European Equity Derivatives Strategy
J.P. Morgan Securities Ltd.
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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**.

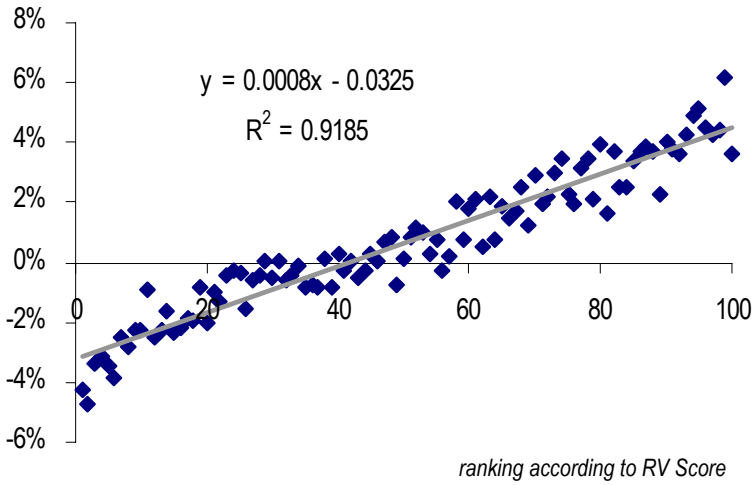
Our model uses a combination of fundamental and technical factors to produce a rich/cheap volatility score – the **RV Score** – for each stock in our European 100-stock universe.

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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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.

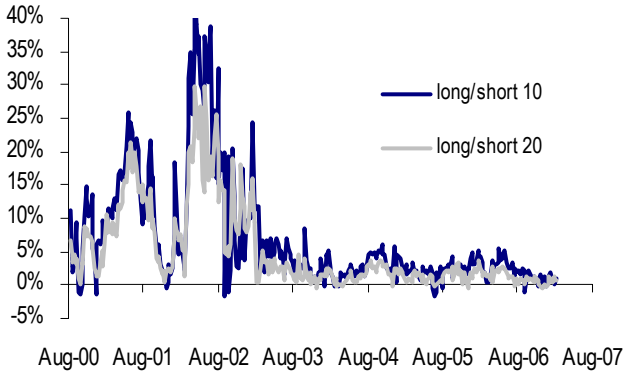
Section 3 shows the detailed results of the backtest of the RV Score, including mark-to-market p/l and an analysis of turnover together with sector and country representation.

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

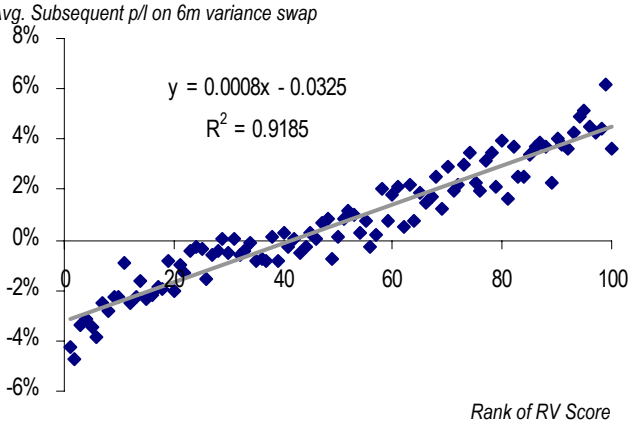
P/L of long top 10 (20) versus short bottom 10 (20) according to our RV ranking



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

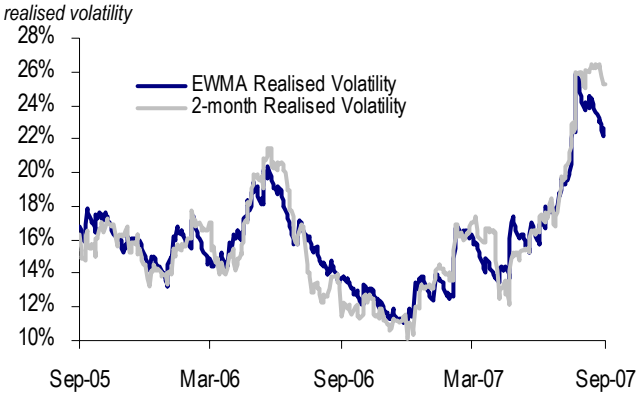
Our **Volatility Z-Score** aims to assess the relative richness or cheapness of single-stock volatility by comparing the current levels of implied volatility with previously realised volatility. As mentioned above, using simple 3-month realised volatility works well (see page 26), but we improve upon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

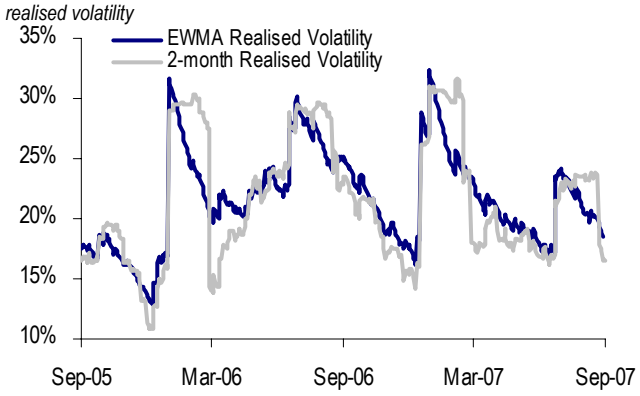
We use an EWMA volatility which equates relatively closely to 2-month realised volatility (Figure 4, Figure 5). The resulting ***Volatility Z-Score*** will reflect the spread of implied variance to EWMA realised volatility, with high Z-Scores representing a large spread of implied over EWMA realised 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

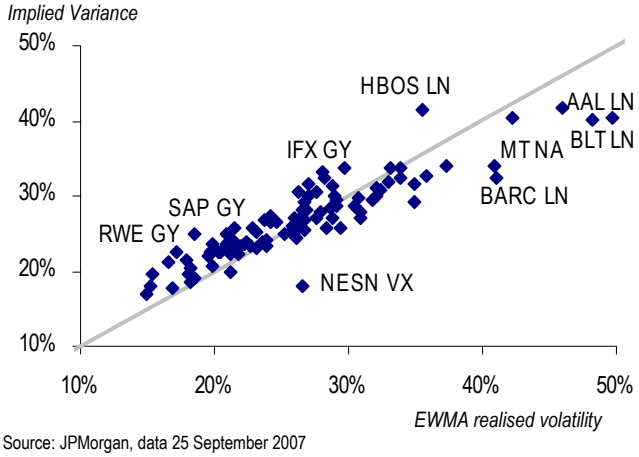
The second approach is to look at (fundamental) factors *other than realised volatility* which could be relevant in predicting future realised volatility. We calculate a ***Fundamental Z-Score*** by comparing implied variance levels with these factors across our entire universe of stocks. This z-score 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

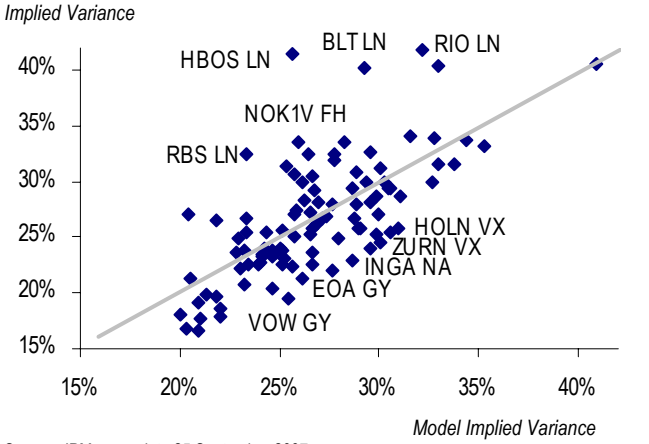
Note that the Fundamental Z-Score does *not* explicitly include realised volatility. This is because at any one time the relative levels of implied volatility across the universe of stocks are well correlated with past levels of realised volatility. Therefore including this parameter in the calculation 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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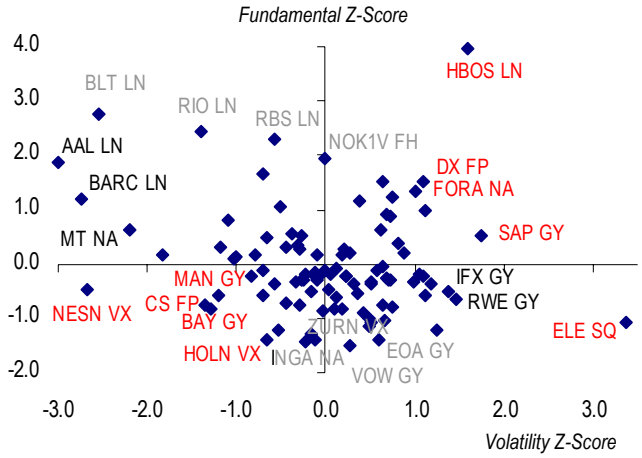
2.4: RV Score – a combination of Volatility and Fundamental Z-Scores

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.

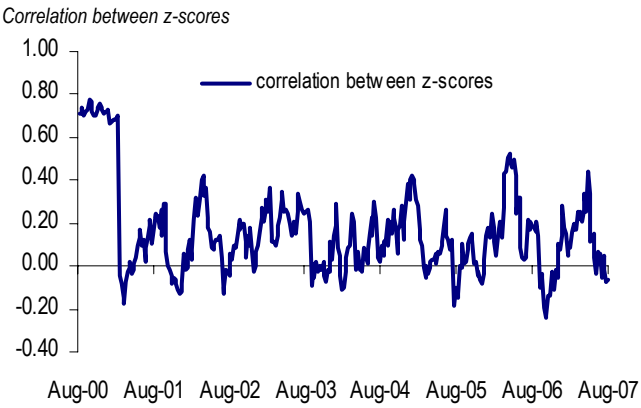
These two z-scores are individually successful in finding rich/cheap volatility (see pages 24 and 25), but tend to be relatively uncorrelated. For example, on the 25th September 2007 the two z-scores were uncorrelated, or even slightly anti-correlated (Figure 8). Over time the correlation between the 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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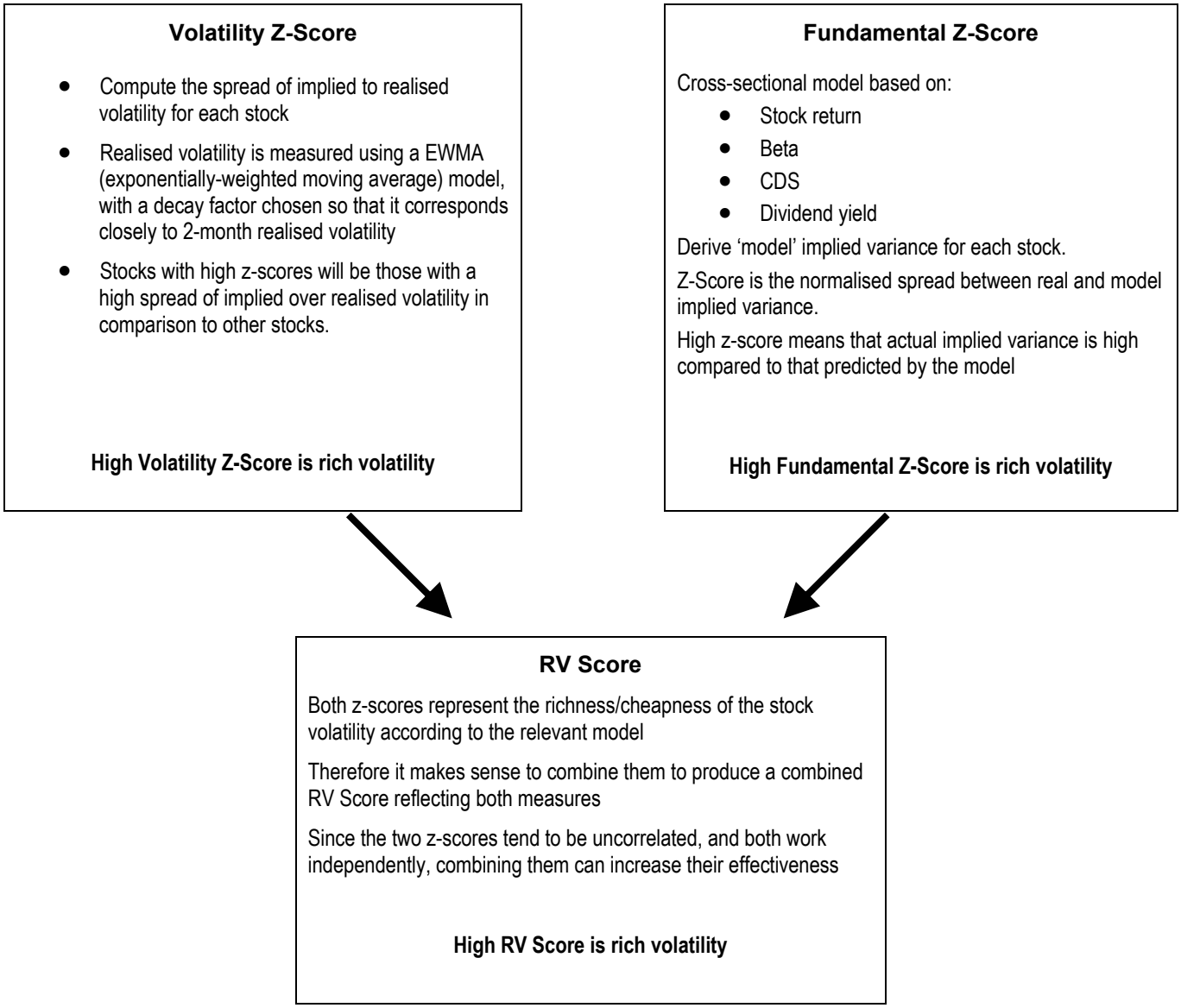
Figure 10: Schema of the RV Score



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.

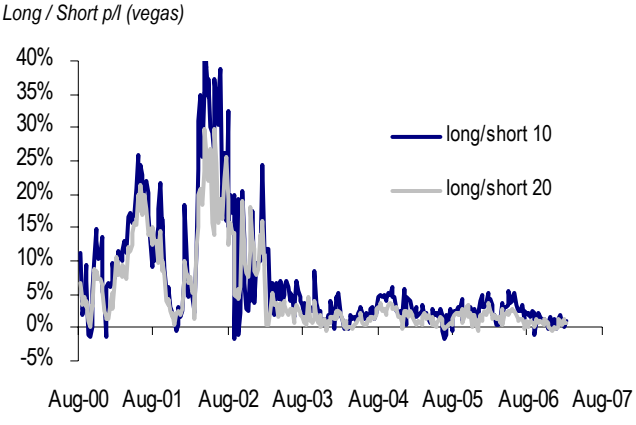
- **The average post bid/offer return from being long the cheapest 10 volatility stocks was 3.8 vegas per trade (first column). This compares well to an average return of zero from being long variance on all 100 stocks** over the same period (third column) - an improvement of 3.8 vegas (first vs. third 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.

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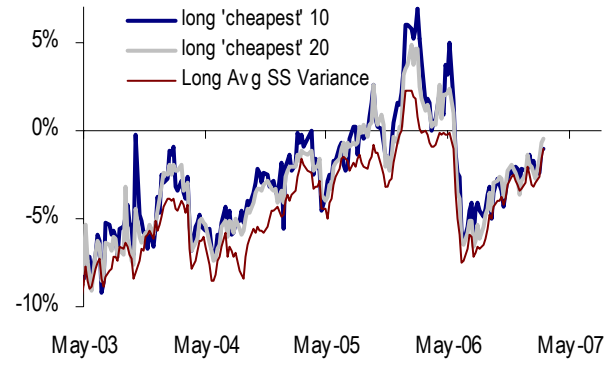
Below the maximum and minimum returns are the **standard deviations** of the returns of the various strategies. We show both regular standard deviation and the 'downside standard deviation' by which we mean the standard deviation of only the negative returns. Note that the standard deviation of being 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.

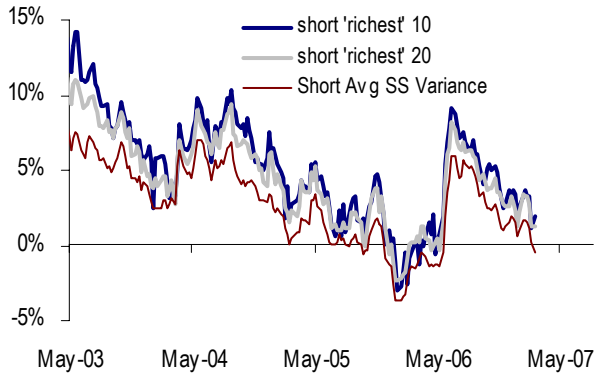
The next two rows show **risk-returns ratios** for the various strategies. By these measures, our ranking performs well, with both long, short and long/short strategies outperforming their benchmarks. Unlike the raw return and standard deviation figures these are annualised. For example the Information 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

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3.4: Predictive Power of the RV Score

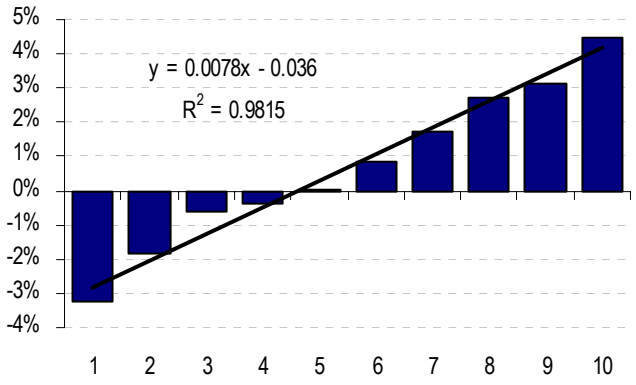
In this section we further analyse the effectiveness of our RV Score by looking across the full spectrum of the ranking, not just the top and bottom deciles. We find that **the RV Score does indeed provide consistent results across the whole ranking**.

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.

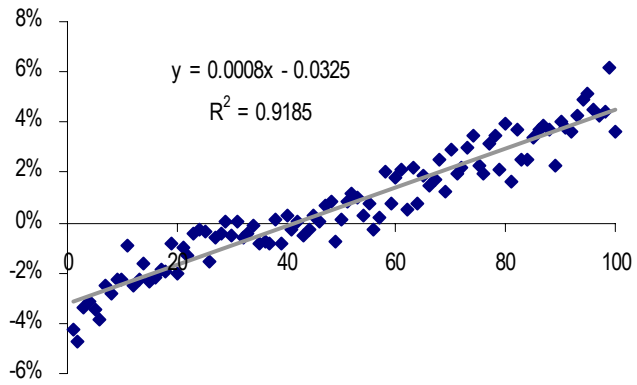
Figure 15 shows the correlation between the RV Score rank and average subsequent long variance p/l for stocks of that rank. The R-squared between the rank of the RV Score and the average subsequent p/l is high, at 0.92. This result is significant since it shows that our ranking metric is effective, in 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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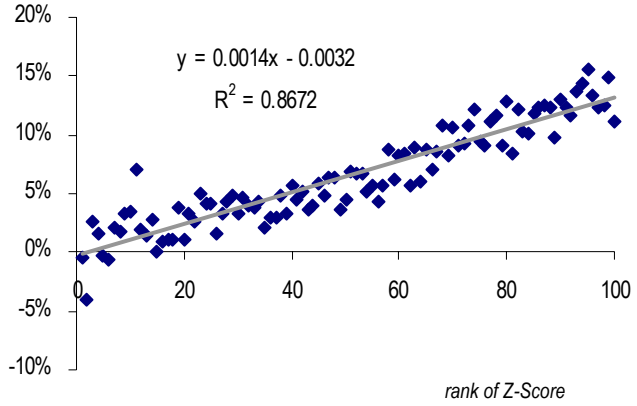
Figure 16 : Performance by rank – Aug 2000 – May 2003

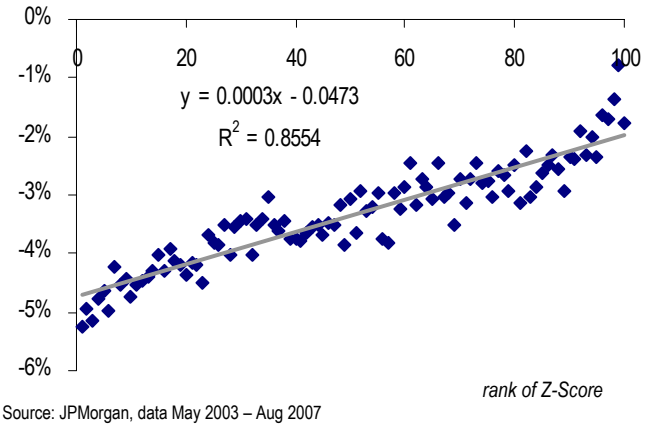
Avg. Subsequent p/l



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.

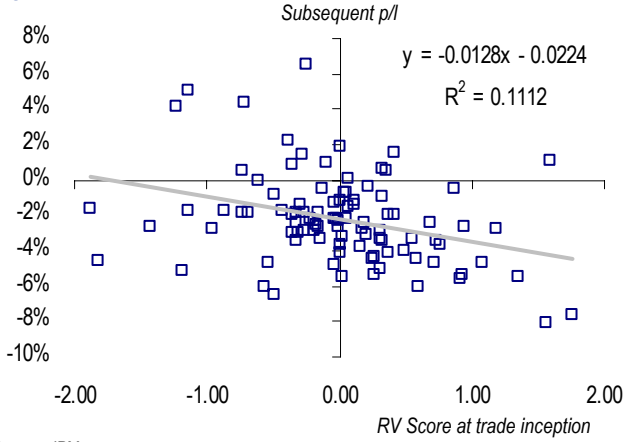
For example, consider the RV Scores assigned to each stock on 31 October 2006. We compute the expiry p/l of each variance swap at the end of April 2007, and then correlate these p/l's with the initial RV Scores. The correlation in this case works out to be -0.33 (Figure 18), again reflecting the lower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

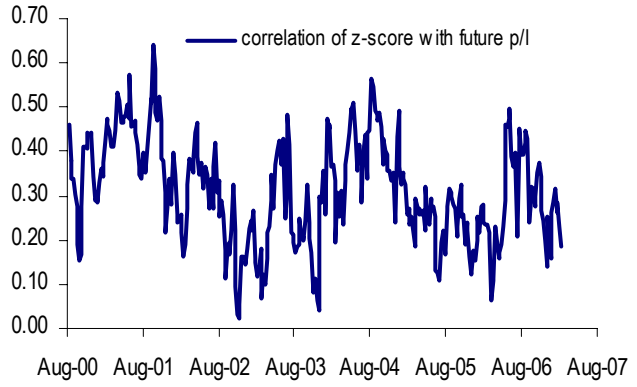
Subsequent p/l



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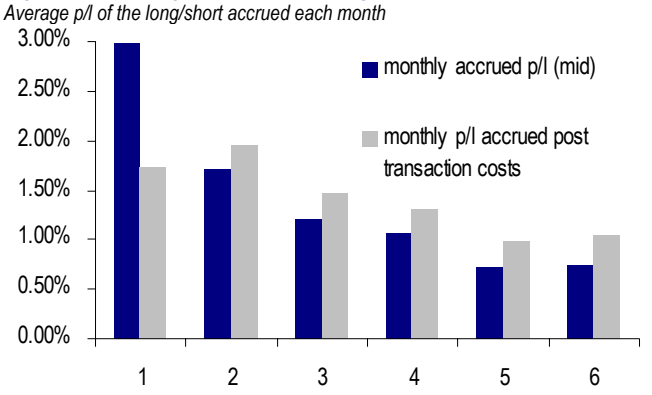
3.5: Mark-to-market: How quickly does the p/l accrue?

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.

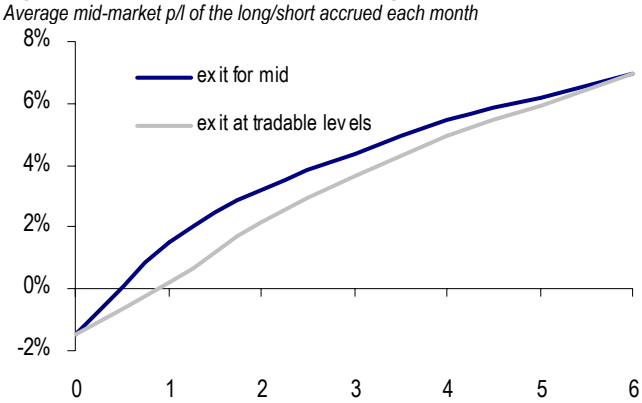
For long/short trades, we analyse p/l accrual in two different ways. Firstly, we look at the accrual of p/l assuming trades can be exited at *mid-market*, in order to gauge when during the 6-month trade the RV Score has most impact. Secondly, we look at the accrual of p/l after accounting for exit costs,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

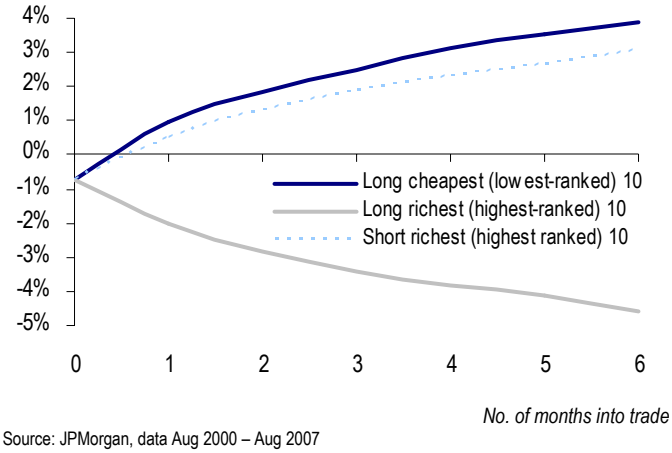
The case for holding trades longer than the first month or two is also supported by an analysis of the success ratio of the long/short trades. After one month, 65% of the trades are in profit before exit costs, a figure which rises steadily with holding period, reaching 90% after four months and 95%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

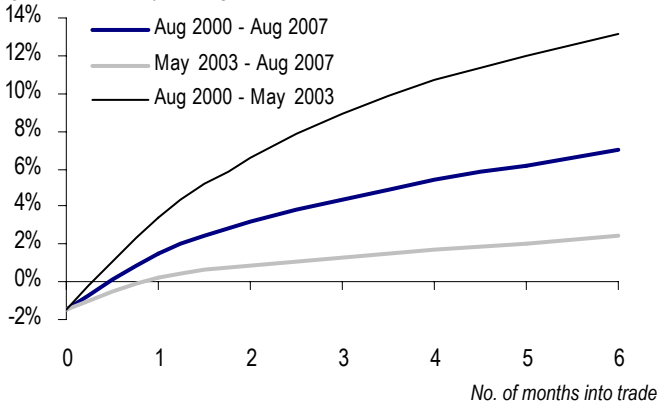
Finally, **the predictive power of the RV Score is almost as great after only 1-month as it is at expiry** (Figure 25).

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



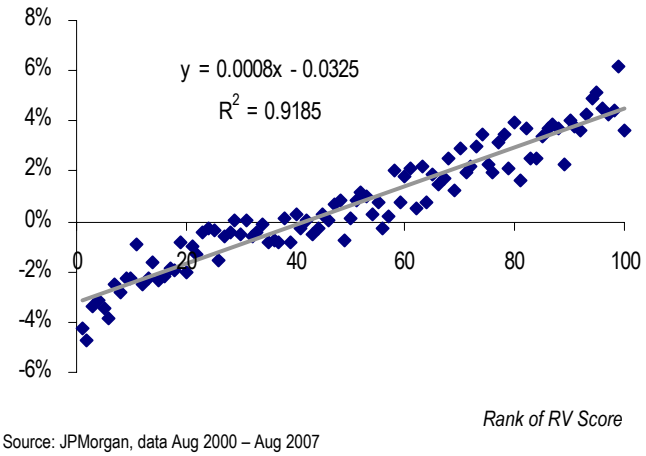
Source: JPMorgan, data Aug 2000 – Aug 2007

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



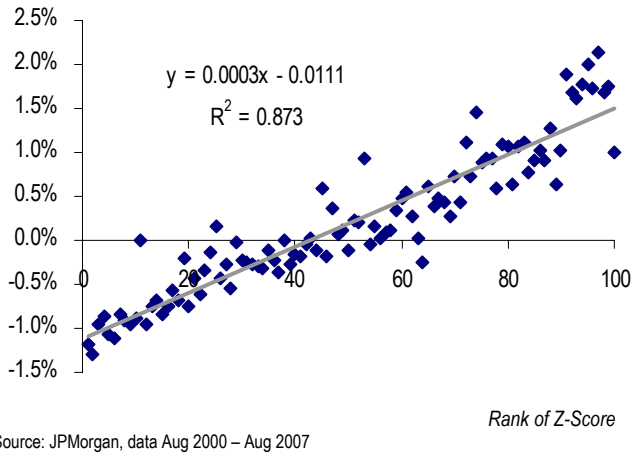
Source: JPMorgan

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.

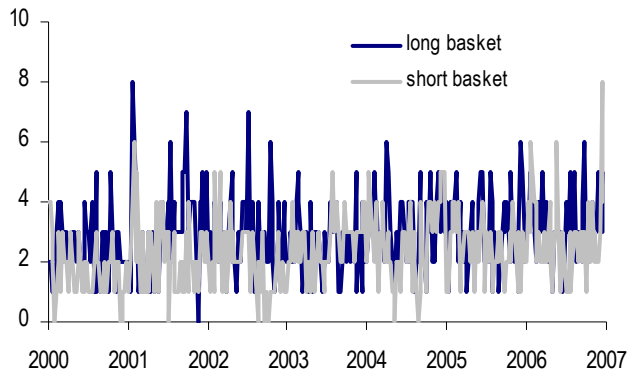
Table 4: Average turnover of the baskets (10 stocks per basket)

	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

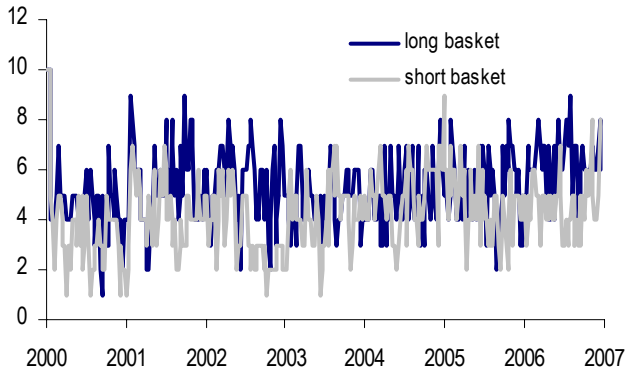
Turnover per basket of 10 stocks



Source: JPMorgan

Figure 27 : Turnover of the basket 1 month apart

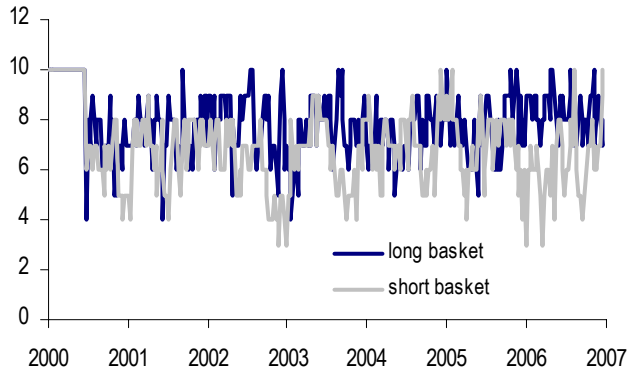
Turnover per basket of 10 stocks



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

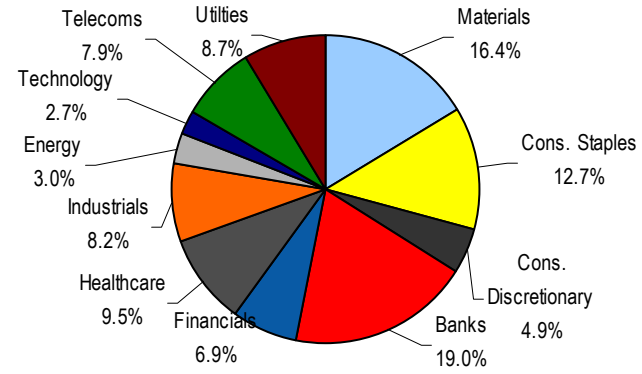
Is there a bias for our RV Score to identify volatilities from certain sectors to be rich or cheap? i.e. do some sectors show a bias to turn up more often than others in either the long or the short baskets?

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

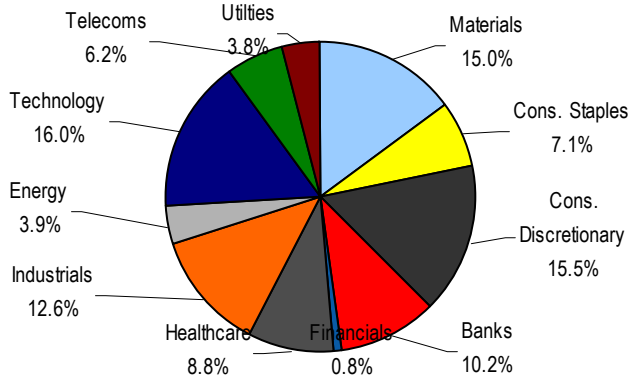


Figure 31 : Average normalised sector composition of the long basket

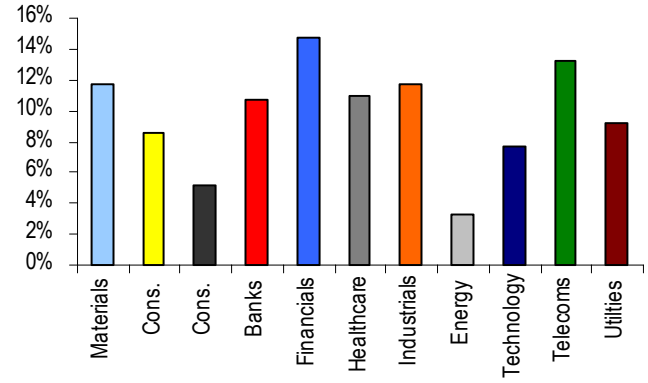
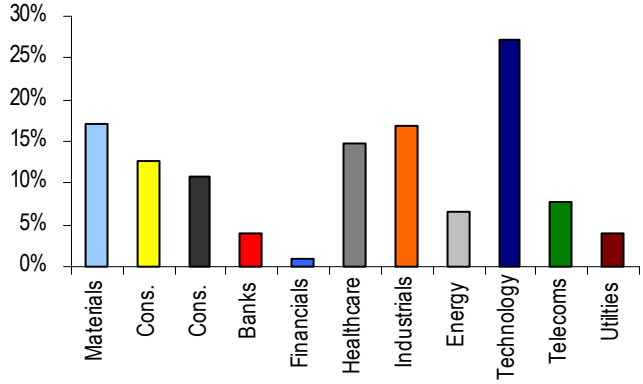


Figure 32 : Average normalised sector composition of short basket



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

Source for all charts: JPMorgan

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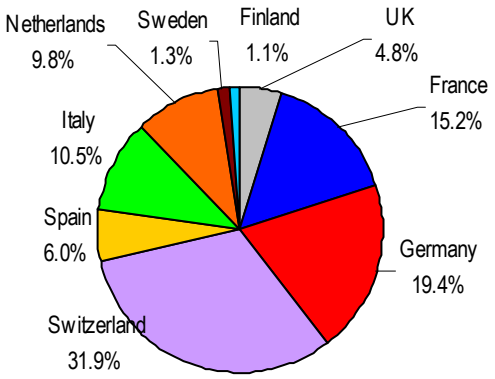
3.8: Country composition of baskets

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

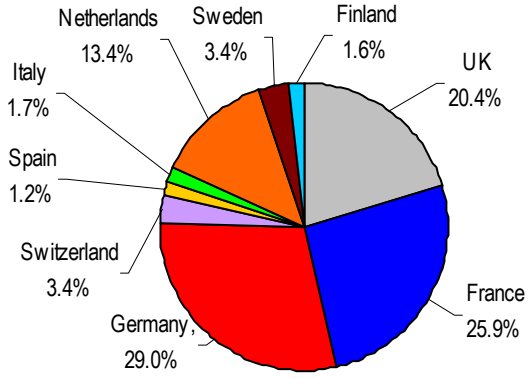
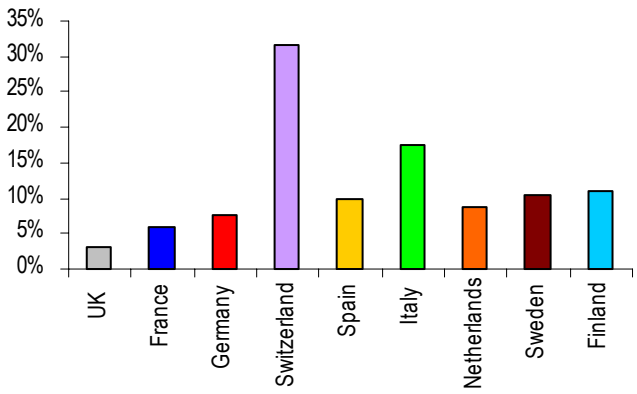
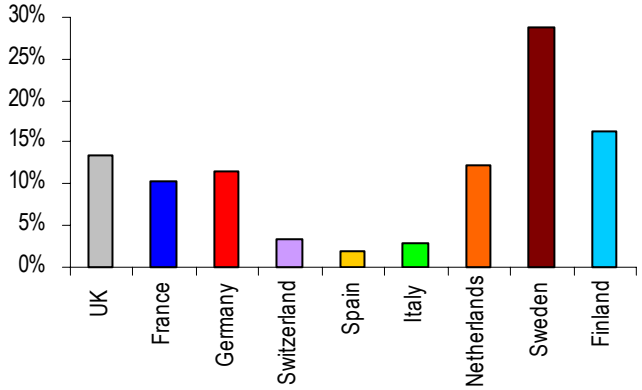


Figure 35 : Average normalised long basket composition by country



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.

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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)

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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

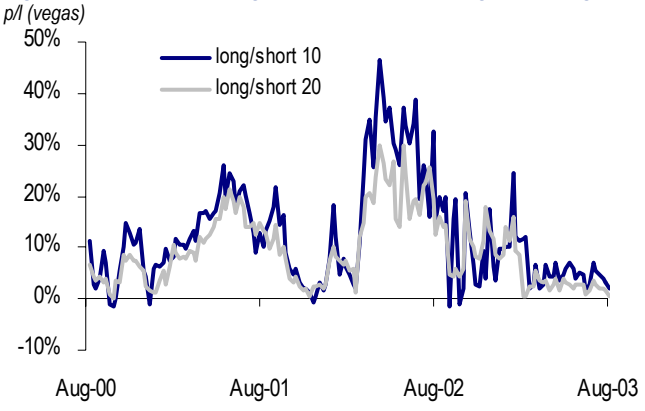
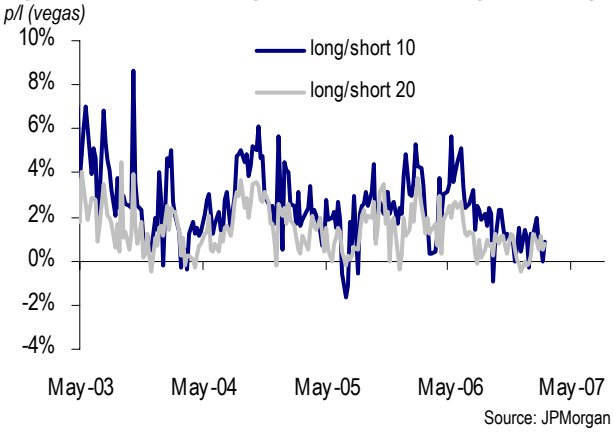


Figure 38 : RV Score - Long/Short Performance May 2003 – Aug 2007



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

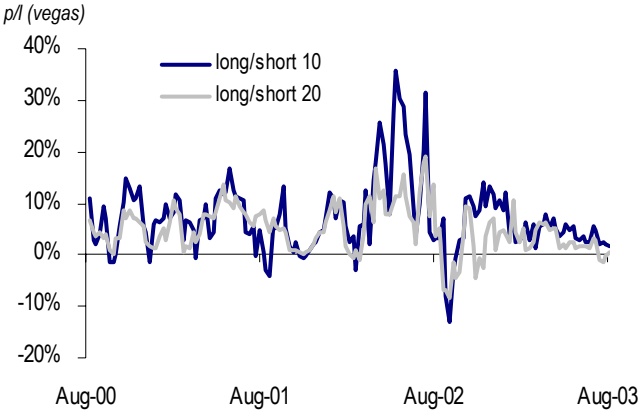
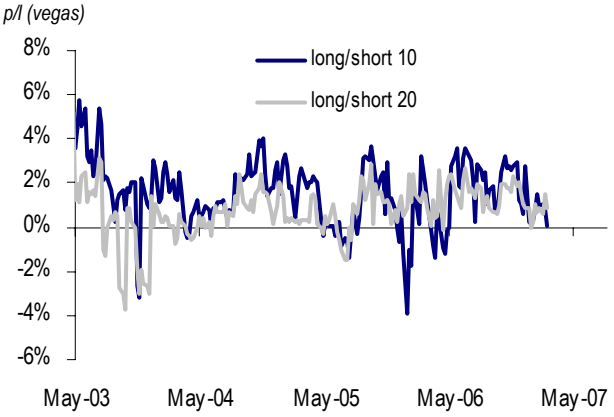


Figure 40 : Fundamental Z-Score Long/Short Performance May 2003 – Aug 2007



Source: JPMorgan

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

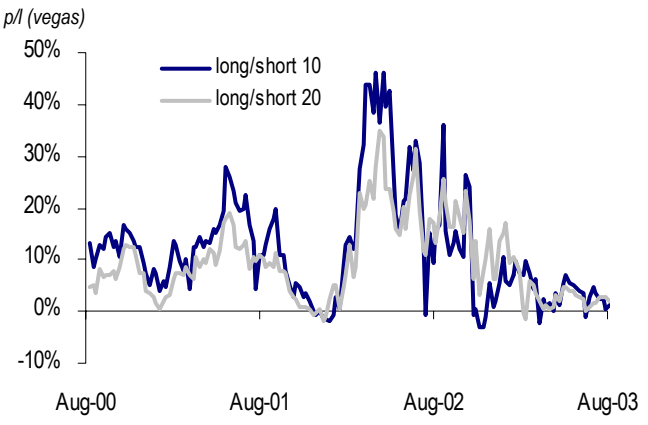
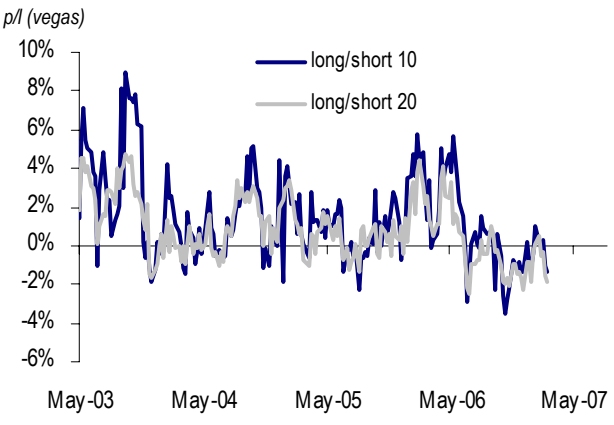


Figure 42 : Volatility Z-Score Long/Short Performance: May 2003 – Aug 2007



Source: JPMorgan

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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)

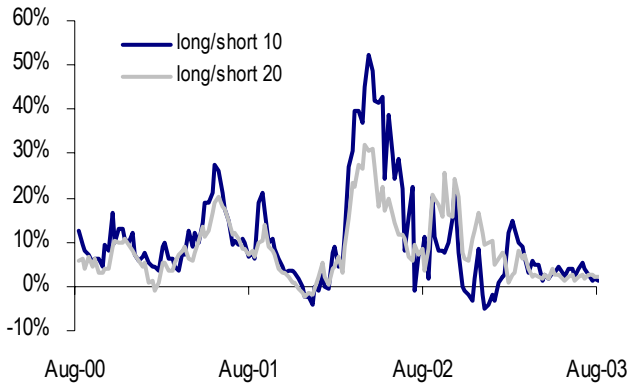
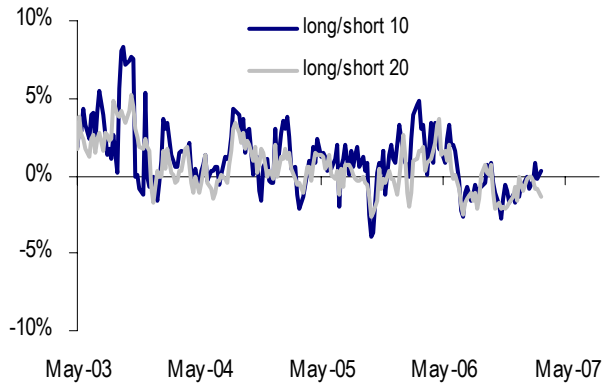


Figure 44 : Implied-Realised Z-Score Long/Short Performance: May 2003 – Aug 2007

p/l (vegas)



Source: JPMorgan

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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

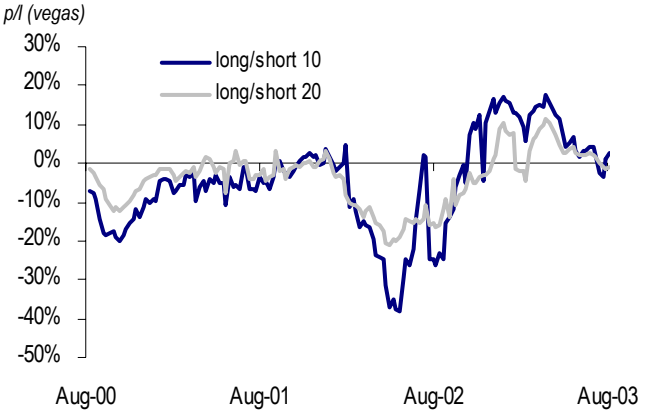
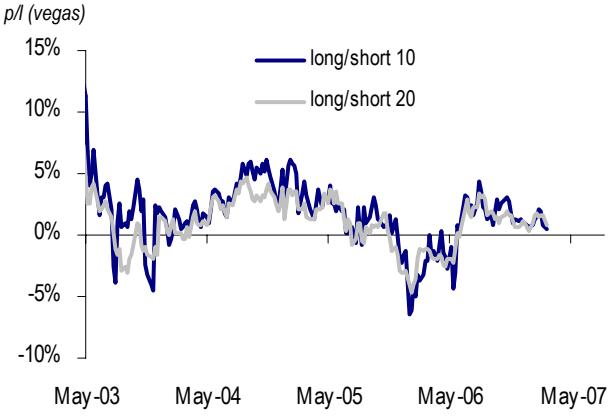


Figure 46 : Implied Only Z-Score Long/Short Performance: May 2003 – Aug 2007



Source: JPMorgan

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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)

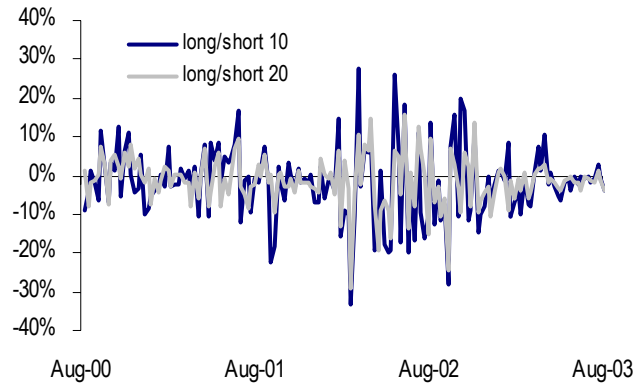
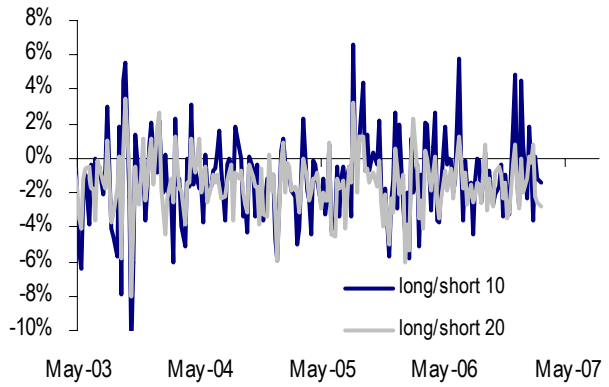


Figure 48 : Random Z-Score Long/Short Performance: May 2003 – Aug 2007

p/l (vegas)



Source: JPMorgan

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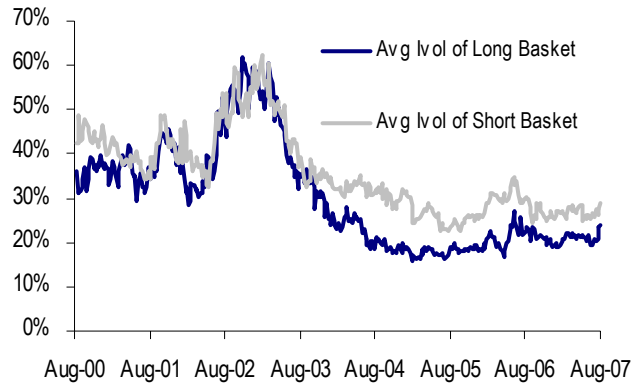
4.7: Volatility Bias

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?

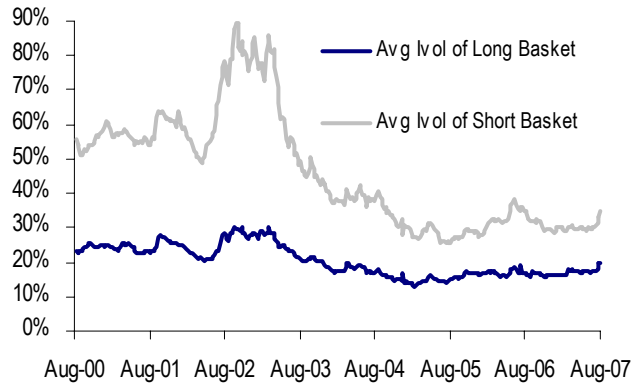
In fact, this strategy, which we refer to as 'Implied Only Z-Score', fared badly in 2000 – 2003 (Figure 45), but has performed relatively well since 2003 (Figure 46). However even in this period, risk-adjusted returns are not quite as good as those from the individual (Volatility and Fundamental) Z-Score 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



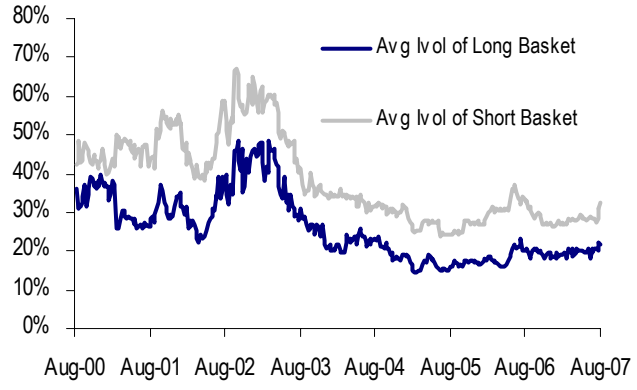
Source: JPMorgan

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



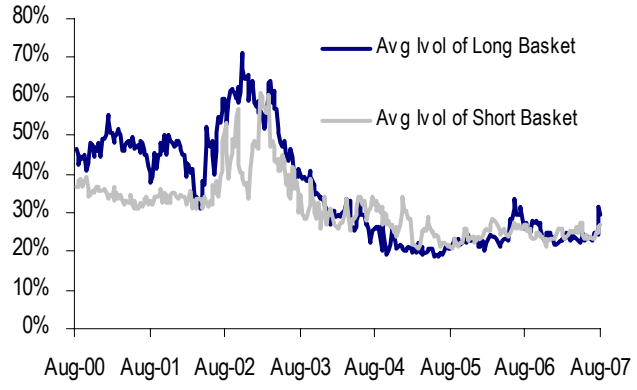
Source: JPMorgan, Long (short) basket is 10 lowest (highest) volatility stocks

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

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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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Relative Value Single Stock Volatility