ASSET PRICING FOUNDATIONS OF INVESTMENT STRATEGIES

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Asset Pricing Foundations of Investment Strategies

(i) Course Description

This course provides a rigorous panoramic analysis of the **interplay between asset pricing theory, investment strategies and the empirical evidence with and without funding liquidity related market frictions (borrowing constraints)**.

- We present a unified treatment of asset pricing models using the **stochastic discount factor framework**, and discuss several key aspects of asset pricing as time-varying expected returns, predictability of future returns, consumption risk, non-separable preferences, and multi-factor asset pricing models.

- Given the asset pricing foundations, we discuss relevant implications for investment strategies.

- Finally, we present asset pricing models with funding liquidity restrictions.

Asset Pricing Foundations of Investment Strategies

(ii) Requirements

- The target audience for this course is economics and finance graduate students. The course presumes some exposure to graduate introductory courses in finance, economics, statistics and econometrics. The grade will be based on problems and empirical exercises with real data and a final exam.

- Exercises by groups of 3 people will represent 40% of the grade. A closed book final exam will represent 60% of the course. All students must obtain at least 4 points out of 10 in the final exam for the 40% of the group exercises to be taken into account in the final grade. Also, class attendance is strictly necessary to compute the group points in the final grade.

- The final exam will consist of multiple choice questions in which you will have to justify your answer.

Asset Pricing Foundations of Investment Strategies

(iii) Contents

Asset Pricing Foundations of Investment Strategies

4. Factor Pricing

4.1 Factor Pricing Theory: An Overview
4.2 Static Factors and the Capital Asset Pricing Model (CAPM)
4.3 Dynamic Factors and Multifactor Asset Pricing Models
4.4 Quality at a Reasonable Price (QARP)
4.5 The Performance of Dynamic Factors Asset Pricing Models
4.6 Factor (Not Assets) Optimal Allocation
4.7 Intertemporal Asset Pricing Models with Non-Separability and Rebalancing

5. ***Factor Pricing with Funding Liquidity and Leverage***

5.1 Liquidity Risk: Market-Wide Liquidity Shocks and Asset Pricing
5.2 Funding Liquidity Risk: The Margin-Based CAPM

Asset Pricing Foundations of Investment Strategies

References

• **Andrew Ang, *Asset Management: A Systematic Approach to Factor Investing*, Oxford University Press, 2014**

• Kerry Back, *Asset Pricing and Portfolio Choice Theory*, Oxford University Press, 2010

• John Cochrane, *Asset Pricing*, Princeton University Press, 2005

• Antti Ilmanen, *Expected Returns on Major Asset Classes*, Wiley Global Finance, 2012

• George Pennachi, *Theory of Asset Pricing*, Pearson-Addison Wesley, 2008

• Lasse H. Pedersen, *Efficiently Inefficiently*, Princeton University Press, 2015

Asset Pricing Foundations of Investment Strategies

References

Adrian, T., E. Etula, and T. Muir (2014), Financial Intermediaries and the Cross-Section of Asset Returns, Journal of Finance 69, 2557-2596.

Asness, C., A. Frazzini, and L.H. Pedersen (2014), Quality Minus Junk, *Working Paper, AQR Capital Management and New York University, Stern School of Business*.

Asness, C., A. Frazzini, N.J. Gormsen, and L.H. Pedersen (2017), Betting Against Correlation: Testing Theories of the Low-Risk Effect, *Working Paper, AQR Capital Management and New York University, Stern School of Business*.

Asness, C., A. Frazzini, R. Israel, T. Moskowitz (2015), Fact, Fiction, and Momentum Investing, *Journal of Portfolio Management*, 40th Anniversary.

Asness, C., A. Frazzini, R. Israel, T. Moskowitz (2015), Fact, Fiction, and Value Investing, Journal of Portfolio Management

Asness, C., A. Frazzini, R. Israel, T. Moskowitz, and L.H. Pedersen (2017), Size Matters, if You Control Your Junk, *Journal of Financial Economics*, forthcoming.

Asness, C., A. Ilmanen, R. Israel, and T. Moskowitz (2015), Investing with Style, *Journal of Investment Management* 13, 27-63.

Asvanunt, A., and S. Richardson (2016), The Credit Risk Premium, *Available at SSRN: http://dx.doi.org/10.2139/ssrn.2563482SSRN*.

Brunnermeier, M. and L. Pedersen (2009), Market Liquidity and Funding Liquidity, Review of Financial Studies 22, 2201-2238.

Carhart, M. (1997), On Persistence in Mutual Fund Performance, *Journal of Finance* 52, 57-82.

Cochrane, J. (2007), Financial Markets and the Real Economy, In *Handbook of the Equity Premium*, edited by Rajnish Mehra, Elsevier, 237-325.

Cochrane, J. (2011), Discount Rates: American Finance Association Presidential Address, *Journal of Finance* 66, 1047-1108.

Cochrane, J. (2017), Macro-Finance, *Review of Finance* 21, 945-985.

Fama, E., and J. MacBeth (1973), Risk, Return and Equilibrium: Empirical Tests, *Journal of Political Economy* 81, 607-636.

Fama, E., and K. French (2015), A Five-Factor Asset Pricing Model, *Journal of Financial Economics* 116, 1-22.

Frazzini, A., D. Kabiller, and L.H. Pedersen (2015), Buffett's Alpha, Working Paper, AQR Capital Management.

Frazzini, A., and L.H. Pedersen (2014), Betting against Beta, *Journal of Financial Economics* 111, 1-25.

Garleanu, N. and L. Pedersen (2011), Margin-Based Asset Pricing and Deviations from the Law of One Price, Review of Financial Studies 24, 1980-2022.

Ghosh, A., C. Julliard, and P. Taylor (2016 a), What is the Consumption-CAPM Missing? An Information-Theoretic Framework for the Analysis of Asset Pricing Models, *Review of Financial Studies* 30, 442-504.

Ghosh, A., C. Julliard, and P. Taylor (2016 b), An Information-Theoretic Asset Pricing Model, *Working Paper, London School of Economics*.

Hansen, L., and R. Jagannathan (1991), Implications of Security Market Data for Models of Dynamic Economies, Journal of Political Economy 99, 225–262.

Harvey, C., Y. Liu, and H. Zhu (2016), …. And the Cross-Section of Expected Returns, *Review of Financial Studies* 29, 5-68.

Israel, R., S. Jiang, and A. Ross (2017), Craftsmanship Alpha: An Application of Style Investing, Working Paper, AQR Capital Management.

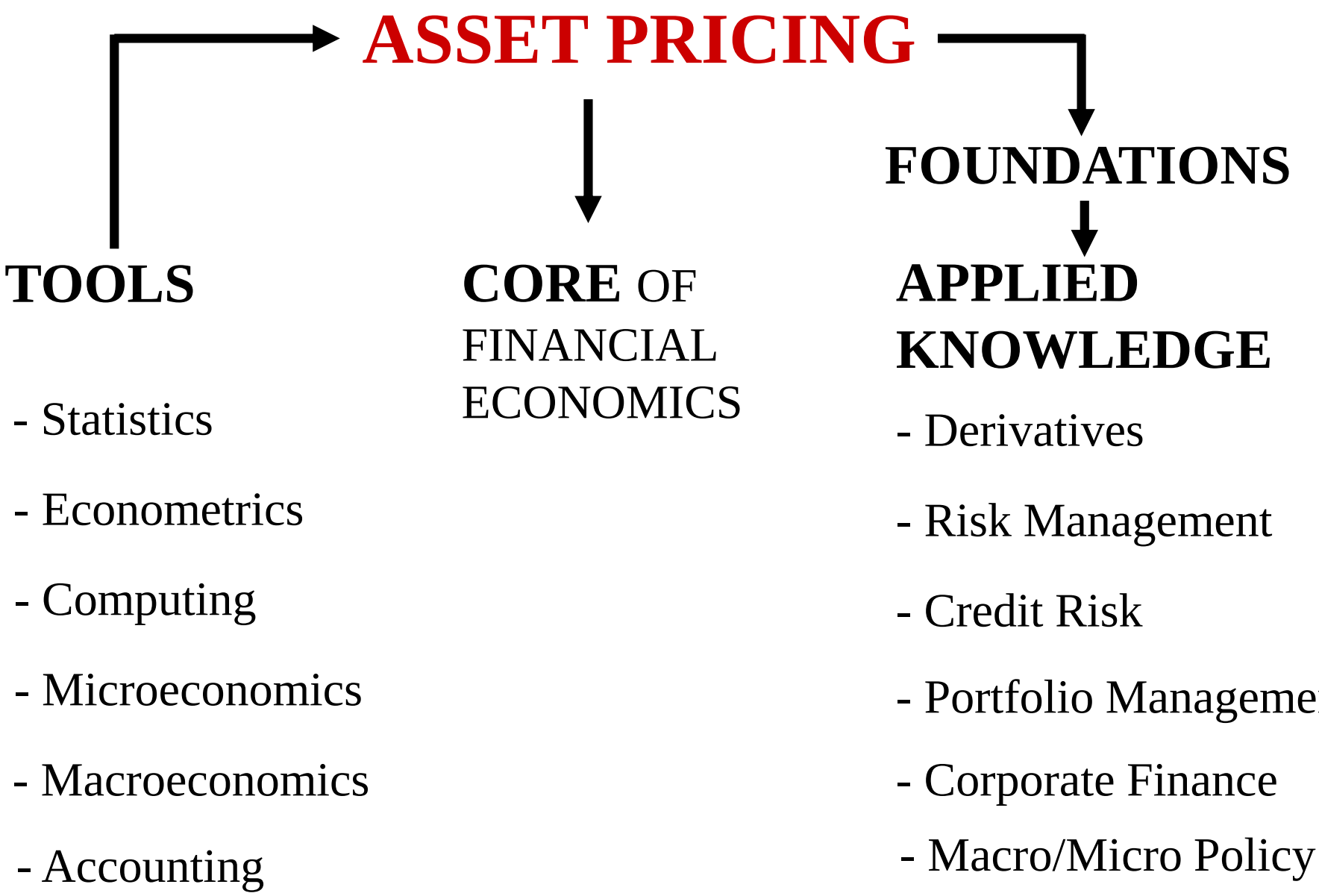
Martin, I. (2017), What is the Expected Return on the Market? *Quarterly Journal of Economics* 132, 367-433.

Pastor, L., and R. Stambaugh (2003), Liquidity Risk and Expected Stock Returns. *Journal of Political Economy* 111, 642-685.

Santa Clara, P., and P. Maio (2012), Multifactor Models and their Consistency with the ICAPM, *Journal of Financial Economics* 106, 586-613.

1. FOUNDATIONS OF ASSET PRICING AND INVESTMENTS

Foundations of Asset Pricing: The Key Ideas



Foundations of Asset Pricing: The Key Ideas

DATA FACTS

• High average market risk premium (average market return over the risk-free rate). It has been extraordinarily large over the past 90 years (July 1926 to May 2016) ≈ 7.8%

• Counter-cyclical time-varying expected returns (expected risk premiums): it opens the door to predictability of returns (long horizons)

• Large cross-sectional variation (size, value-growth, momentum, quality, profitability, investment aggressiveness, volatility, beta)

Foundations of Asset Pricing: The Key Ideas

►Asset pricing models must explain **these regularities** we observe in data (large average market risk premium, time-varying expected returns because counter-cyclical time-varying risk aversion, and large cross-sectional variation)

►Asset Pricing:

How do we explain the time series and cross-sectional behavior of stock returns?

- The same ideas are valid to fixed income assets, derivatives, currencies and commodities

►Implications of modern asset for investment strategies

Foundations of Asset Pricing: The Key Ideas

- The big lesson of Finance

- Expected risk premiums vary over time displaying a strong counter-cyclical pattern (highly positively correlated with recessions), and they are coordinated across asset classes

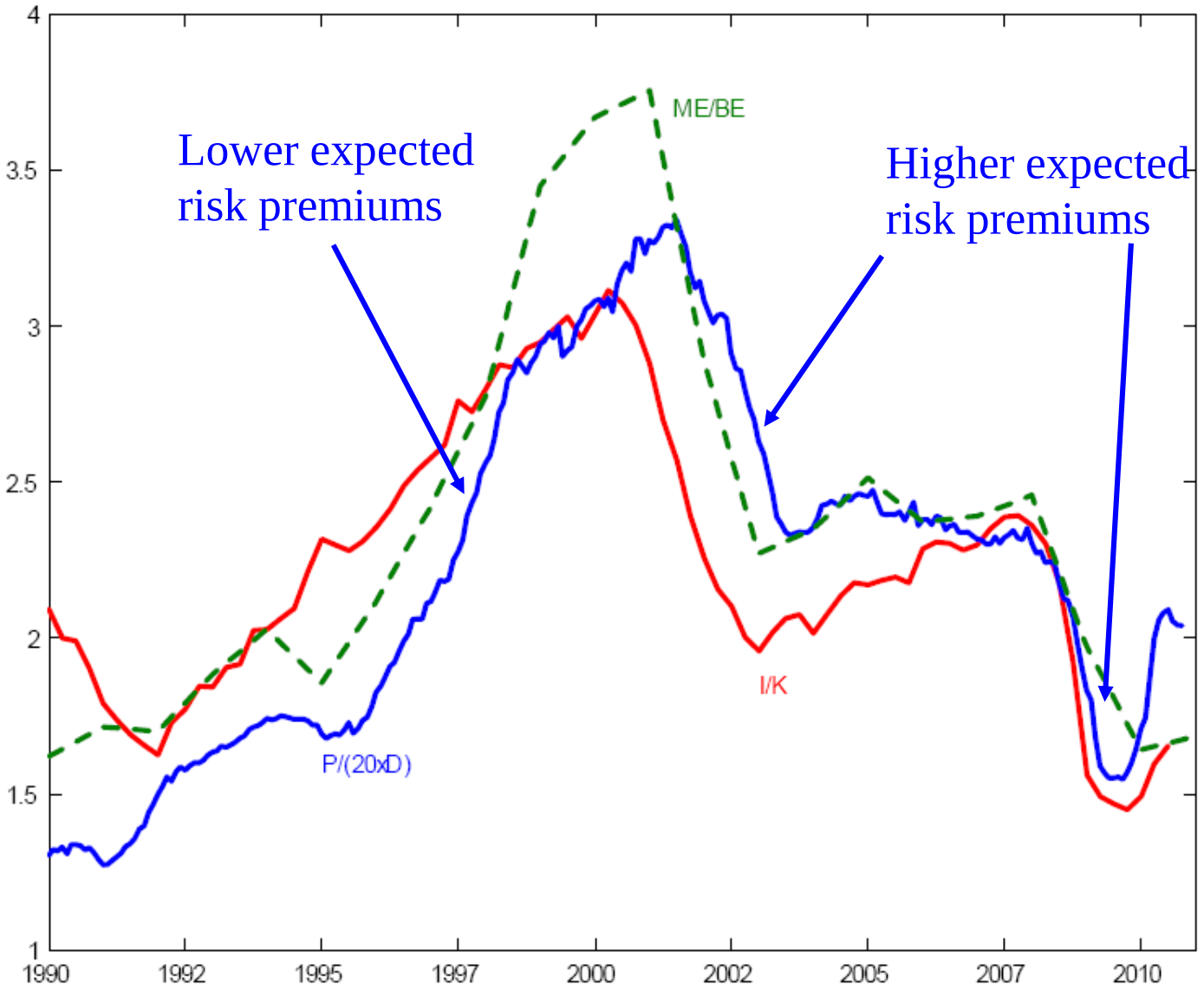
- The stunning coordinated risk associated with expected risk premiums − the spike in credit spreads, the collapse in stocks, the arbitrage opportunities in derivatives − which are absent in most macro models, was the central price phenomenon of the last recession

Foundations of Asset Pricing: The Key Ideas

- The lesson of Finance for Macroeconomics

Counter-cyclical risk aversion, counter-cyclical expected risk premiums, and precautionary savings, not risk-free rates (interest rates) and intertemporal substitution, are the central features of recessions (investment did not fall because interest rose)

Foundations of Asset Pricing: The Key Ideas



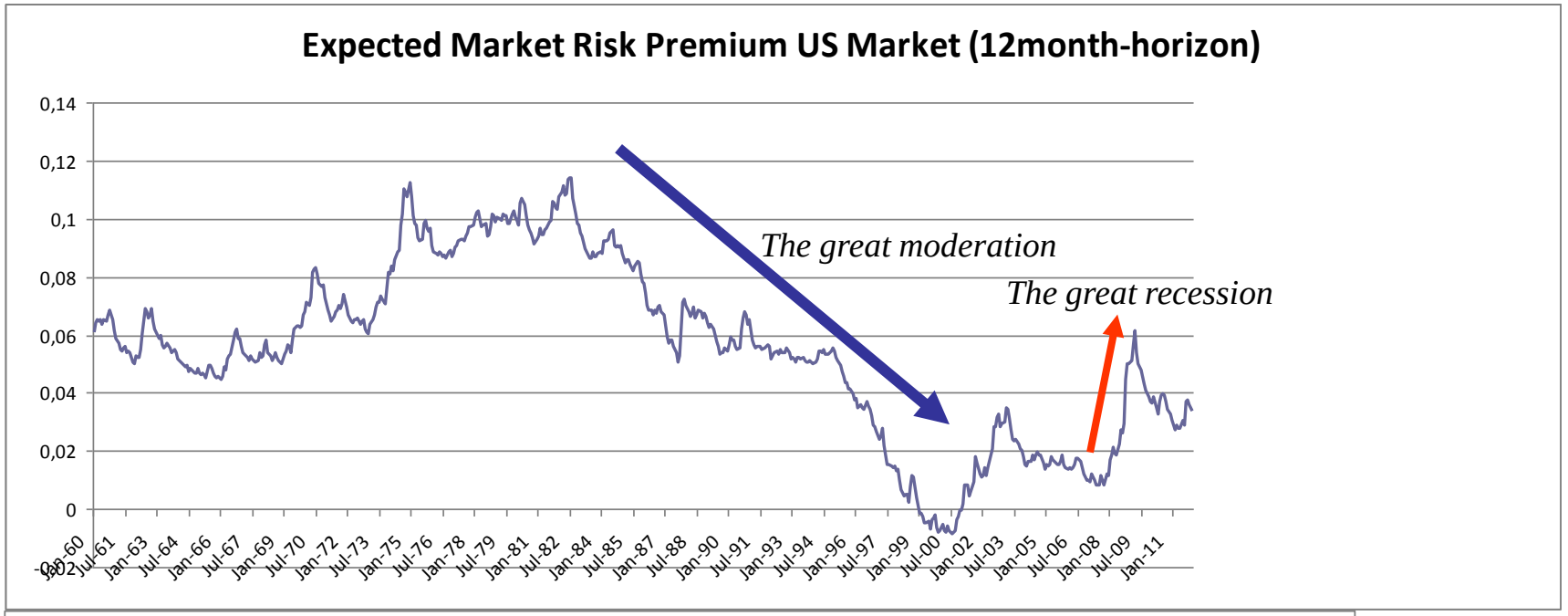
Foundations of Asset Pricing: The Key Ideas

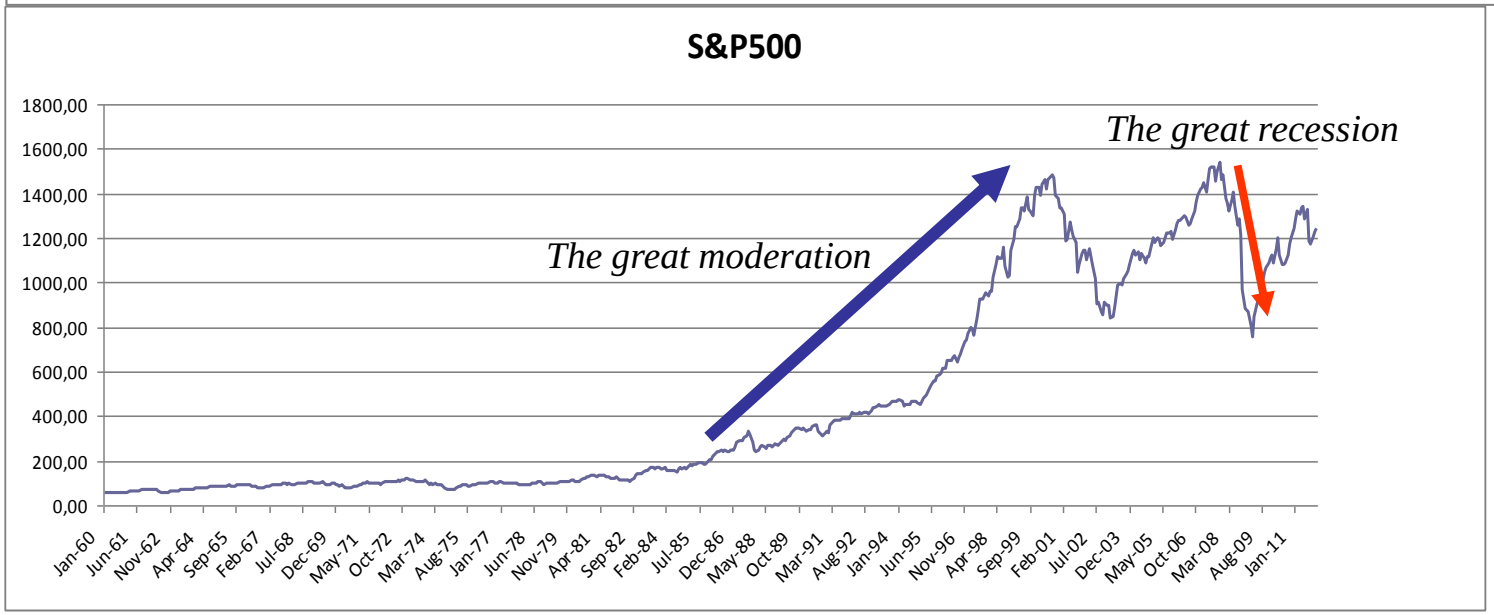
Two main ideas dominate modern asset pricing and investments

► **TIME-VARYING EXPECTED RETURNS** (the key source of price movements)

► **FACTOR RISKS** (the key aggregate drivers of asset returns; main tool to explain cross-sectional differences in the variation of average returns)

Time-Varying Expected Returns





Average Market Risk Premium

1960-2011
5.49%

1960-1982
7.43%

1983-2011
3.95%

Time-Varying Expected Returns

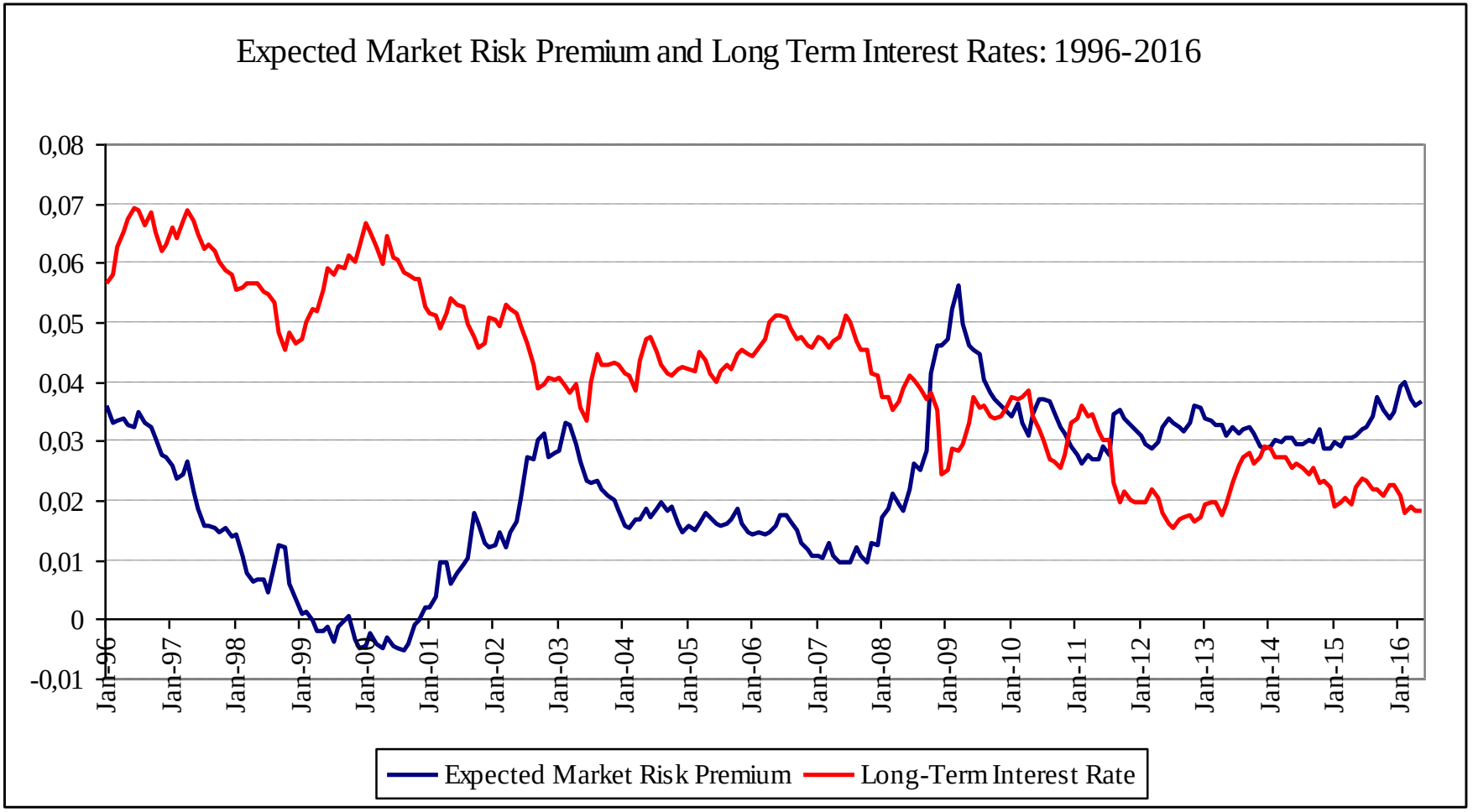
• A low (high) price implies a high (low) expected rate of return,

• The rising expected (required) return by investors is largely responsible for the widespread decline in realized returns (prices) during the early stage of recessions:

• During recessions prices will continue to go down until the expectation of a gain will be high enough to compensate the cost of the risky investment

Time-varying expected returns move prices (and not the other way around)

Time-Varying Expected Returns



Factor Risks

- ¿How do we price financial assets?

- ¿How the prices of financial assets are determined?

- **Any price of any financial asset (stocks, bonds, derivatives) is the present value of future expected cash flows generated by the asset**

$$P_{jt} = \frac{E\left(Cash\ Flow_{jt+1}\right)}{1 + E\left(R_{jt+1}\right)}$$

- The discount rate, $E(R_{jt+1})$, incorporates the risk associated with the asset or firm j

$$E\left(R_{jt+1}\right) = R_{ft+1} + Risk\ Premium_{j}$$

Factor Risks

•¿How the risk premium is determined?

$$Risk\ Premium_j = Risk\ aversion \times Quantity\ of\ risk_j$$

$$Quantity\ of\ risk_j = \begin{cases} Correlation\ of\ R_j \\ with \\ Aggregate\ Risk\ Factors \end{cases}$$

•The big question is, what should one use for risk factors?

Factor Risks

The two most important words in asset pricing and investing are

BAD TIMES

- The essential problem of portfolio selection and asset pricing is that asset owners (from a household to sovereign wealth funds) generally feel the pain of bad times much more acutely than they do the excitement of good times

- And, this is why economic agents (investors) are **risk averse**: they are especially concerned with receiving payoffs during bad times

Key idea: **payoffs during bad times are highly valued**

Factor Risks

- **Technically, "bad times" are times of high marginal utility of consumption**

- Those times in which economic agents value a lot an additional unit of consumption (an additional payoff from financial assets)

Factor Risks

1960-2012 PORTFOLIO	MEAN SIZE	MEAN BOOK-TO-MARKET	MEAN MOMENTUM	MEAN QUALITY
1	**13.683**	**9.346**	**1.838**	**5.906**
2	**12.951**	**10.645**	**7.664**	**8.377**
3	**13.847**	**11.046**	**9.444**	**8.979**
4	**12.996**	**11.043**	**9.916**	**9.162**
5	**13.317**	**11.064**	**9.449**	**9.865**
6	**12.547**	**11.828**	**10.353**	**10.053**
7	**12.634**	**12.524**	**10.725**	**11.729**
8	**12.116**	**12.928**	**12.544**	**10.179**
9	**11.464**	**13.859**	**13.651**	**11.593**
10	**9.754**	**15.146**	**17.969**	**11.941**

- 1= small, low book-to-market (growth), low momentum, low quality portfolios
- 10 = big, high book-to-market (value), high momentum, high quality portfolios

- **Size Premium = 3.93%; Value Premium = 5.80%**
- **Momentum Premium = 16.13%; Quality Premium = 6.04%**

Factor Risks

Assets earn risk premiums because they are exposed to underlying factor risks (assets are bundles of factor risks)

► The **factor risks constitutes different flavors of "bad times"** and investors who bear these factor risks need to be compensated in equilibrium by earning factor risk premiums

► To price assets, we need to obtain an **index of "bad times"**, and bad times are times of high marginal utility of consumption

► Therefore, the index of bad times must approximate marginal utility of consumption

Factor Risks

If the index of bad times can be approximated by only one factor risk we have **ONE-FACTOR ASSET PRICING MODELS** (CAPM)

If the index of bad times is approximated by multiple risk factors where each of them captures a different flavor of bad times, then we have **MULTIPLE-FACTOR ASSET PRICING MODELS** (Fama and French 3- and 5- factor models and the like)

Factor Risks

The “challenge” of **asset pricing models** is how to measure “bad times” and “times of high risk premium (high expected excess return)” in a theoretical coherent and empirically productive way

Factor Risks

- In the first week of August 2007, returns of quantitative hedge funds (any hedge fund that relies upon algorithmic or systematic strategies for implementing its trading decisions) went into a tailspin; from August 7 to 9, quant funds experienced huge and unprecedented losses …. for no obvious reason

- Losses at some of the largest and historically best-performing quant funds reached 30% during the first ten days of August 2007

Factor Risks

• Losses of this magnitude in the absence of significant bad news were shocking to quant HF managers (Matthew Rothman: “events that models only predicted would happen once in 10,000 years happened every day for three days”)

• It was not just the losses that were shocking; quants combined several investment strategies that were supposed to have low correlations with each other and overall low volatility

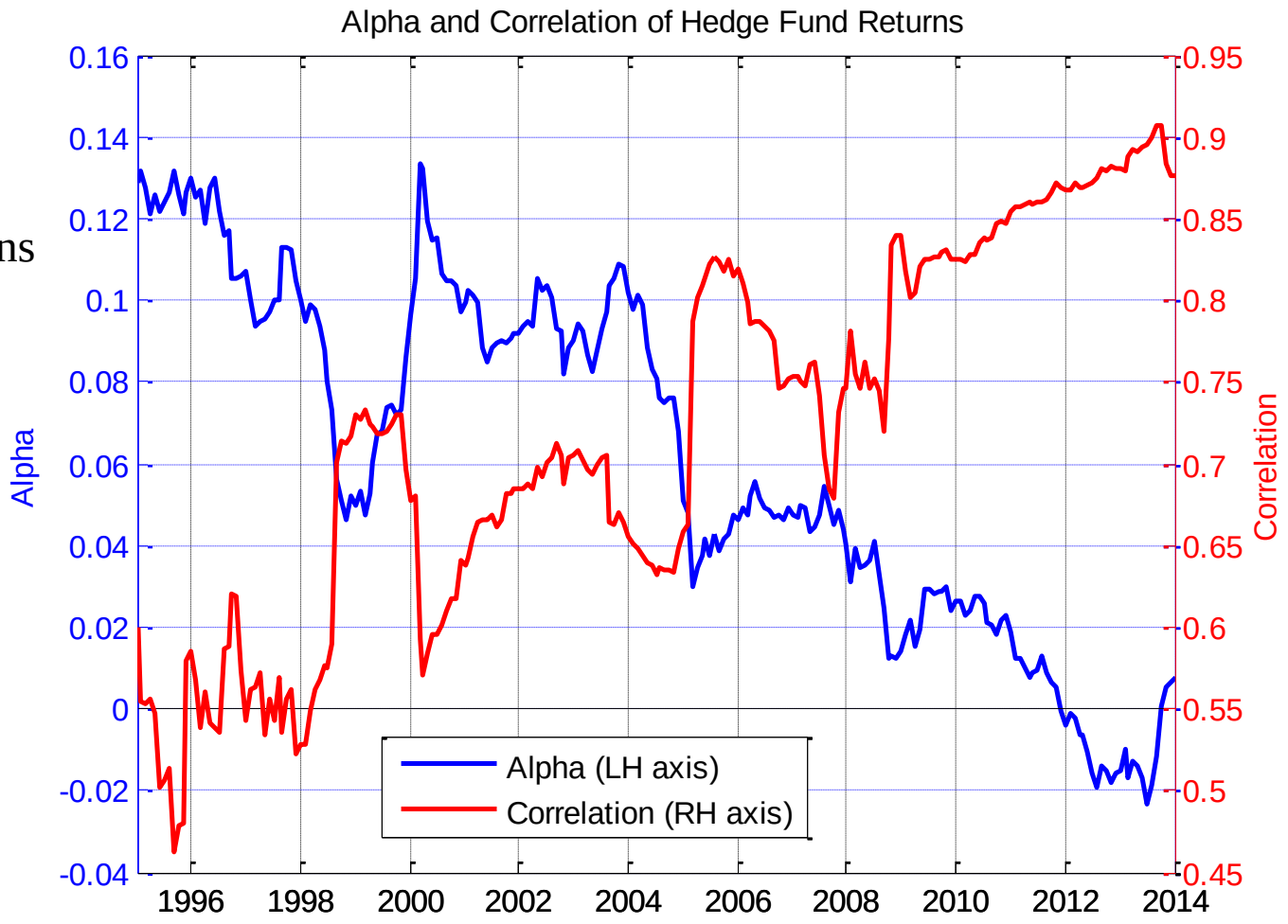
•Yet the resulting investments plummeted together

?

Factor Risks

Performance:

Alphas:
risk-adjusted returns

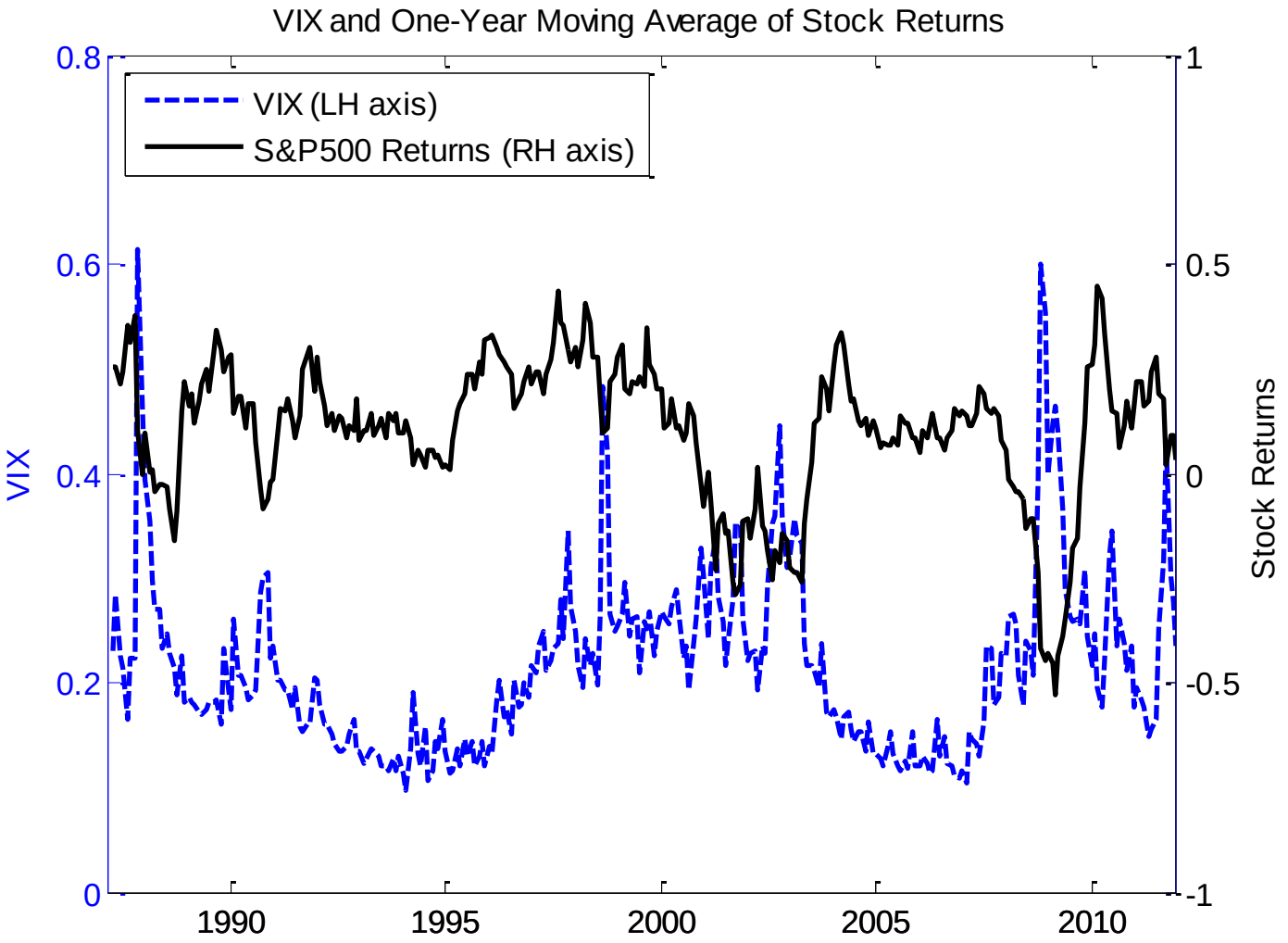


Factor Risks

- We next show correlations of the HF index and various HF strategies with two FACTOR RISKS: the **S&P500** and a **volatility factor**

The **volatility factor** is compiled by Merrill Lynch and is a return series from a **short volatility strategy**

Volatility


VIX and One-Year Moving Average of Stock Returns
VIX (LH axis)
S&P500 Returns (RH axis)
VIX
Stock Returns
0.8
0.6
0.4
0.2
0
1
0.5
0
-0.5
-1
1990
1995
2000
2005
2010

Factor Risks

• Short volatility strategies sell volatility insurance and make money during stable times but lose money when volatility spikes

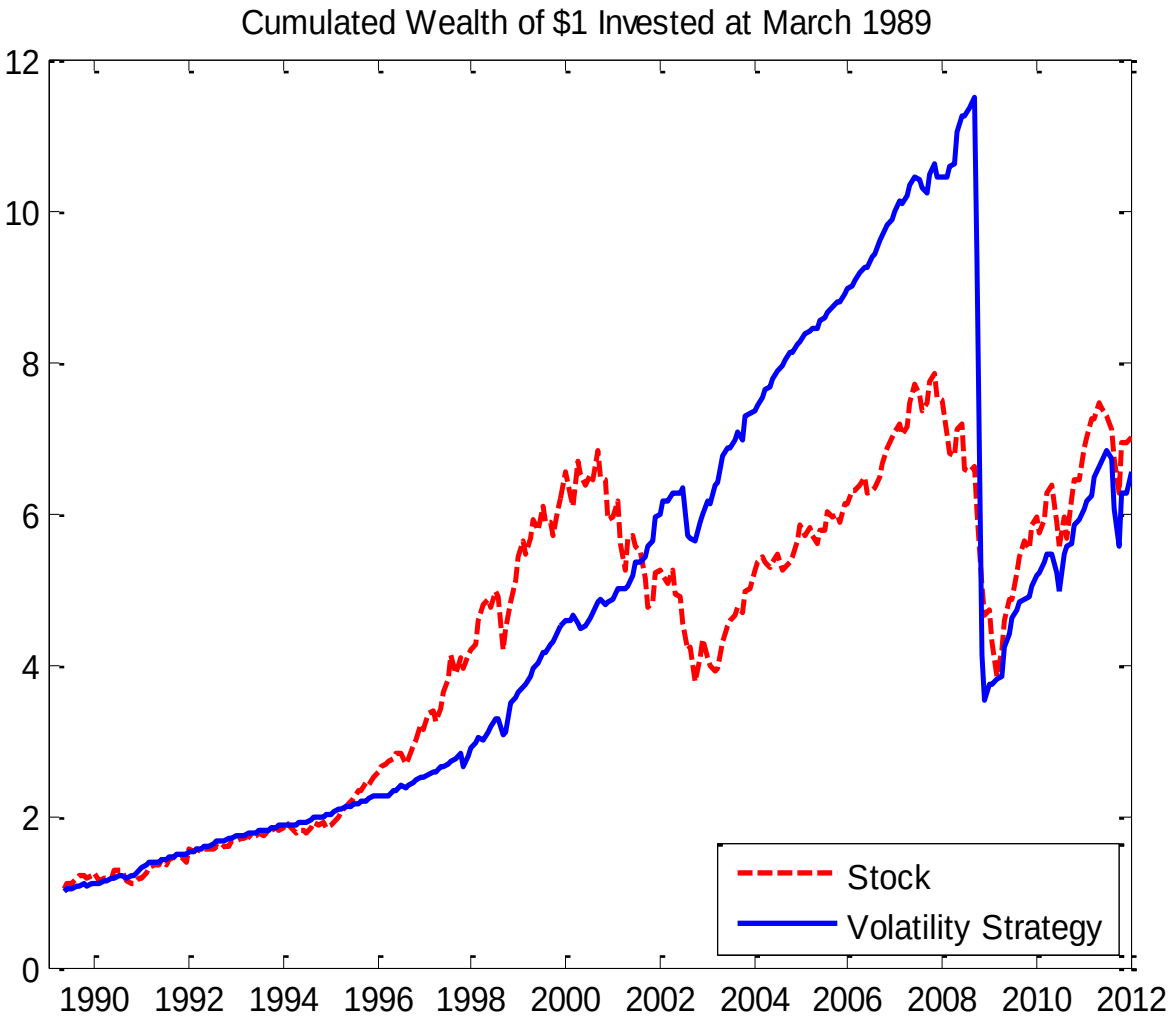
• Note that investors who dislike risk (stock market going down) can buy volatility protection but, as in any other insurance, the average risk premium will be negative; other investors can afford to take on volatility risk by selling volatility protection

Factor Risks

Selling the volatility factor

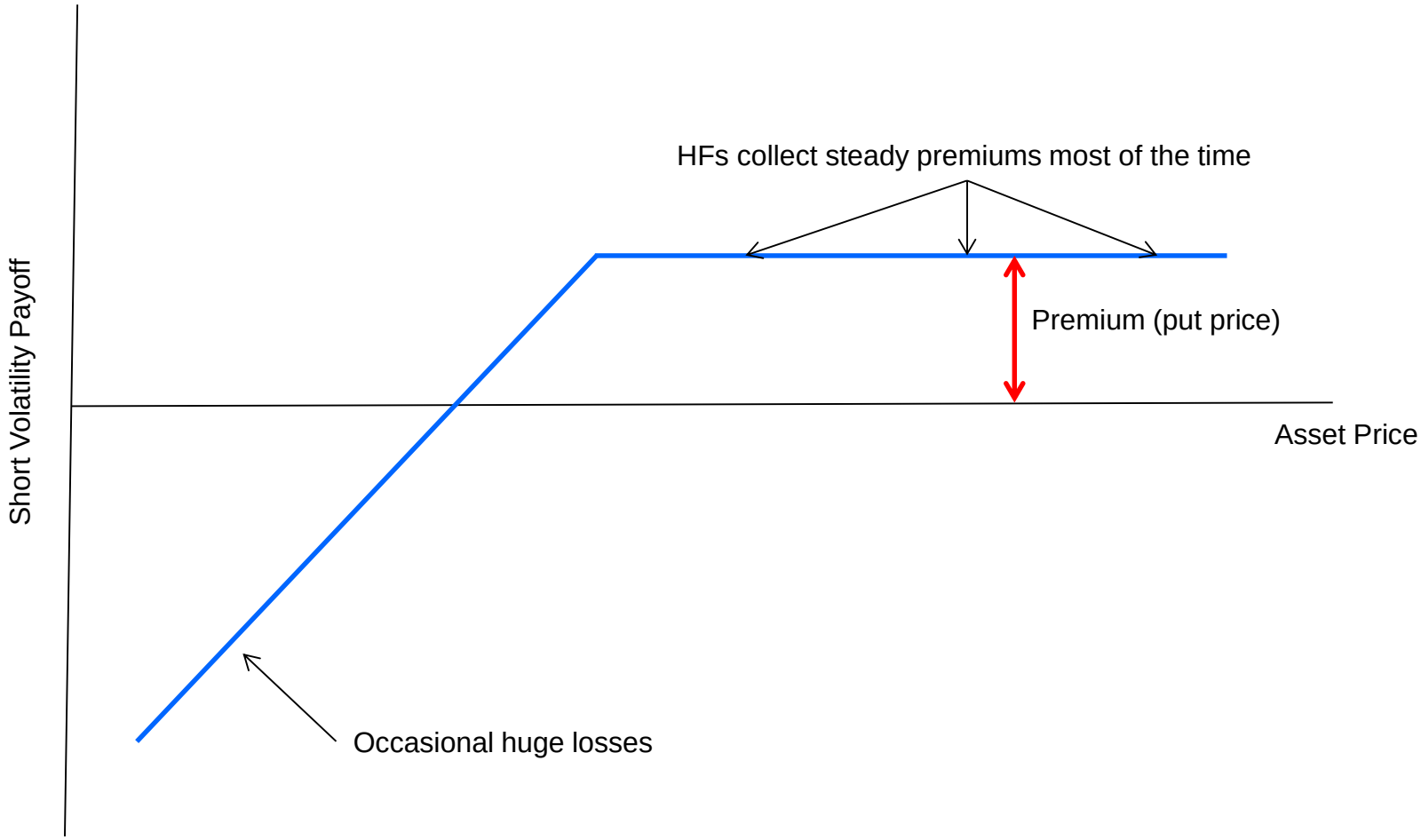
People paying the premiums (buying volatility) have purchased protection against decreases in the stock market

When volatility jumps (in bad market times), investors with short volatility positions suffer losses. These losses represent the gains to those who have bought volatility protection

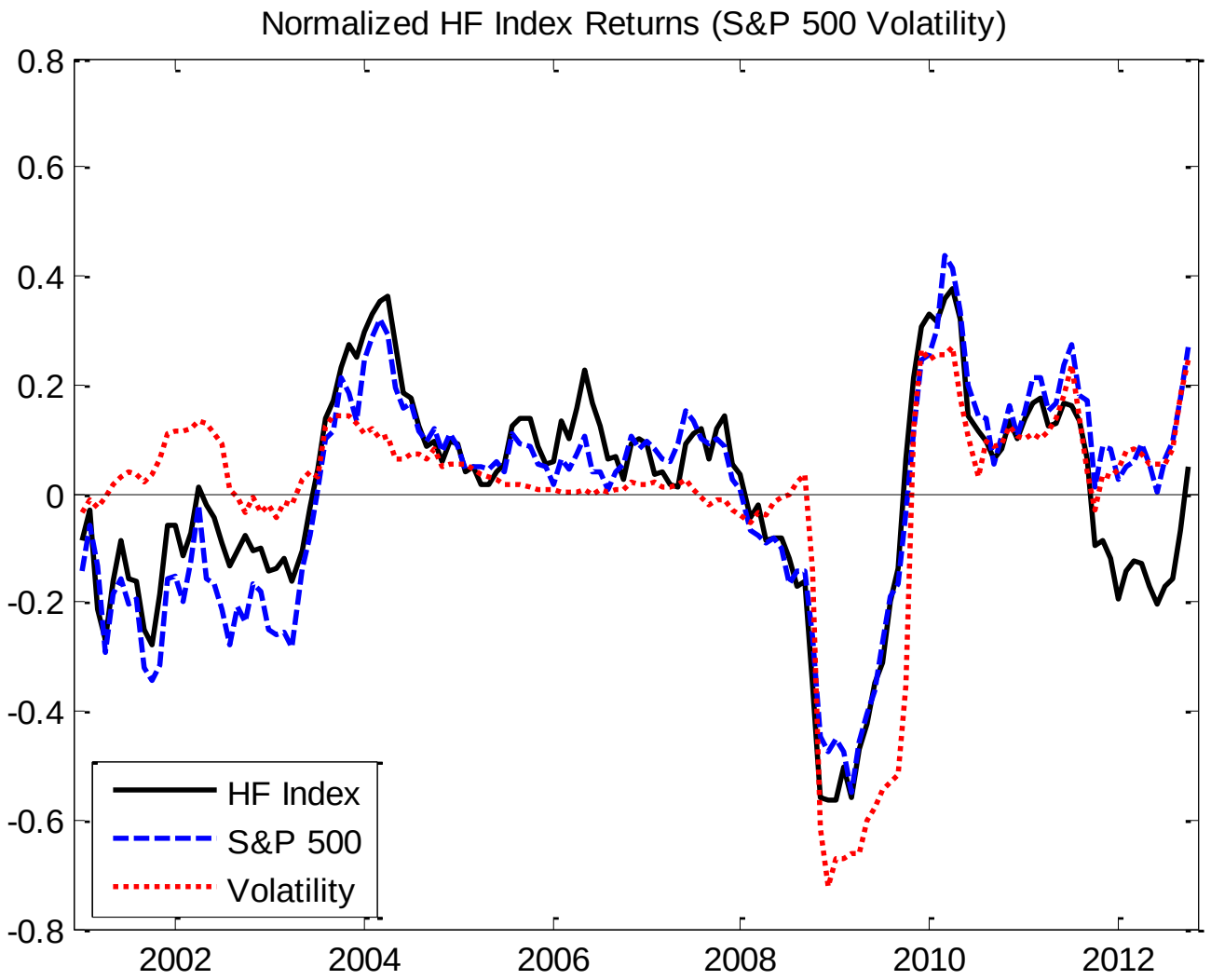


Factor Risks

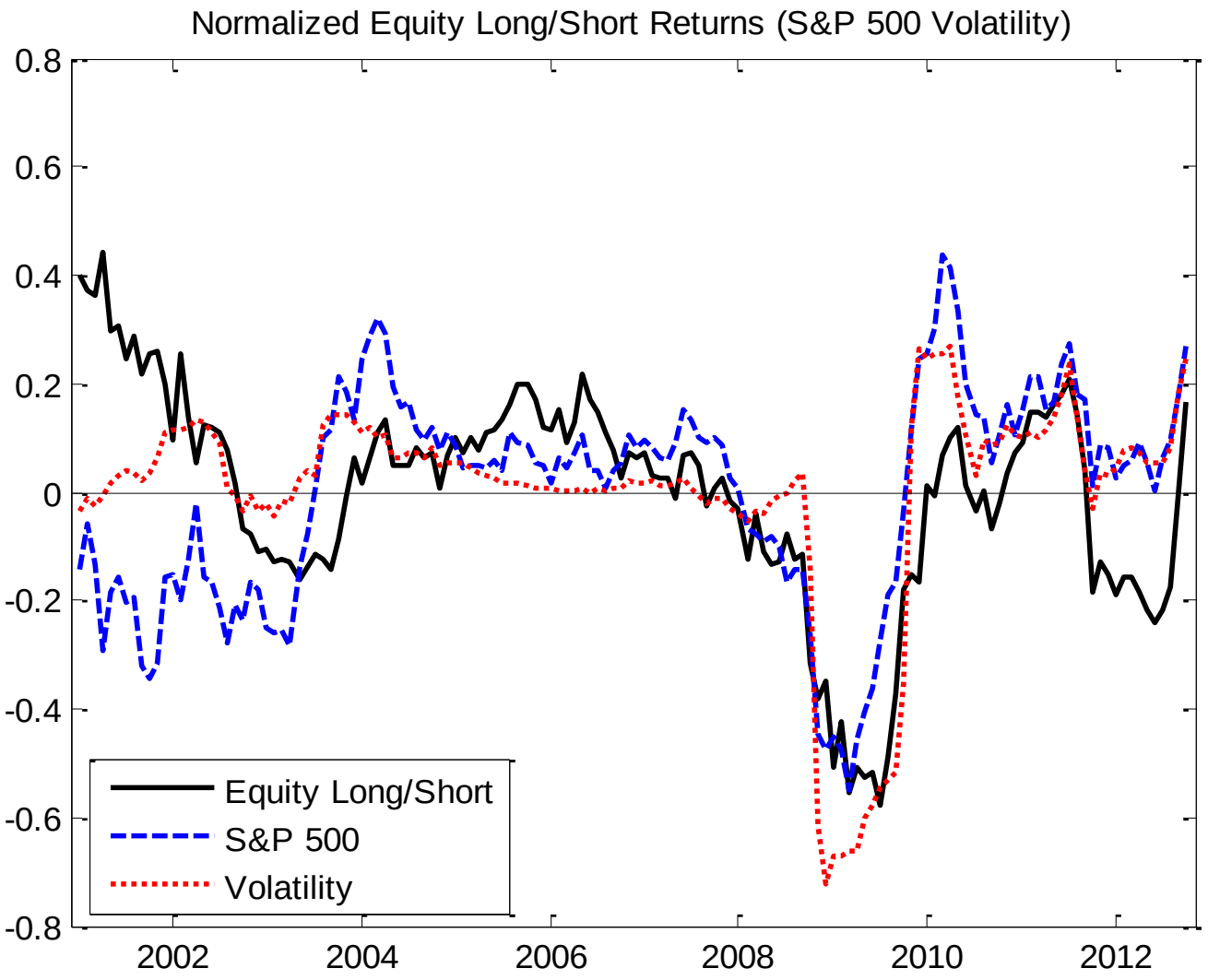
Shorting volatility = fire insurance = selling a put option



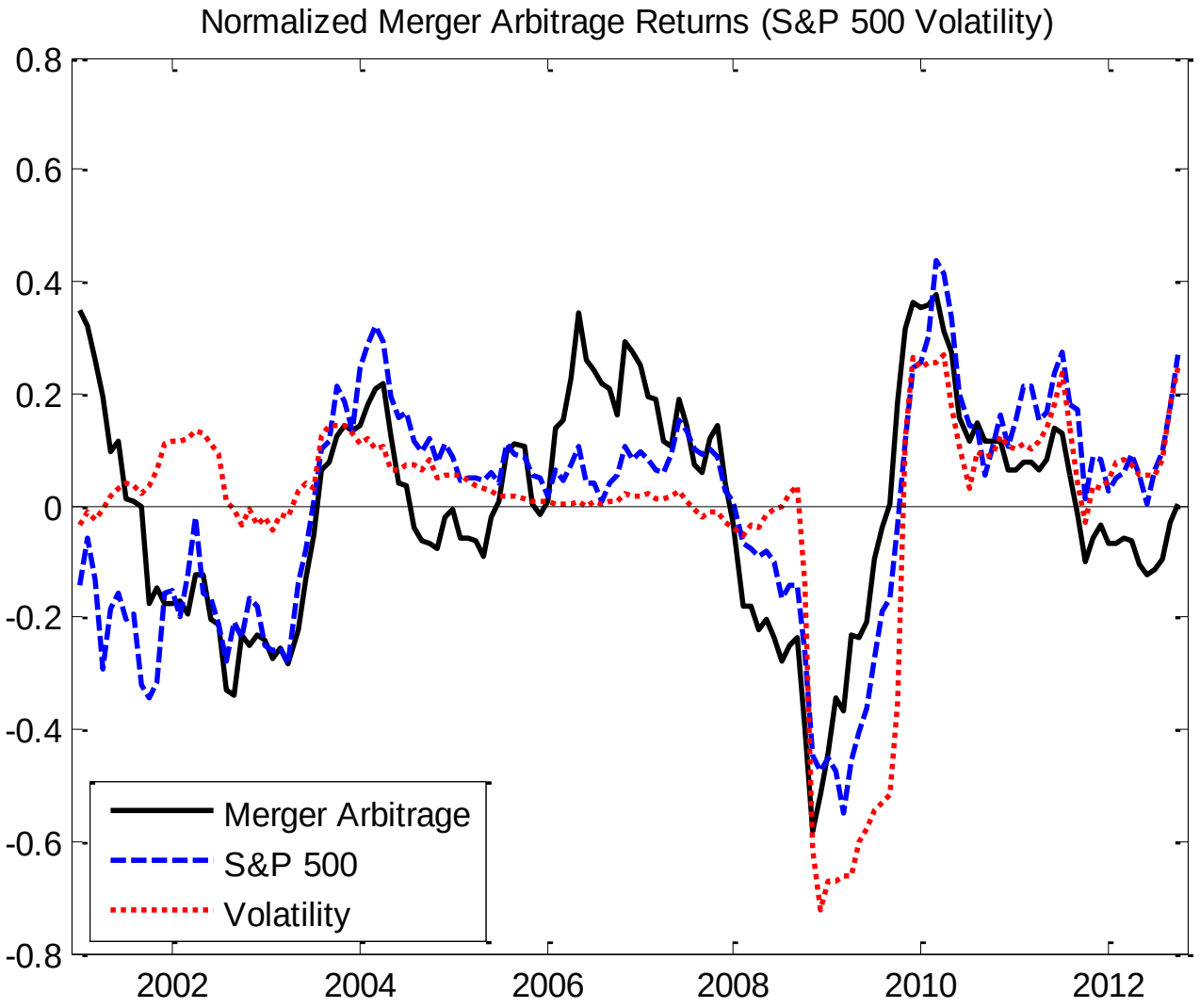
Factor Risks



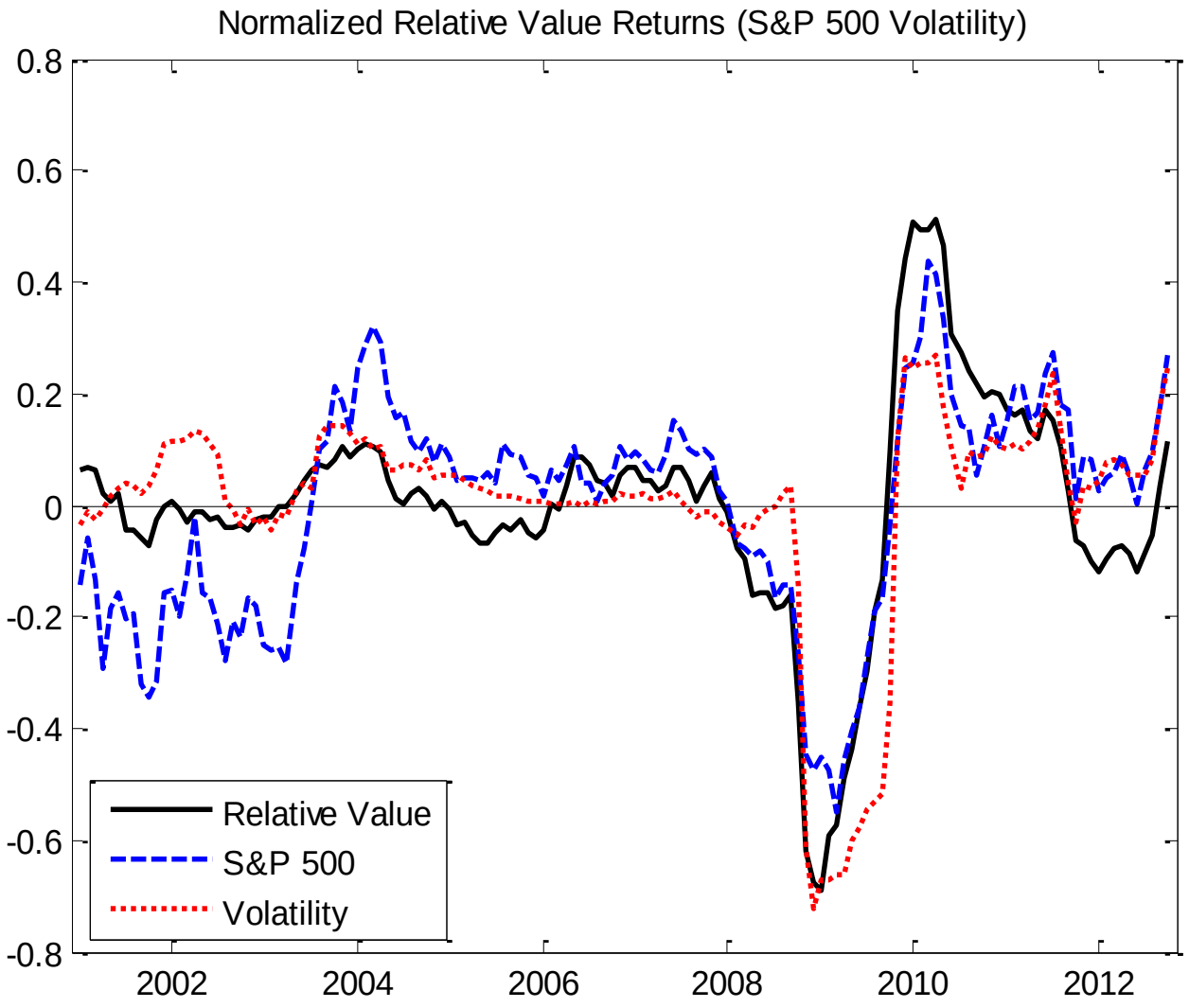
Factor Risks



Factor Risks



Factor Risks



Factor Risks

There is an amazingly close correspondence of these HF returns with the S&P500 and volatility factors in all the panels

HFs repackage equity and volatility risk; they are bundles of risk factors

Asset pricing focuses on **FACTORS: the risk drivers of returns**

Summary

- Our asset pricing models must be able to explain the basic moments characterizing our available data
  - **High average market risk premium**
  - **Time-varying expected returns**
  - **Large cross-sectional variation**
  - **Understand high marginal utility events (bad times) and the underlying factor risks driving data**
  - **And, on top of that, we should take into account borrowing and margin requirement constraints (*funding liquidity*)**

Foundations of Asset Pricing and Investments: Appendix

Hedge funds (HFs) are private investment vehicles open to a limited number of wealthy or professional investors. They are characterized by

- Limited number of investors. Investors must be *accredited* or *qualified purchasers* (legal terms for "rich, sophisticated investors"). Minimum capital requirements are high.
- Usually have limited liquidity (limit access to invested capital)
- Often employ leverage and use derivatives. They invest in a wide range of strategies often not available in other investment vehicles.
- Manager fees are very high and often have a performance component
- Are [relatively] unregulated [Dodd-Frank 2010 have changed slightly this]
- Are not transparent

Foundations of Asset Pricing and Investments: Appendix

HFs take two main approaches:

(i) HFs that attempt market timing seek to capture market trends –directional trades– and take net long or short positions

(ii) Non-directional or market-neutral HFs try to extract value from arbitrage opportunities

These funds do not find pure arbitrages, which are rare. Rather, this type of HF seeks to neutralize market movements and attempts to profit from securities that are misvalued relative to each other

Within these two approaches, there are two main styles: (i) discretionary styles: rely mostly on a trader's judgment; (ii) systematic styles (rules-based quantitative models)

Foundations of Asset Pricing and Investments: Appendix

A Quantitative Hedge Fund is any Hedge Fund that relies upon algorithmic or systematic strategies for implementing its trading decisions. Quant trading strategies may focus on any asset class (equities, derivatives, fixed income, foreign exchange, commodities, etc.), with trades that are based on systematic strategies, rather than discretionary decisions

In other words, at least to some degree Quantitative Hedge Funds employ "automatic" trading rules rather than ones that employees at the fund identify and evaluate

Of course, these two strategies can be mixed, but nearly all Hedge Funds are either primarily a Quant Hedge Fund or primarily a non-Quant Hedge Fund. Many are leveraged and take short positions