

RISK ASSESSMENT OF EURO SOVEREIGN DEBT LIABILITIES VIA A PROBABILISTIC APPROACH

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Università Bocconi Milano

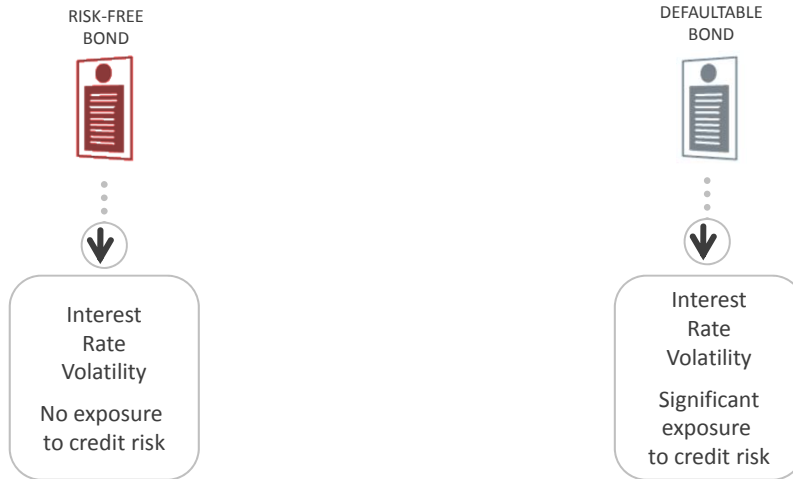


Syllabus

- Bond Pricing and Implied Probability Distributions
- Key credit risk indicators
- CDS and Sovereigns
- The Basis: arbitrage strategies and related issues

Unbundling and Probabilistic performance scenarios

The returns evaluation requires the estimate of all the relevant risk factors connected with the financial structure of each product



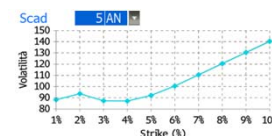
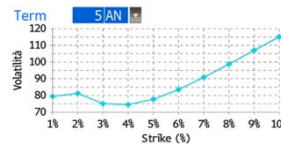
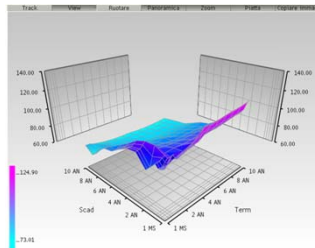
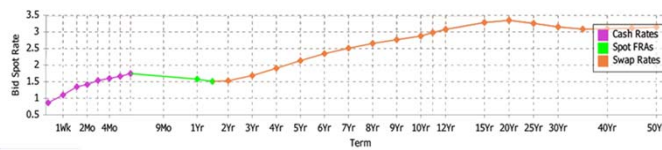
Unbundling and Probabilistic performance scenarios

RISK-FREE BOND



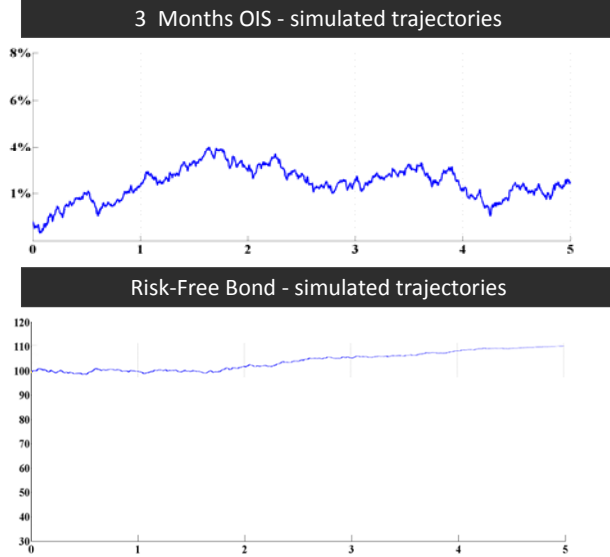
Interest Rate Volatility
No exposure to credit risk

Markets data are used to estimate the relevant risk factors connected with the financial structure of the product



Unbundling and Probabilistic performance scenarios

RISK-FREE BOND

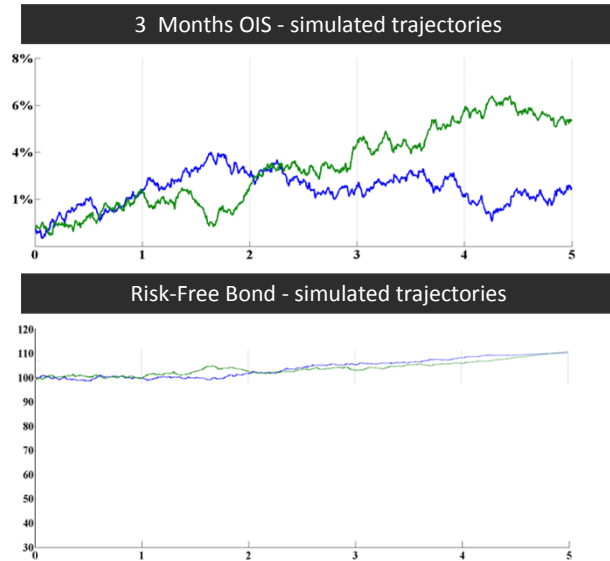


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Unbundling and Probabilistic performance scenarios

RISK-FREE BOND



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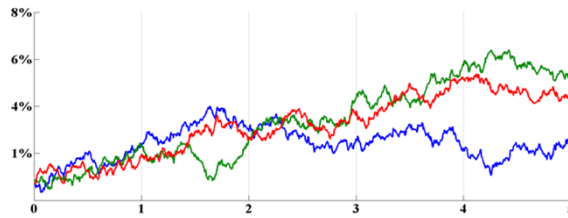
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Unbundling and Probabilistic performance scenarios

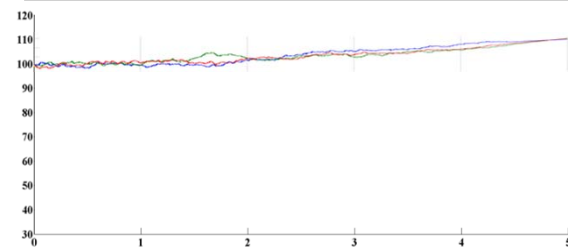
RISK-FREE BOND



3 Months OIS - simulated trajectories



Risk-Free Bond - simulated trajectories



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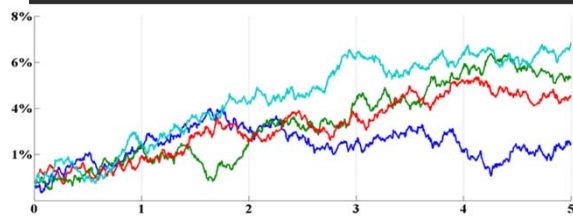
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Unbundling and Probabilistic performance scenarios

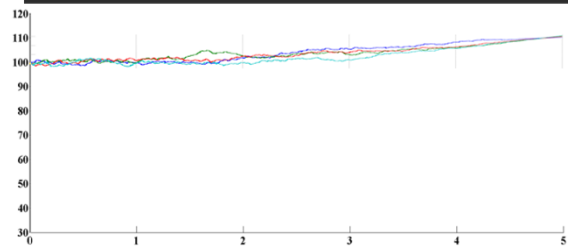
RISK-FREE BOND



3 Months OIS - simulated trajectories



Risk-Free Bond - simulated trajectories



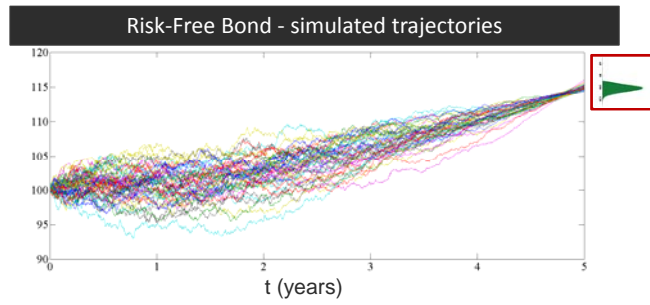
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Unbundling and Probabilistic performance scenarios

RISK-FREE BOND

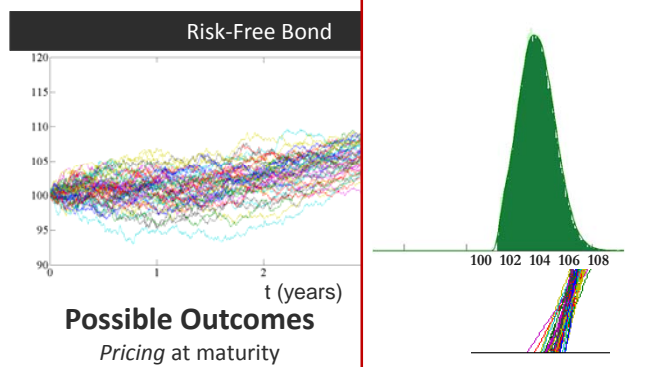
No exposure to credit risk corresponds to zero trajectories incurring in a *default event*.



Unbundling and Probabilistic performance scenarios

RISK-FREE BOND

No exposure to credit risk corresponds to zero trajectories incurring in a *default event*.

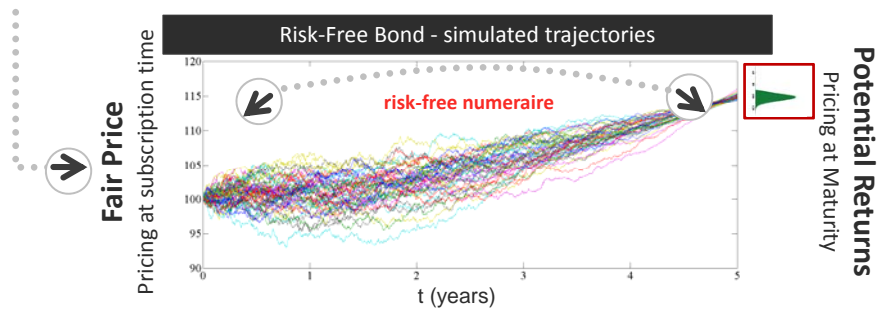


Unbundling and Probabilistic performance scenarios

RISK-FREE BOND



... the "fair value" of the product at the issue date is obtained, like in the *best practice* of the pricing procedures of intermediaries, by evaluating the expected discounted value of this distribution under the risk-neutral measure.

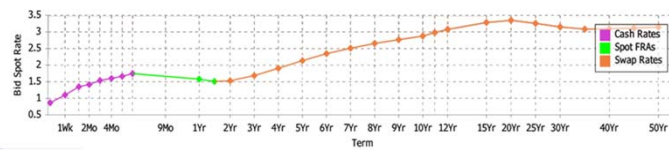


Unbundling and Probabilistic performance scenarios

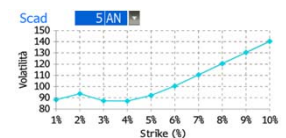
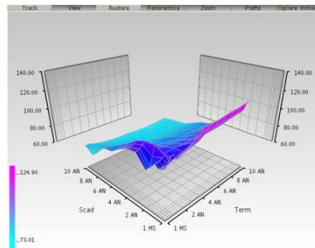
DEFAULTABLE BOND



Markets data are used to estimate the relevant risk factors connected with the financial structure of the product



Interest Rate
Volatility
Significant exposure to credit risk

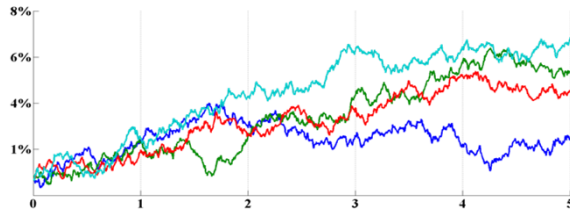


Unbundling and Probabilistic performance scenarios

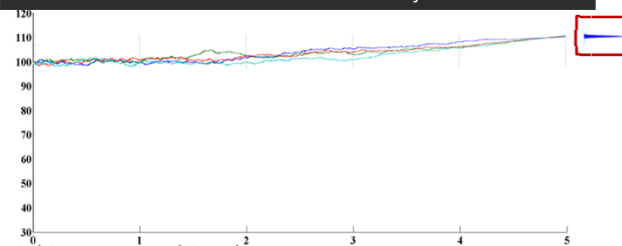
DEFAULTABLE
BOND



3 Months OIS - simulated trajectories



Defaultable Bond - simulated trajectories



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Unbundling and Probabilistic performance scenarios

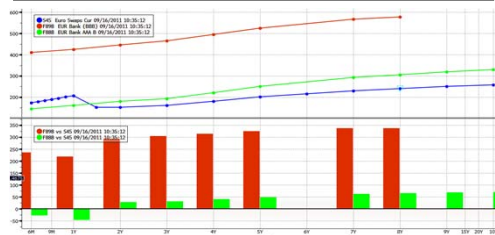
DEFAULTABLE
BOND



Interest
Rate
Volatility
**Significant
exposure
to credit risk**

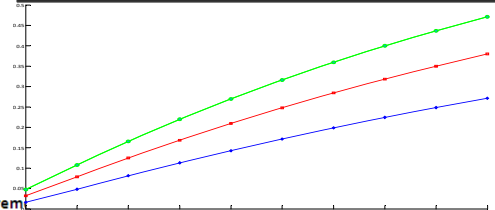
Markets data are used to estimate the relevant risk factors connected with the financial structure of the product

Yield curve for different issuers



By standard bootstrapping techniques the term structure of default probabilities can be easily obtained from the implied credit spread (= Yield - Risk-Free Rate)

PD Term Structure



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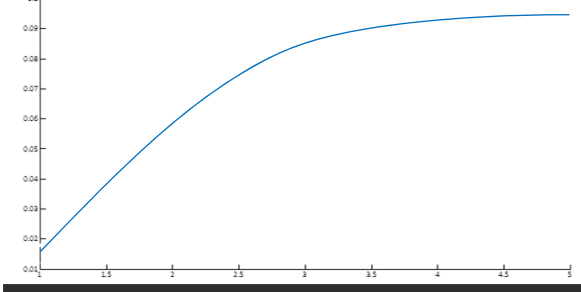
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Unbundling and Probabilistic performance scenarios

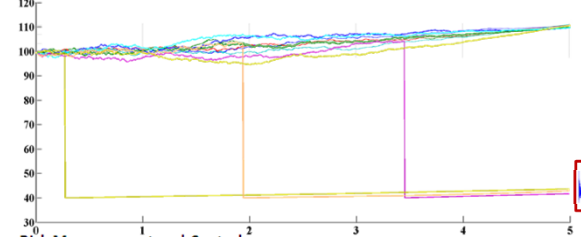
DEFAULTABLE
BOND



PD Term Structure



Defaultable Bond - simulated trajectories



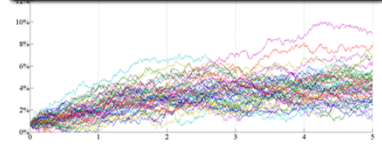
Unbundling and Probabilistic performance scenarios

DEFAULTABLE
BOND

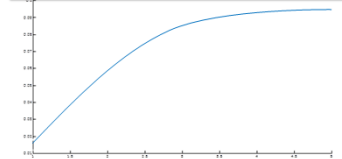


The risk factors define the product values over time and at expiry date

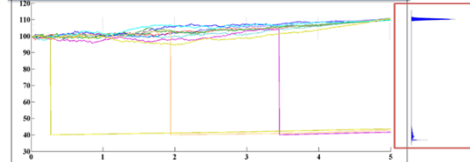
3 Months OIS - simulated trajectories



PD Term Structure



Defaultable Bond - simulated trajectories

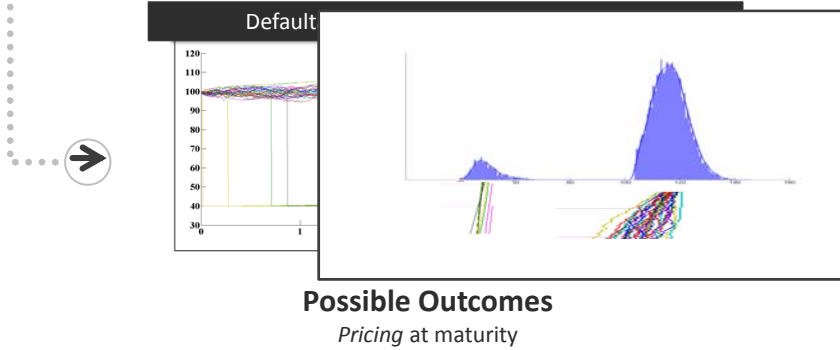


Unbundling and Probabilistic performance scenarios

DEFAULTABLE
BOND



The final values of the product provide the probability distribution of the potential returns (so-called *pricing at maturity*)...

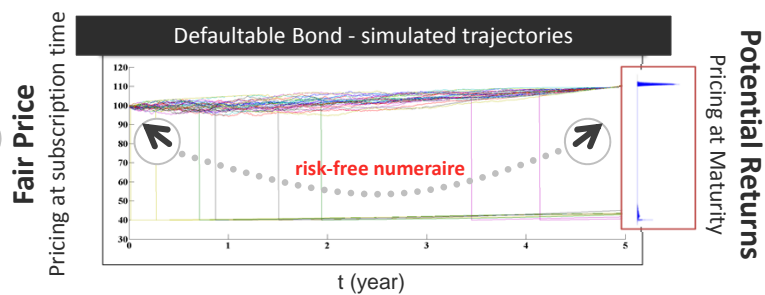


Unbundling and Probabilistic performance scenarios

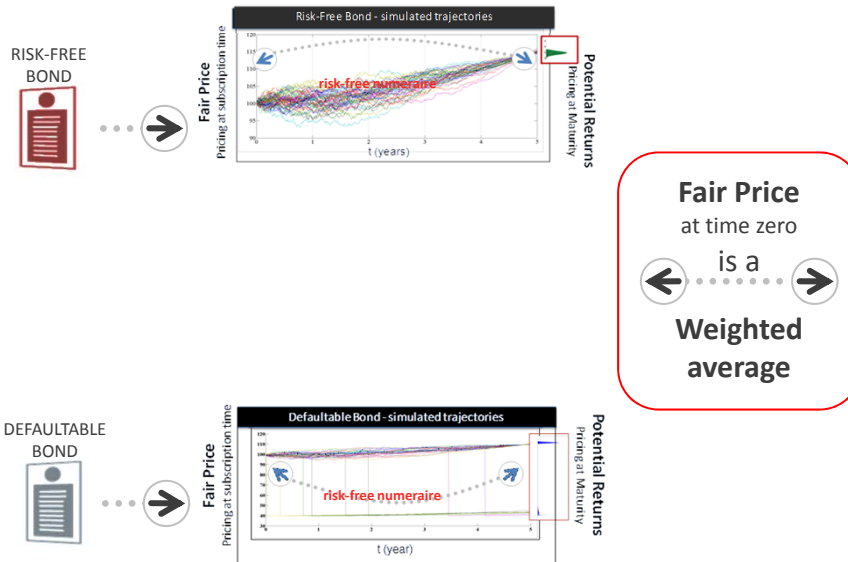
DEFAULTABLE
BOND



... the "*fair value*" of the product at the issue date is obtained, like in the *best practice* of the pricing procedures of intermediaries, by evaluating the expected discounted value of this distribution under the risk-neutral measure.



Unbundling and Probabilistic performance scenarios



Unbundling and Probabilistic performance scenarios



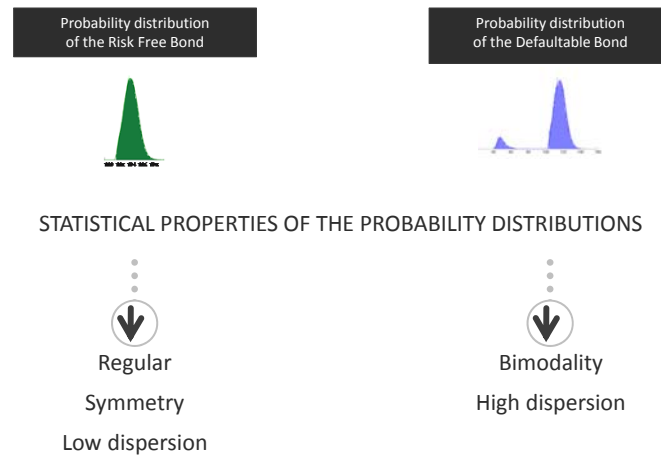
Working Hypothesis: The calculated fair price is the same for completely different financial structures

Unbundling and Probabilistic performance scenarios



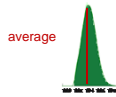
Question: How much information about the original probability distribution the price will convey in each case analyzed?

Unbundling and Probabilistic performance scenarios

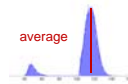


Unbundling and Probabilistic performance scenarios

Probability distribution
of the Risk Free Bond



Probability distribution
of the Defaultable Bond



STATISTICAL PROPERTIES OF THE PROBABILITY DISTRIBUTIONS



Regular

Symmetry

Low dispersion



Bimodality

High dispersion



The price and the corresponding average at expiry date – in presence of **IRREGULAR** distributions – provide a partial and misleading information. Hence, they should be complemented with additional information related to the shape of the probability distribution

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Unbundling and Probabilistic performance scenarios

 **IRREGULAR DISTRIBUTIONS**

The additional information to be supplemented must



be easy to understand for
the average investor



capture efficiently all the main
statistical characteristics of the
probability distribution of the product

Unbundling and Probabilistic performance scenarios

! IRREGULAR DISTRIBUTIONS

The additional information to be supplemented must



be easy to understand for the average investor



capture efficiently all the main statistical characteristics of the probability distribution of the product



Solution:

Perform a reduction in granularity by implementing a partition of the probability distribution

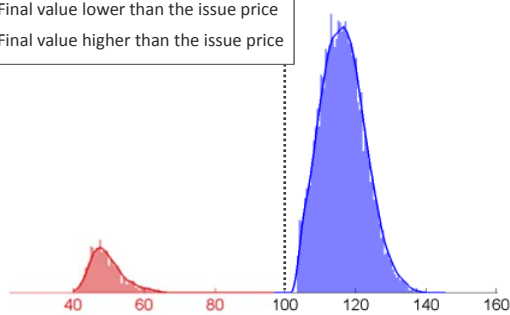
Unbundling and Probabilistic performance scenarios

DEFAULTABLE BOND

Partition of the Probability distribution of the Defaultable Bond with respect to the point of zero return



Final value lower than the issue price
Final value higher than the issue price



The assessment of the probability of recovering at least the amount paid for the product is of great significance for the investor.

Unbundling and Probabilistic performance scenarios

DEFAULTABLE BOND

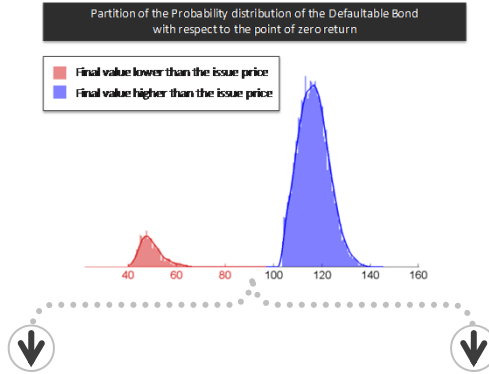
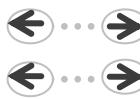


Table of the probabilistic performance scenarios

Scenarios	Probabilities	Mean values
The return is negative	9.44%	49.3
The return is positive	90.56%	116.13

MEAN VALUES



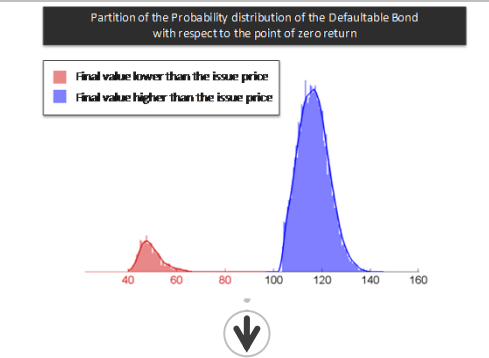
$$E^P(S_T | S_T < 100) = \frac{\int_{-\infty}^{100} x f_{S_T}(x) dx}{P(S_T < 100)}$$



$$E^P(S_T | S_T \geq 100) = \frac{\int_{100}^{+\infty} x f_{S_T}(x) dx}{P(S_T \geq 100)}$$

Unbundling and Probabilistic performance scenarios

DEFAULTABLE BOND



The reduction in granularity of the events determined by the partition involves only a very limited loss of information and the table, built by coupling for each scenario its risk-neutral probability and the associated mean value, is very easy to read

Unbundling and Probabilistic performance scenarios

! IRREGULAR DISTRIBUTIONS

The additional information to be supplemented must



✓ be easy to understand for the average investor



✓ capture efficiently all the main statistical characteristics of the probability distribution of the product

the partition should be done by choosing events that have a strong financial meaning for the investor

the reduction in granularity of the events involves only a very limited loss of information



Solution:

Perform a reduction in granularity by implementing a partition of the probability distribution

The Application of the methodology to Sovereign Bonds

ITALY GOVT BOND
5 YEARS



IRR = 4.67%

FRANCE GOVT BOND
5 YEARS



IRR = 1.74%

SPAIN GOVT BOND
5 YEARS



IRR = 4.73%

Fair Price
at time zero
100

=

Fair Price
at time zero
100

=

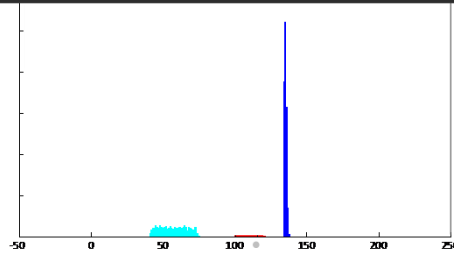
Fair Price
at time zero
100

The Application of the methodology to Sovereign Bonds

ITALY GOVT BOND
5 YEARS



Partition of the Probability distribution of the Defaultable Bond with respect to the point of zero return



Scenarios	Probabilities	Mean values
The return is negative	26.47%	51.57
The return is positive	73.53%	124.01

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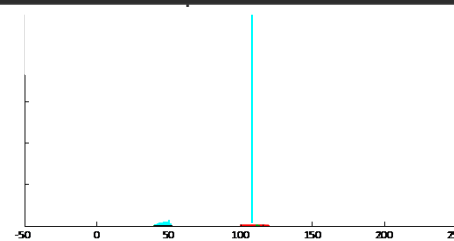
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The Application of the methodology to Sovereign Bonds

FRANCE GOVT BOND
5 YEARS



Partition of the Probability distribution of the Defaultable Bond with respect to the point of zero return



Scenarios	Probabilities	Mean values
The return is negative	7.25%	45.22
The return is positive	92.75%	108.94

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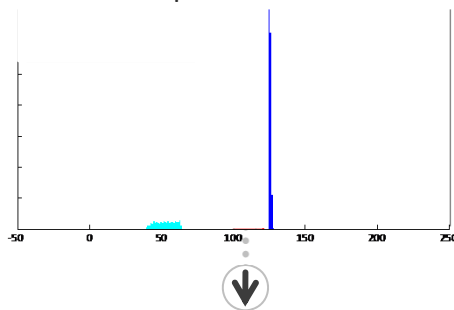
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The Application of the methodology to Sovereign Bonds

SPAIN GOVT BOND
5 YEARS



Partition of the Probability distribution of the Defaultable Bond
with respect to the point of zero return



Scenarios	Probabilities	Mean values
The return is negative	28.75%	50.73
The return is positive	71.25%	125.32

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Syllabus

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- CDS and Sovereigns
- The Basis: arbitrage strategies and related issues

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The Application of the methodology to Sovereign Bonds

Key credit risk indicators

CDS Spread



unfunded asset: credit risk

BOND Coupon (CPN)



funded asset: credit risk + funding risk

The Application of the methodology to Sovereign Bonds

Key credit risk indicators

CDS Spread



unfunded asset: credit risk

BOND Coupon (CPN)



funded asset: credit risk + funding risk

CPN – risk-free rate = BOND Spread

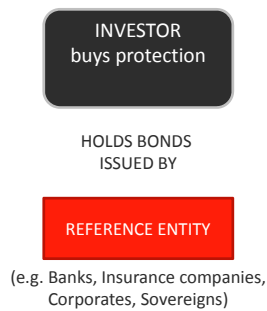


unfunded asset: credit risk

The Application of the methodology to Sovereign Bonds

Key credit risk indicators: **CDS spreads**

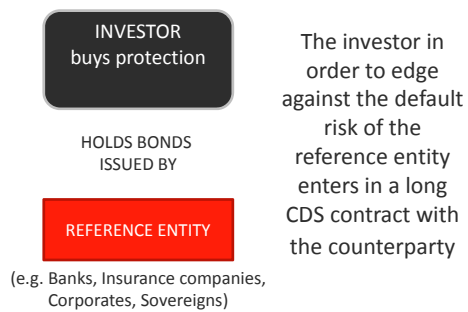
They represent the cost paid to buy an insurance against a credit event



The Application of the methodology to Sovereign Bonds

Key credit risk indicators: **CDS spreads**

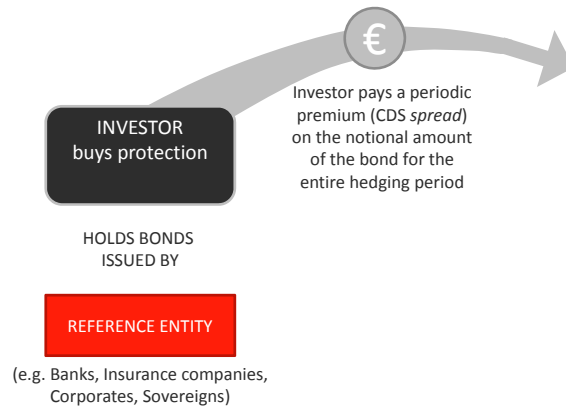
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The Application of the methodology to Sovereign Bonds

Key credit risk indicators: CDS spreads

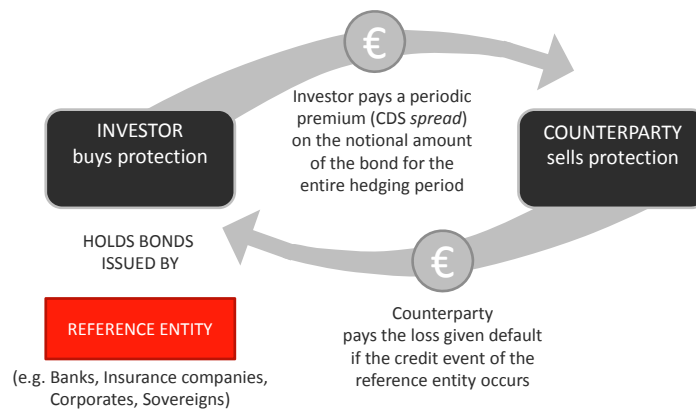
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The Application of the methodology to Sovereign Bonds

Key credit risk indicators: CDS spreads

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The Application of the methodology to Sovereign Bonds

Key credit risk indicators: CDS spreads

They represent the cost paid to buy an insurance against a credit event

What's the meaning of **CDS** for sovereigns?



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The Application of the methodology to Sovereign Bonds

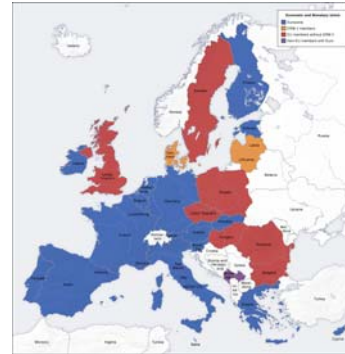
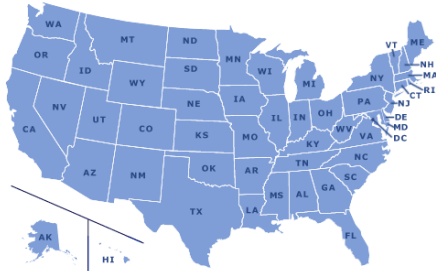
SINGLE CURRENCY AREAS



Federal Reserve Bank

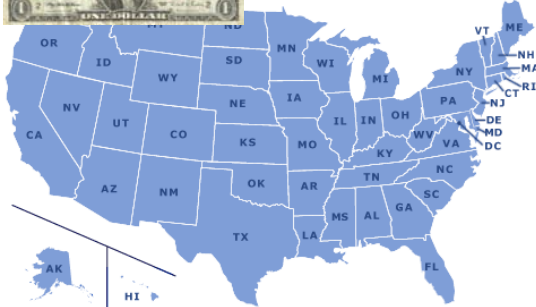


European Central Bank



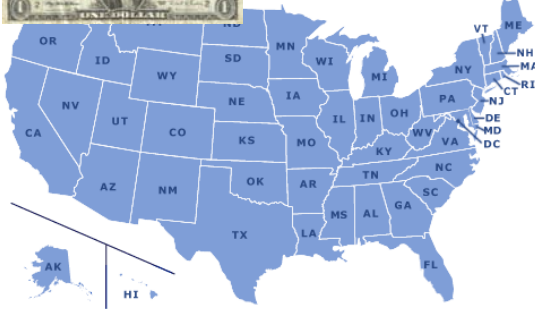
The Application of the methodology to Sovereign Bonds

SINGLE CURRENCY AREAS



The Fed sets the monetary policy by influencing the amount of the available domestic currency and the credit conditions of the economy in order to maximize the employment rate, to achieve prices stability and to moderate long-term interest rates

SINGLE CURRENCY AREAS

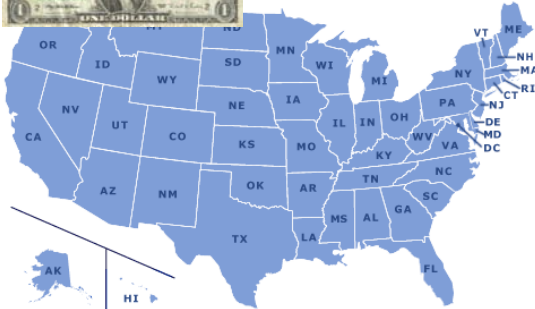


The Fed sets the monetary policy by influencing the amount of the available domestic currency and the credit conditions of the economy in order to maximize the employment rate, to achieve prices stability and to moderate long-term interest rates

The FED's statute does not exclude recourse to inflationary monetary policy in times of recession to preserve employment.

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SINGLE CURRENCY AREAS



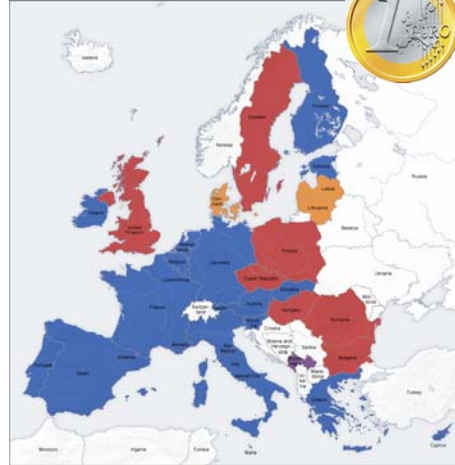
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The FED's statute does not exclude recourse to inflationary monetary policy in times of recession to preserve employment. **On the contrary individual States cannot exercise any independent monetary policy.**

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SINGLE CURRENCY AREAS

The ECB monitors inflation in order to keep stable the purchasing power of the euro.



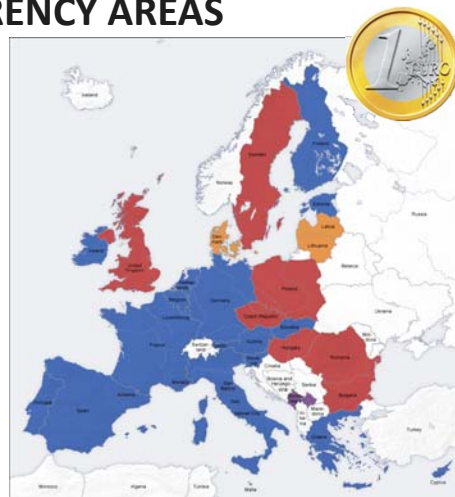
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SINGLE CURRENCY AREAS

The ECB monitors inflation in order to keep stable the purchasing power of the euro.

The ECB's statute does not admit inflationary monetary policies to counter-cyclical purposes.

Euro zone members States
Inflationary monetary policy: NO



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The Application of the methodology to Sovereign Bonds

SINGLE CURRENCY AREAS

The ECB monitors inflation in order to keep stable the purchasing power of the euro.

The ECB's statute does not admit inflationary monetary policies to counter-cyclical purposes.

Euro zone members States
Inflationary monetary policy: NO

New EU members must enter the euro zone through a preliminary agreement of fixed exchange rates (ERM2).

EU members States outside euro zone
Inflationary monetary policy: YES



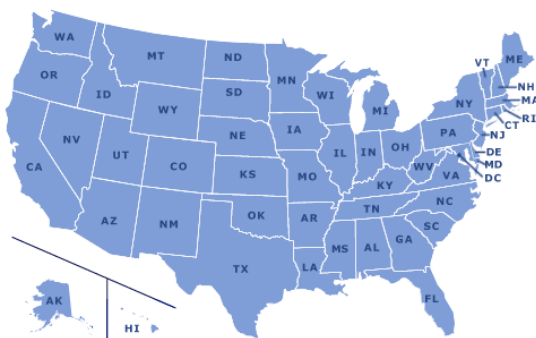
Montenegro, although not belonging to the European Union, adopted the euro as official currency.

The Application of the methodology to Sovereign Bonds

SINGLE CURRENCY AREAS



CDS Sovereign USA
48.30 bps (june 2012)



Measures the risk that the U.S. government does not reimburse its bonds after the FED has tried to manage conditions of financial distress by coining money and, hence, creating inflation and depreciating the USD.

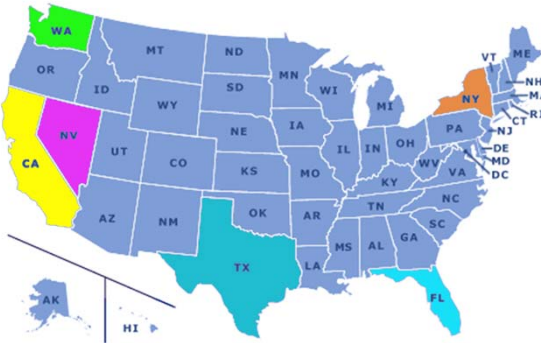
The Application of the methodology to Sovereign Bonds

SINGLE CURRENCY AREAS



CDS single States of the US
(june 2012)

Measures the risk that the State does not reimburse its bonds without the possibility of delaying this event by coining money.



USA	48.30 bps
Washington	92.42 bps
California	193.95 bps
Nevada	122.83 bps
Texas	81.60 bps
Florida	113.97 bps
New York	117.21 bps

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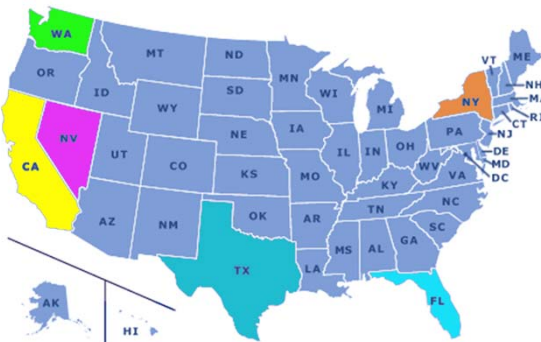
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the higher CDS spreads of single States reflect the lack of monetary sovereignty

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The Application of the methodology to Sovereign Bonds

SINGLE CURRENCY AREAS

Euro zone sovereign CDS (june 2012)

Euro zone members States
No inflationary monetary policy

New EU members must enter the euro zone through a preliminary agreement of fixed exchange rates (ERM2).

Measures the risk that the state does not reimburse its bonds without the possibility of delaying this event by coining money.

France	199.50 bps
Italy	554.27 bps
Spain	623.25 bps



The Application of the methodology to Sovereign Bonds

SINGLE CURRENCY AREAS

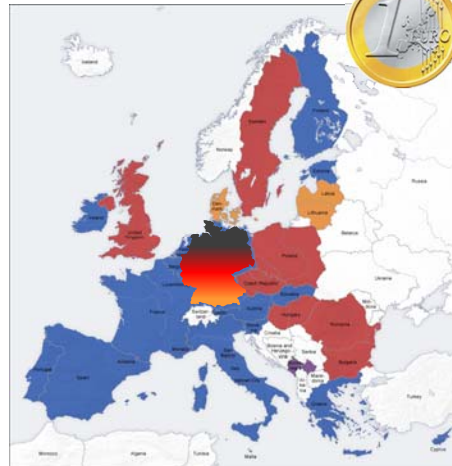
Euro zone sovereign CDS (june 2012)

Euro zone members States
No inflationary monetary policy

New EU members must enter the euro zone through a preliminary agreement of fixed exchange rates (ERM2).

Measures the risk that the state does not reimburse its bonds without the possibility of delaying this event by coining money.

Germany	103.00 bps ?
France	199.50 bps
Italy	554.27 bps
Spain	623.25 bps



The Application of the methodology to Sovereign Bonds

SINGLE CURRENCY AREAS

EU States outside euro zone CDS
(june 2012)

EU members States outside euro zone

Inflationary monetary policy: YES

Measures the risk that the state does not reimburse its bonds with the possibility of delaying this event by coining money and, hence, creating inflation and depreciating their respective currencies.

Sweden **62.53 bps**

UK **72.50 bps**

Czech Rep. **133.33 bps**

Poland **222.25 bps**



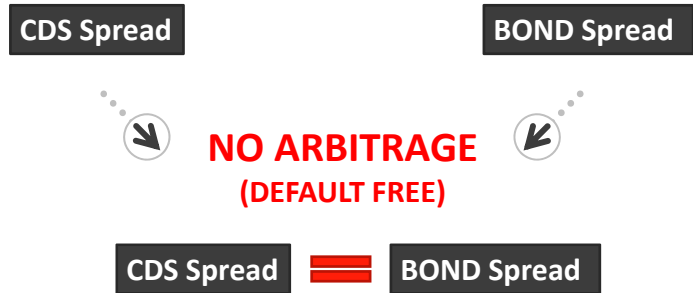
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Syllabus

- Bond Pricing and Implied Probability Distributions
- Key credit risk indicators
- CDS and Sovereigns
- The Basis: arbitrage strategies and related issues

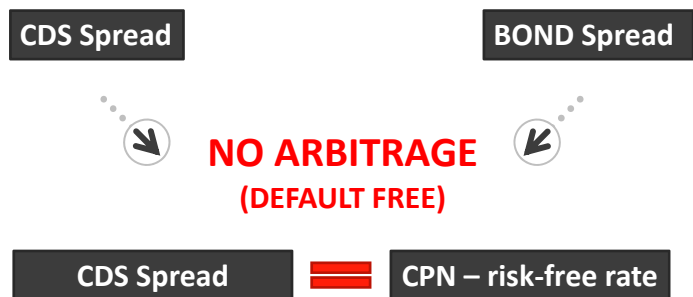
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Key credit risk indicators



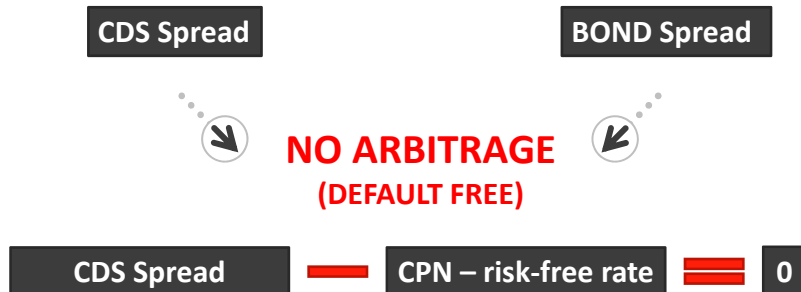
The Application of the methodology to Sovereign Bonds

Key credit risk indicators



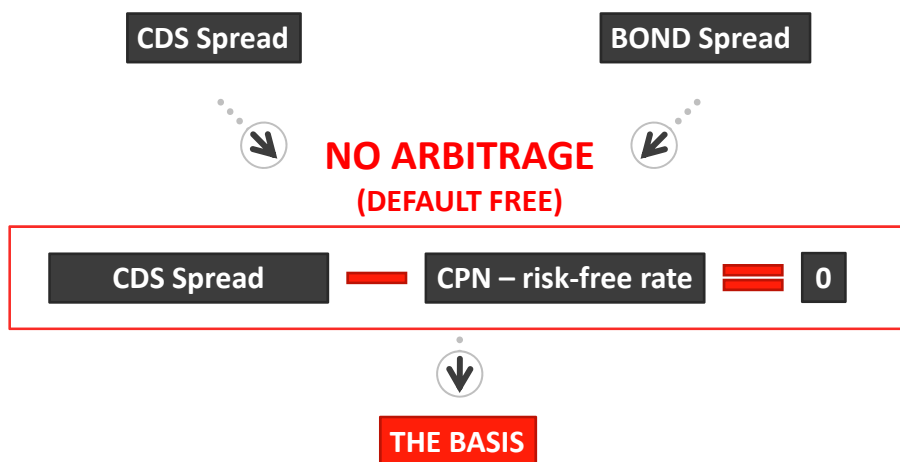
The Application of the methodology to Sovereign Bonds

Key credit risk indicators



The Application of the methodology to Sovereign Bonds

Key credit risk indicators



The Application of the methodology to Sovereign Bonds

The Basis

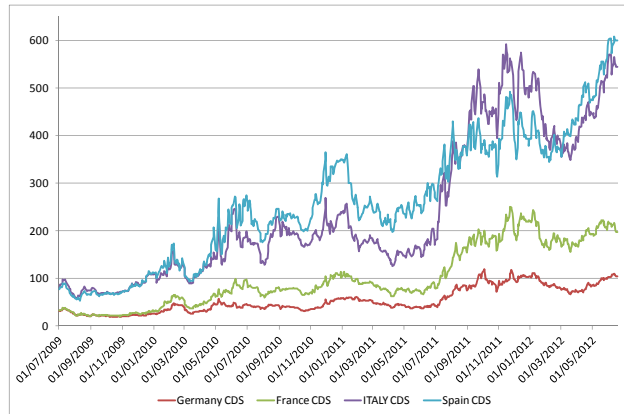
CDS Spread



CPN – risk-free rate



0



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The Application of the methodology to Sovereign Bonds

The Basis

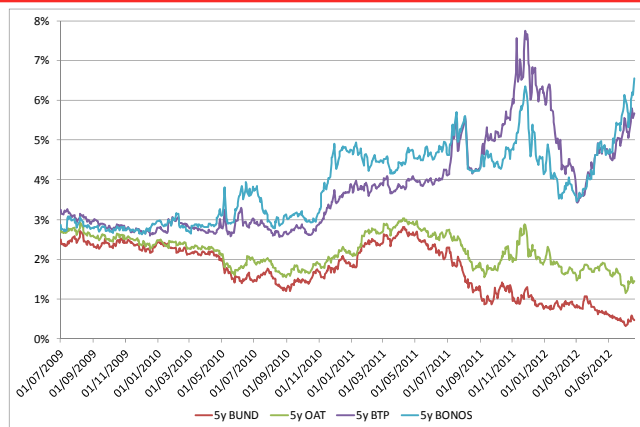
CDS Spread



CPN – risk-free rate



0



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The Basis

$$\text{CDS Spread} = \text{CPN} - \text{risk-free rate} = 0$$



SPAIN BASIS



ITALY BASIS



FRANCE BASIS



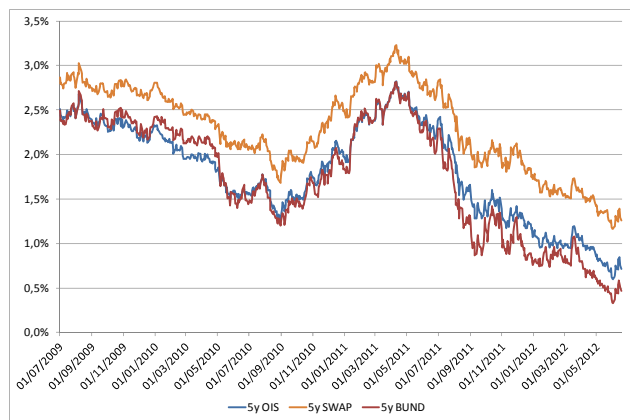
GERMANY BASIS

Eurozone States have
different Basis

The Application of the methodology to Sovereign Bonds

The Basis

$$\text{CDS Spread} = \text{CPN} - \text{risk-free rate} = 0$$



The Application of the methodology to Sovereign Bonds

The Basis

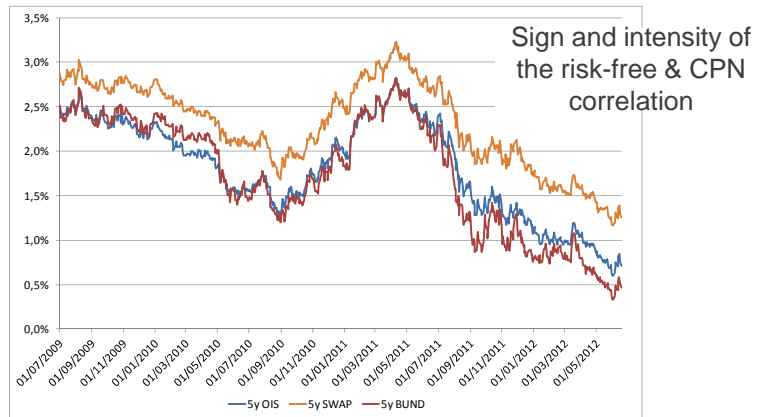
CDS Spread



CPN – risk-free rate



0



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The Application of the methodology to Sovereign Bonds

The Basis

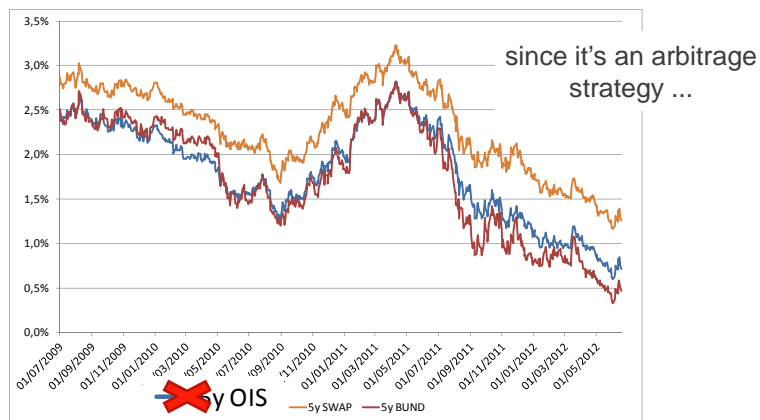
CDS Spread



CPN – risk-free rate



0



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The Application of the methodology to Sovereign Bonds

The Basis

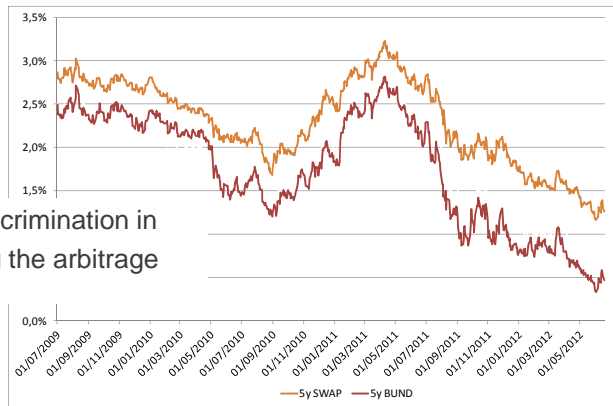
CDS Spread



CPN – risk-free rate



0



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The Application of the methodology to Sovereign Bonds

The Basis

CDS Spread



CPN – risk-free rate



?

**Banks discrimination in
accessing the arbitrage**

**Eurozone States have
different Basis**

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Positive/Negative Basis: Rationale

CDS Spread



CPN – risk-free rate



0

Settlement risk

market micro failures

(i.e. liquidity issues)

market disruptions

(i.e. sovereign default,
euro break-up)

Positive/Negative Basis: Rationale

CDS Spread



CPN – risk-free rate



0

Settlement risk

market micro failures

(i.e. liquidity issues)

market disruptions

(i.e. sovereign default,
euro break-up)

**Funding/collateralization
benefits**

Interbank

ECB

The Application of the methodology to Sovereign Bonds

Positive/Negative Basis: Rationale



Settlement risk
market micro failures
(i.e. liquidity issues)
market disruptions
(i.e. sovereign default,
euro break-up)

**Funding/collateralization
benefits**
Interbank
ECB

The Application of the methodology to Sovereign Bonds

Positive/Negative Basis: Rationale

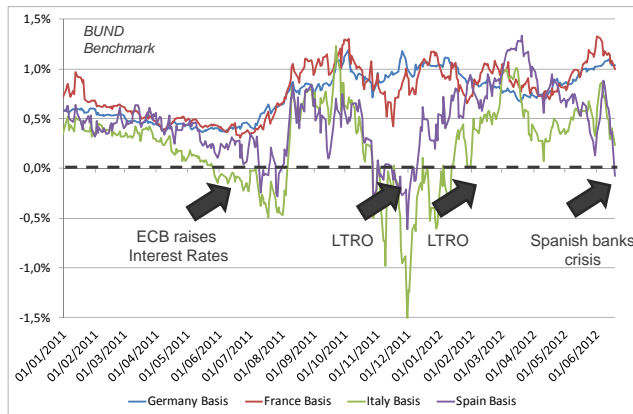


Settlement risk
market micro failures
(i.e. liquidity issues)
market disruptions
(i.e. sovereign default,
euro break-up)

**Funding/collateralization
benefits**
Interbank
ECB

The Application of the methodology to Sovereign Bonds

Negative basis as a signal of market disruptions



The Application of the methodology to Sovereign Bonds

Key credit risk indicators

ARBITRAGE STRATEGIES

must be



POSITIVE BASIS
CDS > BOND CPN – risk-free rate

Arbitrage strategy:

- Sell the CDS
- Sell the bond
(borrowed with a repo agreement)
- Gain a risk-free profit

The Application of the methodology to Sovereign Bonds

Key credit risk indicators

ARBITRAGE STRATEGIES

must be

$$\text{THE BASIS} = 0$$

NEGATIVE BASIS

$$\text{CDS} < \text{BOND CPN} - \text{risk-free rate}$$

Arbitrage strategy:

Borrow money at the "risk-free" rate

Buy the CDS

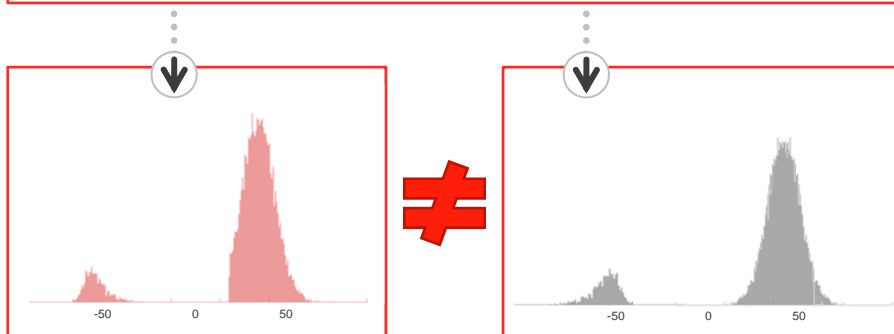
Buy the bond

Gain a risk-free profit

The Application of the methodology to Sovereign Bonds

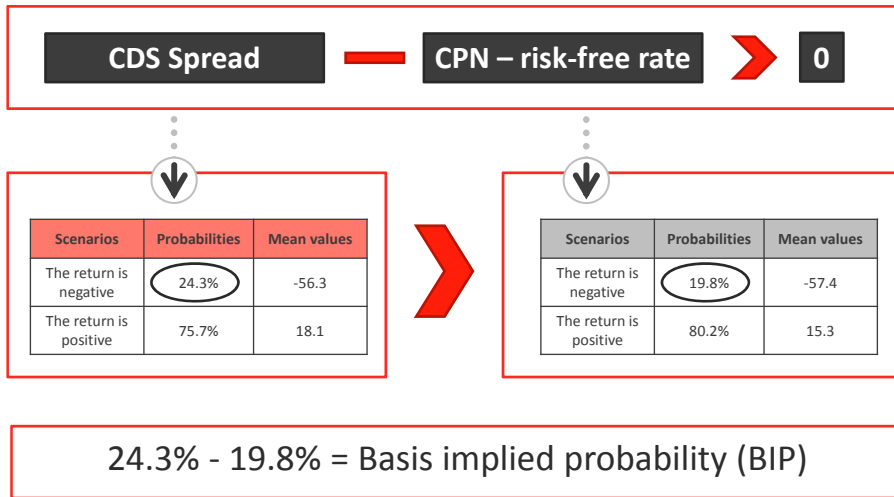
The Basis

$$\text{CDS Spread} - \text{CPN} - \text{risk-free rate} \neq 0$$



The Application of the methodology to Sovereign Bonds

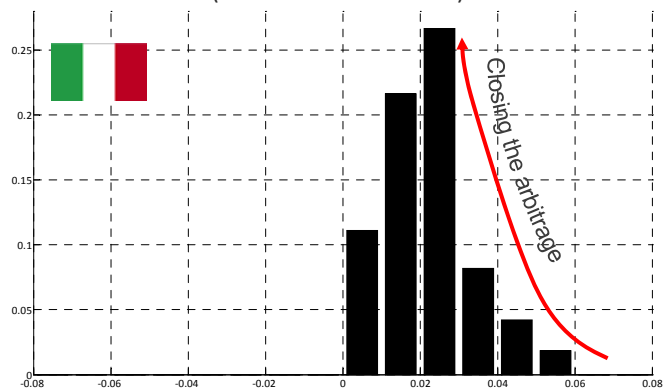
Positive basis



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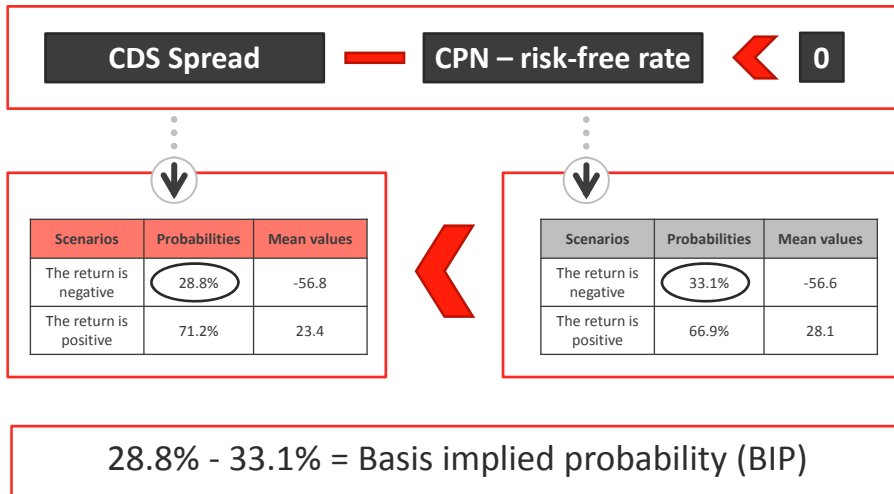
Positive BIP distribution

(Jan. 2011 – June 2012)



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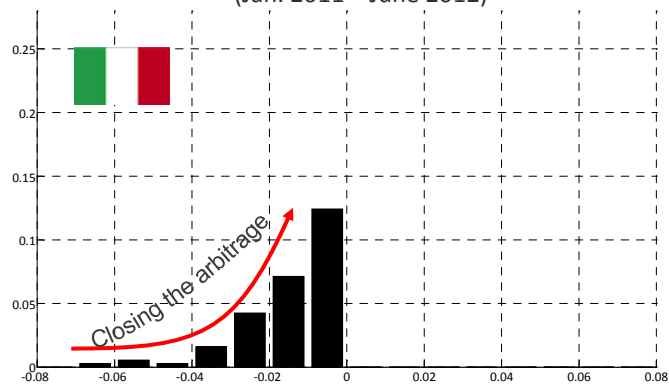
Negative basis



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Negative BIP distribution

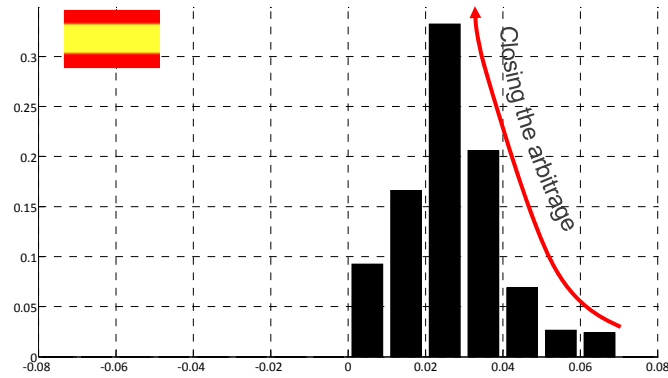
(Jan. 2011 – June 2012)



The Application of the methodology to Sovereign Bonds

Positive BIP distribution

(Jan. 2011 – June 2012)



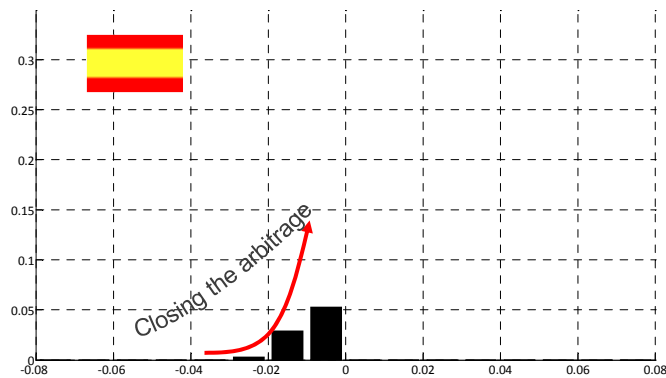
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The Application of the methodology to Sovereign Bonds

Negative BIP distribution

(Jan. 2011 – June 2012)



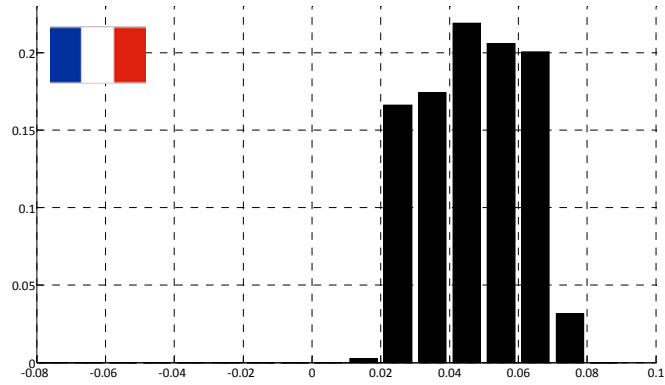
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The Application of the methodology to Sovereign Bonds

Positive BIP distribution

(Jan. 2011 – June 2012)



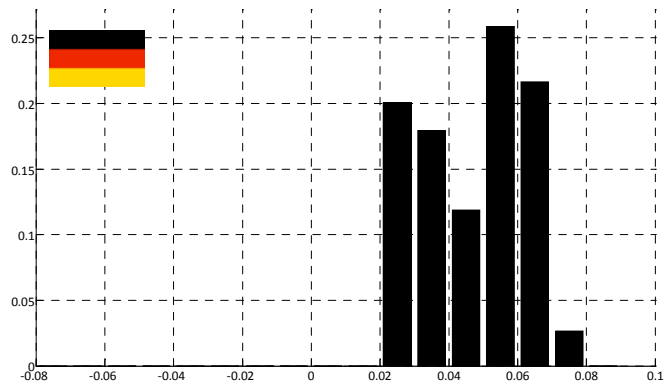
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The Application of the methodology to Sovereign Bonds

Positive BIP distribution

(Jan. 2011 – June 2012)

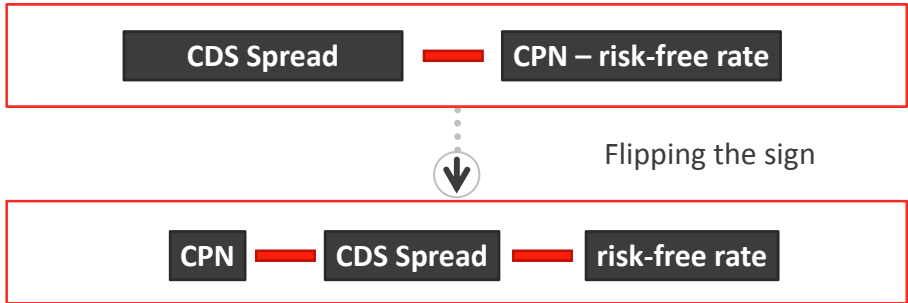


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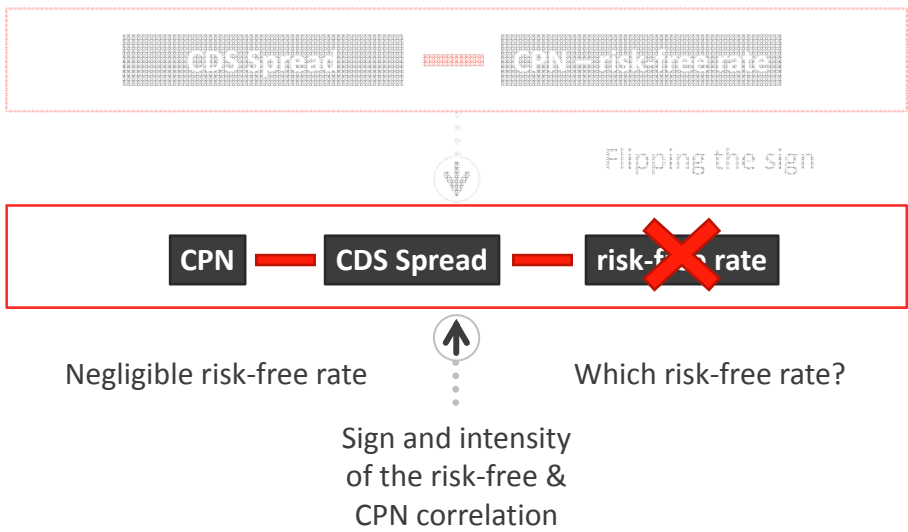
The Application of the methodology to Sovereign Bonds

The basis and the risk-free rate issues



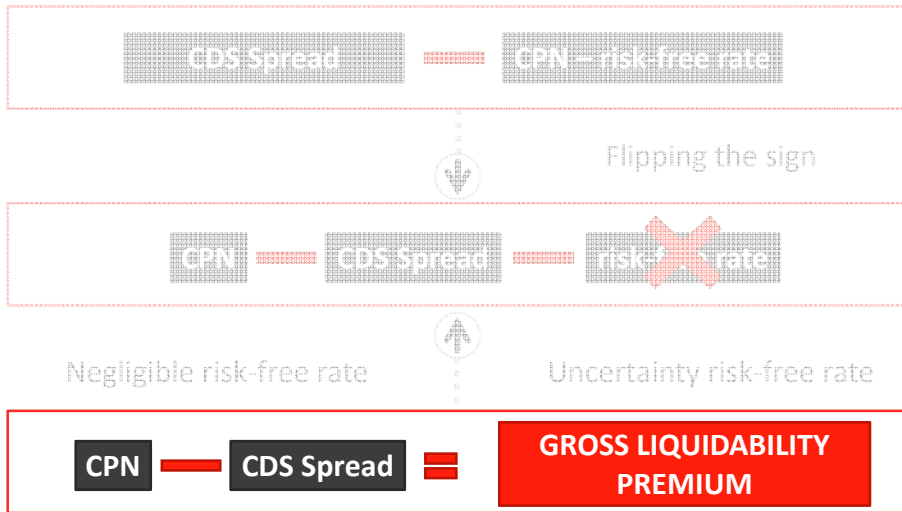
The Application of the methodology to Sovereign Bonds

The basis and the risk-free rate issues



The Application of the methodology to Sovereign Bonds

The basis and the risk-free rate issues



The Application of the methodology to Sovereign Bonds

The basis and the risk-free rate issues



The Application of the methodology to Sovereign Bonds

The basis and the risk-free rate issues

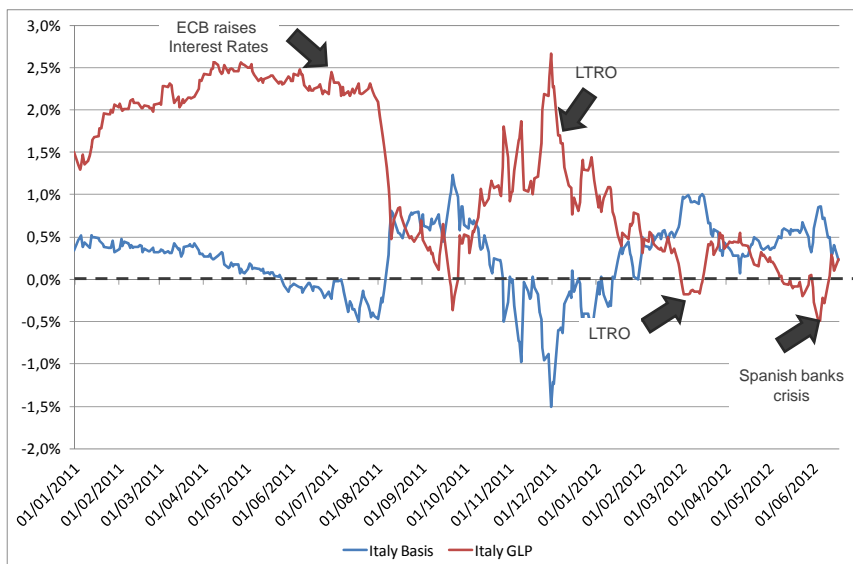
$$\text{CDS Spread} - \text{CPN} - \text{risk-free rate} = \text{THE BASIS} \leftarrow 0$$



$$\text{CPN} - \text{CDS Spread} = \text{GROSS LIQUIDABILITY PREMIUM} \rightarrow 0$$

Negative basis implies deep positive GLP as an indicator of market distressed conditions

The Application of the methodology to Sovereign Bonds



The Application of the methodology to Sovereign Bonds

The basis and the risk-free rate issues

$$\text{CDS Spread} - \text{CPN} - \text{risk-free rate} = \text{THE BASIS} \rightarrow 0$$



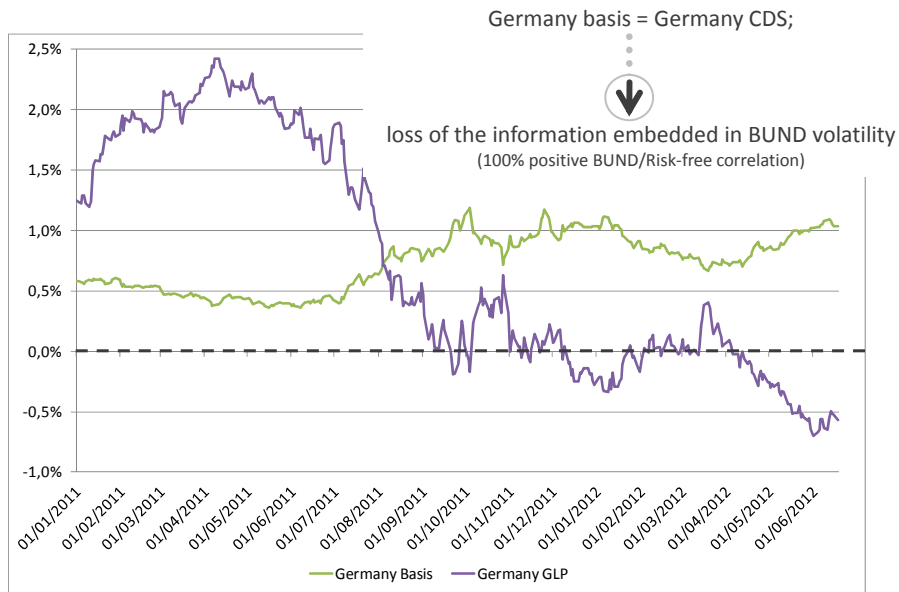
$$\text{CPN} - \text{CDS Spread} = \text{GROSS LIQUIDABILITY PREMIUM} \leftarrow 0$$

Negative GLP implies deep positive basis and hence "flight to quality"

The Application of the methodology to Sovereign Bonds



The Application of the methodology to Sovereign Bonds



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RISK ASSESSMENT OF EURO SOVEREIGN DEBT LIABILITIES VIA A PROBABILISTIC APPROACH

Contract Prof. Marcello Minenna
Università Bocconi Milano

