Do Inflation-Linked Bonds still diversify ?

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Introduction

- Striking growth of IL bonds market since 10 years
  - 13 developed countries now issue IL Bonds (Germany in 2006)
  - 1/3 of new issuances in the US, 10% in Eurozone
  - US Market Value tripled, Euro quadrupled in the last 5 years
  - Regular government issues & liquid market

- 2 main interests for investors in this asset class
  - Hedging inflation risk (Campbell et al. 1996, 2002)
    - **Meets structural demand for inflation protection (retirees, pension funds reform)**
    - **Meets governments need to stabilize govt budgets**
  - Diversification benefits in asset allocation (Roll 2004, Kothari & Shanken 2004, Mamun Visaltanachoti 2006)
    - **Negative correlation with equities**
    - **Low correlation with nominal bonds**
    - **Low volatility**

Introduction

Litterature review

- Studies show IL bonds usefulness for portfolio diversification but data ending in 2003
- Little research on the dynamics of volatility /correlation of IL bonds
- Only Hunter and Simon (2005) : bivariate GARCH, sample period ends in 2001

Questions

- 10Y history, more mature market : is the diversifying power of IL bonds still important ?
- How did the composition optimal portfolio containing IL bonds change over time ?

Introduction

This paper

- Estimates the dynamic conditional volatilities and correlations of Nominal, IL bonds and equities
  - **US and Eurozone, 1997-2007**
  - **DCC-MVGARCH (Engle (2002)) never used before for IL Bonds (but for Exchange Rates, Equities, Equities and Nom Bonds)**
- Highlights the significant change in the dynamics of correlations and volatilities since 2003
- Conducts dynamic portfolio optimizations using conditional VCV matrix from the DCC
  - **Rarely done in practical studies**
  - **Demonstrates the decreasing weight of IL bonds in an optimal allocation**

Methodology

DCC-MVGARCH (Engel and Sheppard 2001, Engle 2002) can be formulated :

- rt daily returns conditionally normal with mean zero and covariance matrix Ht

$$r_t | I_{t-1} \sim N(0, H_t) .$$

$$H_t = D_t R_t D_t$$

$$D_t = \sqrt{h_{it}}$$

- Maximization of the log-likelihood (sum of volatility and correlation components) in 2 steps :
  - **Step 1 : estimation of the Garch(1,1) coefficients for each asset class**
  - **Step 2 : estimation of correlation coefficients confitionally to the parameters estimated in step 1**

$$L = -\frac{1}{2}\sum_{t=1}^{T}\left(n\log(2\pi) + 2\log|D_t| + r_t' D_t^{-1} D_t^{-1} r_t - \varepsilon_t'\varepsilon_t + \log|R_t| + \varepsilon_t' R_t^{-1}\varepsilon\right)$$

$$L_C(\theta,\phi) = -\varepsilon_t'\varepsilon_t + \log|R_t| + \varepsilon_t' R_t^{-1}\varepsilon$$

$$L_v(\theta) = n\log(2\pi) + 2\log|D_t| + r_t' D_t^{-1} D_t^{-1} r_t$$

Use of conditional VCV matrix in a classical mean variance portfolio optimization

Data

- Daily returns in local currency for equities, nominal bonds and IL bonds in US and Eurozone
  - Equities: S&P500 and DJ Eurostoxx
  - IL Bonds: Barclays Global Inflation Total Return Indices for US and France
  - Nom Bonds: Barclays Breakeven Comparator indices for US and France
- Sample period: US (Mar 97 - Aug 07) Eurozone (Oct 98 - Aug 07)

Data

Descriptive statistics of daily returns in local currency

- Theoretically Nom Bonds should have higher returns than IL Bonds because of inflation risk premium
  - **not verified on the full sample**
- Nom Bonds should have higher volatility than IL Bonds
  - **Verified on the full sample**

	Nominal Bonds	IL Bonds	Equities
	US (1997-2007)		
Average	0.03%	0.03%	0.04%
Ann. Average	6.55%	6.55%	9.10%
Median	0.03%	0.02%	0.05%
Min	-1.81%	-1.43%	-6.87%
Max	1.61%	1.24%	5.73%
Std Dev	0.40%	0.28%	1.13%
Ann. Std. Dev.	6.30%	4.43%	18.00%
Skewness	-0.27	-0.15	-0.01
Kurtosis	1.45	2.34	3.05

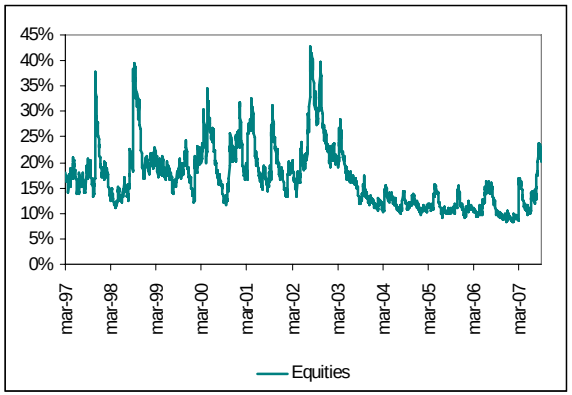
	Nominal Bonds	IL Bonds	Equities
	Eurozone(1998-2007)*		
Average	0.02%	0.02%	0.04%
Ann. Average	4.65%	5.09%	9.37%
Median	0.02%	0.01%	0.08%
Min	-1.84%	-1.29%	-6.38%
Max	1.33%	1.10%	6.35%
Std Dev	0.32%	0.26%	1.29%
Ann. Std. Dev.	5.06%	4.06%	20.42%
Skewness	-0.41	-0.29	-0.04
Kurtosis	1.93	2.26	2.82

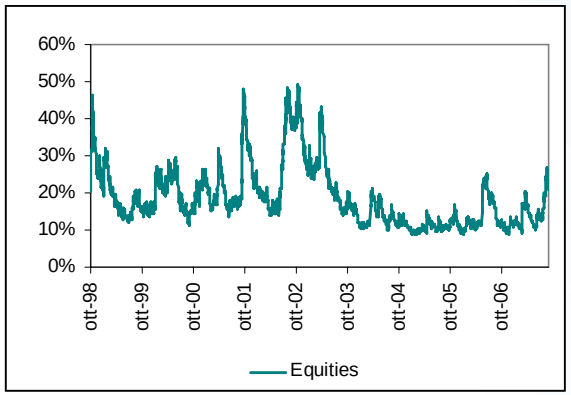
* *French data for IL bonds and nominal bonds*

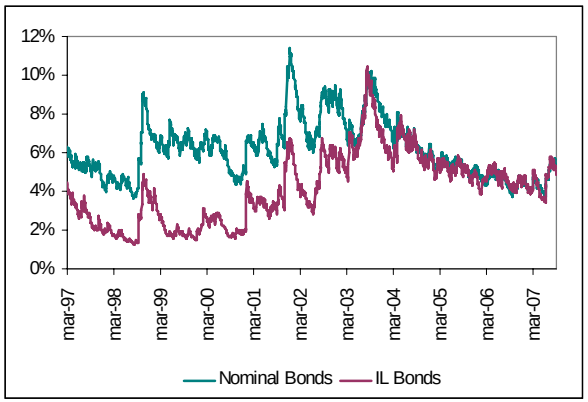
Dynamic correlations and volatilities

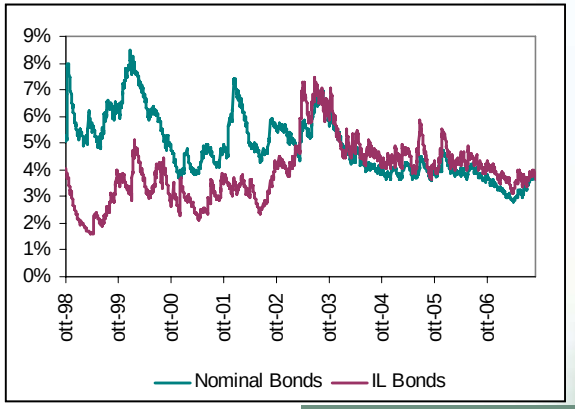
Results of DCC : conditional volatilities, US (left), EU (right)

- **Influence of crises on equity volatility**
- **IL bonds became much more volatile after 2003**
- **IL Bonds as volatile as Nom Bonds after 2003**









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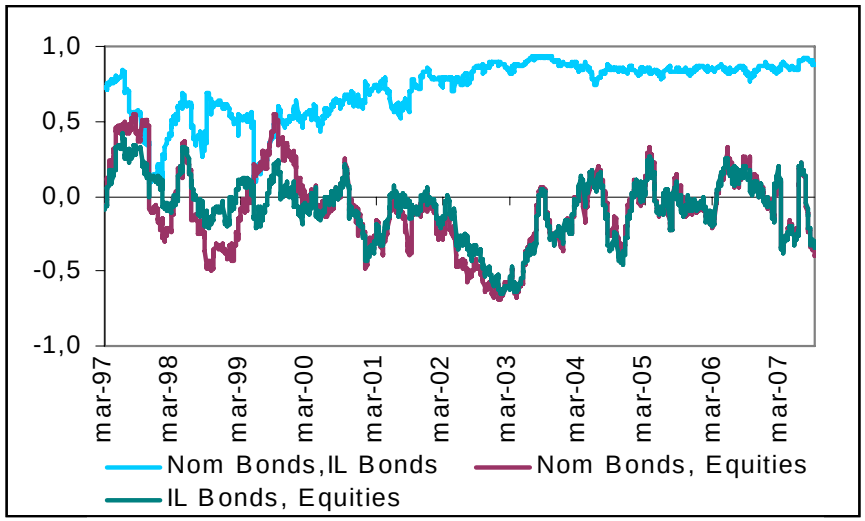
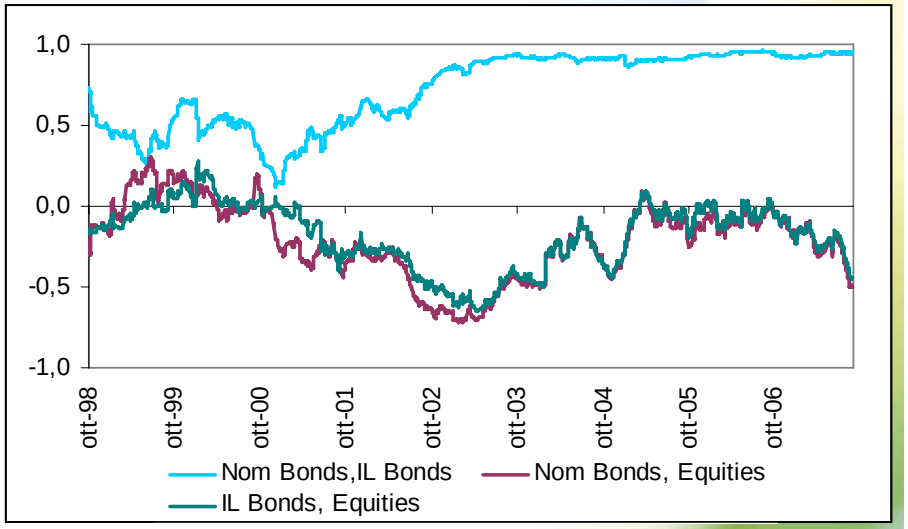
Dynamic correlations and volatilities

Results of DCC : conditional correlations, US (left), EU (right)

- **Flight to quality during crisis**
- **After 2003 strong analogy of equity correlation with nom and IL bonds**
- **After 2003 IL bonds much more correlated (90%) with nom bonds**





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Consequences for asset allocation

Portfolio construction

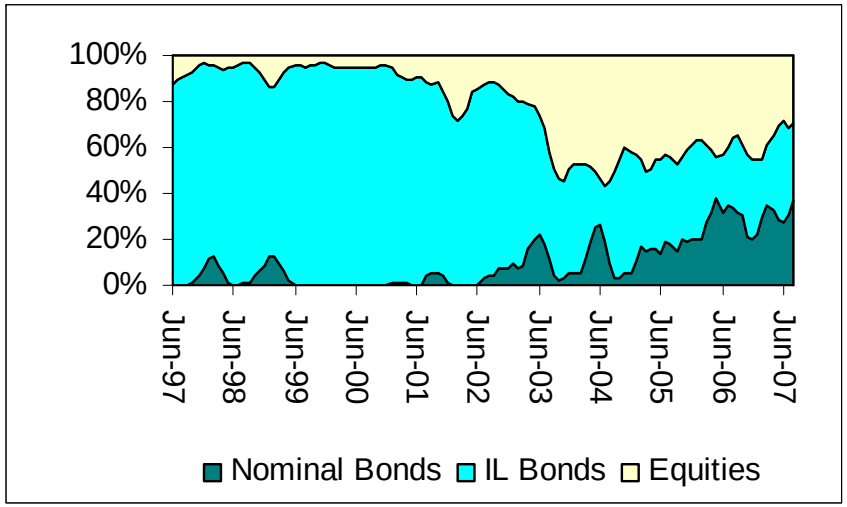
- 2 diversified portfolios (US and Eurozone) with monthly rebalancing
  - **Equities, Nominal and IL Bonds + risk free asset**
- Sharpe Ratio maximization
- Constant Expected Excess Returns (long term equilibrium levels)
  - **To examine changes in portfolio composition due to correlation and volatilities only**
- 9 scenarios
  - **Nominal bonds : 3 cases 1% - 1.5% - 2%**
  - **IL bonds : 3 cases for Inflation Risk Premium 0% - 0.5% - 1%**
  - **Equity : 4%**
- Expected VCV matrix
  - **last conditional VCV matrix estimated at month end from the DCC**

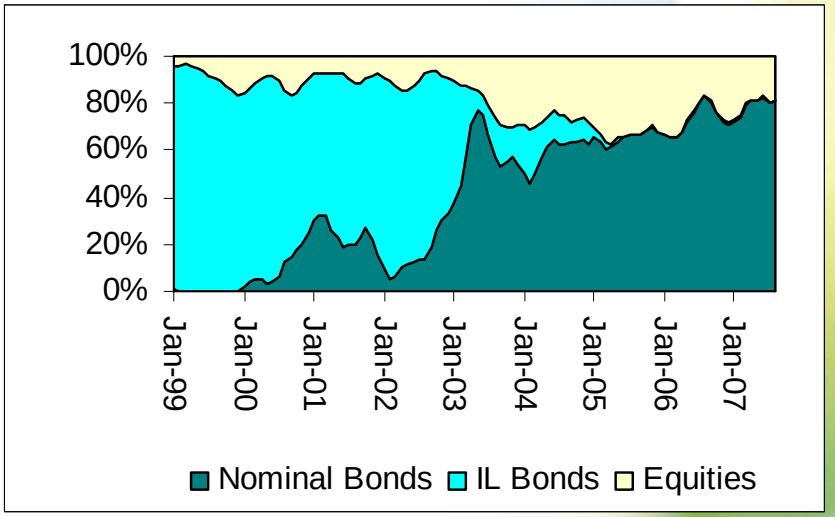
Consequences for asset allocation

Dynamic Optimal Weights

- Decreasing weight of IL bonds since 2003
- More diversifying power of US than Euro IL Bonds

- Exp Returns: Nom Bonds 1% IL Bonds 1% Equities 4% (US : left, EU : right)





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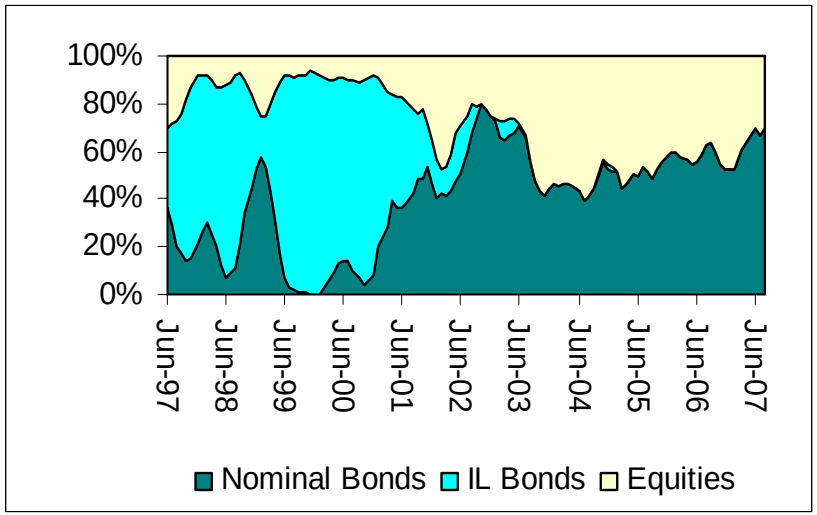
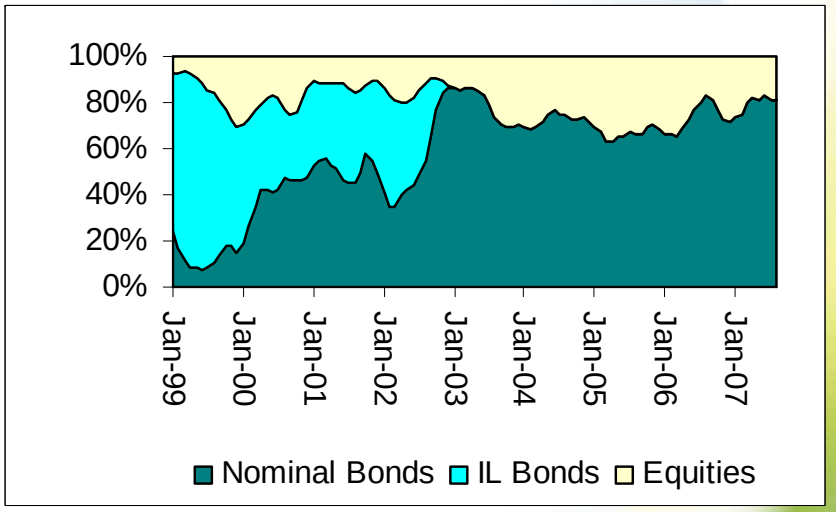
Consequences for asset allocation

Dynamic Optimal Weights

- Exc Returns: Nom Bonds 1% IL Bonds 0.5% Equities 4%





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Consequences for asset allocation

US Average Optimal Weights

- Strong decrease in IL bonds weight after 2003
  - with IRP=0, from 90% to 45%
  - with IRP=0.5%, from 70% to 4%
  - with IRP=1%, from 30% to 0% (average across bond excess returns)

1997-2002

	Excess Return Nominal Bonds								
	1%			1.5%			2%		
IRP	Nominal Bonds	IL Bonds	Equities	Nominal Bonds	IL Bonds	Equities	Nominal Bonds	IL Bonds	Equities
0%	3	86	9	2	89	6	1	91	5
0.5%	28	52	17	14	74	10	8	83	7
1.0%	67	1	30	49	32	16	30	57	10

2003-2007

	Excess Return Nominal Bonds								
	1%			1.5%			2%		
IRP	Nominal Bonds	IL Bonds	Equities	Nominal Bonds	IL Bonds	Equities	Nominal Bonds	IL Bonds	Equities
0%	19	40	41	22	45	33	24	48	28
0.5%	55	1	44	61	3	36	63	7	30
1.0%	55	0	45	64	0	36	69	0	31

**average weights of the monthly optimization in the respective period*

Consequences for asset allocation

Eurozone Average Optimal Weights

- Diversification power less important in Europe
  - **smaller volatility spread between nominal and IL bonds**
- Decrease in IL bonds weight after 2003
  - **with IRP=0, from 80% to 10%**
  - **with IRP=0.5%, from 60% to 0%**
  - **With IRP=1%, from 25% to 0%**

1998-2002

	Excess Return Nominal Bonds								
	1%			1.5%			2%		
IRP	Nominal Bonds	IL Bonds	Equities	Nominal Bonds	IL Bonds	Equities	Nominal Bonds	IL Bonds	Equities
0%	13	78	10	12	81	7	12	82	6
0.5%	40	44	16	28	62	10	23	70	7
1.0%	75	0	25	62	23	15	43	48	10

2003-2007

	Excess Return Nominal Bonds								
	1%			1.5%			2%		
IRP	Nominal Bonds	IL Bonds	Equities	Nominal Bonds	IL Bonds	Equities	Nominal Bonds	IL Bonds	Equities
0%	66	8	26	70	8	22	73	8	19
0.5%	74	0	26	78	0	22	80	1	19
1.0%	74	0	26	78	0	22	81	0	19

**average weights of the monthly optimization in the respective period*

Conclusion

- Using a DCC - MVGARCH model we highlight the evolution of conditional correlations and volatilities
- We show that diversification benefit of IL Bonds dramatically reduced since 2003, this radically modifies the optimal portfolio
- Poor explanation of this phenomenon in the literature
  - greater stability of inflation expectations (Kahn et al. (2002), Ahmed et al. (2004), Bernanke (2006), Aglietta (2007))
  - better liquidity of the linkers' market
- The "diversification" argument is no more sufficient to introduce IL bonds in a portfolio
  - Investor inflation risk aversion and expectations on relative excess return becomes crucial

Directions for future research

- Investigation of the reasons of the change
  - Extending the study to others markets, to find common drivers
  - Examination of the variance decomposition of bonds returns : did it change over time?

- How an unexpected and prolonged surge of inflation could modify this picture?
  - Renewed instability of inflation expectations