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On downside risk predictability through liquidity and trading activity: A dynamic quantile approach

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ABSTRACT

Most downside risk models implicitly assume that returns are a sufficient statistic with which to forecast the daily conditional distribution of a portfolio. In this paper, we analyze whether the variables that proxy for market-wide liquidity and trading conditions convey valid information for forecasting the quantiles of the conditional distribution of several representative market portfolios, including volume- and value-weighted market portfolios, and several Book-to-Market- and Size-sorted portfolios. Using dynamic quantile regression techniques, we report evidence of conditional tail predictability in terms of these variables. A comprehensive backtesting analysis shows that this link can be exploited in dynamic quantile modelling, in order to considerably improve the performances of day-ahead Value at Risk forecasts.

1. Introduction

The implementation of risk control and monitoring systems requires quantitative procedures for capturing the level of underlying uncertainty and making accurate predictions. The Basel Committee on Banking Supervision has popularized certain international standards in the financial services industry, known as Basel Accords, which entitle eligible institutions to use internal risk models based on the Value-at-Risk (VaR) framework for meeting market risk capital requirements. This statistical methodology has transcended the capital regulatory setting and is now applied routinely in risk management, investment assessment, and financial statement disclosure, even by non-financial institutions. The recent crisis has shown the necessity of having adequate risk-management protocols in order to achieve greater resilience, and hence, the need to improve the existing procedures for quantifying the market risk. The present paper is motivated mainly by this concern.

The extant literature has proposed a number of alternative methods for downside risk modelling, mainly VaR, which differ largely in their degree of sophistication: from the simple Exponential Weighting Moving Average (EWMA) popularized by RiskMetrics to the more advanced probabilistic settings based on the Extreme Value Theory (EVT); see McNeil, Frey, and Embrechts (2005) for a review. Remarkably, several studies have revealed that most of these procedures do not perform successfully in practice under standard backtesting techniques (e.g., Kuester, Mittnik, & Paolella, 2006), which underlines the practical complexity that underlies downside risk modelling. Why is accurate VaR forecasting so elusive? Whereas most of the previous literature has attempted to address this question on the grounds of model misspecification, in this paper we adopt an alternative view within the framework of model risk, and analyze the role played by the set of conditioning information. In spite of the large methodological differences, the existing methodologies for modeling market risk share a common characteristic: they all rely almost exclusively on historical returns. Naturally, this may turn out

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to be unnecessarily restrictive, since the conditional loss function of a portfolio may exhibit non-trivial links with the state variables which characterize the market environment and trading conditions, and which may help to forecast bursts in volatility and liquidity shocks, particularly in times of stress.[1]

In this paper, we analyze whether certain state variables which are related to the market trading process can predict the tail of the conditional loss distribution of returns and, consequently, be useful for risk management purposes. Although predictability is not necessarily limited to these variables, our main focus is on bid-ask spreads and volume measures. Our study is motivated by previous findings and theoretical considerations in the asset pricing and market microstructure literature, which jointly underline the link between returns and market liquidity, trading activity, and private information arrivals. Like returns, liquidity- and volume-related variables are available on the trading-basis and are highly sensitive to information flow. Like volatility, these variables are believed to reflect collective expectations, environmental conditions and market sentiments that have a major influence on investor decisions. In contrast to returns and volatility, however, trade-related variables seem to have been ignored in downside risk modelling, even though previous evidence supporting the predictive power of trading activity and liquidity on volatility exists; see, for instance, Bollerslev and Melvin (1994) and Suominen (2001). The main aim of this paper, therefore, is to address whether downside risk forecasts can be improved by using this kind of trade-related information.

In particular, we analyze the predictability at different meaningful quantiles in the left tail of the conditional distribution of the daily returns of several market portfolios, including volume- and value-weighted, Book-to-Market (B/M)- and Size-sorted market portfolios in the US Stock Exchange. The predictive variables are different measures of market-wide liquidity and market-wide trading activity. These variables share a considerable degree of commonality and can be related to liquidity risk (Chordia, Roll, & Subrahmanyam, 2001), but measure different facets of this magnitude. The simplest way to address predictability is through least squares-based regressions. Conditional quantiles are unobservable, however, and such an approach is not feasible. Fortunately, the Quantile Regression theory allows us to analyze tail-predictability without departing significantly from the intuitive spirit of predictive regressions; see Koenker (2005) for an overview. Applying this methodology, we model the VaR dynamics through a functional form that relates this latent process to its own past as well as to lagged predictors, building on the CAViaR model of Engle and Manganelli (2004). The main conclusion from the analysis of the significance of the estimated coefficients in the predictive analysis is that bid-ask spreads and volume-related variables can predict the tail of the conditional distribution of daily returns.

The main practical purpose of VaR models is to construct accurate forecasts. Consequently, we also analyze the out-of-sample performances of daily VaR forecasts from risk models that account for microstructure variables, compared to restricted and alternative methodologies that build solely on return-based information. We consider the return-restricted CAViaR models originally proposed by Engle and Manganelli (2004), as well as alternative volatility-based risk models based on EWMA, EVT and GARCH modelling. Using these procedures, we construct a series of day-ahead forecasts in a period of market distress and apply a comprehensive battery of backtesting procedures, including the likelihood-ratio tests of Christoffersen (1998), the conditional hit test of Engle and Manganelli (2004), and the quantile-regression test recently proposed by Gaglianone, Lima, Linton, and Smith (2011). The overall picture that emerges from this exhaustive analysis agrees with the in-sample predictive results, and suggests that trade-related variables can enhance the performance of return-based VaR risk models considerably, even in a stress scenario.

The analysis of B/M- and Size-sorted portfolios yields meaningful differences in both the extent of the predictability and the suitability of the different state variables. The quantiles in the left tail of the conditional distribution can be predicted accurately in portfolios formed by high B/M or small-cap stocks, using bid-ask spreads and trading activity variables, respectively. This evidence could be related to the way in which price discovery takes place, and to the existence of investment clienteles. Chordia, Sarkar, and Subrahmanyam (2006) argue that informed investors have preferences for large-cap stocks. Since noise trading activity is the main cause of volatility in small-cap stocks, this may explain why the use of volume-related variables enhances VaR forecasts in this particular portfolio. In short, the main conclusion that consistently emerges from our analysis is that liquidity and trading activity convey incremental information for forecasting daily conditional tail dynamics at different quantiles. We show that this property can greatly enhance the forecasting performances of suitable downside risk models for a range of practical applications.

This paper is related to various different streams of previous research. First, it belongs to the literature devoted to VaR modelling in the general context of quantile regression. Previous papers have addressed predictability using different types of variables and methodologies. Taylor (1999) forecasted VaR at a range of horizons in linear quantile regressions, using GARCH-type volatility estimates and deterministic functions of the forecasting horizon involved. Similarly, Chernozhukov and Umantsev (2001) used lagged values of stock and market returns to characterize the daily VaR in an individual stock.

[1] The implicit belief that returns subsume all of the relevant information for forecasting downside risk may originate in a conservative interpretation of the Efficient Market Hypothesis. This forbids the systematic predictability of returns on the basis of the available information; i.e., it posits an orthogonal condition on the first-order conditional moment. However, it remains silent about higher-order moments, such as the conditional volatility, or other distributional features, such as conditional percentiles. Furthermore, in practice, financial markets largely depart from the complete-market and symmetric-information hypotheses that underlie a number of theoretical models in the asset pricing literature. In the presence of asymmetric or imperfect information and other frictions, even the conditional mean of returns may be predictable.