

European Volatility Tracker

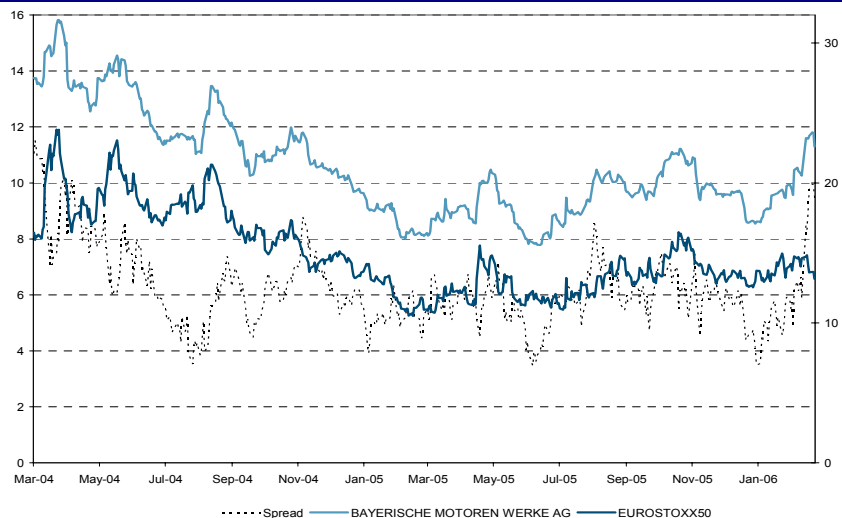
Options Research - Europe

Weekly Summary

- Who's not a takeover target and who will be left aside in the current M&A game? European M&A activity is heading for a good start this year with several deals already announced and rumours mounting on other companies.
- At the market level, short-term implied volatility has declined by around 1.5 volatility points within a week (in the case of the €-Stoxx 50 index), echoing the rise in equity markets over the past few days. At the single stock level, implied volatility declined too but to a lesser extent, by 52bps on average, as the general decline in volatility is partially offset by a rise in names impacted by M&A activity or expected to announce their earnings in the coming days.
- This week, we take a look at BMW's implied volatility. Despite the general downward trend, BMW's 3-month implied volatility is currently trading at a high level when compared with its history and to the €-Stoxx 50's implied volatility. We investigate whether fundamental or technical reasons could explain this relatively high level and conclude that it may provide an interesting volatility selling opportunity. We recommend selling BMW's 3-month volatility while buying €-Stoxx 50 index' 3-month volatility. Using a slightly longer maturity, the strategy could be done by using June 06's variance swap.
- We also provide a Q&A on conditional variance swaps. These products have gathered strong interest in the past few months and we analyse their payoff, how to replicate them using vanilla and binary options and provide comparative statistics with standard variance swaps.

Graph of the Week

BMW vs. €-Stoxx 50 index's 3-month ATM implied volatilities



Source – BNP Paribas

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Idea of the Week

BMW: too fast too furious?

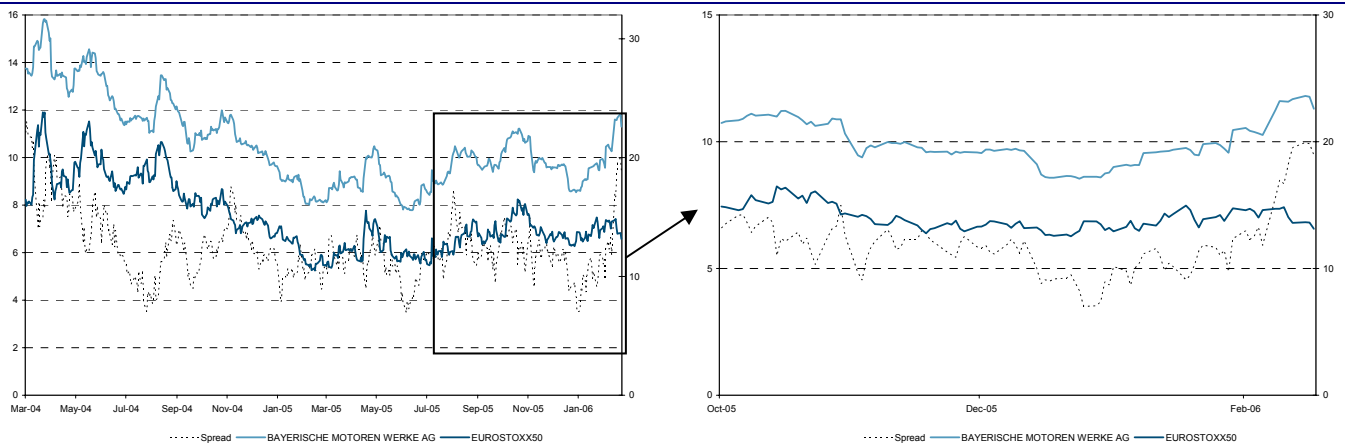
Investment case

■ Is BMW's current implied volatility really fairly representing its current risk? We think otherwise. While the €-Stoxx 50 index's 3-month implied volatility is declining, BMW, the German car manufacturer, has seen its short-term implied volatility rising from around 18% at the start of the year to north of 22% nowadays.

■ On a purely technical basis, BMW's 3-month implied volatility appears too expensive when compared with that of the €-Stoxx 50. The BMW/€-Stoxx 50 3-month implied volatility spread is more than two standard-deviations away from its two-year average as shown in the following graph. Further, our implied volatility valuation model rates BMW in its 8th decile, highlighting a relatively expensive implied volatility when compared with its 5-year CDS, beta, size and market capitalisation.

■ While BMW's 3-month ATM implied volatility is currently trading around 21-22%, its 3-month realised volatility, as a comparison, is equal to 13% and has never lied above 20% since October 2004.

BMW vs. €-Stoxx 50 index's 3-month ATM implied volatilities



Source – BNP Paribas, Bloomberg

■ On a more fundamental basis, we cannot see any reason for such a high implied volatility. On the one hand, results of French car manufacturers Renault and PSA have been lower in Q4 2005 than a year ago. On the other hand, Renault and Peugeot and BMW do not sell cars on the same segment, BMW selling more premium or luxury cars.

■ It seems that despite the slowdown of the European car market in the past few months, low-cost and luxury cars have better resisted than the

average. Audi is probably a better comparison. Audi's revenue increased 9% in Q4 and now represents about a quarter of Volkswagen's total sales. Audi's 2005 operating profit further rose by 15% while other mid-market car manufacturers saw their earnings declining.

■ From a fundamental viewpoint, BMW seems to have limited downside: Only 6 out of 40 analysts rate BMW as a sell opportunity according to Bloomberg data. Furthermore, the average analysts' target price for BMW reported in Bloomberg is equal to €39.41, 5% above its 23 February closing price.

Automobile – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month historical volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
BAYERISCHE MOTOREN WERKE AG	39.63	EUR	9.9%	25.2%	23%	24%	4	14%	12%	2	2.42	2.70	90%	1.56%
DAIMLERCHRYSLER AG-REG	47.44	EUR	6.4%	41.2%	24%	26%	3	30%	20%	6	9.19	5.91	155%	3.16%
PEUGEOT SA	49.41	EUR	4.0%	0.8%	25%	26%	5	23%	26%	6	0.99	1.17	85%	2.73%
RENAULT SA	82.35	EUR	8.8%	24.5%	25%	27%	3	28%	25%	6	1.34	1.57	86%	2.19%
VOLKSWAGEN AG	58.87	EUR	24.5%	62.2%	28%	26%	6	37%	19%	8	3.18	3.38	94%	1.78%
VALEO	33.99	EUR	6.0%	-3.6%	22%	22%	2	15%	17%	1	0.30	0.43	70%	3.24%
MICHELIN (CGDE)-B	52	EUR	8.0%	-0.2%	25%	26%	3	35%	17%	9	0.68	0.87	79%	2.40%

Sources – Bloomberg, BNP Paribas

■ M&A risk? No sector seems to avoid the consolidation trend nowadays. Even Porsche has taken a participation in Volkswagen. BMW, however, does not appear at first sight as a primary M&A target. Two reasons can be pushed forward. First, who could be the buyer? US car manufacturers are not in a healthy situation, Volkswagen and Daimler-Chrysler have already brands competing directly with BMW and Japanese car manufacturers are often linked to US or European manufacturers (such as Nissan and Renault). The second reason lies within BMW's capital ownership. The Quandt family holds about 50% of BMW's ordinary share and has never seen to be keen on selling its company.

■ For all the aforementioned reasons, we recommend selling BMW's 3-month volatility while buying €-Stoxx 50 index' 3-month volatility. Using a slightly longer maturity, the strategy could be done by using June 06's variance swap.

Conditional Variance Swaps' Q&A

■ In the past few months, we have seen a growing interest in new volatility products, and in particular conditional variance swaps. Here, we take the opportunity to provide a technical overview of these products and show they can help taking new bets on both volatility and skew.

What is a conditional variance swap?¹

■ The generic conditional variance swap is a variance swap where squared returns are counted if and only if the underlying asset price is within a specific pre-specified trading range. The payoff is given by:

$$Payoff_{cond} = (K_{pcond}^2 - K^2) \frac{1}{T} \sum_{i=1}^T 1_{Lower\ level \leq S_i \leq Upper\ level}$$

where K^2 is the initial strike price and K_{cond}^2 is described by:

$$K_{cond}^2 = \frac{252}{\sum_{i=1}^T 1_{Lower\ level \leq S_i \leq Upper\ level}} \sum_{i=1}^T [(\ln(S_i/S_{i-1}))^2 1_{Lower\ level \leq S_i \leq Upper\ level}]$$

■ Indeed, upper and lower bands can be – up to a certain level - freely defined by the investor. If the lower level is set equal to zero, then the conditional swap is a down conditional variance and if the upper band is infinite, we talk about up conditional variance swap.

■ Down conditional variance swap (or down var swap):

$$Payoff_{downcond} = (K_{downcond}^2 - K^2) \frac{1}{T} \sum_{i=1}^T 1_{S_i \leq Upper\ level} \quad \text{and}$$

$$K_{downcond}^2 = \frac{252}{\sum_{i=1}^T 1_{S_i \leq Upper\ level}} \sum_{i=1}^T [(\ln(S_i/S_{i-1}))^2 1_{S_i \leq Upper\ level}]$$

■ Up conditional variance swap (or up var swap):

$$Payoff_{upcond} = (K_{upcond}^2 - K^2) \frac{1}{T} \sum_{i=1}^T 1_{S_i \geq Upper\ level} \quad \text{and}$$

$$K_{upcond}^2 = \frac{252}{\sum_{i=1}^T 1_{S_i \geq Upper\ level}} \sum_{i=1}^T [(\ln(S_i/S_{i-1}))^2 1_{S_i \geq Upper\ level}]$$

¹ I thank Jean-Michel Ritoux, from BNP Paribas New Products Group, for useful insights on conditional variance swaps

How can I replicate conditional variance swaps?

■ As we have shown in a previous research note, one of the great advantages with standard variance swaps is that they can be replicated by a static portfolio of options with a continuum of strike prices where each option is weighted by the inverse of its strike price squared². We here show that conditional variance swaps can be approximated by a corridor variance swap and a sum of binary options. Take for example the case of an up conditional variance swap:

$$\begin{aligned}
 \text{Payoff}_{\text{upcond}} &= (K_{\text{upcond}}^2 - K^2) \frac{\sum_{i=1}^T 1_{S_i \geq \text{Lower level}}}{T} \\
 &= \left(\frac{252}{\sum_{i=1}^T 1_{S_i \geq \text{Upper level}}} \sum_{i=1}^T [(\ln(S_i/S_{i-1}))^2] 1_{S_i \geq \text{Upper level}} - K^2 \right) \frac{\sum_{i=1}^T 1_{S_i \geq \text{Lower level}}}{T} \\
 &= \underbrace{\frac{252}{T} \sum_{i=1}^T [(\ln(S_i/S_{i-1}))^2] 1_{S_i \geq \text{lower level}}}_{\text{corridor variance swap's payoff}} - \underbrace{\frac{K^2}{T} \sum_{i=1}^T 1_{S_i \geq \text{Lower level}}}_{\text{payoff of } K^2/T \text{ binary options with maturities ranging from 1 to } T}
 \end{aligned}$$

■ As shown in the research note aforementioned, an up corridor variance swap can be replicated the same way we replicate variance swaps but with options with strike prices above the lower level. In other words, a 100% up corridor variance swap can for example be replicated by a portfolio of calls with a continuum of strike prices ranging from 100% to infinity and where each option is weighted by the inverse of the strike price squared.

■ Binary options are options that pay a flat amount if the stock price is above/below the strike price in the case of a call/put. They are slightly more complex to price and hedge but there exist however several models to price them. In a Black and Scholes' setting for example, the price of a binary call with maturity K and maturity T is equal to:

$$\text{Call}_{\text{Binary}}(K, T-t) = e^{-r(T-t)} N(d_2)$$

Where N() stands for the Normal cumulative distribution and d_2 is equal to:

$$d_2 = \frac{\ln(S/K) + (r - d - 0.5\sigma^2)(T-t)}{\sigma\sqrt{T-t}}$$

where d and σ are the dividend yield and the standard-deviation of the underlying asset. The call's price is therefore equal to the discount factor times the probability that the stock price ends up above the strike price at maturity.

² See our publication entitled "Volatility investing handbook: Variance swaps and beyond", published on September 23rd, 2005.

How different is a conditional variance swap from standard and corridor variance swaps?

■ Variance swaps provide a payoff that is independent from the underlying current and final positions and is replicated by a portfolio of options with strike prices ranging – in theory – from zero to infinity. Therefore, if an investor strongly believes that the market will never fall below 90% of its current level for example and wants to take exposure to variance, he will pay too much by buying a variance since the variance swap will imply buying expensive OTM options with strike prices below 90%.

■ A corridor variance swap, however, would provide a good instrument for trading such a view on both higher volatility and an index not falling below 90% of its current level. Nevertheless, should the investor's view not realise and the index fall below 90%, the loss can be substantial since the realised payoff can be close to zero.

■ Conditional variance swaps are therefore an answer to this market timing issue related to the corridor variance swap. Using conditional variance swaps, one can take a view on both the index's performance and volatility but by reducing its potential maximal loss. Indeed, if the index falls on the first day of the contract below 90%, a 90% up conditional variance swap's final payoff will be equal to zero since the payoff is weighted by the number of days where the index has been above 90% of its initial value.

■ In the case of a 90% up corridor variance swap, the loss would have been equal to the notional amount times the initial strike price.

How do conditional variance swaps behave in practice?

■ By construction, a 100% up corridor plus a 100% down corridor variance swaps should equal a standard variance swap. It is not true however in the case of conditional variance swaps. If the index falls, an up conditional variance swap could still pay a high amount in the case for example when the index has spent a few days above the threshold with a high volatility then followed by a long period below the threshold.

■ We have simulated the realised payoff of 1-year variance swaps, 100% up and down conditional variance swaps and a 95-105% conditional variance swap for the S&P 500 index from August 1975 to January 2006.

■ First, take a look at the average payoff over the past 30 years or so. An up conditional variance swap would pay less than a standard variance swap which itself pays on average less than a down conditional variance swap. This is indeed due to the overall negative correlation between volatility (or variance) and the index performance. Volatility has a tendency to be higher

when markets go down³. A 95-105% conditional variance swap would have yielded a realised payoff close to the variance swap's.

■ The average may however be misleading. Investors need to bear in mind that the payoff of conditional variance swaps are much volatile than those of variance swaps. Over the past 30 years, a 1-year variance swap's payoff on the S&P 500 index has lied between 7.6% and 34.9%. a 100% down conditional variance swaps could yield up to 194.7% should an investor had bought a 100% down conditional variance swaps in November 1986 and therefore benefited from the October '87 market crash.

Statistics for simulated payoff for various types of swaps on the S&P 500 from August 1975 to January 2006					
	1-year performance	variance swap	100% up conditional variance swap	100% down conditional variance swap	95-105% conditional variance swap
Average	9.8%	14.8%	12.9%	15.8%	14.4%
Minimum	-33.6%	7.6%	0.0%	0.0%	0.0%
Maximum	65.3%	34.9%	34.9%	194.7%	79.8%
correlation with 1-year index performance		-27.0%	23.8%	-24.1%	3.2%

Sources – BNP Paribas, Datastream

■ Up and down conditional variance swaps are often priced with respect to the standard variance swaps. The following table therefore reports basic statistics on the spread between the standard variance swap and the various conditional variance swaps. Since the down conditional variance swap is on average higher than the variance swap, the results show the spread (down – var).

■ As expected, the difference between a variance swap and a down conditional variance could have been historically very high. Up and down conditional variance swaps are sometimes used to lock-in an expensive smile. The higher the smile the higher the variance swap's strike price. However, an up conditional variance swap will be less exposed to an expensive smile since its replication does not require the purchase of expensive OTM options. Therefore, in general, the higher the smile, the higher the spread between the variance swap and the up conditional variance swap.

■ The following table thus provides interesting historical probability of the various spread to be above 0%, 2%, 4% and 8%.

■ Simulations can be performed on other underlying assets. Please contact us should you need further backtests.

³ This is indeed an average relationship and the recent rise in volatility and market level in Japan has shown the inverse phenomena.

Basic statistics on spread between the standard variance swap and the various conditional variance swap on the S&P 500 from August 1975 to January 2006

	var - up	down - var	var - 95-105% range
Average	2%	1%	0%
Minimum	-13%	-20%	-48%
Maximum	35%	163%	34%
correlation with 1-year index performance	-53%	-15%	-41%
historical proba of > 0%	68%	66%	53%
historical proba of > 2%	22%	31%	22%
historical proba of > 4%	12%	17%	10%
historical proba of > 8%	8%	7%	4%

Source – BNP Paribas

Implied volatility valuation

In this section, we report the output of our multivariate model which aims at determining the different sources of volatility as well as identifying stocks whose implied volatilities are cheap or expensive with respect to their theoretical values⁴. We use ATM implied volatilities from our proprietary database with 3-month maturities.

On Thursday, February 23, 2006, the theoretical equation takes the following form:

$$Implied\ Volatility_i = \begin{cases} 12.18 \\ + 0.061 * abs(1 - year\ return_i) \\ + 4.05 * beta_i \\ + 23744.5 / (Market\ capitalisation_i) \\ + 0.042 * (5 - year\ CDS_i) \end{cases}$$

The current selection of rich and cheap implied volatilities is:

List of recommended stocks with currently cheap implied volatility

Company	Implied volatility	Theoretical value	Ranking
VALEO SA	22.9	28.3	1
PUBLICIS GROUPE	21.4	25.3	1
LVMH MOET HENNESSY LOUIS VUI	21.9	24.7	1
SOCIETE GENERALE	21.8	24.4	1
BNP PARIBAS	20.8	24.1	1
BAYERISCHE HYPO-UND VEREINSB	21.0	24.3	1
DEUTSCHE BANK AG -REG	22.3	24.9	1
FIAT SPA	28.2	34.3	1
UNILEVER NV-CVA	18.4	21.8	1
ROYAL DUTCH SHELL PLC-A SHS	19.2	21.5	1
GAS NATURAL SDG SA	17.1	22.1	1
BANCO SANTANDER CENTRAL HISP	20.4	22.8	1
TELEFONICA SA	19.1	21.5	1
NESTLE SA-REGISTERED	18.4	20.6	1

Source: BNP Paribas

⁴ For an extensive study of the model, please read "Predicting uncertainty: A new method for valuing implied volatility", 14 October 2004.

List of recommended stocks with currently expensive implied volatility

Company	Implied volatility	Theoretical value	Ranking
ARCELOR	34.0	29.2	10
GROUPE DANONE	27.8	21.2	10
CAPITALIA SPA	26.9	22.9	10
BANCA MONTE DEI PASCHI SIENA	24.3	22.3	10
CORUS GROUP PLC	45.8	36.3	10
KINGFISHER PLC	33.2	24.9	10
O2 PLC	28.3	26.1	10
STANDARD CHARTERED PLC	28.6	24.3	10
ANGLO AMERICAN PLC	29.9	25.5	10
TESCO PLC	22.5	19.3	10
ASTRAZENECA PLC	22.3	19.7	10
VODAFONE GROUP PLC	24.7	20.9	10
KONINKLIJKE KPN NV	30.9	23.7	10
REPSOL YPF SA	26.0	22.9	10

Source: BNP Paribas

Volatility Commentary

- Who's not a takeover target and who will be left aside in the current M&A game? European M&A activity is heading for a good start **this** year with several deals already announced and rumours mounting on other companies.
- Indeed, sector wise, utilities, basic materials and retail banking sectors are so far the most active. However, with L'Oréal stating its interest **in** UK-based Body Shop, no sector seems to be left behind.
- At the market level, short-term implied volatility has declined by around 1.5 volatility points within a week (in the case of the €-Stoxx 50 index), echoing the rise in equity markets over the past few days. At the single stock level, implied volatility declined too but to a lesser extent, by 52bps on average, as the general decline in volatility is partially offset by a rise in names impacted by M&A activity or expected to announce their earnings in the coming days.
- The 90-110% smile continues to decline. The €-Stoxx 50's 6-month smile is currently trading around 4.6%, its lowest level since April 2003.

Automobile – indicative prices only														
Company	Last price	Crncy	1 month return		3m ATM implied Volatility			1-Month historical volatility			Average daily volume			Dividend yield
			1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio		
BAYERISCHE MOTOREN WERKE AG	39.63	EUR	9.9%	25.2%	23%	24%	4	14%	12%	2	2.42	2.70	90%	1.56%
DAIMLERCHRYSLER AG-REG	47.44	EUR	6.4%	41.2%	24%	26%	3	30%	20%	6	9.19	5.91	155%	3.16%
PEUGEOT SA	49.41	EUR	4.0%	0.8%	25%	26%	5	23%	26%	6	0.99	1.17	85%	2.73%
RENAULT SA	82.35	EUR	8.8%	24.5%	25%	27%	3	28%	25%	6	1.34	1.57	86%	2.19%
VOLKSWAGEN AG	58.87	EUR	24.5%	62.2%	28%	26%	6	37%	19%	8	3.18	3.38	94%	1.78%
VALEO	33.99	EUR	6.0%	-3.6%	22%	22%	2	15%	17%	1	0.30	0.43	70%	3.24%
MICHELIN (CGDE)-B	52	EUR	8.0%	-0.2%	25%	26%	3	35%	17%	9	0.68	0.87	79%	2.40%

Sources – Bloomberg, BNP Paribas

Banks – indicative prices only														
Company	Last price	Crncy	1 month return		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio		
ABN AMRO HOLDING NV	25.15	EUR	15.1%	26.7%	19%	20%	3	14%	13%	3	8.64	8.95	97%	3.98%
BANCO BILBAO VIZCAYA ARGENTA	17.02	EUR	12.2%	36.4%	20%	20%	4	21%	13%	5	23.02	26.28	88%	2.43%
BANCO SANTANDER CENTRAL HISP	12.24	EUR	10.2%	34.4%	19%	19%	2	16%	11%	4	63.46	63.41	100%	2.52%
BARCLAYS PLC	664	GBp	12.2%	14.6%	23%	25%	5	21%	15%	5	34.46	31.07	111%	3.76%
BAYERISCHE HYPO-UND VEREINSB	28.34	EUR	8.8%	69.8%	20%	21%	1	19%	19%	2	0.51	2.52	20%	--
BNP PARIBAS	78.35	EUR	12.6%	48.2%	20%	23%	4	27%	17%	8	3.84	3.39	114%	2.55%
CREDIT AGRICOLE SA	30.17	EUR	11.2%	35.6%	25%	25%	7	19%	16%	3	2.59	3.25	80%	1.19%
CREDIT SUISSE GROUP	74.4	CHF	3.6%	53.3%	23%	25%	4	32%	22%	7	9.42	5.47	172%	2.02%
DEUTSCHE BANK AG -REG	93.55	EUR	13.1%	45.8%	21%	22%	3	19%	17%	4	3.53	3.74	94%	1.82%
DEXIA	21.37	EUR	8.1%	25.7%	18%	18%	3	14%	10%	3	1.24	1.38	90%	2.18%
FORTIS	30.56	EUR	12.3%	52.8%	20%	20%	2	16%	14%	3	3.48	3.83	91%	5.10%
HBOS PLC	1040	GBp	9.0%	27.0%	21%	22%	4	20%	14%	5	9.87	14.57	68%	3.26%
HSBC HOLDINGS PLC	962	GBp	4.0%	12.5%	15%	15%	4	9%	13%	2	24.44	32.17	76%	3.90%
ING GROEP NV-CVA	31.59	EUR	12.7%	45.7%	19%	22%	3	14%	20%	2	9.57	8.64	111%	3.55%
LLOYDS TSB GROUP PLC	545	GBp	7.3%	15.7%	28%	30%	7	24%	14%	7	27.44	35.62	77%	6.28%
SOCIETE GENERALE	119.9	EUR	16.7%	56.6%	21%	23%	4	24%	15%	6	1.73	1.64	105%	2.75%
UBS AG-REGISTERED	144.1	CHF	7.5%	47.7%	20%	21%	5	15%	18%	3	2.99	3.72	80%	2.08%

Sources – Bloomberg, BNP Paribas

Basic Materials – indicative prices only														
Company	Last price	Crncy	1 month return		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio		
ARCELOR	30.4	EUR	34.1%	76.5%	35%	36%	7	91%	18%	10	3.14	4.87	64%	2.14%
THYSSENKRUPP AG	21.18	EUR	9.2%	28.6%	27%	27%	5	39%	17%	8	3.26	3.91	83%	3.78%

Sources – Bloomberg, BNP Paribas

Chemicals – indicative prices only														
Company	Last price	Crncy	1 month return		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio		
AIR LIQUIDE	172.9	EUR	3.2%	28.9%	19%	19%	4	20%	15%	6	0.38	0.36	106%	2.02%
BASF AG	63.3	EUR	2.0%	17.1%	21%	22%	3	16%	15%	2	3.43	2.74	125%	2.69%
BAYER AG	34.68	EUR	1.4%	34.9%	24%	25%	3	19%	14%	3	3.70	3.76	98%	1.59%
CLARIANT AG-REG	20.35	CHF	7.4%	4.0%	26%	26%	4	23%	15%	4	2.03	2.21	92%	--

Sources – Bloomberg, BNP Paribas

Construction – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
COMPAGNIE DE SAINT-GOBAIN	57.45	EUR	12.6%	25.6%	20%	21%	2	22%	10%	6	1.24	1.66	74%	2.23%
VINCI S.A.	77.6	EUR	3.0%	47.5%	24%	24%	7	20%	26%	5	1.17	1.30	90%	2.38%
LAFARGE SA	92.2	EUR	15.4%	22.6%	26%	23%	4	31%	21%	7	1.21	1.16	104%	2.60%

Sources – Bloomberg, BNP Paribas

Consumer – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
ACCOR SA	49.37	EUR	-1.2%	44.6%	27%	27%	5	20%	22%	3	0.81	1.10	74%	2.63%
CIE FINANCIERIE RICHEMONT-A	57.7	CHF	2.4%	58.5%	24%	24%	2	16%	15%	2	1.16	1.34	87%	2.69%
L'OREAL	74.5	EUR	14.2%	26.4%	20%	21%	4	19%	17%	4	2.25	1.37	164%	1.10%
LMVH MOET HENNESSY LOUIS VUI	76.7	EUR	4.7%	38.1%	21%	21%	4	16%	18%	2	1.26	1.12	112%	1.24%

Sources – Bloomberg, BNP Paribas

Energy – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
BP PLC	651	GBP	-1.6%	19.9%	21%	22%	4	23%	14%	7	66.37	76.15	87%	3.06%
ENI SPA	24.22	EUR	0.6%	34.5%	20%	20%	5	16%	15%	3	17.81	26.98	66%	5.57%
REPSOL YPF SA	23.59	EUR	-4.6%	20.3%	27%	28%	7	36%	16%	9	11.54	9.91	116%	1.98%
ROYAL DUTCH SHELL (NA)	25.9	EUR	-2.7%	13.3%	18%	19%	3	19%	12%	6	0.47	0.39	120%	3.55%
ROYAL DUTCH SHELL (GB)	1845	GBP	-3.6%	11.3%	20%	21%	3	18%	14%	4	243.60	243.60	100%	3.41%
TOTAL SA	215	EUR	-1.8%	25.9%	21%	21%	5	21%	12%	5	2.37	2.68	89%	2.79%

Sources – Bloomberg, BNP Paribas

Food & Beverage – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
DIAGEO PLC	877.5	GBP	5.6%	20.0%	17%	20%	3	10%	9%	1	20.97	16.26	129%	3.37%
GROUPE DANONE	95.95	EUR	10.9%	31.8%	29%	27%	10	18%	10%	6	1.24	1.13	110%	1.41%
NESTLE SA-REGISTERED	399.5	CHF	5.9%	28.9%	17%	17%	5	14%	13%	5	1.21	1.13	107%	2.00%
UNILEVER NV-CVA	59.15	EUR	4.6%	21.9%	17%	18%	2	12%	11%	2	2.45	2.84	86%	3.25%
CADBURY-SCHWEPPES	586	GBP	5.8%	17.3%	22%	23%	4	19%	11%	6	19.15	11.70	164%	2.17%

Sources – Bloomberg, BNP Paribas

Healthcare – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
ASTRAZENECA PLC	2645	GBP	1.4%	25.2%	23%	24%	4	22%	20%	6	7.09	7.22	98%	2.80%
GLAXOSMITHKLINE PLC	1484	GBP	3.8%	19.8%	21%	21%	2	18%	13%	4	11.37	16.83	68%	2.97%
NOVARTIS AG-REG SHS	71.05	CHF	0.4%	22.8%	17%	17%	4	13%	15%	3	4.51	6.31	71%	1.48%
ROCHE HOLDING AG-GENUSSCHEIN	194.9	CHF	-2.3%	59.9%	20%	21%	4	20%	12%	6	2.02	2.11	96%	1.03%
SANOFI-AVENTIS SA	71.7	EUR	-3.0%	21.7%	25%	27%	5	19%	17%	3	5.68	4.01	141%	1.67%

Sources – Bloomberg, BNP Paribas

Industrials – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
ALSTOM	1.55	EUR	8.1%	#VALUE!	29%	29%	4	25%	27%	1	0.04	0.75	6%	--
EUROPEAN AERONAUTIC DEFENCE	31.86	EUR	3.7%	39.0%	23%	24%	3	21%	17%	2	1.89	1.63	116%	1.57%
THALES SA	38.77	EUR	-0.5%	15.8%	24%	24%	3	14%	12%	1	0.57	0.59	96%	2.06%

Sources – Bloomberg, BNP Paribas

Insurance – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
AEGON NV	13.82	EUR	8.7%	36.7%	25%	25%	3	15%	19%	1	7.27	7.23	100%	3.11%
AGF - ASSUR GEN DE FRANCE	87	EUR	3.4%	55.7%	20%	20%	2	10%	15%	1	0.24	0.30	78%	2.99%
ALLIANZ AG-REG	134.15	EUR	7.9%	47.3%	23%	25%	3	19%	22%	3	2.60	3.50	74%	1.30%
ASSICURAZIONI GENERALI	30.47	EUR	8.9%	23.4%	21%	20%	6	17%	14%	6	9.24	6.91	134%	1.41%
AVIVA PLC	759	GBP	7.8%	20.2%	21%	22%	3	15%	17%	2	6.54	10.40	63%	3.40%
AXA	29.54	EUR	12.0%	54.7%	24%	25%	4	21%	21%	3	5.97	7.12	84%	2.07%
SWISS RE-REG	96.1	CHF	2.8%	17.1%	22%	22%	4	21%	13%	2	1.42	1.73	82%	1.66%

Sources – Bloomberg, BNP Paribas

Media – indicative prices only														
Company	Last price	Crncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
MEDIASET SPA	9.911	EUR	6.2%	-1.7%	23%	22%	4	15%	15%	2	6.56	7.51	87%	3.83%
TELEVISION FRANCAISE (T.F.1)	26.54	EUR	4.0%	12.0%	23%	24%	2	16%	20%	2	1.37	1.22	112%	2.45%
VIVENDI UNIVERSAL SA	25.5	EUR	0.2%	9.6%	26%	26%	3	22%	15%	4	6.64	6.32	105%	2.35%
PUBLICIS GROUPE	31.71	EUR	3.6%	37.0%	20%	21%	3	13%	11%	1	0.87	0.85	102%	0.95%

Sources – Bloomberg, BNP Paribas

Retail – indicative prices only														
Company	Last price	Crcncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
CARREFOUR SA	39.63	EUR	3.9%	1.0%	21%	22%	3	11%	15%	1	2.49	2.80	89%	2.37%
KONINKLIJKE AHOLD NV	6.77	EUR	7.4%	-0.4%	30%	31%	2	20%	24%	1	8.29	11.04	75%	--
METRO AG	42.23	EUR	6.5%	3.2%	23%	23%	3	17%	19%	3	1.08	1.22	88%	2.42%
PINAULT-PRINTEMPS-REDOUTE	94.6	EUR	1.0%	16.9%	21%	21%	3	11%	21%	1	0.29	0.44	67%	2.66%
TESCO PLC	324.5	Gbp	4.9%	9.1%	23%	23%	6	18%	14%	5	32.60	43.90	74%	2.40%

Sources – Bloomberg, BNP Paribas

Technology – indicative prices only														
Company	Last price	Crcncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
ALCATEL SA	11.4	EUR	7.9%	16.1%	29%	30%	3	25%	23%	2	9.61	11.14	86%	--
BOUYGUES	44.23	EUR	2.1%	42.5%	23%	24%	4	13%	17%	1	0.97	1.13	86%	1.70%
DASSAULT SYSTEMES SA	46.95	EUR	-1.2%	33.1%	25%	26%	3	20%	18%	2	0.28	0.33	85%	0.81%
ERICSSON LM-B SHS	27.5	SEK	6.4%	39.2%	25%	24%	1	18%	20%	1	106.36	123.36	86%	0.91%
NOKIA OYJ	15.83	EUR	6.2%	32.5%	25%	26%	3	17%	16%	2	27.24	35.05	78%	2.08%
PHILIPS ELECTRONICS NV	28.05	EUR	6.7%	35.8%	23%	24%	1	21%	20%	3	5.05	6.34	80%	1.43%
SAP AG	172.7	EUR	16.2%	43.5%	21%	22%	2	36%	22%	6	1.22	1.36	90%	0.64%
SIEMENS AG-REG	77.86	EUR	10.0%	33.4%	21%	22%	3	27%	20%	5	3.87	4.83	80%	1.73%
THOMSON (EX-TMM)	14.08	EUR	-21.7%	-29.5%	34%	36%	6	63%	24%	9	2.08	2.46	84%	2.02%

Sources – Bloomberg, BNP Paribas

Telecommunication – indicative prices only														
Company	Last price	Crcncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
BT GROUP PLC	210.25	Gbp	2.5%	7.5%	24%	24%	3	18%	20%	2	31.07	49.30	63%	5.14%
DEUTSCHE TELEKOM AG-REG	13.33	EUR	2.7%	-11.6%	20%	21%	4	19%	14%	4	24.01	23.91	100%	4.65%
FRANCE TELECOM SA	18.91	EUR	1.5%	-15.2%	23%	25%	2	24%	34%	4	10.77	12.58	86%	2.53%
TELECOM ITALIA SPA	2.318	EUR	0.5%	-17.2%	25%	26%	7	19%	22%	4	97.01	116.30	83%	4.72%
TELEFONICA S.A.	12.94	EUR	5.7%	-3.3%	18%	18%	3	14%	14%	3	37.18	45.05	83%	3.60%
VODAFONE GROUP PLC	118.75	Gbp	0.8%	-11.1%	26%	26%	5	25%	23%	6	458.57	349.19	131%	3.67%

Sources – Bloomberg, BNP Paribas

Utilities – indicative prices only														
Company	Last price	Crcncy	1 month		3m ATM implied Volatility			1-Month Historical Volatility			Average daily volume			Dividend yield
			return	1 year return	Last	A week ago	Decile	Last	A month ago	Decile	Last 5 days	6-month	Ratio	
E.ON AG	96.08	EUR	9.6%	46.3%	23%	23%	5	16%	17%	3	5.29	3.35	158%	2.45%
ENDESA S.A.	28.25	EUR	20.6%	71.3%	23%	23%	7	32%	17%	9	21.99	8.25	266%	2.32%
IBERDROLA SA	27.4	EUR	18.8%	43.7%	19%	18%	8	24%	12%	10	10.78	5.05	214%	2.51%
SUEZ SA	31.89	EUR	10.9%	64.5%	26%	23%	6	26%	18%	6	8.38	6.26	134%	2.47%
RWE AG	74.57	EUR	14.7%	67.0%	23%	23%	4	19%	17%	4	3.35	3.01	112%	2.01%

Sources – Bloomberg, BNP Paribas

Notes:
 In order to calculate the volatility deciles, we calculate the 1-month historical volatility for the last 5 years and then rank the outputs in increasing order. If the historical volatility belongs to decile 1, it means that it lies within the lowest historical range, while decile 10 refers to the highest volatility historically.
 The dividend yield is the actual dividend yield.

Leaders and Laggards

Weekly changes in 3-month implied volatility – indicative prices only			
Biggest positive changes	Last	1 week ago	Change
LAFARGE SA	25.6	21.9	3.7
SUEZ SA	25.5	22.2	3.3
IBERDROLA SA	18.4	16.4	2.0
VOLKSWAGEN AG	27.5	25.7	1.8
ASSICURAZIONI GENERALI	19.9	18.8	1.1
METRO AG	22.7	21.8	0.8
CLARIANT AG-REG	25.4	24.6	0.8
MEDIASET SPA	22.4	21.6	0.7
GROUPE DANONE	30.5	30.0	0.5
BANCO SANTANDER CENTRAL HISP	18.0	17.5	0.5
Biggest negative changes	Last	1 week ago	Change
SAP AG	20.0	21.5	-1.4
DIAGEO PLC	16.0	17.5	-1.5
FRANCE TELECOM SA	22.3	23.9	-1.7
BARCLAYS PLC	22.8	24.6	-1.7
SANOFI-AVENTIS	24.4	26.2	-1.8
ALLIANZ AG-REG	21.8	23.8	-2.0
THOMSON (EX-TMM)	32.9	35.3	-2.5
RENAULT SA	24.0	26.7	-2.7
ING GROEP NV-CVA	18.2	21.0	-2.9
BNP PARIBAS	18.6	22.0	-3.4

Sources – Bloomberg, BNP Paribas

Volatility Pairs

Current Selection⁵

Current Volatility Pairs – 3 months							
Buy	Sell	Signal	Half-life (in days)	Distance to average	DF	Stationarity	Same sector
BASF AG	SYNGENTA AG	3.8	4.7	8.0	-6.0	Strongly Stationary	yes
AIR LIQUIDE	SYNGENTA AG	3.2	7.2	8.2	-4.8	Strongly Stationary	yes
PUBLICIS GROUPE	MEDIASET SPA	-2.8	19.2	6.7	-3.1	Stationary	yes
BAYER AG	SYNGENTA AG	2.6	7.6	8.8	-4.7	Strongly Stationary	yes
BAYERISCHE HYPO-UND VEREINSB	AEGON NV	2.5	13.1	7.0	-3.6	Strongly Stationary	yes
BAYERISCHE HYPO-UND VEREINSB	SWISS RE-REG	2.5	21.0	8.0	-2.9	Stationary	yes
BAYERISCHE HYPO-UND VEREINSB	AVIVA PLC	2.2	24.8	8.0	-3.0	Stationary	yes
BAYERISCHE HYPO-UND VEREINSB	DEUTSCHE BANK AG -REG	2.1	19.3	6.7	-3.1	Stationary	yes
ING GROEP NV-CVA	CREDIT SUISSE GROUP-REG	-2.1	13.8	3.6	-3.5	Stationary	yes
DEXIA	BANCO BILBAO VIZCAYA ARGENT ^A	-2.1	17.9	3.2	-3.0	Stationary	yes
SOCIETE GENERALE	UBS AG-REGISTERED	-1.8	20.4	3.1	-3.2	Stationary	yes
PUBLICIS GROUPE	TELEVISION FRANCAISE (T.F.1)	-1.8	17.3	4.1	-3.3	Stationary	yes
ALLIANZ AG-REG	CREDIT SUISSE GROUP-REG	-1.7	17.7	3.0	-3.1	Stationary	yes
AGF - ASSUR GEN DE FRANCE	UBS AG-REGISTERED	-1.7	25.9	3.1	-2.9	Stationary	yes
DAIMLERCHRYSLER AG-REG	VOLKSWAGEN AG	1.7	9.6	2.2	-4.2	Strongly Stationary	yes
DEXIA	AVIVA PLC	-1.6	12.4	2.7	-4.1	Strongly Stationary	yes
FRANCE TELECOM SA	DEUTSCHE TELEKOM AG-REG	-1.6	11.3	2.0	-3.9	Strongly Stationary	yes
ALLIANZ AG-REG	UBS AG-REGISTERED	-1.6	25.3	3.8	-3.0	Stationary	yes
PUBLICIS GROUPE	VIVENDI UNIVERSAL SA	-1.6	20.2	4.5	-3.5	Strongly Stationary	yes
DEUTSCHE BANK AG -REG	CREDIT SUISSE GROUP-REG	1.5	17.3	3.0	-3.2	Stationary	yes
RWE AG	SUEZ SA	-1.5	15.6	2.6	-3.4	Stationary	yes
EUROSTOXX50	SYNGENTA AG	-4.1	6.8	11.0	-4.9	Strongly Stationary	vs. Market
EUROSTOXX50	VOLKSWAGEN AG	3.3	14.7	5.2	-3.2	Stationary	vs. Market
EUROSTOXX50	ACCOR SA	3.2	16.5	6.2	-3.1	Stationary	vs. Market
EUROSTOXX50	SUEZ SA	-2.6	20.9	5.5	-3.2	Stationary	vs. Market
EUROSTOXX50	MEDIASET SPA	2.5	12.5	4.1	-3.9	Strongly Stationary	vs. Market
EUROSTOXX50	CREDIT AGRICOLE SA	-2.5	16.3	3.7	-3.2	Stationary	vs. Market
EUROSTOXX50	BAYERISCHE MOTOREN WERKE A ^I	2.4	9.5	3.3	-4.7	Strongly Stationary	vs. Market
EUROSTOXX50	THOMSON (EX-TMM)	-2.2	21.4	5.3	-3.1	Stationary	vs. Market
EUROSTOXX50	HBOS PLC	-2.1	11.8	3.2	-3.7	Strongly Stationary	vs. Market
EUROSTOXX50	BT GROUP PLC	-2.0	20.2	4.3	-3.0	Stationary	vs. Market
EUROSTOXX50	AIR LIQUIDE	-1.8	15.1	2.8	-3.3	Stationary	vs. Market
EUROSTOXX50	SANOFI-AVENTIS	-1.7	14.5	3.5	-3.4	Stationary	vs. Market
EUROSTOXX50	RWE AG	1.7	12.5	2.9	-3.8	Strongly Stationary	vs. Market
EUROSTOXX50	DEUTSCHE TELEKOM AG-REG	-1.7	20.3	3.4	-3.3	Stationary	vs. Market
EUROSTOXX50	THYSSENKRUPP AG	1.6	18.4	4.6	-3.1	Stationary	vs. Market
EUROSTOXX50	L'OREAL	1.5	9.1	1.9	-4.5	Strongly Stationary	vs. Market

Source – BNP Paribas

⁵ See the appendix for a quick survey of the method

Current Volatility Pairs – 6 months

Buy	Sell	Signal	Half-life (in days)	Distance to average	DF	Stationarity	Same sector
BASF AG	SYNGENTA AG	4.1	4.1	7.0	-6.5	Strongly Stationary	yes
AIR LIQUIDE	SYNGENTA AG	3.3	6.7	7.6	-5.1	Strongly Stationary	yes
BAYER AG	SYNGENTA AG	2.9	5.8	7.5	-5.5	Strongly Stationary	yes
PUBLICIS GROUPE	MEDIASET SPA	-2.2	14.6	4.1	-3.8	Strongly Stationary	yes
BAYERISCHE HYPO-UND VEREINSB	AEGON NV	2.1	18.0	5.5	-3.1	Stationary	yes
RENAULT SA	PEUGEOT SA	-1.9	10.2	1.8	-4.2	Strongly Stationary	yes
ING GROEP NV-CVA	CREDIT SUISSE GROUP-REG	-1.7	13.6	2.5	-3.5	Strongly Stationary	yes
DEXIA	AVIVA PLC	-1.7	14.2	2.7	-3.8	Strongly Stationary	yes
DEXIA	ABN AMRO HOLDING NV	-1.6	19.2	2.6	-2.9	Stationary	yes
SOCIETE GENERALE	BNP PARIBAS	-1.6	7.8	1.0	-4.8	Strongly Stationary	yes
SOCIETE GENERALE	BANCO BILBAO VIZCAYA ARGENT	-1.6	10.2	1.6	-4.1	Strongly Stationary	yes
DEUTSCHE BANK AG -REG	CREDIT SUISSE GROUP-REG	1.5	17.0	2.4	-3.3	Stationary	yes
ALLIANZ AG-REG	BANCO BILBAO VIZCAYA ARGENT	-1.5	14.7	2.1	-3.4	Stationary	yes
PUBLICIS GROUPE	VIVENDI UNIVERSAL SA	-1.5	20.7	3.5	-3.3	Stationary	yes
EUROSTOXX50	SYNGENTA AG	-4.2	6.0	9.8	-5.2	Strongly Stationary	vs. Market
EUROSTOXX50	SUEZ SA	-2.7	22.1	4.3	-3.0	Stationary	vs. Market
EUROSTOXX50	HBOS PLC	-2.1	16.8	3.0	-3.1	Stationary	vs. Market
EUROSTOXX50	BAYERISCHE MOTOREN WERKE A	2.0	12.1	2.5	-4.2	Strongly Stationary	vs. Market
EUROSTOXX50	RWE AG	1.9	14.6	2.7	-3.5	Stationary	vs. Market
EUROSTOXX50	L'OREAL	1.8	11.8	2.0	-3.9	Strongly Stationary	vs. Market
EUROSTOXX50	MEDIASET SPA	1.7	15.2	2.5	-3.6	Strongly Stationary	vs. Market
EUROSTOXX50	BANCO BILBAO VIZCAYA ARGENT	-1.6	13.4	2.1	-3.8	Strongly Stationary	vs. Market
EUROSTOXX50	THYSSENKRUPP AG	1.6	21.1	3.8	-2.9	Stationary	vs. Market
EUROSTOXX50	BNP PARIBAS	-1.6	11.1	1.4	-4.0	Strongly Stationary	vs. Market
EUROSTOXX50	BAYER AG	-1.5	18.5	2.3	-3.2	Stationary	vs. Market

Source – BNP Paribas

Current Volatility Pairs – 1 year

Buy	Sell	Signal	Half-life (in days)	Distance to average	DF	Stationarity	Same sector
DEGUSSA AG	SYNGENTA AG	3.9	12.4	15.5	-3.5	Stationary	yes
BNP PARIBAS	LLOYDS TSB GROUP PLC	3.5	16.5	3.4	-3.1	Stationary	yes
AIR LIQUIDE	SYNGENTA AG	3.4	5.7	6.0	-5.5	Strongly Stationary	yes
FORTIS	LLOYDS TSB GROUP PLC	-3.0	17.4	4.7	-2.9	Stationary	yes
BASF AG	SYNGENTA AG	3.0	3.9	4.9	-6.7	Strongly Stationary	yes
BAYER AG	SYNGENTA AG	2.7	4.3	5.4	-6.4	Strongly Stationary	yes
AVIVA PLC	LLOYDS TSB GROUP PLC	-2.5	21.2	3.7	-3.2	Stationary	yes
RENAULT SA	PEUGEOT SA	-2.1	9.0	1.6	-4.6	Strongly Stationary	yes
DEUTSCHE BANK AG -REG	CREDIT SUISSE GROUP-REG	2.0	17.3	2.5	-3.4	Stationary	yes
ING GROEP NV-CVA	CREDIT SUISSE GROUP-REG	-1.8	13.1	2.1	-3.6	Strongly Stationary	yes
PPR	METRO AG	1.7	10.6	1.8	-4.1	Strongly Stationary	yes
EUROSTOXX50	SYNGENTA AG	-4.4	4.7	7.6	-6.0	Strongly Stationary	vs. Market
EUROSTOXX50	LAFARGE SA	4.0	14.6	3.5	-3.1	Stationary	vs. Market
EUROSTOXX50	SUEZ SA	-2.6	20.6	3.1	-2.9	Stationary	vs. Market
EUROSTOXX50	HBOS PLC	-2.0	14.8	2.1	-3.4	Stationary	vs. Market
EUROSTOXX50	L'OREAL	1.9	16.5	2.0	-3.3	Stationary	vs. Market
EUROSTOXX50	BAYERISCHE MOTOREN WERKE A	1.7	16.5	1.9	-3.7	Strongly Stationary	vs. Market
EUROSTOXX50	BAYER AG	-1.6	21.0	2.2	-3.0	Stationary	vs. Market
EUROSTOXX50	BNP PARIBAS	-1.6	10.5	1.1	-4.1	Strongly Stationary	vs. Market
EUROSTOXX50	THOMSON (EX-TMM)	-1.6	27.3	3.1	-3.1	Stationary	vs. Market

Source – BNP Paribas

Appendices

Stock Universe

Stock Universe and Sector Classification			
Name	Sector	Name	Sector
BAYERISCHE MOTOREN WERKE AG	Automobile	ASTRAZENECA PLC	Healthcare
DAIMLERCHRYSLER AG-REG	Automobile	GLAXOSMITHKLINE PLC	Healthcare
PEUGEOT SA	Automobile	NOVARTIS AG-REG SHS	Healthcare
RENAULT SA	Automobile	ROCHE HOLDING AG-GENUSSCHEIN	Healthcare
VOLKSWAGEN AG	Automobile	SANOFI-SYNTHELABO SA	Healthcare
VALEO	Automobile	EUROPEAN AERONAUTIC DEFENCE	Industrial
MICHELIN (CGDE)-B	Automobile	THALES SA	Industrial
ABN AMRO HOLDING NV	Bank	ALSTOM	Industrial
BANCO BILBAO VIZCAYA ARGENTA	Bank	AEGON NV	Insurance
BANCO SANTANDER CENTRAL HISP	Bank	AGF - ASSUR GEN DE FRANCE	Insurance
BARCLAYS PLC	Bank	ALLIANZ AG-REG	Insurance
BAYERISCHE HYPO-UND VEREINSB	Bank	ASSICURAZIONI GENERALI	Insurance
BNP PARIBAS	Bank	AVIVA PLC	Insurance
CREDIT AGRICOLE SA	Bank	AXA	Insurance
CREDIT SUISSE GROUP	Bank	LLOYDS TSB GROUP PLC	Insurance
DEUTSCHE BANK AG -REG	Bank	SWISS RE-REG	Insurance
DEXIA	Bank	MEDIASET SPA	Media
FORTIS	Bank	TELEVISION FRANCAISE (T.F.1)	Media
HBOS PLC	Bank	VIVENDI UNIVERSAL SA	Media
HSBC HOLDINGS PLC	Bank	PUBLICIS GROUPE	Media
ING GROEP NV-CVA	Bank	CARREFOUR SA	Retail
SOCIETE GENERALE	Bank	KONINKLIJKE AHOLD NV	Retail
UBS AG-REGISTERED	Bank	METRO AG	Retail
ARCELOR	Basic Materials	PINAULT-PRINTEMPS-REDOUTE	Retail
THYSSENKRUPP AG	Basic Materials	TESCO PLC	Retail
AIR LIQUIDE	Chemicals	ALCATEL SA	Technology
BASF AG	Chemicals	BOUYGUES	Technology
BAYER AG	Chemicals	DASSAULT SYSTEMES SA	Technology
CLARIANT AG-REG	Chemicals	ERICSSON LM-B SHS	Technology
DEGUSSA AG	Chemicals	NOKIA OYJ	Technology
SYNGENTA AG	Chemicals	PHILIPS ELECTRONICS NV	Technology
COMPAGNIE DE SAINT-GOBAIN	Construction	SAP AG	Technology
VINCI S.A.	Construction	SIEMENS AG-REG	Technology
LAFARGE SA	Construction	THOMSON (EX-TMM)	Technology
ACCOR SA	Consumer	BT GROUP PLC	Telecommunications
CIE FINANC RICHEMONT-A	Consumer	DEUTSCHE TELEKOM AG-REG	Telecommunications
L'OREAL	Consumer	FRANCE TELECOM SA	Telecommunications
LVMH MOET HENNESSY LOUIS VUI	Consumer	TELECOM ITALIA SPA	Telecommunications
BP PLC	Energy	TELEFONICA S.A.	Telecommunications
ENI SPA	Energy	VODAFONE GROUP PLC	Telecommunications
REPSOL YPF SA	Energy	E.ON AG	Utilities
ROYAL DUTCH PETROLEUM	Energy	ENDESA S.A.	Utilities
SHELL TRANSPRT&TRADNG CO PLC	Energy	IBERDROLA SA	Utilities
TOTAL SA	Energy	SUEZ SA	Utilities
DIAGEO PLC	Food & Beverage	RWE AG	Utilities
GROUPE DANONE	Food & Beverage		
NESTLE SA-REGISTERED	Food & Beverage		
UNILEVER NV-CVA	Food & Beverage		

Source – BNP Paribas

How do we select pairs?

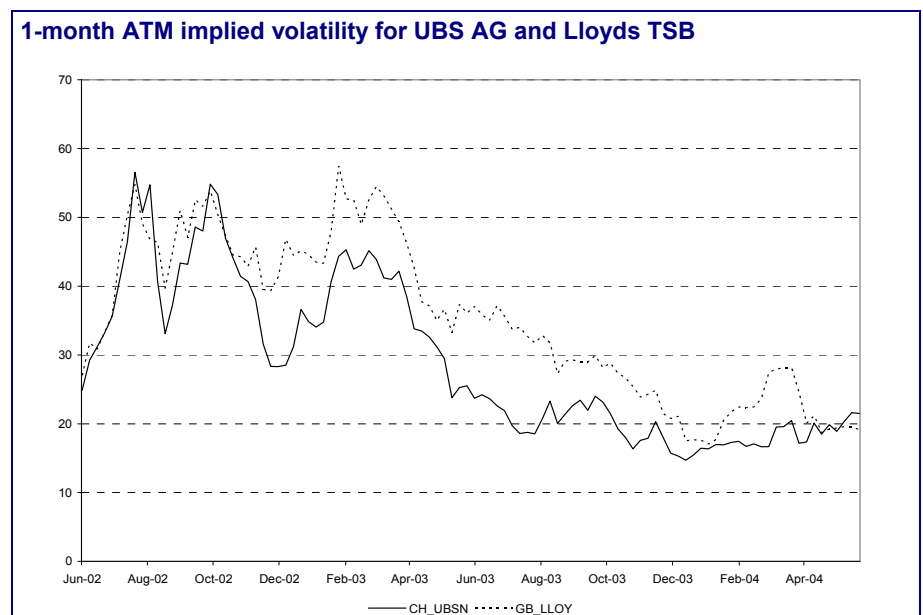
While it is difficult to model implied volatility, we can make a few comments with regard to their dynamics:

- Stock volatilities tend to have upper and lower boundaries. Indeed, volatility cannot be below zero percent and, at the other extreme, it rarely moves above 100%, except when specific events occur (such as M&A announcements).
- Volatility can be split into a specific and a systematic component. A macro-economic shock, such as a change in monetary policy or an increase in oil prices, should affect the volatility of all stocks.
- Furthermore, stocks within a same sector and with the same characteristics are likely to carry similar risks.

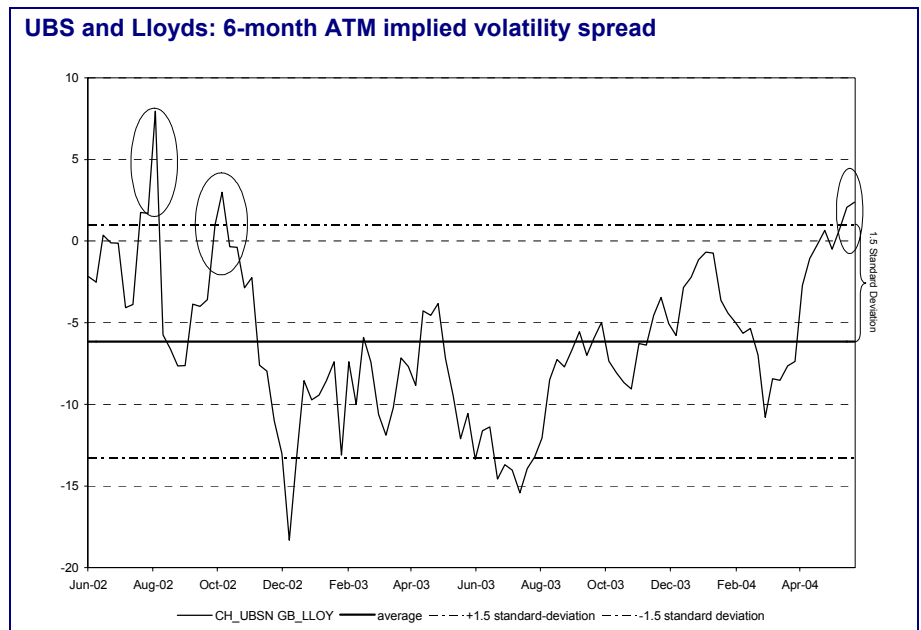
Hence, despite the fact that it may be difficult to forecast single stock volatility, we aim to find short-term anomalies by forming every possible pair of implied volatilities within our universe of 93 stocks.

For example, the graph below shows the 1-month ATM implied volatilities for UBS AG and Lloyds TSB. The implied volatilities of the two stocks have fluctuated around the 20% level for a while and it is rather difficult to assess where both volatilities will go in the future. However, one can observe that the volatility of Lloyds has been lower than that of UBS on only 3 short-lived occasions in the last 2 years, the latest being now.

This is confirmed in the following graph, which shows the spread between the two implied volatilities. We observe clearly that the spread is high relative to its historical mean.



Sources – Bloomberg, BNP Paribas



Sources – Bloomberg, BNP Paribas

Indeed, the spread may simply not be mean-reverting. Such a case occurs, for example, when a company faces structural changes which may greatly affect its risk. Again, a merger may trigger such a change and a graphic analysis may not be sufficient to highlight pairs of stocks whose volatility spread is likely to revert back to its mean.

We therefore test for mean-reversion (see appendix for a detailed description of the test) using the Dickey-Fuller test for stationarity. This gives us a confidence level for stationarity which we translate into qualitative terms:

- 99% and above: strongly stationary
- Between 95 and 99%: stationary
- Below 95%: not stationary

As a result, we aim to find pairs of volatility that are:

- far from their historical mean, and
- stationary

We perform the analysis for all possible pairs within our universe of 93 stocks plus the EUROSTOXX 50 index as a market benchmark, for ATM implied volatilities with 3-month, 6-month and 1-year maturities.

This gives us 4,371 possible pairs for each maturity. After using our two filters, we currently identify 95 pairs with 3-month maturities, 95 pairs with 6-month maturities and 99 pairs with 1-year maturities.

The tables below show the current picks obtained using this method. The first two columns show which volatility to buy/sell.

The third column provides the signal, i.e. the distance to average in terms of standard deviation. We only select pairs with a signal of no less than 1.5 in absolute terms. As ± 1.5 standard deviation corresponds to around 80% of the distribution, selecting spreads outside the ± 1.5 standard deviation range is equivalent to choosing spreads within top and bottom deciles.

The distance to average column reports the same information but in volatility terms. Given the fact that bids-asks are usually higher for options than they are for stocks, monitoring the spread itself may be of importance as well.

What we call half-life is given by our stationarity analysis (see appendix) and gives the time in business days for the spread to go from its current level to half the distance between the current level and its historical mean. For example, if the spread between Nokia and Ericsson is 2 standard deviations from its historical mean and its half-life is 15, it means that it should take on average 15 business days - or 3 weeks - to go from 2 standard deviations to 1 standard deviation. One could favour pairs with a short half-life, since this means that, on average, the pair is likely to revert faster to its mean.

The "DF" column reports the Dickey-Fuller statistics and the next column shows whether the pair is stationary. Lastly, we indicate whether the pair consists of stocks within the same sector.

Testing for mean-reversion

We assume that the dynamics of the spread S_t are given by the following process:

$$S_t - S_{t-1} = a + bS_{t-1} + \varepsilon_t \text{ where } \varepsilon_t \text{ iid } N(0, \sigma^2) \quad (1)$$

Testing for mean-reversion is equivalent to testing whether the coefficient b is different from zero.

A simple linear regression is performed in order to calculate the T-stat associated with b .

The Dickey-Fuller test is equal to the T-stat but with different confidence levels:

3.51 for 99%

2.89 for 95%

2.58 for 90%

Calculating the half-life

The half-life is the expected time the spread should take to go from any point to half the distance from the mean. For example, if the spread is 5% above its mean, its half-life is the time it will take on average to revert back to 2.5%.

By applying the expectation operator on both sides of equation (1), one can show that:

$$E(S_t) = -a/b$$

Let \bar{S}_t be defined as: $\bar{S}_t = S_t - E(S_t) = S_t + a/b$.

Equation (1) can be rewritten as:

$$\bar{S}_t - \bar{S}_{t-1} = b\bar{S}_{t-1} + \varepsilon_t$$

or

$$\bar{S}_t = \rho\bar{S}_{t-1} + \varepsilon_t \text{ with } \rho = 1 + b \quad (2)$$

Then:

$$\begin{aligned} \bar{S}_{t+k} &= \rho\bar{S}_{t+k-1} + \varepsilon_{t+k} \\ \bar{S}_{t+k} &= \rho(\rho\bar{S}_{t+k-2} + \varepsilon_{t+k-1}) + \varepsilon_{t+k} \\ &\dots \end{aligned}$$

$$\bar{S}_{t+k} = \rho^k \bar{S}_t + \sum_{i=0}^{k-1} \rho^i \varepsilon_{t+k-i}$$

The expectation of \bar{S}_{t+k} conditional upon \bar{S}_t can then be simplified to:

$$E(\bar{S}_{t+k} | \bar{S}_t) = \rho^k \bar{S}_t$$

If we want to know how long it will take on average for the spread to go to a specific level q , we need to solve the following equation for k :

$$E(\bar{S}_{t+k} | \bar{S}_t) = q$$

$$\rho^k \bar{S}_t = q$$

Then:

$$k = \frac{\ln(q) - \ln(\bar{S}_t)}{\ln(\rho)}$$

q can be an arbitrary number or relative to the mean. If q is defined as half the distance between the current value of S and its mean, k is then equal to:

$$q = \frac{1}{2}(S_t - E(S_t)) = \frac{1}{2} \bar{S}_t$$

$$\Rightarrow k = \frac{-\ln(2)}{\ln(1+b)} \quad (3)$$

which is what we call the half-life of the strategy⁶

⁶As b is close to zero, this can be approximated by $(-\ln(2)/b)$

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