EDHEC-Risk Days Europe 2012

May 10, 12:15-13:15

A New Class of Volatility Indices for Asia

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Outline

• Volatility Indicators
  – Background and Landscape of Asian volatility indices
  – Limits of Option Implied Volatility Indices

• Introducing a New Form of pan-Asian Volatility Indices
  – Interpretations of Cross-Sectional Volatility
  – The Calculation Methodology in a Nutshell

• Properties of pan-Asian CSV and a Comparison to Asian Option-Implied Indicators.

• Conclusions
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Introduction

• Information about volatility is very useful for investment management for both asset pricing and portfolio selection.

• There has been an increased interest in volatility as an asset class – the main motivation is equity risk diversification through a long volatility exposure since changes in volatility are negatively correlated with stock index returns.

• Negative correlation is particularly pronounced in stock market downturns which offers much needed protection in times when other forms of diversification may be ineffective.
Explanations for the negative correlation include:

- **The leverage effect** – a decrease (increase) in equity prices increases (decreases) the company leverage and increases (decreases) the risk to equity holders (e.g. Black (1976)).

- **The volatility feedback effect** – the argument is ex-ante: an expected increase in risk of equity increases the required rate of return of future cash-flows and hence stock prices are expected to fall (e.g. French et al (1987)).

- The presence of economic reasons provides confidence that the expected diversification benefits would be persistent.
Volatility Indices

• Since information about volatility is important, estimation of volatility has been a topic of intensive research.

• Approaches include
  – Backward-looking method
  – Cross-sectional method
  – Forward-looking method

• The most popular index is the VIX computed from S&P500 option prices, which belongs to the forward-looking methods.
# Volatility Indices in Asia

<table>
<thead>
<tr>
<th>Index</th>
<th>Introduced</th>
<th>Data since</th>
<th>Derivatives (Futures, Options)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P/ASX 200 (VIX)</td>
<td>2010</td>
<td>Jan-2008</td>
<td>Consultations done in 2011</td>
</tr>
<tr>
<td>Nikkei Volatility Index (VNKY)</td>
<td>2010</td>
<td>11-Jun-1989</td>
<td>Futures launched on 27-Feb-2012. Since Apr-12 can be traded from US.</td>
</tr>
<tr>
<td>India NSE VIX (INVIXN)</td>
<td>2008</td>
<td>02-Nov-2007</td>
<td>Press release in 2010: NSE seeks approval from the regulator.</td>
</tr>
<tr>
<td>KOSPI 200 Volatility Index (VKOSPI)</td>
<td>2009</td>
<td>03-Jan-2003</td>
<td>Not available</td>
</tr>
<tr>
<td>Hang Seng Volatility Index (VHSI)</td>
<td>2011</td>
<td>02-Jan-2001</td>
<td>Futures launched on 20-Feb-2012.</td>
</tr>
</tbody>
</table>
Problems with Option-Implied Volatility Indices

• Not available for an extensive set of markets because they require existence of a liquid option market.
  – Volatility indices exist for some developed Asian markets

• In developed markets, they only exist at the aggregate country large cap-stock level: no volatility index for small caps, growth/value stocks or sectors.

• When they exist, option-implied volatility indices may be plagued by option-market problems that have little to do with the underlying equity market.
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Introducing a New Volatility Index Series

• We conceived a project on a volatility indicator which would be:
  – Model-free
  – Based on equity market data alone
  – Available for all markets/sectors
  – Available at all frequencies

• We have identified a methodology and studied its properties
The Cross-sectional Distribution of Stock Returns

- **Important insight:** we exploit the information content of the cross-sectional distribution of stock returns, i.e. the dispersion of stock returns at a given date, to design a novel form of a volatility indicator.

- The performance of an index on a given date is a weighted average of the performance of the constituents.

- **Example:** If an index goes down by 5%, is it the case that
  - All stocks went down by 5% (zero dispersion)
  - Half went down by 20% and half went up by 10%
1 Day Before Fukushima

- The cross-sectional distribution of 450 Japanese large-cap stocks
1 Day After Fukushima

- The cross-sectional distribution of 450 Japanese large-cap stocks

All stock returns were in this range on 10-Mar-2011
Cross-Sectional Volatility

• We propose to use the cross-sectional dispersion of returns at any given date and frequency as an observable, model-free proxy for volatility.

• Formally, define for a given universe of \( N \) stocks the return on a weighting scheme \( w_{it} \),

\[
\bar{r}_{t,w_t} = \sum_{i=1}^{N} w_{it} r_{it}
\]

• The CSV Index is then equal to

\[
CSV_{t,w_t} = \sqrt{\sum_{i=1}^{N_t} w_{it} (r_{it} - \bar{r}_{t,w_t})^2}
\]
CSV around the Fukushima Disaster

- Cross-sectional volatility of 450 large-cap Japanese stocks from 01-Feb-2011 to 01-May-2011.
- CSV time series have information content.
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Interpretations of CSV

• If we assume that a single factor model holds for stock returns,

\[ r_{it} = \beta_{it} F_t + \varepsilon_{it} \]

• We also make the assumptions (to be relaxed later) that
  – All betas are the same, \( \beta_{it} = \beta_t \) for all \( i \)
  – The residual variances are the same, \( E \varepsilon_{it}^2 = \sigma_{\varepsilon}^2(t) \)

• Then we can show that for any regular weighting scheme,

\[ CSV_{t,w_t}^2 = \sum_{i=1}^{N_t} w_{it} (r_{it} - \bar{r}_{t,w_t})^2 \xrightarrow{N_t \to \infty} \sigma_{\varepsilon}^2(t) \]
Interpretations of CSV

• Among all possible weighting schemes, the equally weighted one has a special place.

• The equally weighted CSV has the smallest variance and the small sample bias can be easily calculated.

• If we relax the homogeneous residual variance assumption, we obtain that the cross-sectional variance converges to a weighted average of the residual variances,

\[ CSV_{t,w_t}^2 = \sum_{i=1}^{N_t} w_{it}(r_{it} - \bar{r}_{t,w_t})^2 \xrightarrow{N_t \to \infty} \sum_{i=1}^{\infty} w_{it}\sigma_{s_i}^2(t) \]
Interpretations of CSV

- If we relax the homogeneous beta assumption, we obtain a biased weighted average

\[ CSV_{t,w_t}^2 = \sum_{i=1}^{N_t} w_{it} (r_{it} - \bar{r}_{t,w_t})^2 \xrightarrow{N_t \to \infty} \sum_{i=1}^{\infty} w_{it} \sigma_{zi}^2(t) + \sigma_{t,\beta}^2 E(F_t^2) \]

where

\[ \sigma_{t,\beta}^2 = \sum_{i=1}^{\infty} w_{it} \left( \beta_{it} - \sum_{i=1}^{\infty} w_{it} \beta_{it} \right)^2 \]

is a measure of dispersion of the different betas.

- The bias coming from the factor turns out to be empirically negligible (Garcia et al (2011)).
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Methodology in a Nutshell

- The methodology for the new volatility indicator is centred on CSV with a few important additional enhancements:
  - **Liquidity**: this is an issue in emerging markets and we apply filters to reduce the noise from illiquid stocks.
  - **Robustness**: the weighting scheme is selected with a focus on robustness.
  - **Aggregation**: instead of directly working with the cross-section on regional level, we do so on a country level and then aggregate to regional level.
Methodology: Liquidity

- Lack of liquidity materializes in two ways:
  a) The stock is not traded and we get a return of zero
  b) There are abnormal returns (positive or negative)
- The general recommendation from academic literature with respect to a) is to remove the stocks with a zero return from the sample.
- A way to deal with b) is to set a reasonable upper and lower bound on returns in the cross section.
- We also set a convention rule which is especially useful for regional universes: if 50% of the returns are zeros, the index is not computed.
Methodology: Robustness

• We employ techniques from robust statistics to reduce noise and increase resistance to outliers. The assumption is that cross-sectional data is contaminated.

• Using equal weights $w_{it} = 1/N$ in the estimator or e.g. cap-weights, results in a lot of noise.

• We adjust the weights to the sample so that the outliers get smaller weights ($w_{it} = 0$ for severe outliers) and the returns from the center of the distribution get equal weights.
Value-Added of Robustness

Emerging Asia: Equally-weighted vs Robust

Emerging Asia: Cap-weighted vs Robust
Methodology: Aggregation

- To reduce the bias coming from country-specific factors, for regional universes we employ a two-step procedure:
  - Calculate the CSV Index for all countries in the universe on a stand-alone basis.
  - Aggregate the cross-sectional variances by applying weights proportional to the number of stocks of each country in the regional universe.

\[
CSV_t = \left( \sum_{k=1}^{K} \frac{N_{k,t}}{N_t} CSV_{t,k}^2 \right)^{1/2}
\]
Introducing EVI

• The methodology has been implemented for a universe of 12 country and regional indices and 2 broad global universes.

• The EDHEC-Risk Equity Volatility Indices (EVI) include the following universes:
  – Country level: US, Canada, UK, Japan
  – Regional level: Latin America, Eurozone, Dev Europe ex EUR ex UK, Emerging Europe, Emerging MEA, Developed MEA, Emerging Asia, Developed Asia ex Japan.
Pan-Asian Volatility Indicators

- The EVIs contain three Asian volatility indicators.
- **Japan**: on average based on 440 stocks (in 2002-2012)
- **Emerging Asia** includes the following countries: China, India, Indonesia, Malaysia, Pakistan, the Philippines, Thailand and Taiwan: on average based on 304 stocks (in 2002-2012)
- **Developed Asia ex Japan** includes: Australia, Hong Kong, Korea, New Zealand, and Singapore: on average based on 496 stocks (in 2002-2012)
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Properties of CSV

• Although representing two different measures of uncertainty, systematic and average specific volatility indicators are expected to be highly correlated.

• The rationale is that they both reflect the aggregate uncertainty by investors at a given point in time regarding economic fundamentals.

• We confirm this intuition but also discover different correlations to different systematic Asian volatility indicators.
Pan-Asian Volatility Indicators

The latest recession, from Dec-07 to June 09, as defined by NBER.

Idiosyncratic volatility can be a measure of economic uncertainty.
EVI-Japan vs VNKY

- EVI-Japan tracks well the Japanese option-implied volatility index
- The Fukushima disaster, which was an external shock, is zoomed in
**EVI-Developed Asia ex Japan vs VKOSPI and VHSI**

- Developed Pan-Asian regional volatility index compared to VKOSPI and VHSI.
EVI-Emerging Asia vs INVIXN

- Data for the option-implied volatility index in India is available since Nov-2007.
- Visually, there is high correlation between the two indices since Nov-2007.
Correlations between Asian Option-Implied Indices and VIX

<table>
<thead>
<tr>
<th></th>
<th>VNKY Index (Japan)</th>
<th>VKOSPI Index (Korea)</th>
<th>VHSI Index (Hong Kong)</th>
<th>VIX Index (US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VNKY Index</td>
<td>100.00%</td>
<td>83.30%</td>
<td>87.82%</td>
<td>89.99%</td>
</tr>
<tr>
<td>VKOSPI Index</td>
<td></td>
<td>100.00%</td>
<td>81.18%</td>
<td>84.49%</td>
</tr>
<tr>
<td>VHSI Index</td>
<td></td>
<td></td>
<td>100.00%</td>
<td>86.09%</td>
</tr>
<tr>
<td>VIX Index</td>
<td></td>
<td></td>
<td></td>
<td>100.00%</td>
</tr>
</tbody>
</table>

- The correlations are calculated from 03-Jan-2003 to 03-Jan-2012.
- The correlation with VIX is quite high and also in between the Asian indices.
## Correlations: Asian EVIs

<table>
<thead>
<tr>
<th></th>
<th>EVI-Japan</th>
<th>EVI-Dev Asia ex Japan</th>
<th>EVI-Emerging Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVI-US</td>
<td>71.510%</td>
<td>82.749%</td>
<td>68.823%</td>
</tr>
<tr>
<td>EVI-Japan</td>
<td>100.000%</td>
<td>73.276%</td>
<td>70.742%</td>
</tr>
<tr>
<td>EVI-Dev Asia ex Japan</td>
<td>73.276%</td>
<td>100.000%</td>
<td>75.047%</td>
</tr>
<tr>
<td>EVI-Emerging Asia</td>
<td>70.742%</td>
<td>75.047%</td>
<td>100.000%</td>
</tr>
<tr>
<td>EVI-World Developed</td>
<td>83.969%</td>
<td>89.824%</td>
<td>74.927%</td>
</tr>
<tr>
<td>EVI-World Emerging</td>
<td>73.812%</td>
<td>79.447%</td>
<td>96.074%</td>
</tr>
<tr>
<td>VNKY Index</td>
<td>75.385%</td>
<td>81.227%</td>
<td>62.853%</td>
</tr>
<tr>
<td>VKOSPI Index</td>
<td>70.947%</td>
<td>72.533%</td>
<td>66.898%</td>
</tr>
<tr>
<td>VHSI Index</td>
<td>70.547%</td>
<td>86.208%</td>
<td>69.951%</td>
</tr>
<tr>
<td>VIX Index</td>
<td>66.060%</td>
<td>79.185%</td>
<td>56.623%</td>
</tr>
<tr>
<td>INVIXN Index*</td>
<td>74.114%*</td>
<td>80.183%*</td>
<td>79.496%*</td>
</tr>
</tbody>
</table>

- The correlations are calculated from 03-Jan-2003 to 03-Jan-2012 (only for INVIXN we start from Nov-2007).
We observe different patterns before 2007 and similar pattern afterwards.
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Conclusions

- We introduce a new form of volatility index – the cross-sectional volatility index – and provide examples for three Asian universes.
- Through formal arguments, we demonstrate that the new index is a measure of the average idiosyncratic volatility in the corresponding universe.
- Examples indicate that the pan-Asian indices are closely related to the option-implied indicators, where available.
- CSV indicators can be easily created for other Asian universes/sectors and can be used as volatility proxies.
References


