

# Systemic Risk and Sentiment

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**X JORNADA DE RIESGOS FINANCIEROS RISKLAB-MADRID**

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# Abstract

- The foundations of risk management are rooted in the efficient market hypothesis. If prices are subject to behavioral biases, regulators charged with monitoring systemic risk need to focus on sentiment as well as narrowly defined measures of systemic risk.
- This paper describes techniques for jointly monitoring the co-evolution of sentiment and systemic risk. To measure systemic risk, we use Marginal Expected Shortfall. To measure sentiment, we apply a behavioral extension of traditional pricing kernel theory, which we supplement with external proxies.
- We illustrate the technique by analyzing the dynamics of sentiment before, during, and after the global financial crisis which erupted in September 2008. Using stock and options data for the S&P 500 during the period 2002–2009, our analysis documents the statistical relationship between sentiment and systemic risk. The misperception of risk by the representative investor causes a reversal of the perceived risk-expected return trade-off.

# Systemic Risk and Sentiment

- The report of the Financial Crisis Inquiry Commission (FCIC, 2011) emphasizes the importance of systemic risk and sentiment. These two concepts, and the relationship between them, are important for regulatory bodies.
- The FCIC describes systemic risk as “a precipitous drop in asset prices, resulting in collateral calls and reduced liquidity.” In its report, the FCIC criticized regulators for viewing “the institutions they oversaw as safe and sound even in the face of mounting troubles,” and concluded that “dramatic failures of corporate governance and risk management at many systemically important financial institutions were a key cause of this crisis.
- We will explore the evolution of systemic risk, leverage and sentiment as the crisis unfolded.

# Measuring Systemic Risk

- There is no consensus on the measure or the prediction of systemic risk. It is likely to be non-linear in nature, that makes prediction problematic. We use Marginal Expected Shortfall, (MES), defined for a firm as the expected equity loss per dollar conditional on the occurrence of a systemic event.
- An example of a systemic event is a decline in the value of the market portfolio on a given day by 2% or more. Values for MES are reported at New York University's Volatility Lab website.
- MES is computed as a function of volatility, correlation with the market return, and the tail expectation of the distribution of standardized innovations.

# Measuring Sentiment

- Our main contribution is the introduction of a measure of sentiment based on a behavioral analysis of market returns.
- Statistically, building on Shefrin's work, we take point by point the log-difference between the pricing kernel computed as in BEM and the pricing kernel under CRRA.
- We validate our measure of sentiment by comparing it to traditional measures of sentiment from investor surveys.
- The practical advantage of our measure is that it can be computed instantly from market data, rather than relying on monthly surveys.

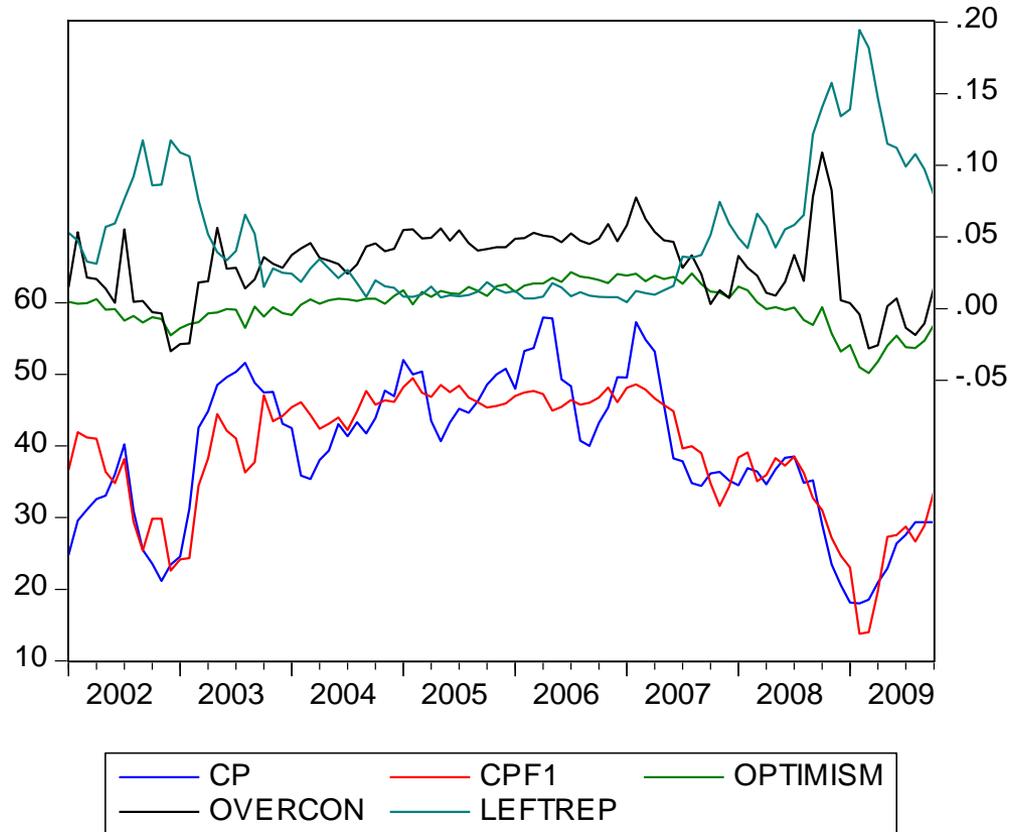
# Optimism and Overconfidence

- We focus on the first two moments of sentiment. Optimism relates to expected return, overconfidence to understatement of risk.
- We also relate optimism to leverage and (lack of) to MES and perceived crash probability.

# Three Probability Measures

- Financial economists use commonly the objective and the pricing probability measure.
- We introduce a third measure for the representative investor. That is computed by projecting a semiparametric price kernel on a CRRA price kernel.
- Our representative investor's price kernel is validated by comparison to survey data.

# Sentiment: from survey (CP) and from market return (CPF1)



# Risk premium under the objective or the representative investor's measure

- The objective risk premium rose sharply from a low of about 2.4% in 2002 to about 4% several months later, after which it followed a downward path, with considerable volatility, dipping close to zero in 2007. It then rose sharply over the next few months, to about 6.5%, before falling to about 5% at the end of the sample period.
- The representative investor's risk premium followed a different pattern, fluctuating between 2% and 4% for most of the sample period.

# Figure 3

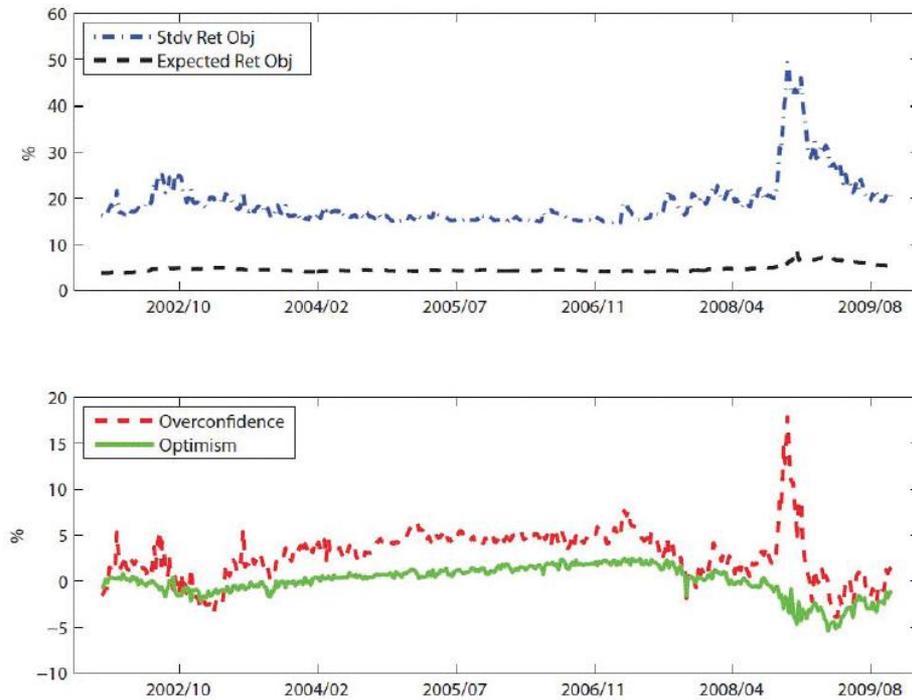
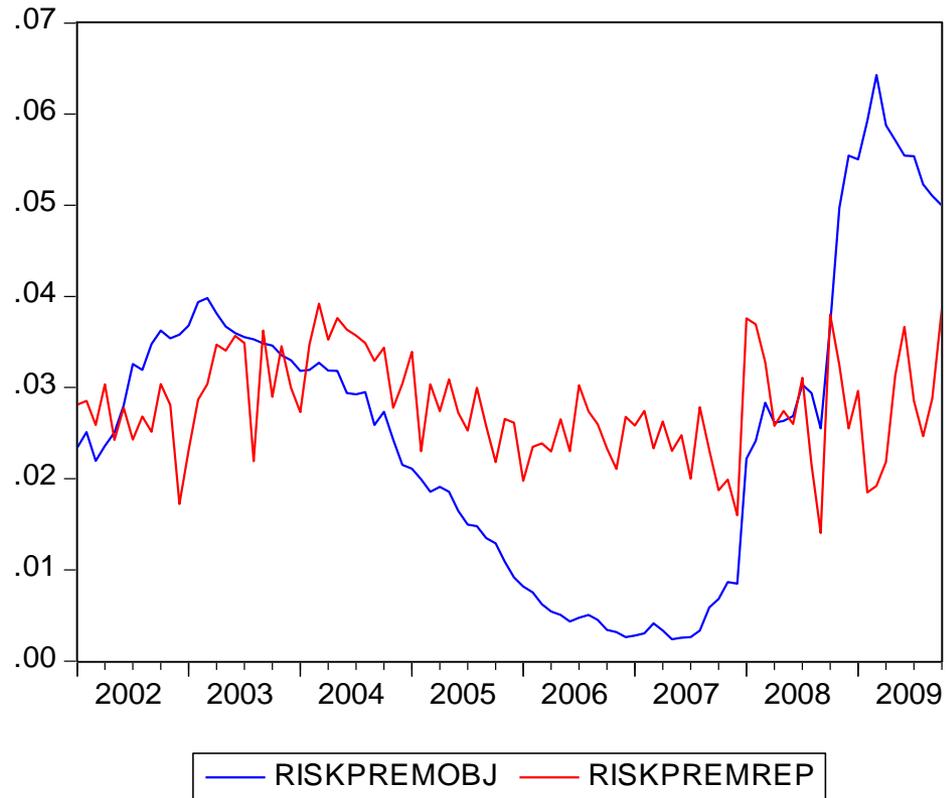


Figure 3: Upper graph: time series for the expected mean and standard deviation of the market return. Lower graph: time series difference between the means and standard deviations of the objective density and the representative investor's density (i.e. optimism and overconfidence, respectively) using the FHS method for our sample period January 2002 – October 2009.

# Risk premium

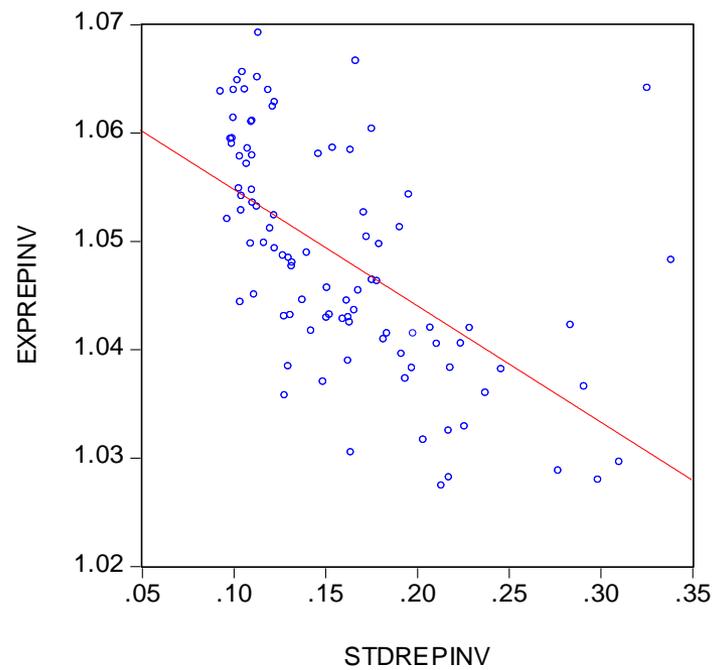
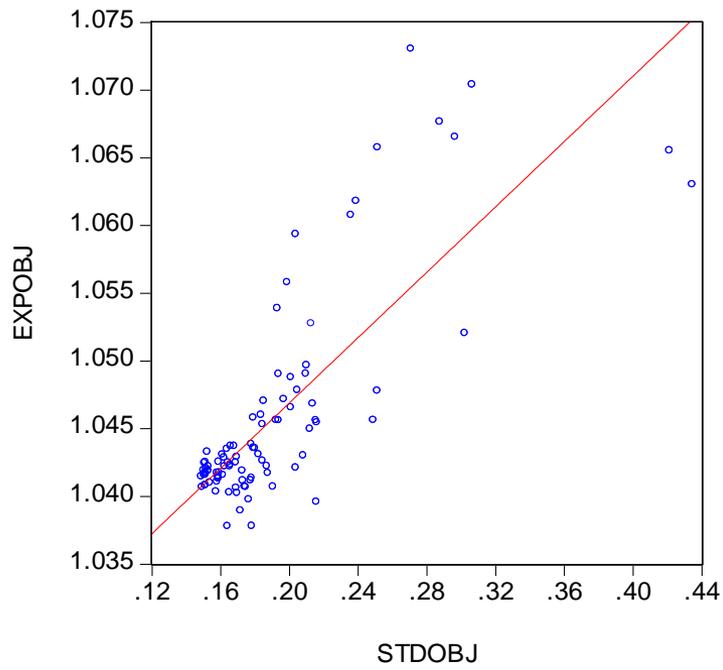
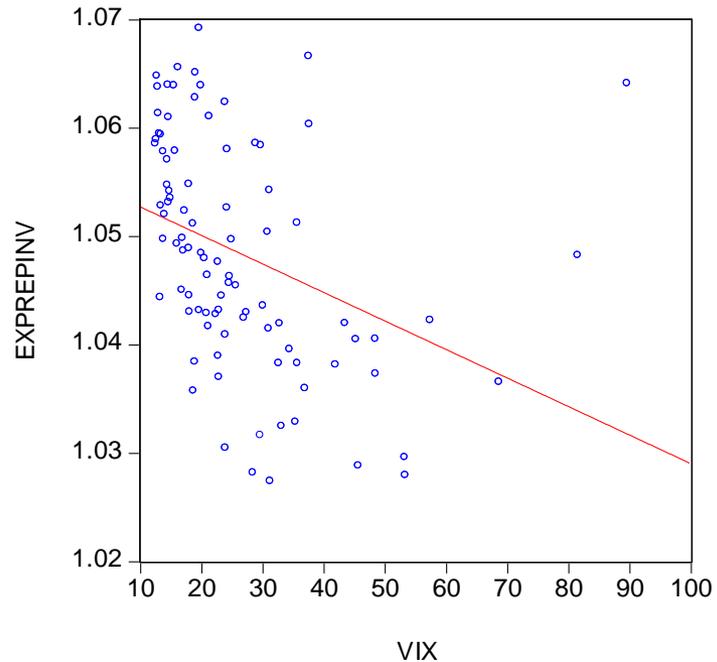
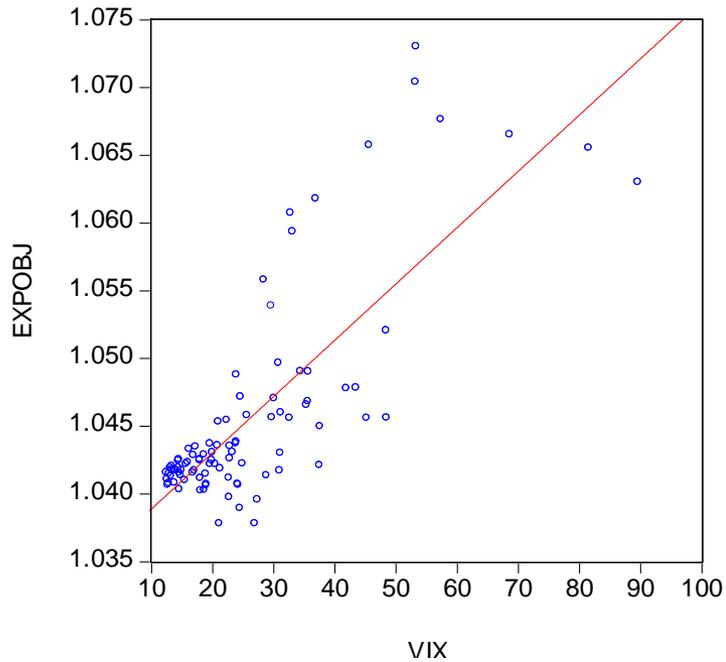


# Risk and expected return under the objective measure

- With respect to our sample, risk aversion generally declined during 2002 from about 1.3 to 0.3, and then rose in a wave pattern through late 2007, first increasing through 2005 above 3.0, falling through mid-2006 to just under 1.0, rising again until 2007, and then falling dramatically with volatility, reaching zero in the aftermath of the Lehman Brothers bankruptcy. Risk aversion then rose through the last part of the sample period.
- Notably, risk aversion was at its lowest during the down markets at the beginning and end of the sample periods and highest in the up market during the middle period.

# Risk/Return

- The trade-off between risk and EXPECTED return is positive under the objective measure, negative under the representative investor's measure.
- The trade-off between risk and return is positive under both measures. After the crash, expected return and risk are positively related, possibly because of sentiment changes.



# The Solution of the Puzzle: optimism and overconfidence

- What drives the negative slope is optimism and overconfidence. They are positively correlated. If they both go up (or down) together by enough, then when the representative investor's expected return goes up because of increased optimism, his return standard deviation simultaneously tends to go down because of increased overconfidence. In our sample, for monthly observations, the correlation between optimism and overconfidence is 0.65. For weekly observations, the correlation is 0.5.

# Crash Confidence 2002-2009

- At the beginning of the sample period, the crash confidence index CP was low,
- below 30. During 2002, it rose to about 40 and then fell sharply to about 21.
- Between 2003 and late 2007, the crash confidence index trended up, peaking just
- Below 60. During the decline, crash confidence fell to the mid 30s, where it
- remained until the Lehman Brothers bankruptcy. After the bankruptcy, crash
- confidence fell sharply, bottoming below 20. As with RMSE and MAE, it too
- dropped sharply in 2007 and the last portion 2008, as earnings declined sharply.
- In this respect, CP provides external corroboration for the evolution of optimism
- and overconfidence.
- There is reason to suggest that CP serves as an indicator of systemic risk.
- High values of CP suggest that the majority of institutional investors attached
- not just low probability, but insufficient probability, to outlying events. Keep in
- mind that the Yale/Shiller indexes are indicators of the proportion of those holding
- particular views. Other indexes are also informative. The value confidence
- index, both for institutional investors and individual investors rose during 2008,
- suggesting that investors increasingly viewed the market decline during this period
- to have been an overreaction. A similar statement applies to the one-year
- confidence indexes.

# MES

- We link our results to individual companies using MES. MES is “the expected equity loss per dollar invested in a particular company if the overall market declines by a certain amount.” That is 2% in our study. We use MES to follow individual firms through the 2008 crash.
- MES measures expected equity loss for a financial firm if the market loss exceeds 2% on a daily basis. Bear Stearns, in April 2008, had an MES of 12.4% (Vlab, NYU). Lehman Brothers, which declared bankruptcy in September, had an MES of 8.75%. AIG’s MES stood at 6.21%. Merrill Lynch, the dominant underwriter of CDOs, which needed to be acquired by Bank of America at year-end, was close behind at 8.15%.
- In March 2007, MES values had been considerably lower. Bear Stearns’s MES was at 4.5%, as was the MES of Lehman. By the end of September when Lehman declared bankruptcy, AIG’s MES had soared to 25.8%. Citigroup, Merrill Lynch, Morgan Stanley, and even JP Morgan Chase all had MES values above 8%. Goldman Sachs stood out as an exception, with an MES of 6.5%. By this time, the market had turned from being optimistic to being pessimistic (by over 1%). Notably, overconfidence soared to almost 8%, as investors seriously underestimated future volatility.

# MES and Leverage

- The relationship between systemic risk and sentiment is complex. If one asks how sensitive was MES to changes in sentiment, the answer is that it was highly firm-dependent. For Bank of America, the correlation between MES and optimism was 84%. For Fannie Mae and Freddie Mac, MES was 72% and 77% respectively. For Citigroup, it was 71%. For AIG, it was 48%. For Bear Stearns, it was 41%. Notably, for Goldman Sachs, it was 36%. Correlations of MES with overconfidence are much lower than for optimism, and also vary in sign.
- If one asks about the correlation of leverage with optimism, the answer is that these tended to be large and negative, in the range of 70% and below. Goldman Sachs was an exception, at 35%. However, the correlations of leverage with overconfidence were closer to zero, and mixed in sign.

# Conclusion

We propose a method to estimate the representative investor's biases and their impact on systemic risk from market data.

We find evidence of the changing optimism and confidence through the last decade. They play an important role in explaining the trade-off between risk and expected return.

Our market-based variables correlate well with results of surveys of investor sentiment.

A long period of low perceived risk is associated to optimism and increasing leverage, showing a build-up in systemic risk.