Volatility Risk Premium:
Stylized Facts and Portfolio Implications

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Stylized Facts about Volatility and Volatility Risk Premium
Volatility Risk Premium compared to Equity Risk Premium

<table>
<thead>
<tr>
<th>Equities</th>
<th>(Equity-)Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>Interpretation</td>
</tr>
<tr>
<td>$\frac{S_T - S_t}{S_t} = \tau_{t,T}$</td>
<td>Realized return over a time period (e.g. 1 year)</td>
</tr>
<tr>
<td>$E \left[ \frac{S_T - S_t}{S_t} \right] = r_{f,T}$</td>
<td>Riskfree rate over the same period (e.g. money market)</td>
</tr>
<tr>
<td>$\tau_{t,T} - r_{f,T}$</td>
<td>Equity risk premium (return over money market)</td>
</tr>
</tbody>
</table>

Volatility risk premium follows the same logic as equity risk premium but is much more attractive over the last 15 years.

Source: Bloomberg and risklab. Based on EuroStoxx50 and VSTOXX data over the period 01.01.2000-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.
The Distribution of Volatility Risk Premium is Skewed!

Source: Bloomberg and risklab. Based on EuroStoxx50 and VSTOXX data over the period 01.01.2000-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.

Manage downside risk when harvesting volatility risk premium
Components of Volatility Risk Premium

Volatility risk premium consists of two components:

<table>
<thead>
<tr>
<th>Volatility risk premium</th>
<th>Additional risk premium, depending on the steepness of the volatility smile/skew</th>
<th>Implied Volatility (e.g. over 30 days)</th>
<th>approx. 2/3 * of the historical realized volatility risk premium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk premium, depending on implied volatility of at-the-money options</td>
<td>Implied atm Volatility (e.g. over 30 days)</td>
<td>approx. 1/3 * of the historical realized volatility risk premium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Realized volatility (e.g. over 30 days)</td>
<td></td>
</tr>
</tbody>
</table>

Received via sale of Variance Swaps (held to expiry)

Received via sale of (delta hedged) atm Options („Gamma“)

\(^1\) atm = at the money

Source: Bloomberg and risklab. Based on EuroStoxx50 and VSTOXX data over the period 01.01.2000-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.
### What is different between Equity and Volatility Risk Premium?

<table>
<thead>
<tr>
<th>Risk Premium</th>
<th>Equities</th>
<th>Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_{t,T} - r_{f_{t,T}}$</td>
<td>Equity Risk Premium</td>
<td>$\sigma_{t,T}^2 - \sigma_{\text{implied}}_{t,T}^2$</td>
</tr>
<tr>
<td><strong>Derivative to capture premium</strong></td>
<td>e.g. equity future</td>
<td>variance swap</td>
</tr>
<tr>
<td><strong>Influencing factors</strong></td>
<td>equity return, interest rate, (possibly dividends)</td>
<td>implied volatility, realized volatility or (equity return)$^2$</td>
</tr>
</tbody>
</table>

#### Sensitivity analysis

- **Impact on risk premium over 30 days**
  - **equity return +1%**: 0.08%
  - **rates +1%**: 0.06%
  - **implied volatility +1%**: 0.04%
  - **very low impact!** 0.02%

- **Impact on risk premium over 30 days**
  - **(equity return +1%)$^2$**: 0.08%
  - **implied volatility +1%**: 0.06%

#### Conclusion

- naive investment approach through rolling of future contracts
- **Significant impact of implied volatility**
- **Effect can be reduced by overlapping investments**

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Source: risklab. For further information please see the risklab disclaimer at the end of the presentation.
Term Structure of Volatility Risk Premium

- Volatility risk premium is on average quite stable over different terms:

- Volatility (uncertainty) of the volatility risk premium reduces slightly for longer terms...

- ...but: average risk premium is stable over different terms, even for the short-end of the term structure.

- Harvesting the volatility risk premium based on shorter terms shows a much more attractive information ratio

- Reason: volatility risk premium is also a compensation for the hedging error of a delta hedged option contract, Because the hedging error is related to the Gamma of an option it is usually higher for short-dated option contracts.

Source: Bloomberg, Merrill Lynch and risklab. Based on underlying data and option data for EuroStoxx50 over the period 01.01.2010-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.
Volatility Risk Premium for different Asset Classes

Equities and FX

Volatility risk premium over 30 days

Information ratio for a rolling synthetic variance swap strategy with different time to maturities of the swap contract

Volatility risk premium
European equities
Eurostoxx50

Volatility risk premium
FX
USD/EUR

Source: Bloomberg, Merrill Lynch and risklab. Based on underlying data and option data for EuroStoxx50 and USD/EUR over the period 01.01.2004-31.07.2015. For further information please see the risklab disclaimer at the end of the presentation.
Volatility Risk Premium for different Asset Classes
Commodities: Gold and Oil

Volatility risk premium over 30 days

Volatility risk premium
Commodities
Gold

Volatility risk premium
Commodities
Oil

Information ratio for a rolling synthetic variance swap strategy with different time to maturities of the swap contract

Source: Bloomberg, Merrill Lynch and risklab. Based on underlying data and option data for Gold and Oil over the period 01.01.2004-31.07.2015. For further information please see the risklab disclaimer at the end of the presentation.
Volatility Risk Premium for different Asset Classes
Rates and Credit

Volatility risk premium over 30 days

Information ratio for a rolling synthetic variance swap strategy with different time to maturities of the swap contract

Source: Bloomberg, Merrill Lynch and risklab. Based on underlying data and option data for US Treasuries and US HY Corporate over the period 01.01.2010-31.07.2015. For further information please see the risklab disclaimer at the end of the presentation.
1. In contrast to other asset classes, volatility does not pay interest or dividends

2. Volatility always returns to its long-term mean (mean reversion effect)

3. Volatility tends to jump (usually when the stock market slumps), followed by lengthier downward trends

4. Volatility forms volatility clusters (regimes)

Source: Bloomberg and risklab. EuroStoxx50 and VSTOXX data over the period 01.01.2000-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.
... and their Effect on Volatility Risk Premium ...

**Volatility Cluster (regimes):**

- **Observation:**
  - Stable and attractive risk premium across all volatility regimes
  - Volatility risk premium is richer in a high volatility environment but its volatility (uncertainty) is also higher, et vice versa

**Sensitivity to volatility (regime-switch):**

- **Observation:**
  - Strong increase in volatilities negatively impacts the volatility risk premium
  - In contrast, a decrease in volatility makes risk premium even richer

Source: Bloomberg and risklab. EuroStoxx50 and VSTOXX data over the period 01.01.2000-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.
... are especially attractive when considered together

Mean-reversion effect causes the impact of increasing and decreasing volatilities to cancel out and enables a stable harvesting of an attractive risk premium over a full volatility cycle.

1. risk premium is expected to be significant but risky
2. risk premium is expected to be low but stable (less risky)
3. risk premium increases further through decrease in market volatilities
4. risk premium decreases through increase in market volatilities
Stylized Facts of Volatility and its Risk Premium have to be considered

- Volatility risk premium is negative
  - Sell volatility (short volatility)

- Significant part of the risk premium is related to the steepness of volatility skew
  - Only variance swaps are able to fully exploit the volatility risk premium

- Risk premium is more attractive over shorter time periods
  - Focus on shorter end of risk premium term structure

- Significant impact of implied volatility when entering into a new trade
  - Consider overlapping investments and reduce timing effects

- Risk/return-ratio depends on the current volatility regime (cluster)
  - Adjust exposure according to the current volatility regime

- Mean-reversion effect introduces volatility cycles
  - Further adjustment of exposure under consideration of the full volatility cycle

- Volatility often jumps which negatively impacts risk premium
  - Include risk management components to reduce significant downside risk when volatility jumps

\[ \text{e.g. risklab Variance Premium Trading (VPT) Index (BB: RLABVPT <Index>)} \]
Harvesting Volatility Risk Premium in a Portfolio Context
Correlation Analysis

Equities

Non-Linear Correlation to Equities:
Diversification benefits in normal market periods but correlation increases in market downturns

Source: Bloomberg and risklab. EuroStoxx50 Index data and VPT Index data over the period 01.01.2000-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.
Correlation Analysis
Fixed Income

Negligible Correlation to Fixed Income:
Diversification benefits in all markets and particularly in rising interest rate markets

Source: Bloomberg and risklab. JPM Government Bond Index data and VPT Index data over the period 01.01.2000-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.
Correlation Analysis
Commodities

Low Correlation to Commodities:
Diversification benefits in nearly all markets but beware of commodity crisis

Source: Bloomberg and risklab.
Bloomberg Commodity Index data and VPT Index data over the period 01.01.2000-31.08.2015. For further information please see the risklab disclaimer at the end of the presentation.
Diversification benefits in a portfolio context:
Replacing equities with volatility reduces risk, replacing fixed income with volatility adds return.

Source: Bloomberg and risklab. Robust optimization using based on risklab analytics framework. For further information please see the risklab disclaimer at the end of the presentation.
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