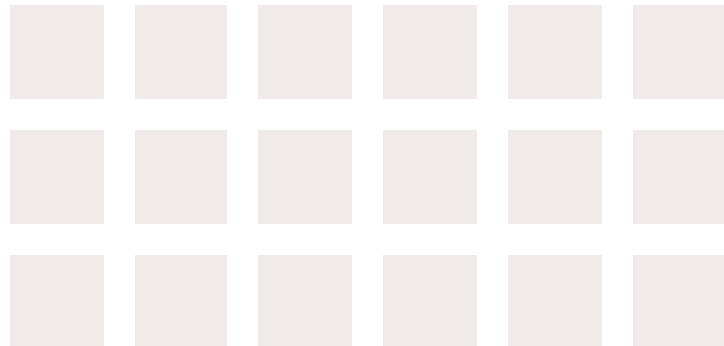


Inflation-Hedging Portfolios

in Different Regimes



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Our questions

- How to build the ideal diversified portfolio protecting from inflation risk?
- Does this optimal allocation change with macroeconomic conditions?
 - Volatile economic environment (1970s and 1980s)
 - Stable - Great Moderation (1990s and 2000s)
- How does the optimal asset allocation change
 - with the investor's horizon?
 - when the investor targets a more ambitious real rate of return?

Contents

■ Literature Review

■ Data and Methodology

■ Results

- Inflation-hedging properties of individual assets
 - Correlations with inflation
 - Probability of not achieving the inflation target at investment horizon
- Optimal allocation to hedge inflation risk
 - For “pure inflation-hedgers”
 - For “ambitious inflation-hedgers”

Literature Review

■ Inflation hedging properties of assets

- Attié and Roache (2009) for detailed literature review

■ Strategic Asset Allocation with partially predictable returns varying overtime

- Assets only framework: Brennan et al. (1997), Campbell and Viceira (2002), Campbell et al. (2003, 2004)
- ALM framework: Van Binsbergen and Brandt (2007), Goetzmann and Valaitis (2006), Hoovenaars et al. (2008), Amenc et al. (2009)

■ Portfolio optimization with liabilities

- ALM research focus on mean/variance optimization of the surplus (Leibowitz (1987), Sharpe and Tint (1990), Hoovenaars et al. (2008))
 - ⇒ Optimization in a mean / shortfall probability framework more appropriate (“safety-first” portfolios, Roy (1952), Amenc et al. (2009))
- Classical ALM liabilities depend on fluctuating “inflation and real rates”
 - ⇒ But some investors have an “inflation + fixed real rate” objective

Data

■ Our case: a US “safety-first” investor

- Minimizing shortfall probability
- With a range of investment horizons from 1 month to 30 years

■ Allowed to invest on six liquid asset classes

- Cash: 3-month T-bills rate
- Nominal bonds: Morgan Stanley 7-10 year
- Inflation-linked bonds: Barclays Global Inflation Total Return Index from 1997, reconstruction before that date (Kothari and Shanken (2004))
- Equities: MSCI US
- Real Estate: FTSE NAREIT Composite Index
- Commodities: GSCI

■ Study period: January 1973 – June 2009

Methodology: VAR estimation

■ Lack of historical data

- Strategic allocation can only be studied with a model for the joint distribution of asset returns and inflation
- This model allows to simulate long-term holding portfolio returns based on different scenarios

■ Specification of the joint dynamics of asset returns

- Vector-Autoregressive (structural VAR(1))
- Six asset classes (log returns)+ three predictive variables: inflation, term spread, dividend yield

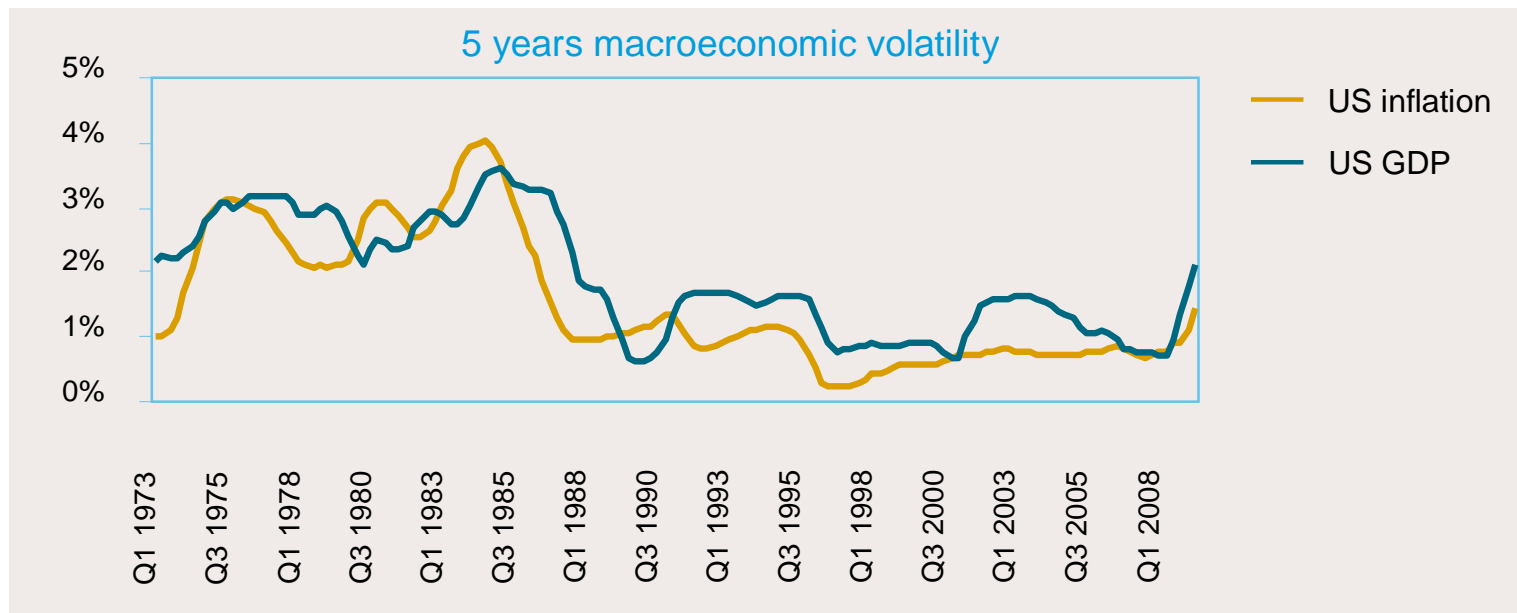
$$z_t = \phi_0 + \phi_1 z_{t-1} + u_t$$

- Following Amisano and Giannini (1997), iid structural innovations ε_t are written as:

$$Au_t = B\varepsilon_t$$

Methodology: VAR estimation

- **Difficulty: change of the asset returns dynamics/correlations**
 - Ex: stock bond correlation (Li (2002), Ilmanen (2003), Baele et al. (2009))
- **Changing economic regime is the main cause**
 - Breakpoint detected in Dec. 1990 (test for structural break in correlations, Goetzmann et al. (2005))



Methodology: Simulations

- We estimate two VAR models
 - First period: Jan. 1973 – Dec. 1990
 - Second period: Jan. 1991 – Jun. 2009

- We simulate 5,000 scenarios
 - Each of the VAR models provides a data-generating process that will serve to run 5,000 simulations
 - We simulate inflation paths and long-term holding returns

- We measure
 - inflation-hedging properties of individual assets
 - optimal composition of inflation-hedging diversified portfolios

Methodology: Portfolio Optimization

■ We compute optimal asset allocation:

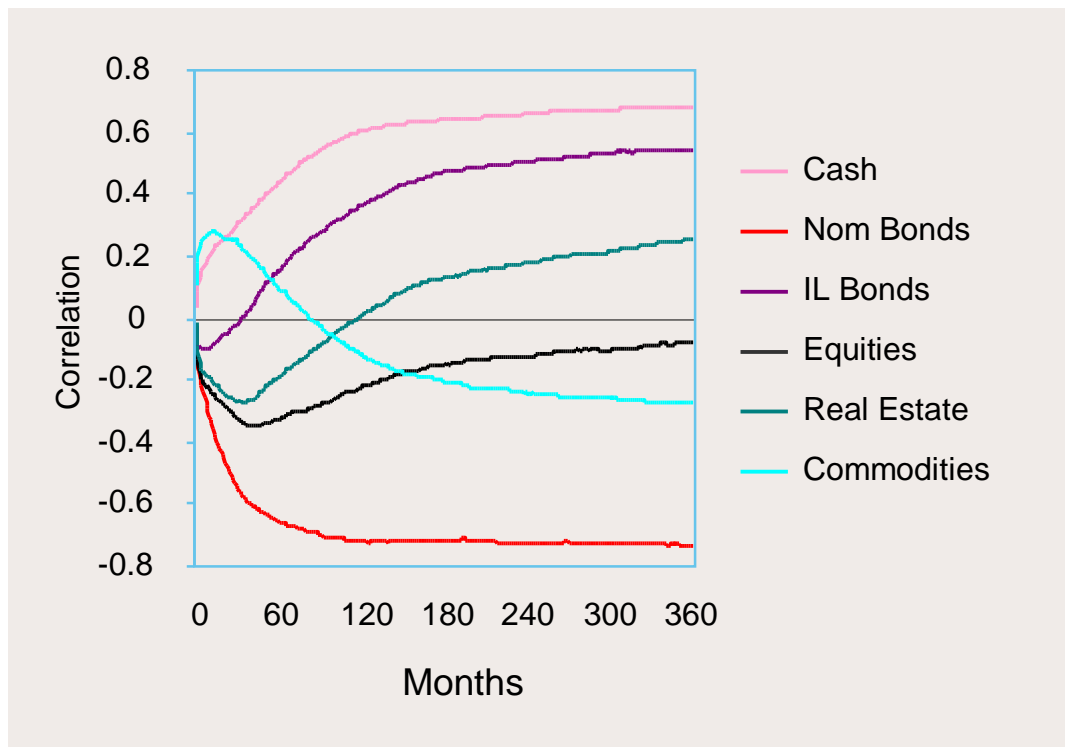
- maximizing above-target (inflation π_T + real rate \bar{R}) portfolio returns at investment horizon
- with the constraint that the probability of not achieving the target remains below a threshold

$$\text{Max}_w E \left[\sum_{i=1}^n w_i R_{iT} - (\pi_T + \bar{R}) \right]$$

$$\left\{ \begin{array}{l} P\left(\sum_{i=1}^n w_i R_{iT} < \pi_T + \bar{R}\right) < \alpha \\ \sum_{i=1}^n w_i = 1 \\ w_i \geq 0 \end{array} \right.$$

Inflation-hedging properties of individual assets

- Assets returns' correlations with inflation
 - 1973-1990



- Vary with investment horizon

- Short horizon

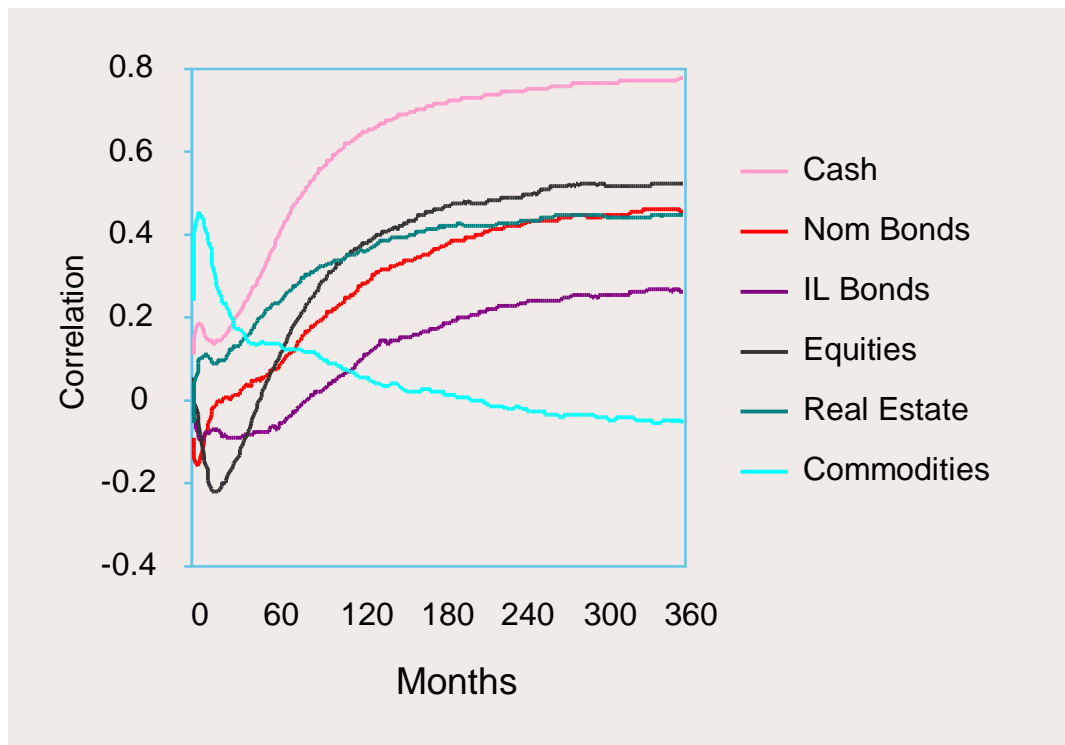
- Best inflation hedgers: commodities, cash

- Long horizon

- Best hedgers: cash, IL bonds

Inflation-hedging properties of individual assets

- Assets returns' correlations with inflation
 - 1991-2009



- Short horizon

- Best inflation hedgers: commodities, cash

- Long horizon

- Best hedgers: cash, followed by equities, nominal bonds, real estate

Inflation-hedging properties of individual assets

■ Shortfall probabilities of individual assets

– 1973-1990

Horizon	2 years	5 years	10 years	30 years
Cash	18%	17%	14%	4%
Nom Bonds	39%	35%	29%	17%
IL Bonds	45%	42%	36%	25%
Equities	38%	29%	20%	6%
Real Estate	44%	40%	32%	18%
Commodities	35%	26%	19%	8%

– 1991-2009

Horizon	2 years	5 years	10 years	30 years
Cash	13%	19%	22%	21%
Nom Bonds	17%	8%	4%	1%
IL Bonds	30%	23%	19%	12%
Equities	32%	29%	26%	13%
Real Estate	36%	31%	27%	19%
Commodities	39%	29%	18%	4%

■ Probabilities decrease strongly with time

■ Short horizon

– Best inflation hedger: cash

■ Long horizon

– Best hedgers 1973-1990: cash, equities, commodities

– Best hedgers 1991-2009: nom bonds, commodities

How to hedge inflation with a diversified portfolio?

- We measure optimal asset allocation of “safety first” portfolios:

- minimizing the shortfall probability
- for a given target return (inflation + x%)

- 2 cases

- “Pure inflation-hedgers” want to attain pure inflation target
- “Ambitious inflation-hedgers” wish to attain inflation +1%, 2%, 3%, 4%.

How to attain a pure inflation target

■ “Safety-first” portfolios (1973-1990)

- Min shortfall probabilities decrease with investment horizon
- Mainly invested in cash when investment horizon is short
- Increase allocation to IL bonds, equities, commodities real estate when horizon increases

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	10.8%	11.5%	9.0%	1.4%
Ann. Excess Return Volatility	1.9%	3.6%	5.1%	5.4%
Ann. Excess Return	1.6%	1.9%	2.2%	2.2%
Cumulated Excess Return	3.2%	9.7%	21.8%	65.2%
Weights				
Cash	88%	81%	72%	64%
Nom Bonds	0%	0%	0%	0%
IL Bonds	6%	7%	11%	17%
Equities	1%	3%	7%	8%
Real Estate	0%	0%	0%	5%
Commodities	5%	9%	10%	6%

How to attain a pure inflation target

■ “Safety-first” portfolios (1991-2009)

- Lower min shortfall probabilities and higher excess returns in a more stable economic environment
- Mainly invested in cash when investment horizon is short
- Increase allocation to nominal bonds, equities and commodities when horizon increases

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	4.4%	3.2%	1.3%	0.0%
Ann. Excess Return Volatility	1.3%	3.0%	4.8%	5.1%
Ann. Excess Return	1.5%	2.4%	3.4%	3.2%
Cumulated Excess Return	3.0%	12.2%	33.8%	96.7%
Weights				
Cash	80%	41%	0%	0%
Nom Bonds	17%	48%	77%	73%
IL Bonds	0%	0%	0%	0%
Equities	0%	5%	10%	10%
Real Estate	1%	0%	0%	0%
Commodities	2%	6%	13%	17%

How to attain a more ambitious target

- Having a more ambitious real return target (from 1% to 4%) leads to
 - A greater shortfall probability
 - A different optimal portfolio composition: larger weight to risky assets

- In a volatile economic environment, ambitious investors should
 - Gradually abandon IL bonds and real estate
 - Concentrate on equities, commodities

- In a more stable economic environment, ambitious investors should
 - Reduce portfolio weights in nominal bonds and equities
 - Invest a higher share in commodities

Conclusion

- Optimally diversifying a portfolio strongly improves inflation-hedging properties and reduces shortfall probabilities

- Be careful of the economic regime! It radically changes:
 - The inflation-hedging properties of individual assets
 - An investor's optimal allocation

- Limitations and further developments:
 - Alternative investments: private equity, infrastructures
 - Optimization framework taking into account non-normality of asset returns
 - Dynamic asset allocation
 - Different specific targets: inflation + real rate (ALM), etc.

Conclusion

■ How to hedge inflation? A simple map

		Volatile Economic Environment	Stable Economic Environment
Short-term investor	Best inflation-hedging asset classes*	Cash	Cash
	Optimal allocation for “pure inflation-hedgers”	Mainly cash (+small allocation to IL bonds, commodities)	Mainly cash + nominal bonds
	Optimal allocation for “ambitious inflation-hedgers”	Decrease cash weight, increase equities and commodities	Decrease cash weight, increase equities and commodities
Long-term investor	Best inflation-hedging asset classes*	Cash, equities, commodities	Nominal bonds, commodities
	Optimal allocation for “pure inflation-hedgers”	Cash, IL bonds, equities, commodities, real estate	Nominal bonds, commodities, equities
	Optimal allocation for “ambitious inflation-hedgers”	Equities and increasing weight of commodities	Nominal bonds, equities and increasing weight of commodities

* Individual asset classes with the smallest shortfall probability

Appendix: Descriptive Statistics

■ Summary statistics, 1973-2009

	Cash	Nom Bonds	IL bonds	Equities	Real Estate	Commodities
Ann. Ret.	5.8%	7.8%	6.5%	8.6%	7.8%	8.3%
Max Monthly	1.3%	11.3%	13.9%	16.4%	26.9%	22.9%
Min Monthly	0.0%	-9.0%	-13.8%	-23.9%	-36.4%	-33.1%
Ann. Vol.	0.9%	7.6%	9.9%	15.9%	18.5%	20.6%
Risk-adjusted Ret.	6.6	1.0	0.6	0.5	0.4	0.4
Skewness	0.7	0.3	0.1	-0.7	-1.2	-0.3
Kurtosis	3.9	5.9	6.8	5.7	12.4	6.1

Appendix: Correlation matrices

■ 1973-1990

	Inflation	Cash	NomBonds	ILbonds	Equities	Real Estate	Commodities
Inflation							
Cash	48%						
NomBonds	-11%	0%					
ILbonds	3%	-10%	71%				
Equities	-7%	-8%	27%	25%			
Real Estate	-3%	-9%	23%	31%	65%		
Commodities	-4%	-9%	-15%	-11%	-7%	-4%	

■ 1991-2009

	Inflation	Cash	NomBonds	ILbonds	Equities	Real Estate	Commodities
Inflation							
Cash	9%						
NomBonds	-21%	7%					
ILbonds	-3%	7%	70%				
Equities	3%	16%	-4%	6%			
Real Estate	11%	9%	4%	18%	53%		
Commodities	33%	6%	-1%	10%	17%	21%	

Appendix: “Safety-first” portfolios (1973-1990)

■ Target = inflation +1%

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	28.9%	23.7%	17.6%	5.8%
Ann. Excess Return Volatility	2.8%	7.1%	14.4%	14.9%
Ann. Excess Return	1.1%	2.3%	4.2%	4.3%
Cumulated Excess Return	2.2%	11.4%	42.4%	127.8%
Weights				
Cash	80%	50%	0%	0%
Nom Bonds	0%	0%	0%	0%
IL Bonds	1%	0%	0%	0%
Equities	9%	23%	55%	63%
Real Estate	0%	0%	0%	0%
Commodities	11%	27%	45%	37%

■ Target = inflation +2%

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	36.7%	30.0%	36.7%	11.4%
Ann. Excess Return Volatility	12.2%	13.1%	14.6%	15.1%
Ann. Excess Return	2.9%	3.1%	3.3%	3.3%
Cumulated Excess Return	5.9%	15.4%	33.0%	99.8%
Weights				
Cash	0%	0%	0%	0%
Nom Bonds	0%	0%	0%	0%
IL Bonds	0%	0%	0%	0%
Equities	45%	47%	51%	59%
Real Estate	0%	0%	0%	0%
Commodities	55%	53%	49%	41%

Appendix: “Safety-first” portfolios (1973-1990)

■ Target = inflation +3%

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	40.9%	35.9%	30.7%	19.7%
Ann. Excess Return Volatility	14.1%	13.8%	15.3%	15.7%
Ann. Excess Return	2.3%	2.2%	2.4%	2.4%
Cumulated Excess Return	4.6%	11.2%	24.3%	73.4%
Weights				
Cash	0%	0%	0%	0%
Nom Bonds	0%	0%	0%	0%
IL Bonds	0%	0%	0%	0%
Equities	33%	40%	44%	52%
Real Estate	0%	0%	0%	0%
Commodities	67%	60%	56%	48%

■ Target = inflation +4%

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	44.0%	41.5%	37.8%	29.9%
Ann. Excess Return Volatility	21.3%	18.1%	18.1%	18.4%
Ann. Excess Return	2.3%	1.7%	1.8%	1.8%
Cumulated Excess Return	4.5%	8.6%	17.7%	53.1%
Weights				
Cash	0%	0%	0%	0%
Nom Bonds	0%	0%	0%	0%
IL Bonds	0%	0%	0%	0%
Equities	0%	14%	23%	32%
Real Estate	0%	0%	0%	0%
Commodities	100%	86%	77%	68%

Appendix: “Safety-first” portfolios (1991-2009)

■ Target = inflation +1%

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	16.0%	9.1%	5.8%	0.8%
Ann. Excess Return Volatility	4.5%	4.5%	4.8%	5.3%
Ann. Excess Return	3.2%	2.7%	2.4%	2.3%
Cumulated Excess Return	6.3%	13.3%	24.1%	70.2%
Weights				
Cash	0%	0%	0%	0%
Nom Bonds	76%	78%	76%	70%
IL Bonds	0%	0%	0%	0%
Equities	17%	13%	10%	10%
Real Estate	0%	0%	0%	0%
Commodities	7%	10%	14%	21%

■ Target = inflation +2%

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	24.7%	20.6%	17.4%	7.5%
Ann. Excess Return Volatility	4.5%	4.6%	5.1%	6.4%
Ann. Excess Return	2.2%	1.7%	1.5%	1.7%
Cumulated Excess Return	4.4%	8.4%	15.1%	50.4%
Weights				
Cash	0%	0%	0%	0%
Nom Bonds	75%	76%	72%	60%
IL Bonds	0%	0%	0%	0%
Equities	18%	13%	9%	9%
Real Estate	0%	0%	0%	0%
Commodities	7%	11%	19%	30%

Appendix: “Safety-first” portfolios (1991-2009)

■ Target = inflation +3%

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	35.4%	36.4%	34.1%	18.8%
Ann. Excess Return Volatility	4.7%	5.1%	9.9%	18.9%
Ann. Excess Return	1.2%	0.8%	1.3%	3.0%
Cumulated Excess Return	2.5%	3.9%	12.8%	91.5%
Weights				
Cash	0%	0%	0%	0%
Nom Bonds	73%	69%	42%	0%
IL Bonds	0%	0%	0%	0%
Equities	20%	11%	0%	0%
Real Estate	1%	5%	7%	0%
Commodities	5%	15%	51%	100%

■ Target = inflation +4%

Horizon	2 years	5 years	10 years	30 years
Min Shortfall Probability	44.9%	45.9%	41.3%	27.6%
Ann. Excess Return Volatility	12.5%	16.3%	18.3%	18.9%
Ann. Excess Return	1.1%	0.7%	1.3%	2.1%
Cumulated Excess Return	2.3%	3.7%	12.8%	61.6%
Weights				
Cash	0%	0%	0%	0%
Nom Bonds	26%	0%	0%	0%
IL Bonds	0%	0%	0%	0%
Equities	33%	0%	0%	0%
Real Estate	40%	54%	0%	0%
Commodities	0%	46%	100%	100%

Complete Reference

Paper downloadable here:

<http://ideas.repec.org/p/sol/wpaper/09-047.html>

Amundi

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