RISK LABORATORY

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Modeling Euro Zone Stress Scenarios to Prepare for Future Shocks

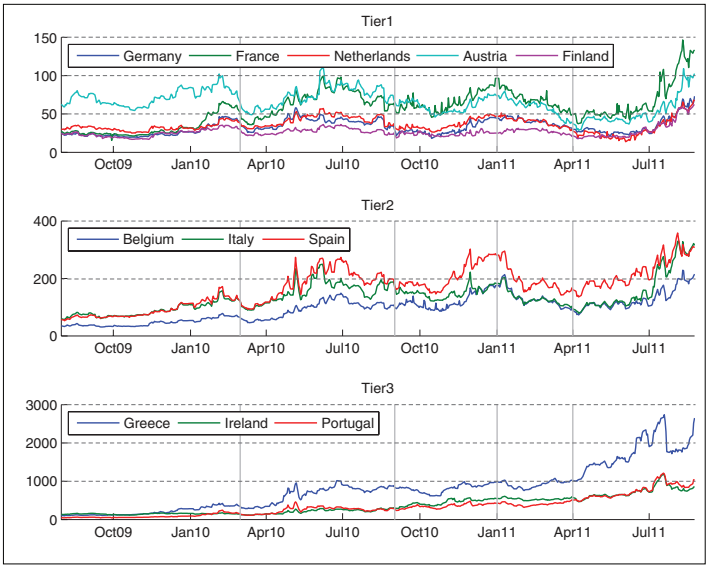
Christopher Finger uses a factor model of sovereign CDS prices to analyze euro zone volatility and contagion, studying the implications for stress testing. Asset returns and correlations over the most stressed periods can be used to model extreme future scenarios.

Before the financial crisis of 2008, and more intensely since, risk models have been criticized for working "only in normal times." As an antidote is the pervasive advice to perform stress tests. Missing from this counsel is a definition of non-normal times and clearer guidance on what stress testing practice should be. So what exactly are non-normal times? What should stress tests entail? And how do they apply to the current situation in Greece and the euro zone?

An important characteristic of non-normal times is that fine distinctions tend to fade, while only bigger ones matter. In normal times, investing is like jumping into a pool where the water may range from cool to warm; in non-normal times, the water is either icy or scalding. In the first case, it is helpful to characterize the distribution of possible outcomes with summary statistics: the average temperature, the standard deviation, the likelihood that the water is below 75F. In the second case, even knowing the precise probability of the icy scenario, the average is useless. And the distribution of temperatures in the icy state is less important than whether the pool is in that state at all. The evaluation of discrete events is the essence of stress testing.

Turning to the euro zone, investors today face a similar set of questions, like the discrete "hot or cold" in the examples above. Will they face a "risk on" or "risk off" scenario, with aggressive moves into risky assets or flight to safety? Will a single European sovereign be left to deteriorate on its own? Or will the euro zone seek to bail out its members, possibly impairing the credit of even its safest sovereigns? In order to examine prospective scenarios, investors can turn to the art of risk management, postulating about market behavior under one or the other of the discrete possibilities.

A more scientific approach is to look for information from the historical data, though being selective about the history that is chosen. While it is true that the euro zone has yet to see an actual default, or contagion leading to a breakup of the common currency, the market for euro zone sovereign credit has demonstrated recently a number of different behaviors, ranging from normal times, to concerns over a single sovereign, to concerns over groups of similar sovereigns. To evaluate different discrete scenarios, a necessary step is to identify those periods where different market conditions seem to have prevailed.



Credit Default Swap spreads on European sovereigns, 2010-2011. Source: *MarkIt*

For a single market factor, sophisticated models of regimes exist, but the identification of regimes can be as straightforward as picking periods of large returns or high realized volatility. In the case of the euro zone, it is the interaction between the different members that is interesting, and so a slightly richer model is necessary. Here, we examine sovereign credit spreads[1] through a simple group factor model.

The model utilizes four factors: a euro zone factor to describe the overall move in spreads, and three additional factors to describe the difference in returns of each tier of countries from the euro zone average. The tiers are defined a priori: Tier 3 contains Greece, Portugal and Ireland; Tier 2 contains Spain, Italy and Belgium; and Tier 1 contains the remaining core countries. As detailed in Menchero (2010), there are two equivalent interpretations of the factors. One is as portfolios: the euro zone factor is an equally weighted portfolio of all countries, and the tier factors are portfolios that are long the countries in the tier and short an equivalent amount of the euro zone factor.

The second interpretation is as the result of a cross-sectional regression. On each day, the returns on the individual sovereigns are regressed against a constant (which represents each sovereign's representation in the overall euro zone factor) and three dummy variables indicating whether a sovereign is a member of each tier[2]. The factor returns for the day in question are then the outputs of this regression. While this interpretation

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[1] This article focuses on credit default swap spreads, since these enable a cleaner statistical analysis. Yield spreads on sovereign bonds display similar qualitative characteristics.

[2] In fact, the three dummy variables plus the constant are redundant, since each sovereign belongs to one and only one tier. To address this redundancy, the regression uses the constraint that the tier factors, weighted by the number of countries in each tier, sum to zero. This is essentially the same constraint (with the tier sizes replacing market capitalization) as that presented in Menchero (2010).

[3] All significance tests presented are at a 90% confidence level. Tests at a 95% confidence level produce a qualitatively similar pattern, though with lower rates of significance overall.

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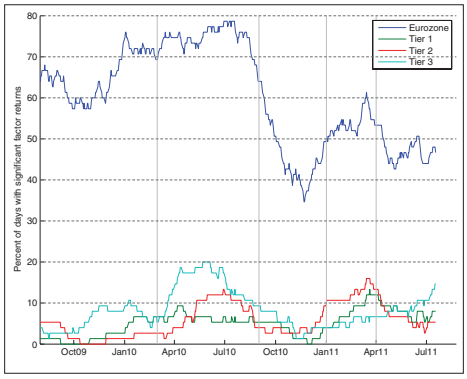
may appear less intuitive than the portfolio one, it has the advantage of providing not only the factor return estimates, but also the statistical significance of these estimates. Observing which factors are significant in different periods provides insight on whether the market is being driven by systemic or idiosyncratic moves, and whether distress on certain countries is propagating to other members of its tier.

We present three figures describing the euro zone credit market over the last two years. The first contains the history of European sovereign spreads. The second shows the rolling 75-day average correlation of returns for these credits. The third plots the rolling percentage of days on which each factor return was statistically significant[3]. Based on these three graphs, we identify a number of periods with different qualitative behaviors, and denote the separation between these with the vertical bars.

The first period represents normal times: spreads moved largely in sync, with the European factor significant most of the time, and the tiers playing minor roles. The second period, beginning in March 2010, saw greater volatility, a rise in Tier 2 and Tier 3 spreads, greater correlation overall and a significant contribution from the tier factors. The latter part of 2010, beginning in September, displayed continued high volatility and a rise in Tier 2 spreads; but correlation fell, as did the significance of the factors, indicating the dominance of country specific effects. Spreads calmed in the first part of 2011; correlation stayed low, but the tiers were more significant, indicating stratification in the market. April 2011 saw the onset the latest period of spread widening and high volatility, but in contrast to 2010, the 2011 turbulence demonstrated lower correlations and lower significance of the tier factors. For much of this period, in fact, Greece and Italy largely decoupled from their respective tiers. Interestingly, though there is not yet enough data to be definitive, it appears that since the bail-out announcement of July 21, there has been an uptick in correlation, and particularly in the significance of the tiers. The announcement, while easing some specific concerns, seems to have had the effect of bundling the various tiers together again.

Average return correlation on European CDS, 75-day rolling window.



Proportion of days with significant factor returns.

Overall, the period in mid-2010 appears most relevant for a stress test on further euro zone distress with contagion that leads to strong correlations. An investor might utilize this data in a variety of ways. One way is to examine the impact of returns from this period (March 2010 through August 2010) on today's portfolio, asking which returns or drawdowns would result should these market conditions occur again. A second way is to use data from this period to produce "stress betas," that is, the relationship between market factors and the portfolio that might be expected should similar market conditions return. Stress betas can serve to forecast the shock to another market factor (for example, an equity index) based on a view on spread moves (for example, Tier 2 widens by another 25%) and the assumption that the stress period market conditions prevail. Stress betas in another context can serve to characterize the expected return on a portfolio or fund based on a view on a benchmark index.

A final application of the stress period is to produce a Stress Value-at-Risk (VaR), that is, a VaR estimate where the statistical model is calibrated on the data from the stress period. The interpretation of Stress VaR is the worst loss (at a particular confidence level) an investor might expect on today's portfolio, should the market conditions (specifically, the volatilities and correlations) of the stress period return. This notion is part of the new risk-based capital charges for banks under Basel 3, but is a statistic of interest to non-bank investors as well.

Consider an example equity portfolio benchmarked to the MSCI Europe index, with a 10 percent overweight on financials. Applying the stress betas from the mid-2010 period, a further 25 percent shock to the Tier 2 spreads would be expected to lead to a 18bp underperformance of the portfolio relative to its benchmark. The relative Stress VaR at 95 percent confidence level suggests a further 46bp underperformance over a ten-day period under the same mid-2010 stress conditions. For comparison, the VaR based on the entire two-year period implies a ten-day underperformance of only 39bp.

Of course, all of these stress measures rely on an assumption that the future looks like the past, albeit a past that has been carefully selected. A more complete analysis requires a dose of art as well, with assumptions about how a prospective stress period might differ from the historical period chosen. Still, the scientific approach here is a key first step in the stress testing exercise, enabling an investor to consider a discrete scenario, to change positioning as necessary, to plan for contingencies, and to communicate all of this to managers, investment committees, and clients.

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FURTHER READING

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