Limits to Arbitrage: Empirical Evidence from Euro Area Sovereign Bond Markets

Stefano Corradin (ECB)
Maria Rodriguez (University of Navarra)

Non-standard monetary policy measures, ECB workshop
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The views expressed here are the authors’ and do not necessarily reflect those of the ECB or the Eurosystem.
June 2008 - February 2013 USD-denominated bonds were “cheaper” on average than comparable EUR-denominated bonds issued by the same euro zone country

- **Countries** - Austria, Belgium, Finland, Italy, and Spain
- **Pairs of bonds** - For each USD-denominated bond we find a comparable bond denominated in Euro

\[
Basis_{i,t} = YTM_{m,j,t}^{USD\rightarrow EUR} - YTM_{n,j,t}^{EUR} > 0
\]

- \(YTM_{m,j,t}^{USD\rightarrow EUR}\) yield-to-maturity of synthetic (from USD to EUR using currency swap) bond \(m\) issued by country \(j\)
- \(YTM_{n,j,t}^{EUR}\) yield-to-maturity of EUR-denominated bond \(n\) issued by country \(j\)
- net of total bid-ask spreads
Law of one price in action
Pricing anomaly - The Financial crisis starts
Pricing anomaly - The Euro debt crisis starts

The chart shows the basis points over time for Italy, Spain, Finland, Belgium, Austria, and Turkey. The crisis starts in 2010 and reaches its peak in 2012.
Pricing anomaly - ECB non-standard measures

Graph showing basis points over time for various countries and monetary policy measures:
- Collateral Policy
- Activation SMP
- Re-activation SMP
- 3-year LTROs

Countries included:
- Italy
- Spain
- Finland
- Belgium
- Austria
- Turkey
Overview

- The paper provides evidence that frictions and market segmentation matters for asset pricing
- The basis is related to
  - **ECB fixed-rate full allotment policy**
    - Counterparties can control the amount of liquidity they demand pledging adequate collateral
  - **ECB haircuts** being lower for EUR-denominated bonds
  - The **amount of bonds pledged to ECB** when
    - country CDS spike
    - 3-year LTROs are implemented
  - **Securities Market Programme** targeting exclusively EUR-denominated bonds
1. Basis

2. Data & Methodology

3. ECB Collateral and Liquidity Policy

4. Alternative basis
Basis

- We select fixed-rate coupon bonds from the same issuer
- Every USD-denominated bond is matched to a EUR-denominated bond (issue and maturity date)
- For every matched-pair bond \( i \) the basis at time \( t \) is:

\[
Basis_{i,j,t} = YTM^{USD\rightarrow EUR}_{m,j,t} - YTM^{EUR}_{n,j,t}
\]

- \( YTM^{USD\rightarrow EUR}_{m,j,t} \) yield-to-maturity of the synthetic (from USD to Euro) bond \( m \) issued by country \( j \)
- \( YTM^{EUR}_{n,j,t} \) yield-to-maturity of the EUR-denominated bond \( n \) issued by country \( j \)
- \( Basis_{i,j,t} \) net of total bid-ask spreads
Currency hedge using a cross-currency asset swap:

- **Asset swap**: exchange the fixed coupons of the USD-denominated into floating cash flows linked to the Libor rates (premium or discount)

- **Cross currency swap**: exchange the Libor linked cash flows with Euribor linked cash flows plus the cross currency spread (CCS)

- **Swap**: exchange the Euribor linked cash flows with fixed cash flows using EUR swap rates

The CCS is a key driver of the basis

- affects the yield-to-maturity of the synthetic bond

- depends on demand for dollar funding (Ivashina, Scharfstein and Stein (2012))
Basis & Theory

The basis should be close to zero, when the following frictions are not in place (Buraschi & al. (2014))

- Liquidity and fungibility
- Short-selling and constraints
- Funding constraints and FX Markets
- *Pari Passu* (same recovery rate in case of default)
- Early default and FX risk

The paper stresses the role of central banks interventions

- Collateral policy: different haircuts imply different prices
  - > **monetary funding premium** (Garleanu&Pedersen (2011))
- Asset purchases when explicitly targeting specific securities
  - > **segmentation** (Greenwood&Vayanos (2011))
Outline

1. Basis
2. Data & Methodology
3. ECB Collateral and Liquidity Policy
4. Alternative basis
Data

- **Bond pairs:**
  - 19 pairs: Italy (9), Spain (4), Austria (2), Belgium (2) and Finland (2).
  - Daily bid and ask prices (Bloomberg BGN)

- **Bond factors:** lending activity, governing law and additional clauses

- **Market factors:** Quanto CDS, Eurepo - OIS spread and VIX

- **ECB data:**
  - Collateral and liquidity (bond and bank level)
  - SMP purchases (bond level)
Empirical Strategy

- **Unbalanced panel regressions** - Prais-Winsten regression specification with country fixed-effects:

  \[ \text{Basis}_{i,j,t} = \alpha + \delta_j + \beta \times \text{Bond Information}_{i,j,t} + \nu \times \text{Market Factors} + \pi \times \text{ECB} + \varepsilon_{i,j,t}, \]

  - \( i \) bonds pair
  - \( j \) country
  - \( t \) time

- **Event study (Diff-in-diff) analysis**
Outline

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Change collateral policy

- 15 October 2008: Fixed-rate full allotment policy
  - ECB admits bonds in USD, pounds sterling and Japanese yen when they are eligible
  - If USD-denominated bond is **eligible**, it is subject to an **additional** haircut (mark-down)
  - Our sample: 6 (2) USD-denominated bonds issued by Italy (Spain) are no eligible
  - **Why?** The bonds are not settled in the European Economic Area (EEA)
  - ECB publishes the list of eligible assets on 14 Nov. 2008
- from 9 Nov. 2012: same expansion of the collateral (announcement on 6 Sep. 2012)
Illustrative example for a pair:

- EUR-den. bond is subject to a 3% haircut
  \[\text{€100} \times (1 - 3\%) = \text{€97}\]
- Eligible USD-den. bond is subject to an additional 8% haircut
  \[\text{\$100} \times (1 - 3\%) \times (1 - 8\%) = \text{\$89.24} \rightarrow \text{overall haircut of 10.76\%}\]
- No Eligible USD-den. bond: 100% haircut

Our estimates:

- Reduction of the basis by over 15 basis points for bond pairs including eligible USD-denominated bonds
- **Monetary funding premium:** the YTM of the USD-denominated bond lowers by 15 bps decreasing haircuts from 100% to 10.76%
Change collateral policy - Event study

Announcement
Implementation

-4.98
-14.62***
-15.55***
-15.983***
-60
-40
-20
0
20
40
60

Sep08  Oct08  Nov08  Dec08  Jan09

No-eligible USD
Eligible USD

-4.98  -14.62***  -15.55***  15.983***
### Change collateral policy - Event study

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>D. After 1w-2w</strong></td>
<td>14.924***</td>
<td>-7.454***</td>
<td>8.209*</td>
</tr>
<tr>
<td></td>
<td>(2.974)</td>
<td>(2.249)</td>
<td>(4.732)</td>
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<td><strong>D. After 3w-4w</strong></td>
<td>26.900***</td>
<td>3.381</td>
<td>29.234***</td>
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<td>(3.316)</td>
<td>(2.394)</td>
<td>(4.692)</td>
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<td><strong>D. After 5w-6w</strong></td>
<td>36.502***</td>
<td>0.975</td>
<td>14.967***</td>
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<tr>
<td></td>
<td>(3.598)</td>
<td>(2.418)</td>
<td>(4.692)</td>
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<tr>
<td><strong>D. After 7w-8w</strong></td>
<td>53.112***</td>
<td>2.102</td>
<td>1.184</td>
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<td>(4.073)</td>
<td>(2.356)</td>
<td>(4.692)</td>
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<td><strong>D. After 1w-2w x Elig. Pair</strong></td>
<td>-4.987</td>
<td>3.303</td>
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<td>(4.000)</td>
<td>(2.754)</td>
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<td><strong>D. After 3w-4w x Elig. Pair</strong></td>
<td>-14.620***</td>
<td>-7.838***</td>
<td>-15.066*</td>
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<td>(4.468)</td>
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<td><strong>D. After 5w-6w x Elig. Pair</strong></td>
<td>-15.551***</td>
<td>-7.032***</td>
<td>-9.413</td>
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<td>(4.876)</td>
<td>(2.952)</td>
<td>(7.418)</td>
</tr>
<tr>
<td><strong>D. After 7w-8w x Elig. Pair</strong></td>
<td>-15.983***</td>
<td>-7.845***</td>
<td>-5.250</td>
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<td></td>
<td>(5.508)</td>
<td>(2.894)</td>
<td>(6.758)</td>
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<td><strong>Eligible Pair</strong></td>
<td>39.787***</td>
<td>73.066***</td>
<td>69.454***</td>
</tr>
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<td></td>
<td>(4.666)</td>
<td>(4.878)</td>
<td>(9.894)</td>
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<td><strong>Constant</strong></td>
<td>-37.782***</td>
<td>-16.766***</td>
<td>-14.323</td>
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<td>(4.923)</td>
<td>(4.786)</td>
<td>(9.922)</td>
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<td>Yes</td>
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<td><strong>Pair FE</strong></td>
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<tr>
<td><strong>ρ</strong></td>
<td>0.780</td>
<td>0.688</td>
<td>0.903</td>
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<td><strong>Num. Obs.</strong></td>
<td>993</td>
<td>695</td>
<td>1294</td>
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<td><strong>R²</strong></td>
<td>0.550</td>
<td>0.801</td>
<td>0.511</td>
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</table>
We focus on the impact of the sovereign debt collateral pledged at the ECB in exchange of liquidity by including $Sov.\ Collateral_{j,t}$ to $Tot.\ Sov.\ Debt_{j,t}$.

We find the amount of sovereign pledged to the ECB during market distress is significantly related to the basis (sovereign CDS above the 90th percentile of its distribution over the full-sample period, similar to Pelizzon & al. (2014))

During the 3-year LTROs is significantly related to the basis.

In both cases only EUR-denominated bonds were eligible.
## Sovereign Debt Pledged to the ECB - Results

<table>
<thead>
<tr>
<th></th>
<th>Panel Analysis</th>
<th>Event Study 8 – 12 – 2011</th>
</tr>
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<tbody>
<tr>
<td>Sov. Coll. to Tot. Sov. Debt $j,t$</td>
<td>17.294</td>
<td>461.256***</td>
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<td>(74.930)</td>
<td>(136.834)</td>
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<td>Sov. Coll. to Tot. Sov. Debt $j,t$ x D. High CDS $j,t$</td>
<td>325.812**</td>
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<td>(146.123)</td>
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<td>Sov. Coll. to Tot. Sov. Debt $j,t$ x D. 3y-LTROs $j,t$</td>
<td>0.753</td>
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<td>(5.621)</td>
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<td>D. High CDS $j,t$</td>
<td>-44.384***</td>
<td>20.475***</td>
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<td>(7.113)</td>
<td>(5.825)</td>
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<tr>
<td>D. After 1w-2w $t$</td>
<td>20.475***</td>
<td>40.280***</td>
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<td>(5.825)</td>
<td>(6.567)</td>
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<tr>
<td>D. After 3w-4w $t$</td>
<td>26.040***</td>
<td>34.271***</td>
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<td>(6.637)</td>
<td>(7.071)</td>
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<td>D. After 5w-6w $t$</td>
<td>3271</td>
<td>1077</td>
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<td>6.489</td>
<td>55.348***</td>
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<td>(11.202)</td>
<td>(5.327)</td>
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<tr>
<td>Constant</td>
<td>6.489</td>
<td>55.348***</td>
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<td>(11.202)</td>
<td>(5.327)</td>
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<td>Country FE</td>
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<td>Yes</td>
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<tr>
<td>Pair FE</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- $\rho$: 0.837
- Num. Obs.: 3271
- $R^2$: 0.098
Outline

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Strategy

- Strategy: identify EUR-denominated bonds that are **similar** but are subject to different haircuts in ECB liquidity operations
- Two examples
  - Fixed vs floating rate bond issued by Italy
  - Fixed rate bonds issued by Cassa Depositi e Prestiti, Italian state-owned bank
Cassa Depositi e Prestiti (I)

- Cassa Depositi and Prestiti (CDP) is an Italian state-owned bank
- The Republic of Italy is legally required
  - to hold majority ownership in CDP (80.2% equity)
  - to unconditionally guarantee postal savings products
- Rating agencies typically assign the CDP and the Republic of Italy the same credit worthiness
- ECB haircuts on June 2011:
  - a fixed-rate bond issued by CDP and expiring in September 2016 is subject to an haircut of 24.5%
  - a comparable Italian sovereign fixed-rate coupon bond expiring in August 2016 is subject to an haircut of 10%
- During 3-year LTROs the basis is of 64 basis points
Conclusions

- We provide evidence that a monetary funding premium is embedded in the EUR-denominated bonds because these bonds could be used as collateral for liquidity operations with the ECB at lower haircuts.
- This monetary funding premium is time varying
  - changes in collateral policy
  - loans at longer maturities than available in the market
  - sovereign issuer experiencing market stress
Outline

1. Basis

2. Data & Methodology

3. ECB Collateral and Liquidity Policy

4. Alternative basis

5. Additional slides
Eligibility criteria - marketable assets

General framework for eligibility of marketable assets

1. Type of asset
2. Credit standards
3. Place of issue: European Economic Area (EEA)
4. Settlement: Euro area
5. Type of issuer (EEA or non EEA G10 countries) / Debtor (EEA) / Guarantor (EEA)
6. Acceptable markets
7. Currency: Euro
Alternative basis - Fixed vs floating rate bond (I)

- **Fixed-rate coupon bond**
  - The haircut applied depends on i) the sovereign issuer rating and ii) the time-to-maturity (maturity buckets)
  - The longer the time-to-maturity, the higher the haircut is applied to the fixed-rate coupon bond.

- **Floating-rate coupon bond**
  - The haircut applied is the one applied to the zero-to-one-year maturity bucket for fixed coupon instruments.

- **Intution:** Expect a basis between a long term fixed-rate coupon bond and its synthetic counterpart - a swapped floating rate bond, issued by the same euro area country.
Alternative basis - Fixed vs floating rate bond (II)
### SMP Panel Analysis Event Study Event Study

<table>
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<th>10 May 2010</th>
<th>11 Aug. 2011</th>
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<tr>
<td>SMP&lt;sub&gt;j,t&lt;/sub&gt;</td>
<td>2.588*** (0.339)</td>
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<tr>
<td>D. After 1w-2w&lt;sub&gt;t&lt;/sub&gt;</td>
<td>30.794*** (3.009)</td>
<td>14.239*** (3.164)</td>
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<tr>
<td>D. After 3w-4w&lt;sub&gt;t&lt;/sub&gt;</td>
<td>22.634*** (3.060)</td>
<td>19.592*** (3.207)</td>
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<tr>
<td>D. After 5w-6w&lt;sub&gt;t&lt;/sub&gt;</td>
<td>49.083*** (3.034)</td>
<td>19.637*** (3.164)</td>
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<tr>
<td>D. After 7w-8w&lt;sub&gt;t&lt;/sub&gt;</td>
<td>58.757*** (2.969)</td>
<td>37.938*** (3.164)</td>
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<tr>
<td>D. After 1w-2w&lt;sub&gt;t&lt;/sub&gt; x Target Coun.&lt;sub&gt;j,t&lt;/sub&gt;</td>
<td></td>
<td>43.046*** (6.964)</td>
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<tr>
<td>D. After 3w-4w&lt;sub&gt;t&lt;/sub&gt; x Target Coun.&lt;sub&gt;j,t&lt;/sub&gt;</td>
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<td>43.847*** (7.060)</td>
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<td>14.063** (6.964)</td>
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<td>D. After 7w-8w&lt;sub&gt;t&lt;/sub&gt; x Target Coun.&lt;sub&gt;j,t&lt;/sub&gt;</td>
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<td>53.840*** (7.302)</td>
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<td>-78.899*** (7.097)</td>
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Other Control Variables
- Yes
- No
- Yes
- Yes
- Yes

Other Control Variables
- Yes
- No
- Yes
- Yes
- Yes

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<td>ρ</td>
<td>0.847</td>
<td>0.780</td>
<td>0.832</td>
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<td>Num. Obs.</td>
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<tr>
<td>R²</td>
<td>0.089</td>
<td>0.628</td>
<td>0.551</td>
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</table>
Reactivation SMP

Non-target

Target (Italy and Spain)