# Breakup and Default Risks in the Great Lockdown

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# Motivation

- In the immediate aftermath of the Covid-19 shock, fears of sovereign defaults and of a Eurozone (EZ) breakup invaded the nightmares of many investors.

- Sovereign default risks in the EZ:
  - *outright* default (i.e., a country stops servicing its debt),
  - debt *redenomination* (i.e., a country redenominates its debt in a new *undervalued* currency).

▸ Eurexit and redenomination ▸ foreign & domestic law ▸ sovereign cds and bond yields ▸ redenomination premia and bond yields

# Contribution

1. We use sovereign credit default swaps (CDS) with different default clauses and denominated in different currencies to:
   - separately estimate redenomination and outright default risks,
   - decompose redenomination risk in components associated with *direct* redenomination and currency depreciation risks.

2. We model breakup and default risk spillovers in the EZ with $\Delta$CoVaR (Adrian and Brunnermeier, 2016):
   - *new* multiple-regression $\Delta$CoVaR to account for simultaneous effect of different sovereigns,
   - filter the relevant nodes with regularization techniques (Elastic Net).

# Preview of results

1. **Risk of EZ breakup** in the aftermath of Covid-19 shock is small (but significant) and not larger than in the pre-Covid-19 period.

2. **Evidence of spillovers**: redenomination risk ↑ in one country is associated with default premia ↑ and bond spreads ↑ in other EZ countries.

3. A sizeable fraction of the variation in redenomination and default premia reflects two factors:
   - the insurance cost against a **euro expected depreciation** conditional on redenomination,
   - **liquidity premia** in the EZ sovereign CDS and bond markets.

# Redenomination Risk

# To begin with: What is a sovereign CDS? (I/II)

- A sovereign CDS is an insurance contract in which the reference entity is the sovereign government (Duffie, 1999; Pan and Singleton, 2008).
- The CDS premium (or spread) is the periodic payment the protection buyer will have to make until maturity of the contract to the protection seller.
- In return, the seller agrees to pay a third party debt if this party is in default.
- The International Swap and Derivative Association (ISDA) establishes the events that trigger a CDS contract.

▸ example: Italy & Germany

# To begin with: What is a sovereign CDS? (II/II)

- Sovereign CDS are available in different *currencies* (i.e., euro or dollar):
  - Conditional on a credit event, the protection seller pays:
    - ⋆ euros to the protection buyer for a euro contract,
    - ⋆ dollars to the protection buyer for a dollar contract.

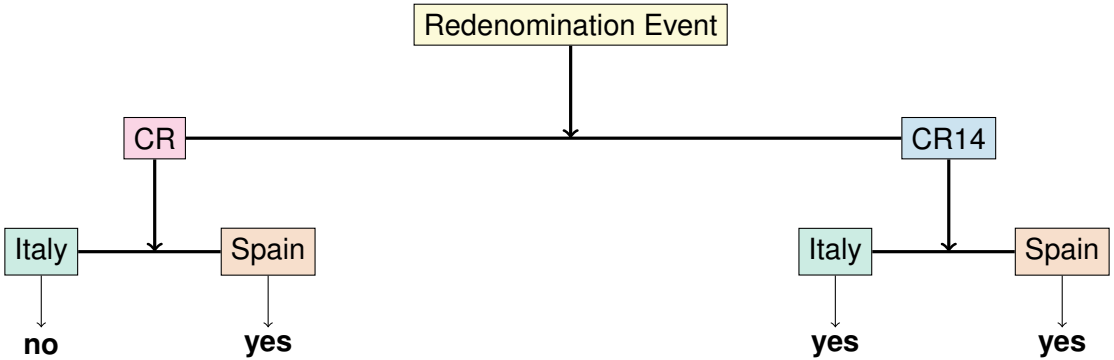
# CDS: CR and CR14 default clauses

- For CDS based on (*older*) ISDA 2003 default definitions (CR), redenomination does not trigger a credit event as long as it "*involves the currencies of the G7 countries and AAA-rated OECD economies*".

- For CDS based on (*current*) 2014 default definitions (CR14), redenomination *de facto* is always considered a credit event.

- *Both* CR and CR14 contracts are currently actively traded.

# Example: CR and CR14 default clauses




*Notes:* Italy belongs to the G7. Spain is a non-G7 country with a rating below AAA.

# Identification strategy

For G7 countries we identify the **redenomination premium** of sovereign *i* (possibly up to a liquidity premium) as the difference between CR14 and CR premia:

$$RP^i = CDS^{i,CR14} - CDS^{i,CR}$$

▸ other differences ▸ redenomination with default ▸ how important?

# Currency redenomination premium

- Suppose investors expect a euro depreciation conditional on a credit event in sovereign $i$.

- They can hedge this (conditional) currency risk using a *quanto*:

$$Q^i = CDS^{i,€} - CDS^{i,\$}$$

- The **quanto premium** captures the expected currency depreciation (possibly up to a liquidity premium) conditional on a credit event and is usually negative.

# Decomposing the redenomination premium

- Combining G7 (or AAA) sovereign CDS with different default clauses and currencies we can decompose the dollar redenomination premium as follows:

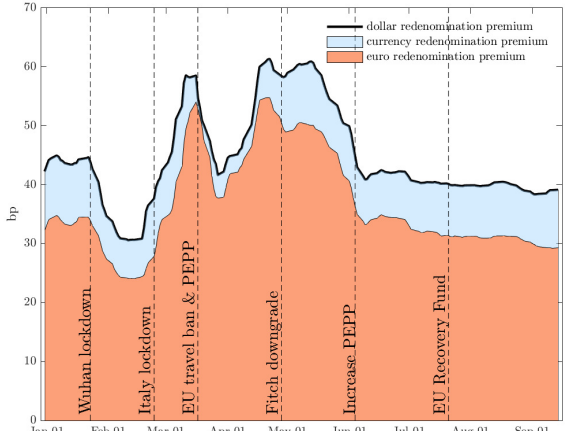
$$RP^{i,\$} = \underbrace{RP^{i,€}}_{\text{euro redenomination premium (ERP)}} + \underbrace{(Q^{i,CR} - Q^{i,CR14})}_{\text{currency redenomination premium (CRP)}}$$

where:

  - ERP is a *direct* redenomination premium,
  - CRP is a currency premium conditional on redenomination.

▸ algebra ▸ CDS notionals ▸ liquidity ▸ country-level characteristics

# Decomposing the redenomination premium (Italy)




▸ longer sample ▸ France, Germany & the Netherlands

# Model

# Model

- We build on the $\Delta$CoVaR measure of systemic risk (Adrian and Brunnermeier, 2016) and critically introduce:
  - a multiple-regression framework,
  - regularization techniques (Elastic Net).
- We denote our new systemic risk measure multiple-regression CoVaR, or MCoVaR.

# Sketch of the Model

- CoVaR is the value at risk (VaR) of one variable ($y$) conditional on a second variable ($x$) being at its VaR.

- $\Delta$CoVaR measures the marginal contribution of $x$ on the VaR of $y$ (i.e., when $x$ moves from its median to a distress state).

- We take $\Delta$CoVaR as measure of redenomination and default risk spillovers:
  - $\Delta$CoVaR does not consider the potential contemporaneous effects of other variables (i.e., sovereigns).
  - We include $N$ sovereigns in a unique model and use the Elastic Net to deal with the curse of dimensionality (Zou and Hastie, 2005).

# Estimation Results

# Data

- Daily sovereign CDS from Markit from 1/1/2020 to 9/14/2020.
- Countries: Austria, Germany, France, Belgium, Spain, Finland, Ireland, Italy, Netherlands, Portugal, and Spain.
- Default clauses: CR and CR14.
- Currencies: U.S. dollar and euro.
- Maturity: 5Y.
- Additional data: daily yields on benchmark EZ 10-year government bonds.

▸ CDS quotes ▸ summary stats redenomination premium ▸ summary stats CDS CR14 ▸ summary stats CDS CR
▸ summary stats CDS CR14 (long sample) ▸ summary stats CDS CR (long sample)

# Two Models (for France, Germany, Italy and the Netherlands)

1. Breakup risk model $\rightarrow$ effect on redenomination premium:
   - dependent variable: dollar redenomination premium country $i$
   - covariates:
     - currency (CRP) and euro (ERP) redenomination premia of countries $j$,
     - liquidity premium,
     - additional control and state variables.

2. Default risk model $\rightarrow$ effect on the default premium:
   - dependent variable: dollar CR14 CDS premium country $i$.
   - covariates:
     - currency (CRP) and euro (ERP) redenomination premia of countries $j$,
     - liquidity premium,
     - additional control and state variables.

▸ liquidity premia ▸ effect on sovereign yields

# Breakup risk model

| | FRANCE | | GERMANY | | ITALY | | NETHERLANDS | | LIQUIDITY |
|---|---|---|---|---|---|---|---|---|---|
| | CRP | ERP | CRP | ERP | CRP | ERP | CRP | ERP | |
| FRANCE | -- | -- | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 32.777*** |
| GERMANY | 31.265*** | 16.162*** | -- | -- | -1.678 | 0.000 | 0.000 | 0.000 | 0.000 |
| ITALY | 1.113 | 0.000 | 0.000 | 0.000 | -- | -- | 0.000 | 0.000 | 37.909*** |
| NETHERL. | 8.216 | 5.467 | 0.644 | 14.289*** | 0.000 | 1.810 | -- | -- | 3.647 |

Note: The dependent variable is the dollar redenomination premium. The model is estimated by Elastic Net on 5-year CDS contracts. Marginal effect is reported as a percentage of the unconditional value at risk. Liquidity is measured as the first two principal component of the difference between CDS premia with contracts CR14 and CR for non-G7 Eurozone countries with rating below AAA. Regressions always include the $t-1$ values of the dependent variable and a set of state (time $t-1$) variables. Standard errors are computed by wild bootstrap (Wang et al., 2018). Data are daily from Markit and Datastream for the period 1/1/2020 to 9/14/2020.

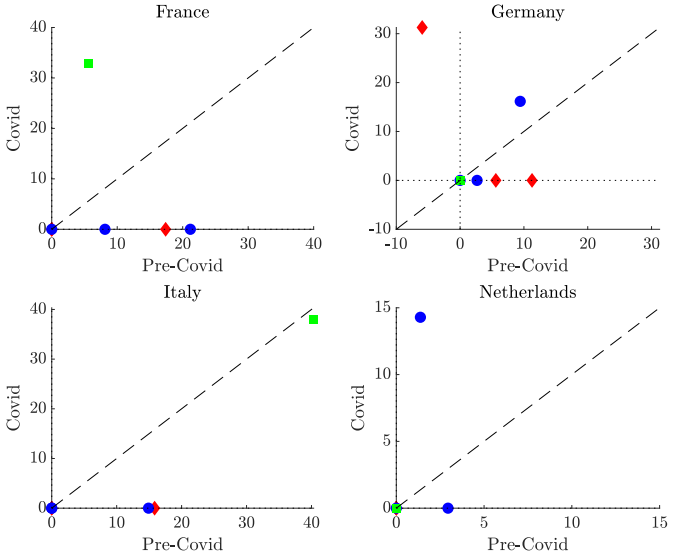
▸ model #1 (alternative versions)

# Default risk model

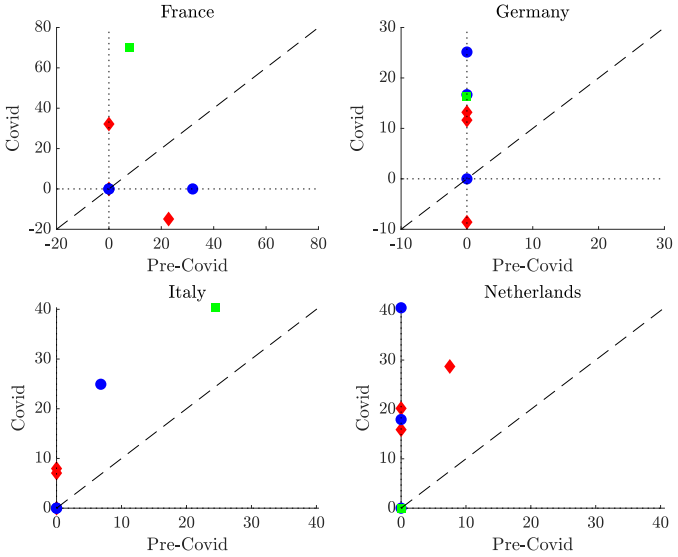
| | FRANCE | | GERMANY | | ITALY | | NETHERLANDS | | LIQUIDITY |
|---|---|---|---|---|---|---|---|---|---|
| | CRP | ERP | CRP | ERP | CRP | ERP | CRP | ERP | |
| FRANCE | -- | -- | 8.283 | 1.373 | -14.912*** | 2.318 | 32.166*** | 0.000 | 69.922*** |
| GERMANY | 11.640** | 16.681** | -- | -- | -8.579*** | 25.130*** | 13.192*** | 0.000 | 16.394*** |
| ITALY | 7.967** | 24.927*** | 7.063*** | 0.000 | -- | -- | 0.000 | 0.000 | 40.312*** |
| NETHERL. | 28.699*** | 40.592*** | 20.211*** | 17.961* | 15.905*** | 10.321 | -- | -- | 1.407 |

Note: The dependent variable is the dollar CDS CR14 premium. The model is estimated by Elastic Net on 5-year CDS contracts. Marginal effect is reported as a percentage of the unconditional value at risk. Liquidity is measured as the first two principal component of the difference between CDS premia with contracts CR14 and CR for non-G7 Eurozone countries with rating below AAA. Regressions always include the $t-1$ values of the dependent variable and a set of state (time $t-1$) variables. Standard errors are computed by wild bootstrap (Wang et al., 2018). Data are daily from Markit and Datastream for the period 1/1/2020 to 9/14/2020.

# Breakup risk model: Covid vs. pre-Covid samples



# Default risk model: Covid vs. pre-Covid samples



# Effect on sovereign bond spreads in the pre-Covid sample

| | FRANCE | | GERMANY | | ITALY | | NETHERLANDS | | LIQUIDITY |
|---|---|---|---|---|---|---|---|---|---|
| | CRP | ERP | CRP | ERP | CRP | ERP | CRP | ERP | |
| AUSTRIA | 4.158*** | 2.118** | 0.000 | 0.000 | 6.774*** | 20.024*** | 0.000 | 0.000 | 14.480*** |
| BELGIUM | 4.330** | 7.094*** | 0.000 | 0.000 | 6.465*** | 13.498*** | 0.280 | 0.000 | 12.147*** |
| FINLAND | 6.786** | 1.468 | 2.170 | 0.000 | 12.360*** | 22.844*** | -4.428** | 3.112 | 15.182*** |
| FRANCE | -- | -- | 0.920* | 0.000 | 7.901*** | 10.985*** | 0.000 | 0.000 | 14.933*** |
| IRELAND | 11.242*** | 1.338 | 1.287* | -0.074 | 0.777 | 11.229*** | 0.000 | 0.000 | 8.359*** |
| ITALY | 4.027*** | 3.310*** | 0.000 | 0.000 | -- | -- | 0.000 | 0.000 | 38.495*** |
| NETHERL. | 1.711*** | 3.338*** | 0.000 | 0.000 | 0.000 | 6.557*** | -- | -- | 10.401*** |
| PORTUGAL | 7.756** | 0.000 | 0.000 | 0.000 | 17.424*** | 34.347*** | -8.408** | 0.000 | 15.841*** |
| SPAIN | 2.637 | 1.791 | 0.924* | 0.000 | 13.620*** | 28.424*** | 0.000 | 0.000 | 18.267*** |

Note: The dependent variables are the sovereign spreads for the benchmark 10-year maturity bonds with respect to the yield on German 10-year government bond. The model is estimated by EN. Marginal effect is reported as a percentage of the unconditional value at risk of sovereign bond spreads. Liquidity is proxied by the first principal component of the spread difference between CDS with contracts CR14 and CR for non-G7 Eurozone countries. Panel (a) refers to the period around the COVID-19 shock (1/1/2020-9/14/2020); Panel (b) refers to the larger period starting in November 2015 (11/2/2015-9/14/2020). For both samples, the response countries are listed in the first column. Regressions always include a set of time state variables: the $t-1$ values of the dependent variable, and the returns of the S&P Global Euro equity index, the IBOXX Euro corporate index, the VDAX volatility index, and the euro 1-month OIS index as set of state variables. Standard errors are computed using the wild bootstrap method (Wang et al., 2018). Data are daily from Markit, Datastream, and Bloomberg.

# Conclusions

- The risk of a EZ breakup around the Covid-19 shock is significant although quantitatively it is not larger than in the period before the Covid-19 shock.

- This evidence is consistent with the fact that redenomination and default risks are mostly related to country characteristics that are stable in our samples (e.g., fiscal capacity).

- The effect of redenomination and default risks is strongly reduced after the ECB intervention with a massive government bond purchase program (e.g., the PEPP program).

Thank you!

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# Appendix

# Domestic & Foreign Law

- A sovereign can redenominate outstanding government bonds issued under *domestic law* with a legislative act (Gulati, 2017).
- The same is not true for bonds issued under *foreign* law (e.g., UK or New York laws).
- For the sovereigns in the Eurozone, most government bonds are under domestic law (Chamon et al., 2018).

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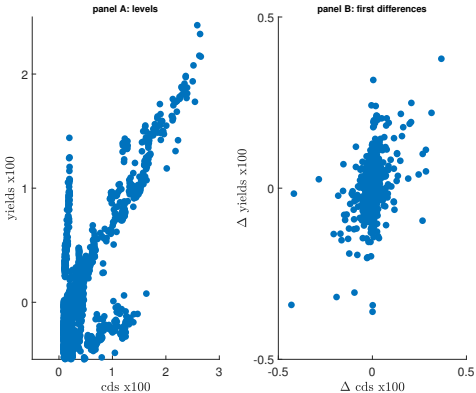
# Sovereign CDS and Bond Yields

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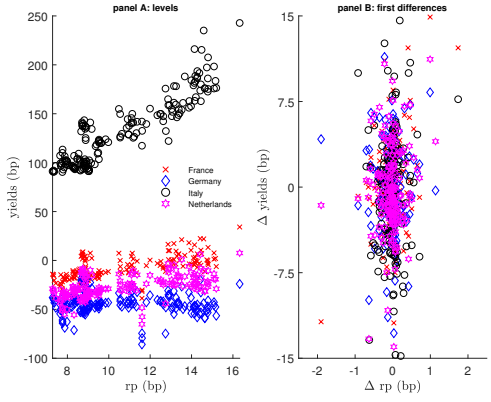
# Redenomination Premia and Bond Yields

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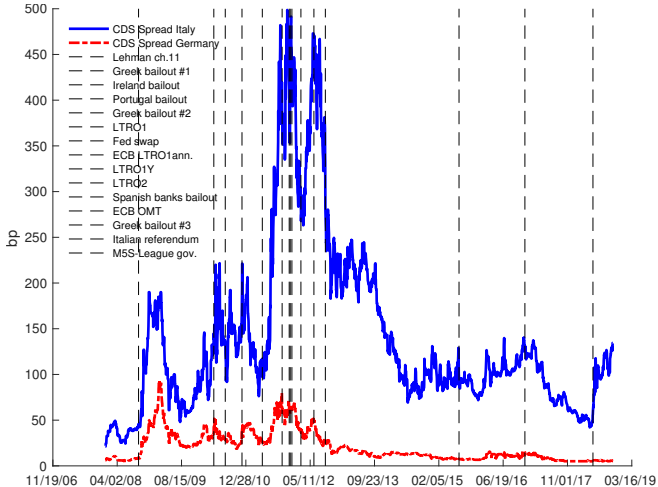
# The risk of Italian government debt

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# Eurexit

- If a country decides to leave the Eurozone (*eurexit*), then debt redenomination is likely to be optimal.

- Without a redenomination, the real value of debt would increase (under the assumption that the new domestic currency depreciates vis-a-vis the euro).

- For example, see the discussion in Kremens (2019), Pastor and Veronesi (2018) and Balduzzi et al. (2019).

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# Asset Package Delivery

- Differences between CR and CR14 also depend on the “Asset Package Delivery” (APD) clause introduced by the ISDA 2014 credit derivative definitions (but no distinction between G7 and non-G7 countries):
  - APD allows market participants to deliver assets resulting from the corresponding deliverable obligations that have been converted in connection with a restructuring event.
  - These assets are also used to determine the final price in an auction (i.e., the recovery value).
  - In instances where bonds are fully expropriated and no assets are delivered in exchange, the value of the asset package will be deemed to be zero.

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# Redenomination and Default

- If investors expect that an outright default will follow a debt redenomination, then we should expect no difference between the premium on CR and CR14 contracts also for G7 countries (possibly up to a liquidity premium).

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# How important is redenomination risk?

- Using data since June 2018, Gros (2018) estimates that 50% of the increase in the spread of Italian sovereign bonds is due to redenomination risk:
  - sovereign CDS of different vintages,
  - sovereign bonds denominated in euros and dollars.

back

# CDS data

- CDS are traded over-the-counter.
- We obtain daily quotes for CR and CR14 contracts, denominated in euro and U.S. dollar, for different maturity, from Markit via WRDS.
- Markit aggregates quotes from a range of market makers and intermediaries.
- Quotes are not necessarily based on transaction prices.
- Markit CDS quotes are the standard data used by derivative market participants.

back

# Summary Statistics (Redenomination Premium)

| | Panel A: levels (bp) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | dollar redenomination premium | | | | | currency redenomination premium | | | | | euro redenomination premium | | | | |
| | $\mu$ | $\sigma$ | *min* | *max* | *VaR* | $\mu$ | $\sigma$ | *min* | *max* | *VaR* | $\mu$ | $\sigma$ | *min* | *max* | *VaR* |
| France | 10.636 | 2.469 | 7.284 | 16.326 | 14.767 | 3.245 | 1.135 | 1.257 | 6.256 | 4.873 | 7.391 | 1.522 | 5.350 | 10.738 | 10.108 |
| Germany | 3.671 | 0.800 | 2.289 | 5.340 | 4.575 | 1.705 | 1.109 | 0.357 | 4.211 | 3.571 | 1.966 | 0.609 | 0.344 | 2.764 | 2.707 |
| Italy | 44.812 | 8.399 | 29.989 | 65.596 | 60.635 | 7.979 | 2.437 | -2.857 | 14.869 | 10.699 | 36.833 | 8.613 | 23.107 | 56.451 | 53.480 |
| Netherlands | 2.558 | 0.453 | 2.036 | 3.538 | 3.403 | -0.101 | 0.393 | -0.950 | 1.088 | 0.580 | 2.659 | 0.495 | 1.561 | 4.116 | 3.665 |
| | Panel B: first differences (bp) | | | | | | | | | | | | | | |
| | $\Delta$ dollar redenomination premium | | | | | $\Delta$ currency redenomination premium | | | | | $\Delta$ euro redenomination premium | | | | |
| | $\mu$ | $\sigma$ | *S* | *K* | *VaR* | $\mu$ | $\sigma$ | *S* | *K* | *VaR* | $\mu$ | $\sigma$ | *S* | *K* | *VaR* |
| France | -0.009 | 0.419 | 2.718 | 26.930 | 0.466 | 0.004 | 0.351 | 0.122 | 7.768 | 0.542 | -0.013 | 0.370 | 0.543 | 7.805 | 0.713 |
| Germany | 0.004 | 0.166 | 1.080 | 11.645 | 0.248 | 0.001 | 0.176 | 0.008 | 15.911 | 0.228 | 0.003 | 0.135 | 1.696 | 17.102 | 0.162 |
| Italy | -0.018 | 2.592 | -0.131 | 11.068 | 3.655 | -0.001 | 1.746 | -0.756 | 18.081 | 1.945 | -0.017 | 1.779 | 0.507 | 9.995 | 3.181 |
| Netherlands | -0.001 | 0.135 | 0.624 | 8.084 | 0.195 | -0.002 | 0.348 | -0.247 | 6.053 | 0.585 | 0.002 | 0.348 | 0.271 | 5.715 | 0.572 |

*Notes:* Data are daily from Markit for the period 1/1/2020 to 4/28/2020 and reported in basis points.

back

# Summary Statistics (CDS CR14)

| | Panel A: CR14 – levels (bp) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | euro CDS premium | | | | | dollar CDS premium | | | | |
| | $\mu$ | $\sigma$ | *min* | *max* | *VaR* | $\mu$ | $\sigma$ | *min* | *max* | *VaR* |
| France | 18.903 | 7.581 | 10.939 | 37.262 | 31.610 | 27.147 | 10.413 | 15.812 | 52.169 | 44.416 |
| Germany | 9.956 | 3.419 | 5.770 | 16.660 | 15.419 | 15.383 | 5.771 | 8.598 | 26.827 | 24.801 |
| Italy | 128.598 | 38.064 | 71.265 | 222.212 | 197.085 | 163.726 | 42.628 | 95.383 | 265.348 | 239.301 |
| Netherlands | 10.185 | 2.259 | 7.446 | 14.357 | 14.070 | 14.109 | 3.180 | 10.689 | 20.136 | 19.668 |
| *Median* | 14.544 | 5.500 | 9.193 | 26.961 | 23.514 | 21.265 | 8.092 | 13.250 | 39.498 | 34.608 |
| | Panel B: CR14 – first differences (bp) | | | | | | | | | |
| | $\Delta$ euro CDS premium | | | | | $\Delta$ dollar CDS premium | | | | |
| | $\mu$ | $\sigma$ | *S* | *K* | *VaR* | $\mu$ | $\sigma$ | *S* | *K* | *VaR* |
| France | -0.016 | 1.159 | 2.165 | 24.493 | 1.624 | -0.018 | 1.540 | 2.113 | 25.473 | 1.952 |
| Germany | 0.007 | 0.462 | 1.135 | 11.631 | 0.785 | 0.010 | 0.736 | 0.948 | 10.427 | 1.268 |
| Italy | 0.038 | 8.254 | 0.101 | 21.030 | 11.497 | 0.065 | 10.769 | 0.188 | 20.382 | 14.236 |
| Netherlands | 0.000 | 0.423 | 1.245 | 10.437 | 0.557 | -0.003 | 0.540 | 1.578 | 13.720 | 0.740 |
| *Median* | 0.004 | 0.811 | 1.190 | 16.330 | 1.205 | 0.004 | 1.138 | 1.263 | 17.051 | 1.610 |

*Notes:* Data are daily from Markit for the period 11/1/2020 to 4/28/2020 and reported in basis points.

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# Summary Statistics (CDS CR)

| | Panel A: CR – levels (bp) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | euro CDS premium | | | | | dollar CDS premium | | | | |
| | $\mu$ | $\sigma$ | *min* | *max* | *VaR* | $\mu$ | $\sigma$ | *min* | *max* | *VaR* |
| France | 11.512 | 6.151 | 5.007 | 26.524 | 21.817 | 16.511 | 7.986 | 8.448 | 35.843 | 29.829 |
| Germany | 7.990 | 3.810 | 3.876 | 15.777 | 14.349 | 11.712 | 5.097 | 6.200 | 22.353 | 20.350 |
| Italy | 91.764 | 29.941 | 47.814 | 167.143 | 143.860 | 118.914 | 35.136 | 59.823 | 206.021 | 181.074 |
| Netherlands | 7.526 | 2.013 | 5.206 | 12.248 | 11.088 | 11.551 | 2.770 | 8.614 | 17.222 | 16.493 |
| *Median* | 9.751 | 4.980 | 5.106 | 21.151 | 18.083 | 14.112 | 6.542 | 8.531 | 29.098 | 25.090 |
| | Panel B: CR – first differences (bp) | | | | | | | | | |
| | $\Delta$ euro CDS premium | | | | | $\Delta$ dollar CDS premium | | | | |
| | $\mu$ | $\sigma$ | *S* | *K* | *VaR* | $\mu$ | $\sigma$ | *S* | *K* | *VaR* |
| France | -0.003 | 0.938 | 2.106 | 24.493 | 1.210 | -0.009 | 1.175 | 1.779 | 25.473 | 1.457 |
| Germany | 0.004 | 0.482 | 0.652 | 11.631 | 0.934 | 0.006 | 0.650 | 0.495 | 10.427 | 1.288 |
| Italy | 0.055 | 6.779 | -0.190 | 21.030 | 9.444 | 0.082 | 8.847 | -0.067 | 20.382 | 11.315 |
| Netherlands | -0.002 | 0.444 | 1.718 | 10.437 | 0.650 | -0.002 | 0.470 | 1.596 | 13.720 | 0.611 |
| *Median* | 0.001 | 0.710 | 1.185 | 16.330 | 1.072 | 0.002 | 0.912 | 1.045 | 17.051 | 1.373 |

*Notes:* Data are daily from Markit for the period 1/1/2020 to 4/28/2020 and reported in basis points.

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# Summary Statistics (CDS CR14, Long Sample)

| | Panel A: CR14 – levels (bp) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | euro CDS premium | | | | | dollar CDS premium | | | | |
| | $\mu$ | $\sigma$ | *min* | *max* | *VaR* | $\mu$ | $\sigma$ | *min* | *max* | *VaR* |
| France | 19.639 | 7.224 | 10.646 | 47.997 | 33.050 | 28.356 | 9.868 | 15.635 | 68.242 | 45.978 |
| Germany | 9.365 | 2.833 | 4.618 | 17.303 | 14.771 | 14.353 | 4.377 | 8.351 | 30.838 | 23.036 |
| Italy | 128.430 | 38.388 | 61.398 | 238.905 | 201.759 | 159.947 | 45.968 | 85.354 | 286.095 | 250.427 |
| Netherlands | 11.843 | 4.234 | 6.120 | 29.082 | 19.385 | 17.106 | 5.930 | 9.270 | 35.053 | 28.157 |
| *Median* | 15.741 | 5.729 | 8.383 | 38.540 | 26.217 | 22.731 | 7.899 | 12.453 | 51.648 | 37.067 |
| | Panel B: CR14 – first differences (bp) | | | | | | | | | |
| | $\Delta$ euro CDS premium | | | | | $\Delta$ dollar CDS premium | | | | |
| | $\mu$ | $\sigma$ | *S* | *K* | *VaR* | $\mu$ | $\sigma$ | *S* | *K* | *VaR* |
| France | -0.011 | 1.000 | -1.952 | 88.316 | 0.917 | -0.010 | 1.325 | -2.127 | 90.198 | 1.211 |
| Germany | -0.003 | 0.517 | -0.637 | 41.368 | 0.537 | -0.002 | 0.585 | 1.014 | 58.439 | 0.642 |
| Italy | 0.009 | 6.228 | 3.209 | 71.390 | 7.828 | 0.025 | 6.907 | 3.310 | 70.587 | 7.946 |
| Netherlands | -0.001 | 0.476 | 1.002 | 20.079 | 0.698 | -0.004 | 0.586 | 1.444 | 19.622 | 0.907 |
| *Median* | -0.002 | 0.759 | 0.182 | 56.379 | 0.807 | -0.003 | 0.955 | 1.229 | 64.513 | 1.059 |

*Notes:* Data are daily from Markit for the period 10/1/2014 to 4/28/2020 and reported in basis points.

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# Summary Statistics (CDS CR)

| | Panel A: CR – levels (bp) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | euro CDS premium | | | | | dollar CDS premium | | | | |
| | $\mu$ | $\sigma$ | *min* | *max* | *VaR* | $\mu$ | $\sigma$ | *min* | *max* | *VaR* |
| France | 14.051 | 6.467 | 5.007 | 33.824 | 25.848 | 20.057 | 8.849 | 8.448 | 48.151 | 35.973 |
| Germany | 7.696 | 2.987 | 3.756 | 16.235 | 13.364 | 11.811 | 4.455 | 6.170 | 27.570 | 19.954 |
| Italy | 91.621 | 24.906 | 41.287 | 167.143 | 130.667 | 114.443 | 28.731 | 58.001 | 206.021 | 161.110 |
| Netherlands | 9.863 | 4.439 | 4.180 | 20.892 | 18.154 | 14.861 | 6.312 | 6.715 | 32.630 | 26.285 |
| *Median* | 11.957 | 5.453 | 4.593 | 27.358 | 22.001 | 17.459 | 7.580 | 7.581 | 40.391 | 31.129 |
| | Panel B: CR – first differences (bp) | | | | | | | | | |
| | $\Delta$ euro CDS premium | | | | | $\Delta$ dollar CDS premium | | | | |
| | $\mu$ | $\sigma$ | *S* | *K* | *VaR* | $\mu$ | $\sigma$ | *S* | *K* | *VaR* |
| France | -0.011 | 0.691 | 3.009 | 88.316 | 0.753 | -0.013 | 0.911 | 4.452 | 90.198 | 0.951 |
| Germany | -0.005 | 0.520 | -0.364 | 41.368 | 0.605 | -0.005 | 0.520 | 0.636 | 58.439 | 0.587 |
| Italy | -0.011 | 4.286 | 0.989 | 71.390 | 5.359 | 0.002 | 5.012 | 1.432 | 70.587 | 5.984 |
| Netherlands | -0.004 | 0.477 | 1.052 | 20.079 | 0.723 | -0.006 | 0.619 | 1.864 | 19.622 | 0.839 |
| *Median* | -0.008 | 0.605 | 1.021 | 56.379 | 0.738 | -0.005 | 0.765 | 1.648 | 64.513 | 0.895 |

*Notes:* Data are daily from Markit for the period 10/1/2014 to 4/28/2020 and reported in basis points.

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# Decomposition: Algebra

- Start from definition of redenomination premium in dollars:

$$RP^{\$} = CDS^{\$,CR14} - CDS^{\$,CR}$$

- Add and subtract the euro premium for contracts CR and CR14:

$$RP^{\$} = CDS^{\$,CR14} + (CDS^{\cancel{€},CR14} - CDS^{\cancel{€},CR14}) - CDS^{\$,CR} + (CDS^{\cancel{€},CR} - CDS^{\cancel{€},CR})$$

- Apply the definition of quanto: $Q = CDS^{\cancel{€}} - CDS^{\$}$, and rearrange terms:

$$RP^{\$} = RP^{\cancel{€}} + (Q^{CR} - Q^{CR14})$$

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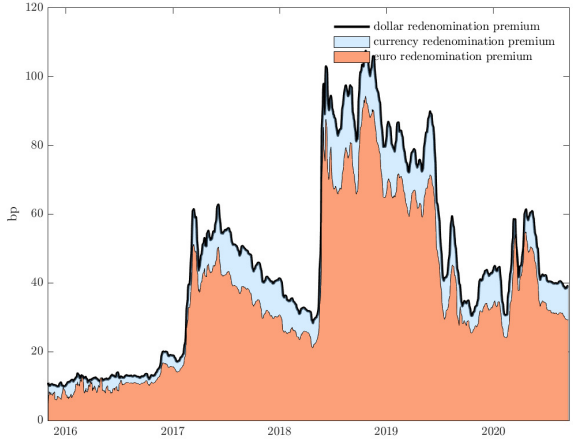
# Decomposing the Redenomination Premium (Italy, Long Sample)

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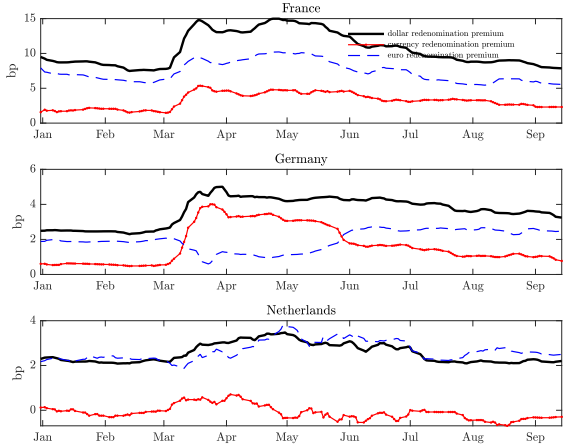
# Decomposing the Redenomination Premium (France, Germany & the Netherlands)

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# Liquidity Premia

- We consider aggregate liquidity shocks to the CDS market by estimating liquidity Premia:
  - the first two principal components of the differences in the CDS premia between CR and CR14 contracts for non-G7 Eurozone countries (which account for $\approx$ 90% of total variation).

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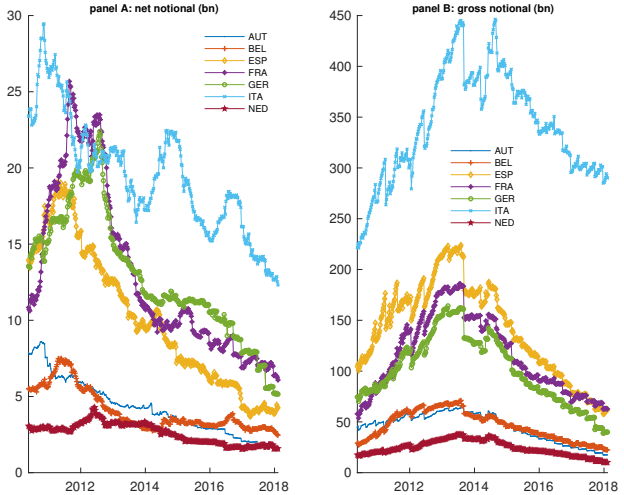
# CDS Notionals

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# Summary Statistics (Bid/Ask spread)

| | $\mu$ | $\sigma$ | *min* | *max* | *median* | *VaR* |
|---|---|---|---|---|---|---|
| | Panel A: baseline sample | | | | | |
| Belgium | 6.000 | 0.000 | 6.000 | 6.000 | 6.000 | 6.000 |
| Finland | 4.000 | 0.000 | 4.000 | 4.000 | 4.000 | 4.000 |
| France | 4.733 | 1.255 | 3.743 | 7.657 | 3.743 | 6.991 |
| Germany | 3.701 | 1.257 | 2.693 | 6.839 | 2.693 | 5.718 |
| Ireland | 8.573 | 1.174 | 6.160 | 10.604 | 9.374 | 9.374 |
| Italy | 6.513 | 2.866 | 3.660 | 14.080 | 4.789 | 12.296 |
| Portugal | 20.000 | 0.000 | 20.000 | 20.000 | 20.000 | 20.000 |
| Spain | 7.000 | 0.000 | 7.000 | 7.000 | 7.000 | 7.000 |
| Netherlands | 5.000 | 0.000 | 5.000 | 5.000 | 5.000 | 5.000 |
| | Panel B: alternative sample | | | | | |
| Belgium | 5.975 | 0.220 | 4.000 | 6.000 | 6.000 | 6.000 |
| Finland | 4.000 | 0.000 | 4.000 | 4.000 | 4.000 | 4.000 |
| France | 4.356 | 2.098 | 2.856 | 22.734 | 4.000 | 5.344 |
| Germany | 3.448 | 0.951 | 2.353 | 9.978 | 3.350 | 4.491 |
| Ireland | 10.000 | 2.035 | 5.246 | 30.876 | 9.390 | 12.905 |
| Italy | 7.137 | 2.090 | 1.473 | 13.627 | 7.365 | 10.000 |
| Portugal | 19.900 | 0.957 | 10.000 | 20.000 | 20.000 | 20.000 |
| Spain | 6.985 | 0.173 | 5.000 | 7.000 | 7.000 | 7.000 |
| Netherlands | 4.990 | 0.128 | 3.000 | 5.000 | 5.000 | 5.000 |

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# Country-Level Characteristics

| | Panel A: GDP | | | | | | Panel B: PUBLIC DEBT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Austria | 3.35 | 3.34 | 3.37 | 3.37 | 3.40 | 3.40 | 3.04 | 3.13 | 3.11 | 3.02 | 2.94 | 2.86 |
| Belgium | 4.05 | 4.04 | 4.06 | 4.06 | 4.06 | 4.06 | 4.68 | 4.69 | 4.74 | 4.73 | 4.73 | 4.76 |
| Finland | 2.08 | 2.05 | 2.05 | 2.06 | 2.07 | 2.07 | 1.34 | 1.44 | 1.44 | 1.44 | 1.43 | 1.45 |
| France | 21.57 | 21.31 | 21.10 | 20.90 | 20.75 | 20.75 | 22.13 | 22.50 | 23.01 | 23.53 | 23.83 | 24.23 |
| Germany | 29.41 | 29.37 | 29.60 | 29.54 | 29.49 | 29.49 | 24.03 | 23.40 | 22.80 | 22.07 | 21.30 | 20.90 |
| Ireland | 1.96 | 2.55 | 2.57 | 2.71 | 2.86 | 2.86 | 2.21 | 2.16 | 2.11 | 2.10 | 2.12 | 2.08 |
| Italy | 16.35 | 16.04 | 16.01 | 15.81 | 15.57 | 15.57 | 23.90 | 23.98 | 24.03 | 24.27 | 24.51 | 24.54 |
| Netherlands | 6.75 | 6.69 | 6.69 | 6.72 | 6.83 | 6.83 | 4.89 | 4.73 | 4.56 | 4.33 | 4.50 | 4.54 |
| Portugal | 4.13 | 4.17 | 4.03 | 4.25 | 4.38 | 4.38 | 2.50 | 2.52 | 2.58 | 2.58 | 2.57 | 2.55 |
| Spain | 10.37 | 10.44 | 10.52 | 10.58 | 10.60 | 10.60 | 11.28 | 11.46 | 11.61 | 11.93 | 12.08 | 12.10 |
| | Panel C: STOCK MARKET CAP | | | | | | Panel B: BANK ASSETS | | | | | |
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Austria | 1.39 | 1.38 | 1.40 | 1.77 | 1.60 | 1.49 | 98.98 | 98.98 | 97.52 | 93.89 | 90.06 | – |
| Belgium | 7.30 | 7.70 | 8.75 | 7.76 | 6.49 | 5.83 | 98.35 | 98.49 | 96.57 | 91.70 | 86.50 | – |
| Finland | 4.58 | 4.56 | 4.55 | 4.27 | 4.58 | 3.98 | 99.87 | 99.79 | 98.11 | 94.25 | 91.05 | – |
| France | 27.11 | 27.09 | 27.55 | 27.58 | 30.20 | 31.38 | 97.82 | 98.18 | 96.60 | 92.49 | 88.37 | – |
| Germany | 22.85 | 23.10 | 22.31 | 22.28 | 21.47 | 21.10 | 99.84 | 99.84 | 98.42 | 94.70 | 90.80 | – |
| Ireland | 1.86 | 2.28 | 2.05 | 2.23 | 1.97 | 1.99 | 92.65 | 84.62 | 81.06 | 77.36 | 75.64 | – |
| Italy | 9.26 | 9.89 | 8.72 | 9.28 | 8.73 | 9.02 | 95.20 | 94.79 | 92.90 | 89.06 | 84.67 | – |
| Netherlands | 11.22 | 10.59 | 11.74 | 11.99 | 12.60 | 13.86 | 99.86 | 99.74 | 98.40 | 95.44 | 92.69 | – |
| Portugal | 1.11 | 1.17 | 1.08 | 1.10 | 1.12 | 1.06 | 99.50 | 99.54 | 97.64 | 93.61 | 90.74 | – |
| Spain | 13.32 | 12.24 | 11.84 | 11.73 | 11.22 | 10.28 | 98.24 | 98.05 | 96.50 | 92.61 | 88.23 | – |

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# Multiple-regression CoVaR (I/II)

- The Elastic Net combines LASSO and ridge methods and minimizes the following loss function:

$$L(\delta_\theta, \boldsymbol{\beta}_\theta) = \frac{1}{T-1} \sum_{t=2}^{T} \rho_\theta \left( x_{N,t} - \delta_\theta - \boldsymbol{\beta}_\theta \mathbf{Z}_t' \right) + \nu \left[ \alpha ||\boldsymbol{\beta}_\theta||_1 + \frac{1-\alpha}{2} ||\boldsymbol{\beta}_\theta||_2^2 \right],$$

where $\nu > 0$ and $0 \leq \alpha \leq 1$.

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# Multiple-regression CoVaR (I/II)

- We compute the multiple-regression CoVaR (MCoVaR) of the $N$-th sovereign conditional on the state of the $i$-th sovereign (for $i = 1, \cdots, N-1$) as:

$$MCoVaR_{t,\theta,\tau}^{x_{N,t}|x_{i,t}=\widehat{q}_\tau(x_{i,t})} = \widehat{\delta}_\theta + \sum_{\substack{j=1 \\ j\neq i}}^{N-1} \widehat{\lambda}_{j,\theta} x_{j,t} + \widehat{\lambda}_{i,\theta} \widehat{q}_\tau(x_{i,t}) + \widehat{\boldsymbol{\phi}}_\theta \mathbf{F}_t' + \widehat{\boldsymbol{\gamma}}_\theta \mathbf{M}_{t-1}',$$

and obtain the $\Delta$MCoVaR as:

$$\Delta MCoVaR_\theta^{x_N|x_i} = \widehat{\lambda}_{i,\theta} \left[ \widehat{q}_\tau(x_{i,t}) - \widehat{q}_{1/2}(x_{i,t}) \right].$$

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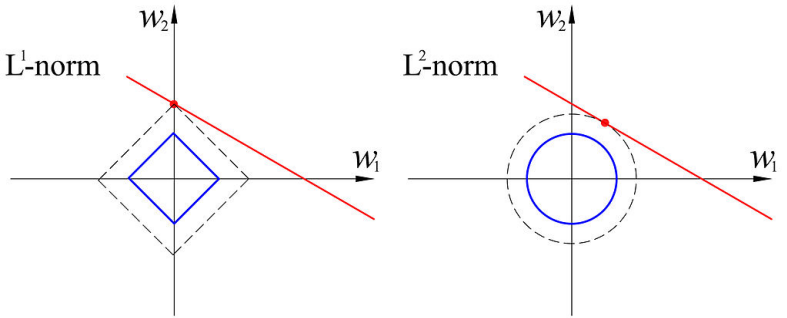
# L1 and L2 Norms

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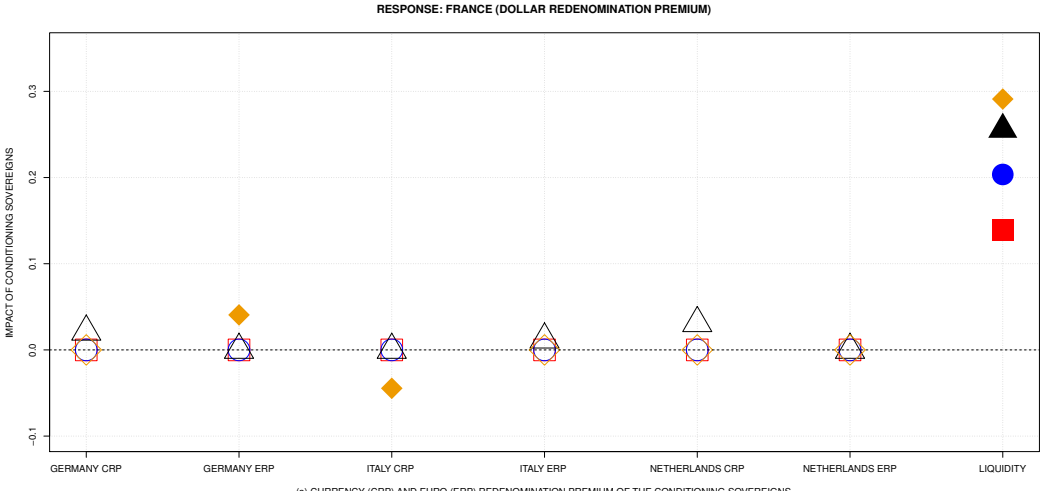
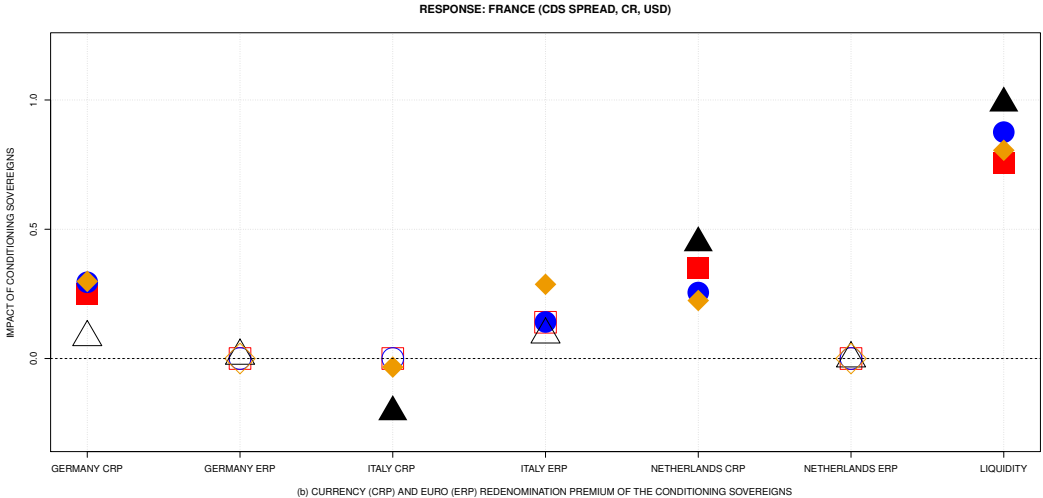
# Term Structure of Redenomination Risk Spillovers: France (I/II)

Figure: Model #1



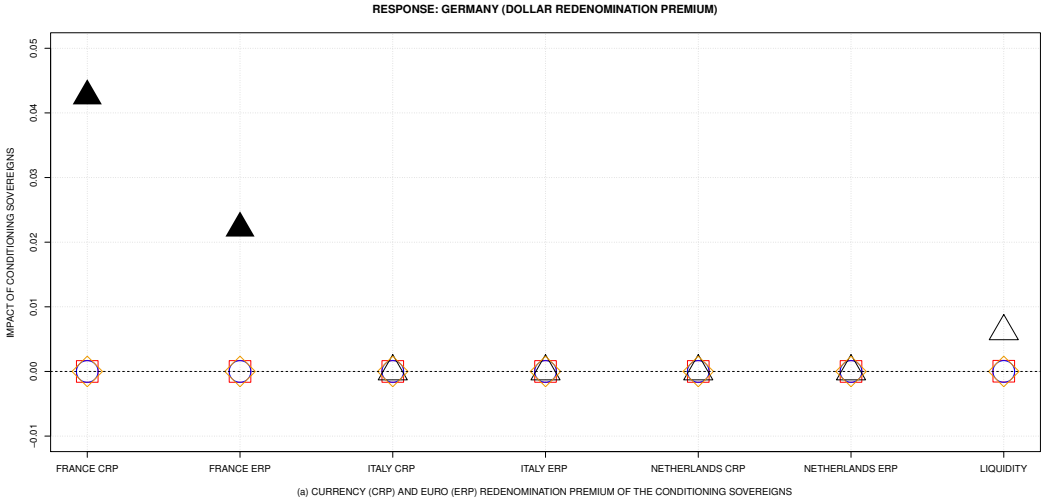
# Term Structure of Default Premium Spillovers: France (II/II)

Figure: Model #2



# Term Structure of Redenomination Risk Spillovers: Germany (I/II)

Figure: Model #1



# Term Structure of Default Premium Spillovers: Germany (II/II)

Figure: Model #2