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Is risk higher during non-trading periods? The risk trade-off for intraday versus overnight market returns☆

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ABSTRACT

We study the magnitude of tail risk – particularly lower tail downside risk – that is present in intraday versus overnight market returns and thereby examine the nature of the respective market risk borne by market participants. Using the Generalized Pareto Distribution for the return innovations, we use a GARCH model for the conditional market return components of major stock markets covering the U.S., France, Germany and Japan. Testing for fat-tails and tail index equality, we find that overnight return innovations exhibit significant tail risk, while intraday innovations do not. We illustrate this volatility versus tail risk trade-off based on conditional Value-at-Risk calculations. Our results show that overnight downside market risk is composed of a moderate volatility risk component and a significant tail risk component. We conclude that market participants face different intraday versus overnight risk profiles and that a risk assessment based on volatility only will severely underestimate overnight downside risk.

1. Introduction

The nature of the risk inherent in the books of financial institutions and other market participants once we consider intraday and overnight periods separately is not yet fully understood. Intraday and overnight returns break up the usually examined close–close returns into a component during trading periods (i.e. periods with high market functionality of major exchanges) and a component during non-trading periods, (i.e. overnight periods including weekends and holidays with reduced market functionality where less liquid alternative trading platforms may be available). While market risk measures today are uniquely set on a basis by banks and regulators, trading and risk sharing behavior in stock markets suggests that not all market participants typically maintain their risky positions for a full daily holding period. The existence of intraday

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traders has recently obtained renewed public attention with the emergence of high-speed intraday trading, also called "flash trading". Furthermore, the well-documented U-shape pattern of intraday volume – implying that market participants' trading activity is more pronounced at the beginning and at the end of the trading day, see e.g. Wood et al. (1985) and Admati and Pfleiderer (1988) – yields opportunities for market participants to open or close intraday or overnight positions at times of above average market liquidity. A natural question, which arises in this context, is how the risk-sharing scheme looks like for investors who exit versus those how enter overnight. As return distributions are known to exhibit fat-tails, a related question is whether intraday and overnight returns can be described by the same magnitude not only of volatility but also of tail risk.[1]

The present paper addresses the possible existence of a volatility versus tail risk trade-off for intraday versus overnight market returns. The focus is on differences in risk composition. Such differences may directly evolve from the operation of stock market exchanges. As such, the U.S. Securities and Exchange Commission, SEC (2000), identifies additional components of risk in after-hours trading, including a lack of liquidity, larger spreads, higher price volatility for stocks with low trading activity and a potential bias toward limit orders. The resulting differences in overnight price changes play a crucial role for several market participants including dealers, brokers, retail and institutional investors, but also for regulating authorities. For example, intraday traders are required to close their books by the end of the trading day. Holding a sub-optimal portfolio during a non-trading period may imply substantial costs to institutional investors. The identification of trading times that reduce the probability of large adverse market movements is also a crucial task in financial risk management.

Based on Bollerslev (1987), who considers fat-tailed innovations within the generalized autoregressive conditional heteroskedasticity (GARCH) model, we analyze the conditional return distributions of intraday and overnight returns for major stock market indices, covering the U.S., France, Germany and Japan. Our focus is on the conditional individual distributions as we are interested in capturing the tail risk, which is given beyond the time-varying conditional risk which is readily predicted by the time-series model. The magnitude of extreme downside risk exposure is thereby governed by the time-series model and its return innovations' distribution. We use extreme value theory (EVT) and thereby characterize independent and identically distributed (i.i.d.) return innovations by the classic limit results of extreme value theory (see for example Embrechts et al. (1997), Diebold et al. (1998), Lauridsen (2000), and McNeil and Frey (2000)). Conditional index returns follow the GARCH model (see Engle (1982), Bollerslev (1986) and Bollerslev (1987)), which accounts for volatility clustering. The threshold-GARCH (TGARCH or GJR-GARCH) specification of Glosten et al. (1993) and Zakoian (1994) allows us to capture the effect of asymmetric volatility, which is typically present in stock market returns. Relying on EVT results, the GARCH model innovations are modeled by the generalized Pareto distribution (GPD), whose central parameter is the so-called tail index. The GPD allows for an explicit individual modeling of the upper and lower tails, where the downside risk perspective implies a focus on the lower tail.[2]

The estimated GARCH processes offer a good approximation to the time series behavior of our respective market returns. This holds for the standard close–close as well as for the intraday and overnight conditional returns. Based on the models of conditional market returns, we demonstrate that conditional overnight market returns are subject to a significantly larger magnitude of unpredictable tail risk than those for intraday holding periods. Our results from maximum likelihood estimation, tests for fat-tailedness, and additional likelihood ratio tests for tail index equality reveal consistent and highly significant differences in tail behavior between intraday and overnight observations. Overnight downside tail risk is found to be most remarkable for the four markets under examination, i.e. strongest evidence for tail risk is given for overnight market losses.

The conditional GARCH framework allows us to break up market risk into two major components, namely in (i) conditional volatility and (ii) unconditional tail risk of the return innovations. Several papers have documented that overnight risk as measured by volatility, i.e. component (i), is lower than comparable intraday risk (see e.g. French and Roll (1986), Stoll and Whaley (1990) and Barclay et al. (1990).) While we confirm this finding, our results show that the picture is opposite for overnight tail risk, i.e. component (ii). Hence, while overnight volatility risk is typically remarkably lower, overnight returns are subject to significant innovation tail risk, which intraday returns are not at all. In other words, intraday fat-tailedness can be explained by time-varying GARCH volatility, while conditional overnight returns contain significant unexplained components of fat-tailedness. These latter components are obviously due to an overnight lack of market functionality and liquidity, which also manifests itself by a price jump in the market open. In a Value-at-Risk (VaR) setting, we demonstrate the implications of our findings and show that the tail risk component is of general relevancy for market downside risk. Overnight VaR calculations for the U.S. NASDAQ market illustrate how the risk components add to each other and that

[1] Numerous studies following Mandelbrot (1963) and Fama (1965) suggest that asset return distributions deviate from the normal distribution. Return distributions tend to exhibit fat-tails, which implies that the probability of extreme return realizations is greater than the one predicted by the normal. Oldfield and Rogalski (1980) suggest and test different combinations of diffusion and jump processes for intraday versus overnight stock returns. It is known that overnight returns are characterized by a lower per-period volatility, see e.g. French and Roll (1986), Stoll and Whaley (1990) and Barclay et al. (1990). Results in Ben-Zion and Wagner (2006) suggest higher levels of excess kurtosis for overnight stock market returns.

[2] Our approach has been validated in detail by McNeil and Frey (2000) and Jalal and Rockinger (2008). EVT forms a powerful modeling framework for extreme market movements. Straetmans and Candelon (2013) test for structural change in the tail index and find that stationary tail behavior over long time spans can well be assumed for emerging as well as developed stock markets. Financial risk management applications based on tail index estimation methods include for example Bali and Neftci (2003), Danielsson and de Vries (2000), Galbraith and Zernov (2004), Phillip and Pagan (1997), Lauridsen (2000), Longin (2000), Wagner and Marsh (2005).