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Implied volatility index for the Norwegian equity market

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ABSTRACT

We introduce and evaluate the NOVIX - an implied volatility index for the Norwegian equity index OBX. NOVIX is created according to the VIX methodology. We compare the NOVIX to the German VDAX-NEW and the U.S. VIX and find that NOVIX has similar properties as these two indices. We also evaluate the VIX, VDAX-NEW and NOVIX in terms of volatility forecasting. As a benchmark model we use a precise HAR model of Corsi (2009) based on high-frequency data. All three implied volatility indices significantly improve daily, weekly and monthly forecasts of volatility of their underlying equity indices. This improvement is largest for the VIX, followed by VDAX-NEW and NOVIX.

1. Introduction

Implied volatility indices based on equity index options have become immensely popular during the two decades they have existed. Investors use them as an expectation of future volatility, a gauge of market sentiment, and as a way to buy and sell volatility itself. In this paper, we introduce the NOVIX - a volatility index for the Norwegian market based on the VIX methodology. The NOVIX is part of a larger trend, in which more and more exchanges have introduced their own implied volatility indices. In addition to the many official volatility indices, there are several academic studies that construct and evaluate volatility indices for markets without official volatility indices, see e.g. Skiadopoulos (2004) and González and Novales (2009).

Internationally, the interest in implied volatility indices has been growing since the Chicago Board Option Exchange (CBOE) introduced the CBOE Volatility Index (VIX) in 1993. Whaley (1993) proposed that these indices can help the investment community in at least two different ways. First, they provide reliable estimates of expected short-term stock market volatility. Second, they offer a market volatility "standard" upon which derivative contracts may be written. The potential to hedge against volatility risk and for profit trading in volatility has led to successful introductions of markets for volatility derivatives and exchange traded products that replicate implied volatility indices.

Today, the combined trading activity in VIX options and futures is over 800,000 contracts per day (Chicago Board Options Exchange, 2015). CBOE alone publishes 28 volatility indices for stock indices, ETFs, interest rates, commodities, currencies and individual stocks. Gradually, other derivatives exchanges have begun offering volatility indices for their respective markets. Some notable examples are Deutsche Börse with the VDAX (1994), later updated to VDAX-NEW (2005), the Marche des Options Negociables de Paris (MONEP) with VX1 and VX6 (1997) and NYSE Euronext with the FTSE 100 Volatility Index (2008).

There is no official implied volatility index for Oslo Børs or the Norwegian market. Oslo Børs is an independent exchange, and the only regulated market for securities trading in Norway (Oslo Børs, 2015). It is internationally recognized as a global leader in the segments energy, shipping and seafood. The main objective of Oslo Børs is to be the central marketplace for listing and trading of financial instruments in the Norwegian market, and nearly all Norwegian companies regard Oslo Børs as the natural place to list.

We construct the NOVIX from options on the OBX Total Return Index (OBX). The OBX is a stock market index composed of the 25 most traded securities on Oslo Børs, and a natural choice as the underlying for an implied volatility index. Oslo Børs has offered options on OBX since 1990, and futures since 1992. On May 22nd 2016, the 25 stocks in OBX had a total market capitalization of NOK 1437bn compared to the total market capitalization of NOK 1810bn for all stocks listed on Oslo Børs, representing over 75% of the total value.

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Considering the central position of Oslo Børs, we believe the NOVIX can be used as a reference for both practitioners and academic studies about volatility in the Norwegian market. As a way to facilitate for further research, we calculate and provide continuously updated 5-minute intraday values for the NOVIX available at https://novix.xyz.

We use the VDAX-NEW and the VIX from the German and US markets as reference indices to evaluate the properties and behaviour of the NOVIX. In general, we find that the NOVIX exhibits many of the same characteristics as the reference indices, and that its relevance has increased in the most recent years. The degree of negative correlation between OBX returns and NOVIX returns has increased consistently over the last decade, and approaches the level seen in the other markets. This increases the potential of NOVIX derivatives as a tool for risk management. Further, we find that the NOVIX exhibits an asymmetric leverage effect, which is in line with the findings for VDAX-NEW and VIX. However, the asymmetric effect is more pronounced in our reference indices.

Finally, we study how useful the NOVIX is for predicting future volatility in the Norwegian market. For this, we use realized volatility from high-frequency OBX data as a proxy for the true volatility, and include the NOVIX in the Heterogeneous Autoregressive model (HAR-RV) of Corsi (2009). Our out-of-sample results show that the NOVIX adds information beyond the information that is captured by past realized volatility.

The rest of the paper is organized as follows. In Section 2, we describe the methodology. Section 3 presents the data. Section 4 is an analysis of the relationship between the NOVIX and OBX returns. Section 5 investigates the potential of the NOVIX for the volatility forecasting, before we give a conclusion in Section 6.

2. Methodology

The Chicago Board Option Exchange (CBOE) introduced the VIX volatility index in 1993 as a measure of the expected 30-day future market volatility (Whaley, 1993). This original VIX index was based on the Black-Scholes (BS) pricing model (Black & Scholes, 1973), and calculated as the average BS implied volatility from S&P 100 put and call options. In total, this method uses eight near-the-money puts and calls for the nearby and second most nearby maturity. The original VIX depends on the assumptions of the BS model, and is therefore a model-based implied volatility index. Although it captures more info than the implied volatility of a single strike, it does not capture all the information in the wide range of strikes available.

A decade after its introduction, the VIX was revised in a collaboration with Goldman Sachs. The purpose was to provide exchange-traded volatility derivatives. Still a measure of the expected 30-day future market volatility, the underlying index changed from the S&P 100 to the S&P 500. More importantly, the method for calculating the index was replaced by a model-free approach. The concept of model-free implied variance was first coined by Britten-Jones and Neuberger (2000), and is based on work by Derman and Kani (1994), Dupire (1994, 1997) and Rubinstein and Neuberger (1994). They use no-arbitrage conditions to extract common features of all stochastic processes that are consistent with observed option prices. This has the advantage of not depending on any particular option-pricing model, and extracts information from all relevant option prices (Jiang & Tian, 2005). Demeterfi and Zou (1999) show theoretically how a portfolio of standard options can replicate a variance swap and that the cost of this replicating portfolio is the fair price of a variance swap. The VIX methodology is essentially a discretization of the formula for the fair value of a variance swap. Other exchanges have followed CBOE, and like the VIX, the VDAX was updated with a similar model-free approach in 2005 and renamed VDAX-NEW.

2.1. Creating the NOVIX

The NOVIX is constructed with the model-free VIX methodology, according to the formula (Chicago Board Options Exchange, 2015)

$$\sigma^2 = \frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T}\left(\frac{F}{K_0} - 1\right)^2, \tag{1}$$

where

σ	NOVIX/100
T	Time to expiration in years
F	Forward level of underlying
K_0	First strike below F
K_i	Strike price of the i-th out-of-money option
ΔK_i	$\frac{1}{2} \times (K_{i+1} - K_{i-1})$
R	Risk-free rate
$Q(K_i)$	Midpoint of bid-ask spread for option with strike K_i

Following Chicago Board Options Exchange (2015), we compute the implied volatility estimate σ for two selected maturities, a *near-term* and *next-term* maturity, that represents the options expiring before and after the desired 30-day horizon. For each maturity, we select a subset of options to include in the calculation by the procedure below.

We determine the forward level from the option prices by first identifying the strike with the smallest absolute difference in put-call price and then applying the formula

$$F = \text{Strike} + e^{RT} \times \left|\text{Call Price} - \text{Put Price}\right| .$$

We define K_0 as the first strike below F, and consider the option pair with strike K_0 as at-the-money. Then, we discard all in-the-money options. That is, we only consider the at-the-money options, the call options with strikes $K_i > K_0$ and the put options with strikes $K_i < K_0$. Intuitively, the demand for out-of-the-money options can be interpreted as a need for insurance by investors, which in turn reflects the market volatility. Further, we exclude all out-of-the-money options with a zero bid price, and all options following two zero bid prices in a row, when the options are ordered by type as increasingly out-of-the-money.

We obtain the final desired 30-day volatility estimate from a linear interpolation between the near-term and next-term results,

$$NOVIX = 100 \times \sqrt{\left(T_1\sigma_1^2\left[\frac{N_{T_2} - N_{30}}{N_{T_2} - N_{T_1}}\right] + T_2\sigma_2^2\left[\frac{N_{30} - N_{T_1}}{N_{T_2} - N_{T_1}}\right]\right) \times \frac{N_{365}}{N_{30}}},$$

where the subscripts 1 and 2 represent the *near-term* and *next-term* options, respectively. The NOVIX is calculated using a time precision of a minute, where T is the time to expiration in years quoted as minutes to expiration over minutes in a year. The remaining time terms are

N_{T_1} = Number of minutes to settlement of *near-term* options
N_{T_2} = Number of minutes to settlement of *near-term* options
N_{30} = Number of minutes in 30 days
N_{365} = Number of minutes in a year (365 days).

For more details on the VIX method, we refer to the CBOE White Paper (Chicago Board Options Exchange, 2015).

Our implementation of the VIX-methodology has been tested on the examples in the CBOE White Paper (Chicago Board Options Exchange, 2015). In addition, it has been more comprehensively