Academic Research Monitor

Forecasting Returns

Equities

Global

Quantitative

Not so steady CAPE!

CAPE, i.e. the cyclically-adjusted price-to-earnings ratio, has often been used to forecast long-run future returns on the assumption that it mean-reverts to a steady state. Empirical evidence, however, has highlighted that CAPE does not settle on a stable equilibrium value but differs according to the macro-economic environment. The first two papers we review in this edition of the ARM take account of the macroeconomic effects on the forecast model driven by CAPE; the first incorporates real interest rates; the second includes the difference between the current CAPE and the fair value given the current yield and inflation environment. In both cases they report a significant improvement in forecasting accuracy.

Low CAPE and high future returns: is this a risk story?

Does CAPE dictate the distribution of future returns? The next set of papers we review focuses on the relationship between CAPE and the shape of the distribution. In the first case, the authors offer a risk-based explanation for the negative relationship between CAPE and future returns and show that low CAPE is associated with a higher dispersion of future returns (we find conflicting evidence when using an alternative definition of risk, however). The authors of the latter paper observe that a) the speed and nature of mean-reversion of valuation ratios differs according to the level and b) returns are negatively skewed when valuation ratios are high. We replicated the analysis with UK data and observed similar results.

Is Beta Dispersion better than Beta?

The last paper we review shows that beta dispersion, i.e. the spread in betas, is an effective measure for forecasting future returns. Consequently, it turns out that it can be used to construct a successful market timing strategy which offers improved Sharpe ratios and reduced drawdowns.

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Introduction

This edition of the Academic Research Monitor is focused on approaches to forecasting the stock market's return. All but one paper use the Cyclically Adjusted Price / Earnings ratio (CAPE, or the Shiller PE) as their forecasting variable. We give a few results about the US CAPE below in an extended introduction to this edition.

The CAPE measures the value of the market, comparing the current price to a ten-year moving average of inflation adjusted earnings. This ratio can be used to give a long term forecast of the market return, given its historical relationship with the market as can be seen in Figure 1.

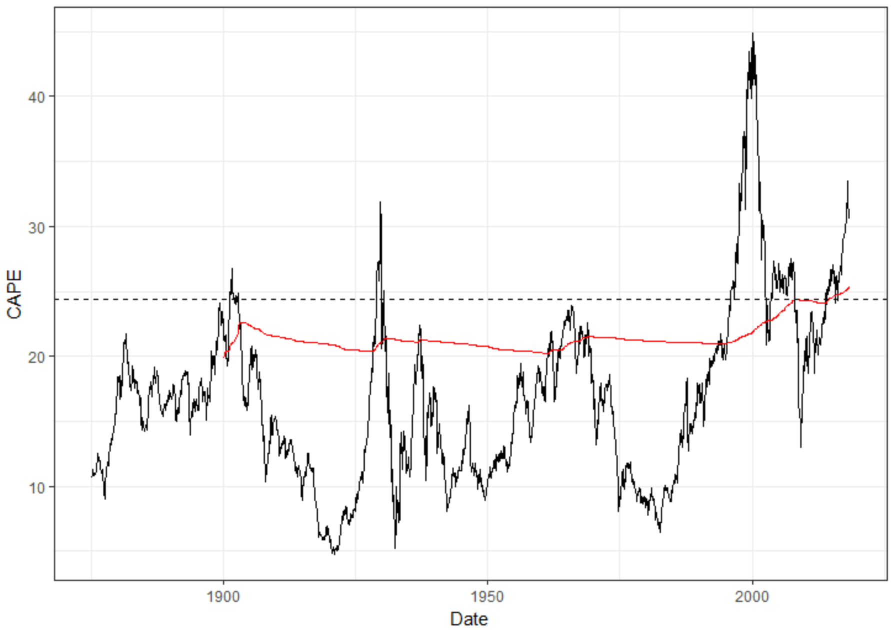
Figure 1: 10 year subsequent returns to S&P 500 based on CAPE decile

	Min CAPE	Max CAPE	Average	Stdev	Min	Max	Range
Decile 1	4.74	8.94	12.91%	5.39%	-1.68%	21.23%	22.92%
Decile 2	8.94	10.80	13.56%	4.39%	2.77%	21.28%	18.51%
Decile 3	10.80	11.97	12.06%	4.19%	4.28%	19.00%	14.72%
Decile 4	11.97	13.99	9.61%	4.54%	1.68%	18.49%	16.81%
Decile 5	13.99	15.89	9.39%	4.93%	0.34%	19.49%	19.15%
Decile 6	15.89	17.28	8.57%	3.99%	0.42%	19.01%	18.59%
Decile 7	17.28	18.56	7.45%	4.26%	-0.02%	18.85%	18.87%
Decile 8	18.56	20.78	6.86%	3.52%	-2.13%	15.26%	17.39%
Decile 9	20.78	24.39	5.51%	3.48%	-4.61%	11.59%	16.19%
Decile 10	24.39	44.88	4.44%	3.98%	-5.37%	9.38%	14.76%

Source: UBS, Global Financial Data. The decile breakpoints are defined using the 1875-2008 period and hence these are in sample results.

As we can see, as the CAPE increases the average future 10 year return falls, as does (although less smoothly) the standard devation around this average. We note, as an aside, that the end-May 2018 CAPE is 31.1, in the 10th decile.

Figure 2: US CAPE



Source: Global Financial Data. Data starts in Jan 1875. The dotted line is the 90th percentile over the 1875 to 2008 period, the red line is the 90th percentile defined on a growing window.

As we can see in Figure 2, the periods when the data is in Decile 10 are very concentrated in time. If we use the overall breakpoints (defined using data to 2008) then almost all the "expensive" data is in the most recent period. There are two earlier "expensive" periods (1901 and 1928) and then three long runs between 1995-2002, 2003-2008 and 2014 to the present day. This observation (which suggests the question of whether the "mean" CAPE has changed) partly drives the analysis in the first two papers we review.

The first two papers consider the effect of macroeconomic conditions on the forecast being generated from the CAPE. The second two look at the question of how the CAPE effects the likely distribution of future returns.

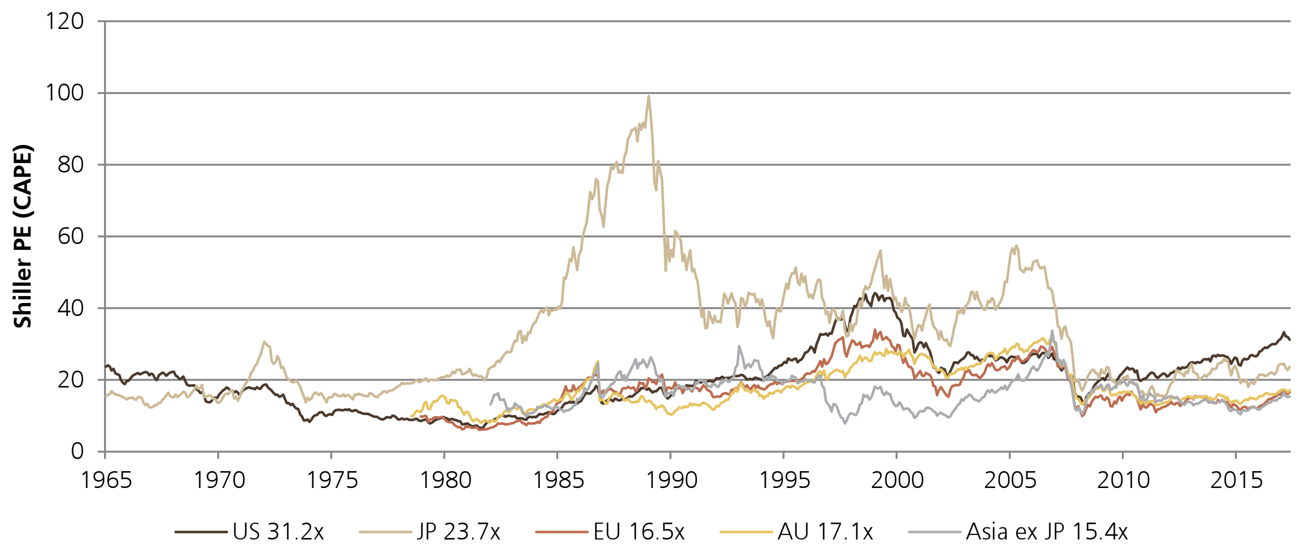
Figure 3: Papers on Shiller's P/E

"Improving U.S. Stock Return Forecasts: A 'Fair Value' CAPE Approach" *Joseph H. Davis, Roger A. Aliaga-Diaz, Harshdeep Ahluwalia and Ravi Tolani*	*Journal of Portfolio Management, 2017*
"King of the Mountain: The Shiller P/E and Macroeconomic Conditions" *Robert D. Arnott, Denis B. Chaves and Tzee-Man Chow*	*Journal of Portfolio Management, Fall 2017*
"Shiller's CAPE: Market Efficiency and Risk" *Valentin Dimitrov and Prem C. Jain*	*SSRN working paper, April 2018.* *Forthcoming in* The Financial Review
"Up the Stairs, Down the Elevator: Valuation Ratios and Shape Predictability in the Distribution of Stock Returns" *Paolo Giordani and Michael Halling*	*SSRN working paper, November 2017*

Source: UBS.

The CAPE for other markets along with the US is shown in Figure 4.

Figure 4: Shiller PE (CAPE) of regions through time



Source: UBS, Global Financial Database, DataStream

Figure 5 shows the monthly Shiller PE (CAPE) from Dec-1965 to May-18 for the United States (US), Japan (JP), Europe (EU), Australia (AU) and Asia ex Japan (Asia ex JP). The Shiller PE is calculated by dividing the average 10-year inflation-adjusted index earnings into the inflation-adjusted price index level for each region. The Shiller PE for May-18 is shown alongside the region in the legend.

The final paper we review focuses on beta dispersion, instead, and investigates its relationship to market returns and, hence, its ability to forecast future returns. Based on constituents from the S&P 500 index, It is shown that high beta-dispersion periods are followed by severe market downturns; regressing lagged values of beta dispersion on market returns yields consistently negative coefficients for various beta estimation horizons and forecasting horizons. Finally, the author demonstrates that an investor can exploit the explanatory power of beta dispersion for building a successful market timing strategy with appealing risk-adjusted return and maximum drawdown characteristics.

Figure 5: Other forecasting papers

"Beta Dispersion and Market-Timing" *Laura-Chloe Kuntz*	*SSRN Working Paper, November 2017*

Source: UBS.

"Improving U.S. Stock Return Forecasts: A 'Fair Value' CAPE Approach"

by Joseph H. Davis, Roger A. Aliaga-Diaz, Harshdeep Ahluwalia and Ravi Tolani

The authors of this paper and the subsequent one have a simple hypothesis: the fair value of the CAPE is not a steady state, but varies depending on the economic environment. In this paper that is captured by the real interest rate. They create a model forecasting the future 10 year returns taking this macro dependence into account and find it is much more accurate than a simple linear CAPE model.

CAPE is negatively associated with future returns …

The CAPE is often assumed to be mean-reverting. Shiller's CAPE time series goes back to 1881 and pre 1985, it did appear to mean-revert. This meant that the CAPE was a good forecasting variable for future ten year returns, with high CAPE suggesting lower future returns. So an equation of the form:

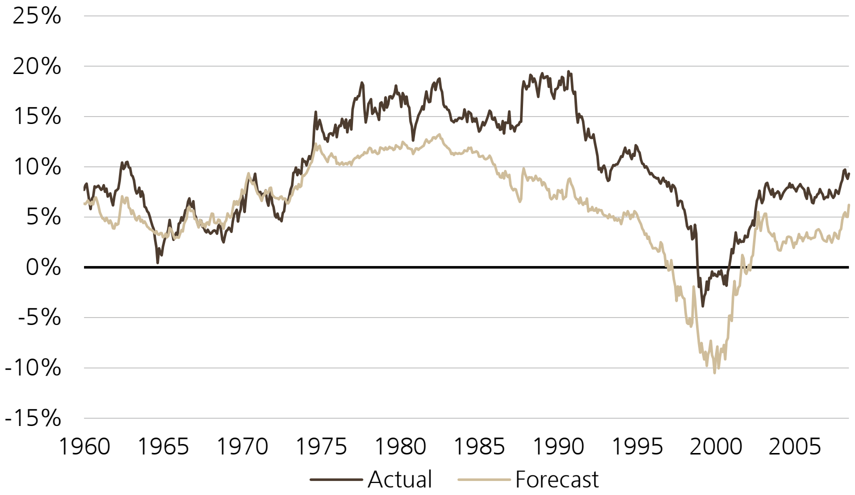
$$future\ return = \alpha + \beta \cdot CAPE\ ratio + \varepsilon$$

was a reasonable model.

… but a simple linear model would have failed in recent years

However, since 1985, the CAPE has been very consistently above its long-term (1926 to 1986) average, as can be seen in Figure 2. That means that this linear model has performed extremely poorly in recent years. In fact, the mean squared error (MSE) of this model would have been worse than if you had simply "forecast" the 10 year return to be the long term average 10 year return. Figure 6 shows the forecast (based on an increasing window) and the actual 10 year S&P 500 total returns.

Figure 6: Forecast and actual 10 year S&P 500 returns



Source: Global Financial Data, UBS. Chart shows the out-of-sample forecasts of the annualised S&P 500 10 year total return and the actual 10 year return. . The CAPE and S&P 500 data start in 1875.

Some researchers have suggested that the failure of this linear model is due to changes in accounting standards, so that the definition of earnings (the "E" in the CAPE ratio) is no longer appropriate. Davis et al find that tweaking the definition helps, but does not fully rescue the simple linear model.

The authors examined the model in more detail, and found that the beta parameter in the model is not stable through time. It is highly unstable and periods of parameter instability coincide with shifts in the bond yield. This strongly suggests that we need to take macro-economic variables into account to forecast 10 year returns.

Why? Perhaps because of changes in the real interest rate

The authors suggest an intuitive explanation: lower real bond yields mean that investors are prepared to accept lower earnings yields and hence the equilibrium value of the CAPE ratio is higher.

They propose a two step model. First, they forecast the changes in the inverse CAPE ratio (i.e. yields) and then they use this to forecast the future returns.

Two-step model

Step 1: forecasting change in the CAPE

Davis et al propose an vector auto-regressive model (VAR) with 12 monthly lags to forecast a vector of five variables, which they call X_t:

(1) inverse CAPE ratio

(2) real 10 year bond yields

(3) year on year CPI inflation

(4) realised S&P volatility over previous 12 months

(5) realised volatiltiy of changes in the real bond yields over the previous 12 months

Note that the authors do take into account publication delay etc, to ensure that they only use data that would have been available at the time.

The VAR model is simply:

$$X_t = \alpha + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \cdots + \beta_{12} X_{t-12} + \varepsilon$$

Step 2: forecasting 10 year future returns

They then split out the future return into three parts: % change in the PE ratio, earnings growth and dividend yield and make the approximation that:

$$future\ return = \%\ change\ in\ PE\ ratio + earnings\ growth + dividend\ yield$$

They use the VAR model's forecast as an estimate for the % change in the CAPE ratio, take the long-term average as an estimate for the earnings growth and take the current earnings yield multiplied by the payout ratio as an estimate for the dividend yield. This gives us a forecast for the future returns.

If the CAPE reverts to the fair value CAPE from the VAR model, which takes macro-economic conditions into account rather than its long-term average, then forecasts from this model should be more accurate.

CAPE does not revert to a fixed value – its fair value varies depending on the macro environment

Davis et al find that their two-step model is far more accurate. Over the period since 1960 the MSE of the two-step model is 3.2% vs 5.5% for the simple linear model. In the period since 1985, the MSE of their two-step model is 4.1% vs 7.8% for the simple linear model - an improvement of around 40%.

This is strong evidence to suggest that the CAPE does not revert to a fixed value, but instead its equilibirium value varies depending on the macro environment. Investors should estimate the fair value first and compare the CAPE to that value rather than simply a long-term average.

King of the Mountain: The Shiller P/E and Macroeconomic Conditions

By Robert D. Arnott, Denis B. Chaves and Tzee-Man Chow

Arnott, Chaves and Chow begin by discussing the evidence on the impact of inflation and the real interest rates on stock market returns with the aim of improving on the traditional Shiller PE. They note that these impacts are non-linear and that there appears to be a "Goldilocks zone" that maximises the Shiller PE, where inflation and real interest rates are neither too high or too low.

Inflation, real interest rates and stock market valuations are interconnected in a nonlinear way

In order to study the CAPE under different real-yield and different inflation regimes, they define a continuous nonlinear Gaussian model to determine the normal Shiller PE ratio to which the prevailing Shiller PE ratio should mean revert. They explain that a polynomial function would "fail miserably" when it comes to accounting for extremely high or low values of the independent variables.

Their preferred function (a Gaussian mountain) is given by fitting parameters based on the following expression:

A Gaussian mountain is a suitable way to condition the Shiller PE on macroeconomic variables

$$\ln\left(\frac{P}{E}\right) = f(i, \pi)$$

The function can be plotted in two-dimensional space using what are effectively contour lines. The reason the function takes on the shape of a mountain is because unusually high or low real yields (i) – or inflation rates (π) – tend to coincide with much lower average valuation multiples. To explain the logic of their approach, the authors show empirically that earnings, risk premiums and inflation are interconnected. Earnings tend to decline during periods of high inflation and inflation uncertainty is much higher when real interest rates are high.

The authors suggest that for forecasting stock market returns in the shorter term (less than 3 to 5 years), instead of using the normal forecasting equation of a linear relationship between future returns and the logarithm of the CAPE, one should use:

Can the model be used to improve return forecasting?

$$r_{t+k} = \alpha + \beta\left[ln\left(\frac{P_t}{E_{t-3}}\right) - f(i_t, \pi_t)\right] + \varepsilon_{t+k}$$

In other words, one should compare the current value of the CAPE with the fair value given the current yield and inflation environment. This looks to have a better Adjusted R^2 for forecast periods up to 12 months over the sample period (1880 to 2016 for the US market).

Yes, but only for shorter term forecasts

On a long-term basis, their forecasting model is less effective because inflation and real yields are likely to be significantly different from current levels and they recommend using the traditional CAPE.

As a robustness check, the authors perform the same analysis using data for the period 1972 to 2016 for developed stock markets other than the US. They find similar parameter values for their model, providing evidence that the CAPE depends on real-yield and inflation regimes globally. The Adjusted R^2 for their return forecasting equation is lower for most forecasting horizons using the international sample, however.

Returning to the Gaussian mountain, what regimes produce the highest and lowest CAPEs? We summarise the paper's findings for the US in the figure below.

Figure 7: US Normal Shiller PE (mean reverting level) for different regimes

	Maximum Normal Shiller PE	Low Normal Shiller PE 1	Low Normal Shiller PE 2
Normal Shiller PE	20	9	10
Real interest rate	2.92%	8%	-2%
Inflation rate	1.36%	8%	-2%

Source: UBS, Arnott and Chaves (2017)

The current Shiller PE is well above the maximum normal Shiller PE implied by the model

The sweet spot for maximising the US CAPE's mean reverting level at 20x occurs when real yields are 2.92% and inflation is 1.36%. High single digit real yields and inflation can drive the normal CAPE to less than 9x. Low negative single digit real yields and inflation produce a similarly low mean reverting level. The model's parameters compare to a current Shiller PE of 31.2x, real yield of 0.81% and inflation of 2.8%. Food for thought for market participants and policy makers alike.

"Shiller's CAPE: Market Efficiency and Risk"

by Valentin Dimitrov & Prem C. Jain

As we show in the Introduction, the CAPE is known to be negatively associated with 10-year future returns to the equity market and this result has been widely known for a long time. This seems like evidence of market inefficiency – surely if investors were rational and knew that a low CAPE is a signal of higher future returns, they would act on this knowledge by buying equities, bidding the price up and hence the strong future returns would not materialise.

Lower CAPE appears to forecast higher future returns – is this market inefficiency?

Can we use the CAPE to time the market? Probably not

However, in this paper, the authors show that timing the equity market in this way would not be a successful strategy.

An investor could not have used CAPE deciles to outperform T-bonds

For this analysis, they start by dividing the months of history in their data into deciles based on their CAPE. To remove any lookback bias from their results, they use an expanding window to decide which decile they are in "in real time". They then computed the average 10-year return for the S&P 500 versus the returns to 10 year US Treasury bonds (T-bonds).

They found that equities outperformed in all the CAPE deciles. This suggests that, even though 10-year future stock returns are lower when the CAPE is higher, the CAPE may still not be useful as a market timing signal because investors are typically interested in relative returns (as they must invest their assets somewhere) rather than absolute returns. The only exception is "when the CAPE is in the upper half of its 10th decile (CAPE higher than 27.6)."

They also note that the CAPE is very persistent and can take a long time to mean-revert. Even if investors recognise that it is unusually high they may not be willing to take advantage of this opportunity as they cannot afford to be "wrong" for several years.

These findings imply that the relationship between the CAPE and future returns may not be entirely due to market inefficiency.

A risk-based explanation

In light of these results, the authors investigate an alternative, rational explanation for the "negative association between CAPE and subsequent stock returns." They show that a lower CAPE is associated with more dispersion in subsequent 10-year returns (and vice versa). Put differently, the cross-sectional standard deviation of returns associated with each CAPE decile is higher for lower CAPE deciles. The authors argue that under this risk-based explanation, investors are compensated for taking on the additional return uncertainty that is associated with a lower CAPE.

Risk-based explanation: lower CAPE is associated with higher return because the variation in returns are higher

They note that the cross-sectional standard deviation of cumulative 10-year total returns within the lowest CAPE decile is 137% compared to just 54% for the highest CAPE decile. In Figure 1 we show the standard devation of annualised returns and we can make a similar, if less extreme observation (5.39% in the lowest decile against 3.98% in the lowest). While the relationship between CAPE and return dispersion is not perfectly monotonic, it is clear and strongly negative, which suggests that the CAPE ratio may be a proxy for risk.

Many asset pricing models, most notably CAPM, suggest that investors should demand higher returns to accept higher risk. In the same vain, Dimitrov and Jain provide a rational explanation for the negative relationship between the CAPE ratio and future returns and encourage future research on business conditions and risk.

Does the clustering of the "expensive" periods drive the reduction in volatility?

We were intrigued as to whether the clustering of the expensive periods into four main intervals could be a driver of the reduction in the cross sectional standard devation as there is obviously a great deal of autocorrelation in overlapping 10 year returns.

In our data set we have 1602 data points where we have an actual future 10 year return. For our first analysis we simply summarise the cross sectional standard devation of randomly sampled 160 data points. The results are shown in Figure 8.

Figure 8: Distribution of the standard deviation randomly sampled 10 year returns

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
4.38%	5.05%	5.20%	5.20%	5.35%	6.00%

Source: UBS. We randomly sampled 160 data points from our history of 1,602 ten year returns and calculated the standard devation. We carried out 10,000 samples.

Comparing these results with column four of Figure 1 we see that all of the actual standard devations except for Decile 1 are below the first quartile in the table above, showing that the fact we are analysing overlapping periods is affecting the results.

Figure 9: Distribution of the standard deviation of overlapping sampled 10 year returns

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
1.06%	3.42%	4.23%	4.31%	5.18%	8.60%

Source: UBS.

Figure 9 shows the similar result except now for overlapping returns with a similar pattern of overlaps as the actual Decile 10 data[1]. The actual standard deviation of 3.98% falls between the 1st quartile and the median, so although lower than what we might randomly expect the difference is not significant.

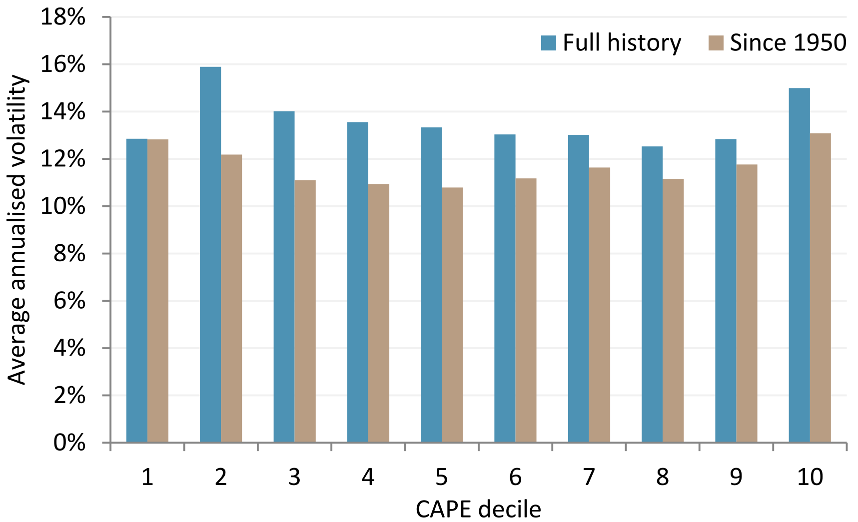
What about time series volatility?

The authors' choice of risk measure is unusual. It is more typical for risk to be measured using time series volatility rather than the dispersion of returns. Accordingly, we have used Shiller's time series data to compute the average realised monthly volatility to the excess returns of the S&P 500 over the next ten years, broken down by the CAPE decile. Following Dimitrov and Jain's methodology we use an expanding window to define the CAPE decile to avoid introducing a lookback bias.

The period of the Great Depression caused enormous stock market volatility, so for robustness, we have run this analysis over two periods: either as far back as we can go (1900 -2008) or a shorter, more recent period (1950 to 2008).

[1] We sampled runs of 80, 53, 14 and 13 returns and calculated the standard devations of these. These four runs are similar to what is visible in the data.

Figure 10: Time series volatility by CAPE decile



Source: UBS Quantitative Research, Robert J. Shiller's CAPE time series data, accessed from here: http://www.econ.yale.edu/~shiller/data.htm

Our analysis: CAPE is not strongly associated with risk as measured by time series volatility

As Figure 10 illustrates, we do not find convincing evidence that the CAPE ratio is systematically associated with time series volatility. Under this alternative definition of risk, we do not find the same results as the paper – risk appears to be independent of the CAPE ratio.

"Up the stairs, down the elevator: valuation ratios and the shape predictability in the distribution of stock returns"

by Paolo Giordani and Michael Halling

The main idea of this paper is encapsulated in the following two figures: the left hand chart shows the distribution of 12-month total log-returns conditional on the CAPE being in the top quartile; the right hand chart shows the distribution when the CAPE is in the bottom quartile[2].

We see that when the valuation ratio is low then the future returns are relatively symmetrical but they become negatively skewed when valuation ratios are high.

Figure 11: US Market 12m returns, high valuation quartile

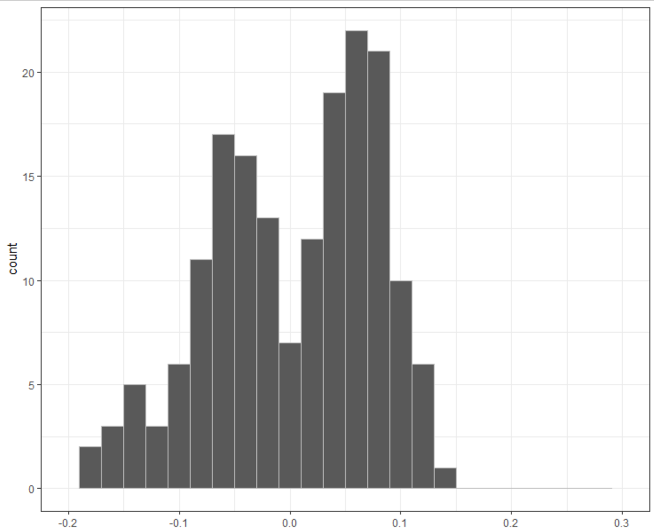
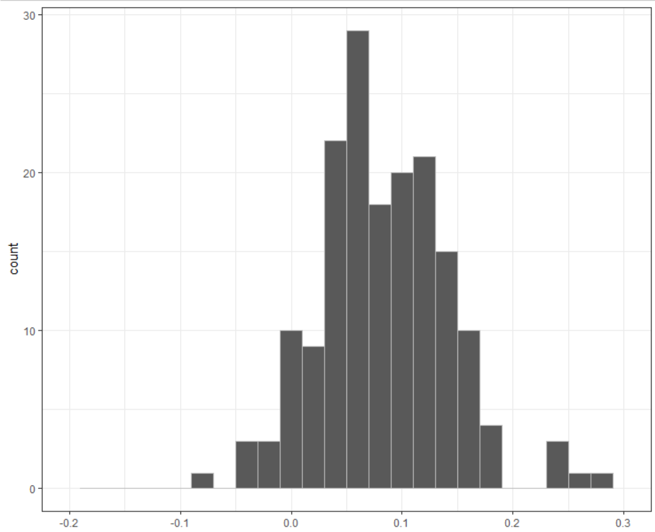


Figure 12: US Market 12m returns, low valuation quartile



Source: UBS. Charts show the distribution of log 12m returns to the US Market from 1881 to date. The left hand chart shows the returns when the 10 year CAPE is in the top quanrtile; the right hand chart when it's in the bottom quartile.

Expensive markets are more likely to correct with extremely negative returns

The authors say "the existing literature on return predictability helps us understand the dynamics of time varying expected rates of return, it does not explain how the reversion to that mean will actually occur." Their summary explanation is "if valuation ratios are high, regression to the mean is more likely to happen with extremely negative returns (i.e. a crash); in contrast, if valuations are low it is more likely to happen smoothly."

The most likely (mode) return is positive even when valuations are high

The authors model has very similar implications to the previous papers in terms of prediction of the mean return. However even when valuation ratios are high the most likely value (i.e. the mode) of the future return remains positive, "in fact roughly unchanged". This result explains why forecasting the end of a bull market is more difficult than the end of a bear market.

If valuations are high tail risk is underestimated if skewness is ignored

This result also has consequences for risk measurement. If return distributions are very negatively skewed when valuation ratios are high then this will lead to "severe underestimation" of value-at-risk and expected shortfall. The authors give the example of the 1% / 12 month value at risk. If this is estimated over the whole

[2] We note that this is an in-sample exercise – the quartiles are taken over the whole distribution.

distribution it has a value of -45%; calculated over the period when valuation ratios are high gives an answer of -71%.

As expressed above the basic forecasting equation is

$$r_{t,t+h} = \beta_0 + \beta_1 x_t + \varepsilon_t$$

In this case the authors define $r_{t,t+h} = \log(\frac{P_{t+h}+D_{t+1,t+h}}{P_t})$ – the cumulative log returns – and x_t as the log of the valuation ratio.

Their idea is to write the distribution of returns as the skew-T distribution[3] of Fernandez and Steel (1998)

$$r_{t,t+h} \sim skewt(m_t, \sigma, \upsilon, \gamma_t)$$

The parameters to the distribution are the mode, the dispersion, the degrees of freedom and the asymmetry. These four parameters are then modelled as

$$m_t = \beta_{0,m} + \beta_{1,m} x_t$$

$$\log \sigma = \beta_{0,\sigma}$$

$$\log \nu = \beta_{0,\nu}$$

$$\log \gamma_t = \beta_{0,\gamma} + \beta_{1,\gamma} x_t$$

By modelling the logs of the latter three parametrers the distribution of $r_{t,t+h}|x_t$ is then well-defined for any values of the two slope parameters.

The authors fit three variants of this model using the US CAPE[4] from January 1881 to December 2014, forecasting the forward 12- and 24-month returns. The first, the *Symmetric-T model* has $\beta_{1,m} = \beta_{1,\gamma} = 0$; the *Constant-Skew-T model* has $\beta_{1,\gamma} = 0$ and the *Conditional-Skew-T model* is the main model of interest where $\beta_{1,m} = 0$.

Future returns become more negatively skewed as valuation increases

The primary result, which backs up the intuition from the figures above is that $\beta_{1,\gamma} = -0.175$ over the whole sample period (with a t-stat of -4.3) – future returns become more negatively skewed as valuation ratios increase.

The mode doesn't change with valuation

The authors comment on the restriction of $\beta_{1,m} = 0$. Their version of the model with both β_1 parameters always had the t-stat of $\beta_{1,m}$ less than one. This implies that the mode of the distribution is fixed and the lower mean returns from higher valuations are driven by the increasing negative skewness.

We note that the authors have a constant for the dispersion parameter – they comment that adding a $\beta_{1,\sigma}$ parameter "would improve the fit to the data" but given it doesn't have "implications for the analysis of the shape of the return distribution" they used the simpler model. The authors did try a version of the model with time varying dispersion, but the estimates of $\beta_{1,\sigma}$ were not significantly different from zero – thus "there does not seem to be a strong association between current valuation levels and the dispersion of future returns." It is interesting to contrast this result with that reported in the previous paper.

[3] There are a number of skewed T distributions in the literature. This is the one the authors have chosen.
[4] They report similar results with other valuation measures.

We repeated the initial anlaysis with data from the UK, and find similar results. The UK CAPE data runs monthly from 1962 and so we divide the CAPE into thirds.

Figure 13: FT-All Share 12m returns, high valuation third

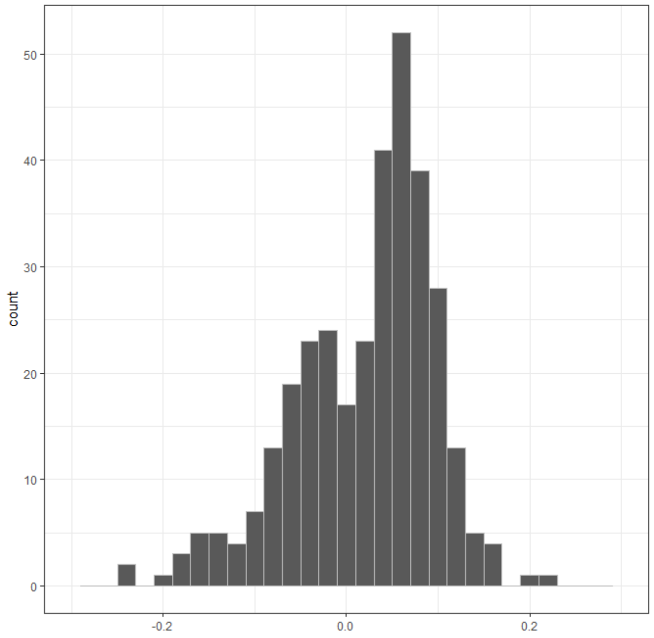
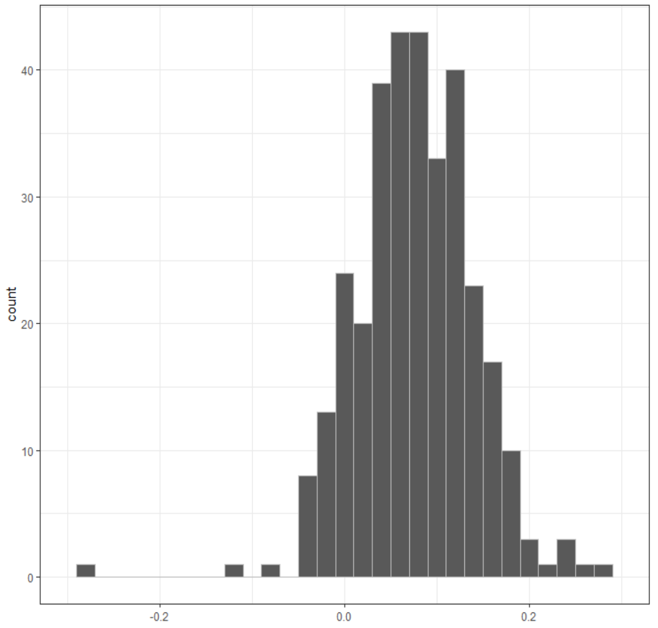


Figure 14: FT-All Share 12m returns, low valuation third



Source: UBS. Charts show the distribution of log 12m returns to the FT All Share from 1962 to date. The left hand chart shows the returns when the 10 year CAPE for the UK (Source: Global Financial Data) is in the top third; the right hand chart when it's in the bottom third.

"Beta Dispersion and Market-Timing"

by Laura-Chloe Kuntz

The time-varying spread of betas, known as beta dispersion (henceforth BD) is advocated in this paper for the purpose of achieving two tasks: it can be used as a tool for predicting future market returns; secondly, it is a measure with valuable informational content which can be exploited for constructing a successful market timing strategy.

Beta dispersion can be used for predicting future market returns and building market timing strategies.

We note, as an aside, that we discussed the time varying dispersion of betas in Why is low risk investing successful? (Sep 2011) as an explanation for the higher risk adjusted return offered by low risk portfolios.

The author describes how BD translates into market downturn risk via the cascading effect of a systematic shock. In situations where betas are highly dispersed, stocks react inhomogeneously to a systematic shock resulting in an increased level of financial distress. Consequently, a second endogenous market shock manifests itself from this heightened level of risk. On the other end of the spectrum, when betas are more clustered, the market only suffers from the initial systematic shock. Hence the dispersion of betas could give us a way to predict the probability of a future market downturn.

Primary and secondary endogenous shocks occur in high beta dispersion environments

Whilst, elsewhere in the literature, return dispersion has been proposed as a measure of market risk, Kuntz advocates BD on the basis that it accounts for both heterogeneity of returns and their relationship with the overall market. The magnitude of BD can therefore function as a proxy of market stability and be used to quantify the likelihood of a future market crash.

Beta dispersion can serve as a proxy for market stability

Deriving the market timing component of the expected return

The theoretical part of the paper starts with a stochastic version of CAPM where the conditional expected return of stock i is a function of time-varying beta:

$$E\left(R_{t+1}^{i} \middle| I_t\right) = \gamma_{0,t} + \beta_{i,t}\gamma_{m,t} \;\; with \; \beta_{i,t} = \frac{cov\left(R_{t+1}^{i}, R_{t+1}^{M} \middle| I_t\right)}{var(R_{t+1}^{M}|I_t)}$$

where $\gamma_{0,t}$ is the conditional expected return on a zero beta portfolio, and $\gamma_{m,t}$ is the conditional market risk premium.

Taking the unconditional expectation of the above results in an expression containing the covariance between the beta of the asset and the return of the market which can then be decomposed as follows:

$$cov(\beta_t, \gamma_{m,t}) = cov(\beta_{i,t} - \beta_{i,t-1}, \gamma_{m,t}) + cov(\beta_{i,t-1}, \gamma_{m,t})$$

The first term on the right-hand side is a "natural hedge" component which, when positive, indicates a greater exposure to the market when markets are rising (due to a rising beta) and lower exposure when the market is falling (due to a declining beta). The second covariance term above represents the relationship between the backard-looking beta and the future market return. When this term is positive, it signifies that a high backward-looking beta is associated with a positive market return over the holding period and vice versa. This latter term is therefore described as the market-timing component.

The covariance between the beta and the market can be decomposed into a natural hedge component and a market timing component

Empirical results

The empirical section of the paper aims to answer the following questions:

1. How do the natural hedge and market timing components contribute to the expected return?
2. What is the relationship between BD and market dynamics?
3. What is the predictive power of BD?
4. How can we effectively build a market timing strategy using BD?

Data

In all the analyses in the paper, the universe consists of stocks from S&P 500 index over the period April 1964 to December 2016. At each month over the entire period, rolling windows of daily returns over 3, 6, 12 and 36 months are used for estimating betas. Two different measures of beta dispersion are then computed at the end of every month; one based on quantiles; the other a value-weighted deviation of betas from one, the market beta.

Figure 15: Return Decomposition: Natural Hedge & Market Timing Contributions

ex ante Estimation	ex post Estimation	Market Timing	Natural Hedge
3 Months	1 Month	−0.0394	0.0226
3 Months	3 Months	−0.0332	0.0228
3 Months	6 Months	−0.0290	0.008
3 Months	12 Months	−0.0210	−0.0013
6 Months	1 Month	−0.0291	0.0064
6 Months	3 Months	−0.0255	0.0047
6 Months	6 Months	−0.0247	0
6 Months	12 Months	−0.0161	−0.0089
12 Months	1 Month	−0.0250	0.003
12 Months	3 Months	−0.0221	−0.0006
12 Months	6 Months	−0.0190	−0.0023
12 Months	12 Months	−0.0112	−0.0046
36 Months	1 Month	−0.0132	0.0174
36 Months	3 Months	−0.0112	0.0135
36 Months	6 Months	−0.0093	0.0086
36 Months	12 Months	−0.0042	0.0034

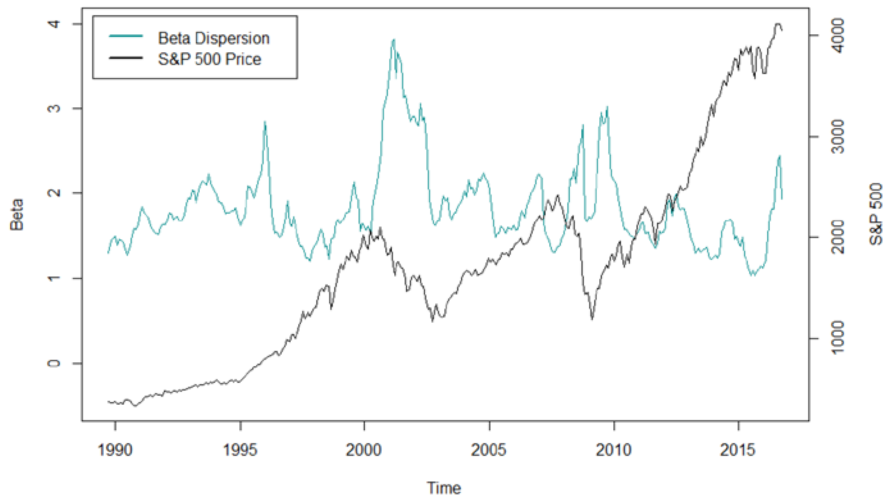
Source: Panel A of Table 1taken from "Beta Dispersion and Market Timing" by Kuntz, Aug 2017. Used with permission.

In the first instance, low beta, high beta and beta dispersion portfolios are formed based on beta estimation over 3, 6, 12 and 36 months. For various holding periods, the natural hedge and market timing contributions to the beta dispersion portfolio returns are provided in Figure 15 where the low and high quintiles are set at 5% and 95%, respectively. The first observation to make is that the natural hedge component is relatively small and volatile. The market timing contribution, however, is more stable and consistently negative. The same conclusions were made for the high beta portfolio and when beta dispersion was defined over different quantile levels. These results support the thesis that high beta dispersion in one period leads to a reduction in market returns over the subsequent period. Quantifying BD as the difference between the 90%- and 10%-quantile of the beta-sorted constituents and plotting this alongside the S&P 500 price yields Figure 16.

The market timing component is consistently negatively related to the expected return…

Positive spikes in beta dispersion appear to precede market crashes

Figure 16: Time Series of Beta Dispersion and S&P 500 Price



Source: Figure 1 taken from "Beta Dispersion and Market Timing" by Kuntz, Aug 2017. Used with permission.

To test the efficacy of BD as a return predictor, predictive regressions are run using two different specifications of BD:

Two definitions of beta dispersion are used

$$QBD_t = \bar{\beta}_t^{High} - \bar{\beta}_t^{Low}$$

which is the spread between the mean beta of the high beta quintile and the mean of the low beta quintile. The second measure is

$$BD_t = \sqrt{\sum_{i=1}^{n} \left(\omega_{i,t} \cdot \beta_{i,t} - 1\right)^2}$$

The regressions estimate the exposure of the excess log-return of the market to the lagged BD meaures (M_{t-1}):

Lagged values of beta dispersion are regressed on the market return

$$R_{m,t}^{ex,c} = \alpha + \beta \cdot M_{t-1} + \epsilon_t$$

In support of the previous results, it turns out that, in all cases (for both measures and for returns over various horizons from one to twelve months), the exposure to the lagged beta dispersion is negative. In addition, almost all of the results are significant at the 10% level at least. Out of the two beta dispersion measures, BD slightly outperforms QBD in the sense that its adjusted R^2 values are marginally higher. Furthermore, the explanatory power of BD remains even after accounting for extra variables which have been found in the academic literature to successfully predict market returns (the cay factor of Lettau & Ludvigson (2001), the average variance and average correlation from Pollet & Wilson (2010), the moving average defined in Neely, Rapach, Tu & Zhou (2014) and the VIX investigated by Whaley (2009)).

Market-timing

Beta dispersion is used to time when to invest in the market and and to what extent

Having confirmed the ability of BD to predict future market returns, the final exercise was to investigate the opportunity for an investor to use BD as a market timing signal. Three approaches are evaluated for allocating wealth (initially set at 1) to the market portfolio and a risk-free instrument:

Three market timing approaches are studied

1. Invest 100% in the market if the probability that the subsequent market return will be positive is greater than 50%; do not invest otherwise (*Basic*);
2. Conditional on the probability, hold a 100% long or short position in the market (*Unweighted*);
3. Invest in a long-short strategy where the amount invested in the market (bounded by [-1,1]) is determined by the conditional probability. I.e., the market position is defined by $X_M = 2(p|M - 0.5)$ and the amount held in the risk-free rate is given by $X_R = 1 - 2(p|M - 0.5)$ (*Weighted*).

In addition to the above, for comparative purposes, a traditional 60/40 market/risk-free rate portfolio is included as an extra benchmark.

Distributional regressions are run to estimate the market return…

The probabilities which determine the shifts in allocations in all three approaches above are given by the derived normal distribution of the market returns conditioned on the beta dispersion. More specifically, the mean and standard deviation of the normally-distributed market return are estimated via distributional regressions as follows:

$$\mu_i = \beta_0^{\mu} + \beta_1^{mu} x_i$$

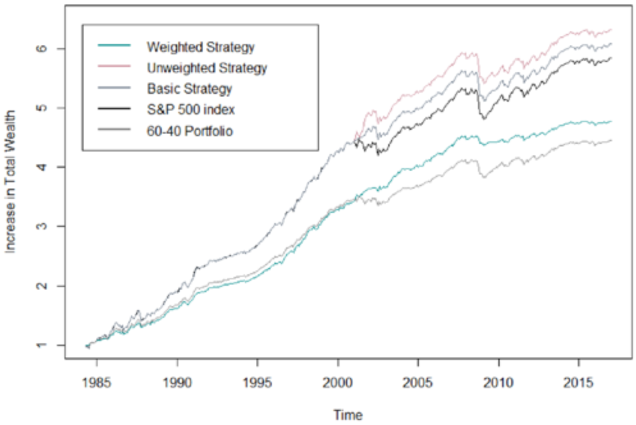
$$\sigma_i = \beta_0^{\sigma} + \beta_1^{sigma} x_i$$

This determines the probability used to switch weights in and out of the market

All three market timing approaches are rebalanced on a monthly basis and are studied with various horizons on the market returns used to compute BD and the horizon of returns BD is assumed to predict.

According to Figure 17, the beta dispersion becomes effective around 2001 following which the unweighted market timing approach appears to experience the greatest increase in total wealth. If we consult Figure 18, where the estimation period for the betas and the forecasting horizon are both 6 months, the weighted market timing strategy (approach 3) is actually superior from a risk-adjusted return perspective.

Figure 17: Performance of Market Timing Strategies



Source: Figure 5 taken from "Beta Dispersion and Market Timing" by Kuntz, Aug 2017. Used with permission.

Figure 18: Performance Summary for Market Timing Strategies

6m/6m	Avg Return	SD	SR	Max DD
Basic	10.0%	13.5%	55.1%	-10.4%
Unweighted	10.1%	13.7%	54.3%	-10.4%
Weighted	5.5%	4.7%	62.2%	-3.6%
Buy-and-Hold	10.0%	13.7%	0.54	-10.4%
60/40	7.1%	8.3%	0.54	-7.4%

Source: Part of Table 6 taken from "Beta Dispersion and Market Timing" by Kuntz, Aug 2017. Used with permission.

This is confirmed by the maximum drawdown figures in the last column of Figure 18. Furthermore, the average return to all strategies improves the longer the horizons are for both beta estimation and return forecasting.

Overall, the weighted market timing strategy offers an improved Sharpe ratio compared with more basic market timing strategies and the traditional 60/40 as well as the buy-and-hold strategy due to its ability to better time market drawdowns and therefore reduce the standard deviation of portfolio returns.

A weighted market timing strategy based on beta dispersion appears to offer improved Sharpe Ratios due to its superiority at timing market downturns.

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