This document explains VJO with former label VXJ.

GUIDE TO VOLATILITY INDEX JAPAN (VXJ)

Benchmark of volatility expectations in the Japanese stock market

Market volatility -the rate of change in asset prices- is an important concept in risk-management models and financial market regulation. Volatility estimates implied by options prices provide a reliable forecast of volatility in financial markets. The VXJ Research Group at the Center for the Study of Finance and Insurance presents the Volatility Index Japan (VXJ) as a benchmark of future volatility in the Japanese stock market. The VXJ index provides a measure of how volatile the Japanese stock market will be over the next month and it is based on Nikkei225 index options. The VXJ index is presented herein, not so much as a tradable class of assets, but as a guide for firms in the dynamic hedging of exposures to equity risk, and for financial regulators in the supervision of banks' compliance with capital requirements through Value-at-Risk modelling. This volatility index can be also useful in the examination of the reaction of volatility expectations to macroeconomic information.

Methodology

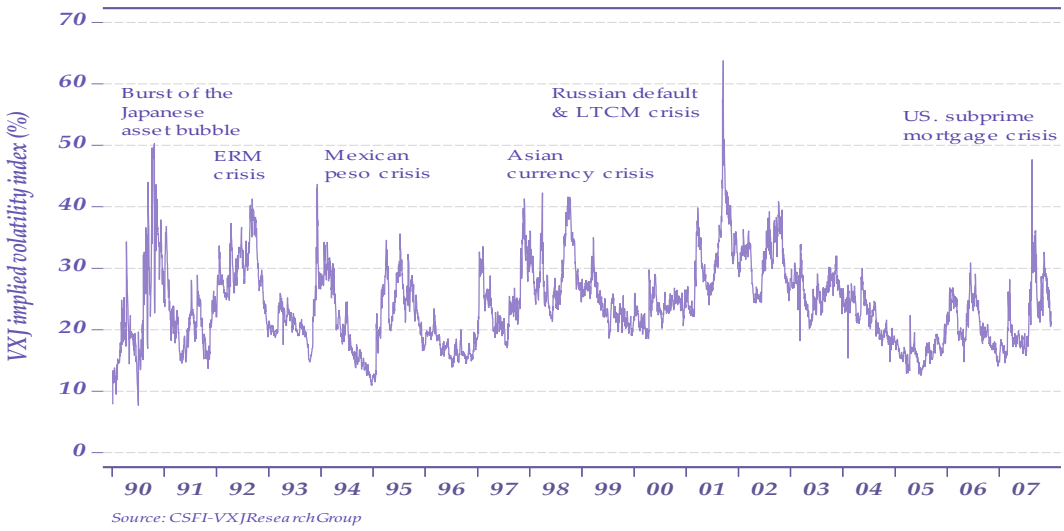
The methodology is based on the fair value of future variance, a concept developed in earlier work by Breeden and Litzenberger (Journal of Business, 1978), Demeterfi, et al. (Quantitative Strategies Research Notes, Goldman Sachs, 1999) and Britten-Jones and Neuberger (Journal of Finance, 2000). This model-free approach underlies the new VIX index from S&P500 options, and the VDAX new index from DAX options. For comparative purposes, the VXJ is calculated following the new VIX methodology, as a model-free index of market volatility implicit in the prices of Nikkei225 options traded at the Osaka Securities Exchange. The data for calculation of VXJ are obtained from NEEDS（Nikkei Economic Electronic Databank System) of Nikkei Digital Media, Inc.

- The overriding advantage of the model-free estimation is that it does not assume, as traditional numerical analysis and weighting approaches based on option valuation models such as the Black-Scholes option pricing model do, that volatility remains constant over the period of time remaining until expiration. Thus, the new approach avoids estimation errors due to model misspecification based on the invalid assumption of constant volatility.
- The VXJ index represents the level of volatility expectations implicit in a hypothetical option with 30 days to maturity. It is based on selected options spanning the near-term and next-term maturities and the rollover to the next maturity options takes place when the time remaining to expiration falls below eight calendar days. The focus is not made solely on near-the-money options, which are associated with relatively higher time premium than deep-in-the-money or deep-out-of-the-money options, and are theoretically more sensitive to changes in volatility. In addition to at-the-money options, the new methodology is based also on the broader set of traded out-of-the-money options, in order to better capture the available spectrum of volatility skew.
- For both the near-term and next-term maturities, the implied variance $\sigma^2 = \frac{2}{\tau}\sum_i \frac{\Delta K_i}{K_i^2} e^{r\tau} G(K_i) - \frac{1}{\tau}\left(\frac{F}{K_0} - 1\right)^2$ can be estimated using the forward index level F based on at-the-money strike price K_0, which is associated with the minimum spread between call-put premia. Given the prevailing three-month rates on Japanese certificates of deposit, which are used as proxy for interest rates r; given the remaining time to maturity τ; and given the average difference between adjacent strike prices ΔK, the contribution of each option to implied variance $\frac{\Delta K}{K^2} e^{r\tau} G(K)$ is an increasing function of option price $G(.)$ and it is inversely proportional to its exercise price. Further details on the new VIX calculation methodology are provided on the website of the Chicago Board Options Exchange.
- The implied variance of the hypothetical option with thirty days to expiration is calculated through interpolation of near-term and next-term variances. This interpolation process is based on the assumption that uncertainty is proportional to the square root of time remaining to expiration. This model-free approach is conducive, as noted by Jiang and Tian (Journal of Derivatives, 2007), to approximation errors due to truncation, Taylor series expansion, and discretization errors, in addition to measurement errors from maturity interpolation. It is however, more reflective of advances in option theory, as well as the reality of options trading and industry practice. The recourse to option pricing models in the estimation of implied volatility does not for instance, take account of the impact of transactions costs and bid-ask spreads. Also, market participants do not necessarily price options on the assumption that the underlying index returns follow a lognormal probability distribution.

Historical time-series

The VXJ levels based on the closing prices of Nikkei225 options varied, on average, between 15% and 40% over the period from 1990 to 2007 (Figure 1). There are sudden surges in expected volatility which are associated with significant economic shocks. In addition to internal shocks and economic events such as the collapse of the Japanese asset bubble with lingering economic recession over the 1990s, the VXJ is also reflective of the impact of international shocks on market expectations, such as the Exchange Rate Mechanism crisis in 1992, the Asian financial and currency crisis in 1997, the Russian debt default and Long-Term Capital Management (LTCM) crisis in 1998, and the recent US subprime mortgage problems, inter alia.

Figure 1. Historical behavior of VXJ index

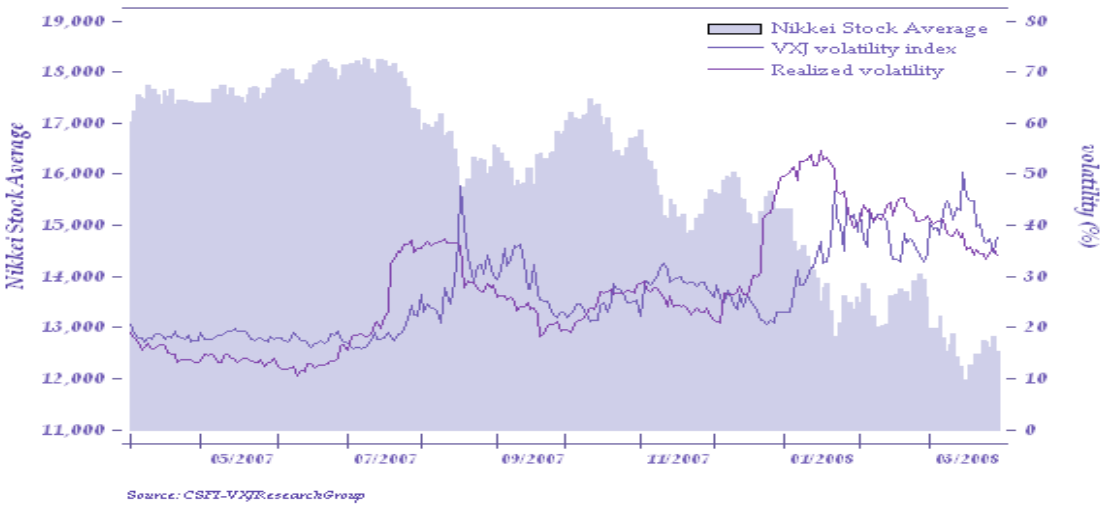


The stochastic patterns that characterize the behavior of VXJ index indicate that market participants expect levels of annual volatility below 20%, but anticipate greater uncertainty, above 40%, in association with the onset of financial crises. This forward-looking measure of market volatility can provide interesting insights into market reaction to the arrival of new information, the development of financial crises, and the impact of macroeconomic policies on the formation of volatility expectations.

Economic significance

The increase in VXJ levels over the recent couple of years can be attributed in part, to the onset of the US subprime mortgage crisis. A closer examination of the VXJ series over the year-long period from April 2007 to March 2008 suggests a negative relationship between stock price movements and market volatility (Figure 2).

Figure 2. Relationship between stock price movements and VXJ index (April 2007~ March 2008)

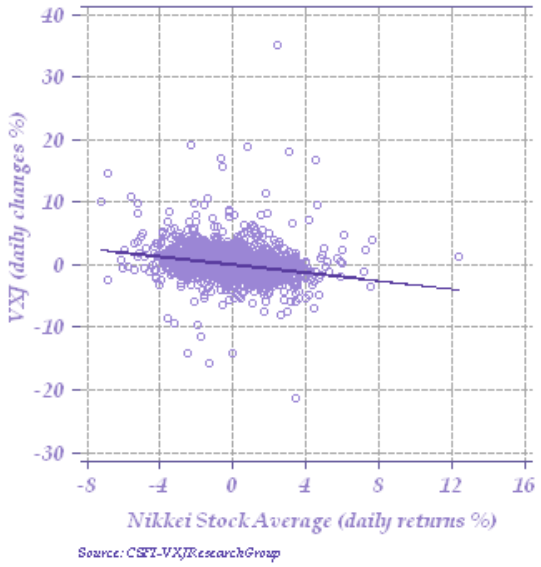


Nikkei Stock Average is owned by Nikkei.

The empirical evidence of leverage effects, -lower equity translates into higher leverage, which increases the firm's riskiness and volatility- is observed with respect to realized volatility. Judging from the behavior of these volatility series, the VXJ provides a good approximation of short-term market volatility and it is shown to have a higher forecasting power than alternative measures of volatility based on historical returns.

In addition to evidence of higher predictive power, the fact that the implied volatility index tends to increase in response to bad news explains the well-known appellation of "fear gauge". The recent US subprime crisis is found to have not only depressing effects on Japanese equity valuation. It is also conducive to greater market anxiety, and rising VXJ levels, which reflect anticipations of higher uncertainty. The negative correlation between daily changes in VXJ index and market returns, which amounted to -0.218 in 2005, has indeed increased significantly, reaching -0.544 and -0.753 in the subsequent two years. The dynamic relationship between market returns and changes in volatility over the period 1990-2007 is indeed negative (Figure 3 below). The regression line suggests that a 1% decrease in market returns is conducive to expectations of 0.31% increase in market volatility.

Figure 3. Scatter plot of daily market returns and changes in VXJ index (1990-2007)



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The VXJ index reflects thus, important information on the dynamic relationship between market returns and volatility expectations. Given the paucity of databases on Japanese market volatility, the VXJ index is made available as public information, with the aim of providing a measure of market expectations of economic uncertainty. It is provided solely for research and information purposes, with all reasonable efforts made towards frequent updates under the Terms of Use and Disclaimer of Liability expressed below.

VXJ Research Group Members: Kazuhiko Nishina, Kosuke Oya, Nabil Maghrebi, Michi Nishihara, and Masaaki Fukasawa

Prepared by Prof. Nabil Maghrebi, Visiting Professor at CSFI, Osaka University

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