Discussion of Inflation-Hedging Properties of Real Assets and Implications for Asset-Liability Management Decisions

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Summary of paper

- Assume pension funds choose investments by forming a performance-seeking portfolio (PSP) and a liability-hedging portfolio (LHP).

- If the risk to the liability is inflation, reasonable benchmark for the LHP is 100% TIPS.

- Goal: create a "better" LHP, i.e. more return, but with little (or no) added risk.

- Consider investments in commodities and in real estate (call these "alternative investments" or AI for short).

  While these may have little ability to hedge inflation in the short run, perhaps they have superior hedging ability in the long run.

- Use a vector error correction model (VECM) to measure these long-run relations.

Summary (cont.)

- Find AI portfolio that minimizes tracking error with TIPS.
- Evaluate gains and losses relative to 100% TIPS by simulating 5000 time series from VECM.
- Result: Inclusion of AI into the LHP leads to much higher funding ratios with very little risk.
- Example:
  - ⋆ Assume 15% of LHP is allocated to AI (85% toTIPS).
  - ⋆ At a horizon of 30 years, the probability of any shortfall is only 5%.
  - ⋆ The probability of a severe shortfall (funding ratio $< 90\%$) is essentially zero.
  - ⋆ The mean funding ratio is 33% better than with TIPS only.

Model Assumptions

Portfolio Allocation

Model assumes that pension funds form portfolio by

1. Choosing PSP to maximize Sharpe ratio assuming investments are a stock and a bond portfolio.

2. Choosing portfolio of AIs to minimize tracking error with TIPS. Then create LHP by allocating between this portfolio and TIPS.

3. Allocating between PHP and LHP.

Is this a good procedure? Compare with standard mean-variance portfolio theory.

Mean-variance portfolio theory

- Assume that investor likes mean, dislikes variance, and doesn't care about higher-order moments.
- Assume investor cares about real wealth, i.e. adjusts for inflation.
- $\mathbf{r}$ = vector of risky asset returns.
- $\mathbf{V}$ = variance-covariance matrix for $\mathbf{r}$.
- r_f = riskfree asset (TIPS).
- $\mathbf{e}$ = vector of mean risky asset returns in excess of r_f.
- All returns are inflation-adjusted.

Mean-variance portfolio theory (2)

- Optimal allocation in the risky assets is a vector $\mathbf{w}$:

$$\mathbf{w} = a\mathbf{V}^{-1}\mathbf{e}, \tag{1}$$

  where a is a measure of risk tolerance.

- $1 - (w_1 + \cdots + w_N)$ is the implied investment in TIPS.

- The Sharpe ratio of the portfolio equals: $\frac{E[r_p - r_f]}{\sigma_p}$ where $E[r_p - r_f]$ is the portfolio mean and σ_p is the portfolio standard deviation.

- Separation theorem: Any portfolio with risky asset weights given by (1) for some a achieves the maximum Sharpe ratio.

  Investors first find the maximum Sharpe ratio portfolio, and then, based on a, allocate wealth between this portfolio and the riskfree asset.

The Asset Management Decision

According to the paper, how should pension funds choose investments?

- Portfolio can be decomposed into
  - ⋆ PSP, which maximizes Sharpe ratio
  - ⋆ LHP, which hedges liabilities.
- In the framework of this paper, hedging liabilities is the same as hedging inflation.
- However, as long as mean-variance framework is done in real terms, hedging inflation is fully incorporated.
- $\Longrightarrow$ The standard mean-variance framework is optimal for pension funds.
- $\Longrightarrow$ Non-traditional assets should be used to enhance the PSP (and improve the Sharpe ratio), while LHP should remain 100% TIPS.

Econometric Methodology

The VECM approach to risk management

- Consider a set of asset classes: stocks, bonds, commodities, real estate.

- For each asset class, use returns on an index to proxy for returns on that asset class.

- Consider the value of an initial $1 investment in each asset class over time. Refer to this as the price.

  [Note: Need to make some assumption about re-investment of cash flows (e.g. dividends) – assumption is not specified in the paper.]

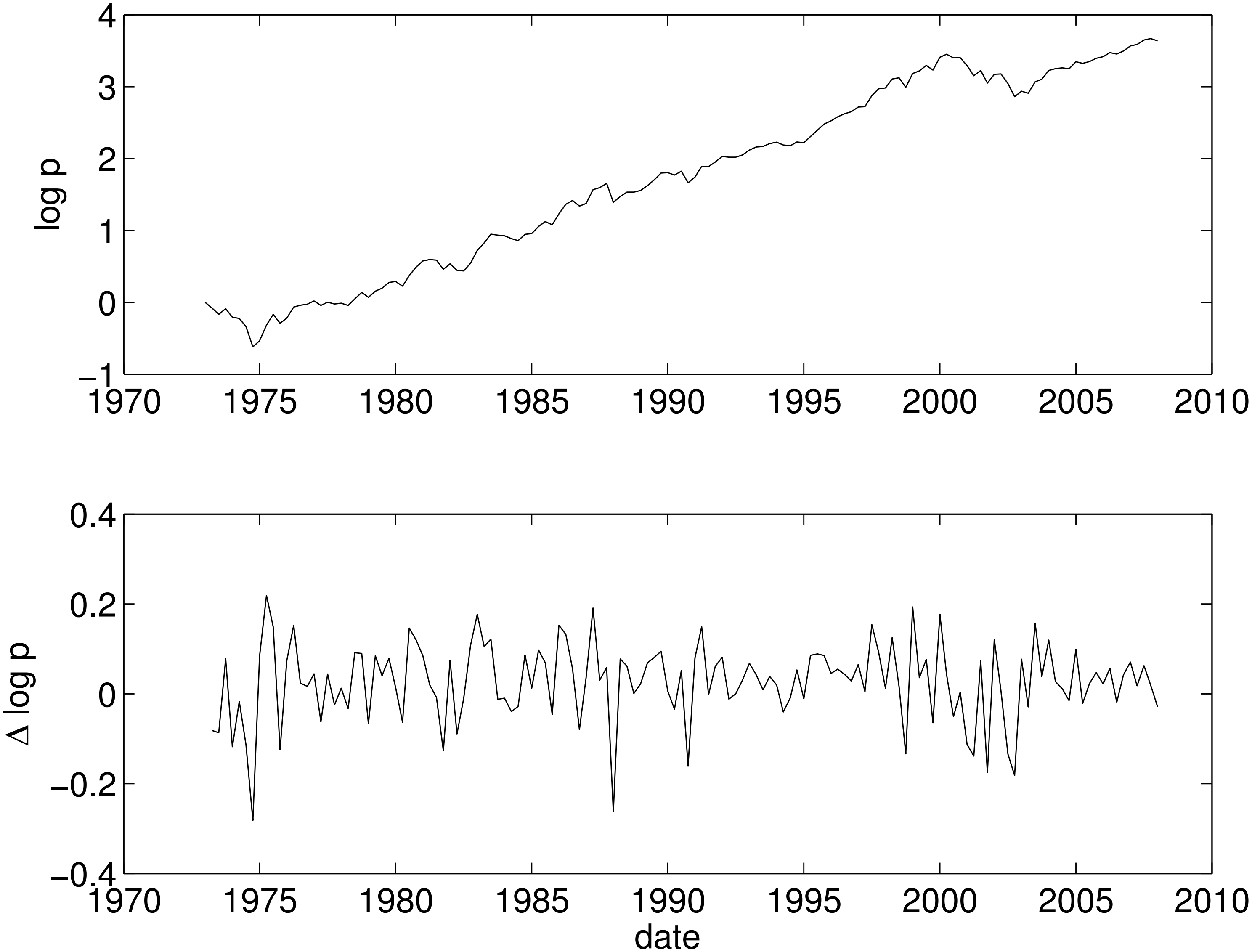
- Stack log prices into a vector process y_t.

- Augment y_t with variables conveying information about inflation and the state of the economy.

The VECM approach to risk management (cont.)

- Most studies move directly to drawing inference on Δy_t.
- Why? Whereas prices appear to be non-stationary, changes in prices appear to be stationary. That is, their unconditional probability distribution is constant over time.
- In contrast, the VECM approach uses the prices themselves (at least as a first step).

Log price (top) and change in log price (bottom) of the CRSP value-weighted index



The VECM approach (cont.)

- Goal: Find linear combinations of the elements of y_t for which non-stationarity is statistically rejected.

- This paper reports six such linear combinations (CR1, ..., CR6). For example, CR1 equals:

$$p_{\text{liabilities}} - 0.55p_{\text{commodities}} - 0.06p_{\text{real estate}} + \\ 6.60\text{credit spr.} + 0.57\text{term spr.} + 0.04\text{div. yield.}$$

- The linear combinations are stacked into a vector z_t, and included in a regression of changes in y_t on past changes in y_t.

$$\Delta y_t = c + \alpha z_t + \Gamma \Delta y_{t-1} + u_t. \tag{2}$$

- Standard techniques can be used to estimate α, Γ and the variance-covariance matrix of u_t.

- Results are based on simulations from (2), assuming that the shocks to u_t are multivariate normal.

How risky are the resulting portfolios?

Properties of the LHP when investments in real estate and commodities are added (Table 11).

Probability of "shortfall"

	Allocation to AI (in %)								
Horizon	0	5	10	15	20	25	30	35	40
3	0.00	32.78	32.78	32.78	32.78	32.78	32.78	32.78	32.78
7	0.00	22.30	22.30	22.30	22.30	22.30	22.30	22.30	22.30
10	0.00	17.48	17.48	17.48	17.48	17.48	17.48	17.48	17.48
15	0.00	12.98	12.98	12.98	12.98	12.98	12.98	12.98	12.98
20	0.00	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08
30	0.00	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20

Probability of "severe shortfall"

	Allocation to AI (in %)								
Horizon	0	5	10	15	20	25	30	35	40
3	0.00	0.00	0.00	0.00	0.00	0.10	0.56	1.84	3.28
7	0.00	0.00	0.00	0.00	0.08	0.44	1.48	2.68	3.88
10	0.00	0.00	0.00	0.00	0.10	0.56	1.58	2.56	3.48
15	0.00	0.00	0.00	0.00	0.24	0.78	1.62	2.28	3.10
20	0.00	0.00	0.00	0.00	0.16	0.52	0.94	1.56	2.10
30	0.00	0.00	0.00	0.00	0.20	0.46	0.76	0.98	1.26

How risky are the resulting portfolios (cont.)?

Table 11 understates the true risks of taking this approach.

- It does not take into account the need to estimate c, z_t, α, Λ and the variance-covariance matrix for u_t.

- It assumes that the model specification is correct.

  Equilibrium considerations do not give us an *a priori* reason to believe in the VECM specification.

  An economically motivated assumption: The ratio of values between any two assets is stationary (note that this is an assumption, not a requirement of equilibrium).

  This assumption does not justify the VECM specification because

  - ⋆ There are no economic conditions imposed on linear combinations z_t.
  - ⋆ The prices in y_t are not the total market values (which take into account issuance and buy-backs).

How risky are the resulting portfolios (cont.)?

Even if the VECM is the correct model and estimated parameters are correct,

- The model (or the parameters) could shift over time, and,

- The shocks u_t might not be multivariate normal, but rather be drawn from a distribution with more weight in the extremes.

  The assumption of multivariate normality most likely drives the sharp decrease in probability between any shortfall and a severe shortfall (33% to 0%).

The statement "0% probability of a severe shortfall" must be treated with caution.

Summary

- Real estate and commodities belong in the risky part of the portfolio, not as a substitute for TIPS.

- The VECM offers an appearance of decreased risk by estimating long-run relations between variables. Whether these long-run relations are stable, or even present should be carefully evaluated.

  The effectiveness of real estate and commodities as a hedge depends on the accuracy of the model and estimation.

- In contrast, the effectiveness of TIPS depends not on estimation of statistical properties, but on contractually specified cash flows. As long as the contract is satisfied, TIPS are a nearly perfect hedge.