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Fragility, stress, and market returns ☆,☆☆

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ABSTRACT

We propose a novel risk measure that relates to subsequent negative conditional stock market returns. Our risk measure considers both the fragility and stress of the market. Fragility is measured by the Fragility Index developed by Berger and Pukthuanthong (2012) and market stress is based on several economic variables. Results show that incorporating both market stress and fragility improves the information content of a risk measure. Our risk measure relates to poor subsequent monthly market returns. We show the risk measure contains predictive information in a purely ex-ante specification.

1. Introduction

Given the recent financial environment, as well as the impact that crashes may have on investor wealth, financial crises and risk have been the focus of significant research. Recent research identifies many variables that may predict an increasing likelihood of a market downturn, or of negative joint co-exceedances across markets (e.g., Markwat et al., 2009; Kumar et al., 2003; Christiansen and Ranaldo, 2009; Kritzman et al., 2011, Berger and Pukthuanthong, 2012). However, the extant literature largely focuses on conditional probabilities, and does not consider first moments. Therefore, it is unclear if the existing risk measures relate to conditional mean returns. We develop a new measure of market risk, and investigate the relation between risk and subsequent returns. A key innovation is that our novel risk measure incorporates information regarding market fragility, as well as market stress, and consequently offers a contribution relative to extant measures. Conditional mean market returns for months following the risky state are negative, and significantly lower than mean returns conditional on the stable state.

It is well known that second moments of financial data are persistent (cf., Poterba and Summers, 1986). Extending the literature on volatility, recent research considers the probability of financial crashes, thereby focusing on the most extreme periods of volatility. For example, Markwat et al. (2009) document a domino effect in which an initial local or regional shock increases the likelihood of a subsequent global shock. Kumar et al. (2003) identify economic variables that predict an increasing probability of currency devaluation. Christiansen and Ranaldo (2009) find that closer economic linkages following EU entry increase the probability of a joint co-exceedance across nations. Kritzman et al. (2011) create their Absorption Ratio and find that significant stock downturns are frequently preceded by spikes in this measure. Berger and Pukthuanthong (2012) study joint co-exceedances across nations. They find high levels of their Fragility Index indicate significantly higher probabilities of market crashes across many nations.

The literature above indicates that information variables exist that may be associated with an increasing likelihood of a market downturn. However, excluding Kritzman et al. (2011), these studies focus on second moment estimation or on the conditional probability of an event occurring. Variables that predict an increasing probability of a shock do not necessarily imply poor subsequent average returns. Periods in which risk is high, or risk sources are concentrated, may lead to especially strong returns in the event

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of a positive innovation in an underlying factor. For example, Kritzman et al. (2011) note that in many instances strong stock performance follows spikes in the Absorption Ratio. Similarly, Berger and Pukthuanthong (2012) show that their Fragility Index also predicts joint co-exceedances in the right tail of the distribution, indicating a greater likelihood of strong simultaneous performance across multiple markets. From this, it is not clear that the risk measures present in the literature relate to subsequent mean returns. Consequently, we focus the current study on the relation between risk and subsequent conditional returns.

Our risk measure considers both fragility and market stress. Fragility can be considered as the susceptibility of the system to a shock. A fragile system can be expected to 'break' in the event of a shock occurring. For example, Kritzman et al. (2011) discuss that high levels of their Absorption Ratio indicate fragility, which may be a necessary, but not sufficient, criteria for a sharp downturn. Similarly, Berger and Pukthuanthong (2012) argue that their measure captures periods in which a shock would be most damaging, if it were to occur. Or alternatively, they argue that the impact of a given shock would be the greatest during periods of high market fragility. A key point is that fragility alone will not necessarily lead to a crash. In this context, the occurrence of a crash would depend on the system being fragile, as well as a shock occurring. We combine a fragility measure similar to that of Berger and Pukthuanthong (2012), with a number of economic variables that identify periods of market stress, which can be considered as turbulent periods within the market in which shocks may be more likely to occur. Arguably, the intersection of increasing fragility, indicative of a system that is susceptible to a shock, with increasing market stress, indicative of a likely shock, will precede many market downturns.

We find strong results for our novel risk measure, indicating increases in the risk measure precede a flight to quality dynamic in which prices adjust following innovations in risk. These results indicate that the intersection of fragility and market stress strongly relates to subsequent poor conditional mean returns. In isolation, we show that neither fragility nor market stress alone contains the same information as our combined risk measure. As examples of our results, we use lagged market volatility as the primary indicator of market stress. Considering mean returns, our measure identifies 131 months within our sample as risky based on an increase in both fragility and stress during the previous month. The average excess US market return during the subsequent months is −0.62%. The average excess return during the remaining 445 months is significantly higher, and equal to +0.74%. Results further indicate that minimum daily returns are larger in magnitude, and large daily losses occur with a greater frequency during months that follow the risky state. We find similar results across additional measures of market stress. For example, using VIX as an indicator of stress, average excess returns during month t are −0.78% and +0.83% conditional on increasing and decreasing values of our risk measure during month $t-1$, respectively. Finally, our regression results reveal the importance of both stress and fragility. Specifically, the combination of stress and fragility decreases conditional mean returns, as well as the lower percentiles of the return distribution. For example, conditional on the fragile state, a one standard deviation increase in stress decreases the conditional 10th percentile of monthly returns from −4.09% to −6.71%, and this change is much larger in magnitude when compared to the impact of stress in isolation (stress without fragility). Finally, results indicate that absent fragility, stress may lead to additional upside in returns. For example, if the market is not in the fragile state, a one standard deviation increase in stress increases the conditional 90th percentile of monthly returns from 5.47% to 6.83%.

Taken in total, the results present a novel measure of risk, in which increases in both stress and fragility precede market downturns in the short-run. In addition, there is evidence that long-run returns relate positively to increases in stress and fragility.[1] Therefore, our primary interpretation of the results is that increases in risk lead to price adjustments (and consequently negative returns) as these innovations in risk are priced in the market. However, the results may also be consistent with a form of neglected risk. In particular, Gennaioli et al. (2012) present a standard model of innovation, but assume that investors ignore certain unlikely risks. Their model builds on the 'local thinking' of Gennaioli and Shleifer (2010), and emphasizes that an agent may not consider all possible outcomes for a risky asset, but rather only the most likely outcomes, while the least likely outcomes are neglected. Considering that our quantile regression results suggest the strongest impact of fragility and stress on returns manifests in the lower quantiles of the distribution, the high stress and high fragility state would be a good candidate for the form of unlikely and neglected risk discussed above. This idea may also relate to crash risk. For example, Kim et al. (2011) find high levels of crash risk relate to corporate tax avoidance. Baron and Xiong (2014) find that credit expansion predicts increased crash risk, as well as lower mean returns over the subsequent one to eight quarters, suggesting that this form of risk may also be neglected. Therefore, an alternative interpretation of our results would be that the results represent an example of an unlikely outcome that is neglected under local thinking, and consequently not priced in the market. We leave the issue of potential pricing of fragility risk for future research, and focus the current study on the short-run relation between innovations in risk and market returns.

The paper proceeds as follows. In Section 2, we discuss the intuition behind the novel risk measure, and highlight the importance of both stress and fragility. Sections 3 and 4 present our primary results relating conditional monthly returns, as well as measures of large daily losses, to our identified risk states. Section 5 considers the relation between multiple stress variables, and assesses the information content of the risk measure across multiple stress variables. Finally, Section 6 concludes.

2. Data and risk measures

In this section we describe the risk measure and necessary data. We focus on the monthly excess US market return as our test portfolio. In general, our analyses relate risk to subsequent market returns. In contrast to the short-term predictive power shown by Berger and Pukthuanthong (2012), we consider a longer window of monthly returns. Applying a longer window may provide a more relevant measure for policy makers. We further extend Berger and Pukthuanthong (2012) by combining stress and fragility and considering conditional mean returns. Fragility represents the susceptibility of the market to a shock, and stress captures the possibility of shocks occurring.

Considering stress and fragility, we focus on *increases* in both measures, as opposed to *levels* throughout our analysis. First, across a lengthy sample, absolute levels of risk may vary, and relative risk may be more valuable. Specifically, an absolute level of fragility, or of a stress variable, may indicate varying levels of risk at different points within our sample (cf., Kritzman et al., 2011). Second, our analysis attempts to relate risk in month $t-1$ to negative mean returns during month t. This requires some level of mispricing. Therefore, we expect that general levels of risk may be priced accurately, but innovations in risk may precede market downturns. Consequently, we focus our analysis on changes in

[1] In unreported results, we regress calendar year excess market returns on changes in fragility during the previous calendar year and find positive and significant results. For example, regressing calendar year returns in year t on relative fragility measured from July through December, compared to January through June in year $t-1$ leads to a positive and significant coefficient, with an R^2 of 7.9%.