Zeppelin Universität

Chair of Empirical Finance and Econometrics

Measuring the information content of VIX volatility in comparison to historic volatility

Humboldt Project

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Abstract

Abstract text

1 Introduction: The importance of volatility measurement

1.1 Why volatility matters: Volatility as key input to both risk measures and option pricing models

- key input to risk measures (VaR etc)
- key input to pricing derivative securities
- financial market stability
- Problems: can not be directly observed and thus has to be estimated

1.2 Weaknesses of existing models: VIX introduced by CBOE

- power of volatility models lies in out-of-sample forecasting power
- so far BS implied volatility models had the best out of sampling forecasting power, but they have several problems (most importantly joint hypothesis problem)

Volatility is for example both a key input factor to risk measures (such as Value-at-risk), or pricing of derivative securities, which both again are crucial for financial decision making. As volatility can not be observed as directly as price can, it has to be both estimated and forecasted. There are multiple ways to forecast volatility. The strenght of a volatility model however lies in it's out-of-sample forecasting power (Poon and Granger 2003).

Volatility measures play an important role for financial market stability.

Stylized facts of financial market data suggests that return distributions are not i.i.d., meaning that the variance of returns over a long horizon can not be derived from a single observed period (ibid.).

2 Selected models of volatility measurement

2.1 Models using historic volatility

- historic volatility: just lagged realized volatility
- econometric models: GARCH (as an example for a frequently used one)

2.2 Implied volatility

2.2.1 Black-and-Scholes implied volatility

- explain basic idea of BS implied volatility
- advantages of BS implied volatility: forward-looking nature of option prices
- disadvantages of BS implied volatility: joint hypothesis problem due to underlying pricing assumption (is a joint test of market efficiency and underlying pricing assumption), use only at-the-money options and fail to incorporate information,..

Disadvantages of Black and Scholes: Black and Scholes uses only at-the-money option and thus fails to incorporate information (Jiang, George J & Tian 2003). Black and Scholes are joint tests of market efficiency and the B-S model, thus studies are subject to model misspecification errors (ibid.).

2.2.2 VIX and model-free implied volatility

- explain basic idea of model-free implied volatility
- advantages of model-free implied volatility: solved joint hypothesis problem (direct test of market efficiency), can incorporate not only at-the-money options,..
- the VIX as the model-free implied volatility estimate from the Cboe

Primilary described and derived by Britten-Jones and Neuberger. Instead of being based on a specific option pricing model, it is derived entirely from no-arbitrage conditions. After that some papers did various corrections, such as Jiang, George J & Tian extended the model so that is not derived under diffusion assumptions and generalized it to processes including random jumps. Two advantage of the model-free option implied volatility, are firstly that it has no pricing assumption and thus constitutes a direct test of the option market's informational efficiency, and not a joined test of market efficiency and an assumed option pricing model. Secondly it incorporates information from options across different strike prices.

3 Review of Empirical Results on Volatility Forecasting

Fr. Peter: include only review of volatility measurement, as measurement and forecasting are two separated and large chapters

- overview of volatility estimation: Poon and Granger
- origins of model-free implied volatility: Britten-Jones and Neuberger
- could not confirm forecasting power:
- confirmed forecasting power: Jiang, George J & Tian, Bakanova
- for methods: Corsi
- VIX: Whaley, Exchange

4 Methodology and Data

4.1 Methodology: Linear Regression and HAR-RV model

- Reg1: without VIX
  - Reg1a: regress realized volatility on historic volatility using simple linear regression
  - Reg1b: regress realized volatility on historic volatility using HAR-RV model
- Reg2: with VIX

– Reg2b: regress realized volatility on historic volatility using simple linear regression

– Reg2b: regress realized volatility on historic volatility using HAR-RV model

$$\sigma_{t,x}^{RV} = \alpha_{x,t} + \beta_{x,t}^{HV} \sigma_{x,t}^{HV} \tag{1}$$

$$\sigma_{x,t}^{RV} = \alpha_{x,t} + \beta_{x,t}^{HV,d} \sigma_{x,t}^{HV,d} + \beta_{x,t}^{HV,w} \sigma_{x,t}^{HV,w} + \beta_{x,t}^{HV,m} \sigma_{x,t}^{HV,m} \tag{2}$$

$$\sigma_{x,t}^{RV} = \alpha_{x,t} + \beta_{x,t}^{HV} \sigma_{x,t}^{HV} + \beta_{x,t}^{VIX} + \sigma_{x,t}^{VIX} \tag{3}$$

$$\sigma_{x,t}^{RV} = \alpha_{x,t} + \beta_{x,t}^{HV,d} \sigma_{x,t}^{HV,d} + \beta_{x,t}^{HV,w} \sigma_{x,t}^{HV,w} + \beta_{x,t}^{HV,m} \sigma_{x,t}^{HV,m} + \beta_{x,t}^{VIX} + \sigma_{x,t}^{VIX} \tag{4}$$

4.2 Data and calculation of input factors

- S&P 500 index data on daily basis
- sampling period: 2000 - 2018
- realized volatility: daily realized volatility of S&P 500, calculated using 5 minute returns, retrieved from
- model-free implied volatility: VIX index data
- historic volatility: lagged realized volatility, for HAR-RV model use the average over the time period used to forecast

5 Results

6 Discussion

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