# Managing Sovereign Credit Risk in Bond Portfolios

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# Outline

1. Some facts
   - Rediscovering the sovereign credit risk
   - The eurozone crisis
2. Measuring the risk of sovereign bond portfolios
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   - Defining the risk measure and risk contributions
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3. Implications for the management of bond portfolios
   - Fundamental indexation
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   - Comparison of the indexing schemes
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# Major financial crises

- 200 sovereign external defaults and 68 internal defaults since 1800
- 1982 (Mexico, Latin America)
- 1997 (Asia, Russia)
- 2001 (Turkey, Argentina)

Sovereign credit risk concerns generally emerging markets:

Argentina (1982-83, 1989, 1995, 2001), Brazil (1982, 1987, 1990, 1994, 1998-99), Mexico (1982, 1989, 1994-95), Nigeria (1987, 1989, 1996, 1999), Pakistan (1983, 2000), Philippine (1983, 1997), Turkey (1982, 1994, 1999, 2001), etc.

⇒ Costs may be huge: Argentina (55% of GDP, 1980-82), Japan (10% of GDP, 1990s), Chile (41% of GDP, 1981-87), Israel (30% of GDP, 1977-83), United States (3% of GDP, 1980s), Sweden (10% of GDP, 1990-93), etc.

*Source*: Crockett (1997), Wyplosz (1999).

# Definition

The country risk encompasses three types of risk:

- External debt (e.g. Russian crisis)
- Banking system (e.g. U.S. savings and loan crisis)
- Financial crisis (e.g. Subprime crisis)

**Problem with sovereign risk lending (Kindleberger, 1939, 1978)**

1. Overenthusiasm
2. Loss of confidence
3. Credit rationing

**Instability as a public bad: market failures (Wyplosz, 1999)**

1. Moral hazard
2. Adverse selection
3. Multiple equilibria (bad/good)

Specificity of sovereign debt: it takes a long time to deleverage (e.g. Canada, 2000)

# The syndrome of this-time-is-different

*The essence of this-time-is-different syndrome is simple. It is rooted in the firmly held belief that* ***financial crises are things that happen to other people in other countries at other times****; crises do not happen to us, here and now. We are doing things better, we are smarter, we have learned from past mistakes. The old rules of valuation no longer apply. The current boom, unlike the many booms that preceded catastrophic collapses in the past (even in our country), is built on sound fundamentals, structural reforms, technological innovations, and good policy. Or so the story goes [...] Unfortunately, a* ***highly leveraged economy*** *can unwittingly be sitting with its back at the edge of a financial cliff for many years before chance and circumstance provoke a* ***crisis of confidence that pushes it off****.*

*Source: Reinhart and Rogoff (2009).*

# Debt crisis or Euro crisis?

- 2001-2007: No major financial crises
- 2007-2008: Subprime crisis
- September 2008: Bankruptcy of Lehman Brothers
- April 2010: Greece sovereign debt rating is cut to BB+
- August 2011: Downgrade of US government debt

**Theory of debt sustainability**

- Ponzi scheme
- Bubbles as payoffs at infinity
- Instability of the debt ratio dynamics (primary balance, real interest rate & output)

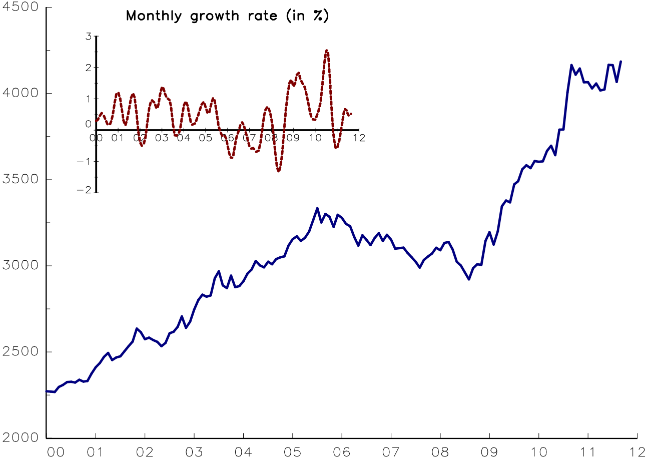
**Theory of optimum currency area**

It describes the optimal characteristics for the creation of a currency (e.g. a monetary union)

Is the eurozone an optimal currency area?

# The eurozone debt

## Evolution of the debt market value (in MEUR)




*Source*: Datastream.

# Exposure of investors to the eurozone risk

From domestic bonds to non-domestic bonds (since 2000) $\Rightarrow$ Diversification of sovereign bond portfolios

- Institutional investors
- Pension funds
- Retail ("contrat en euro")

Figure: Detention of the public debt in 2008

| Country | France | Germany | Greece | Italy | Portugal | Spain | UK |
|---|---|---|---|---|---|---|---|
| France | 29.2% | 9.1% | 16.8% | 9.4% | 26.6% | 12.9% | 3.4% |
| Germany | 5.9% | 26.5% | 9.5% | 6.2% | 16.3% | 13.1% | 2.3% |
| Italy | 3.1% | 3.0% | 6.7% | 47.4% | 4.5% | 1.8% | 0.9% |
| Japan | 4.1% | 5.1% | 2.1% | 2.2% | 1.1% | 1.2% | 2.1% |
| UK | 4.0% | 4.4% | 3.2% | 3.3% | 3.6% | 4.1% | 65.3% |
| US | 2.4% | 2.8% | 0.3% | 0.6% | 0.2% | 1.9% | 4.8% |
| Domestic | 29.2% | 26.5% | 22.0% | 47.4% | 1.3% | 36.4% | 65.3% |
| Non-resident | 70.8% | 73.5% | 78.0% | 52.6% | 98.7% | 63.6% | 34.7% |

*Source*: Broyer and Bruner (2010).

# Ratings or spreads?

Figure: Some popular measures of country risk

| Country | S&P Rating[1] | Euromoney Country Risk[2] | | Opacity Score[3] | CDS Spread (in bp) | |
|---|---|---|---|---|---|---|
| | | Score | Rank | | 01/09/11 | 04/10/11 |
| Austria | AAA | 84.01 | 13 | 16 | 123 | 186 |
| Belgium | AA+ | 77.81 | 19 | 19 | 249 | 309 |
| Finland | AAA | 86.96 | 8 | 9 | 64 | 85 |
| France | AAA | 80.90 | 16 | 23 | 163 | 201 |
| Germany | AAA | 84.98 | 11 | 17 | 76 | 122 |
| Greece | CCC | 52.38 | 65 | 31 | 2,291 | 5,736 |
| Ireland | BBB+ | 62.33 | 43 | 15 | 781 | 726 |
| Italy | A | 71.20 | 30 | 36 | 384 | 487 |
| Netherlands | AAA | 86.67 | 9 | 24 | 80 | 117 |
| Portugal | BBB- | 61.35 | 44 | 25 | 957 | 1,167 |
| Spain | AA | 66.71 | 36 | 26 | 376 | 391 |
| Norway | AAA | 93.44 | 1 | | 44 | 52 |
| Switzerland | AAA | 90.31 | 3 | 22 | 58 | 79 |
| Denmark | AAA | 89.21 | 4 | 15 | 100 | 153 |
| Sweden | AAA | 88.74 | 5 | 14 | 54 | 66 |
| Canada | AAA | 87.17 | 7 | 20 | | |
| United Kingdom | AAA | 80.22 | 17 | 18 | 76 | 102 |
| United States | AA+ | 82.10 | 15 | 22 | 52 | 52 |
| Japan | AA- | 74.66 | 25 | 25 | 102 | 155 |

[1] Sep. 15th 2011 [2] March 2011 [3] 2009, Milken Institute

# Choosing the right measure

- Volatility of price returns $\neq$ a good measure of sovereign credit risk
- Correlation of price returns $\neq$ a good measure of contagion
- A better measure is the yield spread, but it is difficult to compute because it is difficult to define the reference (risk-free) rate.

$\Rightarrow$ One of the best measure is the CDS spread (it does not depend on the currency, the yield curve or the duration).

# Some analytics

Let $S_i(t)$ be the spread of the $i^{\text{th}}$ country. We have[1]:

$$\mathrm{d}S_i(t) = \sigma_i^S \cdot S_i(t)^{\beta_i} \cdot \mathrm{d}W_i(t)$$

Moreover, we assume that the correlation between the brownian motions $W_i(t)$ and $W_j(t)$ is $\Gamma_{i,j}$.

**Remark**

$\beta = 0 \Rightarrow$ *Absolute variations of spread are Gaussian.*
$\beta = 1 \Rightarrow$ *Relative variations of spread are Gaussian.*

[1] The dynamics is the same as in the SABR model.

# Calibration of the $\beta_i$ parameter

We assume that we observe spreads at some known dates $t_0, \ldots, t_n$. Let $S_{i,j}$ be the observed spread for the $i^{\text{th}}$ country at date $t_j$. The log-likelihood function for the $i^{\text{th}}$ country is:

$$\begin{aligned} \ell &= -\frac{n}{2}\ln 2\pi - n \ln \sigma_i^S - \frac{1}{2}\sum_{j=1}^{n} \ln \left(t_j - t_{j-1}\right) - \\ & \beta_i \sum_{j=1}^{n} \ln S_{i,j-1} - \frac{1}{2}\sum_{j=1}^{n} \frac{\left(S_{i,j} - S_{i,j-1}\right)^2}{\left(\sigma_i^S S_{i,j-1}^{\beta_i}\right)^2} \end{aligned}$$

Figure: Results for the period January 2008-August 2011

| Country | AT | BE | FI | FR | DE | GR | IE | IT | NL | PT | ES | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| estimate | 0.996 | 1.017 | 0.816 | 0.786 | 0.899 | 1.070 | 0.836 | 1.157 | 0.793 | 1.013 | 1.148 | 0.957 |
| std-dev. | 1.10% | 2.00% | 1.60% | 1.60% | 2.00% | 1.10% | 0.70% | 1.70% | 0.90% | 1.10% | 2.10% | 1.45% |

$\Rightarrow$ We assume that $\beta_i = 1$.

# Estimation of the volatility $\sigma_i^S$

Figure: Statistics of $\sigma_i^S$

| Country | July-08 | July-09 | July-10 | July-11 | September-11 |
|---|---|---|---|---|---|
| Austria | 66.9% | 105.8% | 77.8% | 45.9% | 54.4% |
| Belgium | 73.3% | 88.9% | 78.0% | 57.2% | 65.8% |
| Finland | 106.8% | 97.9% | 75.2% | 49.8% | 55.7% |
| France | 78.2% | 91.8% | 97.7% | 57.3% | 63.9% |
| Germany | 81.3% | 98.5% | 74.9% | 48.8% | 55.7% |
| Greece | 67.5% | 65.8% | 94.7% | 49.4% | 56.8% |
| Ireland | 80.3% | 99.8% | 73.4% | 51.7% | 53.5% |
| Italy | 58.8% | 69.5% | 89.3% | 61.5% | 69.3% |
| Netherlands | 95.2% | 103.7% | 68.6% | 47.3% | 54.9% |
| Portugal | 66.9% | 72.0% | 116.6% | 53.5% | 58.3% |
| Spain | 72.4% | 76.8% | 90.2% | 58.9% | 64.6% |

$\Rightarrow \sigma_i^S$ decreases when $S_i(t)$ increases.

# Estimation of the contagion matrix

Figure: Estimated Γ matrix (January 2008)

| Country | AT | BE | FI | FR | DE | GR | IE | IT | NL | PT | ES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 100% | | | | | | | | | | |
| Belgium | 54% | 100% | | | | | | | | | |
| Finland | 27% | 34% | 100% | | | | | | | | |
| France | 55% | 60% | 42% | 100% | | | | | | | |
| Germany | 51% | 43% | 23% | 50% | 100% | | | | | | |
| Greece | 42% | 38% | 29% | 47% | 43% | 100% | | | | | |
| Ireland | 33% | 35% | 41% | 37% | 27% | 22% | 100% | | | | |
| Italy | 47% | 50% | 37% | 60% | 47% | 61% | 35% | 100% | | | |
| Netherlands | 22% | 38% | 32% | 29% | 17% | 4% | 29% | 22% | 100% | | |
| Portugal | 38% | 48% | 23% | 45% | 45% | 58% | 29% | 58% | 12% | 100% | |
| Spain | 35% | 49% | 22% | 33% | 33% | 35% | 28% | 41% | 30% | 41% | 100% |

⇒ The average correlation is 38%.

# Estimation of the contagion matrix

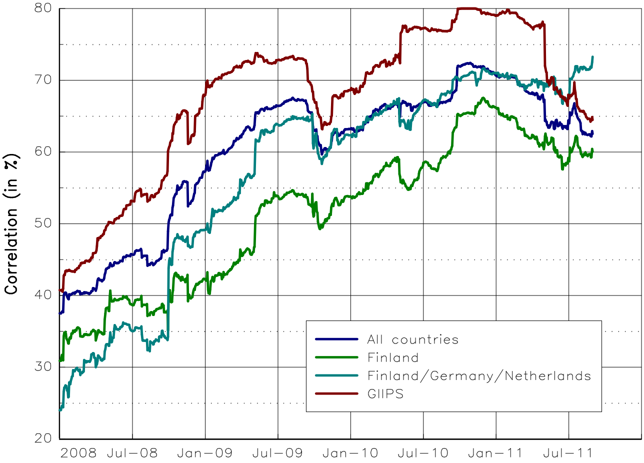
Figure: Estimated Γ matrix (September 2011)

| Country | AT | BE | FI | FR | DE | GR | IE | IT | NL | PT | ES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 100% | | | | | | | | | | |
| Belgium | 75% | 100% | | | | | | | | | |
| Finland | 68% | 64% | 100% | | | | | | | | |
| France | 72% | 70% | 61% | 100% | | | | | | | |
| Germany | 77% | 72% | 65% | 72% | 100% | | | | | | |
| Greece | 38% | 48% | 35% | 37% | 37% | 100% | | | | | |
| Ireland | 58% | 62% | 55% | 56% | 59% | 54% | 100% | | | | |
| Italy | 71% | 85% | 66% | 67% | 69% | 48% | 68% | 100% | | | |
| Netherlands | 69% | 67% | 72% | 67% | 78% | 45% | 56% | 68% | 100% | | |
| Portugal | 55% | 66% | 50% | 55% | 57% | 54% | 80% | 73% | 52% | 100% | |
| Spain | 67% | 76% | 56% | 60% | 61% | 49% | 69% | 80% | 56% | 71% | 100% |

$\Rightarrow$ The correlations have increased (the average correlation is now 62%).

# Estimation of the contagion matrix

## Evolution of the Γ matrix



# Computing the sovereign risk measure for one bond

Let $B_t(D_i)$ be a zero-coupon risky bond of maturity (or duration) $D_i$. We have:

$$\mathrm{d}\ln B_t(D_i) = -D_i \cdot \mathrm{d}R(t) - D_i \cdot \mathrm{d}S_i(t)$$

with $R(t)$ the "risk-free" interest rate.

We then define the credit risk component of bond volatility as follows:

$$\sigma_i^B = D_i \cdot \sigma_i^S \cdot S_i(t)^{\beta_i}$$

# Computing the sovereign risk measure of a bond portfolio

Let $x = (x_1, \ldots, x_m)$ be the weights of bonds in the portfolio. The risk measure is:

$$\mathscr{R}(x) = \sqrt{x^\top \Sigma x}$$

with:

$$\Sigma_{i,j} = \Gamma_{i,j} \cdot \sigma_i^B \cdot \sigma_j^B$$

$\mathscr{R}(x)$ is the volatility of the CDS basket which would perfectly hedge the sovereign credit risk of the bond portfolio.

# Euler decomposition of convex risk measure

Let $\mathscr{R}(x_1,\ldots,x_m)$ be a coherent convex risk measure. We have:

$$\mathscr{R}(x_1,\ldots,x_m) = \sum_{i=1}^{m} \underbrace{x_i \cdot \frac{\partial\,\mathscr{R}(x_1,\ldots,x_m)}{\partial\, x_i}}_{RC_i}$$

We can then decompose the risk measure exactly by $m$ individual sources of risk.

Our risk measure $\mathscr{R}(x) = \sqrt{x^\top \Sigma x}$ is convex:

$$\begin{aligned}
\frac{\partial\,\mathscr{R}(x)}{\partial\, x} &= \frac{\Sigma x}{\sqrt{x^\top \Sigma x}} \\
RC_i &= x_i \cdot \frac{(\Sigma x)_i}{\sqrt{x^\top \Sigma x}} \\
\sum_{i=1}^{m} RC_i &= \sum_{i=1}^{m} x_i \cdot \frac{(\Sigma x)_i}{\sqrt{x^\top \Sigma x}} = x^\top \frac{\Sigma x}{\sqrt{x^\top \Sigma x}} = \sqrt{x^\top \Sigma x} = \mathscr{R}(x)
\end{aligned}$$

# The IRB formula is an example of a convex risk measure

Assumptions in the Basle II IRB model:

1. The portfolio is infinitely granular.
2. LGD is independent of default times.
3. Default times are correlated with a one-factor model.

The expression of the unexpected loss is then:

$$\begin{aligned}\mathrm{UL}(\alpha) &= \sum_{i=1}^{m} \mathrm{EAD}_i \cdot K_i \\ &= \sum_{i=1}^{m} \mathrm{EAD}_i \cdot \mathbb{E}[\mathrm{LGD}_i] \cdot \left( \Phi\left( \frac{\Phi^{-1}(\mathrm{PD}_i) + \sqrt{\rho}\,\Phi^{-1}(\alpha)}{\sqrt{1-\rho}} \right) - \mathrm{PD}_i \right)\end{aligned}$$

It satisfies the Euler decomposition: $K_i$ is the marginal risk and $\mathrm{EAD}_i \cdot K_i$ is the risk contribution.

# Illustration of the risk decomposition

- 3 assets
- Volatilities are respectively 20%, 30% and 15%
- Correlations are set to 60% between the 1st asset and the 2nd asset and 10% between the first two assets and the 3rd asset
- The risk measure is the volatility of the portfolio

Traditional approach

| Asset | Weight | Marginal Risk | Risk Contribution | |
|---|---|---|---|---|
| | | | Absolute | Relative |
| 1 | **60.00%** | 18.80% | 11.28% | 66.67% |
| 2 | **20.00%** | 23.94% | 4.79% | 28.30% |
| 3 | **20.00%** | 4.26% | 0.85% | 5.03% |
| Volatility | | | 16.92% | |

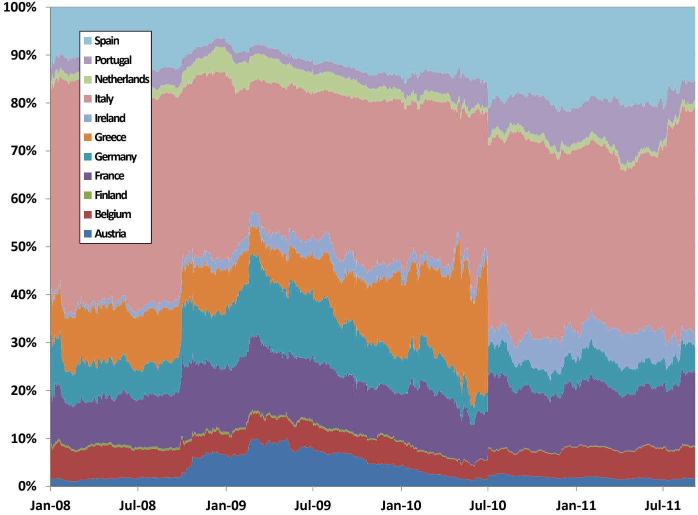
# Some results for the EGBI index

Figure: EGBI weights and risk contributions

| Country | July-08 | | July-09 | | July-10 | | July-11 | | September-11 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Weights | RC | Weights | RC | Weights | RC | Weights | RC | Weights | RC |
| Austria | 4.1% | 1.7% | 3.6% | 7.7% | 4.1% | 2.3% | 4.3% | 1.5% | 4.3% | 1.8% |
| Belgium | 6.2% | 6.1% | 6.5% | 5.1% | 6.3% | 5.7% | 6.4% | 6.5% | 6.4% | 6.7% |
| Finland | 1.2% | 0.4% | 1.3% | 0.5% | 1.3% | 0.2% | 1.6% | 0.2% | 1.6% | 0.3% |
| France | 20.5% | 9.8% | 20.4% | 13.2% | 22.2% | 15.1% | 23.1% | 13.3% | 23.1% | 15.5% |
| Germany | 24.4% | 6.1% | 22.3% | 13.0% | 22.9% | 6.0% | 22.1% | 5.3% | 22.1% | 5.5% |
| Greece | 4.9% | 11.4% | 5.4% | 8.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Ireland | 1.0% | 1.3% | 1.5% | 4.3% | 2.1% | 3.3% | 1.4% | 5.4% | 1.4% | 2.7% |
| Italy | 22.1% | 45.2% | 22.4% | 29.5% | 23.4% | 38.7% | 23.1% | 38.5% | 23.1% | 46.3% |
| Netherlands | 5.3% | 1.7% | 5.3% | 4.1% | 6.1% | 1.6% | 6.2% | 1.2% | 6.2% | 1.5% |
| Portugal | 2.4% | 3.9% | 2.3% | 2.3% | 2.1% | 6.3% | 1.6% | 6.6% | 1.6% | 4.4% |
| Spain | 7.8% | 12.4% | 9.1% | 11.8% | 9.6% | 20.9% | 10.3% | 21.3% | 10.3% | 15.5% |
| Sovereign Risk | 0.70% | | 2.59% | | 6.12% | | 4.02% | | 8.12% | |

# Some results for the EGBI index

## Evolution of risk contributions



# Alternative indexation

We remind that the debt (capitalisation)-weighting is defined by[2]:

$$x_i = \frac{\mathrm{DEBT}_i}{\sum_{i=1}^{m} \mathrm{DEBT}_i}$$

Two forms of alternative indexation:

1. Fundamental indexation
2. Risk-based indexation

[2] Two forms of debt-weighting are considered : DEBT (with the 11 countries) and DEBT* (without Greece after July 2010). This last one corresponds to the weighting scheme of the EGBI index.

# Fundamental indexation

The GDP-weighting is then defined by:

$$x_i = \frac{\mathrm{GDP}_i}{\sum_{i=1}^{m} \mathrm{GDP}_i}$$

Other economic fundamentals may concerns (Brodsky *et al.*, 2011):

1. fiscal space;
2. external finance position;
3. financial sector health;
4. willingness to pay.

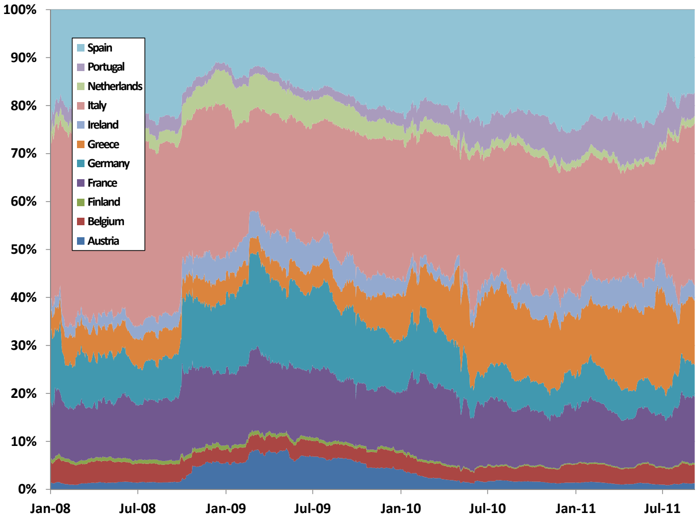
# GDP indexation

Figure: Weights and risk contributions of the GDP indexation

| Country | July-08 | | July-09 | | July-10 | | July-11 | | September-11 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | GDP | RC | GDP | RC | GDP | RC | GDP | RC | GDP | RC |
| Austria | 3.1% | 1.4% | 3.1% | 7.0% | 3.1% | 1.7% | 3.2% | 1.0% | 3.2% | 1.3% |
| Belgium | 3.8% | 4.0% | 3.8% | 3.2% | 3.9% | 3.3% | 4.0% | 3.5% | 4.0% | 4.0% |
| Finland | 2.0% | 0.8% | 1.9% | 0.7% | 2.0% | 0.3% | 2.1% | 0.3% | 2.1% | 0.3% |
| France | 21.2% | 11.2% | 21.5% | 14.9% | 21.4% | 13.4% | 21.5% | 10.6% | 21.5% | 13.8% |
| Germany | 27.4% | 7.6% | 27.2% | 17.0% | 27.7% | 6.7% | 27.9% | 5.8% | 27.9% | 6.7% |
| Greece | 2.6% | 6.2% | 2.7% | 4.4% | 2.6% | 15.7% | 2.4% | 19.8% | 2.4% | 13.8% |
| Ireland | 2.0% | 3.0% | 1.9% | 5.6% | 1.8% | 2.6% | 1.7% | 5.9% | 1.7% | 3.3% |
| Italy | 17.4% | 37.5% | 17.3% | 23.5% | 17.2% | 25.8% | 17.0% | 23.9% | 17.0% | 32.6% |
| Netherlands | 6.5% | 2.5% | 6.5% | 5.3% | 6.5% | 1.6% | 6.6% | 1.2% | 6.6% | 1.6% |
| Portugal | 1.9% | 3.3% | 1.9% | 2.0% | 1.9% | 5.3% | 1.9% | 6.7% | 1.9% | 5.1% |
| Spain | 12.0% | 22.6% | 12.0% | 16.5% | 11.8% | 23.7% | 11.8% | 21.4% | 11.8% | 17.5% |
| Sovereign Risk | 0.64% | | 2.47% | | 6.59% | | 4.56% | | 8.26% | |

$\Rightarrow$ Debt and GDP indexations produces similar sovereign credit risk measures.

# GDP indexation
## Evolution of risk contributions



# Risk-based indexation

To define a RB portfolio, we consider a set of **given** risk budgets $\{\mathrm{RB}_1, \ldots, \mathrm{RB}_m\}$.
Then we have to solve the following non-linear system of $m$ equations:

$$\begin{cases} RC_1(x_1, \ldots, x_m) = \mathrm{RB}_1 \\ \vdots \\ RC_i(x_1, \ldots, x_m) = \mathrm{RB}_i \\ \vdots \\ RC_m(x_1, \ldots, x_m) = \mathrm{RB}_m \end{cases}$$

**Traditional approach**

Weights $\longrightarrow$ Risk Contributions

**Risk-budgeting approach**

Risk Contributions $\longrightarrow$ Weights

# Illustration of the risk-budgeting approach

- 3 assets
- Volatilities are respectively 20%, 30% and 15%
- Correlations are set to 60% between the 1st asset and the 2nd asset and 10% between the first two assets and the 3rd asset
- The risk measure is the volatility of the portfolio

Traditional approach

| Asset | Weight | Marginal Risk | Risk Contribution Absolute | Risk Contribution Relative |
|---|---|---|---|---|
| 1 | **60.00%** | 18.80% | 11.28% | 66.67% |
| 2 | **20.00%** | 23.94% | 4.79% | 28.30% |
| 3 | **20.00%** | 4.26% | 0.85% | 5.03% |
| Volatility | | | 16.92% | |

Risk budgeting approach

| Asset | Weight | Marginal Risk | Risk Contribution Absolute | Risk Contribution Relative |
|---|---|---|---|---|
| 1 | 48.50% | 17.69% | 8.58% | **60.00%** |
| 2 | 13.17% | 21.71% | 2.86% | **20.00%** |
| 3 | 38.32% | 7.46% | 2.86% | **20.00%** |
| Volatility | | | 14.30% | |

# GDP-RB indexation

In this cas, we have:

$$RC_i = \frac{\mathrm{GDP}_i}{\sum_{i=1}^{m} \mathrm{GDP}_i}$$

⇒ Simulation with portfolios rebalanced every months.

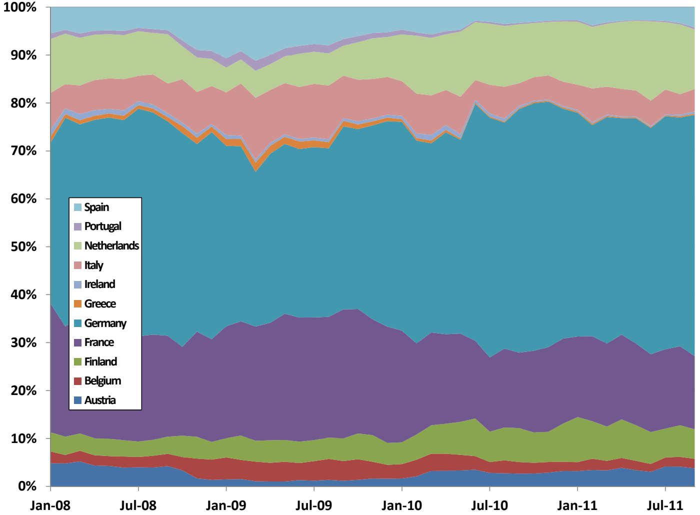
# GDP-RB indexation

Figure: Weights and risk contributions of the GDP-RB indexation

| Country | July-08 | | July-09 | | July-10 | | July-11 | | September-11 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RC | Weights | RC | Weights | RC | Weights | RC | Weights | RC | Weights |
| Austria | 3.1% | 3.9% | 3.1% | 1.2% | 3.1% | 2.9% | 3.2% | 4.2% | 3.2% | 3.8% |
| Belgium | 3.8% | 2.1% | 3.8% | 4.1% | 3.9% | 2.2% | 4.0% | 1.9% | 4.0% | 2.0% |
| Finland | 2.0% | 3.2% | 1.9% | 4.4% | 2.0% | 6.3% | 2.1% | 6.0% | 2.1% | 6.1% |
| France | 21.2% | 22.0% | 21.5% | 25.6% | 21.4% | 15.5% | 21.5% | 16.5% | 21.5% | 15.3% |
| Germany | 27.4% | 47.8% | 27.2% | 35.5% | 27.7% | 50.0% | 27.9% | 48.7% | 27.9% | 50.2% |
| Greece | 2.6% | 0.7% | 2.7% | 1.4% | 2.6% | 0.2% | 2.4% | 0.2% | 2.4% | 0.3% |
| Ireland | 2.0% | 0.8% | 1.9% | 0.6% | 1.8% | 0.6% | 1.7% | 0.2% | 1.7% | 0.5% |
| Italy | 17.4% | 5.3% | 17.3% | 11.2% | 17.2% | 6.0% | 17.0% | 5.2% | 17.0% | 4.7% |
| Netherlands | 6.5% | 9.2% | 6.5% | 6.7% | 6.5% | 12.8% | 6.6% | 14.0% | 6.6% | 12.5% |
| Portugal | 1.9% | 0.7% | 1.9% | 1.6% | 1.9% | 0.4% | 1.9% | 0.2% | 1.9% | 0.4% |
| Spain | 12.0% | 4.2% | 12.0% | 7.7% | 11.8% | 3.1% | 11.8% | 2.9% | 11.8% | 4.2% |
| Sovereign Risk | 0.39% | | 2.10% | | 3.25% | | 1.91% | | 4.13% | |

# GDP-RB indexation

## Evolution of weights



# DEBT-RB indexation

In this cas, we have:

$$RC_i = \frac{\mathrm{DEBT}_i}{\sum_{i=1}^{m} \mathrm{DEBT}_i}$$

If all countries present the same risk level and correlations:

Debt-based risk budgeting $\longrightarrow$ Debt (capitalisation)-weighting

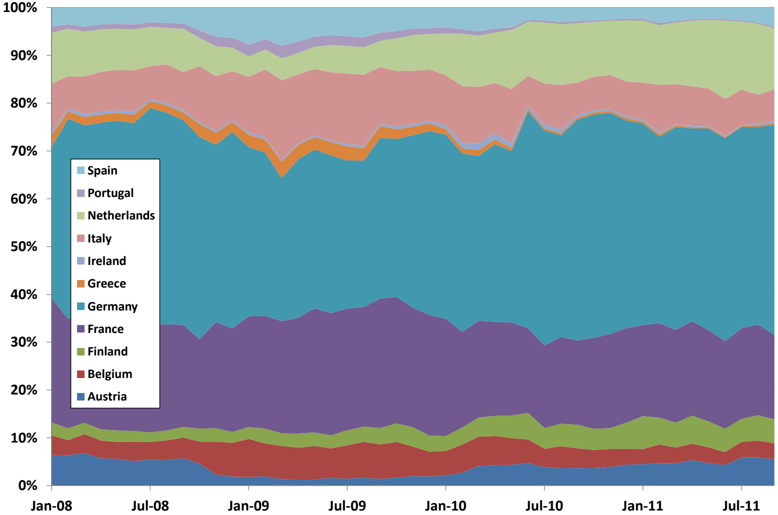
# DEBT-RB indexation

Figure: Weights and risk contributions of the DEBT-RB indexation

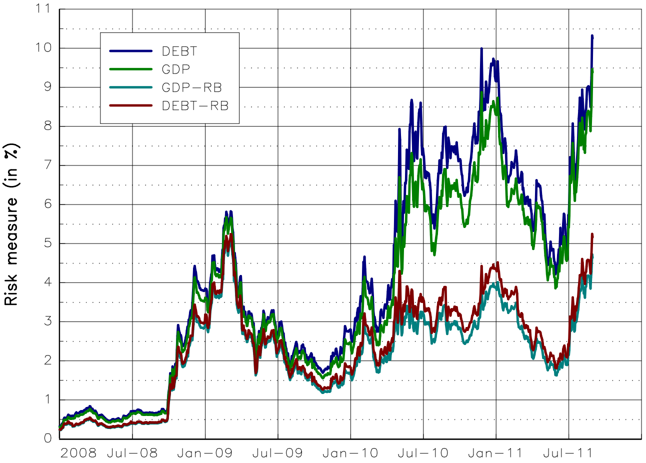
| Country | July-08 | | July-09 | | July-10 | | July-11 | | September-11 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RC | Weights | RC | Weights | RC | Weights | RC | Weights | RC | Weights |
| Austria | 4.1% | 5.4% | 3.6% | 1.4% | 3.9% | 3.9% | 4.2% | 5.9% | 4.2% | 5.5% |
| Belgium | 6.2% | 3.6% | 6.5% | 7.1% | 6.0% | 3.8% | 6.2% | 3.2% | 6.2% | 3.4% |
| Finland | 1.2% | 2.0% | 1.3% | 3.1% | 1.2% | 4.4% | 1.5% | 4.8% | 1.5% | 5.0% |
| France | 20.5% | 22.4% | 20.4% | 25.5% | 21.2% | 17.2% | 22.5% | 18.9% | 22.5% | 17.7% |
| Germany | 24.4% | 45.8% | 22.3% | 30.9% | 21.9% | 45.0% | 21.5% | 42.1% | 21.5% | 43.9% |
| Greece | 4.9% | 1.4% | 5.4% | 2.9% | 4.3% | 0.4% | 2.6% | 0.2% | 2.5% | 0.3% |
| Ireland | 1.0% | 0.4% | 1.5% | 0.5% | 2.0% | 0.8% | 1.4% | 0.2% | 1.4% | 0.4% |
| Italy | 22.1% | 6.9% | 22.4% | 14.8% | 22.4% | 8.5% | 22.5% | 7.4% | 22.5% | 6.7% |
| Netherlands | 5.3% | 8.2% | 5.3% | 5.8% | 5.9% | 12.8% | 6.0% | 14.3% | 6.0% | 12.7% |
| Portugal | 2.4% | 0.9% | 2.3% | 2.0% | 2.0% | 0.4% | 1.6% | 0.2% | 1.6% | 0.4% |
| Spain | 7.8% | 3.0% | 9.1% | 6.0% | 9.2% | 2.7% | 10.1% | 2.7% | 10.1% | 4.0% |
| Sovereign Risk | 0.41% | | 2.19% | | 3.63% | | 2.10% | | 4.57% | |

# DEBT-RB indexation

## Evolution of weights

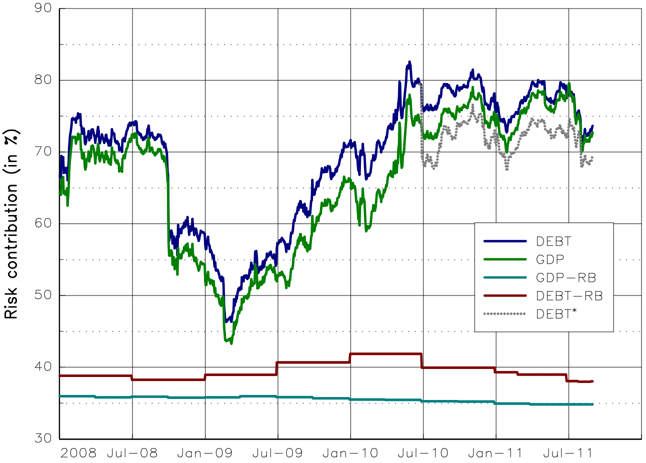


# Comparison of the indexing schemes
## Evolution of the risk measure



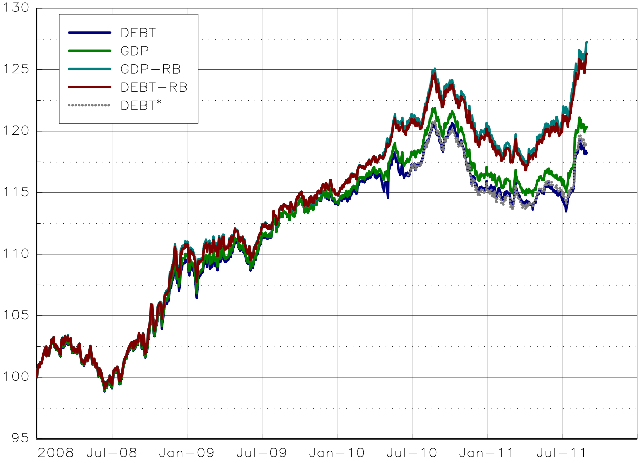
# Comparison of the indexing schemes

## Evolution of the GIIPS risk contribution



# Comparison of the indexing schemes

## Simulation of the performance



# Comparison of the indexing schemes

## Main statistics (01/01/2008 – 06/09/2011)

| | DEBT | GDP | GDP-RB | DEBT-RB | DEBT* | DEBT*-RB |
|---|---|---|---|---|---|---|
| Average Return | 4.7% | 5.2% | 6.8% | 6.5% | 4.8% | 6.6% |
| Volatility | 4.4% | 4.3% | 4.4% | 4.4% | 4.4% | 4.4% |
| Sharpe | 1.05 | 1.19 | 1.53 | 1.49 | 1.10 | 1.50 |
| Tracking Error | | 0.6% | 2.2% | 2.0% | 0.3% | 2.0% |
| Information Ratio | | 0.84 | 0.91 | 0.90 | 0.55 | 0.91 |
| Correlation | | 99.2% | 87.4% | 89.7% | 99.8% | 89.6% |
| Beta | | 97.1% | 87.5% | 88.8% | 98.9% | 88.7% |

# Comparison of the indexing schemes

## Characteristics of the portfolios (September 2011)

| Country | DEBT | | GDP | | GDP-RB | | DEBT-RB | | DEBT* | | DEBT*-GDP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Weights | RC | Weights | RC | Weights | RC | Weights | RC | Weights | RC | Weights | RC |
| Austria | 4.2% | 1.5% | 3.2% | 1.3% | 3.8% | 3.2% | 5.5% | 4.2% | 4.3% | 1.8% | 5.5% | 4.3% |
| Belgium | 6.2% | 5.8% | 4.0% | 4.0% | 2.0% | 4.0% | 3.4% | 6.2% | 6.4% | 6.7% | 3.4% | 6.4% |
| Finland | 1.5% | 0.2% | 2.1% | 0.3% | 6.1% | 2.1% | 5.0% | 1.5% | 1.6% | 0.3% | 5.0% | 1.6% |
| France | 22.5% | 13.2% | 21.5% | 13.8% | 15.3% | 21.5% | 17.7% | 22.5% | 23.1% | 15.5% | 17.7% | 23.1% |
| Germany | 21.5% | 4.7% | 27.9% | 6.7% | 50.2% | 27.9% | 43.9% | 21.5% | 22.1% | 5.5% | 43.9% | 22.1% |
| Greece | 2.5% | 13.0% | 2.4% | 13.8% | 0.3% | 2.4% | 0.3% | 2.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| Ireland | 1.4% | 2.4% | 1.7% | 3.3% | 0.5% | 1.7% | 0.4% | 1.4% | 1.4% | 2.7% | 0.4% | 1.4% |
| Italy | 22.5% | 40.2% | 17.0% | 32.6% | 4.7% | 17.0% | 6.7% | 22.5% | 23.1% | 46.3% | 6.8% | 23.1% |
| Netherlands | 6.0% | 1.3% | 6.6% | 1.6% | 12.5% | 6.6% | 12.7% | 6.0% | 6.2% | 1.5% | 12.8% | 6.2% |
| Portugal | 1.6% | 3.9% | 1.9% | 5.1% | 0.4% | 1.9% | 0.4% | 1.6% | 1.6% | 4.4% | 0.4% | 1.6% |
| Spain | 10.1% | 13.6% | 11.8% | 17.5% | 4.2% | 11.8% | 4.0% | 10.1% | 10.3% | 15.5% | 4.0% | 10.3% |
| Yield-to-Maturity | 3.88% | | 3.83% | | 2.86% | | 2.92% | | 3.51% | | 2.88% | |
| Duration | 6.11 | | 6.07 | | 6.03 | | 6.06 | | 6.13 | | 6.06 | |
| Average Spread | 3.26% | | 3.08% | | 1.50% | | 1.63% | | 2.68% | | 1.56% | |
| Implied Rating | A | | A | | AA+ | | AA+ | | A+ | | AA+ | |
| Weight Concentration | 48.8% | | 50.7% | | 65.4% | | 61.2% | | 51.9% | | 61.6% | |
| Risk Concentration | 56.6% | | 52.6% | | 50.7% | | 48.8% | | 64.0% | | 51.9% | |
| Risk Measure | 8.97% | | 8.26% | | 4.13% | | 4.57% | | 8.12% | | 4.48% | |

# Comparison with active management

- Database: Morningstar
- Category: Bond EURO Government
- 218 funds

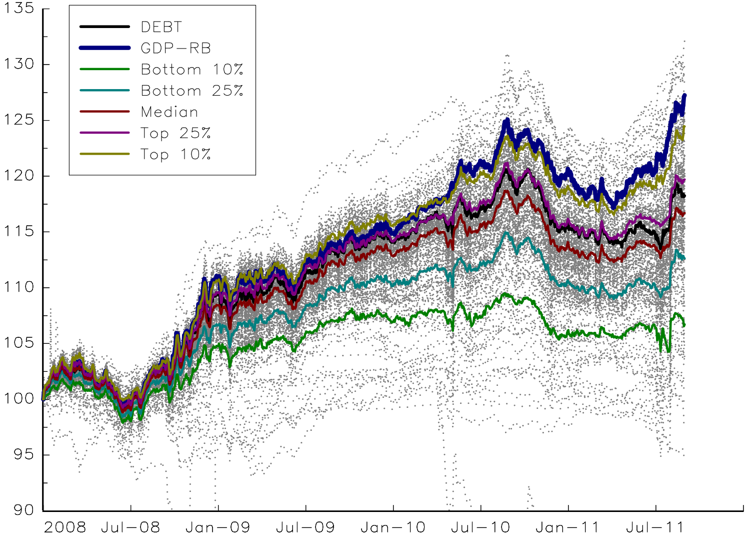
The Academic Rule[3]:

Average Performance of Active Management
=
Performance of the Index − Management Fees

⇒ Implied fees for Bond EURO Government: 36 bps / year

[3] There is a large literature on this subject, see e.g. Blake *et al.* (1993).

# Comparison with active management



# Conclusion

- Fundamental indexation is not enough.
- Fundamental indexation must be completed by risk-based methods.
- Risk-budgeting approach is a good compromise between managing the performance and managing the risk.
- Extension of this approach:
  1. to take into account trading constraints;
  2. to take into account other risks (e.g. interest rates or foreign exchange);
  3. to be applied to other asset classes (corporate bonds, high yield, global aggregate, etc.).
- Risk-budgeting approach = good model for Solvency II.

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