypothetical events in the future.

The convenience yields of those three countries (measured by their CDS-bond bases) may therefore provide an approximate measure of breakup risk before CR14 contracts were introduced and after CR contracts cease trading. Using equation (9), the CDS-bond basis can be written as

$$(14) \qquad \begin{aligned} \text{CDS\_BOND\_BASIS}_{i,t} &\equiv \text{CDS}^{\text{EUR}}_{i,t} - (y_{i,t} - \text{OIS}^{\text{EUR}}_t) \\ &\approx -[\text{REDENOMINATION\_RISK}_{i,t}]^{-}. \end{aligned}$$

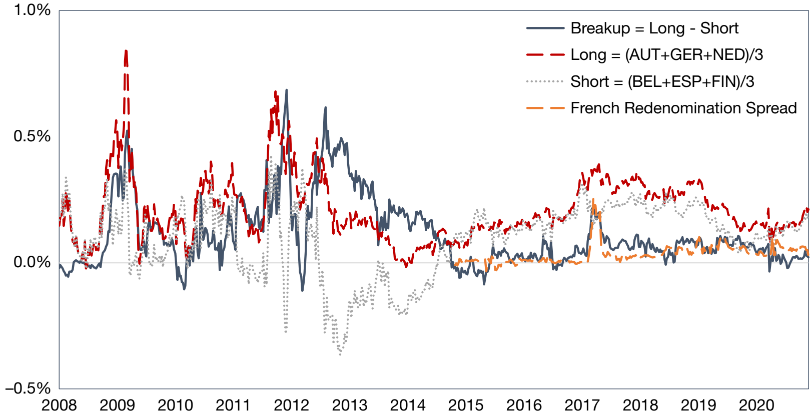
The above holds only approximately since the CDS-bond basis also deviates from 0 for potentially time-varying reasons relating to arbitrage frictions and regulation-driven demand (Mitchell and Pulvino (2012), Klingler and Lando (2018), Bai and Collin-Dufresne (2019), and Augustin and Schnitzler (2021)). One approach to account for this variation is to subtract the same average for the three countries with statistically zero yield comovement with French redenomination risk (Belgium, Finland, and Spain). Figure 6 shows that the CDS-bond basis is volatile and typically positive for both groups, with a high correlation across groups post 2014. Interestingly, their difference (solid, blue) closely tracks the French RS (dashed, orange): The weekly correlation is 0.61 and statistically significant; the standard deviations differ by less than a basis point.[11]

[11]The similarity in *levels* is somewhat coincidental: One measure reflects the strengths of German, Austrian, and Dutch shadow currencies, and the other reflects the weakness of the French one, each relative to the euro. This coincidence does, however, indicate that the exit probability estimated from the French redenomination spread (around 1.08% for $RS = 0.21$ in Apr. 2017) can be used for loose extrapolations of implied breakup probabilities in the pre-2014 sample.

FIGURE 6

CDS-Bond Bases

Figure 6 plots the average CDS-bond basis described in equation (14) for Germany, Austria, and the Netherlands ("Long") and the average for Belgium, Finland, and Spain ("Short"), along with the difference between the two ("Breakup" = Long − Short) and, for comparison, the French redenomination spread from Section III (only available from Sept. 2014 onward).



The similarity in the bond-basis measure and the French redenomination spread suggests that breakups with default (reflected in the bond-basis measure but not in the redenomination spread) are not a key driver of total breakup risk since 2014. An exception is the 2016 Brexit referendum, which is associated with a short-lived spike in the bond-basis measure, indicating a (minor) risk of a breakup with default, while the redenomination spread signals no risk of a breakup without default.

Relative to the redenomination spreads from Section III, the key limitation of the bond-basis measure of breakup risk is that it is potentially confounded by cross-sectional differences in other drivers of convenience yields or in the pricing impact of arbitrage frictions on the CDS-bond basis. Particularly, German bonds may earn convenience yields from other sources, but the measure looks similar excluding Germany (Figure IA.5 in the Supplementary Material); the correlation between the two versions is 0.98.

Its advantage is that it captures redenominations that coincide with default: As a result, this measure may be a useful proxy for overall redenomination risk during the sovereign debt crisis, where this measure is observable, while the redenomination spread is not, as the latter requires two simultaneously observable types of CDSs.

While both CR14 and CR contracts are observable, combining the two measures allows for an explicit separation of default-driven from political exit risk (e.g., the minor variation around the Brexit referendum). During the sovereign debt crisis, the bond-basis measure indicates breakup risk of around 3–4 times the magnitude seen around the French election, that is, implied probabilities close to 4%. The measure is volatile during the crisis period, mostly due to the "short leg" which, under the identifying assumption, only contains frictions common to both groups: The short leg turns negative in 2012, perhaps due to doubts about a sovereign default triggering CDS (see Appendix IA.D.3 of the Supplementary Material). This friction lowers the CDS-bond basis (more) for higher-risk countries, biasing this breakup-risk proxy upward prior to the Greek restructuring.

Since redenomination risk is country-specific, the resulting convenience yields are common across sovereign and quasi-sovereign issuers. Appendix IA.G of the Supplementary Material documents how CIP deviations constructed using Bund and KfW yields are driven by *common* variation in convenience yields for both issuers over the subsample of heightened redenomination risk. For a more general study of the role of country-specific convenience yields in CIP deviations, see Augustin, Chernov, Schmid, and Song (2023).

B. Fiscal Cost and "Exorbitant Privilege"

A quantitative measure of redenomination risk can also be used to estimate the overall fiscal consequences of redenomination risk for sovereign bond issuers. For instance, the above results suggest that the German treasury collects insurance premia in the form of interest savings on newly issued debt. The role of Germany as an insurance provider against redenomination risk can be viewed in analogy to the role of the United States as a provider of safe assets and the U.S. dollar as the reserve currency within the global financial system, which has been described as an "exorbitant privilege" by French then-Minister of Finance, Valéry Giscard d'Estaing in the 1960s, and is interpreted as that of an insurance provider by Gourinchas et al. (2010).

To estimate the impact of French redenomination risk on the whole term structure of German yields, I repeat regression (10) for yields of various maturities (Table 4). I then compute counterfactual yield savings over the first 4 months of 2017, as if the French redenomination spread were 0 throughout. For each maturity T, I define $c_{t,T} = \widehat{\beta}_T \text{RS}_{\text{FRA},t}$. As a flipside to the exorbitant privilege, I can also estimate the direct cost to French and Italian taxpayers from redenomination risk over the respective relevant period. To this end, I use the directly computed euro-denominated redenomination spreads with maturities of 1, 5, and 10 years as proxies for $c_{t,T}$. Since the euro-denominated contracts (particularly the 1-year maturity) are less liquid than the 5-year dollar contracts, these are generally noisier than the headline measures from Section III. I smooth the series using 2-week moving averages.[12] For each issuance (excluding inflation-linked bonds), I then multiply $c_{t,T}$ by the issuance volume, $v_{t,T}$ and capitalize the interest cost/saving over the maturity of the bond with an annuity factor to obtain $C_{t,T} = c_{t,T} \cdot v_{t,T} \cdot a\left(T, y_{t,T}\right)$.[13]

Table 4 reports this back-of-the-envelope estimation: From Jan. to Apr. 2017, French taxpayers incurred a present-value cost from redenomination risk totaling €300 million. The cost to Italian taxpayers from eurozone breakup risk around the French election totals €928 million. Elevated redenomination risk during the

[12]See Figure IA.6 in the Supplementary Material. Whenever RS < 0, I set it to 0 to limit the impact of measurement error.

[13]This exercise assumes that the choice of maturity and issuance volume is fixed. If countries adjust issuance volume and/or maturity, the estimate will be biased downward. I thank Andrea Vedolin for pointing this out.

TABLE 4

Fiscal Cost and "Exorbitant" Privilege

Table 4 reports the results for a back-of-the-envelope calculation of the interest cost (savings) incurred by German, French, and Italian taxpayers as a result of redenomination risk. For German and French estimates, these relate to bonds issued during the first 4 months of 2017 (redenomination risk around the French election). For Italy, they relate to bonds issued immediately before and during the first Conte government (May 2018 to Sept. 2019). Each panel reports the issuance volume over the relevant period and the present value of estimated cost savings by maturity. The 30-year column includes issuances with longer maturities. For Germany, estimates are based on time-series regressions of German sovereign bond yields net of swap rates on French redenomination spreads and default risk, for yields of various maturities:

(15) $$\Delta(y_{i,t,T} - \mathrm{OIS}_{i,t,T}) = \alpha_{i,T} + \beta_{i,T} \times \Delta \mathrm{RS}_{\mathrm{FRA},t} \times \mathbb{1}_{\mathrm{FRA},t} + \gamma_{i,T} \times \Delta \mathrm{CR}^{\mathrm{EUR}}_{\mathrm{FRA},t} + \varepsilon_{i,t,T}.$$

The indicator equals 1 during the same event window as in regression (10). The parentheses contain *t*-statistics based on heteroskedasticity-robust standard errors. Asterisks are omitted for readability. All estimates differ from 0 with *p*-values <0.05. The daily data run from Sept. 2014 to Nov. 2020. For France and Italy, they are obtained from nonnegative euro-denominated redenomination spreads of 1, 5, and 10-year maturity, computed using the same procedure as the headline measure. Spreads are linearly interpolated for other maturities <10 years and set equal to the 10-year spread for longer maturities.

Maturity (y)	1	2	3	4	5	7	10	15	20	30
Panel A. Germany (Jan. to Apr. 2017)										
$\widehat{\beta}_T$	−0.498	−0.553	−0.455	−0.418	−0.386	−0.313	−0.300	−0.301	−0.253	−0.292
	(−7.16)	(−9.04)	(−9.04)	(−8.02)	(−6.33)	(−7.05)	(−7.96)	(−6.16)	(−3.92)	(−3.93)
$\widehat{\gamma}_T$	−0.254	−0.234	−0.235	−0.233	−0.223	−0.226	−0.253	−0.161	−0.167	−0.174
	(−3.00)	(−3.36)	(−3.10)	(−3.36)	(−2.82)	(−2.88)	(−3.33)	(−2.23)	(−2.50)	(−2.39)
No. of obs.	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604
Issuances	3	4	—	—	3	—	8	—	—	5
Volume (€m)	4,808	14,289	—	—	9,621	—	13,950	—	—	3,024
Costs (€m)	3.6	14.7	—	—	26.3	—	43.3	—	—	31.0
Panel B. France (Jan. to Apr. 2017)										
Issuances	17	—	4	—	6	—	6	3	2	5
Volume (€m)	28,754	—	15,538	—	12,416	—	18,871	7,678	4,543	4,914
Costs (€m)	14.7	—	30.9	—	40.8	—	93.0	58.7	34.2	27.8
Panel C. Italy (Jan. to Apr. 2017)										
Issuances	15	8	10	2	10	18	10	4	6	4
Volume (€m)	52,498	10,550	15,914	1,000	14,744	25,145	14,363	3,787	4,246	2,267
Costs (€m)	68.6	31.7	61.2	8.3	109.2	246.5	170.1	95.3	84.1	53.3
Panel D. Italy (May 2018 to Aug 2019)										
Issuances	60	32	26	—	54	48	32	14	10	4
Volume (€m)	207,134	40,787	40,318	—	54,577	49,054	48,311	9,952	6,768	2,800
Costs (€m)	512.4	248.3	459.7	—	1,353.8	1,600.5	2,009.1	620.2	573.6	282.9

first Conte government (and its formation) resulted in an additional fiscal cost of €7.7 billion. For comparison, if redenomination risk remained indefinitely at the levels observed during the first Conte government (around 0.5% in euro-denominated redenomination spreads) the 2020 debt level of €2.6 trillion would translate into *annual* extra debt service costs of €13 billion relative to a counterfactual full commitment to an "irreversible" currency union.

German taxpayers, on the other hand, earned interest *savings* with a present value of €119 million between Jan. and Apr. 2017. Over €100 million of this total are attributable to March and April, with 11 bond issuances of €24 billion in face value. These costs and savings, some of which may appear minuscule in relation to the trillions of euros of outstanding sovereign debt, are incurred only on debt issued in a short period, over which the actual event probabilities have still remained low at a few (single-digit) percentage points. The economically large consequences of such small probabilities highlight the need for investors, politicians, and electorates alike to understand the fiscal implications of changes in borrowing costs following a eurozone exit or breakup.

VI. Conclusion

I document eurozone redenomination risk during the years following the sovereign debt crisis, using a directly observable quantitative measure. The measure captures the risk of eurozone exits in the absence of default and therefore speaks to "politically motivated" exits from the currency union. Empirically, this new dimension of sovereign risk has gained importance with the rise of euro skepticism since the sovereign debt crisis.

A direct measure is only available for Germany, France, and Italy, but reflects variation in eurozone exit risk irrespective of whether this is driven by national, eurozone-wide, or global shocks. French redenomination risk accounts for 40% of the total credit spread ahead of the 2017 presidential elections. Italian redenomination risk correlates strongly with the French measure during that time, but is also high during the coalition government formed in 2018. For Germany, the direct measure and comovement of bond yields with French exit risk suggest that from a bondholder's perspective redenomination into a new German currency creates exchange rate *gains.*

The observed levels indicate small probabilities of a eurozone exit, but large devaluations of the national currencies thereafter. Despite the small probabilities, the observed episodes provide insights into future incidences of redenomination risk: Breakup risk induces heterogeneous bond movements across the eurozone according to the expected strength of the national currency. This pattern arises around the French 2017 election, but not during the later Italian episode.

Like German bonds, Austrian and Dutch bonds appreciate in anticipation of repayment in a stronger numéraire. When breakup risk rises, these countries earn "convenience yields," reflecting insurance premia derived from state-contingent appreciation. In summary, this article quantifies how, 2 decades after the launch of the monetary union, national politics and the economics of shadow currencies continue to leave a mark on the euro.

Appendix A. Credit Events and Quanto Spreads

Appendix A describes different combinations of eurozone sovereign CDS, which are traded in two currency denominations (euro and dollar) and two different doc clauses (CR and CR14). Different within-country spreads correspond to different dimensions of sovereign risk.

a) QUANTO (CR) $= \mathrm{CR}^{\$} - \mathrm{CR}^{\mathrm{EUR}} \leftrightarrow \mathbb{E}^{\$}(\mathrm{EUR}/\$|\mathrm{DEFAULT}) + \mathrm{FRICTIONS}.$
b) QUANTO (CR14) $= \mathrm{CR14}^{\$} - \mathrm{CR14}^{\mathrm{EUR}} \leftrightarrow \mathbb{E}^{\$}(\mathrm{EUR}/\$|\mathrm{CREDIT\_EVENT}) + \mathrm{FRICTIONS}.$
c) ISDA (\$) $= \mathrm{CR14}^{\$} - \mathrm{CR}^{\$} \leftrightarrow \mathbb{E}^{\$}(\mathrm{SHADOW\_FX}/\mathrm{EUR}|\mathrm{REDENOMINATION}) + \mathrm{FRICTIONS}.$
d) ISDA (EUR) $= \mathrm{CR14}^{\mathrm{EUR}} - \mathrm{CR}^{\mathrm{EUR}} \leftrightarrow \mathbb{E}^{\mathrm{EUR}}(\mathrm{SHADOW\_FX}/\mathrm{EUR}|\mathrm{REDENOMINATION}) + \mathrm{FRICTIONS}.$
e) QUANTO ISDA $= b - a = c - d \leftrightarrow \mathbb{E}^{\$}(\mathrm{EUR}/\$|\mathrm{REDENOMINATION}) + \mathrm{FRICTIONS}.$

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Spread a) is used by De Santis (2019), Augustin et al. (2020), and Della Corte et al. (2023). For a G7 country, it addresses the question: What happens to the euro–dollar exchange rate if the country defaults, but does not redenominate (e.g., Greece in 2012)? More precisely, it measures the risk-neutral covariance of the exchange rate with default risk. It therefore scales with the overall default probability, but is unaffected by the separate exit event. Spread b) extends a) from the default event to the union of default and redenomination for all eurozone members.

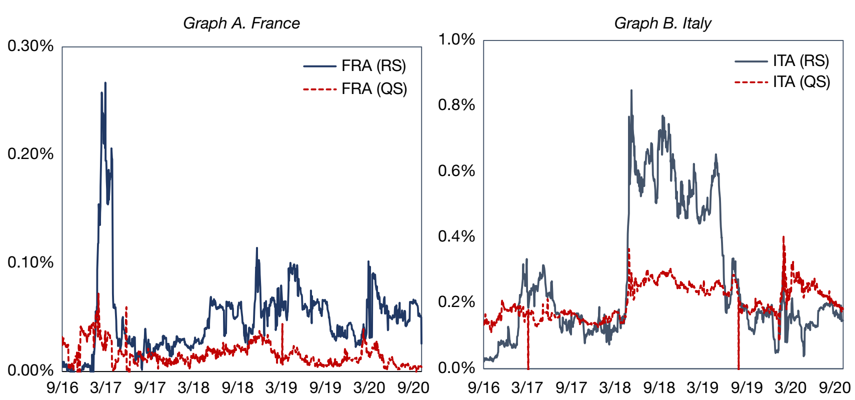
To account for frictions in the quanto spread, De Santis (2019) subtracts the same measure for Germany, thus assuming that the absolute pricing impact of frictions is constant across countries and that the German measure contains only frictions (e.g., because the true default risk is 0). In contrast, the approach outlined in Section III.B allows for frictions to vary with country characteristics and does not assume any individual country's quantitative default or redenomination risk. The finding that German *CDS-implied* redenomination risk is indeed 0, meaning that true redenomination risk is non-positive, is a result rather than an assumption. For comparison, Figure A1 plots the redenomination spreads against the measure proposed by De Santis (2019). Given the conceptual difference, and the fact that French and Italian CR contracts explicitly carve out the redenomination event, it is no surprise that the measures differ substantially throughout the sample.

Spreads c), d), and e) address redenomination without default by a G7 country. Spread e) reflects the implied covariance of euro–*dollar* depreciation with redenomination risk; c) and d) capture the expected loss from redenomination, driven largely by the expected depreciation of the *new currency* against the euro (see Appendix IA.C of the Supplementary Material for more details). Ignoring frictions, c) and d) quantify redenomination risks from the perspective of a dollar investor and a euro investor, respectively. Bonaccolto et al. (2023) focus on spread e) during the COVID-19 crisis. I start with c) rather than d), because the dollar-denominated CR14 contracts are most widely quoted and traded. Due to their lower price, the euro contracts anecdotally play a larger role for banks seeking regulatory relief for uncollateralized swap positions against

FIGURE A1

Redenomination Spreads Versus Quanto Spreads

In Figure A1, I plot the redenomination spreads from Section III with quanto spreads of De Santis (2019): $QS_{i,t} \equiv CR^{\$}_{i,t} - CR^{EUR}_{i,t} - \left(CR^{\$}_{GER,t} - CR^{EUR}_{GER,t}\right)$.



sovereigns, thus distorting their valuation (see also Klingler and Lando (2018)). Consistent with noise in the euro contracts, the two notable drops in the Italian quanto spread (Graph B of Figure A1) are due to erratic jumps in the Italian euro-CR quotes.

Derivation of equation (12)

This derivation is analogous to that for depreciation-upon-default in Della Corte et al. (2023). Let $\mathrm{RS}_t^{\$}$ and $\mathrm{RS}_t^{\mathrm{EUR}}$ denote dollar- and euro-denominated redenomination spreads, respectively. Each redenomination spread is the premium payable in the respective currency for a hypothetical single-period swap triggered only by redenomination in the absence of default. In that event (denoted by $\mathbb{1}_{t+1}^{R}$), each swap pays, in the respective currency, $(1-R)$ per unit of notional, and 0 otherwise. $R \in [0,1]$ is the market value of the redenominated bond in euros divided by its original principal.

Now, consider a strategy that is long one unit of the euro swap and short N units of the dollar swap. Denoting by e_t the value of a euro in dollars, the net dollar premium payment on this strategy is $\mathrm{RS}_t^{\$} N^{\$} - \mathrm{RS}_t^{\mathrm{EUR}} e_t$. For a zero-cost strategy, this implies $N^{\$} = \mathrm{RS}_t^{\mathrm{EUR}} e_t / \mathrm{RS}_t^{\$}$. In the event of a redenomination at $t+1$, the net payout from this strategy in dollars is $(1-R)e_{t+1} - (1-R)N^{\$} = (1-R)(e_{t+1} - \mathrm{RS}_t^{\mathrm{EUR}} e_t / \mathrm{RS}_t^{\$})$. Since this is a zero-cost strategy at inception, the no-arbitrage present value of this payoff (the discounted expectation under the dollar risk-neutral measure) is 0:

$$(12)\quad \begin{aligned} &(1-R)\mathbb{E}_t^{\$}\left[\left(e_{t+1} - e_t \frac{\mathrm{RS}_t^{\mathrm{EUR}}}{\mathrm{RS}_t^{\$}}\right)\mathbb{1}_{t+1}^{R}\right] = 0 \\ &\Rightarrow \mathbb{E}_t^{\$}\left(1 - \frac{e_{t+1}}{e_t}\middle| \mathbb{1}_{t+1}^{R} = 1\right) = \frac{\mathrm{RS}_t^{\$} - \mathrm{RS}_t^{\mathrm{EUR}}}{\mathrm{RS}_t^{\$}}. \end{aligned}$$

Appendix B. ISDA Basis: AAA-Rated OECD Countries

The CR contract (Section 4.7(a)(v) of the 2003 ISDA definitions), cited in Section II, states that a redenomination by a AAA-rated OECD country would not trigger CR contracts:

> "Permitted Currency" means (1) the legal tender of any Group of 7 country (or any country that becomes a member of the Group of 7 if such Group of 7 expands its membership) or (2) the legal tender of any country which, as of the date of such change, is a member of the Organization for Economic Cooperation and Development and has a local currency long-term debt rating of either AAA or higher assigned to it by Standard & Poor's [...], Aaa or higher assigned to it by Moody's Investors Service, Inc. [...] or AAA or higher assigned to it by Fitch Ratings[...].

A naïve conclusion is that the ISDA basis reflects redenomination risk for G7 countries and for *currently* AAA-rated OECD countries. However, the AAA-OECD exemption refers to a AAA-rating *at the time of the redenomination.* Since the credit rating is endogenous to the country's credit risk, including the risk of redenomination, a AAA-rated country that is nearing redenomination into a devalued currency would likely be downgraded by diligent rating agencies. For completeness, consider two collectively exhaustive possibilities with respect to expected depreciation:

1. If the country's new currency is expected to depreciate (under the relevant risk-neutral measure) upon introduction, redenomination implies losses to bondholders and is therefore a relevant dimension of credit risk and reflected in a forward-looking credit rating, consistent with the revised CR14 clause, under which CDS are triggered. For the ISDA basis to capture redenomination risk, CDS markets would have to anticipate a failure to downgrade by at least one major credit rating agency. While this may not be impossible, it considerably impairs the potential for the ISDA basis to measure redenomination risk.
2. If the country's new currency does not depreciate upon introduction, neither the CR nor the CR14 contracts are triggered by the redenomination and the ISDA basis is consequently silent on the probability of the redenomination event.

The only other eurozone country that is rated AAA by at least one agency throughout the sample is the Netherlands. I construct the corresponding redenomination spread, which is typically within a basis point of 0 (Figure B1); as for Germany, this *could* mean that Dutch redenomination risk is non-positive (scenario 2 above). The results obtained from *bond yields* in Section IV of the main text suggest that it is negative. However, the zero-redenomination spread alone, unlike for the G7-country Germany, does *not* rule out positive redenomination risk via scenario 1 above.

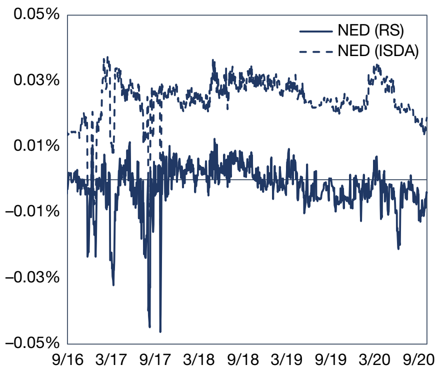
The two only other AAA-rated OECD countries in the sample (Finland and Austria) were both downgraded by all relevant agencies by June 2016, that is, prior to most of the relevant observable variation in redenomination risk. For both countries, the ISDA basis rises after their respective downgrades. If the ISDA basis reflected redenomination risk pre- but not post-downgrade, it would *fall*, since the CR contract becomes more valuable other things equal. Other things are not equal following a downgrade; one might imagine that the ISDA basis rises because the APD-component interacts with default risk, which may rise following the downgrade. However, both the CR and CR14 *fall* following the downgrade; the ISDA basis rises because the CR falls by more.

These patterns are inconsistent with the ISDA basis reflecting redenomination based on the AAA-rating before but not after the downgrade. Instead, they are consistent

FIGURE B1

ISDA Basis and Redenomination Spread for the Netherlands

Figure B1 plots the ISDA basis and redenomination spread for the Netherlands.



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with the argument outlined above: Markets understand that the current rating is irrelevant and only matters conditional on redenomination. Other than removing the Netherlands from the control group, which is not obviously necessary but inconsequential, I ignore the AAA-OECD part in the CR clause.

Supplementary Material

To view supplementary material for this article, please visit http://doi.org/10.1017/S002210902300087X.

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