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These reports related to Relative Volatility Strategies, originally published as of the date stamp on each of them, are now presented as a single report within the Investment Strategies series of publications under number 82.

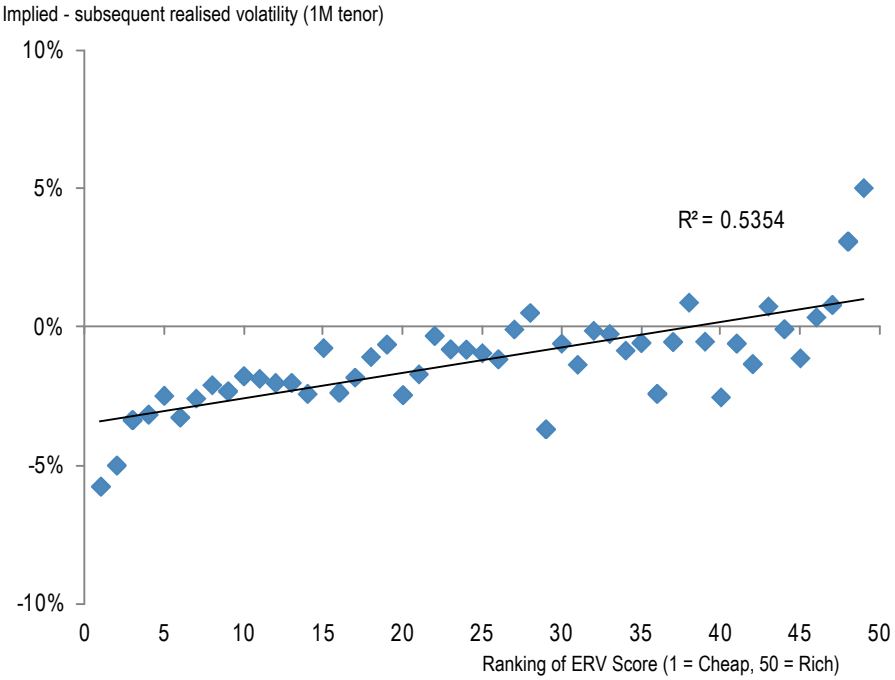
Europe Equity Derivatives & Delta One Strategy
03 April 2012

Relative Value Single Stock Volatility

Building on Strength: Improving the RV model

- We revisit our RV model, a **quantitative framework for determining the rich/cheapness of volatility on single stocks,** to adapt to the structural changes that have happened since its introduction in 2007.
- Our model uses a combination of realised volatility, CDS spread, beta and return to produce a rich/cheap volatility score – the Enhanced Relative Value (ERV) score – for each stock in our European stock universe.
- There is a strong correlation between the ERV-rank of a stock and the average subsequent realised volatility, **showing that the ERV score is an effective tool for volatility strategies.**
- At the end of the report we attach the ranking of the ERV screen, showing the **10 richest and cheapest vol names** in our liquid European universe.

Figure 1: Rank of ERV score is strongly correlated with subsequent realised volatility



Source: J.P. Morgan Equity Derivatives Strategy

European Equity Derivatives and Delta-One Strategy

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See page 16 for analyst certification and important disclosures, including non-US analyst disclosures.

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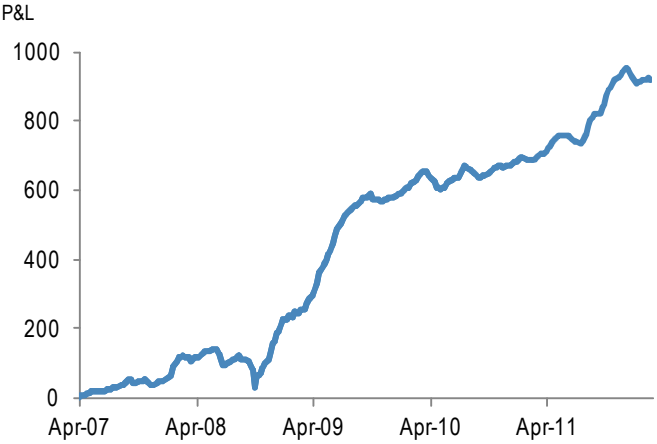
Introduction

The Relative Value Single Stock Volatility model is a quantitative framework for determining the rich/cheapness of volatility on single stocks. The model aims to **find relative value between stocks' volatility rather than predicting the future volatility of a stock in isolation**. The rich/cheap signals are based on a combination of fundamental and technical factors, including realised volatility, credit spreads, stock performance, and beta. Since our introduction of the RV model in October 2007[1], the model has produced consistently effective signals for volatility relative value opportunities[2].

In this report, we introduce the **Enhanced RV Model (ERV Model) which is modified to adapt to the current market conditions and dynamics, which have clearly evolved since 2007**. The ERV model retains the main features of the earlier model, while treating the relationship between CDS and implied volatility in a different manner.

We tested the effectiveness of the ERV model over the last five years on the Euro STOXX 50 index constituents. As Figure 2 and Figure 3 below demonstrate, the ERV score has been successful in identifying rich and cheap volatility stocks.

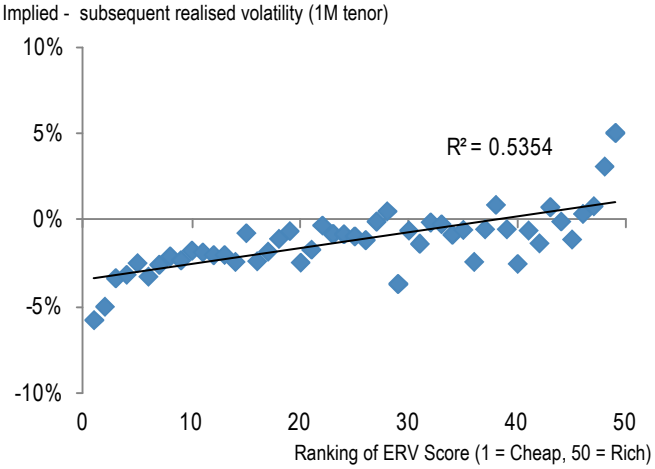
Figure 2: Cumulative P&L* of volatility long/short strategy based on the ERV model



Source: J.P. Morgan Equity Derivatives Strategy

*P&L calculated as the difference between the 1M ATM implied volatility and the subsequent realised, by going long/short the 5 cheapest/richest names using the ERV ranking, entered on a weekly basis, assuming 2.0 vol bid-ask spread

Figure 3: Rank of RV score is strongly correlated with subsequent realised volatility



Source: J.P. Morgan Equity Derivatives Strategy

In the following sections, we describe in detail the ERV model, and provide results of the back test of the RV score.

The ERV screen will be made available on a daily basis on MorganMarkets. At the end of this report, we attach the ranking of the ERV screen, showing the **10 richest and cheapest vol names** in our liquid European universe.

[1] See the original RV model report by Granger et al, 01-Oct-07
[2] We looked at the live performance of the RV score between Sep-07 and Aug-10 in the Equity Derivatives Weekly, 12-Oct-10

Relative Value Volatility Model

The ERV model is derived from two component metrics: the **Risk Premium Z-Score** and **Fundamental Z-score**. We run two separate regressions over the data in the universe to obtain the two Z-Scores and combine them into the ERV score. In this section we discuss the construction and intuition of the ERV model.

Instead of trying to find the 'fair value' of implied vol, we start from the implied-realised volatility spread. For most equity volatility market participants, it is the most commonly used measure for assessing the rich/cheapness of implied volatility. The measure has proven to be simple, intuitive and effective. Therefore, **we start with the implied-realised vol spread and build upon it**, following the steps below to arrive at the ERV model.

Step 1: Refine the measurement of realised volatility to improve the implied-realised volatility metric (EWMA)

Step 2: Adjust the implied-realised vol spread by the company's CDS

Step 3: Correct for the sector biases in the implied-realised vol spread

→Risk Premium Z-Score

Step 4: Use independent, fundamental information (stock performance, beta) as a cross-validation

→Fundamental Z-Score

Step 5: Average the Risk Premium and Fundamental Z-Scores

→Enhanced Relative Value Z-Score

Step 1: Refine the measurement of realised volatility (EWMA)

Realised volatility is commonly defined as the standard deviation of returns over an observation period. The standard deviation gives equal importance to the returns on every day of the time period. In the equity markets, however, we observe that days of high volatility are usually followed by more days of high volatility, and days of low volatility are usually followed by more days of low volatility. Therefore, recent observations should be given more weight.

On the other hand, we also observe that the implied volatility market has a long memory. When a stock experiences a sharp move on one day, its implied volatility will usually stay elevated for a long period of time relative to its realised vol, even after the sharp move has dropped out of the observation period.

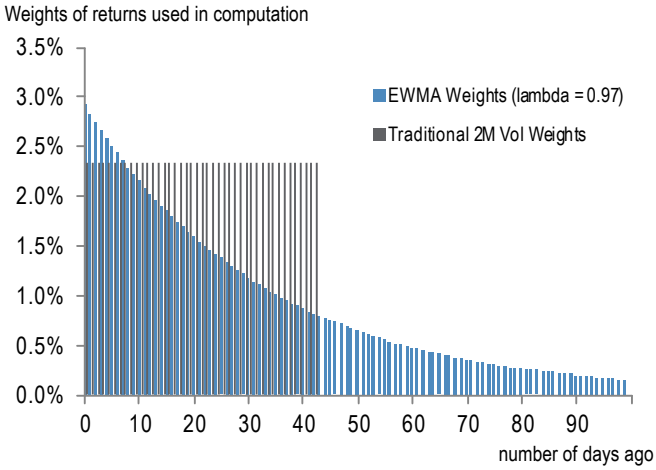
Based on the two observations above, we can improve the measurement of realised volatility by using a measure that gives more importance to the very recent returns, without chopping off its observation window after a set period of time. The Exponentially Weighted Moving Average (EWMA) volatility serves this dual purpose. There are two equivalent definitions of the EWMA volatility:

$$EWMAVol_t^2 = \lambda \cdot EWMAVol_{t-1}^2 + (1-\lambda) r_t^2 \qquad [1]$$

$$EWMAVol_t^2 = (1-\lambda) r_t^2 + \lambda(1-\lambda) r_{t-1}^2 + \lambda^2(1-\lambda) r_{t-2}^2 + \cdots \qquad [2]$$

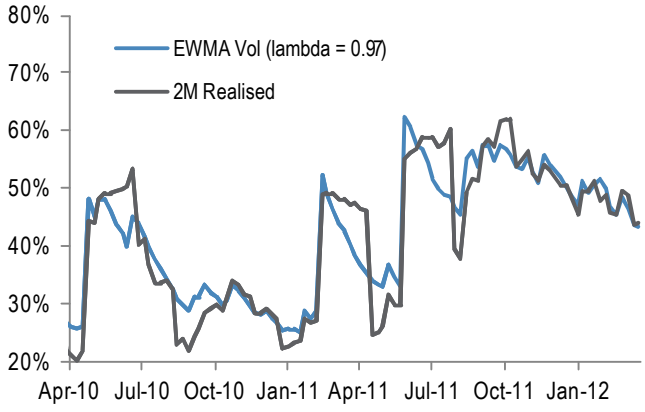
In [1], we cam see that the EWMA variance (volatility squared) on day t is the weighted average of the previous day EWMA variance and the squared return on day t (r_t^2). We can choose the parameter λ between 0 and 1 to assign the weight to the most recent return. In [2] the weights given to the observations are explicitly shown. The weights decay every day by a factor of λ, but never go to 0, thereby preserving more distant observations. In our ERV model we choose λ to correspond approximately to the traditionally defined two-month realised volatility.

Figure 4: The EWMA weighting scheme gives more importance to recent observations and retains more distant data points



Source: J.P. Morgan Equity Derivatives Strategy

Figure 5: The large moves in EWMA volatility fall out of the sample more gradually than traditional realised volatility for Nokia



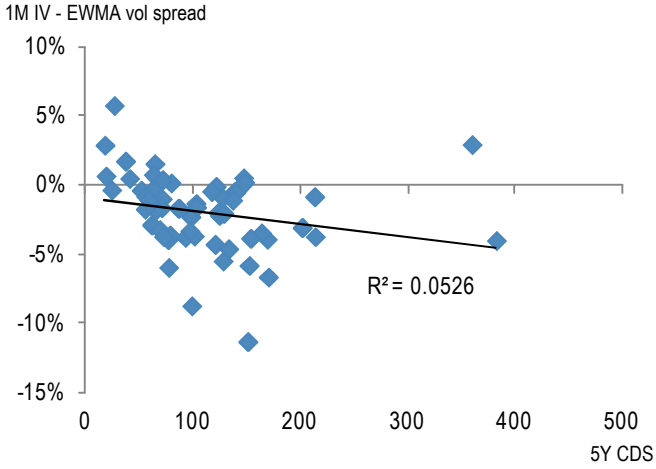
Source: J.P. Morgan Equity Derivatives Strategy

In Figure 4 and Figure 5, we demonstrate the features of the EWMA volatility compared to the traditional definition of realised volatility. For the rest of the report, we use the EWMA definition to compute realised volatility.

Step 2: Adjust the implied-realised vol spread by the company's CDS

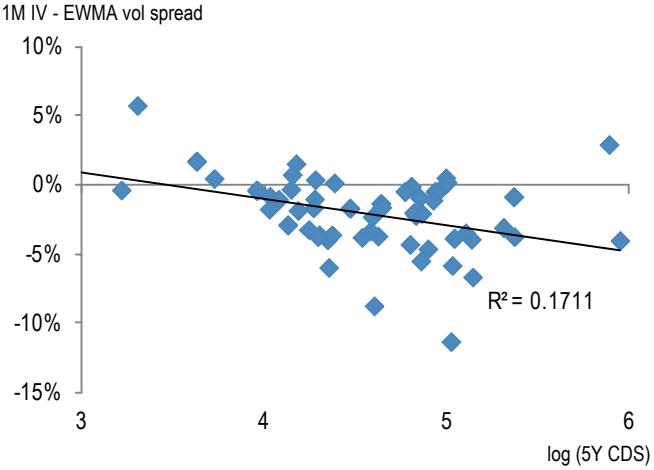
Next, we adjust the implied-EWMA vol spread by CDS. Names with very high CDS should have higher implied to (expected) realised spread to compensate for the higher risks. The relationship between the Implied-EWMA vol spread and CDS is not linear. As Figure 6 demonstrates, the range of CDS levels is disproportional to the implied-EWMA vol spread. Instead, a linear relationship appears more appropriate for the implied-EWMA spread and the natural log of CDS (Figure 7).

Figure 6: Average 1M Implied-EWMA vol spread shows very weak linear relationship with 5Y CDS



Source: J.P. Morgan Equity Derivatives Strategy

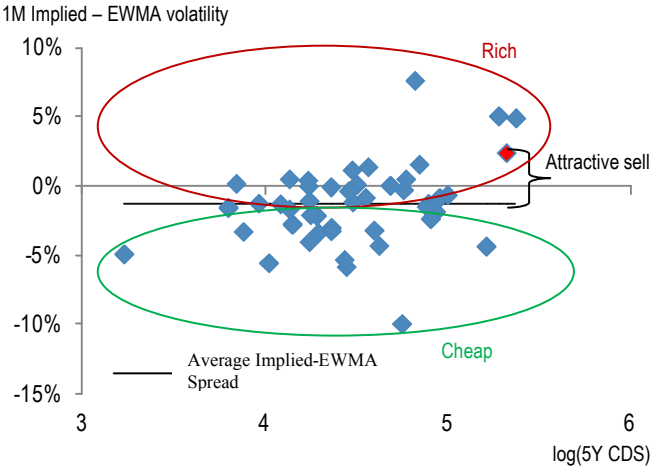
Figure 7: The linear relationship between average 1M Implied-EWMA vol spread and log 5Y CDS appears stronger



Source: J.P. Morgan Equity Derivatives Strategy

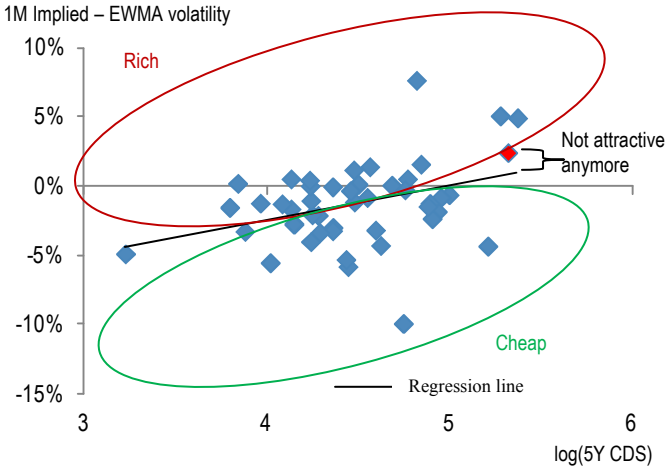
Figure 8 and Figure 9 below illustrate an example. On 10 May 2011, we apply **Step 1** outlined above on the Euro STOXX 50 members and calculate the difference between the 1M implied volatility and the EWMA realised vol (Figure 8). The data points circled in red have higher than average implied to EWMA vol spread, signalling rich implied vols, and the data points circled in green have lower than average spread, signalling cheap implied vols. By simply ranking the vol spread we would find the data point highlighted in red (Santander) as an attractive vol selling candidate, given its high implied to EWMA spread.

Figure 8: Sample rich and cheap vol classification without adjusting for CDS (data as of 10 May 2011)



Source: J.P. Morgan Equity Derivatives Strategy

Figure 9: Sample rich and cheap vol classification adjusting for CDS (data as of 10 May 2011)



Source: J.P. Morgan Equity Derivatives Strategy

However, we can also see that the name has one of the highest CDS levels in the universe, implying the market is pricing a relatively high risk premium in the name. This makes us wonder whether the implied-EWMA vol spread properly compensates us for the higher risk. To answer that question, we run a regression of the implied-EWMA vol spread against the log-CDS levels on that day across the universe. Figure 9 shows the new classification of rich and cheap names in the universe. The area circled in red contains the rich names with implied-EWMA vol spread higher than what is implied by their respective CDS levels. As we can see, the highlighted data point now has a much smaller deviation from the model relationship, and does not appear as a very attractive vol selling candidate anymore.

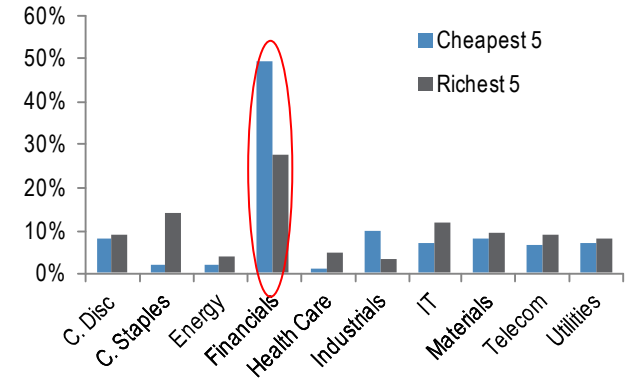
Step 3: Correct for the sector biases in the implied-realised vol spread

Another issue with the use of implied-EWMA vol spread is the strong sector bias. Figure 10 shows the sector weight in the 5 richest/cheapest names ranked by implied – EWMA vol spread, based on Euro STOXX 50 members over the last 5 years. The bias to go long financials vol is especially strong. The observation is due to the backward looking nature of the realised volatility (including EWMA). Often times as the volatility declines, the forward looking implied vol will fall rapidly, thus producing negative implied-EWMA vol spreads. The issue is heightened for financials given the abnormally high realised volatility we witnessed in the last few years.

Ideally, we would want similar weights of each sector in both the long and the short legs of a trade. To do so we make an adjustment to the regression we run in **Step 2**: the CDS-equity vol relationships are fitted separately for Financials, Telecoms/Utilities, and others. For Financials, the 'bail-out' regime we witnessed after Lehman Brothers' bankruptcy means governments are inclined to wipe out Financials equity holders but make senior credit holders whole in times of distress, thus distorting the credit-equity relationship. For Utilities and Telcos, given many of them have state ownerships, their credit-equity relationship is often confounded by the risks of their sovereigns. The companies in the remaining sectors are grouped together. Figure 11 shows the resulting sector distribution of the richest and cheapest names. The sector biases, especially in Financials, have been largely eliminated.

Figure 10: The implied-EWMA vol spread produces strong sector biases…

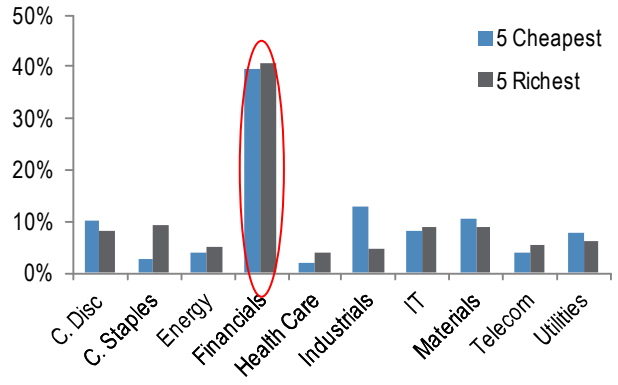
% weight in the 5 richest/cheapest names over the last 5Y



Source: J.P. Morgan Equity Derivatives Strategy

Figure 11: …whereas the Risk Premium Score achieves more balanced sector allocation

% weight in the 5 richest/cheapest names over the last 5Y



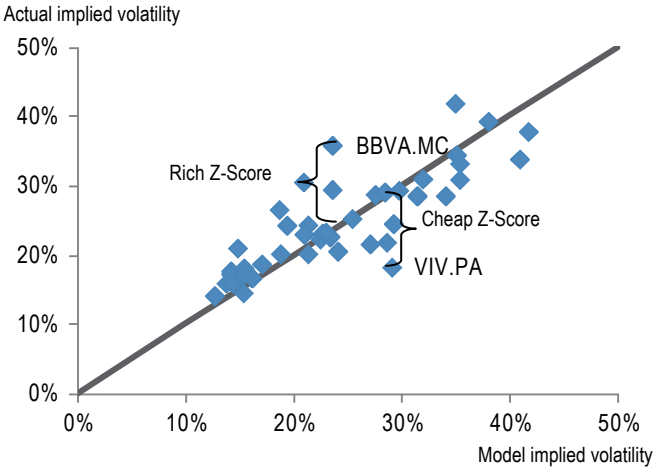
Source: J.P. Morgan Equity Derivatives Strategy

Equation [3] shows the functional form of the **Risk Premium Z-Score** arrived from **Steps 1 – 3**. To briefly summarise, on any given day for a universe of stocks, we first compute the spread between the implied and EWMA volatility, then run a regression (sector adjusted) against the companies' 5Y CDS. From the regression we obtain the model forecasted implied volatility, which we can compare with the actual implied volatility and determine the rich/cheapness of each name (Figure 12).

$$Implied\ Vol - EWMA\ Vol = \begin{bmatrix} \alpha_1^{Financials} \\ \alpha_1^{Tecos/Utils} \\ \alpha_1^{Others} \end{bmatrix} + \begin{bmatrix} \beta_1^{Financials} \\ \beta_1^{Telcos/Utils} \\ \beta_1^{Others} \end{bmatrix} \cdot log \begin{bmatrix} CDS_{Financials} \\ CDS_{Telcos/Utils} \\ CDS_{Others} \end{bmatrix} + \varepsilon$$

Risk premium [3]

Figure 12: Sample Risk Premium Z-Score (13-Mar-2012)



Source: J.P. Morgan Equity Derivatives Strategy

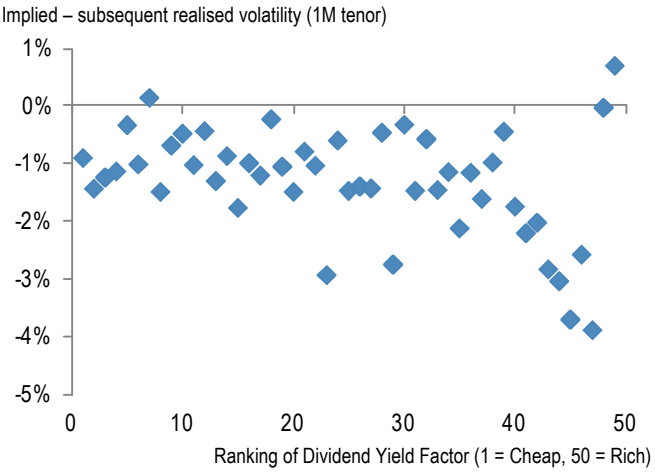
Step 4: Use independent, fundamental information (stock performance, beta) to provide cross validation

Although using the Risk Premium Z-Score can produce effective results for determining the rich/cheapness of single stock volatility, we believe independent, fundamental information can be helpful as a cross validation when combined with the Risk Premium Z-Score.

$$Implied\ Vol = \alpha_2 + \beta_2 \cdot 3M\ Return + \beta_3 \cdot Beta + \varepsilon \qquad \text{Fundamental [4]}$$

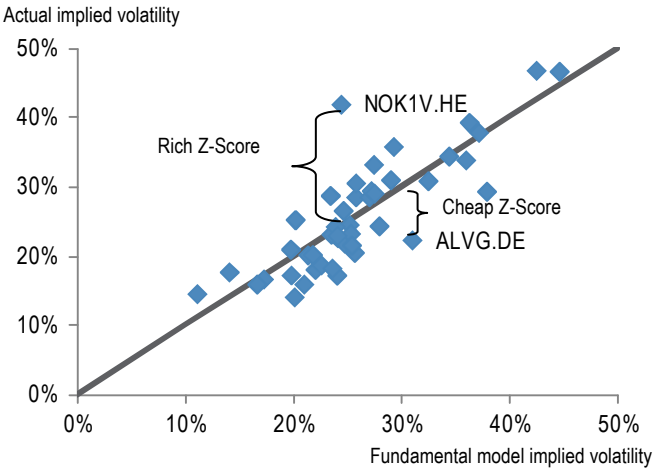
We inherited the stock return and beta from the old RV model. Names with high (low) beta should display high (low) volatility, and names with weak (strong) performance should produce high (low) volatility. On the other hand, we **eliminate dividend yield as a factor**. As recent experience suggests, a high historical dividend yield does not imply lower risk. This is also confirmed by our back test on the historical dividend yield factor (Figure 13). The model forecasted implied volatility is obtained from the cross-sectional regression [4]. We then compare the model implied volatility with the actual market value to determine the rich/cheapness of vol (Figure 14).

Figure 13: Historical 1Y dividend yield fails to distinguish rich and cheap implied volatility in our back test



Source: J.P. Morgan Equity Derivatives Strategy

Figure 14: Sample Fundamental Z-Score (13-Mar-2012)



Source: J.P. Morgan Equity Derivatives Strategy

To see how the Fundamental Z-Score can correct for the occasional pitfalls of the Risk Premium Z-Score, let's take Tesco as an example. On 12-Jan-2012 the company reported poor Christmas sales figures, which led to the stock collapsing 16% on the day. As a result the realised volatility (40%) remains elevated compared to implied (21%), close to three months after the event. If we rank Tesco simply by the implied-realised vol spread, it would rank as the second cheapest vol candidate out of 78 in our liquid European universe. However, the 10/30/50D realised volatility is around 17 - 18%, suggesting the carry for the 3M implied vol is actually expensive. Our Risk Premium score was able to correct the bias somewhat, but due to the magnitude of the discrepancy between 3M implied and realised, it still ranks sixth cheapest.

On the other hand, when ranking by Fundamental Z-Score, Tesco falls to 57 out of 78 in terms of cheapness. Therefore, our Fundamental model is able to discount the large discrepancy between implied and realised volatility using the information in the Fundamental model such as the company's low beta (0.54 vs. the FTSE index).

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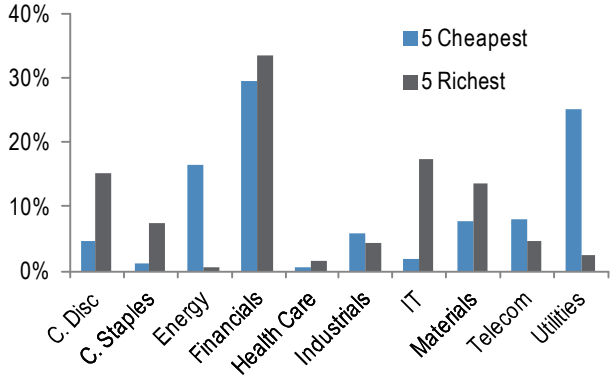
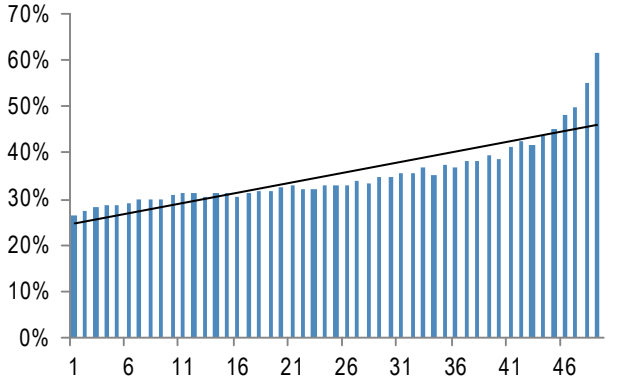
Figure 15: Fundamental Z-Score, while independent from Risk Premium Z-Score, shows strong sector biases…



Source: J.P. Morgan Equity Derivatives Strategy

Figure 16: …as well as the bias to go long low vol names and short high vol names

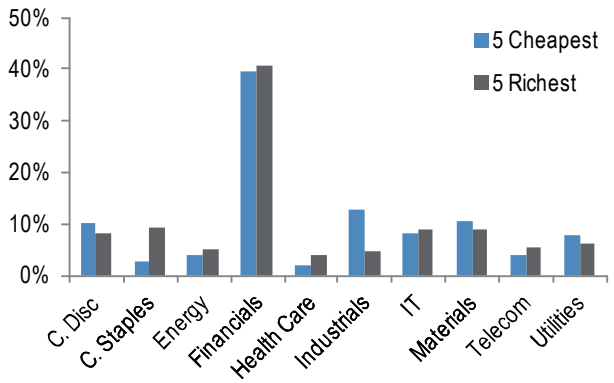


Source: J.P. Morgan Equity Derivatives Strategy

One caveat about the Fundamental Z-Score, however, is that the metric shows strong biases. In addition to **the tendency to go long utilities and energy vol, while shorting IT and consumer discretionary vol** (Figure 15), the Fundamental model also has an **inclination to go long low vol names and short high vol names** (Figure 16). We augment the Fundamental Z-Score to the Risk Premium Z-Score mainly as a cross-validation. As a comparison, the Risk Premium Z-Score does not show strong sector and volatility biases in its rich/cheap signals, as shown in Figure 17 and Figure 18.

Figure 17: In comparison the Risk Premium Z-Score does not show such sector bias…

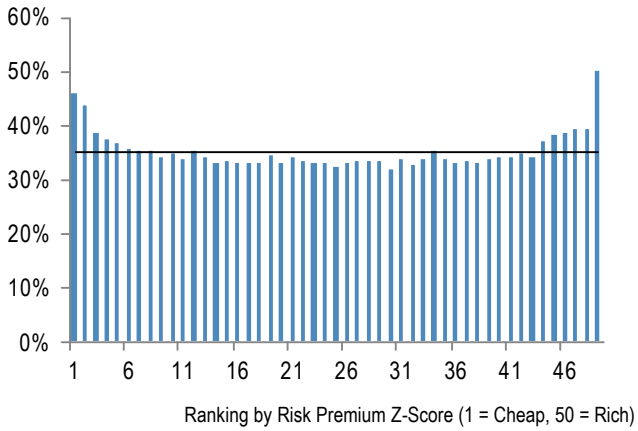
% weight in the 5 richest/cheapest names



Source: J.P. Morgan Equity Derivatives Strategy

Figure 18: …or the bias in terms of vol levels and direction

Average 1M implied volatility

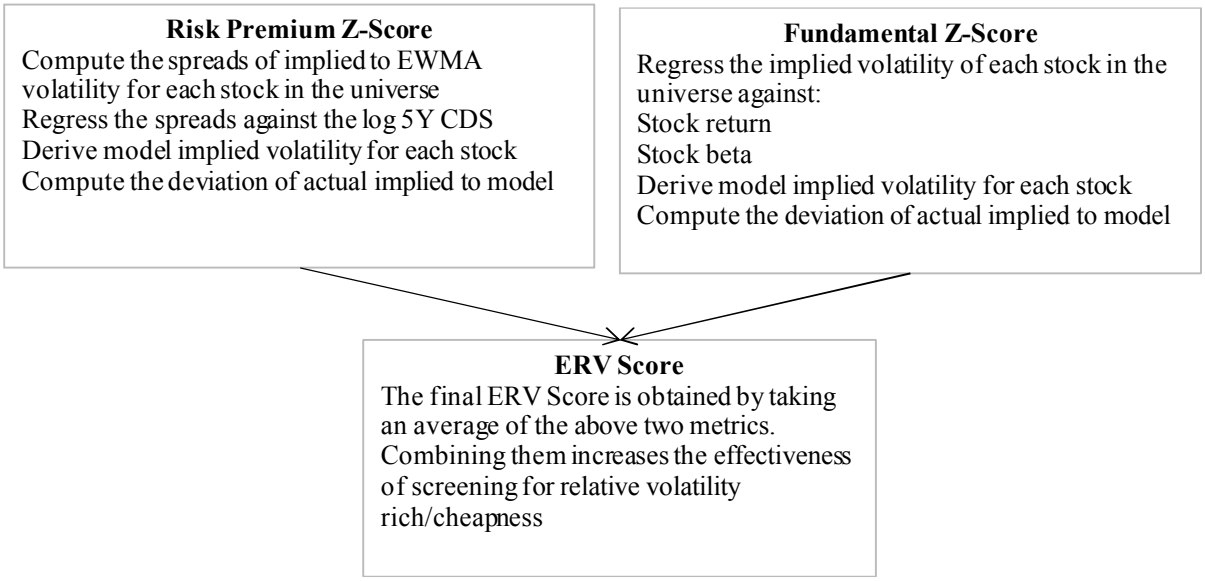


Source: J.P. Morgan Equity Derivatives Strategy

Step 5: Average the Risk Premium and Fundamental Z-Scores

The final ERV score is obtained by taking an average of the two metrics. Figure 19 summarises how the ERV score is calculated through a combination of the Risk Premium and Fundamental Z-Scores.

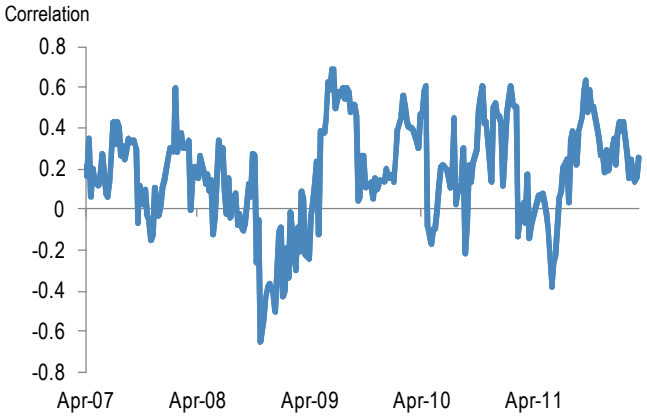
Figure 19: Schema of the ERV Score



Source: J.P. Morgan Equity Derivatives Strategy

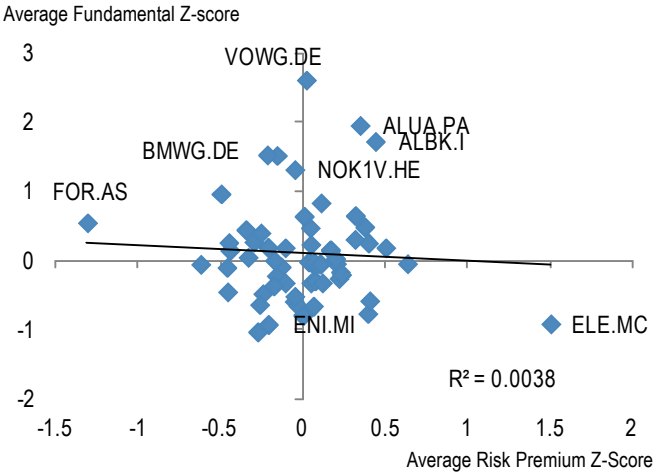
The result of combining the two models are additive, since both produce useful signals independently, while the two metrics are weakly correlated, with average correlation of 18% (Figure 20 and Figure 21). In the next section we show the detailed back test results, and that combining the two relationships produce better results than stand alone results.

Figure 20: Correlation of Risk Premium and Fundamental Z-scores (average 18%)



Source: J.P. Morgan Equity Derivatives Strategy

Figure 21: Relationship between Fundamental Z-Score and Risk Premium Z-Score is weak



Source: J.P. Morgan Equity Derivatives Strategy

Why cross sectional and not time series analysis?

Readers may wonder why we regress CDS and equity volatility premium on a cross-sectional sample, rather than over the companies' own time series. Although it may sound counterintuitive, the answer is that cross-sectional models are generally better at capturing long term relationships than time series models. For instance, from a cross-sectional sample on a given day, the 5Y CDS can range from 20 to 1,000, and the implied-EWMA vol spread between -10% to +10%, thereby giving us opportunities to observe the relationship between equity vol and CDS over a broad range of risk profiles. On the other hand, time series analysis on an individual company may only reveal such information, assuming the absence of structural breaks, with a very long observation window.

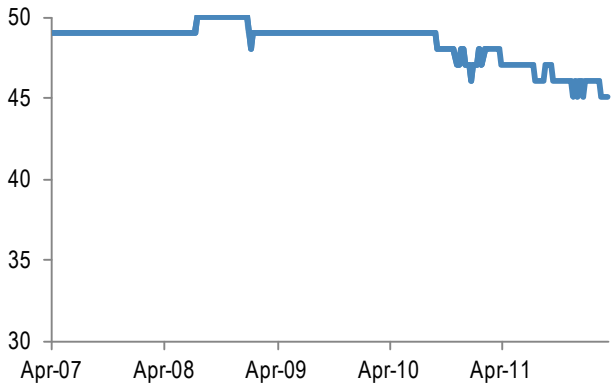
Back Tests

We demonstrate that the ERV score does a good job of distinguishing between rich and cheap volatility, over the challenging periods of the last five years. Both the Risk Premium Z-Score and the Fundamental Z-Score work well independently, but results are consistently better by combining them into the ERV score. Moreover, the ERV score outperforms the earlier RV score, validating the enhancements we have made to the model.

Data

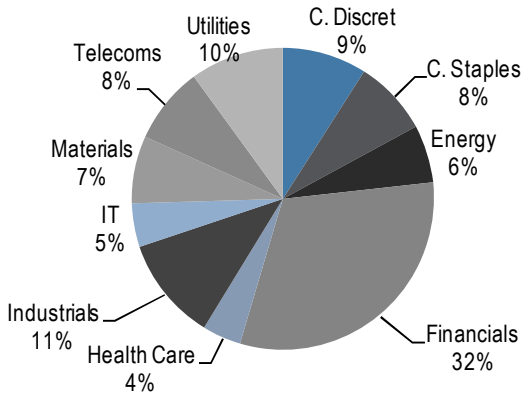
We take the 1M implied volatility, 5Y CDS, 3M stock returns, and 1Y beta (with respect to the Euro STOXX 50 index) of the Euro STOXX 50 members over the last five years (Apr 2007 – Mar 2012). Our sample is based on the historical composition and we aim to minimize survivorship bias. This means during the '08 period, names such as Fortis and Volkswagen, which could have material impact on the strategy's P&L, are included in the back test. Figure 22 shows the number of constituents available. Not all 50 members have all available data, but at any point in time we have at least 45 names in the sample. Figure 23 shows the sector composition. Financials make up the largest sector at 32% in the universe, whereas the other sectors are more evenly distributed at between 5 – 10% weights each.

Figure 22: Number of SX5E constituents with data available during our back test window



Source: J.P. Morgan Equity Derivatives Strategy

Figure 23: Historical average sector distribution of the Euro STOXX 50 index



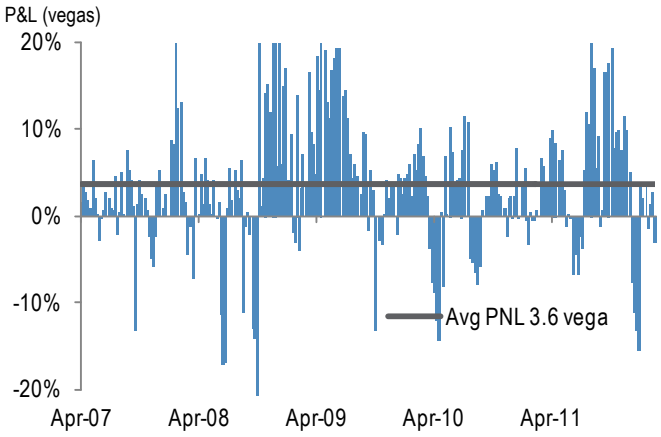
Source: J.P. Morgan Equity Derivatives Strategy

Methodology

- Every week we rank the Euro STOXX 50 members according to the ERV score and initiate short volatility positions on the 5 richest stocks, and long volatility positions on the 5 cheapest stocks.
- The positions are held until the 1-month expiry. In total we have 254 completed trades in the back test period.
- The profit and loss of each position is computed only at expiry, as the average difference between ATM[3] volatility and subsequent realized vol. We assume a bid-ask spread of 2.0 vol points on each name. Although the results are not directly tradeable we compute the risk and return statistics to give an idea of the performance of a pure volatility strategy based on our ERV model.
- By the convention of volatility swaps, we cap maximum gains/losses at 2.5 times the implied vol levels entered.

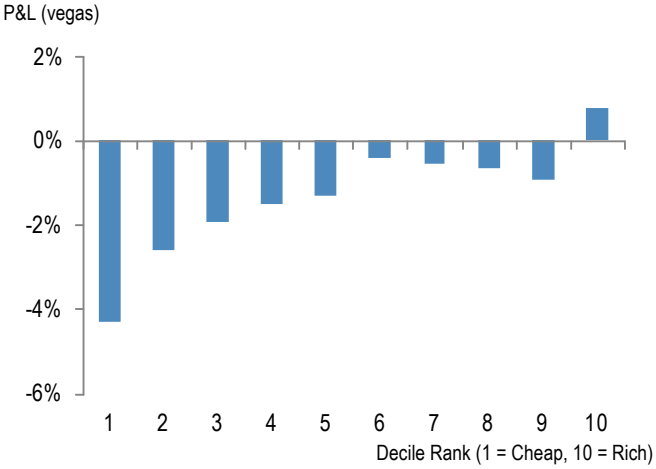
3 We also ran the back tests using ATM Forward volatility and the results are very close to using ATM volatility

Figure 24: P&L of going long/short five cheap/rich names with 1M maturity[4]



Source: J.P. Morgan Equity Derivatives Strategy

Figure 25: Average performance of short volatility strategy by ERV decile rank[4]



Source: J.P. Morgan Equity Derivatives Strategy

Table 1 summarizes the results of our back test. We choose the blanket long/short strategy as our benchmark: on everyday we go long/short all single stocks in the index. The long leg of our ERV strategy outperformed long all single stocks, the short leg outperformed short all single stocks, and the long short produced an information ratio of 1.5. The hit ratio of the long short strategy is 74%.

Table 1: ERV Score Results trading 1-Month Implied Volatility

	Long Cheap 5	Long All SS	Short Rich 5	Short All SS	ERV Long Short
Average	2.8%	0.0%	0.8%	-2.0%	3.6%
Median	0.0%	-2.3%	3.3%	0.3%	3.4%
Max	59.5%	60.7%	30.2%	17.7%	32.4%
Min	-11.6%	-19.7%	-104.2%	-60.8%	-47.6%
Standard Deviation	10.7%	10.5%	13.8%	10.3%	8.4%
Information Ratio	0.9	0.0	0.2	-0.7	1.5

Source: J.P. Morgan Equity Derivatives Strategy

To ensure the performance of the strategy does not depend on a specific time period, we divide the back test period into two windows: Apr-07 to Dec-09, which includes the '08/09 Financial Crisis, and Jan-10 to Mar-12, which includes the European Sovereign Crisis. As Table 2 and Table 3 demonstrate, the results are consistent with the overall performance shown in Table 1.

Table 2: ERV Score Results trading 1-Month Implied Volatility from Apr-07 to Dec-09

Apr-07 - Dec-09	Long Cheap 5	Long All SS	Short Rich 5	Short All SS	ERV Long Short
Average	3.3%	0.2%	0.9%	-2.1%	4.2%
Median	-0.5%	-2.6%	4.0%	0.6%	3.6%
Max	59.5%	60.7%	30.2%	17.7%	32.4%
Min	-11.4%	-19.7%	-104.2%	-60.8%	-47.6%
Standard Deviation	12.2%	12.2%	16.2%	11.9%	9.3%
Information Ratio	0.9	0.1	0.2	-0.6	1.5

Source: J.P. Morgan Equity Derivatives Strategy

[4] Note the results shown are hypothetical and not directly tradable

Table 3: ERV Score Results trading 1-Month Implied Volatility from Jan-10 to Mar-12

Jan-10 - Mar-12	Long Cheap 5	Long All SS	Short Rich 5	Short All SS	Long Short
Average	2.2%	-0.2%	0.8%	-1.7%	2.9%
Median	0.3%	-1.8%	2.7%	-0.2%	3.2%
Max	28.0%	28.6%	22.0%	11.2%	23.9%
Min	-11.6%	-13.2%	-37.2%	-29.6%	-15.4%
Standard Deviation	8.4%	8.0%	10.0%	7.9%	7.0%
Information Ratio	0.9	-0.1	0.3	-0.78	1.5

Source: J.P. Morgan Equity Derivatives Strategy

We decompose the model into its two components: the Risk Premium strategy and Fundamental strategy in Table 4. As discussed previously, the two models independently produce profits. Moreover, due to the low correlation between the two Z-Scores, the combined ERV score yields better results than each stand alone metric.

We can also see in Table 4 that: 1) the long-short strategy based on implied-EWMA vol spread does better than the traditional implied-realised vol spread; and 2) the Risk Premium Z-Score in turn improves upon the implied-EWMA vol spread strategy in terms of risk-adjusted P&L (information ratio).

Table 4: Long-Short volatility strategy results of the various models: ERV outperforms the old RV model, and improves on both Risk Premium and Fundamental scores

	ERV	Old RV	Risk Premium	Fundamental	Imp-EWMA	Imp-Real
Average	3.6%	3.1%	2.7%	1.5%	2.9%	2.4%
Median	3.4%	2.8%	2.7%	2.4%	2.2%	1.7%
Max	32.4%	29.8%	40.6%	24.9%	34.6%	55.3%
Min	-47.6%	-45.4%	-39.8%	-71.3%	-39.8%	-16.1%
Standard Deviation	8.4%	8.6%	7.7%	9.8%	8.8%	9.5%
Information Ratio	1.5	1.3	1.2	0.5	1.1	0.9

Source: J.P. Morgan Equity Derivatives Strategy

Table 5 and Table 6 below show more detailed performance for the Risk Premium and Fundamental Z-Score individually. We can see that on both the long and short legs the strategies outperformed the benchmarks.

Risk Premium Z-Score Back Test

Table 5: Comparing the performance of trading rich/cheap names ranked by the Risk Premium Z-Score

Volatility Spread	Long Cheap 5	Long All SS	Short Rich 5	Short All SS	Risk Premium Z-Score Long Short
Average	1.9%	0.0%	0.8%	-2.0%	2.7%
Median	-0.9%	-2.3%	2.7%	0.3%	2.7%
Max	74.0%	60.7%	22.5%	17.7%	40.6%
Min	-15.3%	-19.7%	-95.4%	-60.8%	-39.8%
Standard Deviation	12.0%	10.5%	12.8%	10.3%	7.7%
Information Ratio	0.6	0.0	0.2	-0.7	1.2

Source: J.P. Morgan Equity Derivatives Strategy

Fundamental Z-Score Back Test

Table 6: Comparing the performance of trading rich/cheap names ranked by the new Fundamental Z-Score

	Long Cheap 5	Long All SS	Short Rich 5	Short All SS	Fundamental Z-Score Long Short
Average	1.6%	0.0%	-0.1%	-2.0%	1.5%
Median	-0.9%	-2.3%	2.3%	0.3%	2.4%
Max	63.3%	60.7%	34.2%	17.7%	24.9%
Min	-14.4%	-19.7%	-126.7%	-60.8%	-71.3%
Standard Deviation	10.5%	10.5%	16.2%	10.3%	9.8%
Information Ratio	0.5	0.0	-0.0	-0.7	0.5

Source: J.P. Morgan Equity Derivatives Strategy

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Term structure considerations

In our back tests above we have chosen a 1-month maturity. Although on an absolute basis the RV score performs better for shorter tenors, it produces superior performance compared to the benchmarks for maturities of 2 and 3 months. Moreover, the RV ranking based on 1 month volatility is robust over a range of tenors. When we apply the 1M ranking to trade implied volatility of up to 3 months, the performance is similar to using the rankings based on the implied volatility of their respective maturity (see Table 7 and Table 8).

Table 7: P&L of trading 2M Implied Vol using 1M ERV Ranking

Volatility Spread	Long Cheap 5	Long All SS	Short Rich 5	Short All SS	ERV Long Short
Average	3.5%	0.8%	-0.7%	-2.7%	2.7%
Median	-0.3%	-2.5%	2.4%	0.5%	2.5%
Max	57.6%	52.2%	22.0%	13.6%	27.1%
Min	-12.9%	-15.6%	-89.3%	-53.0%	-37.4%
Standard Deviation	11.7%	11.6%	14.3%	11.3%	7.0%
Information Ratio	0.7	0.2	-0.1	-0.6	1.0

Source: J.P. Morgan Equity Derivatives Strategy

Table 8: P&L of trading 3M Implied Vol P&L using 1M ERV Ranking

Volatility Spread	Long Cheap 5	Long All SS	Short Rich 5	Short All SS	ERV Long Short
Average	3.8%	1.6%	-2.2%	-3.5%	1.6%
Median	0.0%	-2.3%	2.3%	0.3%	1.6%
Max	50.9%	48.0%	22.6%	14.3%	23.7%
Min	-12.6%	-16.3%	-78.9%	-48.1%	-33.5%
Standard Deviation	12.3%	12.4%	15.1%	12.0%	6.5%
Information Ratio	0.6	0.3	-0.3	-0.6	0.5

Source: J.P. Morgan Equity Derivatives Strategy

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ERV Screen on Morgan Markets

The ERV Screen is available on MorganMarkets in a spreadsheet format. The screen can be downloaded from the link below:

European Single Stock Volatility Relative Value

Figure 26 and Figure 27 show snapshots of the 10 richest and cheapest names based on the combined ERV ranking for 30 Mar 2012.

Figure 26: 10 names with cheapest vol in the ERV screen (data as of 30 Mar 2012)

Ticker	Name	Sector	Risk Premium Z-Score	Risk Premium Rank	Fundamental Z-Score	Fundamental Rank	Combined Rank	Trading Signal
EOAN GY	E.ON AG	Utilities	-1.53	5	-1.21	5	1	Cheap
RWE GY	RWE AG	Utilities	-1.17	8	-1.10	8	2	Cheap
ENEL IM	Enel SpA	Utilities	-1.66	4	-0.64	21	3	Cheap
ALV GY	Allianz SE	Financials	-0.43	20	-1.01	9	4	Cheap
CS FP	AXA SA	Financials	-0.59	16	-0.84	15	5	Cheap
NOVN VX	Novartis AG	Health Care	-0.23	31	-1.83	2	6	Cheap
BT/A LN	BT Group PLC	Telecommunication Services	-0.43	22	-0.86	14	7	Cheap
VIV FP	Vivendi SA	Consumer Discretionary	-2.67	2	-0.34	34	8	Cheap
ABBN VX	ABB Ltd	Industrials	-0.08	35	-1.71	3	9	Cheap
PRU LN	Prudential PLC	Financials	-0.27	29	-1.00	10	10	Cheap

Source: J.P. Morgan Equity Derivatives Strategy

Figure 27: 10 names with richest vol in the ERV screen (data as of 30 Mar 2012)

Ticker	Name	Sector	Risk Premium Z-Score	Risk Premium Rank	Fundamental Z-Score	Fundamental Rank	Combined Rank	Trading Signal
BN FP	Danone	Consumer Staples	0.63	65	0.52	54	69	Rich
NG/ LN	National Grid PLC	Utilities	1.15	73	0.41	52	70	Rich
ISP IM	Intesa Sanpaolo SpA	Financials	0.46	56	1.24	70	71	Rich
OGZD LI	Gazprom OAO	Energy	0.46	57	1.38	73	72	Rich
IBE SQ	Iberdrola SA	Utilities	1.62	75	0.55	55	73	Rich
IMT LN	Imperial Tobacco Group PLC	Consumer Staples	0.96	71	0.97	66	74	Rich
LKOD LI	Lukoil OAO	Energy	0.61	64	1.46	75	75	Rich
SAN SQ	Banco Santander SA	Financials	2.44	77	1.36	72	76	Rich
BBVA SQ	Banco Bilbao Vizcaya Argentari	Financials	2.74	78	1.48	76	77	Rich
NOK1V FH	Nokia OYJ	Information Technology	2.34	76	4.50	78	78	Rich

Source: J.P. Morgan Equity Derivatives Strategy

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"Other Disclosures" last revised January 6, 2012.

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Relative Value Score for Single Stock Volatility

A quantitative framework for identifying volatility pair trading opportunities for the Asia Pacific region

- The *RV Score* is a quantitative framework for screening relative value opportunities in single stock volatility based on a combination of fundamental and technical factors. It was originally developed by our EMEA Equity Derivatives & Delta One Strategy team in 2007 and has shown promising backtest results for the European market.
- In this report, we enhance the original model by introducing additional factors and test it in major Asian markets. Furthermore, we extend the application of the model into single stock versus index volatility trading. The backtest is performed separately in Australia, Japan and Hong Kong based on the stock universe with reasonable options liquidity.
- The backtest shows that our *RV Score* is an effective framework for ranking single stock volatility in Australia, Japan and Hong Kong. Applications of the *RV Score* could include trading long/short baskets of single stock volatility and more generally screening a universe of single stock volatilities for relative value opportunities, perhaps for volatility pair trades. In addition, the methodology naturally lends itself to constructing baskets for enhanced dispersion trades (or single stock versus index volatility trade) with a basket of cheap volatility stocks based on the *RV Score* ranking.
- Our *RV Score* suggests the following current opportunities:
  - In Japan, **Central Japan Railroad** (9022 JT) and **Nomura Holdings** (8604 JT) implied volatilities appear to be cheap while **West Japan Railway** (9021 JT) implied volatility looks particularly expensive. **Mitsui** (8031 JT) and **Komatsu** (6301 JT) are potential candidates for the single stock versus index volatility trade.
  - In Australia, **Foster's** (FGL AU), **Oil Search** (OSH AU) and **National Australia Bank** (NAB AU) implied volatilities appear to be relatively cheap while **Telstra** (TSL AU) and **Brambles** (BXB AU) implied volatilities look relatively expensive (note that Foster's is going through corporate restructuring now, which will bring noises on the stock's price movement and volatility). **Oil Search** is also a potential candidate for the single stock versus index volatility trade.
  - In Hong Kong, **Cheung Kong** (1 HK) and **Hang Seng** (11 HK) implied volatilities appear to be relatively cheap and **China Unicom** (762 HK) and **China Petroleum** (386 HK) implied volatilities look relatively expensive while their *RV Scores* are not extremely negative or positive. Both **Cheung Kong** and **Hang Seng** are also potential candidates for the single stock versus index volatility trade.

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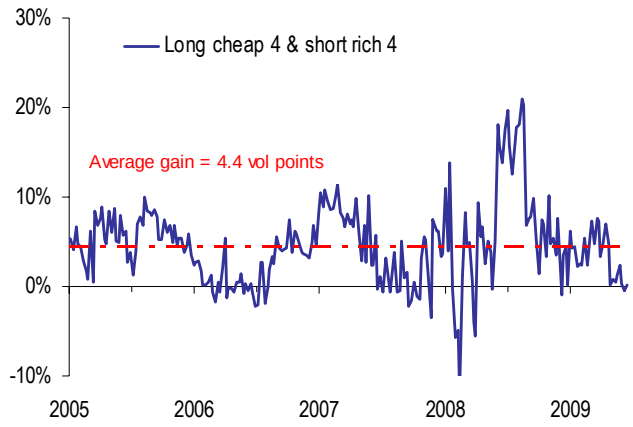
Relative Value Opportunities with Single Stock Volatility

The price of volatility is determined by two factors – 1) the expectation of future realized volatility; and 2) the supply and demand from various market participants – which are usually the result of directional and hedging flows, the issuance of retail structured products, and the over-reaction of market participants to short-term moves. While the price of volatility as an asset should reflect the market's expectation for future realized volatility, supply and demand are important factors that drive the price of volatility away from its theoretical value, creating relative value trading opportunities for volatility arbitrageurs.

The *Relative Value* (*RV) Score* is a quantitative framework for screening relative value opportunities in single stock volatility based on a combination of fundamental and technical factors. It was originally developed by our EMEA Equity Derivatives & Delta One Strategy team in 2007 and has shown promising backtest results for the European market.[1]

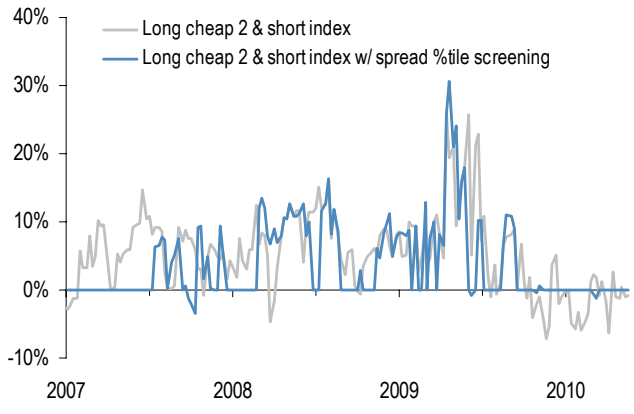
In this report, we enhance the original model by introducing additional factors and test it in major Asian markets. Furthermore, we extend the application of the model into single stock versus index volatility trading. The backtest is performed separately in Australia, Japan and Hong Kong based on the stock universe with reasonable options liquidity and shows meaningful results overall.

Figure 1: Performance of the long/short singe stock volatility strategy based on RV Score in Japan
Volatility P/L



Source: J.P. Morgan.

Figure 2: Performance of the long single stock & short index volatility strategy based on RV Score in Hong Kong
Volatility P/L



Source: J.P. Morgan.

[1] See "*Relative Value Single Stock Volatility: Screening stocks for rich and cheap volatility*", Adam Rudd, published on Oct 1, 2007.

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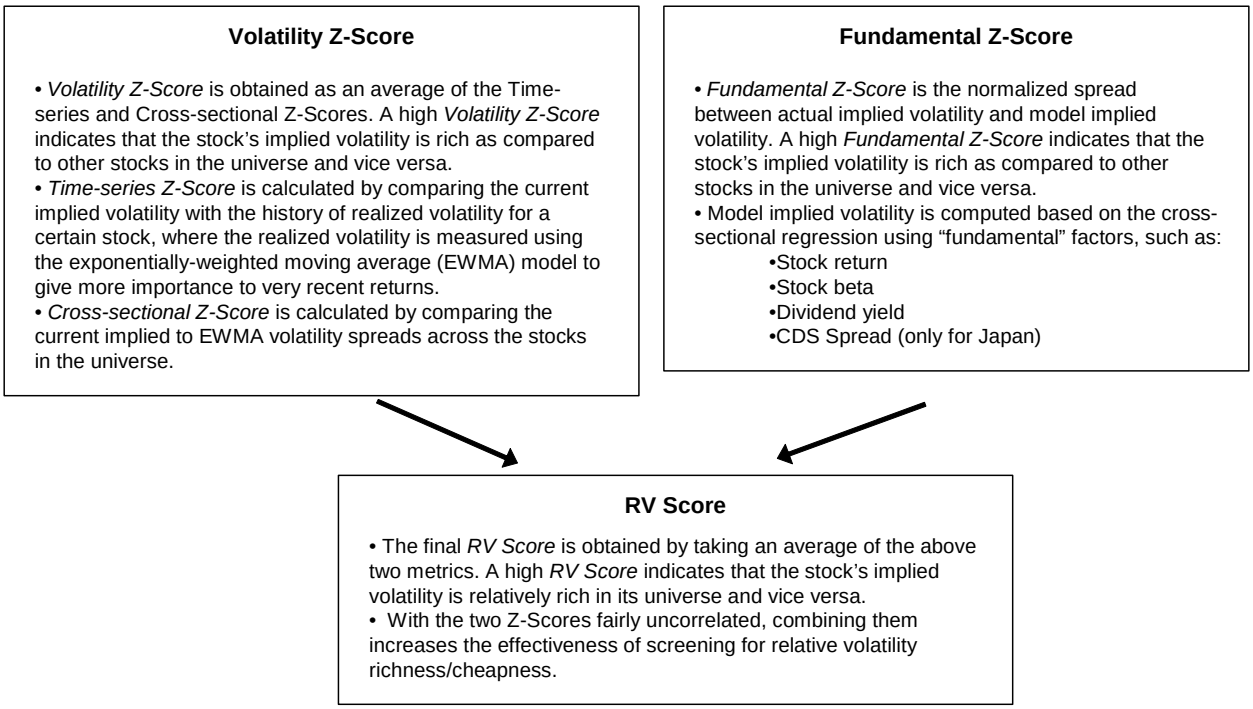
The *RV Score* is derived from two simpler metrics: *Volatility Z-Score* and *Fundamental Z-Score*. *Volatility Z-Score* determines a stock's relative volatility richness/cheapness as compared to the stock's historical realized levels (time-series component) as well as compared to the implied to realized spreads of other stocks in the same universe (cross-sectional component). On the other hand, *Fundamental Z-Score* considers stock fundamental factors (such as stock beta, stock return, dividend yield and CDS spread) that can help to explain future realized volatility to determine a stock's relative volatility richness/cheapness.

The final *RV Score* is obtained by taking an average of those two metrics - see Figure 3 for the quick summary of the *RV Score* scheme. A high *RV Score* indicates that the stock's implied volatility is relatively rich in its universe and vice versa.

The volatility ranking suggested by the *RV Score* can be used for long/short single stock volatility strategies, such as buying volatility on the stocks with low scores and selling volatility on the stocks with high scores. These volatility long/short strategies turned out to work generally well in Japan and Australia, but to a lesser extent in Hong Kong. The *RV Score* can be also used for single stock versus index volatility trading, i.e. buying volatility on stocks with low scores and pairing them with short index volatility, which not only captures the relative cheapness in single stock volatility but also takes advantage of the rich premium inherent in index implied volatility.

In the following sections, we will discuss the *RV Score* and its backtesting results in detail. We will also recommend trading strategies on the single stocks that currently look attractive based on our *RV Score*.

Figure 3: Schema of RV Score



Source: J.P. Morgan.

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Volatility Z-Score

Volatility Z-Score aims to assess a stock's relative volatility richness/cheapness based on the stock's implied to realized spread from a historical perspective versus its own time series as well as from a cross sectional perspective versus other stocks in the universe.

Realized volatility is usually the first thing we look at to gauge the future realized volatility. Generally, based on our findings, 30-trading day realized volatility does the best job of forecasting future 6-month realized volatility among fixed-maturity realized volatilities. When we delve into the data, however, we find that during high volatility regimes, very short-dated volatility fares best, even as short as 10 days. Conversely, during low volatility regimes, longer-dated volatility, even up to 5-months, tends to be a better estimator.

This suggests that when volatility is high, it is the very recent events which are most important, but when volatility is lower, taking more data into account can add value. To achieve both of these aims simultaneously, we use the **exponentially weighted moving average (EWMA)** model. This is a single-parameter model which acts somewhat like traditional realized volatility but gives relatively more importance to very recent returns without chopping off its information window after the data points drop off from the rolling observation period. It can be thought of as weighting the (log-squared) returns with an exponential decay function:

$$\sigma_t^2 = \lambda \sigma_{t-1}^2 + (1-\lambda) r_{t,annual}^2$$

where λ is a decay factor, ranging between 0 and 1. With a smaller decay factor, the EWMA realized volatility will give larger weights on the recent returns and vice versa.

Then we come to this question: what will be the optimal decay factor to predict the future realized volatility? The optimal decay factor could vary across markets with different volatility regimes. The backtest (based on the data since 2005) shows that a decay factor of 0.94 works well across different markets overall while optimal decay factors were generally higher for Australian stocks with an average of 0.95 but lower for Japanese stocks with an average of 0.93.

Table 1: Optimal decay factors for different periods and markets

	Australia	Hong Kong	Japan	Average
Optimal decay factor	0.95	0.94	0.93	0.94

Source: J.P. Morgan, based on data since 2005.

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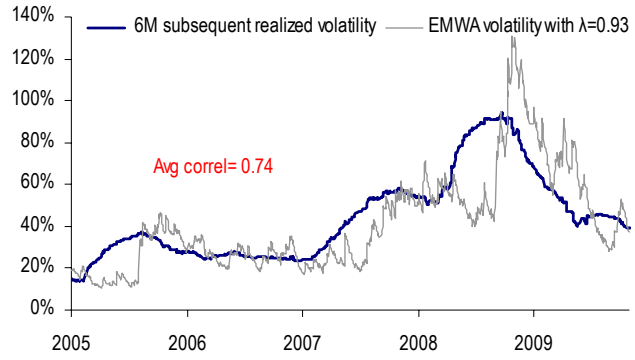
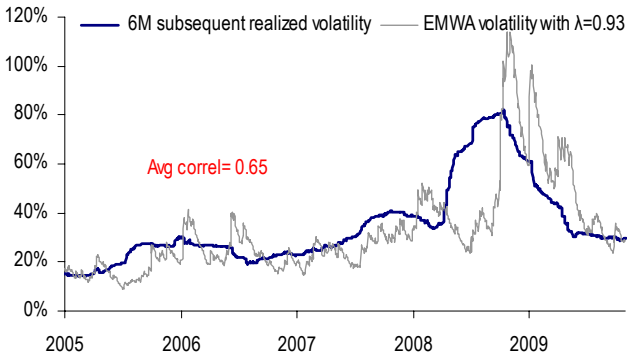
Figure 4: SMFG (8316 JP) EMWA vol vs 6M subsequent realized vol



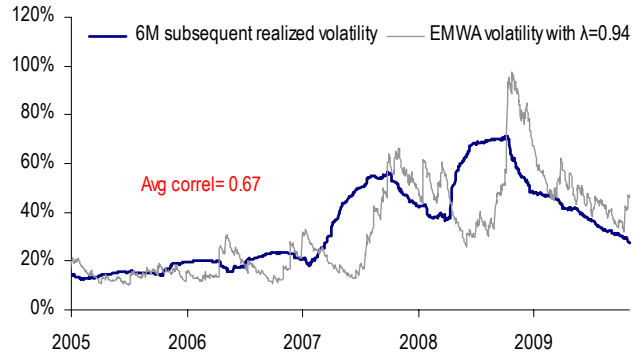
Source: J.P. Morgan.

Figure 5: Sharp (6753 JP) EMWA vol vs 6M subsequent realized vol



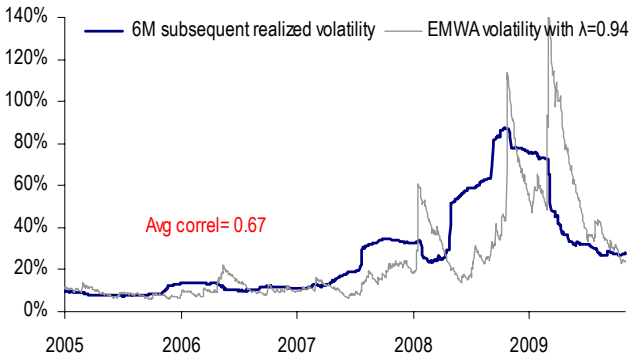
Source: J.P. Morgan.

Figure 6: SHK (16 HK) EMWA vol vs 6M subsequent realized vol



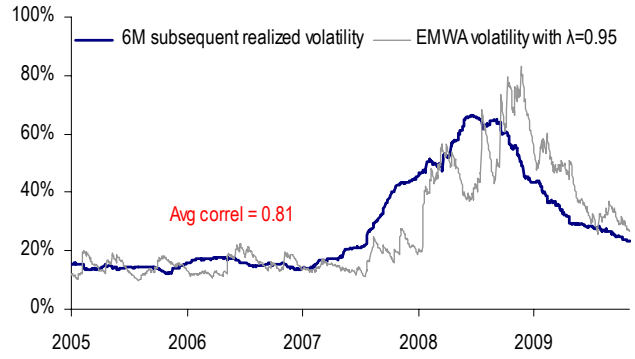
Source: J.P. Morgan.

Figure 7: HSBC (5 HK) EMWA vol vs 6M subsequent realized vol



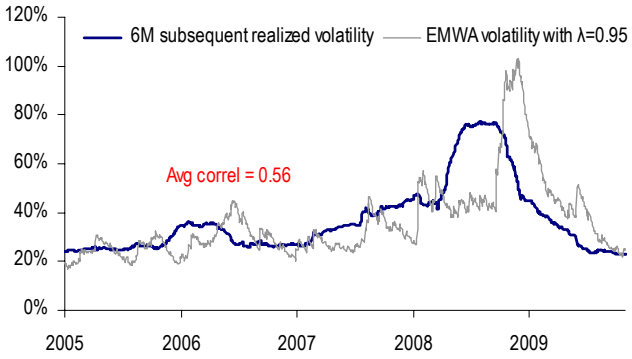
Source: J.P. Morgan.

Figure 8: ANZ (ANZ AU) EMWA vol vs 6M trailing realized vol



Source: J.P. Morgan.

Figure 9: BHP Billiton(BHP AU) EMWA vol vs 6M trailing realized vol



Source: J.P. Morgan.

Using the optimal decay factors outlined above for each market, we calculate the EWMA volatility for predicting the future 6M realized volatility and compare it with the current 6M implied volatility. Then we calculate two components of *Volatility Z-Scores*, one from a time-series perspective and the other from a cross-sectional perspective.

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The *Time-series Z-Score* is calculated by comparing the current implied volatility with the history of the EWMA realized volatility over the past two years, to determine a stock's relative volatility richness/cheapness. On the other hand, the *Cross-sectional Z-Score* is calculated by comparing the implied to EWMA volatility spreads across the stocks in the universe, to determine a stock's relative volatility richness/cheapness.

The final *Volatility Z-Score* is obtained as an average of the *Time-series* and *Cross-sectional Z-Scores*. A high *Volatility Z-Score* indicates that the stock's implied volatility is rich as compared to other stocks in the universe and vice versa.

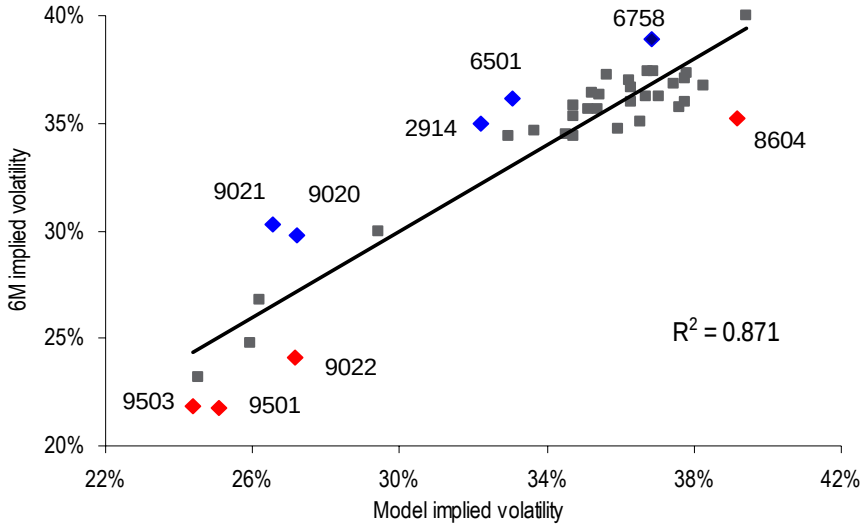
Fundamental Z-Score

In addition to realized volatility, we can also look at fundamental factors to forecast future realized volatility. The *Fundamental Z-Score* is the normalized spread between actual implied volatility and model implied volatility. The model implied volatility is computed based on the cross-sectional regression using "fundamental" factors, such as:

- **stock return**
- **stock beta**
- **dividend yield**
- **CDS spread** (for Japan only)

This Z-Score represents the relative volatility richness/cheapness across the stocks in the universe based on these factors, independent of the overall richness/cheapness of market volatility at the time. A high *Fundamental Z-Score* indicates that the stock's implied volatility is rich as compared to other stocks in the universe and vice versa.

Figure 10: Calculating Fundamental Z-Scores: Actual implied volatility versus versus. model implied volatility based on fundamental factors. Stocks above the line have rich volatility according to the model, below the line cheap volatility, on a relative basis.



Source: J.P. Morgan, based on the Japan stock universe with data as of 28-May-2010

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RV Score – a Combination of Volatility and Fundamental Z-Scores

We have defined two z-scores:

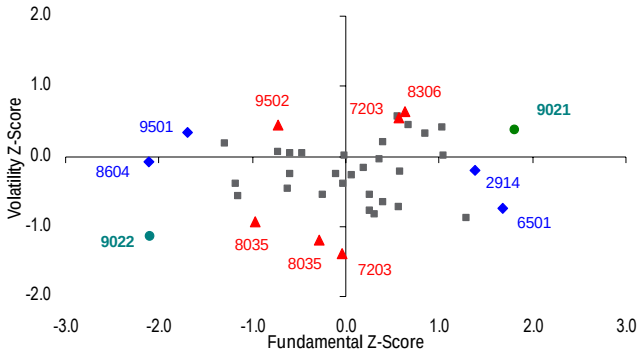
1. *Volatility Z-Score* based on the stock's implied to EMWA realized volatility spread from a historical perspective versus its own time series as well as cross sectional perspective versus other stocks in the universe.

2. *Fundamental Z-Score* based on the cross-sectional regression analysis using stock return, beta, dividend yield and CDS spread.

These two Z-Scores are individually successful in determining a stock's volatility relative richness/cheapness but tend to be fairly uncorrelated as illustrated in Figures 11 and 12. Therefore by combining them, we can produce an even more efficient indicator for rich/cheap volatility.

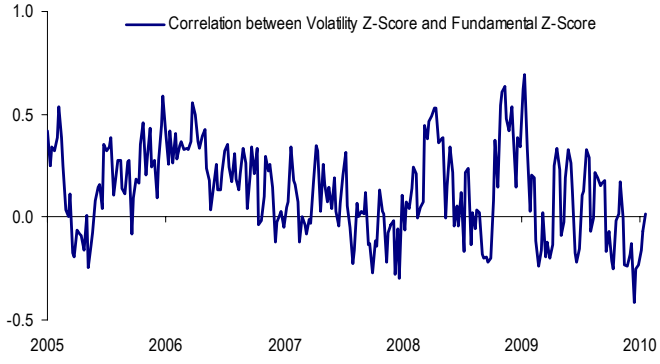
The overall combined score, which we call the *RV Score*, is arrived at by taking an average of the *Volatility Z-Score* and *Fundamental Z-Score*. Across the stocks in the universe, high (positive) *RV Scores* indicate relatively rich volatility and low (negative) *RV Scores* indicate relatively cheap volatility. Thus a stock with an *RV Score* of greater than +1.0 would be considered as having relatively rich volatility, whereas an *RV Score* of smaller than -1.0 would indicate cheap volatility.

Figure11: Comparison of *Volatility Z-score* and *Fundamental Z-Score*: Blue points are stocks with extreme fundamental z-scores, red points are stocks with extreme volatility z-scores and green points are stocks where both fundamental and volatility z-scores give the same strong signals.



Source: J.P. Morgan, based on the Japan stock universe with data as of 28-May-2010

Figure 12: *Volatility Z-Score* and *Fundamental Z-Score* are fairly uncorrelated and therefore a combination of those two scores produces an even more efficient indicator for rich/cheap volatility



Source: J.P. Morgan, based on backtesting with the Japan stock universe.

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Backtesting

We backtest the *RV Score* in three markets in the Asia Pacific region - including Australia, Japan and Hong Kong – where we can obtain a sufficiently large pool of single stocks with reasonably liquid options markets. Each market is its own universe, consisting of the current large-cap stocks - 40 stocks in Japan, 29 stocks in Australia and 22 stocks in Hong Kong. The backtesting is performed on the period since 2005 or when the data is available. The backtesting methodology is as follows:

- On any day, we rank all stock volatilities according to our *RV Score* and sell volatility on the top 10 %-tile stocks (4 for Japan, 3 for Australia and 2 for Hong Kong) with the highest *RV Scores* while buying volatility on the bottom 10 %-tile stocks with the lowest *RV Scores*.
- Trades are initiated once a week and held until the 6-month expiry. Hence, we have a total of 264 trades for the given the backtesting period.
- The profit and loss of each trade is computed only once at expiry and estimated by calculating the implied to subsequent realized volatility spreads with a bid/offer spread of 3.0 vol points applied. For example, the volatility gain/loss for the long single stock volatility leg is calculated as (subsequent 6M realized volatility – 6M implied volatility at trade initiation – 1.5 vol points).

Tables 2 - 4 summarize the results of our backtest for the three markets. Column 1 shows results for the long only strategy, i.e. choosing the bottom 10%-tile volatility stocks according to our *RV Score*, while column 2 shows the results for the short only strategy with the top 10%-tile volatility stocks. Columns 3 and 4 show the results of being systematically long or short volatilities on all stocks in the universe, for comparison. The final column shows results for being long/short volatilities of the top & bottom 10%-tile stocks based on our *RV Score*. Considering that the equity market experienced unusual, extreme moves driven by macro factors during the financial crisis in late 2008, we show two sets of the performance statistics - one for the entire period since 2005 and the other excluding the financial crisis period.

Table 2: RV Score results in Japan

	Long cheap 4	Short rich 4	Long All SS	Short All SS	Long 4 & short 4
Avg Return	6.2%	-1.8%	2.3%	-5.2%	4.4%
Median	4.3%	-0.8%	0.6%	-3.3%	3.6%
Max	45.2%	25.5%	36.1%	15.7%	30.2%
Min	-14.7%	-45.5%	-18.7%	-39.1%	-4.5%
Stdev	12.6%	13.3%	12.3%	12.0%	4.8%
I.R.	0.49	-	0.19	-	0.90

based on the data since 2005

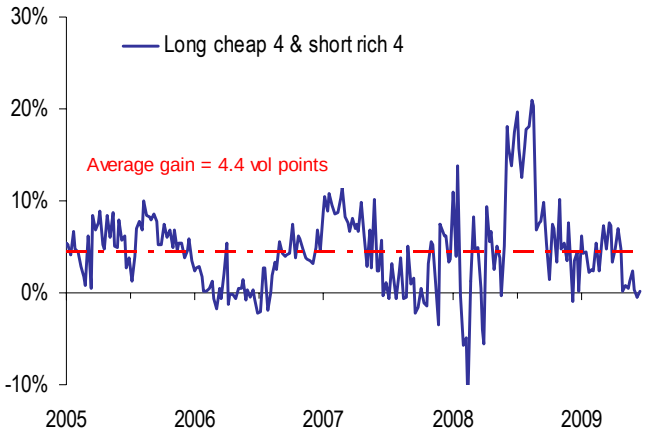
	Long cheap 4	Short rich 4	Long All SS	Short All SS	Long 4 & short 4
Avg Return	2.8%	1.7%	-1.0%	-2.0%	3.8%
Median	2.8%	0.0%	-0.2%	-3.0%	3.1%
Max	23.3%	25.5%	13.0%	15.7%	20.0%
Min	-14.7%	-13.6%	-18.7%	-16.0%	-3.3%
Stdev	8.3%	8.6%	7.7%	7.6%	4.2%
I.R.	0.34	0.20	-	-	0.91

based on the data since 2005, excluding the financial crisis period from Oct-08 to Apr-09

Source: J.P. Morgan

Figure 13: Performance of the long/short singe stock volatility based on RV Score in Japan

Volatility P/L



Source: J.P. Morgan.

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Table 3: RV Score results in Australia

	Long cheap 3	Short rich 3	Long All SS	Short All SS	Long 3 & short 3
Avg Return	4.5%	-1.5%	1.5%	-4.5%	3.0%
Median	3.0%	-0.5%	0.5%	-3.5%	2.9%
Max	37.7%	19.4%	24.9%	12.5%	18.6%
Min	-16.4%	-30.9%	-15.5%	-27.9%	-11.5%
Stdev	11.3%	11.1%	9.6%	9.6%	4.4%
I.R.	0.40	-	0.16	-	0.68

based on the data since 2005

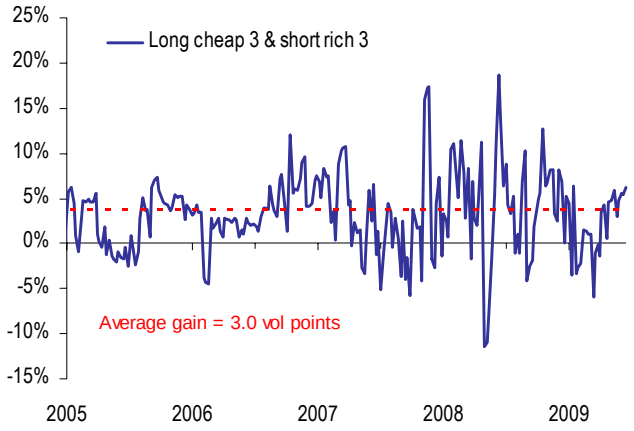
	Long cheap 3	Short rich 3	Long All SS	Short All SS	Long 3 & short 3
Avg Return	1.5%	1.3%	-0.8%	-2.2%	2.9%
Median	2.0%	0.6%	0.2%	-3.2%	2.8%
Max	22.5%	19.4%	14.6%	12.5%	18.6%
Min	-16.4%	-17.2%	-15.5%	-17.6%	-5.9%
Stdev	7.5%	7.8%	7.1%	7.1%	3.9%
I.R.	0.20	0.17	-	-	0.74

based on the data since 2005, excluding the financial crisis period from Oct-08 to Apr-09

Source: J.P. Morgan

Figure 14: Performance of the long/short singe stock volatility based on RV Score in Australia

Volatility P/L



Source: J.P. Morgan.

Table 4: RV Score results in Hong Kong

	Long cheap 2	Short rich 2	Long All SS	Short All SS	Long 2 & short 2
Avg Return	7.9%	-5.4%	4.2%	-7.2%	2.5%
Median	6.7%	-1.3%	1.7%	-4.7%	2.8%
Max	44.5%	23.3%	39.6%	15.0%	31.1%
Min	-15.8%	-54.5%	-18.0%	-42.6%	-29.3%
Stdev	13.7%	16.9%	14.0%	14.0%	9.0%
I.R.	0.58	-	0.30	-	0.28

based on the data since 2005

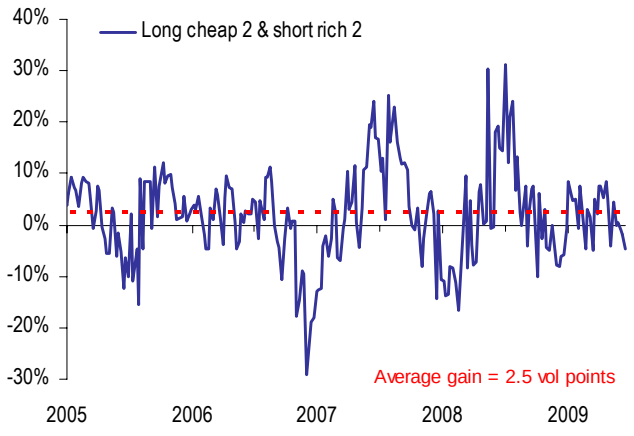
	Long cheap 2	Short rich 2	Long All SS	Short All SS	Long 2 & short 2
Avg Return	4.5%	-1.4%	0.8%	-3.8%	3.1%
Median	5.1%	-0.1%	1.1%	-4.1%	3.1%
Max	27.4%	23.3%	28.7%	15.0%	31.1%
Min	-15.8%	-37.2%	-18.0%	-31.7%	-29.3%
Stdev	9.9%	12.2%	10.0%	10.0%	8.7%
I.R.	0.45	-	0.08	-	0.36

based on the data since 2005, excluding the financial crisis period from Oct-08 to Apr-09

Source: J.P. Morgan

Figure 15: Performance of the long/short singe stock volatility based on RV Score in Hong Kong

Volatility P/L



Source: J.P. Morgan.

- **The average post bid/offer returns from being long volatilities of the bottom 10%-tile stocks (column 1) are significantly higher than the returns from being long volatilities of all stocks in the universe (column 3) in all three markets.** Similarly, the average post bid/offer returns from being short volatilities of the top 10%-tile stocks (column 2) were significantly higher than the returns from being short volatilities of all stocks in the universe (column 4). This proves the effectiveness of the *RV Score* for screening for rich/cheap volatility.

- **The long/short strategy with the top & bottom 10%-tile volatility stocks (column 5) generally provides positive returns in all three markets.** Also note that the median returns, which take the asymmetric feature of volatility trades into account, are also significantly different from zero.

- **The long/short strategy based on the *RV Score* ranking works particularly well in Japan with the average post bid/offer return of 4.4 vol points since 2005.** This is partially due to: 1) CDS spreads being used as an additional fundamental factor which increases the predictive power of the *RV Score*; 2) a larger sample size in Japan which improves the statistical efficiency of the model. It can be also explained by the relatively mature options market in Japan, where implied volatility reflects the fundamentals of the underlying asset more efficiently.

  On the other hand, the strategy shows quite volatile performance in Hong Kong. Single stock volatilities in Hong Kong are easily squeezed by liquidity and also some Chinese stocks listed in the Hong Kong market have a high volatility of volatility, which makes forecasting the future volatility more difficult than other developed markets. A small sample size of 22 stocks would be another reason for the relatively poor performance.

Single Stock versus Index Volatility Trade

Index implied volatility tends to trade at a sizable premium to its realized volatility due to the demand for portfolio hedging. Therefore, pairing cheap single stock volatility with index volatility to establish a long/short strategy would be an effective way to take advantage of the index volatility premium. However, the index implied volatility premium could contract from time to time, as in the case of 4Q09-1Q10 when the index implied volatility softened quickly amid the continued range-bound market.

To take this into account, we apply a final screening on the cheap single stock volatilities based on the *RV score* ranking such that we enter the trade only if the current single stock versus index implied volatility spread is below the 5%-tile in the history of the realized spread since 2004 (stocks with the realized volatility history less than 3 years at the time are excluded). The backtesting results are summarized in Table 6 and Figures 16 - 18.

The long/short strategy with the cheapest volatility stocks versus index generates positive returns in all three markets. Given the performance of the long/short single stock volatility strategy, the strong result in Japan (post bid/offer return of 4.5 vol points on average) is not surprising. What is interesting is, this strategy also works well in Hong Kong in contrast with the previous long/short single stock volatility strategy. This can be largely explained by the rich premium inherent in the Hang Seng index implied volatility, which is reflected in its implied correlation usually trading at a larger premium to the realized correlation than other indices. The structural imbalance of volatility supply and demand caused by the issuance of retail structured products as well as the relatively poor liquidity in the single stock options market may also explain these result trends. By systematically buying the bottom 10%-tile stocks based on the *RV Score* ranking and selling the index volatility, the strategy provides an average post bid/offer return of 5.4 vol points.

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In Table 5, you can compare the performance statistics with/without the final screening procedure of the single stock versus index volatility spread percentiles. By selectively entering the trade only when the current implied spread of single stock versus index volatility is low as compared to the historical realized spread, we can prevent losses incurred from selling index volatility when it is not sufficiently rich. This additional screening improves the performance of the strategy in Hong Kong as it successfully screens out most of the trades that would have resulted in losses during the volatility compression period between 4Q09-1Q10, as shown in Figures 16 and 18 (also note the significant improvement in the maximum losses as shown in Table 4). However, due to the much less frequency of putting on trades, the accumulative return actually decreases with this additional screening.

Meanwhile, the improvement is less obvious in Australia as many trades with large gains in 4Q08-1Q09 are screened out leading to a decrease in the average/ accumulative returns. This can be partially justified by the fact that those trades occurred during the financial crisis period, a very unusual environment where long volatility would have made money no matter what. Excluding this period, the screening with the single stock versus index volatility spread percentiles is useful for minimizing losses.

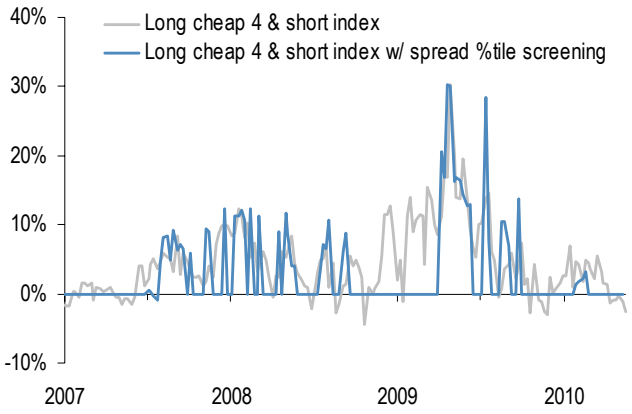
Table 5: Single stock versus index volatility strategy based on RV Score

	Japan		Australia		Hong Kong	
	Long 4 & short index	with spread %tile screening	Long 3 & short index	with spread %tile screening	Long 2 & short index	with spread %tile screening
Avg Return	4.5%	9.7%	5.1%	2.5%	5.4%	8.5%
Median	3.6%	9.0%	2.8%	0.7%	5.1%	8.4%
Max	30.2%	30.2%	22.6%	21.6%	26.0%	30.6%
Min	-4.5%	-1.0%	-10.3%	-6.2%	-7.2%	-3.5%
Stdev	5.2%	6.9%	7.4%	6.0%	6.0%	6.0%
I.R.	0.87	1.42	0.69	0.41	0.90	1.43
No of Trades	177	53	177	121	177	78
Acc. Return*	76.3%	59.9%	81.3%	42.9%	83.8%	69.2%

*annualized accumulated return based on the data since 2007.
Source: J.P. Morgan.

Figure 16: Performance of single stock versus index volatility strategy in Japan

Volatility P/L



Source: J.P. Morgan.

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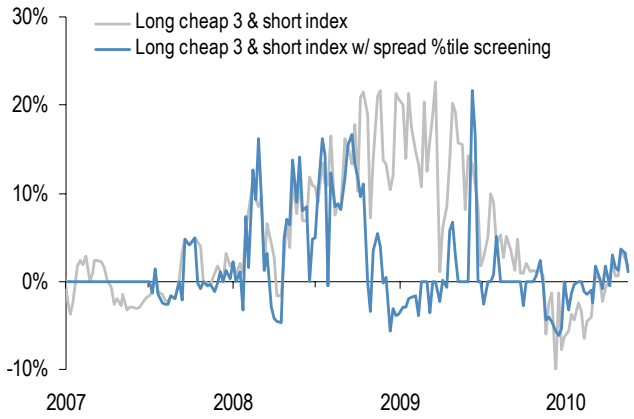
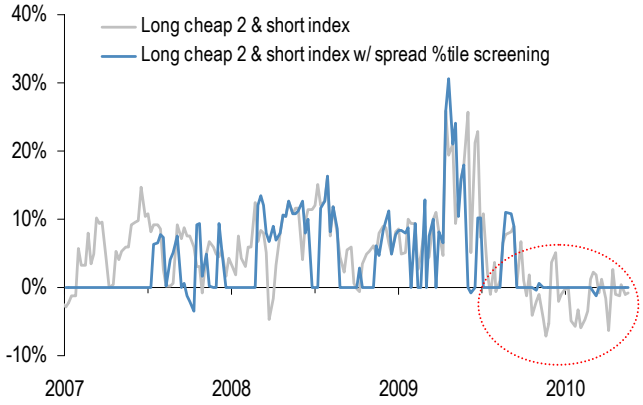
Figure 17: Performance of single stock versus index volatility strategy in Australia
Volatility P/L



Source: J.P. Morgan.

Figure 18: Performance of single stock versus index volatility strategy in Hong Kong
Volatility P/L



Source: J.P. Morgan.

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Applications

The results of the backtest presented so far demonstrate that our *RV Score* is an effective framework for ranking single stock volatility in Australia, Japan and Hong Kong. Applications of the *RV Score* could include **trading long/short baskets of single stock volatility** and more generally screening a universe of single stock volatilities for relative value opportunities, perhaps for **volatility pair trades.** In addition the methodology naturally lends itself to constructing baskets for **enhanced dispersion trades (or single stock versus index volatility trade)** where the aim is to find a basket of stocks with cheap volatility to trade against an index.

These volatility strategies can be implemented in many different ways such as through volatility swaps or straddles. Note that the backtesting shown here only factors in bid/offer spread as trading cost and does not take into account other potential costs such as delta/vega rebalancing costs from trading straddles.

The *RV Score* is only a framework for screening relative value opportunities in single stock volatility and we intend to make ongoing efforts to further enhance the model. A new screening product based on this model will be launched shortly.

Tables 6 - 8 summarize the current *RV Score* rankings for Japan, Australia and Hong Kong. Stocks on the top are the ones with low *RV Scores* while stocks on the bottom are the ones with high *RV Scores*. The last two columns show the current single stock versus index implied volatility spread and its percentile compared to the historical realized spread, a trigger for the single stock versus index volatility trade. Our *RV Score* suggests the following current opportunities:

- **Japan: Central Japan Railroad** (9022 JT) and **Nomura Holdings** (8604 JT) implied volatilities appear to be cheap with the *RV Scores* less than -1.0 while **West Japan Railway** (9021 JT) implied volatility looks particularly expensive with the *RV Score* of +1.1. Among the bottom 10%-tile cheapest stocks, **Mitsui** (8031 JT) and **Komatsu** (6301 JT) meet the 5%-tile single stock versus index volatility spread criteria and therefore are potential candidates for the single stock versus index volatility trade (note that Central Japan Railroad and Nomura Holdings which have lower *RV Score*s do not meet the 5%-tile single stock versus index volatility spread criteria and therefore do not trigger the single stock versus index volatility trade).

- **Australia: Foster's** (FGL AU), **Oil Search** (OSH AU) and **National Australia Bank** (NAB AU) implied volatilities appear to be relatively cheap with the *RV Scores* close less than -0.9 while **Telstra** (TSL AU) and **Brambles** (BXB AU) implied volatilities look relatively expensive with the *RV Scores* greater than 0.9. Note that **Foster's** is going through corporate restructuring now, which will bring noises on the stock's price movement and volatility. Among the bottom 10%-tile cheapest stocks, **Oil Search** is a potential candidate for the single stock versus index volatility trade.

- **Hong Kong: Cheung Kong** (1 HK) and **Hang Seng** (11 HK) implied volatilities appear to be relatively cheap and **China Unicom** (762 HK) and **China Petroleum** (386 HK) implied volatilities look relatively expensive while their *RV Scores* are not extremely negative or positive. Among the bottom 10%-tile cheapest stocks, both **Cheung Kong** and **Hang Seng**' single stock versus

implied volatility spreads are at the lower end of the realized volatility spread history since 2004 and therefore potential candidates for the single stock versus index volatility trade.

Table 6: RV Score screening results – Japan (data as of May 28, 2010)

RV Score Ranking	Ticker	Name	RV Score	6M Implied Vol	6M Realized Vol	6M Implied - Realized	SS - index implied vol spread	%-tile vs realized vol spread
1	9022 JT	CENTRAL JAPAN RL	-1.62	24.1%	22.7%	1.4%	-2.2%	7.9%
2	8604 JT	NOMURA HOLDINGS	-1.09	35.2%	31.0%	4.1%	8.9%	15.5%
3	8031 JT	MITSUI & CO	-0.95	36.8%	35.8%	1.0%	10.5%	**5.0%**
4	6301 JT	KOMATSU LTD	-0.86	36.0%	31.4%	4.5%	9.7%	**0.0%**
5	8058 JT	MITSUBISHI CORP	-0.78	35.7%	32.0%	3.7%	9.4%	3.9%
:	:	:		:	:	:	:	:
:	:	:		:	:	:	:	:
36	8053 JT	SUMITOMO CORP	0.59	37.3%	30.8%	6.5%	-4.5%	27.5%
37	2914 JT	JAPAN TOBACCO	0.59	35.0%	35.2%	-0.2%	-4.5%	25.6%
38	8306 JT	MITSUBISHI UFJ F	0.63	36.4%	28.9%	7.5%	10.5%	54.4%
39	5108 JT	BRIDGESTONE CORP	0.72	34.4%	26.5%	7.9%	8.5%	48.8%
40	9021 JT	WEST JAPAN RAILW	1.10	30.3%	19.9%	10.4%	10.8%	1.6%

Source: J.P. Morgan.

Table 7: RV Score screening results – Australia (data as of May 28, 2010)

RV Score Ranking	Ticker	Name	RV Score	6M Implied Vol	6M Realized Vol	6M Implied - Realized	SS - index implied vol spread	%-tile vs realized vol spread
1	FGL AU	FOSTER'S GROUP L	-0.94	20.7%	20.0%	0.7%	-2.8%	5.9%
2	OSH AU	OIL SEARCH LTD	-0.93	28.3%	27.7%	0.6%	4.9%	**0.0%**
3	NAB AU	NATL AUST BANK	-0.93	28.5%	26.8%	1.8%	5.1%	48.1%
4	WOW AU	WOOLWORTHS LTD	-0.86	17.9%	15.7%	2.2%	-5.6%	0.0%
5	WBC AU	WESTPAC BANKING	-0.83	29.9%	29.0%	0.9%	6.5%	49.6%
:	:	:		:	:	:	:	:
:	:	:		:	:	:	:	:
25	BLD AU	BORAL LTD	0.47	33.4%	24.0%	9.5%	10.0%	16.7%
26	MQG AU	MACQUARIE GROUP	0.64	38.1%	30.7%	7.4%	14.7%	48.2%
27	CSR AU	CSR LTD	0.66	34.1%	29.1%	4.9%	10.7%	11.7%
28	BXB AU	BRAMBLES LTD	0.97	32.5%	27.7%	4.9%	9.1%	N/A
29	TLS AU	TELSTRA CORP	1.72	28.3%	22.4%	6.0%	4.9%	39.9%

Source: J.P. Morgan.

Table 8: RV Score screening results – Hong Kong (data as of May 28, 2010)

RV Score Ranking	Ticker	Name	RV Score	6M Implied Vol	6M Realized Vol	6M Implied - Realized	SS - index implied vol spread	%-tile vs realized vol spread
1	1 HK	CHEUNG KONG	-0.63	25.9%	21.3%	4.7%	-1.1%	**0.0%**
2	11 HK	HANG SENG BK	-0.61	16.9%	14.7%	2.2%	-10.1%	**0.0%**
3	1088 HK	CHINA SHENHUA -H	-0.55	40.1%	36.3%	3.8%	13.1%	21.4%
4	2318 HK	PING AN INSURA-H	-0.51	39.2%	33.6%	5.7%	12.3%	30.7%
5	3328 HK	BANK OF COMMUN-H	-0.51	35.3%	31.9%	3.4%	8.4%	13.0%
:	:	:		:	:	:	:	:
:	:	:		:	:	:	:	:
18	1398 HK	IND & COMM BK -H	0.05	33.4%	29.4%	4.1%	6.5%	12.1%
19	13 HK	HUTCHISON WHAMPO	0.39	28.0%	23.4%	4.6%	1.0%	30.2%
20	939 HK	CHINA CONST BA-H	0.62	35.6%	29.3%	6.3%	8.6%	22.4%
21	386 HK	CHINA PETROLEU-H	0.77	34.8%	27.8%	7.0%	7.8%	9.1%
22	762 HK	CHINA UNICOM HON	0.81	40.3%	35.5%	4.8%	13.3%	10.1%

Source: J.P. Morgan.

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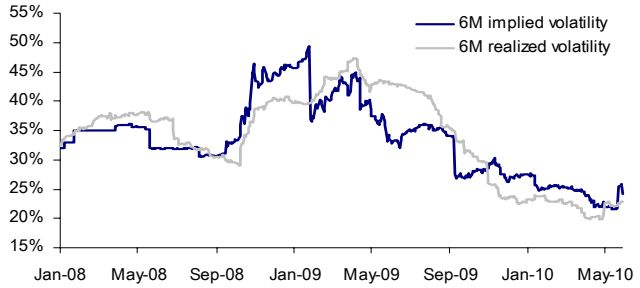
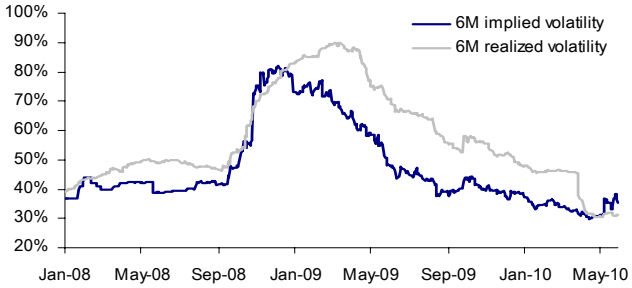
Figure 19: Central Japan (9022 JT) 6M implied and realized volatility



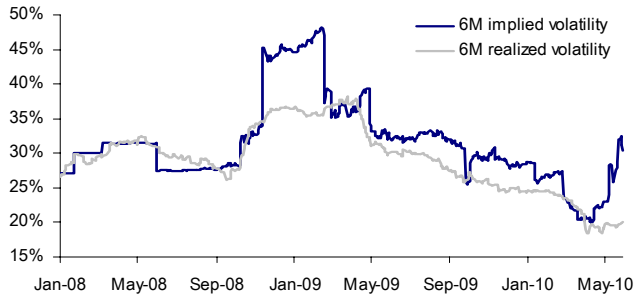
Source: J.P. Morgan.

Figure 20: Nomura (8604 JT) 6M implied and realized volatility



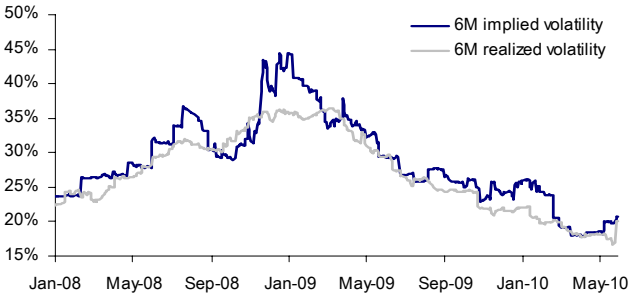
Source: J.P. Morgan.

Figure 21: West Japan RW (9021 JT) 6M implied and realized volatility



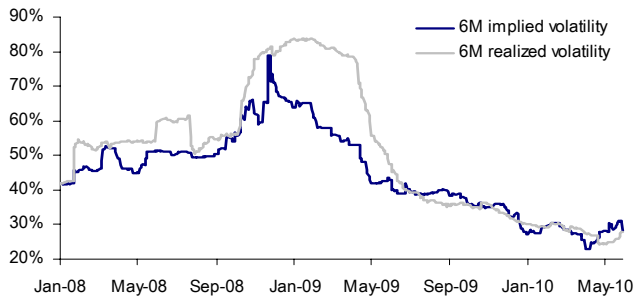
Source: J.P. Morgan.

Figure 22: Foster's (FGL AU) 6M implied and realized volatility



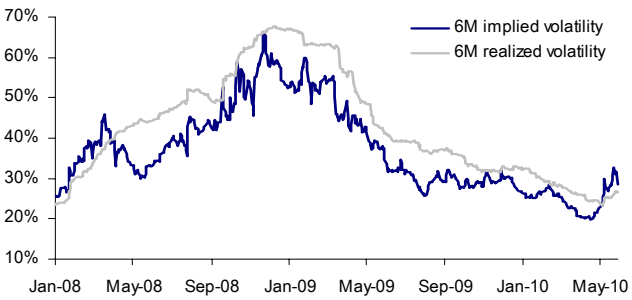
Source: J.P. Morgan.

Figure 23: Oil Search (OSH AU) 6M implied and realized volatility



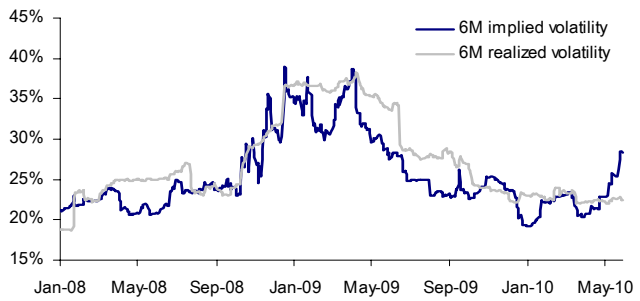
Source: J.P. Morgan.

Figure 24: Nat'l Aust Bank (NAB AU) 6M implied and realized volatility



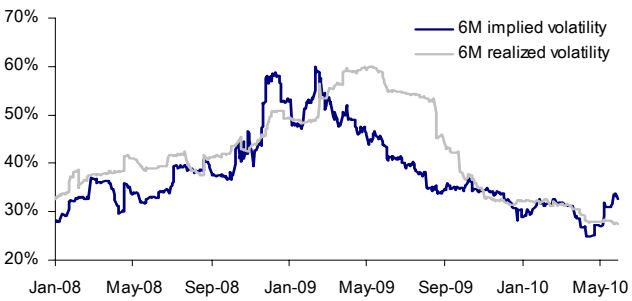
Source: J.P. Morgan.

Figure 25: Telstra (TLS AU) 6M implied and realized volatility



Source: J.P. Morgan.

Figure 26: Brambles (BXB AU) 6M implied and realized volatility



Source: J.P. Morgan.

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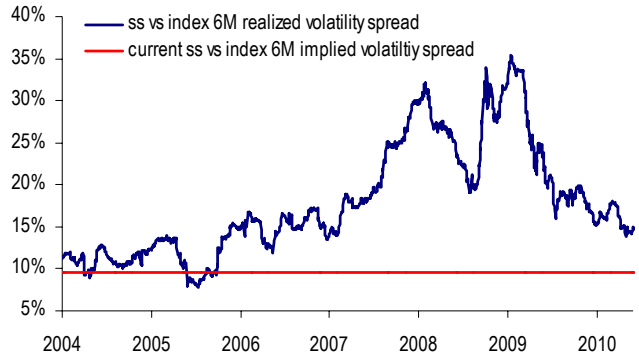
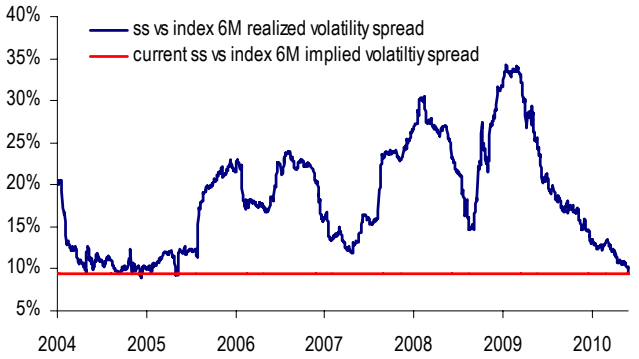
Figure 27: Mitsui (8031 JT) single stock versus index 6M implied and realized volatility spread



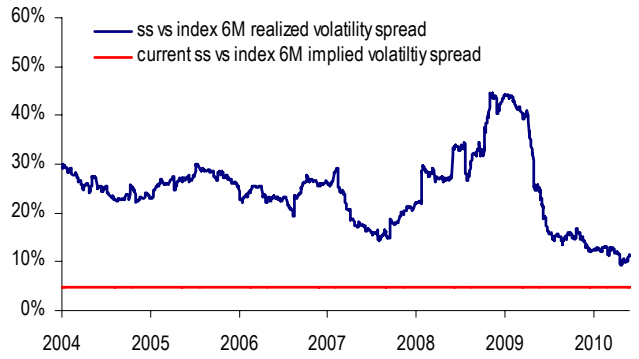
Source: J.P. Morgan.

Figure 28: Komatsu (6301 JT) single stock versus index 6M implied and realized volatility spread



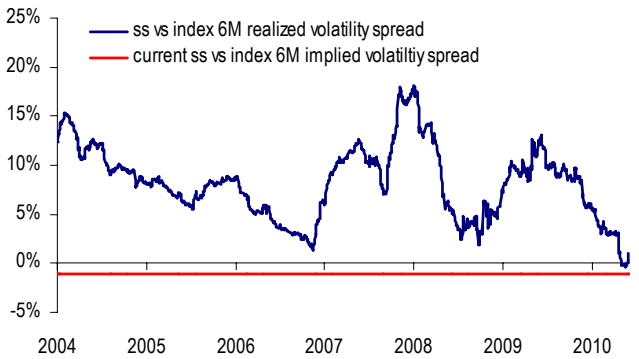
Source: J.P. Morgan.

Figure 29:Oil Search (OSH AU) single stock versus index 6M implied and realized volatility spread



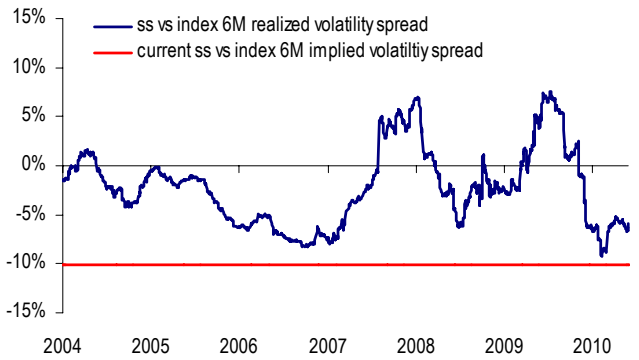
Source: J.P. Morgan.

Figure 30: Cheung Kong (1 HK) single stock versus index 6M implied and realized volatility spread



Source: J.P. Morgan.

Figure 31: Hang Seng (11 HK) single stock versus index 6M implied and realized volatility spread



Source: J.P. Morgan.

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European Equity Derivatives Strategy
J.P. Morgan Securities Ltd.
1 October 2007

Relative Value Single Stock Volatility

Screening stocks for rich and cheap volatility

Overview

We introduce a **quantitative framework for determining rich and cheap volatility on single-stock equity underlyings**.

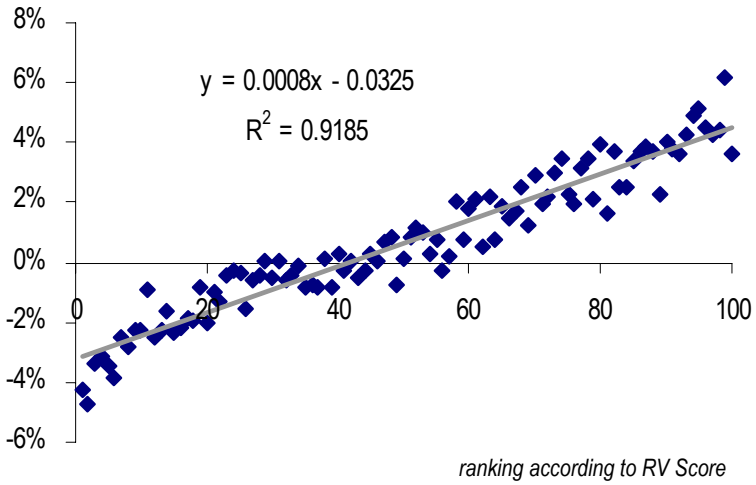
Our model uses a combination of fundamental and technical factors to produce a rich/cheap volatility score – the **RV Score** – for each stock in our European 100-stock universe.

There is a strong correlation between the RV-rank of a stock and the average subsequent return from a long 6-month variance swap (Figure 1), showing that **on average the RV Score has been an effective predictor of future variance swap p/l.**

Long / short variance swap trades on the bottom and top decile of RV-ranked stocks have performed well, with **a 95% success rate**.

Figure 1 : Rank of RV Score is strongly correlated with subsequent variance swap p/l

Average subsequent p/l on 6m variance swap



Source: JPMorgan, data Aug 2000 – Aug 2007

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European Equity Derivatives Strategy
1 October 2007

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1: Introduction

In this note we introduce a **quantitative framework for determining rich and cheap volatility on single-stock equity underlyings**. The model aims to find relative value volatility *between* stocks rather than predicting the future volatility of a stock in isolation, and is particularly useful for long/short variance swap strategies.

Our model uses a combination of fundamental and technical factors to produce a rich/cheap volatility score, which we call the ***RV Score***. Factors used include credit spreads, stock performance, dividend yield and realised volatility. In **Section 2** we describe our RV Score, itself a combination of a Volatility Score and a Fundamental Score.

We have tested the effectiveness of the RV Score over the last seven years, and find that the **RV Score has been successful in identifying rich and cheap volatility stocks**, in both high and low volatility regimes. The mechanics of our RV Score calculation mean that top ranked stocks have relatively rich volatility and bottom ranked stocks have relatively cheap volatility.

Figure 3 illustrates the predictive power of ranking stocks according to their RV Score. It shows **a strong correlation between the RV-rank of a stock and the average subsequent return from a long 6-month variance swap**. On average, being long variance swaps on the bottom ranked stocks outperformed the top ranked stocks by around 8.5 vegas.

Further, a long variance / short variance strategy on the bottom 10 versus top 10 stocks produced consistently positive results, with **95% of trades in profit and an average profit of 6.9 vegas per trade** (post bid/offer). Trades made money in both high and low volatility regimes – although absolute returns are lower in the low volatility environment since 2003, so are risks. In fact, Information Ratios of long/short trades are slightly higher since 2003 than in 2000-2003.

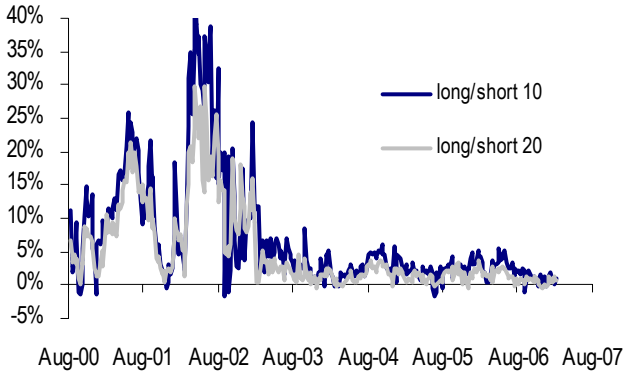
Section 3 shows the detailed results of the backtest of the RV Score, including mark-to-market p/l and an analysis of turnover together with sector and country representation.

Finally in **Section 4** we compare our RV-ranking with other ranking schema, such as a simple implied-historic volatility ranking. The results indicate that the **RV Score outperforms alternative ranking measures,** particularly given the consistency of the RV Score across both different performance criteria and across high and low volatility regimes.

RV Rankings are produced each day on our new report "***European Single Stock Variance Relative Value Report***", available on MorganMarkets, Bloomberg and email. See Appendix 2 on page 32 for a sample report.

Figure 2 : RV ranking produces a profitable long / short variance strategy

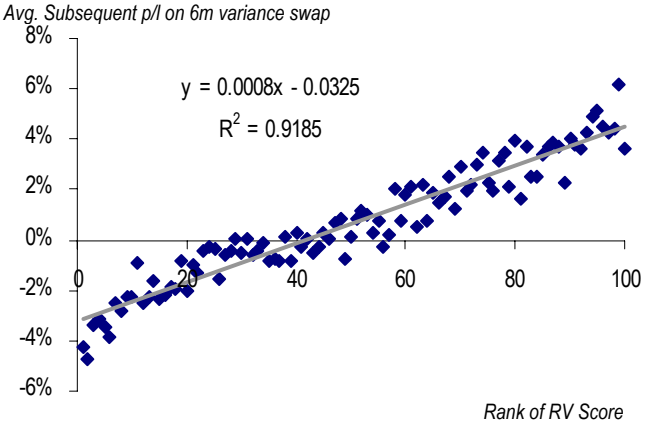
P/L of long top 10 (20) versus short bottom 10 (20) according to our RV ranking



Source: JPMorgan

Figure 3 : Rank of RV score is strongly correlated with subsequent variance swap p/l

Avg. Subsequent p/l on 6m variance swap



Source: JPMorgan, data Aug 2000 – Aug 2007

2: Relative Value Volatility

In this section we discuss strategies for determining where single-stock volatilities are trading rich or cheap in comparison to each other. We present our **RV Score** which is our favoured method of screening relative value in single-stock volatility. This score is a combination of two simpler metrics: a **Volatility Z-Score** and a **Fundamental Z-Score**. Below we describe how these scores work and why we choose to use them. In the following sections we assess the effectiveness of these z-scores through various backtests.

2.1: Screening for Rich and Cheap Volatility

How do we differentiate between rich and cheap single-stock volatility? Clearly fundamental views on the future risk of the various stocks are important, as is knowledge of market sentiment and flows. Here however, we adopt a purely quantitative approach aiming to assign to each stock a score indicating relative richness or cheapness of volatility.

Which factors could give signals as to the value of volatility?

- Realised volatility (particularly the spread of implied over realised volatility).
- Volatility cone – how often has realised volatility been above the current level of implied?
- Absolute level of implied volatility – is it better to be long variance on high or low volatility stocks?
- CDS levels – should companies with higher CDS spreads trade at higher volatility?
- Market performance – e.g. in a sell-off is it better to own volatility on stocks which have sold off most, or least?
- Market capitalisation – should large companies have lower volatility?
- Stock beta – are higher beta stocks really more volatile?
- Dividend yield – should a high yield imply lower risk and hence lower volatility?
- Stock vs. sector volatility – where is the stock volatility trading relative to how it usually trades vs. sector peers?
- P/E and/or PEG ratios – should high P/E lead to high volatility or vice versa?
- Skew – steep skew indicates risk aversion, is it better to be long or short volatility on steep skew names?

In fact, in turns out that it is hard to beat perhaps the most naïve measure: the spread between implied and realised volatility. The strategy of being short variance swaps on stocks with implied volatility much higher than recent realised and long variance swaps where the spread is smallest (or most negative), is consistently successful. See Table 15 and Table 16 on page 26 for backtest results of this simple strategy.

The implied-realised strategy works because to some extent, past realised volatility *is* a good predictor of future realised volatility. This is especially true when looking across a universe of stocks on any given day. Each stock's volatility can be modelled as a market volatility component together with a stock specific component. By trading long/short spreads of single-stock variance the market volatility component is hedged out (to some degree), leaving the trade long/short the spread of the stock-specific volatility components.

Although a strategy based on the implied-realised spread works well, we aim to do better. In particular, the performance of this simple strategy in the low volatility environment since 2003 has been muted; in practice bid/offer spreads would have wiped out much of the 2-2.5 vega pre-cost performance. What can we do to improve our identification of rich/cheap volatility stocks? We use two main approaches, which are later combined into a single metric:

1. If implied-realised spread works well because past realised volatility is a good predictor of future realised volatility (at least for the stock-specific volatility component) then perhaps we can do better by using **a more sophisticated model of realised volatility** than simple 3-month realised volatility. This leads to our **Volatility Z-Score**.

2. Look at **other factors which may impact the volatility of a stock**. These could include stock beta, dividend yield, P/E and or PEG ratios, CDS levels, recent market performance, market capitalisation, regression of implied volatility against average sector volatility and so on. This approach leads to our **Fundamental Z-Score.**

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2.2: Volatility Z-Score

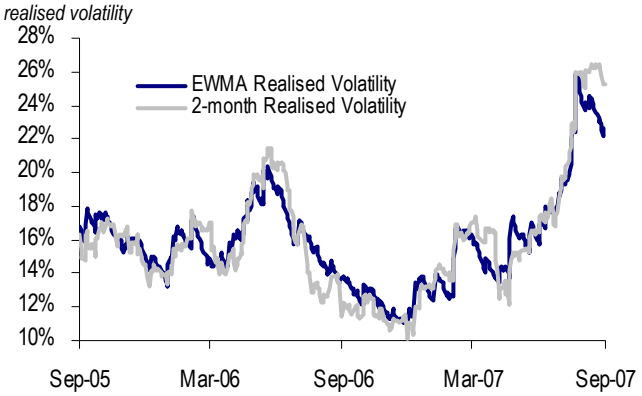
Our **Volatility Z-Score** aims to assess the relative richness or cheapness of single-stock volatility by comparing the current levels of implied volatility with previously realised volatility. As mentioned above, using simple 3-month realised volatility works well (see page 26), but we improve upon this by varying the model of volatility used.

We can first consider which *fixed* maturity of realised volatility does the best job of forecasting future 6-month realised volatility. It turns out that when volatility is high, very short-dated volatility fares best – even as short as 10 days. Conversely, when volatility is low, longer-dated volatility – e.g. up to 6-months – tends to be a better estimator. Overall using realised volatility of around 2-3 months seems to be the best compromise.

The above suggests that when volatility is high, it is the very recent events which are most important, but when volatility is lower, taking more data into account can add value. One way of achieving both of these aims simultaneously is to use an **EWMA (exponentially weighted moving average) model**. This is a single-parameter model which acts somewhat like traditional realised volatility, but gives relatively more importance to very recent returns without chopping off its information window after a few days. It can be thought of as weighting the (log-squared) returns with an exponential decay function – hence the name.

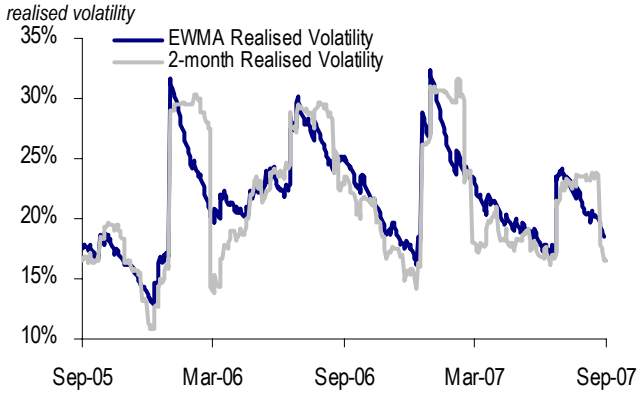
We use an EWMA volatility which equates relatively closely to 2-month realised volatility (Figure 4, Figure 5). The resulting ***Volatility Z-Score*** will reflect the spread of implied variance to EWMA realised volatility, with high Z-Scores representing a large spread of implied over EWMA realised volatility and, by implication, rich volatility (Figure 6). See page 25 for the results of a backtest of this metric.

Figure 4 : EWMA and traditional 2-month realised volatility for Royal Dutch Shell are very similar…



Source: JPMorgan, Royal Dutch Shell, Dutch A-Shares listing

Figure 5 : … but for SAP the difference is more noticeable : the one-off large moves fall out of the sample more gradually for EWMA



Source: JPMorgan

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2.3: Fundamental Z-Score

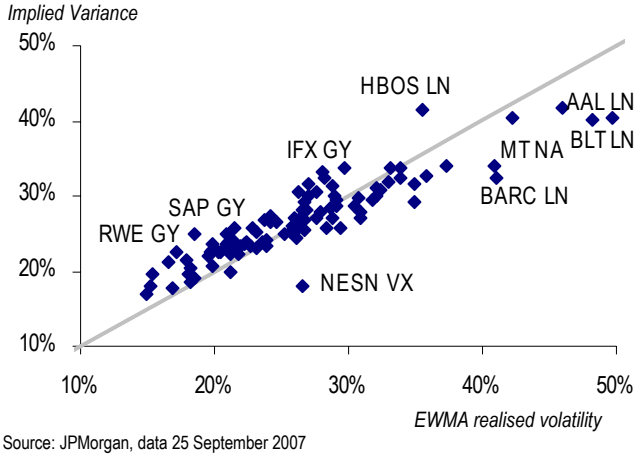
The second approach is to look at (fundamental) factors *other than realised volatility* which could be relevant in predicting future realised volatility. We calculate a ***Fundamental Z-Score*** by comparing implied variance levels with these factors across our entire universe of stocks. This z-score represents the relative richness/cheapness of volatilities across the universe according to these factors, independent of the overall richness/cheapness of market volatility at the time. (The average z-score will be zero). In common with the Volatility Z-Score, high Fundamental Z-Scores indicate rich volatility and low z-score indicates cheap volatility.

The factors used in our model are as follows:

- Stock return
- Stock beta
- CDS
- Dividend yield

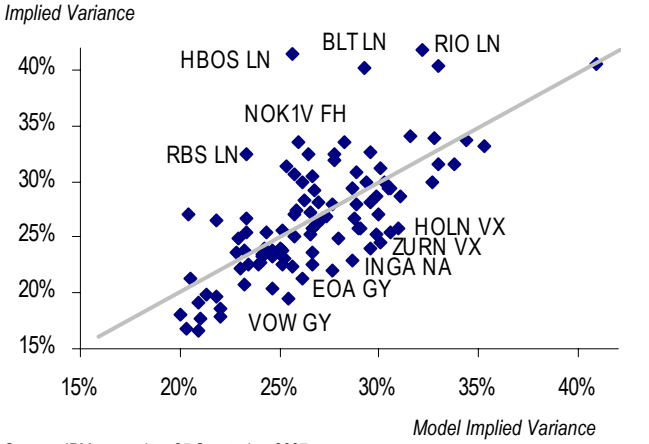
Note that the Fundamental Z-Score does *not* explicitly include realised volatility. This is because at any one time the relative levels of implied volatility across the universe of stocks are well correlated with past levels of realised volatility. Therefore including this parameter in the calculation of the Fundamental Z-Score would have the effect of overwhelming all the other parameters and making the Fundamental Z-Score not significantly different from the Volatility Z-Score.

Figure 6 : Calculating the Volatility Z-Score: Implied variance versus EWMA volatility. Stocks above the line have a positive spread of implied over realised variance, below the line, the spread is negative



Source: JPMorgan, data 25 September 2007

Figure 7 : Calculating the Fundamental Z-Score: Implied variance vs. model implied variance from the Fundamental Z-Score. Stocks above the line are rich volatility according to the model, below the line is cheap vol.



Source: JPMorgan, data 25 September 2007

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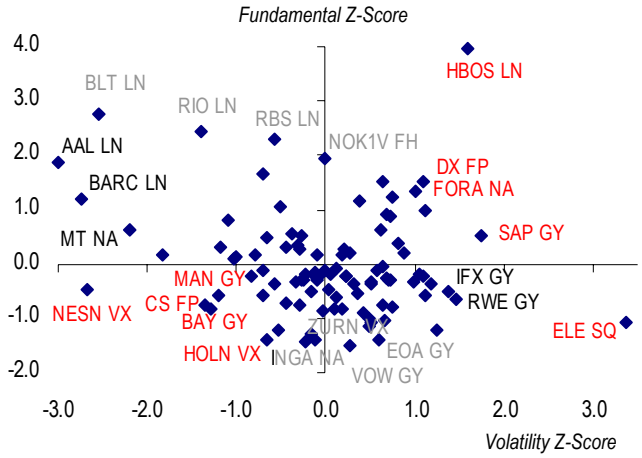
2.4: RV Score – a combination of Volatility and Fundamental Z-Scores

We have defined two z-scores:

1. A **Volatility Z-Score** based on the spread of implied variance to exponentially weighted realised volatility; and
2. A **Fundamental Z-Score** using return, beta, CDS and dividend-yield.

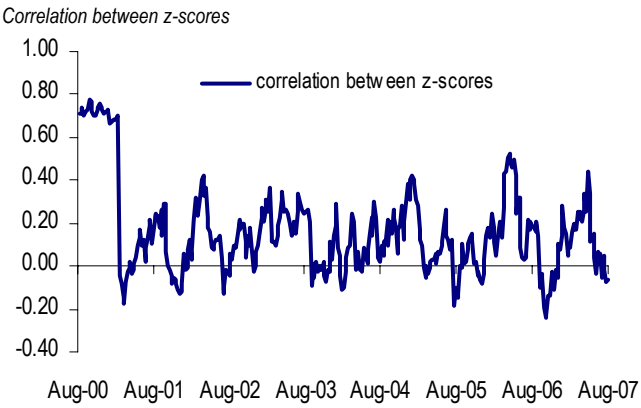
These two z-scores are individually successful in finding rich/cheap volatility (see pages 24 and 25), but tend to be relatively uncorrelated. For example, on the 25th September 2007 the two z-scores were uncorrelated, or even slightly anti-correlated (Figure 8). Over time the correlation between the z-scores has varied from a minimum of -0.25 to a maximum of 0.47 with an average of 0.11 (Figure 9). Thus, in some sense, these two z-scores both give useful but different signals for finding rich/cheap volatility, suggesting we can produce an even more useful indicator by combining them.

Figure 8 : Comparison of z-scores on 25 September 2007 – the two scores are slightly anti-correlated



Source: JPMorgan, data 25 September 2005, Highest and lowest combined RV Score highlighted in Red. Grey and Black are for individual Fundamental and Volatility Z-Scores resp.

Figure 9 : Correlation of Volatility and Fundamental Z-Scores – correlation tends to be low



Source: JPMorgan

Our overall combined score, which we call the ***RV Score***, is arrived at by combining the Volatility and Fundamental Z-Scores. High RV Scores indicate rich volatility and low (negative) RV Scores indicate cheap volatility. Thus a stock with an RV Score of +1 would be considered as having relatively rich volatility, whereas an RV Score of -2 would indicate cheap volatility.

The RV Score is the metric we use for our volatility screening and forms the focus of our backtest in the following sections.

Figure 10 on page 8 summarises how the RV Score is calculated through a combination of the Volatility and Fundamental Z-Scores.

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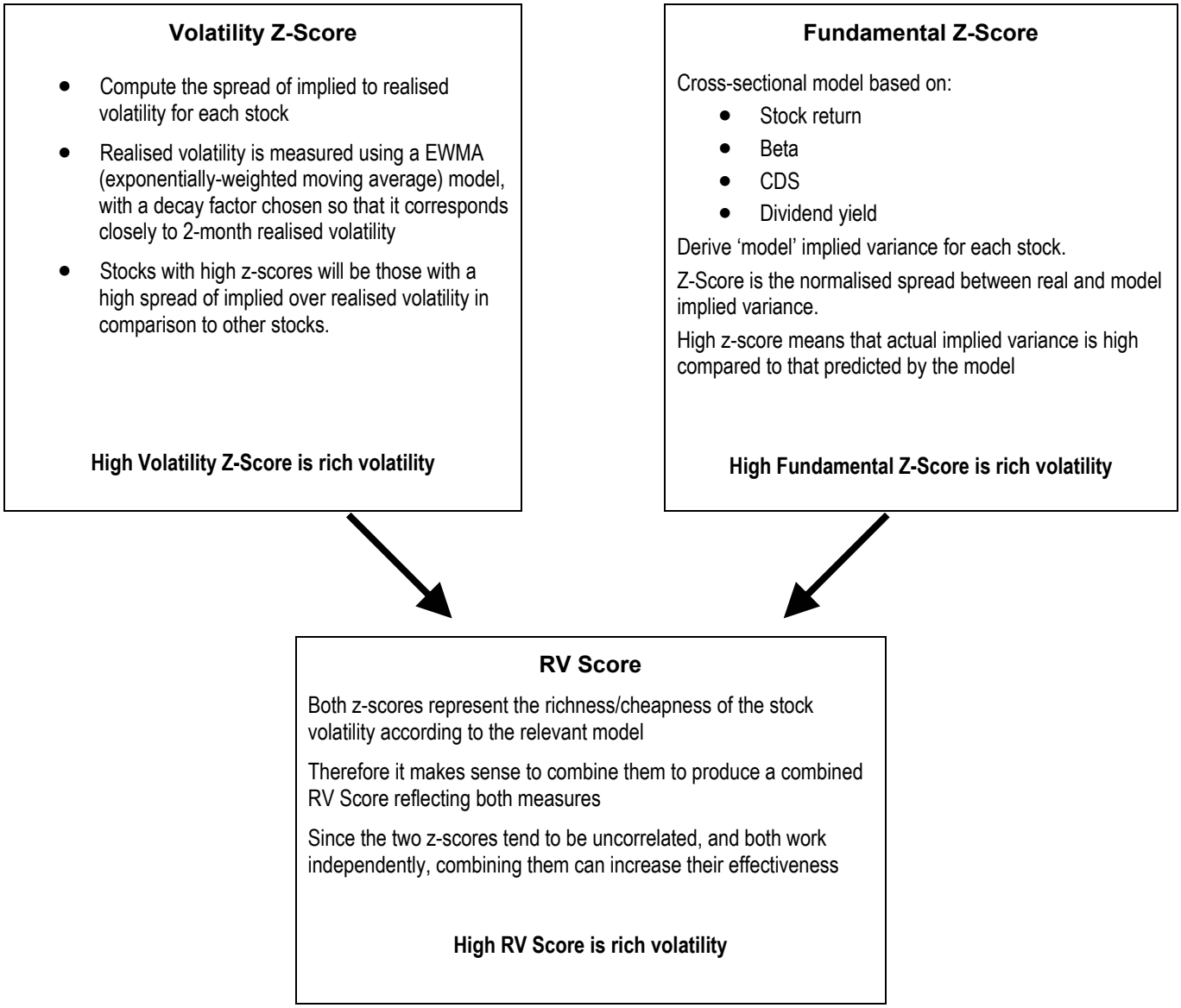
Figure 10: Schema of the RV Score



3: The Backtest

In the following sections we present the results of various backtests relating to the z-scores outlined above. We demonstrate that **the RV Score does a good job of distinguishing between rich and cheap volatility across different volatility regimes**. Both the Volatility Z-Score and Fundamental Z-Score work well independently, but results are consistently better by combining them into the RV Score (see Section 4).

Results for the RV Score are impressive, with a 'hit ratio' of around 95% on a long / short variance swap strategy (bottom versus top decile). Further, **both the long and short legs each consistently outperform their benchmarks** by around 3.5 vegas per trade. Although absolute returns were greater in the high volatility period 2000 – 2003, volatility of returns was higher also, and Information Ratios were actually slightly superior in the recent lower volatility period.

We begin by giving an outline of how the backtest was conducted, and go on to discuss the results.

3.1: Backtest Methodology

We choose our set of stocks from a dynamically changing universe of 100 large cap European names with reasonably liquid options and variance swap markets. This list is chosen dynamically to comprise the top 'n' members of various European indices (15 from the FTSE, 25 from the CAC, 10 from the SMI etc), and should give a fair reflection of past variance swap liquidity. The list is rebalanced every 3 months. Overall, 152 stocks appear at some stage in our universe. The current universe is given in Appendix 1 on page 30.

Implied variance levels are taken as prevailing tradable 6-month variance swap levels if available, and otherwise are estimated from the volatility surface at the time. In all cases we assume a 1.5 vega bid/offer spread on single-stock variance swaps which are, by convention, capped at 2.5 times the variance strike.

All trades are 6-month maturity, and for our initial results the p/l of each trade is computed only once: at expiry. Trades are initiated once a week (on Tuesdays), so at any one time, not close to the beginning or end of the backtest period, there will be 26 trades running concurrently. The backtest starts in August 2000 and ends in August 2007. Thus the last trade for which we have p/l will be one initiated 6 months beforehand in February 2007.

On any day, we rank all stock volatilities according to our RV Score, arising as a combination of our Volatility and Fundamental Z-Scores. **Throughout, a high z-score corresponds to rich volatility and low (negative) z-score corresponds to cheap volatility.**

We backtest the effectiveness of the z-scores by selling variance on the 10 (or 20) stocks with the highest z-scores and buying variance on the 10 (respectively 20) stocks with the lowest, or most negative z-scores. With a universe of 100 stocks, the top/bottom ten correspond to the 1st/10th deciles and the top/bottom 20 correspond to 1st/5th quintiles. We also consider performance of the top and bottom 10 ranked stocks individually.

Whilst this is principally a backtest of our combined RV-Score, in section 4 we also compare results with other z-scores: notably the Fundamental and Volatility Z-Scores used to create the combined RV-Score, but also for more simple metrics such as implied-realised volatility, overall level of implied volatility and a random z-score acting as a control. These other z-scores help us to put the performance of the combined RV Score into context and explain its effectiveness.

Since the backtest period over the last 7 years encompasses two distinct volatility regimes, we generally present results separately for both periods: a high volatility period up until May 2003, and a low(er) volatility period since.

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3.2: Backtest Results

In this section we describe the results of the backtest of long, short and long/short volatility strategies using our RV-Score as a ranking metric. **The backtest highlights how our RV-Score provides a powerful tool for distinguishing rich and cheap single stock volatility**. For example long, short and long/short strategies beat their respective benchmarks around 95% of the time.

Table 1 displays the results of our backtest of the combined RV Score for the 7 years since August 2000. The first column shows results for the long only strategy – choosing the ten (first decile) cheapest volatility stocks according to our RV Score. The second column shows the analogous results for being short variance on the ten richest volatility stocks, whilst for comparison the third column shows the results of being systematically long variance on all members of our universe. The final two columns show results for being long/short the ten (and twenty) cheapest/richest stocks according to our ranking.

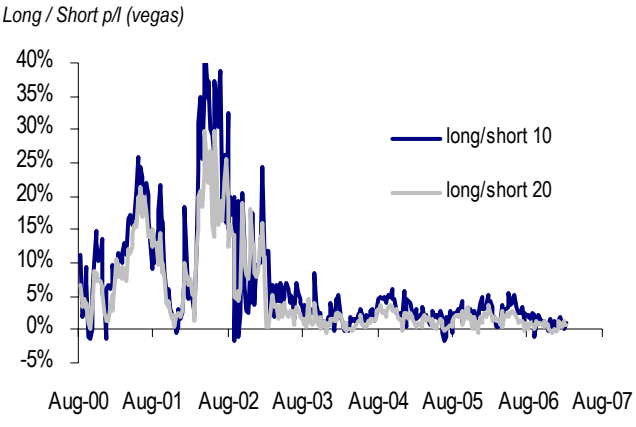
- **The average post bid/offer return from being long the cheapest 10 volatility stocks was 3.8 vegas per trade (first column). This compares well to an average return of zero from being long variance on all 100 stocks** over the same period (third column) - an improvement of 3.8 vegas (first vs. third column).
- **Similarly being short variance on the ten richest stocks produces a return of 3.1 vegas per trade (second column), much better than being short variance on all members of our universe produced an average return of -1.5 vegas** (not shown) – an improvement of 4.6 vegas.
- After crossing bid/offers, **the long/short strategy for the bottom versus top-ranked ten stocks produced an average return of 6.9 vegas** over the period (fourth column) or 5.1 vegas for the top 20 long/short (fifth column).

Table 1: RV Score Results: Aug 2000 - Aug 2007

Aug 2000 – Aug 2007	Long cheap 10	Short rich 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	3.8%	3.1%	0.0%	6.9%	5.1%
Median	-1.4%	4.2%	-2.6%	3.2%	2.3%
Max	62.3%	14.4%	39.9%	46.7%	29.9%
Min	-11.3%	-25.6%	-12.6%	-1.7%	-0.5%
Stdev	13.9%	7.0%	9.7%	8.6%	6.3%
Down-Stdev	2.4%	7.2%	2.7%	0.5%	0.1%
I.R.	0.4	0.6	0.0	1.1	1.1
Sortino	2.3	0.6	0.0	18.9	53.7
Beats Bench.	92%	97%		95%	96%
...by 2 vegas	49%	75%		73%	54%
...by 5 vegas	25%	0%		45%	32%
Avg Implied	30.1%	35.7%	Rank correlation		0.92

Source: JPMorgan

Figure 11 : The long / short strategies have been consistently profitable, even after bid/offer



Source: JPMorgan. Each point represents the expiry p/l from a 6-month trade, post bid/offer.

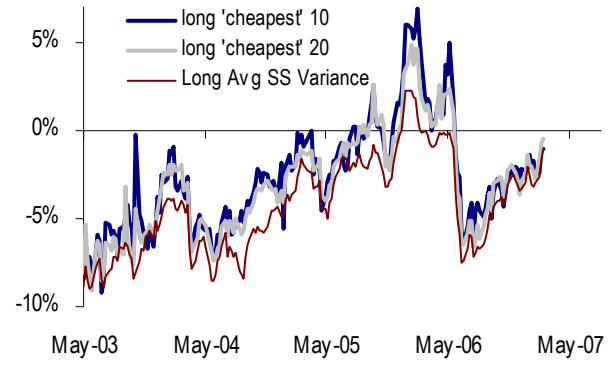
The table also shows **median returns** – which are qualitatively similar to the average returns but are different in magnitude, due to the asymmetry of variance swap p/l. Median returns of long variance strategies are much lower as extreme results influence the median less than the mean, although the difference is much less in the low volatility period (see Table 3).

Maximum and minimum returns are shown next. These refer to the maximum/minimum return *per trade*. Thus the maximum return of 62.3 vegas for the long strategy was the *average* p/l of being long variance on the ten cheapest stocks – in this case for the six months starting on 7th May 2002. This was over 20 vegas more than the maximum return of being long variance swaps on the entire universe – 39.9 vegas starting on 28th May 2002. Note these figures assume that all variance swaps are capped at 2.5 times the strike price, and in these cases some caps were hit.

Below the maximum and minimum returns are the **standard deviations** of the returns of the various strategies. We show both regular standard deviation and the 'downside standard deviation' by which we mean the standard deviation of only the negative returns. Note that the standard deviation of being long variance on the cheap 10 basket (13.9%) is higher than the standard deviation of being long variance on the entire universe (9.7%). However, this is, in some sense, a good thing, since the volatility of returns for the cheap basket occurs mostly on the upside. In addition, the standard deviation of *downside* returns is only 2.4%, slightly *below* the 2.7% for the whole universe. Finally, the standard deviations for the long/short basket are lower than for the long only baskets.

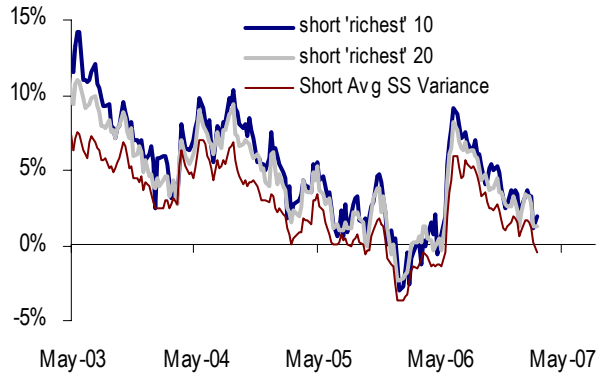
The next two rows show **risk-returns ratios** for the various strategies. By these measures, our ranking performs well, with both long, short and long/short strategies outperforming their benchmarks. Unlike the raw return and standard deviation figures these are annualised. For example the Information Ratio (I.R) is the *annualised* return (twice the average six-month return) divided by the *annualised* standard deviation. The *Sortino Ratio* is analogous except the downside standard deviation is used. In both cases a high ratio is 'good' indicating high return per unit of risk. Over the entire period the long/short strategies tend to have the best risk-return ratios.

Figure 12 : Long variance on our bottom-ranked stocks has outperformed long average single-stock variance
Long variance p/l



Source: JPMorgan

Figure 13 : Short variance on top-ranked stocks has also outperformed
Short variance p/l



Source: JPMorgan

The next section of the table shows more detail of the **performance versus relevant benchmarks**: benchmarks are long variance on *all* stocks for the long basket, short variance on *all* stocks for the short basket and zero for the long/short baskets. That is, the long/short basket is considered to have beaten its benchmark if its return (post bid/offer) is positive. **All strategies beat their benchmarks over 90% of the time, and beat them by at least 2 vegas over half the time**. In fact the long/short bottom/top 10 has a return of at least 5 vegas for 45% of trades.

The final row shows two separate pieces of information. Firstly, the **average implied variance** of members of the long and short baskets. There is a clear bias for the long basket to consist of lower volatility names than the short basket – on average by about 5.5 vegas. That is, the long/short variance strategy has a bias to be long low volatility names against short high volatility names. However this bias has been most noticeable in the more recent lower volatility period and was not present in 2000 – mid 2003 when volatility was at its highest. In Section 4 we show that our strategy is doing more than simply being long low volatility versus short high volatility, and we find that such a naive strategy has not performed well in recent history. See page 29 for details.

Secondly the ***rank correlation*** is displayed. This number is an indicator of the effectiveness of the RV-Score in predicting rich and cheap volatility and is explained in more detail in Section 3.4.

3.3: Results in high and low volatility regimes

We also consider performance over two sub-periods: Aug 2000 – May 2003 when volatility was high, and a lower volatility period from May 2003 to August 2007. Results for each sub-period are shown in Table 2 and Table 3 below.

Strategies based on the RV Score performed strongly across both periods, with information ratios of around 2.0 for the long/short strategy, 95% of long/short baskets producing positive returns and a rank correlation of around 0.86 in both cases.

Absolute returns of the long and long/short variance strategies were much higher in the high volatility period, but so was volatility of returns. In the high volatility period both the long and short strategies were independently profitable. Although the short volatility strategy only just broke even, returns were much better than being short volatility on all single-stocks.

In the low volatility period since 2003, the long/short variance strategy continued to perform well, yielding an average p/l of 2.5 vegas (post bid/offer) for baskets of 10 variance swaps. The short variance strategy, with an average p/l of 5.1 vegas, surpassed the returns of simply being short volatility on all stocks by 2.3 vegas. Although the long variance strategy had negative average returns, it still outperformed its benchmark by 1.7 vegas per trade.

Moreover, all strategies, in both volatility regimes, managed to outperform their benchmarks at least 90% of the time. **In conclusion, we believe that our RV Score ranking shows itself to be robust in both high and low volatility regimes.** This is particularly the case when compared to other strategies, as discussed in Section 4.

Table 2: RV Score Results: Aug 2000 – May 2003

Aug 2000 – May 2003	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	12.6%	0.4%	5.8%	13.0%	10.1%
Median	8.4%	2.1%	1.9%	10.9%	8.6%
Max	62.3%	14.4%	39.9%	46.7%	29.9%
Min	-11.3%	-25.6%	-12.6%	-1.6%	0.0%
Stdev	17.7%	9.5%	12.6%	10.3%	7.0%
Down-Stdev	3.2%	7.2%	3.7%	0.4%	-
I.R.	1.0	0.1	0.6	1.8	2.0
Sortino	5.5	0.1	2.2	52.3	-
Beats Bench.	89%	94%		96%	100%
...by 2 vegas	74%	90%		91%	91%
...by 5 vegas	57%	0%		80%	76%
Avg Implied	41.8%	44.5%	Rank correlation		0.87

Source: JPMorgan

Table 3: RV Score Results: May 2003 – Aug 2007

May 2003 – Aug 2007	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	-2.6%	5.1%	-4.3%	2.5%	1.4%
Median	-2.7%	5.3%	-4.3%	2.4%	1.3%
Max	6.9%	14.3%	2.2%	8.6%	4.5%
Min	-9.2%	-3.0%	-9.0%	-1.7%	-0.5%
Stdev	3.1%	3.4%	2.7%	1.7%	1.0%
Down-Stdev	2.0%	1.0%	2.4%	0.5%	0.1%
I.R.	-1.2	2.1	-2.3	2.1	2.0
Sortino	-1.8	7.0	-2.5	7.2	15.1
Beats Bench.	94%	98%		95%	94%
...by 2 vegas	31%	65%		60%	27%
...by 5 vegas	2%	0%		19%	1%
Avg Implied	22.6%	30.0%	Rank correlation		0.86

Source: JPMorgan

3.4: Predictive Power of the RV Score

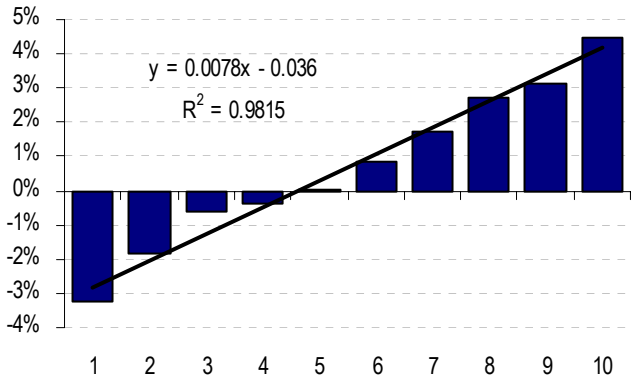
In this section we further analyse the effectiveness of our RV Score by looking across the full spectrum of the ranking, not just the top and bottom deciles. We find that **the RV Score does indeed provide consistent results across the whole ranking**.

We look to see if there is a general trend for the rank of the RV Score to correlate with the subsequent p/l of the long variance swap. For example, we know that the average p/l of long variance swaps on the cheapest 10 stocks over the entire period is 3.8 vegas and the average p/l of the being long the richest 10 is -4.6 vegas. But does our ranking work across the whole range of stocks, not just the outliers? How do the other deciles perform?

We find that the performance of other deciles is consistent with that of our top and bottom deciles. There is a steady increase in p/l from long variance swaps as we move from the first decile to the tenth decile (Figure 14). This pattern remains even when we move to a more detailed view of individual ranks.

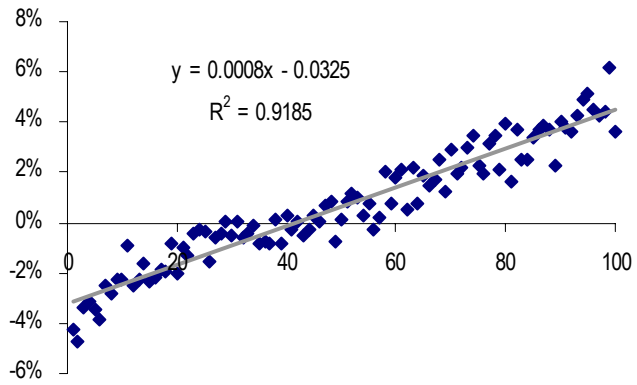
Figure 15 shows the correlation between the RV Score rank and average subsequent long variance p/l for stocks of that rank. The R-squared between the rank of the RV Score and the average subsequent p/l is high, at 0.92. This result is significant since it shows that our ranking metric is effective, in that **lower rank implies cheaper volatility throughout our universe**. It confirms that results are not being unduly distorted by a few outliers amongst the highest and lowest ranked stocks.

Figure 14 : Average performance of long variance, by decile rank
Avg. Subsequent p/l



Decile of ranking (1st decile is richest volatility / highest RV Score)
Source: JPMorgan, data Aug 2000 – Aug 2007

Figure 15 : Average performance of long variance, by individual rank
Avg. Subsequent p/l



rank of RV Score
Source: JPMorgan, data Aug 2000 – Aug 2007

The strong correlation of rank and subsequent return remains when we consider the high and low volatility periods separately (Figure 16 and Figure 17). In the high volatility period up to May 2003, being long single-stock variance was mostly profitable. However, long variance p/l on the highest ranked (richest volatility) stocks was close to zero, whereas long variance p/l on the cheapest stocks was 10 or more vegas. In between, the p/l increases with rank, as before.

In the low volatility period since 2003, virtually any systematic long volatility strategy on large cap European stocks would have lost money – with the obvious corollary that most short volatility strategies would have made money. Nonetheless there remains a strong correlation between rank of the RV Score and subsequent long variance p/l, with the worst ranked stocks losing around 5 vegas on average, but the highest ranked stocks losing only around 2 vegas. Although the difference in p/l between the lowest and highest ranked stocks is less than in the high volatility regime, the correlation between RV Score rank and subsequent p/l is equally strong - with an R-squared of around 0.86 in both cases.

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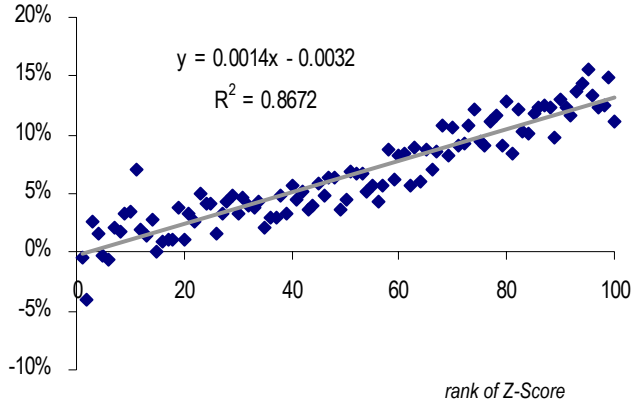
Figure 16 : Performance by rank – Aug 2000 – May 2003

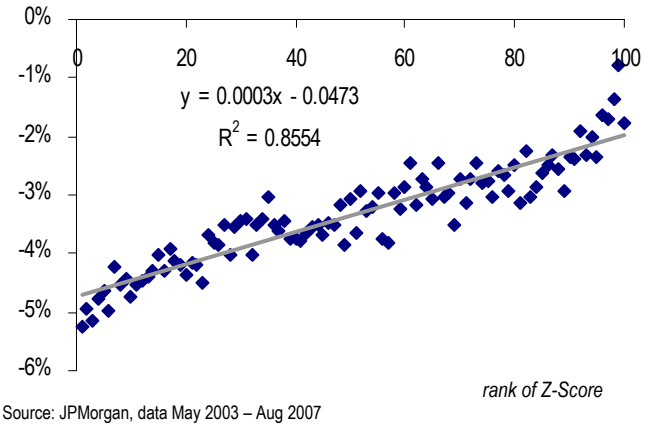
Avg. Subsequent p/l



Source: JPMorgan, data Aug 2000 – May 2003

Figure 17 : Performance by rank – May 2003 – Aug 2007

Avg. Subsequent p/l



Source: JPMorgan, data May 2003 – Aug 2007

These relatively high correlations are found by computing the correlation of rank with the *average* p/l through time for all stocks of that rank. In contrast, we can look at the correlation for each separate set of 6-month trades over the 7 year period (there are around 350 of these), and then average the correlations. That is (and read this slowly), we can calculate the average of the correlations rather than the correlation of the averages.

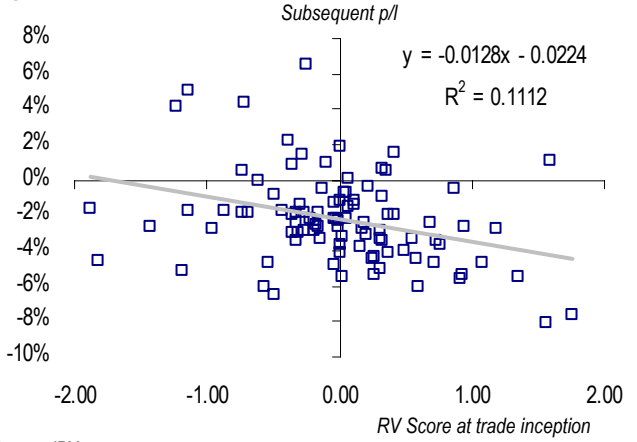
For example, consider the RV Scores assigned to each stock on 31 October 2006. We compute the expiry p/l of each variance swap at the end of April 2007, and then correlate these p/l's with the initial RV Scores. The correlation in this case works out to be -0.33 (Figure 18), again reflecting the lower long variance returns for stocks with higher RV Scores.

The correlation here is much lower than the average rank correlations considered above (an R-squared of 0.11 versus 0.92). However, this is to be expected since we could hardly expect the RV Score to perfectly predict the relative future profitability of every variance swap *on each day*.

If we examine this correlation over time (Figure 19) we find that a correlation of around (negative) 0.33 is about average. In the 'Equity Quant' world this figure is called the ***Information Coefficient (IC)*** of the strategy and anything over 0.05 in absolute value is considered good. Whilst not perhaps directly comparable, our value is over six times greater than this level.

Figure 18 : RV Score versus future p/l – trade on 31 October 2006

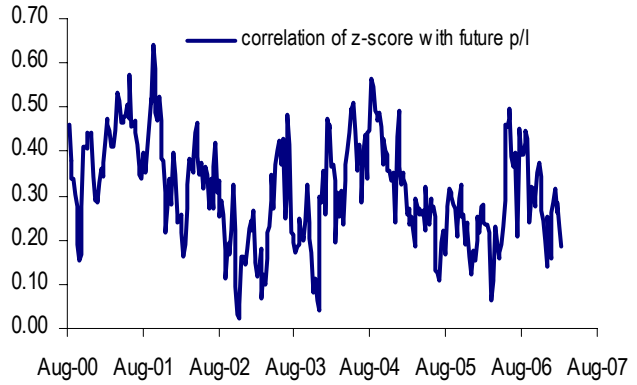
Subsequent p/l



Source: JPMorgan

Figure 19 : IC – Correlation of RV Score with future p/l

Correlation of RV score with future returns



Source: JPMorgan. NB. Correlation is shown as minus the actual correlation.

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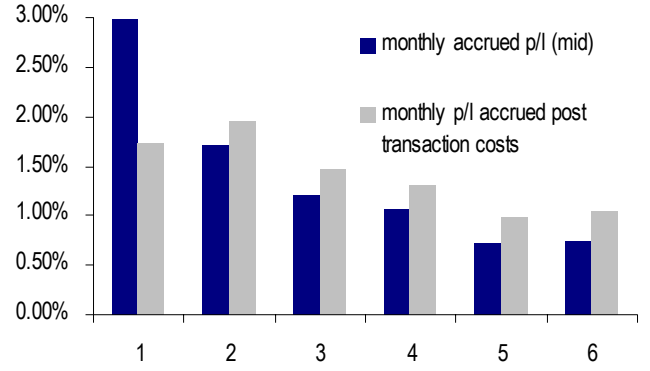
3.5: Mark-to-market: How quickly does the p/l accrue?

The trades considered in our backtest are of 6-month maturity. But is it really necessary to wait the full 6-months to realise the p/l? Is the bulk of this p/l realised towards the start or end of the trade or is p/l accrued smoothly throughout? **We find that on average, profits do accrue smoothly during the lifetime of the trade, with the RV Score having more impact during the early months**. Even one month into the trade, the predictive power of the RV Score remains high. In addition, profits accrue steadily in both high and low volatility periods and on both long and short variance baskets.

We have calculated the mark-to-market p/l of long, short and long/short variance swap strategies at monthly intervals during each trade. We assume an initial p/l of -1.5 vegas to account for the cost of entering the trade. Trades are marked-to-market accounting for both realised volatility accrued to that month and the prevailing value of implied variance up to trade expiry.

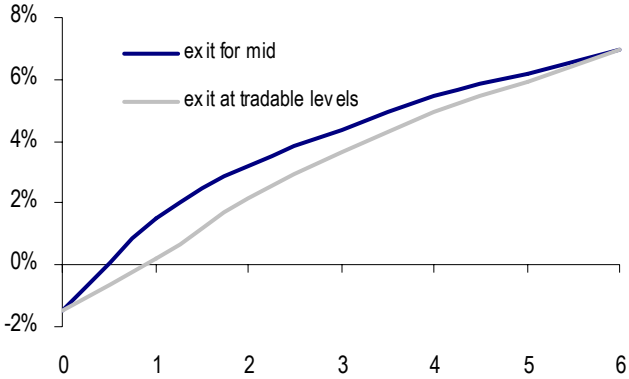
For long/short trades, we analyse p/l accrual in two different ways. Firstly, we look at the accrual of p/l assuming trades can be exited at *mid-market*, in order to gauge when during the 6-month trade the RV Score has most impact. Secondly, we look at the accrual of p/l after accounting for exit costs, in order to gauge how quickly realistic profits can be made.

Figure 20 : Monthly accrued p/l on long/short trades
Average p/l of the long/short accrued each month



Source: JPMorgan, data Aug 2000 – Aug 2007

Figure 21 : Cumulative accrued p/l on long/short trades
Average mid-market p/l of the long/short accrued each month



Source: JPMorgan, data Aug 2000 – Aug 2007

Disregarding exit costs, most p/l is accrued during the first month, with a 3 vega profit. That is, from an initial p/l of -1.5 vegas (entry cost), the trade is up 1.5 vegas at the end of the first month. In the second month, the trade makes a further 1.7 vegas. The pattern of monthly accrual can be seen in the blue bars in Figure 20, which illustrate two points. First, the p/l is positive in each month of the trade, so that p/l accrues smoothly throughout its 6-month tenor. **Second, most of the relative performance of the RV-selected long/short stocks, occurs toward the beginning of the trade**. Most value is generated in the first month and then gently tails off in subsequent months.

However, after **taking account of the bid-offer cost of exiting the trade, the accrual of p/l is more linear through time**. (grey bars in Figure 20). This is because the 1.5 vega exit cost is spread out over the course of the trade, so its impact is more muted the longer the trade is held. Of course, holding the trade to maturity suffers no exit costs as each variance swap is marked simply against 6-months of realised volatility.

For example, if trades can be exited at mid, p/l is seen to accrue most quickly at the beginning of the trade, with a 3 vega p/l in the first month (Figure 20, blue bar). However to exit the trade after a month it would usually be necessary to cross bid/offers. Since 5/6 of the variance swap is left to run, it will cost about 5/6 of the 1.5 vega bid offer, or 1.25 vegas, to exit the trade. This leaves a gain during the first month of 1.75 vegas (Figure 20, grey bar), which from a base of -1.5 leaves a net p/l of only 0.25 vegas. Thus, although **the average mid-market p/l generated during the first month of the trade is 3 vegas, almost all of this would be wiped out by trading costs**. Figure 21 shows cumulative p/l accrual.

So although the informational content of the RV Score is highest at the beginning of the trade, bid/offer considerations mean it is often necessary to wait until closer to maturity to realise the bulk of the p/l.

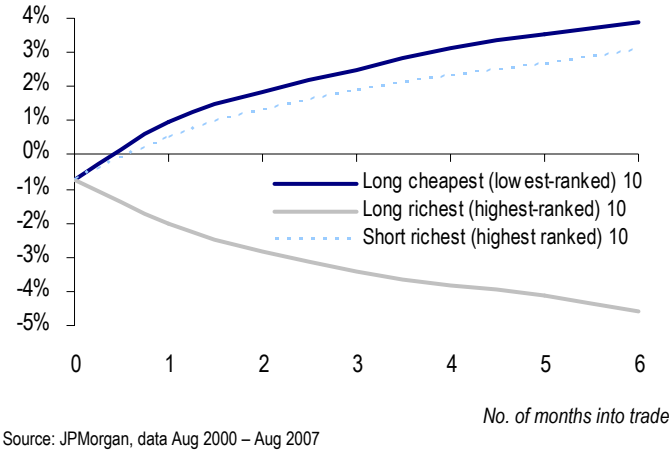
The case for holding trades longer than the first month or two is also supported by an analysis of the success ratio of the long/short trades. After one month, 65% of the trades are in profit before exit costs, a figure which rises steadily with holding period, reaching 90% after four months and 95% after six months.

The steady accrual of p/l occurs in both the long and the short baskets. Figure 22 shows the cumulative mark-to-market average performance of both long and short baskets separately. Profits generated from the short basket are nearly the same as those generated from the long basket.

In addition, **the steady accrual of p/l occurs in both high volatility and low volatility periods**. Figure 23 shows the cumulative mark-to-market performance of the average long/short basket in the period up to May 2003 and in the subsequent lower volatility period, with the pattern broadly similar in both cases.

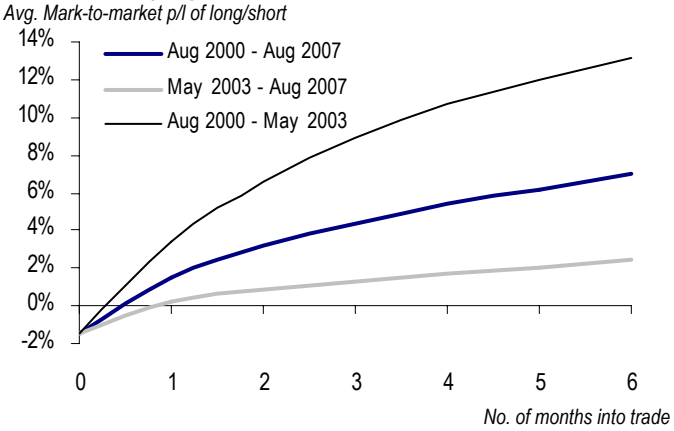
Finally, **the predictive power of the RV Score is almost as great after only 1-month as it is at expiry** (Figure 25).

Figure 22 : Mark-to-market performance of long and short baskets
Avg. Mark-to-market p/l



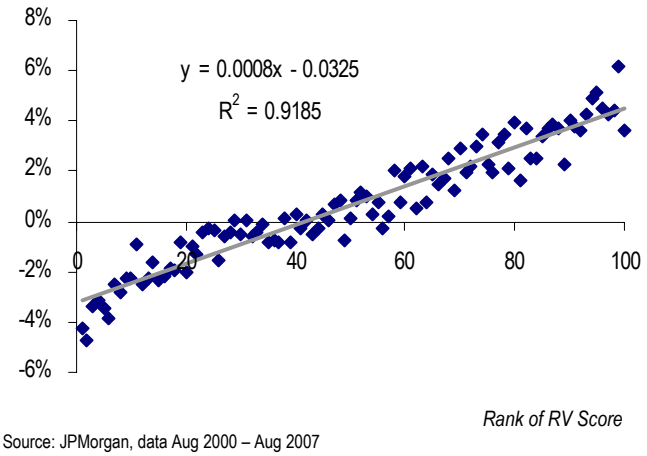
Source: JPMorgan, data Aug 2000 – Aug 2007

Figure 23 : Mark-to-market performance of long/short trades in high and low volatility regimes
Avg. Mark-to-market p/l of long/short



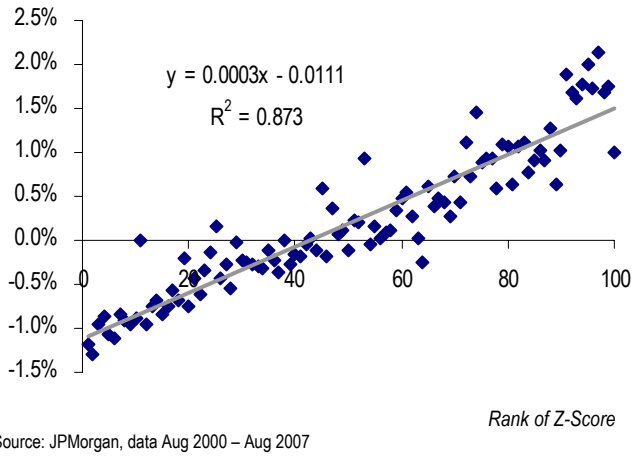
Source: JPMorgan

Figure 24 : The RV Score is effective for predicting p/l at maturity ....
Avg. p/l at 6-month maturity



Source: JPMorgan, data Aug 2000 – Aug 2007

Figure 25 : ... and also before maturity, in this case after 1 month
Avg. Mark-to-market p/l after 1 month



Source: JPMorgan, data Aug 2000 – Aug 2007

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3.6: Basket Turnover

Our backtest works by selecting baskets of 10 (or 20) stocks based on the highest and lowest RV Score. New baskets are selected every week, but do the constituents change substantially? Given a universe of 100 stocks and basket size of 10, if each basket selection was independent we would expect an average turnover of 9. However, since many of the factors used in determining our RV Score may change little from one week to the next, it is not unreasonable to expect that turnover figures will be much lower than this.

A realistic trading strategy may look to trade only once every month, or even to have only one set of trades running concurrently, and hence re-assign the baskets only once every 6 months. What would the turnover of these less frequent trading strategies look like?

We find that baskets change relatively little from week to week, with an average turnover of only 2 - 3 stocks per basket of 10 from one week to the next (Figure 26). Unsurprisingly, baskets change more over longer intervals (Table 4). Baskets change around half their stocks over a month, and most (all but 2 or 3) between the beginning and end of each 6-month period. Frequency of turnover is much the same across the high and low volatility periods and for the long and short baskets.

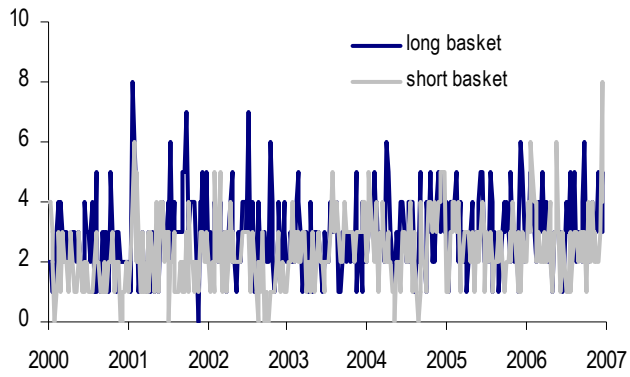
Table 4: Average turnover of the baskets (10 stocks per basket)

	Period over which change in basket composition is measured			
	1 W	1 M	3 M	6 M
Avg. turnover of long basket	2.7	5.1	6.9	7.7
Avg. turnover of short basket	2.4	4.3	6.0	6.9

Source: JPMorgan

Figure 26 : Turnover of the baskets 1 week apart

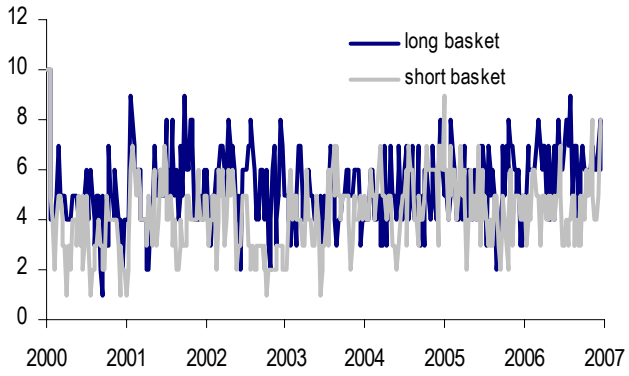
Turnover per basket of 10 stocks



Source: JPMorgan

Figure 27 : Turnover of the basket 1 month apart

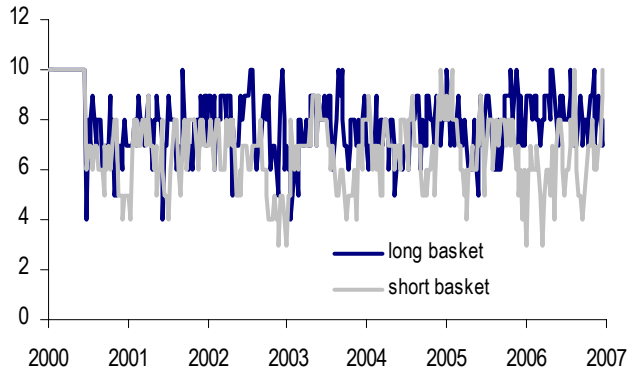
Turnover per basket of 10 stocks



Source: JPMorgan

Figure 28 : Turnover of the baskets 6 months apart

Turnover per basket of 10 stocks



Source: JPMorgan

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3.7: Sector composition of baskets

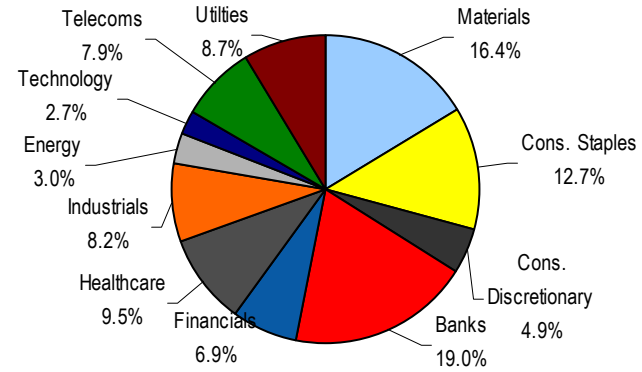
Is there a bias for our RV Score to identify volatilities from certain sectors to be rich or cheap? i.e. do some sectors show a bias to turn up more often than others in either the long or the short baskets?

We classify stocks using the GICS classification which assigns each stock to one of ten broad-based sectors. Since our universe contains a large proportion of financial stocks we subdivide this sector into banks and financials (non-banks), which in our universe almost entirely constitute insurance stocks.

Figure 29 and Figure 30 show the average sector composition of the 10-stock long and short volatility baskets. Since there are 11 sectors, a sector is over (respectively under) -represented if it contributes on average more (respectively less) than 9.1%. In the long volatility basket (Figure 29) Banks clearly form the largest proportion, with Materials and Consumer Staples also figuring prominently. Technology and Energy are under-represented. In the short volatility basket (Figure 30) Consumer Discretionary and Technology feature most, with Financials (ex. banks) featuring the least.

However, these figures fail to take account of the number of stocks in each sector in our overall universe. For example on average there are about 3 times more banks in our universe than technology companies, so it is not surprising that banks feature more often than Technology companies in the long basket (although, interestingly, not in the short basket). To correct for this bias, we rescale the percentage participation figure for each sector by that sector's weight in our universe. The resulting number, in effect, gives the probability of a stock from a specific sector ending up in any one basket. We then see that **the long basket tends to be relatively fairly balanced between sectors,** though with a tendency for Materials and Healthcare stocks to be more likely to end up in the basket. **There is a strong bias for technology stocks to end up in the short basket, with financials, banks, utilities and energy companies much less likely to make it in.**

Figure 29 : Average sector composition of the long basket



Percentage represents the average proportion of stocks in the basket from each sector

Figure 30 : Average sector composition of the short basket

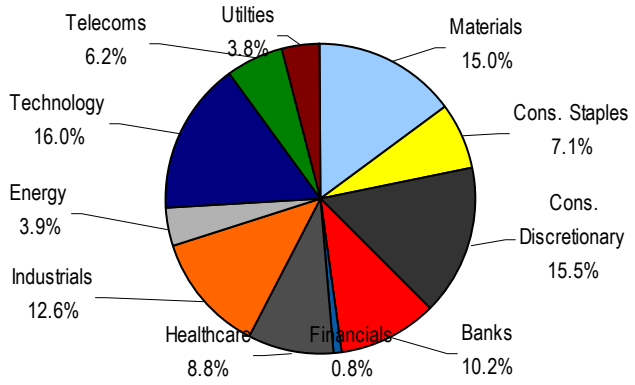
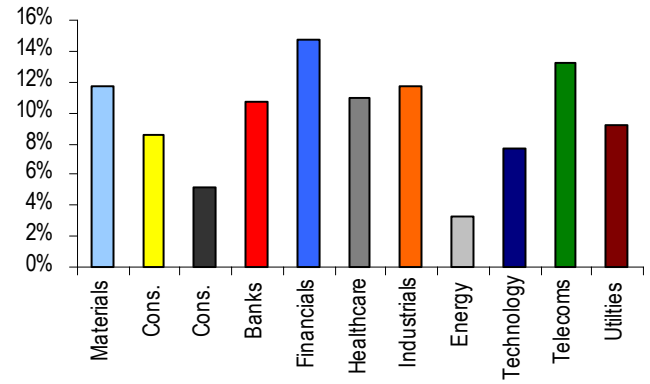
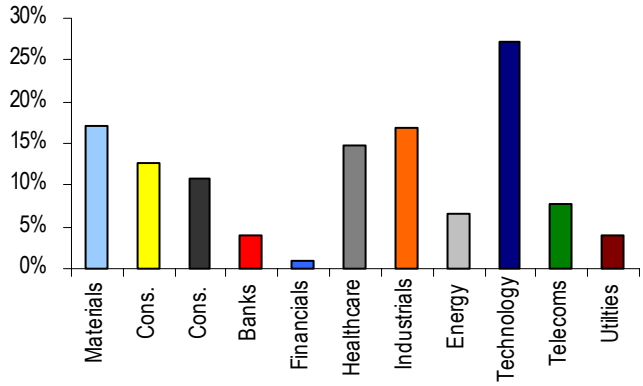


Figure 31 : Average normalised sector composition of the long basket



Percentage represents the probability that a stock from the given sector is included in the basket

Figure 32 : Average normalised sector composition of short basket



Source for all charts: JPMorgan

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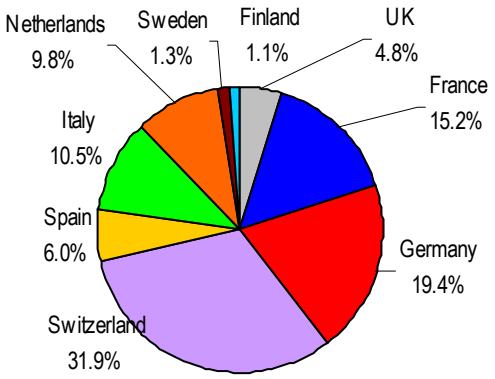
3.8: Country composition of baskets

We also consider if there is a bias for stocks from certain countries to be in either basket. There are nine countries in our universe, though two – Sweden and Finland – usually only contribute one stock each. **In the long volatility basket, the most heavily featured country is Switzerland, followed by France and Germany** (Figure 33). **In the short basket France, Germany and the UK dominate (Figure 34).**

Figure 33 and Figure 34 fail to take into account the distribution of countries within our universe. For example France accounts for about a quarter of all stocks, whereas only 1 stock from our universe is from Finland. Figure 35 and Figure 36 show the normalised country composition, in effect giving the probability that a stock in our universe from a particular country will find its way into either basket. There is a clear bias for Swiss stocks to end up in the long basket, with stocks from the UK and France much less likely to appear to have cheap volatility (Figure 35). In the short basket Finnish stocks (Nokia) and Swedish stocks (Ericsson) are very likely to be included, but since there is only one stock each in these cases, this is saying more about the individual stocks (Ericsson and Nokia), than their countries. Stocks from Spain, Italy and Switzerland are relatively unlikely to have rich looking volatility and be included in the short basket (Figure 36).

Noticeably, Swiss stocks appear consistently cheap according to our metrics. This could be due to flows in the Swiss market, with retail investors selling volatility to enhance yield, and lack of demand for single-stock volatility for dispersion trades compared to Euro Stoxx names.

Figure 33 : Average long basket composition by country



Percentage represents the average proportion of stocks in the basket from each country

Figure 34 : Average short basket composition by country

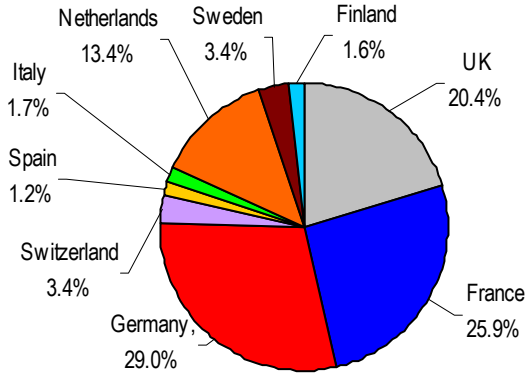
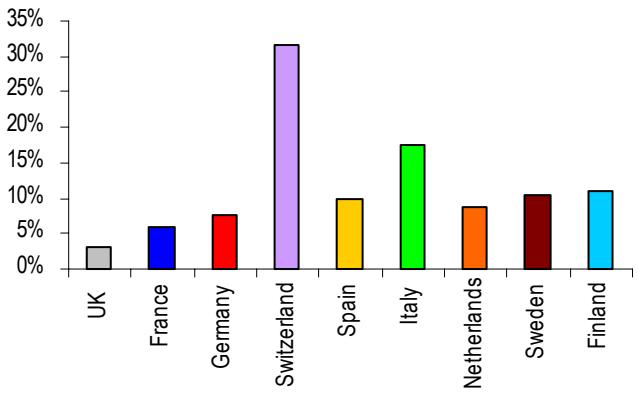
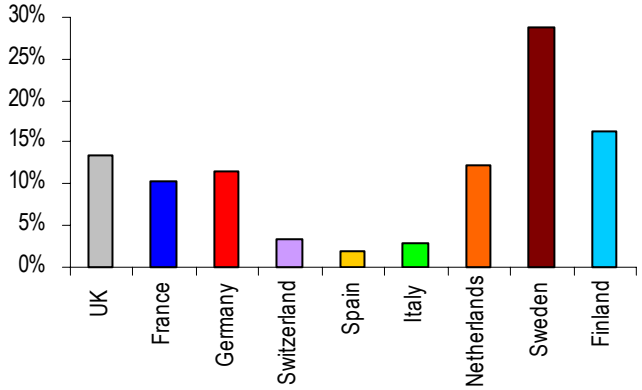


Figure 35 : Average normalised long basket composition by country



Percentage represents the probability that a stock from the given country is included in the basket

Figure 36 : Average normalised short basket composition by country



Source for all charts: JPMorgan

3.9: Results by Sector

Does our RV Score metric work *within* sectors? That is, if we restrict our universe of stocks to only those from a single sector and then run our ranking and backtest only on that sector, do we still get the same positive results we achieved on the entire 100 stock universe? **We find that the RV Score still works *within* sectors,** although the relative lack of stocks to choose from makes results less impressive than on the universe as a whole.

Since there are only 100 stocks in our universe, dividing them into the 10 (or 11, see p18) GICS sectors would leave an average of only 9 stocks to choose baskets from. We believe this is too few, and so have amalgamated the sectors into 5 groups:

1. Consumer (Discretionary and Staples)
2. Financials
3. Telecoms and Technology
4. Energy and Materials
5. Industrials and Utilities (including Pharma)

With around 20 stocks in each of these groupings we backtest each sector grouping using long/short variance swap baskets of 3 stocks each. Results are shown in the first five columns of Table 5. P/L is clearly more volatile than for the long/short baskets of 10 or 20 stocks chosen from the entire universe (final two columns), but average levels of returns are comparable to those obtained by choosing from all 100 stocks. **On average the long/short strategy within sectors returns 4.6 vegas**, with a maximum average return of 6.3 vegas for consumer stocks and a minimum return of 2.7 vegas for Telecoms and Technology. The long/short strategies within sectors produce positive returns between 65% and 85% of the time, depending on the sector. As usual these are all post bid/offer returns, so all intra-sector strategies are clearly beating their benchmarks. However, information and Sortino ratios are lower than equivalents for the whole universe, due in part to higher volatility resulting from less diversified baskets.

Table 5 also shows the effect of varying the basket size of the long/short variance swap strategy for the entire universe (final four columns). As would be expected, given the correlation of RV Score rank with future p/l (see p13), **using smaller baskets leads to higher absolute p/l.** However, p/l from smaller baskets is correspondingly more volatile, and the diversifying effect of using larger baskets makes up for the slightly lower returns of the extra stocks included. As a result information ratios (and hit ratios) stay relatively constant up to a basket size of 20. Overall, **baskets of size 5 – 20 (corresponding to top deciles or quintiles) appear to provide a good trade-off between risk and return.**

Table 5: Results by Sector Long/Short 3 stocks, August 2000 – August 2007

	Consumer	Financials	Telco & Tech	Energy & Materials	Industrials & Utilities	Entire Universe of 100 Stocks, basket size of …			
						3	5	10	20
Avg. Return	6.3%	4.6%	2.7%	4.2%	5.1%	9.7%	8.5%	6.9%	5.1%
Median	3.1%	1.8%	1.2%	2.6%	3.1%	6.3%	5.0%	3.2%	2.3%
Max	66.2%	61.9%	40.4%	29.5%	70.7%	67.7%	60.8%	46.7%	29.9%
Min	-14.2%	-24.6%	-25.6%	-9.2%	-42.6%	-13.1%	-3.8%	-1.7%	-0.5%
Stdev	11.2%	9.2%	7.0%	6.8%	11.0%	12.3%	10.6%	8.5%	6.3%
Down-Stdev	2.6%	3.5%	3.9%	1.7%	6.8%	3.3%	1.2%	0.5%	0.1%
I.R.	0.8	0.7	0.5	0.9	0.7	1.1	1.1	1.1	1.1
Sortino	3.5	1.9	1.0	3.6	1.1	4.1	10.3	18.8	53.7
% Positive	85%	68%	65%	73%	75%	91%	93%	95%	96%
… > 2 vegas	64%	48%	41%	55%	59%	78%	79%	73%	54%
… > 5 vegas	43%	33%	30%	37%	40%	61%	59%	45%	32%
IC	0.36	0.31	0.23	0.40	0.28	0.31	0.31	0.31	0.31

Source: JPMorgan

4: Comparison with other Z-Scores

In this section we compare the effectiveness of our RV Score with other ranking schema. Firstly we compare the RV Score to each of its component z-scores, the Fundamental Z-Score and the Volatility Z-Score. Secondly we compare the RV Score to more straightforward rankings based on implied and realised volatilities. Finally, as a control, we compare the scores resulting from purely random ranking.

In general, **we find that the RV Score outperforms our alternative ranking measures, particularly given the consistency of the RV Score across both high and low volatility regimes**.

Does this mean that our ranking is the optimal one to use? The short answer is we don't know, and we certainly haven't attempted to 'tune' our method to the data. What we have done is to compare our ranking with commonly used alternatives, which are at least partially successful in their own right. We also find that our Fundamental and Volatility Z-score rankings improve on these simpler measures, with the RV Score successfully combining *and* outperforming both of these measures.

In total we consider 6 different z-scores:

1. The 'combined' **RV Score** (p 23)
2. The **Fundamental Z-Score** (p24)
3. The **Volatility Z-Score** (p25)
4. An **Implied – Realised Z-Score** based on the spread of implied to traditional (3-month) realised volatility (p26)
5. An **Implied Only Z-Score** resulting from ranking stocks by their absolute level of implied volatility (p27)
6. A **Random Z-Score** created by assigning random values from a standard normal distribution to each stock on each trading day (p28). This acts as a control to determine if there is a bias in our method.

The results show that the **RV Score is consistently the best performing of any of these scores**, in particular showing improved performance in comparison to both the Fundamental Z-Score and the Volatility Z-Score from which it is constructed.

The **Volatility Z-Score** is based on the spread of implied minus realised volatility, but using an exponentially-weighted moving average model rather than traditional realised volatility. Is this an improvement? We find that it is. Although the improvement is slight, the Volatility Z-Score is consistently better across different performance measures and volatility regimes. In turn, the RV Score outperforms **the Implied – Realised Z-score**.

The **Fundamental Z-Score** has a bias to be long low volatility stocks and short high volatility stocks, a bias which is to some extent transferred to the combined RV Score. It is then natural to ask if the Fundamental Z-Score is doing no more than the **Implied Only Z-Score** which selects baskets based purely on the absolute level of implied variance. We find that whilst performance of these scores is similar since mid 2003, in the high volatility period the Implied-Only Z-Score made substantial losses whilst the Fundamental Z-Score performed well. Even since 2003, information ratios have been greater for the Fundamental Z-Score. We conclude that the Fundamental Z-Score (and the RV Score) has been superior to the Implied-Only Z-Score. See page 29 for details.

Finally using a **random Z-Score** produces the expected results: a 1.5 vega average loss for the long/short strategy equating to the loss from crossing the bid/offer spread. Information coefficients and rank correlations for this measure were close to zero, exactly as would be expected.

Table 6, Table 7 and Table 8 summarise results across the six ranking strategies for the entire 7-year period, as well as for the two sub-periods. Results for each strategy individually are then presented over the following pages.

The tables below show how **the RV Score outperforms all the other measures on an average return, Information Ratio and Hit Ratio**, during both high and low volatility regimes. See the following pages for more detailed descriptions of the performance of each of the individual strategies.

Table 6: Comparison of Z-Scores Aug 2000 – Aug 2007, performance of long/short variance strategy

	1. RV. Score	2. Fundamental Z-Score	3. Volatility Z-Score	4. Implied-Realised Z-Score	5. Implied only Z-Score	6. Random Z-Score
Avg. Return	**6.9%**	**4.0%**	**6.2%**	**5.3%**	**-1.4%**	**-1.5%**
Median	3.2%	2.4%	2.6%	2.1%	0.9%	-1.4%
Max	46.7%	35.7%	46.0%	52.4%	17.8%	27.8%
Min	-1.7%	-13.2%	-3.5%	-5.2%	-38.3%	-33.5%
Stdev	8.6%	5.7%	9.2%	9.1%	9.1%	6.7%
I.R.	**1.1**	**1.0**	**0.9**	**0.8**	**-0.2**	**-0.3**
Sortino	19.0	2.4	10.4	6.8	-0.2	-0.4
Hit ratio	**95%**	**88%**	**79%**	**78%**	**59%**	**30%**
I.C.	0.31	0.25	0.23	0.20	0.16	-0.01
Rank Correl	0.92	0.82	0.88	0.85	0.07	0.03

Table 7: Comparison of Z-Scores Aug 2000 – May 2003, performance of long/short variance strategy

	1. RV. Score	2. Fundamental Z-Score	3. Volatility Z-Score	4. Implied-Realised Z-Score	5. Implied only Z-Score	6. Random Z-Score
Avg. Return	**13.0%**	**7.5%**	**12.8%**	**11.1%**	**-5.5%**	**-2.0%**
Median	10.9%	6.3%	11.9%	8.2%	-4.9%	-1.7%
Max	46.7%	35.7%	46.0%	52.4%	17.8%	27.8%
Min	-1.6%	-13.2%	-3.2%	-5.2%	-38.3%	-33.5%
Stdev	10.3%	7.3%	10.9%	11.5%	12.6%	9.9%
I.R.	**1.8**	**1.5**	**1.7**	**1.4**	**-0.6**	**-0.3**
Sortino	52.3	3.0	18.3	10.9	-0.8	-0.4
Hit ratio	**96%**	**90%**	**92%**	**90%**	**29%**	**39%**
I.C.	0.32	0.24	0.29	0.26	-0.06	0.00
Rank Correl	0.87	0.69	0.84	0.75	0.20	0.02

Table 8: Comparison of Z-Scores May 2003 – Aug 2007, performance of long/short variance strategy

	1. RV. Z-Score	2. Fundamental Z-Score	3. Volatility Z-Score	4. Implied-Realised Z-Score	5. Implied only Z-Score	6. Random Z-Score
Avg. Return	**2.5%**	**1.5%**	**1.4%**	**1.1%**	**1.6%**	**-1.5%**
Median	2.4%	1.6%	0.9%	0.8%	1.9%	-1.5%
Max	8.6%	5.8%	8.9%	8.3%	7.0%	3.4%
Min	-1.7%	-3.9%	-3.5%	-3.9%	-6.5%	-8.0%
Stdev	1.7%	1.5%	2.3%	2.1%	2.5%	1.7%
I.R.	**2.1**	**1.4**	**0.9**	**0.8**	**0.9**	**-1.3**
Sortino	7.2	2.2	2.5	1.9	1.4	-1.6
Hit ratio	**95%**	**87%**	**71%**	**71%**	**82%**	**15%**
I.C.	0.30	0.26	0.18	0.15	0.31	-0.01
Rank Correl	0.86	0.80	0.75	0.68	0.83	0.02

Source for all tables: JPMorgan. All results refer to long/short baskets of 10 stocks each and assume a variance swap bid/offer spread of 1.5 vegas. For description of performance measures see p10. Hit ratio is the percentage of long/short variance trades with positive p/l. I.C. is the information coefficient (see p14)

4.1: RV Score Results

Over the following 6 pages we present detailed results for each of the six ranking strategies listed on page 21. All results are presented separately for the two periods, August 2000 – May 2003 and May 2003 – August 2007, and preceded by a summary of the salient points of each strategy.

RV Score

- Consistent risk-adjusted performance across high and low volatility periods
- Both long and short variance swap strategies outperform their benchmarks
- Average post bid/offer return of 2.5 vegas on the long/short strategy since 2003, and 13 vegas from 2000 to 2003.
- Information Ratios of around 2 for the long/short strategies over both periods
- Hit ratios of at least 95% for the long/short strategies over both periods
- Rank-correlation of around 0.86 over both periods
- Clear bias to be long low versus high volatility since 2003, prior to that bias was much less apparent

Table 9: RV Score Results: Aug 2000 – May 2003

Aug 2000 – May 2003	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	12.6%	0.4%	5.8%	13.0%	10.1%
Median	8.4%	2.1%	1.9%	10.9%	8.6%
Max	62.3%	14.4%	39.9%	46.7%	29.9%
Min	-11.3%	-25.6%	-12.6%	-1.6%	0.0%
Stdev	17.7%	9.5%	12.6%	10.3%	7.0%
Down-Stdev	3.2%	7.2%	3.7%	0.4%	-
I.R.	1.0	0.1	0.6	1.8	2.0
Sortino	5.5	0.1	2.2	52.3	-
Beats Bench.	89%	94%		96%	100%
...by 2 vegas	74%	90%		91%	91%
...by 5 vegas	57%	0%		80%	76%
Avg Implied	41.8%	44.5%	Rank correlation		0.87

Table 10: RV Score Results: May 2003- Aug 2007

May 2003 – Aug 2007	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	-2.6%	5.1%	-4.3%	2.5%	1.4%
Median	-2.7%	5.3%	-4.3%	2.4%	1.3%
Max	6.9%	14.3%	2.2%	8.6%	4.5%
Min	-9.2%	-3.0%	-9.0%	-1.7%	-0.5%
Stdev	3.1%	3.4%	2.7%	1.7%	1.0%
Down-Stdev	2.0%	1.0%	2.4%	0.5%	0.1%
I.R.	-1.2	2.1	-2.3	2.1	2.0
Sortino	-1.8	7.0	-2.5	7.2	15.1
Beats Bench.	94%	98%		95%	94%
...by 2 vegas	31%	65%		60%	27%
...by 5 vegas	2%	0%		19%	1%
Avg Implied	22.6%	30.0%	Rank Correlation		0.86

Figure 37 : RV Score - Long/Short Performance Aug 2000 - Aug 2003

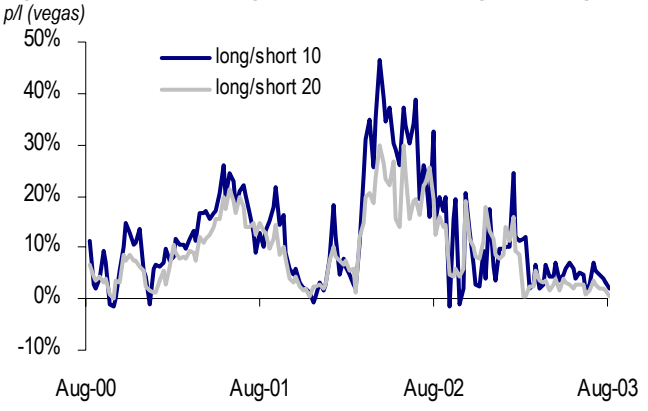
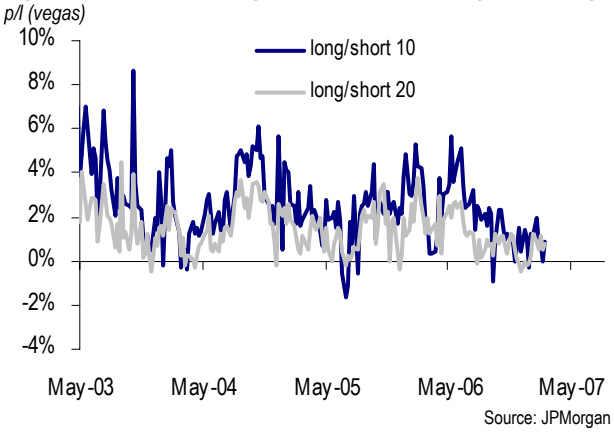


Figure 38 : RV Score - Long/Short Performance May 2003 – Aug 2007



Source: JPMorgan

4.2: Fundamental Z-Score Results

- Performs well across both periods, though not as well as the RV-Score.
- Average post bid/offer return of 1.5 vegas on the long/short strategy since 2003, and 7.5 vegas from 2000 to 2003.
- Shows a consistent and strong bias to be long low volatility over high volatility (see Figure 51)
- Since 2003, performance is similar to being simply long variance on low volatility stocks and short variance on high volatility stocks (compare Table 18 and Figure 46) although performance was far to superior to this naïve strategy pre 2003 (Table 17).

Table 11: Fundamental Z-Score Results: Aug 2000 – May 2003

Aug 2000 – May 2003	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	8.9%	-1.4%	5.8%	7.5%	5.3%
Median	6.4%	0.3%	1.9%	6.3%	5.2%
Max	55.2%	17.1%	39.9%	35.7%	19.1%
Min	-11.5%	-28.6%	-12.6%	-13.2%	-8.3%
Stdev	13.7%	10.1%	12.6%	7.3%	4.7%
Down-Stdev	2.3%	6.4%	3.7%	3.6%	2.7%
I.R.	0.9	-0.2	0.6	1.5	1.6
Sortino	5.4	-0.3	2.2	3.0	2.7
Beats Bench.	76%	87%		90%	92%
...by 2 vegas	63%	77%		83%	75%
...by 5 vegas	31%	0%		69%	64%
Avg Implied	34.1%	49.5%	Rank correlation		0.69

Table 12: Fundamental Z-Score Results: May 2003- Aug 2007

May 2003 – Aug 2007	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	-3.0%	4.5%	-4.3%	1.5%	0.7%
Median	-3.0%	5.0%	-4.3%	1.6%	0.8%
Max	6.6%	13.8%	2.2%	5.8%	3.2%
Min	-9.0%	-6.4%	-9.0%	-3.9%	-3.7%
Stdev	2.9%	3.6%	2.7%	1.5%	1.1%
Down-Stdev	2.2%	1.9%	2.4%	1.0%	1.1%
I.R.	-1.5	1.8	-2.3	1.4	0.9
Sortino	-2.0	3.5	-2.5	2.1	0.9
Beats Bench.	96%	90%		87%	83%
...by 2 vegas	12%	43%		40%	9%
...by 5 vegas	0%	0%		4%	0%
Avg Implied	20.5%	31.2%	Rank correlation		0.80

Figure 39 : Fundamental Z-Score Long/Short Performance Aug 2000 - Aug 2003

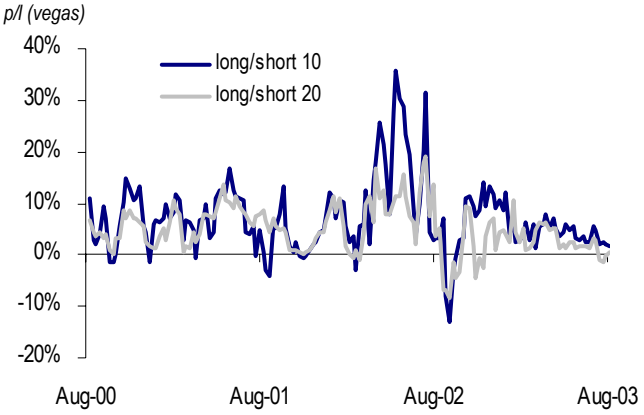
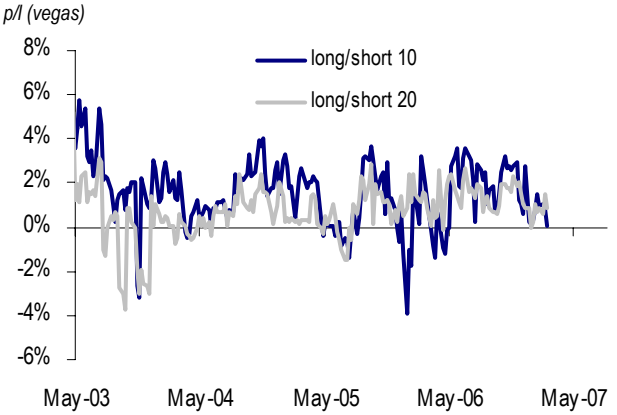


Figure 40 : Fundamental Z-Score Long/Short Performance May 2003 – Aug 2007



Source: JPMorgan

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4.3: Volatility Z-Score Results

- Performs better in the higher volatility period up to 2003, but still does relatively well in the period since.
- Performs noticeably better than the Fundamental Z-Score in the period 2000-2003, but the Fundamental Z-Score has done slightly better in the period since.
- Particularly good for choosing the short volatility basket – beats being short average single-stock volatility 99% of the time pre 2003, and 97% of the time since then.
- Unlike the Fundamental Z-Score, shows a bias to be long *higher* volatility stocks up to 2003, but shows no volatility bias since then.
- Performance is similar to, but marginally better than, the Implied-Realised Z-Score, though it is consistently better across both time periods and on all performance measures.

Table 13: Volatility Z-Score Results: Aug 2000 – May 2003

Aug 2000 – May 2003	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	12.7%	0.1%	5.8%	12.8%	10.3%
Median	8.8%	2.4%	1.9%	11.9%	8.7%
Max	57.8%	14.8%	39.9%	46.0%	35.1%
Min	-13.6%	-33.2%	-12.6%	-3.2%	-1.8%
Stdev	18.1%	9.4%	12.6%	10.9%	7.7%
Down-Stdev	3.5%	8.4%	3.7%	1.0%	0.6%
I.R.	1.0	0.0	0.6	1.7	1.9
Sortino	5.1	0.0	2.2	18.3	22.5
Beats Bench.	83%	99%		92%	96%
...by 2 vegas	74%	90%		86%	85%
...by 5 vegas	60%	0%		80%	76%
Avg Implied	49.5%	37.9%	Rank correlation		0.84

Table 14: Volatility Z-Score Results: May 2003- Aug 2007

May 2003 – Aug 2007	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	-3.2%	4.6%	-4.3%	1.4%	0.9%
Median	-3.3%	4.2%	-4.3%	0.9%	0.7%
Max	7.8%	13.2%	2.2%	8.9%	4.7%
Min	-9.9%	-3.0%	-9.0%	-3.5%	-2.5%
Stdev	3.1%	3.1%	2.7%	2.3%	1.6%
Down-Stdev	2.2%	0.9%	2.4%	0.8%	0.6%
I.R.	-1.4	2.1	-2.3	0.9	0.7
Sortino	-2.0	7.6	-2.5	2.5	2.0
Beats Bench.	73%	97%		71%	67%
...by 2 vegas	18%	41%		34%	25%
...by 5 vegas	6%	0%		15%	5%
Avg Implied	26.4%	27.0%	Rank correlation		0.75

Figure 41 : Volatility Z-Score Long/Short Performance Aug 2000 - Aug 2003

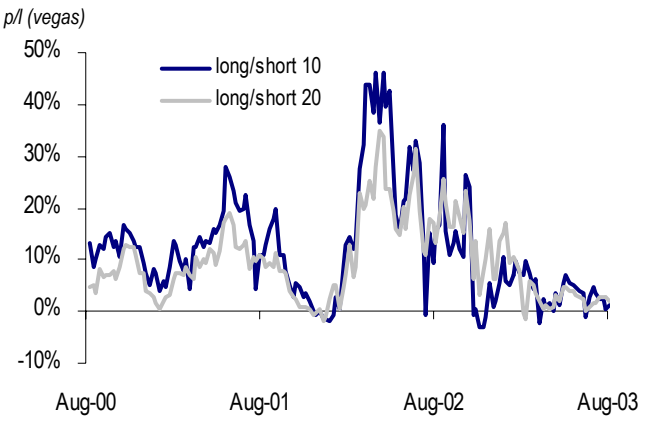
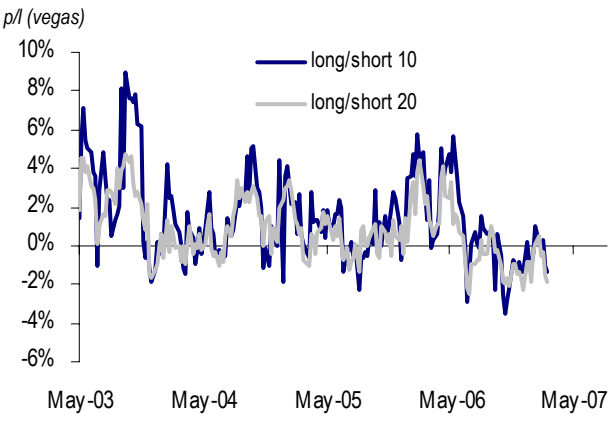


Figure 42 : Volatility Z-Score Long/Short Performance: May 2003 – Aug 2007



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4.4: Implied - Realised Z-Score Results

- Performs well, especially in the higher volatility period pre 2003.
- More recently performance has been muted (Figure 44).
- Similar, though slightly inferior, to Volatility Z-Score performance (see previous page).

Table 15: Implied-Realised Z-Score Results: Aug 2000 – May 2003

Aug 2000 – May 2003	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	11.9%	-0.9%	5.8%	11.1%	9.2%
Median	7.0%	1.3%	1.9%	8.2%	7.4%
Max	67.1%	16.9%	39.9%	52.4%	32.2%
Min	-12.2%	-32.7%	-12.6%	-5.2%	-2.2%
Stdev	19.1%	10.2%	12.6%	11.5%	7.3%
Down-Stdev	3.2%	9.1%	3.7%	1.4%	0.7%
I.R.	0.9	-0.1	0.6	1.4	1.8
Sortino	5.2	-0.1	2.2	10.9	19.0
Beats Bench.	82%	96%		90%	95%
...by 2 vegas	73%	83%		83%	88%
...by 5 vegas	50%	0%		75%	74%
Avg Implied	48.6%	38.9%	Rank correlation		0.75

Table 16: Implied-Realised Z-Score Results: May 2003- Aug 2007

May 2003 – Aug 2007	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	-3.3%	4.4%	-4.3%	1.1%	0.6%
Median	-3.4%	4.4%	-4.3%	0.8%	0.3%
Max	5.4%	13.1%	2.2%	8.3%	5.2%
Min	-9.6%	-4.7%	-9.0%	-3.9%	-2.6%
Stdev	3.0%	3.1%	2.7%	2.1%	1.6%
Down-Stdev	2.3%	1.5%	2.4%	0.8%	0.7%
I.R.	-1.5	2.0	-2.3	0.7	0.5
Sortino	-2.1	4.1	-2.5	1.9	1.1
Beats Bench.	70%	95%		71%	58%
...by 2 vegas	21%	36%		28%	18%
...by 5 vegas	4%	0%		8%	3%
Avg Implied	26.3%	26.9%	Rank correlation		0.68

Figure 43 : Implied-Realised Z-Score Long/Short Performance Aug 2000 - Aug 2003

p/l (vegas)

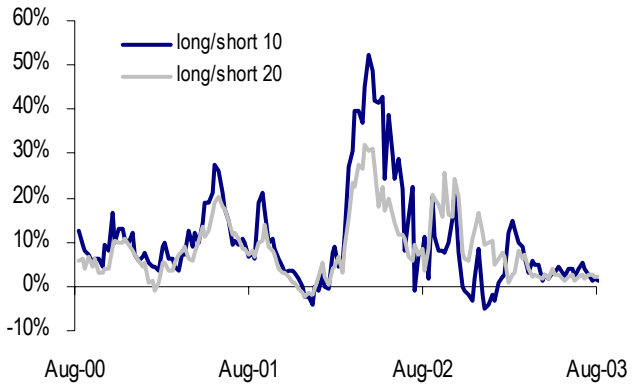
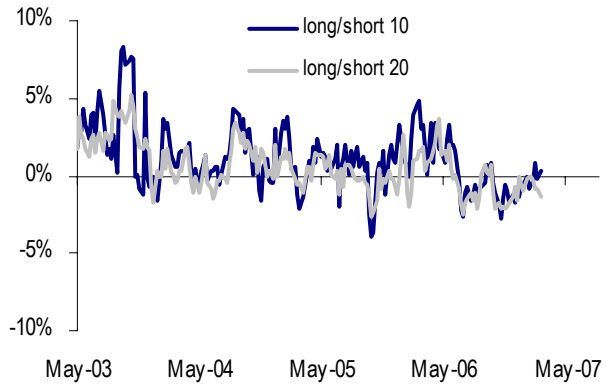


Figure 44 : Implied-Realised Z-Score Long/Short Performance: May 2003 – Aug 2007

p/l (vegas)



Source: JPMorgan

4.5: Implied Only Z-Score Results

- Overall performs poorly, especially when volatility is higher.
- Performs well in the low volatility environment with similar performance characteristics to the Fundamental Z-Score. However information ratios are less than 1.0 for the long/short.
- However in the high volatility environment before 2003, performance is consistently worse than the relevant benchmarks. Returns of the long/short strategy are negative.

Table 17: Implied Only Z-Score Results: Aug 2000 – May 2003

Aug 2000 – May 2003	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	4.4%	-9.9%	5.8%	-5.5%	-4.5%
Median	2.8%	-11.3%	1.9%	-4.9%	-3.2%
Max	25.2%	24.4%	39.9%	17.8%	11.6%
Min	-7.4%	-62.1%	-12.6%	-38.3%	-21.3%
Stdev	8.2%	19.0%	12.6%	12.6%	7.2%
Down-Stdev	2.3%	14.0%	3.7%	9.4%	5.8%
I.R.	0.8	-0.7	0.6	-0.6	-0.9
Sortino	2.7	-1.0	2.2	-0.8	-1.1
Beats Bench.	49%	34%		29%	23%
...by 2 vegas	26%	27%		22%	14%
...by 5 vegas	8%	0%		20%	10%
Avg Implied	25.1%	63.4%	Rank correlation		0.20

Table 18: Implied Only Z-Score Results: May 2003- Aug 2007

May 2003 – Aug 2007	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	-2.7%	4.4%	-4.3%	1.6%	1.0%
Median	-2.7%	4.8%	-4.3%	1.9%	1.3%
Max	2.0%	12.9%	2.2%	7.0%	4.6%
Min	-7.3%	-8.6%	-9.0%	-6.5%	-4.7%
Stdev	2.2%	3.9%	2.7%	2.5%	2.0%
Down-Stdev	2.0%	2.1%	2.4%	1.7%	1.0%
I.R.	-1.7	1.6	-2.3	0.9	0.7
Sortino	-1.9	2.9	-2.5	1.4	1.3
Beats Bench.	93%	85%		82%	73%
...by 2 vegas	30%	43%		47%	34%
...by 5 vegas	0%	0%		15%	3%
Avg Implied	17.3%	34.7%	Rank correlation		0.83

Figure 45 : Implied Only Z-Score Long/Short Performance Aug 2000 - Aug 2003

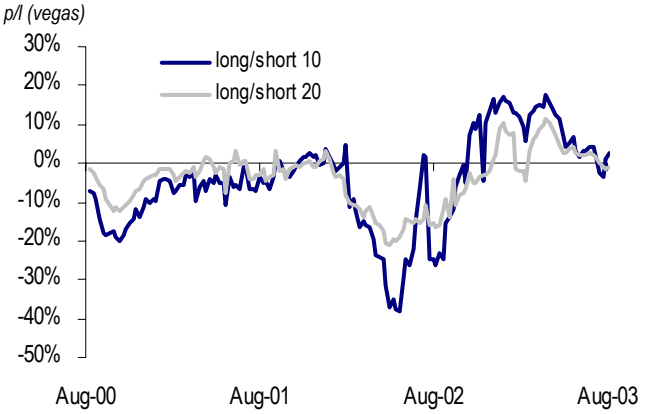
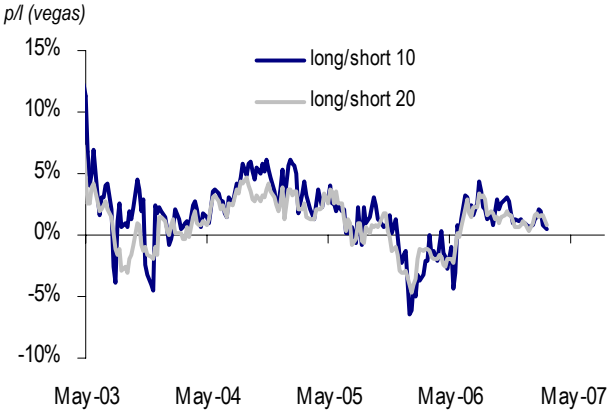


Figure 46 : Implied Only Z-Score Long/Short Performance: May 2003 – Aug 2007



Source: JPMorgan

4.6: Random Z-Score Results

- Acts as a control to demonstrate the backtest method is un-biased
- Long/short strategies have average return of around -1.5 vegas, equal to the transaction costs of entering the trade
- Long/short performance similar across volatility regimes.
- Individual long and short strategies perform in line with their benchmarks
- Correlation of rank with subsequent p/l is close to zero
- Average implied volatility of the long and short baskets is the same.

Table 19: Random Z-Score Results: Aug 2000 – May 2003

Aug 2000 – May 2003	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	4.9%	-6.9%	5.8%	-2.0%	-1.5%
Median	1.1%	-3.3%	1.9%	-1.7%	-1.0%
Max	49.2%	20.3%	39.9%	27.8%	15.6%
Min	-15.3%	-50.3%	-12.6%	-33.5%	-29.3%
Stdev	13.6%	14.1%	12.6%	9.9%	6.7%
Down-Stdev	3.9%	12.9%	3.7%	6.7%	5.2%
I.R.	0.5	-0.7	0.6	-0.3	-0.3
Sortino	1.8	-0.8	2.2	-0.4	-0.4
Beats Bench.	41%	57%		39%	42%
...by 2 vegas	26%	37%		27%	26%
...by 5 vegas	15%	0%		23%	19%
Avg Implied	39.6%	39.6%	Rank correlation		0.02

Table 20: Random Z-Score Results: May 2003- Aug 2007

May 2003 – Aug 2007	Long top 10	Short top 10	Long All SS	Long / Short 10	Long / Short 20
Avg. Return	-4.3%	3.1%	-4.3%	-1.2%	-1.5%
Median	-4.4%	3.1%	-4.3%	-1.2%	-1.5%
Max	4.8%	9.8%	2.2%	6.7%	3.4%
Min	-12.7%	-7.9%	-9.0%	-11.1%	-8.0%
Stdev	3.3%	3.1%	2.7%	2.5%	1.7%
Down-Stdev	2.7%	1.9%	2.4%	1.8%	1.4%
I.R.	-1.9	1.4	-2.3	-0.7	-1.3
Sortino	-2.3	2.3	-2.5	-1.0	-1.6
Beats Bench.	42%	65%		23%	15%
...by 2 vegas	10%	11%		9%	2%
...by 5 vegas	3%	0%		4%	0%
Avg Implied	25.6%	25.4%	Rank correlation		0.02

Figure 47 : Random Z-Score Long/Short Performance Aug 2000 - Aug 2003

p/l (vegas)

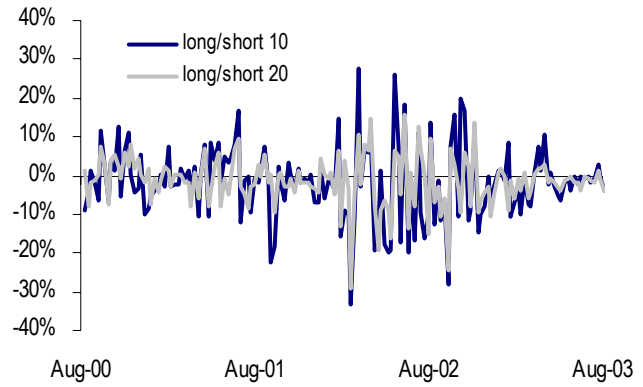
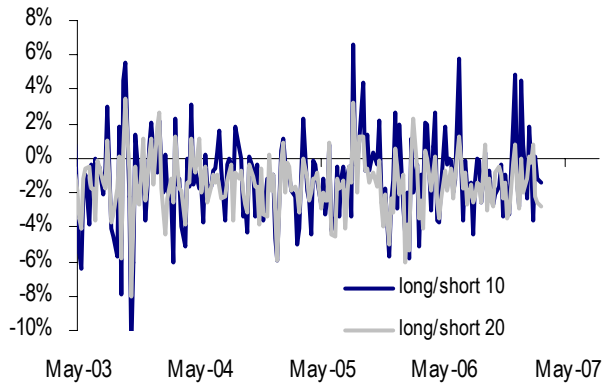


Figure 48 : Random Z-Score Long/Short Performance: May 2003 – Aug 2007

p/l (vegas)



Source: JPMorgan

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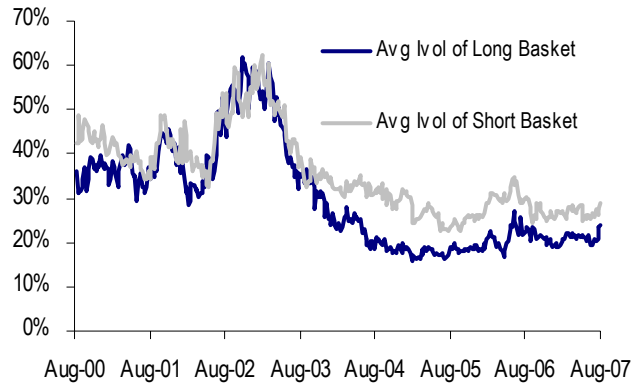
4.7: Volatility Bias

The Fundamental Z-Score strategy has a strong bias to be long variance on low-volatility stocks and short variance on high-volatility stocks. In fact the average spread of implied volatilities between the long and short baskets is around 10 vegas (Figure 51). No such systematic bias exists for the Volatility Z-Score strategy. In fact, at least up until 2003, it exhibited the opposite bias (Figure 52). However, since 2003, the combined strategy has shown a clear bias, inherited from the Fundamental Z-Score, to be long variance on low volatility against high volatility stocks (Figure 49). This naturally begs the question: how well does a strategy which is systematically long variance on the lowest volatility names and short variance on the highest volatility names perform?

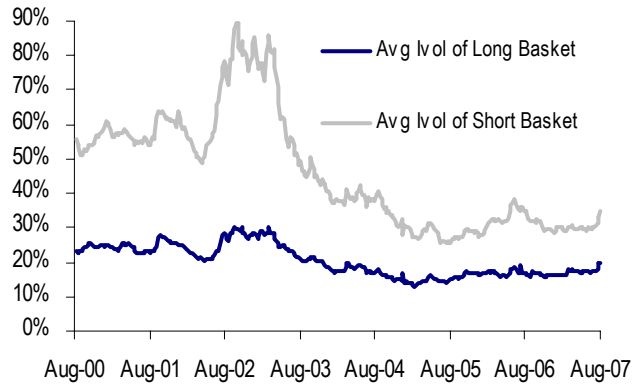
In fact, this strategy, which we refer to as 'Implied Only Z-Score', fared badly in 2000 – 2003 (Figure 45), but has performed relatively well since 2003 (Figure 46). However even in this period, risk-adjusted returns are not quite as good as those from the individual (Volatility and Fundamental) Z-Score strategies, and certainly not as good as returns from the combined Z-Score strategy. Over the entire 7-year period, performance of this long/short strategy has actually been slightly negative (Table 6, column 5). **We conclude our combined RV Score strategy *is* performing significantly differently to simply selecting low versus high implied variance.**

Figure 49 : RV Score - average volatility of the long and short baskets. Recently there has been a bias to be long low vs. high volatility…
Average implied variance



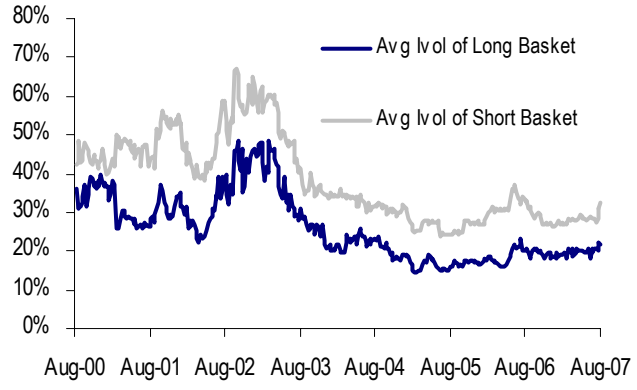
Source: JPMorgan

Figure 50 : … but not as much if we had simply chosen the highest and lowest volatility stock in each basket
Average implied variance



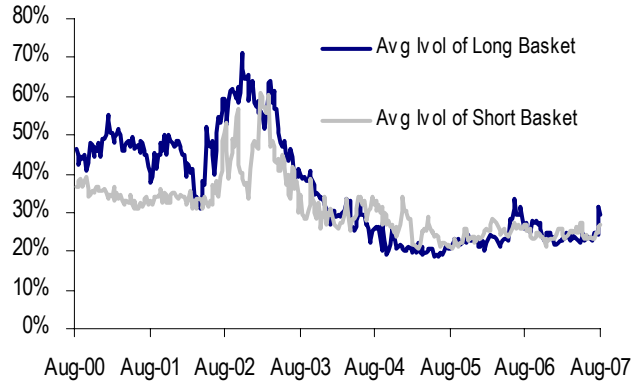
Source: JPMorgan, Long (short) basket is 10 lowest (highest) volatility stocks

Figure 51 : Fundamental Z-Score - shows a systematic bias to be long low volatility stocks and short high volatility stocks
Average implied variance



Source: JPMorgan

Figure 52 : Volatility Z-Score – is close to neutral since 2003 and was biased to be *long* higher volatility stocks before then
Average implied variance



Source: JPMorgan

5: Conclusions

The results of the backtest presented above demonstrate that our **RV Score works well in ranking European single-stock volatility across different performance measures and across high and low volatility regimes.** The RV score shows a consistent improvement from both the Volatility Z-Score and the Fundamental Z-Score from which it is constructed. In turn these are both improvements on simpler scores such as using a simple spread of implied over realised, or just the absolute level of implied volatility.

Our new daily report lists each day's RV Score ranking across a universe of 100 European names. In Appendix 2 we include a copy of the most recent report at the time of publication (see page 32). In some sense this scoring metric and report aims to do the same thing for single-stock variance swaps as our Rangebound Report does for vanilla options (see *Movers and Shakers, May 2003*). **Whilst the rangebound scores are effective for determining value for vanilla options, the RV Score looks for value amongst single-stock variance swaps.**

Our ranking (and backtest) was carried out entirely for 6-month maturity variance swaps. In our view, not only is this a reasonable benchmark for backtesting variance swap strategies, but results are likely to be relevant for 3-month and 1-year variance. Indeed partial backtesting of a 3-month strategy shows that results are at least similar to the 6-month backtest presented here.

Applications of our RV Score could include trading **long/short baskets of single-stock variance** and more generally screening a universe of single-stocks for relative value volatility, perhaps for **volatility pairs trades**. In addition the methodology naturally lends itself to **constructing baskets for enhanced dispersion trades** where the aim is to find a basket of stocks with 'cheap' variance to trade against an index. See JPMorgan's forthcoming paper on this topic.

Finally, it should be emphasised that **the methodology for computing our RV Score is not set in stone**. Our aim here has been to present a relative simple and intuitive basis for our ranking and to demonstrate how *and why* it is successful. Of course it is unlikely to be *the* optimal ranking to use, and part of our belief in the robustness of our results stems from the fact that we have not attempted to tune our parameters to the data set. Having said that, one of the biggest risks to any quantitative factor-driven model is that the model fails to include future drivers of volatility.

Nonetheless improvements should be possible by refining scores in a *meaningful* way. In the case of the Volatility Z-Score, more sophisticated volatility models could be used, and GARCH would be one possibility. Also the effect of earnings day moves should perhaps be dealt with more subtly, especially in an exponentially-weighted type model where very recent moves are given extra weight. The Fundamental Z-Score could perhaps be improved through different, or even dynamic, choices of parameters. Perhaps a process could identify factors which have recently become relevant and include them in the model for the Fundamental Z-Score when they are judged sufficiently important.

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Appendices

Appendix 1: The Current Universe

Table 21 shows the current universe of stocks as would be used by our backtest. This list is selected purely algorithmically to give the top 'n' stocks from each of various European country indices as follows:

1. **UK** (FTSE 100) top 15
2. **Switzerland** (SMI) top 10
3. **France** (CAC 40) top 25
4. **Germany** (DAX 30) top 25
5. **Spain** (IBEX) top 6
6. **Italy** (SPMIB) top 6
7. **Netherland**s (AEX) top 11
8. **Sweden** (OMX) top 1
9. **Finland** (HEX) top 1

In reality a trading basket would be chosen to screen out dual listings (e.g. Royal Dutch Shell) and to exclude stocks which are awaiting completion of a cash offer (e.g. Endesa currently). Our daily report (see Appendix 2) amends the basket to take account of some of these issues.

Table 21: Current universe of 100 European Stocks

Country	No.	BB Ticker	Country	No.	BB Ticker	Country	No.	BB Ticker	Country	No.	BB Ticker
UK	**1**	BP/ LN	**France**	**26**	FP FP	**Germany**	**51**	SIE GY	**Spain**	**76**	SAN SQ
(15)	**2**	HSBA LN	**(25)**	**27**	BNP FP	**(25)**	**52**	EOA GY	**(6)**	**77**	TEF SQ
	3	VOD LN		**28**	SAN FP		**53**	ALV GY		**78**	BBVA SQ
	4	GSK LN		**29**	GLE FP		**54**	DCX GY		**79**	IBE SQ
	5	RDSA LN		**30**	CS FP		**55**	DBK GY		**80**	REP SQ
	6	RBS LN		**31**	SZE FP		**56**	BAS GY		**81**	ELE SQ
	7	RDSB LN		**32**	FTE FP		**57**	DTE GY	**Italy**	**82**	ENI IM
	8	BARC LN		**33**	VIV FP		**58**	BAY GY	**(6)**	**83**	UC IM
	9	AAL LN		**34**	MTP FP		**59**	RWE GY		**84**	ISP IM
	10	HBOS LN		**35**	CA FP		**60**	MUV2 GY		**85**	ENEL IM
	11	AZN LN		**36**	SGO FP		**61**	SAP GY		**86**	G IM
	12	RIO LN		**37**	SU FP		**62**	CBK GY		**87**	TIT IM
	13	TSCO LN		**38**	ACA FP		**63**	DPW GY	**Netherlands**	**88**	RDSA NA
	14	LLOY LN		**39**	OR FP		**64**	VOW GY	**(11)**	**89**	INGA NA
	15	BLT LN		**40**	MC FP		**65**	TKA GY		**90**	AABA NA
Switzerland	**16**	NESN VX		**41**	ALU FP		**66**	CON GY		**91**	MT NA
(10)	**17**	NOVN VX		**42**	LG FP		**67**	BMW GY		**92**	FORA NA
	18	ROG VX		**43**	RNO FP		**68**	MAN GY		**93**	UNA NA
	19	UBSN VX		**44**	VIE FP		**69**	MEO GY		**94**	PHIA NA
	20	CSGN VX		**45**	EDF FP		**70**	LIN GY		**95**	AGN NA
	21	ABBN VX		**46**	EN FP		**71**	LHA GY		**96**	KPN NA
	22	ZURN VX		**47**	RI FP		**72**	ADS GY		**97**	AKZA NA
	23	RUKN VX		**48**	DX FP		**73**	IFX GY		**98**	AH NA
	24	CFR VX		**49**	AC FP		**74**	HRX GY	**Sweden**	**99**	ERICB SS
	25	HOLN VX		**50**	ML FP		**75**	DPB GY	**Finland**	**100**	NOK1V FH

Source: JPMorgan

Appendix 2: Current Rankings and Daily Report

Below is a copy of our new Daily Report, available via MorganMarkets, Bloomberg and email. The report ranks 100 stocks according to their RV score (most expensive volatility at the top, cheapest at the bottom), and shows component Volatility and Fundamental Z-Scores. Variance levels are estimated mid levels. Stocks with missing data are ranked at the bottom.

European Single Stock Variance Relative Value Report

Data for close of business 28 September 2007 (Source: J.P. Morgan Securities Ltd.). Universe of 100 most liquid single stock variance.

Rank	Company	Bloomberg	Reuters	6M Implied Variance	Volatility Z-Score	Rank	Fundamental Z-Score	Rank	RV Score	Rank
1	KONINKLIJKE AHOLD	AH NA	AHLN.AS	30.7	0.98	11	1.82	5	1.40	1
2	ENDESA	ELE SQ	ELE.MC	17.6	3.60	1	-0.91	83	1.35	2
3	PEUGEOT	UG FP	PEUP.PA	31.0	0.74	22	1.80	7	1.27	3
4	CARREFOUR	CA FP	CARR.PA	26.7	0.58	32	1.54	10	1.06	4
5	SAP	SAP GY	SAPG.DE	23.8	1.52	3	0.37	30	0.94	5
6	STMICROELECTRONICS	STM FP	STM.PA	29.1	0.83	16	1.02	17	0.92	6
7	GLAXOSMITHKLINE	GSK LN	GSK.L	21.8	1.11	8	0.62	24	0.87	7
8	AKZO NOBEL	AKZA NA	AKZO.AS	28.8	0.31	41	1.31	12	0.81	8
9	ELECTRICITE DE FRANCE	EDF FP	EDF.PA	26.7	0.88	14	0.64	23	0.76	9
10	DEUTSCHE LUFTHANSA	LHA GY	LHAG.DE	28.8	0.54	35	0.96	18	0.75	10
11	ASTRAZENECA	AZN LN	AZN.L	23.9	1.21	5	0.28	34	0.75	11
12	ASML HOLDING	ASML NA	ASML.AS	29.6	0.62	29	0.76	21	0.69	12
13	DEUTSCHE TELEKOM	DTE GY	DTEGn.DE	20.8	1.60	2	-0.33	67	0.64	13
14	NOKIA OYJ	NOK1V FH	NOK1V.HE	31.2	-0.47	75	1.64	9	0.58	14
15	TESCO	TSCO LN	TSCO.L	26.3	-0.52	77	1.67	8	0.58	15
16	IBERDROLA	IBE SQ	IBE.MC	26.9	0.72	24	0.42	28	0.57	16
17	ROYAL BANK OF SCOTLAND GROUP	RBS LN	RBS.L	29.9	-1.05	89	2.13	2	0.54	17
18	UNILEVER NV-CVA	UNA NA	UNc.AS	23.7	0.61	31	0.43	27	0.52	18
19	RWE	RWE GY	RWEG.DE	22.5	1.42	4	-0.42	72	0.50	19
20	BT GROUP	BT/A LN	BT.L	25.0	-0.19	65	1.15	15	0.48	20
21	LLOYDS TSB GROUP	LLOY LN	LLOY.L	26.0	0.12	50	0.80	20	0.46	21
22	VIVENDI	VIV FP	VIV.PA	24.0	0.69	25	0.23	36	0.46	22
23	ERICSSON LM-B SHS	ERICB SS	ERICb.ST	30.0	0.40	40	0.51	26	0.46	23
24	THYSSENKRUPP	TKA GY	TKAG.DE	30.9	1.14	7	-0.24	57	0.45	24
25	METRO	MEO GY	MEOG.DE	27.6	-0.16	63	1.05	16	0.44	25
26	PERNOD-RICARD	RI FP	PERP.PA	23.4	0.99	10	-0.12	50	0.44	26
27	VODAFONE GROUP	VOD LN	VOD.L	27.7	0.01	56	0.81	19	0.41	27
28	GROUPE DANONE	BN FP	DANO.PA	24.9	0.87	15	-0.06	47	0.40	28
29	RENAULT	RNO FP	RENA.PA	32.7	-0.68	81	1.47	11	0.40	29
30	VEOLIA ENVIRONNEMENT	VIE FP	VIE.PA	24.8	1.06	9	-0.29	63	0.39	30
31	DEXIA	DX FP	DEXI.PA	28.3	0.09	52	0.67	22	0.38	31
32	ALCATEL-LUCENT	ALU FP	ALUA.PA	42.0	-0.50	76	1.20	14	0.35	32
33	HSBC HOLDINGS	HSBA LN	HSBA.L	20.7	0.66	26	0.01	40	0.34	33
34	TELECOM ITALIA	TIT IM	TLIT.MI	24.5	0.81	18	-0.15	51	0.33	34
35	INTESA SANPAOLO	ISP IM	ISP.MI	23.4	0.80	19	-0.19	55	0.31	35
36	SUEZ	SZE FP	LYOE.PA	27.8	0.21	45	0.30	32	0.26	36
37	BP	BP/ LN	BP.L	23.1	0.46	38	0.00	41	0.23	37
38	CREDIT AGRICOLE	ACA FP	CAGR.PA	27.1	0.31	42	-0.05	45	0.13	38
39	BRITISH AMERICAN TOBACCO	BATS LN	BATS.L	22.0	-0.13	62	0.37	29	0.12	39
40	BHP BILLITON	BLT LN	BLT.L	39.0	-2.31	97	2.55	1	0.12	40
41	FRANCE TELECOM	FTE FP	FTE.PA	22.4	0.61	30	-0.39	70	0.11	41
42	DEUTSCHE POST	DPW GY	DPWGn.DE	22.1	0.49	36	-0.28	62	0.11	42
43	ENI	ENI IM	ENI.MI	23.5	0.08	53	0.10	38	0.09	43
44	RIO TINTO	RIO LN	RIO.L	38.4	-1.91	93	2.08	3	0.08	44
45	SANOFI-AVENTIS	SAN FP	SASY.PA	21.3	0.47	37	-0.32	66	0.08	45
46	PHILIPS ELECTRONICS	PHIA NA	PHG.AS	26.2	0.65	27	-0.51	73	0.07	46
47	BASF	BAS GY	BASF.DE	22.8	0.73	23	-0.64	79	0.05	47
48	ROYAL DUTCH SHELL PLC-A SHS	RDSA NA	RDSa.AS	22.6	0.13	49	-0.09	49	0.02	48
49	MUENCHENER RUECKVER	MUV2 GY	MUVGn.DE	21.3	1.20	6	-1.18	90	0.01	49
50	REPSOL YPF	REP SQ	REP.MC	26.3	0.17	48	-0.16	54	0.01	50

continued overleaf

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European Single Stock Variance Relative Value Report (Cont'd)

Data for close of business 28 September 2007 (Source: J.P. Morgan Securities Ltd.). Universe of 100 most liquid single stock variance.

Rank	Company	Bloomberg	Reuters	6M Implied Variance	Volatility Z-Score	Rank	Fundamental Z-Score	Rank	RV Score	Rank
51	L'OREAL	OR FP	OREP.PA	23.1	0.20	46	-0.25	59	-0.02	51
52	AEGON	AGN NA	AEGN.AS	25.2	0.81	17	-0.87	82	-0.03	52
53	BANCO SANTANDER	SAN SQ	SAN.MC	25.7	-0.01	57	-0.04	44	-0.03	53
54	ROCHE HOLDING AG-GENUSSCHEIN	ROG VX	ROG.VX	18.2	0.90	13	-0.96	84	-0.03	54
55	BOUYGUES	EN FP	BOUY.PA	29.8	-0.40	70	0.33	31	-0.03	55
56	DAIMLERCHRYSLER	DAI GY	DAIGn.DE	27.8	0.09	51	-0.16	53	-0.03	56
57	DIAGEO	DGE LN	DGE.L	20.0	0.56	34	-0.63	78	-0.04	57
58	LAFARGE	LG FP	LAFP.PA	30.3	-0.38	69	0.29	33	-0.05	58
59	LINDE	LIN GY	LING.DE	23.0	0.43	39	-0.60	76	-0.08	59
60	ASSICURAZIONI GENERALI	G IM	GASI.MI	21.2	0.96	12	-1.15	89	-0.10	60
61	LVMH MOET HENNESSY LOUIS VUI	MC FP	LVMH.PA	23.3	0.74	21	-0.97	85	-0.12	61
62	VINCI	DG FP	SGEF.PA	29.7	-0.78	84	0.52	25	-0.13	62
63	ABB LTD	ABBN VX	ABBN.VX	32.5	-0.18	64	-0.19	56	-0.18	63
64	BANCO BILBAO VIZCAYA ARGENTA	BBVA SQ	BBVA.MC	25.8	-0.06	59	-0.31	65	-0.19	64
65	AIR LIQUIDE	AI FP	AIRP.PA	26.2	-0.44	74	0.06	39	-0.19	65
66	HBOS	HBOS LN	HBOS.L	31.1	-2.34	99	1.95	4	-0.20	66
67	TELEFONICA	TEF SQ	TEF.MC	22.2	-0.07	60	-0.37	69	-0.22	67
68	SCHNEIDER ELECTRIC	SU FP	SCHN.PA	28.5	-0.41	71	-0.04	43	-0.23	68
69	KONINKLIJKE KPN	KPN NA	KPN.AS	23.1	-0.32	66	-0.15	52	-0.24	69
70	ALLIANZ SE	ALV GY	ALVG.DE	25.4	0.04	54	-0.57	75	-0.27	70
71	NOVARTIS	NOVN VX	NOVN.VX	16.8	0.56	33	-1.10	87	-0.27	71
72	SIEMENS	SIE GY	SIEGn.DE	29.2	-0.70	82	-0.00	42	-0.35	72
73	E.ON	EOA GY	EONG.DE	22.1	0.77	20	-1.51	92	-0.37	73
74	ANGLO AMERICAN	AAL LN	AAL.L	39.4	-2.58	100	1.81	6	-0.39	74
75	UNICREDITO ITALIANO	UC IM	CRDI.MI	26.8	-1.02	88	0.19	37	-0.42	75
76	TOTAL	FP FP	TOTF.PA	23.8	-0.37	67	-0.56	74	-0.47	76
77	INFINEON TECHNOLOGIES	IFX GY	IFXGn.DE	30.8	0.64	28	-1.59	96	-0.47	77
78	BAYERISCHE MOTOREN WERKE	BMW GY	BMWG.DE	25.4	-0.67	79	-0.29	64	-0.48	78
79	FORTIS	FORA NA	FOR.AS	27.1	-0.94	86	-0.05	46	-0.49	79
80	BAYER	BAY GY	BAYG.DE	26.1	-0.76	83	-0.25	60	-0.51	80
81	ENEL	ENEL IM	ENEI.MI	17.6	0.18	47	-1.26	91	-0.54	81
82	BARCLAYS	BARC LN	BARC.L	31.9	-2.32	98	1.21	13	-0.55	82
83	SWISS RE	RUKN VX	RUKN.VX	21.8	0.01	55	-1.15	88	-0.57	83
84	COMPAGNIE DE SAINT-GOBAIN	SGO FP	SGOB.PA	27.9	-1.06	90	-0.09	48	-0.57	84
85	MAN	MAN GY	MANG.DE	31.5	-0.82	85	-0.33	68	-0.58	85
86	CONTINENTAL	CON GY	CONG.DE	28.6	-0.44	73	-0.81	80	-0.62	86
87	UBS	UBSN VX	UBSN.VX	23.4	0.22	43	-1.71	97	-0.74	87
88	DEUTSCHE BANK AG-REGISTERED	DBK GY	DBKGn.DE	26.2	-0.67	80	-0.85	81	-0.76	88
89	ING GROEP NV-CVA	INGA NA	ING.AS	22.6	-0.03	58	-1.55	94	-0.79	89
90	ZURICH FINANCIAL SERVICE	ZURN VX	ZURN.VX	23.3	-0.07	61	-1.52	93	-0.80	90
91	ARCELORMITTAL	MT NA	ISPA.AS	33.1	-1.95	94	0.23	35	-0.86	91
92	COMMERZBANK	CBK GY	CBKG.DE	30.3	-1.70	91	-0.26	61	-0.98	92
93	CIE FINANCIERE RICHEMON-BR A	CFR VX	CFR.VX	25.0	-0.41	72	-1.56	95	-0.99	93
94	AXA	CS FP	AXAF.PA	26.9	-1.01	87	-0.98	86	-1.00	94
95	VOLKSWAGEN	VOW GY	VOWG.DE	18.6	0.22	44	-2.24	100	-1.01	95
96	BNP PARIBAS	BNP FP	BNPP.PA	26.3	-1.74	92	-0.40	71	-1.07	96
97	CREDIT SUISSE GROUP	CSGN VX	CSGN.VX	23.9	-0.38	68	-1.79	99	-1.09	97
98	SOCIETE GENERALE	GLE FP	SOGN.PA	27.9	-1.96	95	-0.25	58	-1.11	98
99	HOLCIM LTD	HOLN VX	HOLN.VX	23.7	-0.62	78	-1.79	98	-1.21	99
100	NESTLE	NESN VX	NESN.VX	18.4	-2.20	96	-0.61	77	-1.40	100

Source JPMorgan

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IB clients*	69%	62%	48%

*Percentage of investment banking clients in each rating category.
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European Equity Derivatives and Delta One Strategy

European Single Stock Enhanced Relative Value Model

Data as of 02 Dec 2013 (close)

Sources for data: Equity Derivatives and Delta One Strategy, Bloomberg.

Ticker	Name	Sector	Last Price	3M Return	3M ATMF IVol	3M Realised Vol	3M IVRV Spread	3M IR Spread Rank	Risk Premium Z-Score	Risk Premium Rank	Fundamental Z-Score	Fundamental Rank	Combined Rank	Trading Signal
SHBA SS	Svenska Handelsbanken AB	Financials	304	5%	16%	17%	0%	10	-1.60	6	-1.21	13	1	Cheap
RB/ LN	Reckitt Benckiser Group PLC	Consumer Staples	4880	10%	16%	19%	-3%	2	-1.82	4	-0.97	19	2	Cheap
AH NA	Koninklijke Ahold NV	Consumer Staples	13.33	7%	18%	17%	1%	23	-0.84	20	-1.44	7	3	Cheap
SIE GY	Siemens AG	Industrials	97.42	18%	19%	18%	1%	25	-0.93	14	-1.03	16	4	Cheap
G IM	Assicurazioni Generali SpA	Financials	16.75	13%	20%	18%	2%	49	-1.00	12	-0.96	20	5	Cheap
ULVR LN	Unilever PLC	Consumer Staples	2431	-2%	17%	18%	-1%	8	-0.86	18	-1.14	14	6	Cheap
SEBA SS	Skandinaviska Enskilda Banken	Financials	80.2	15%	18%	16%	2%	47	-0.93	15	-0.82	23	7	Cheap
UNA NA	Unilever NV	Consumer Staples	28.705	-1%	16%	16%	0%	15	-0.55	33	-1.28	10	8	Cheap
AZN LN	AstraZeneca PLC	Health Care	3510	10%	15%	12%	3%	57	-0.86	19	-0.66	27	9	Cheap
REP SQ	Repsol SA	Energy	19.145	7%	22%	19%	3%	60	-1.70	5	-0.25	42	10	Cheap
ENI IM	Eni SpA	Energy	17.55	0%	19%	14%	4%	73	-0.71	26	-0.74	25	11	Cheap
ZURN VX	Zurich Insurance Group AG	Financials	251.9	7%	16%	12%	4%	67	-0.22	43	-1.28	11	12	Cheap
GSK LN	GlaxoSmithKline PLC	Health Care	1619.5	-3%	15%	13%	1%	33	-0.72	25	-0.57	31	13	Cheap
TLSN SS	TeliaSonera AB	Telecommunication Services	53.25	11%	16%	15%	0%	20	-0.06	48	-1.35	8	14	Cheap
CSGN VX	Credit Suisse Group AG	Financials	27.18	-1%	22%	23%	-1%	9	-0.82	21	-0.36	37	15	Cheap
TEF SQ	Telefonica SA	Telecommunication Services	11.93	13%	18%	17%	1%	29	0.19	57	-1.67	2	16	Cheap
UL NA	Unibail-Rodamco SE	NA	191.45	9%	18%	18%	0%	21	0.06	54	-1.50	5	17	Cheap
CS FP	AXA SA	Financials	19.26	13%	24%	22%	2%	37	-0.63	31	-0.60	30	18	Cheap
SWEDA SS	Swedbank AB	Financials	168.1	10%	20%	17%	2%	51	-0.78	22	-0.32	39	19	Cheap
MC FP	LVMH Moet Hennessy Louis Vuitt	Consumer Discretionary	138.3	2%	20%	19%	1%	34	-0.12	46	-1.01	17	20	Cheap
GSZ FP	GDF Suez	Utilities	17.175	4%	19%	19%	0%	14	-0.90	16	-0.07	48	21	Cheap
IMT LN	Imperial Tobacco Group PLC	Consumer Staples	2313	8%	17%	16%	1%	24	-1.43	7	0.19	57	22	Cheap
DGE LN	Diageo PLC	Consumer Staples	1926	-3%	17%	15%	2%	54	-0.74	24	-0.25	41	23	Cheap
ABBN VX	ABB Ltd	Industrials	23.06	14%	17%	16%	1%	30	0.26	62	-1.48	6	24	Cheap
MUV2 GY	Muenchener Rueckversicherungs	Financials	161	15%	16%	14%	2%	40	-0.03	50	-0.98	18	25	Fair
PRU LN	Prudential PLC	Financials	1291	15%	22%	20%	2%	44	-0.21	44	-0.81	24	26	Fair
SAN FP	Sanofi	Health Care	77.23	4%	19%	18%	2%	35	-0.67	29	-0.27	40	27	Fair
SAB LN	SABMiller PLC	Consumer Staples	3117	0%	20%	20%	0%	12	-0.48	34	-0.37	36	28	Fair
FP FP	Total SA	Energy	44.44	5%	15%	12%	3%	64	0.39	66	-1.56	4	29	Fair
BAS GY	BASF SE	Materials	78.97	16%	18%	14%	4%	66	0.51	68	-1.66	3	30	Fair
ENEL IM	Enel SpA	Utilities	3.222	23%	25%	26%	-1%	7	-1.32	9	0.41	66	31	Fair
ML FP	Cie Generale des Etablissement	Consumer Discretionary	79.44	7%	24%	24%	0%	13	-1.05	11	0.39	64	32	Fair
SYNN VX	Syngenta AG	Materials	353.1	-5%	17%	14%	2%	55	-0.67	30	-0.18	45	33	Fair
ROG VX	Roche Holding AG	Health Care	254.3	7%	15%	11%	4%	69	0.38	65	-1.22	12	34	Fair
NESN VX	Nestle SA	Consumer Staples	65.6	7%	14%	11%	3%	58	0.55	69	-1.33	9	35	Fair
NG/ LN	National Grid PLC	Utilities	771.5	3%	15%	12%	3%	62	0.05	53	-0.60	29	36	Fair
LKOD LI	Lukoil OAO	Energy	61.65	5%	20%	16%	4%	65	-0.36	39	-0.20	44	37	Fair
ALV GY	Allianz SE	Financials	127.8	15%	18%	12%	6%	88	1.12	83	-2.09	1	38	Fair

Ticker	Name	Sector	Last Price	3M Return	3M ATMF IVol	3M Realised Vol	3M IVRV Spread	3M IR Spread Rank	Risk Premium Z-Score	Risk Premium Rank	Fundamental Z-Score	Fundamental Rank	Combined Rank	Trading Signal
ATCOA SS	Atlas Copco AB	Industrials	181.3	0%	21%	20%	1%	31	-0.88	17	0.42	67	39	Fair
DG FP	Vinci SA	Industrials	47.26	17%	20%	15%	5%	78	-0.02	52	-0.56	32	40	Fair
MT NA	ArcelorMittal	Materials	12.85	24%	31%	27%	3%	61	-1.36	8	0.75	78	41	Fair
NOVN VX	Novartis AG	Health Care	72.05	3%	15%	11%	4%	74	0.64	71	-1.13	15	42	Fair
HOLN VX	Holcim Ltd	Materials	65.4	2%	21%	18%	2%	46	-0.22	42	-0.13	46	43	Fair
GLEN LN	Glencore Xstrata PLC	Materials	306	-2%	26%	21%	4%	70	-1.12	10	0.81	79	44	Fair
DTE GY	Deutsche Telekom AG	Telecommunication Services	11.62	17%	20%	20%	0%	18	-0.68	27	0.35	63	45	Fair
INGA NA	ING Groep NV	Financials	9.538	12%	26%	24%	2%	48	-0.41	37	0.08	54	46	Fair
UCG IM	UniCredit SpA	Financials	5.285	18%	31%	31%	0%	16	-2.18	1	1.79	92	47	Fair
GLE FP	Societe Generale SA	Financials	42.175	21%	29%	24%	5%	79	0.21	58	-0.43	35	48	Fair
CNA LN	Centrica PLC	Utilities	337.9	-14%	18%	19%	-2%	5	-0.78	23	0.61	72	49	Fair
LIN GY	Linde AG	Materials	149.65	2%	16%	14%	2%	52	0.26	61	-0.48	34	50	Fair
RWE GY	RWE AG	Utilities	27.965	28%	25%	34%	-9%	1	-2.02	2	1.82	93	51	Fair
WPP LN	WPP PLC	Consumer Discretionary	1339	8%	22%	18%	4%	71	-0.46	35	0.35	61	52	Fair
EAD FP	European Aeronautic Defence an	Industrials	53.1	17%	24%	22%	2%	50	-0.95	13	1.25	85	53	Fair
ISP IM	Intesa Sanpaolo SpA	Financials	1.766	14%	30%	31%	0%	11	-1.90	3	2.04	96	54	Fair
BMW GY	Bayerische Motoren Werke AG	Consumer Discretionary	85.11	16%	21%	19%	2%	43	0.89	79	-0.89	21	55	Fair
STAN LN	Standard Chartered PLC	Financials	1438	-2%	22%	21%	2%	36	-0.68	28	0.65	75	56	Fair
VOW3 GY	Volkswagen AG	Consumer Discretionary	196.7	11%	22%	20%	2%	53	1.01	81	-0.87	22	57	Fair
BATS LN	British American Tobacco PLC	Consumer Staples	3223.5	-2%	17%	12%	5%	77	0.80	78	-0.66	26	58	Fair
PHIA NA	Koninklijke Philips NV	Industrials	26.3	8%	22%	22%	1%	26	-0.10	47	0.29	59	59	Fair
SU FP	Schneider Electric SA	Industrials	61.75	4%	25%	23%	2%	45	-0.39	38	0.42	68	60	Fair
ORA FP	Orange SA	Telecommunication Services	9.527	21%	24%	26%	-2%	3	0.24	59	-0.02	50	61	Fair
DPW GY	Deutsche Post AG	Industrials	26.32	15%	22%	22%	0%	17	0.10	55	0.18	56	62	Fair
RI FP	Pernod Ricard SA	Consumer Staples	82.73	-6%	20%	18%	2%	42	-0.59	32	0.86	80	63	Fair
ABI BB	Anheuser-Busch InBev NV	Consumer Staples	75.15	4%	21%	17%	4%	68	0.37	64	0.04	52	64	Fair
NDA SS	Nordea Bank AB	Financials	83.95	7%	19%	15%	4%	72	0.32	63	0.10	55	65	Fair
UBSN VX	UBS AG	Financials	17.26	-7%	23%	25%	-2%	4	-0.17	45	0.63	74	66	Fair
AKZA NA	Akzo Nobel NV	Materials	55.4	21%	24%	23%	1%	28	0.68	73	-0.09	47	67	Fair
IBE SQ	Iberdrola SA	Utilities	4.598	13%	20%	14%	6%	87	2.25	95	-0.65	28	68	Fair
RR/ LN	Rolls-Royce Holdings PLC	Industrials	1214	8%	21%	20%	2%	38	-0.46	36	1.42	87	69	Fair
SGO FP	Cie de St-Gobain	Industrials	38.96	8%	25%	24%	1%	32	-0.34	40	1.09	83	70	Fair
DAI GY	Daimler AG	Consumer Discretionary	61.22	14%	23%	16%	7%	95	1.61	92	-0.52	33	71	Fair
BNP FP	BNP Paribas SA	Financials	55.09	12%	25%	19%	6%	91	1.26	88	-0.34	38	72	Fair
BP/ LN	BP PLC	Energy	475.3	6%	17%	15%	2%	39	0.74	75	0.07	53	73	Fair
LLOY LN	Lloyds Banking Group PLC	Financials	78.58	7%	25%	23%	2%	41	-0.32	41	1.56	89	74	Rich
BLT LN	BHP Billiton PLC	Materials	1822	-5%	24%	19%	5%	76	0.25	60	0.60	71	75	Rich
AI FP	Air Liquide SA	Materials	102.5	1%	17%	12%	5%	80	1.38	89	-0.22	43	76	Rich
BN FP	Danone	Consumer Staples	53.38	-6%	19%	16%	3%	56	-0.03	51	0.92	81	77	Rich
BAYN GY	Bayer AG	Health Care	98.55	14%	21%	15%	5%	82	1.25	87	-0.03	49	78	Rich
PUB FP	Publicis Groupe SA	Consumer Discretionary	65.05	12%	22%	17%	5%	84	1.18	85	0.03	51	79	Rich
BBVA SQ	Banco Bilbao Vizcaya Argentari	Financials	8.741	18%	26%	20%	6%	86	0.70	74	0.39	65	80	Rich
BG/ LN	BG Group PLC	Energy	1232	-1%	21%	18%	3%	59	0.63	70	0.52	70	81	Rich
RIO LN	Rio Tinto PLC	Materials	3231	6%	27%	22%	6%	89	-0.03	49	1.92	94	82	Rich
TSCO LN	Tesco PLC	Consumer Staples	340.9	-8%	20%	15%	5%	83	0.78	77	0.49	69	83	Rich
OGZD LI	Gazprom OAO	Energy	8.53	8%	28%	27%	1%	22	0.11	56	1.98	95	84	Rich
AGN NA	Aegon NV	Financials	6.546	18%	25%	18%	7%	94	1.67	93	0.31	60	85	Rich
CA FP	Carrefour SA	Consumer Staples	28.985	17%	27%	16%	10%	97	2.32	96	0.23	58	86	Rich
DBK GY	Deutsche Bank AG	Financials	35.36	6%	24%	17%	7%	96	2.05	94	0.35	62	87	Rich
BARC LN	Barclays PLC	Financials	270.25	2%	26%	22%	4%	75	0.66	72	1.36	86	88	Rich
ACA FP	Credit Agricole SA	Financials	9.235	17%	29%	23%	7%	93	1.09	82	0.68	76	89	Rich
EOAN GY	E.ON SE	Utilities	14.085	15%	24%	25%	-1%	6	0.48	67	1.66	91	90	Rich

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VIV FP	Vivendi SA	Consumer Discretionary	18.625	17%	23%	20%	3%	63	0.76	76	0.97	82	91	Rich
SAN SQ	Banco Santander SA	Financials	6.48	20%	26%	20%	6%	90	1.22	86	0.63	73	92	Rich
BT/A LN	BT Group PLC	Telecommunication Services	367.2	8%	20%	14%	6%	92	1.13	84	0.71	77	93	Rich
ERICB SS	Telefonaktiebolaget LM Ericsso	Information Technology	81.15	3%	24%	24%	0%	19	1.01	80	1.64	90	94	Rich
SBER LI	Sberbank of Russia	Financials	12.33	14%	29%	24%	5%	81	1.55	91	1.20	84	95	Rich
VOD LN	Vodafone Group PLC	Telecommunication Services	226	6%	21%	20%	1%	27	1.41	90	1.44	88	96	Rich
ASML NA	ASML Holding NV	Information Technology	69.25	3%	27%	22%	5%	85	2.53	97	2.68	97	97	Rich

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