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Portfolio Stochastic Design Scans:
Ranking Funds in a 401k Plan

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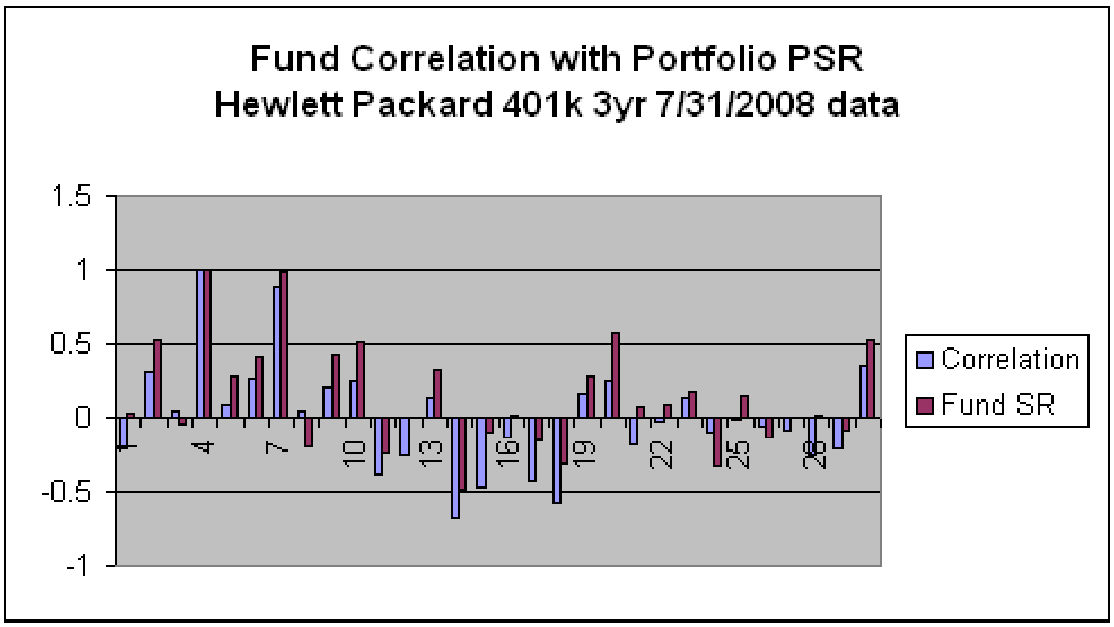
“ In the end, how your investments behave is much less important than how you behave. ”

Benjamin Graham
The Intelligent Investor

Portfolio Performance Sensitivity to Fund Data

After scanning dozens of 401k plans some with as many as 200 investment options I got interested in ranking each fund's contribution to portfolio performance. Engineers are always asking what are the design drivers for this vehicle or product. In portfolio design for 401k plans with many options where should you put your money, in all of them? If not which ones should be in your portfolio for best risk adjusted performance. The metaphor is not perfect but it reminded me that sensitivity analyses and Pareto charts are important tools for answering these questions in engineering and I had not provided that type information with the 401k scans. To illustrate this point consider the Hewlett Packard 401k plan with 30 funds in the scan. How did each fund correlate with 3yr and 5yr scan portfolio performance? In my way of thinking the APR parameter argues for, STD argues against, and PSR considers both and makes a summary recommendation about a fund.



As you can see in the HP illustration many of the funds had a negative PSR correlation meaning they reduced portfolio 3yr risk-adjusted return. The chart also shows that each funds Sharpe ratio was a pre-scan indicator that this would happen. If the 5yr scan shows the same funds with negative 5yr correlation there would be a strong case for not including them in your portfolio.

In the case of the HP 401k plan, the 3yr and 5yr correlations were similar and both Sharpe ratio asset allocation portfolios correlated well with their scan portfolios PSR. They were 92% correlated. However, the comparison misses an important difference in the 3yr and 5y PSDS Balanced portfolios. PSDS automatically excludes from the Balanced portfolio any fund with a Sharpe ratio $\leq$ zero for the period. In the 5yr scan only one fund was excluded from the Balanced portfolio but 12 were excluded from the 3yr scan Balanced portfolio. That explains why the 3yr APR is about the same as the 5yr APR for the HP Balanced portfolios posted. To confirm this I ran a third scan with only the 18 funds with positive 3yr Sharpe ratios in the plan and compared the results.

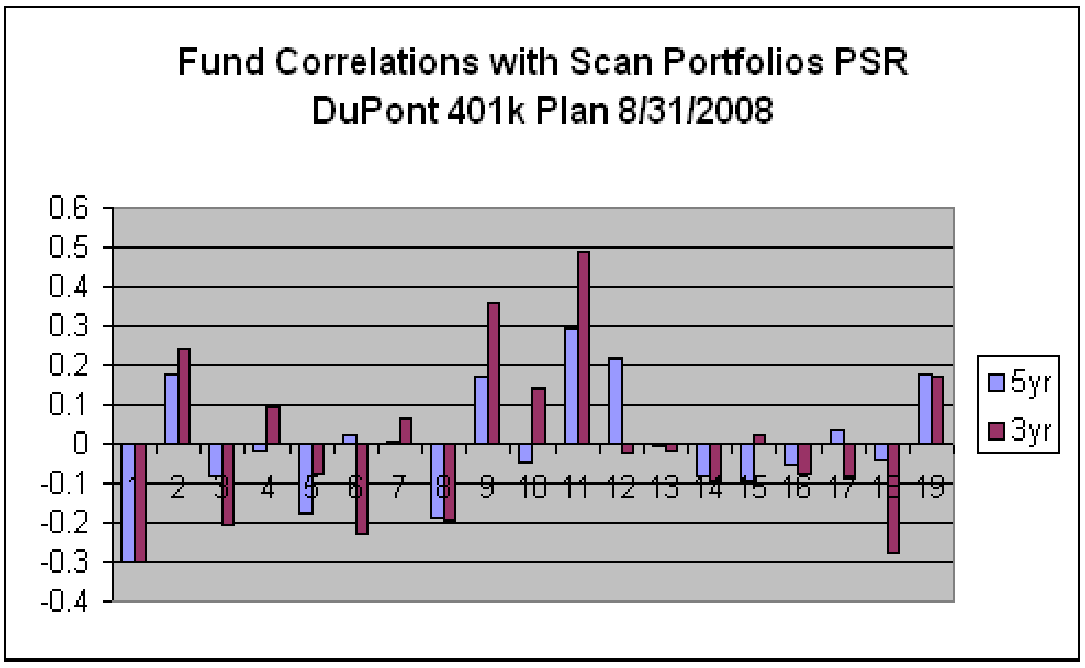
Balanced Portfolio Comparisons

Period	5yr	3yr	3yr
Funds in Scan	30	30	18
APR	13.71	13.19	13.13
STD	2.44	4.47	4.45
PSR	4.54	2.36	2.36
PSDS Exclusions	1	12	0

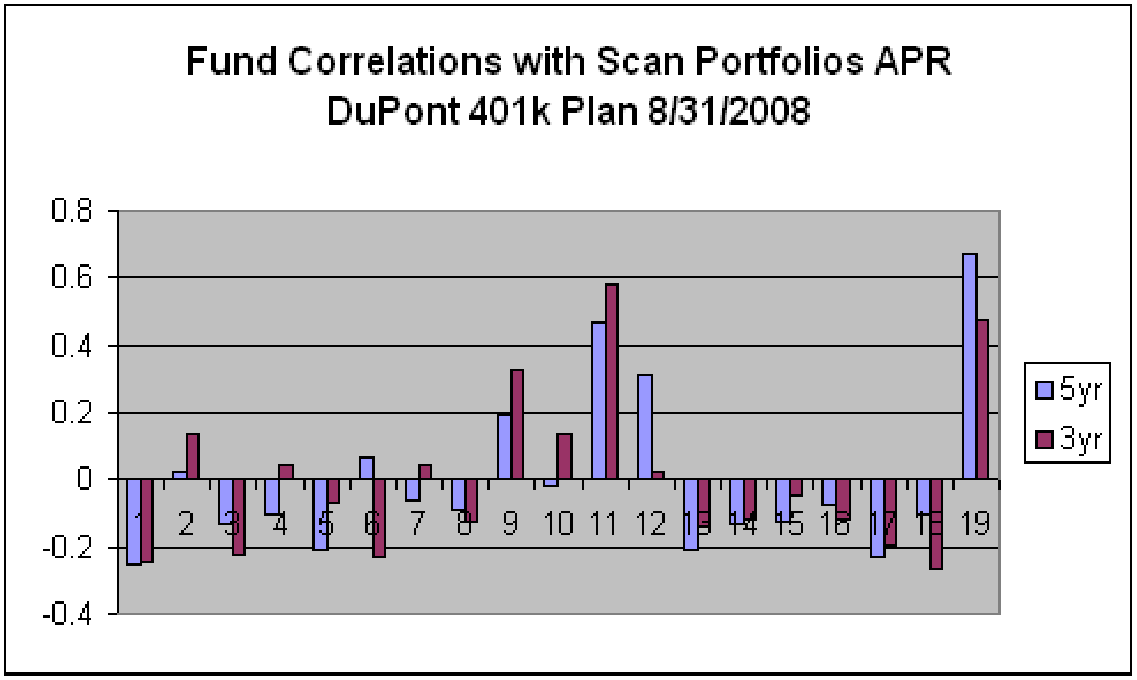
In effect the PSDS Sharpe ratio ≤ zero rule excludes funds from the 401k plan Balanced portfolio. In my RJF IRA portfolio this rule rarely gets activated because I screen out funds that do not meet this rule as part of the watch list process. The manually excluded 3yr scan with 18 funds shows that the rule effectively reduced the number of funds from 30 to 18 to preserve performance. There was a factor of two reduction in 3yr Balanced portfolio Shape ratio relative to 5yr that reflects sharply increased market volatility in the last two years.

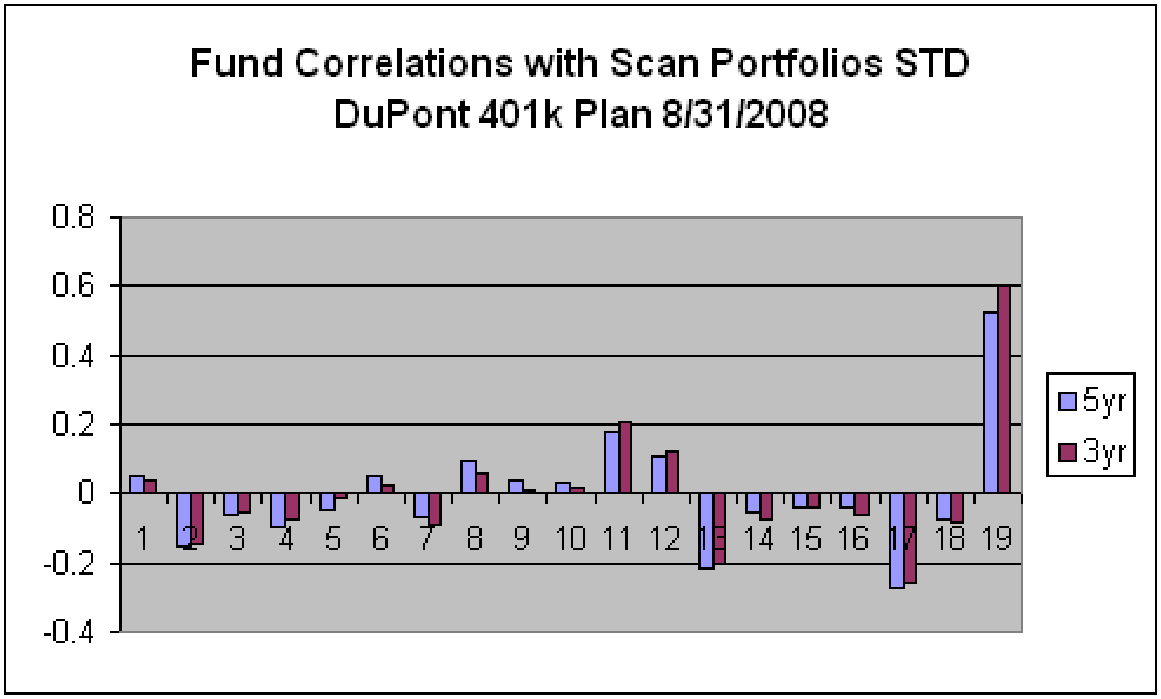
Design Process

What I want to discuss next is a portfolio design process that uses correlation data to rank investment options in 401k plans. The DuPont 401k is the model plan in the study and I have studied several other plans. Lets begin with PSR correlations using 8/31/2008 data,



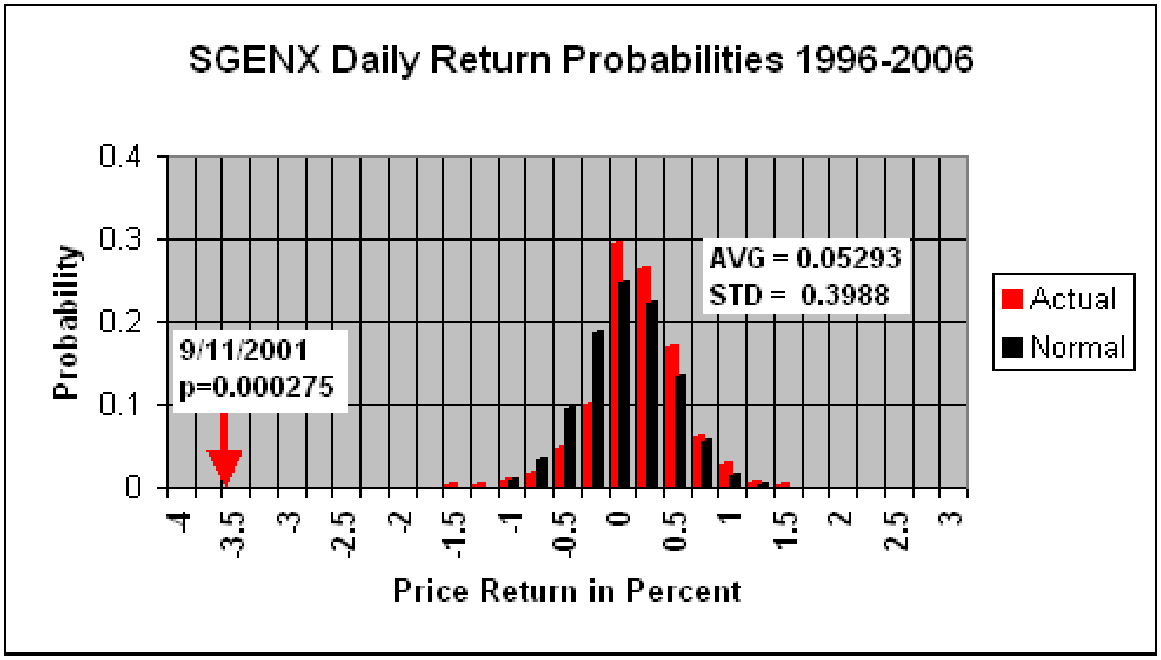
There are four other parameters computed in a PSDS scan and model fund correlations with all five were run. The other four are APR, STD, Skew and Kurtosis.



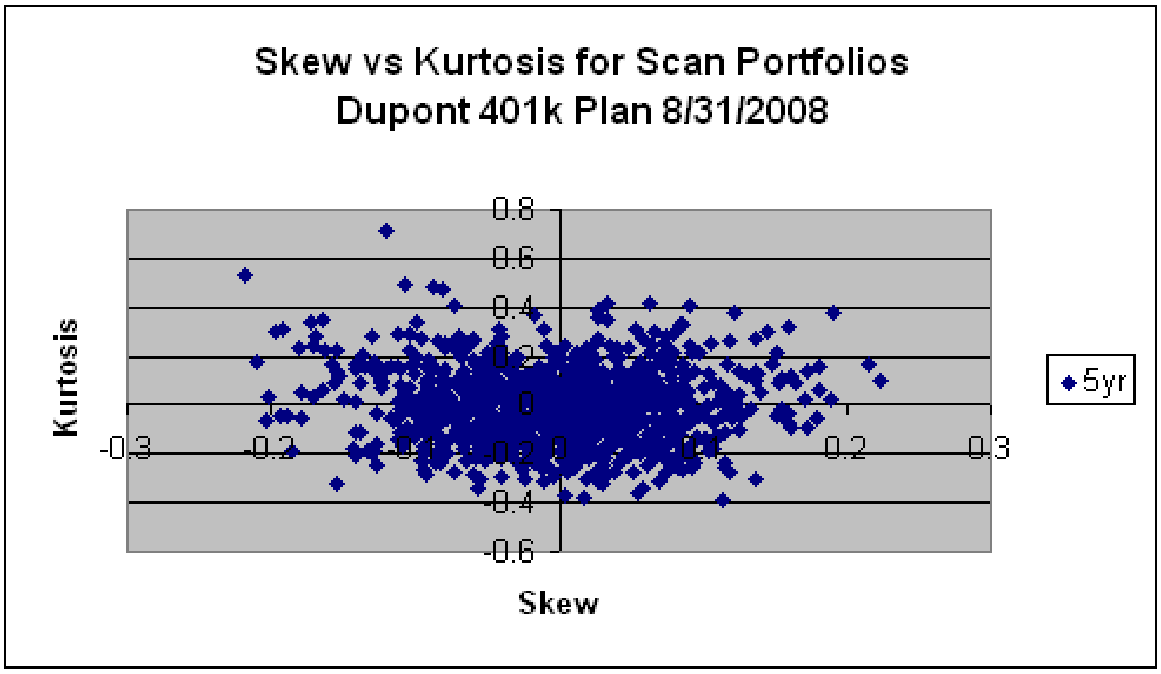


It is clear from the STD correlations that fund 19, TEEMX, greatly increases STD and would not be in many post retirement portfolios. It is a well-run emerging market fund but clearly emerging markets increase volatility sharply. I am a bit more aggressive than the average retiree and I do not own one. If I thought I was going to live another 20 years I might. TEEMX has a positive correlation with 3yr and 5y PSR.

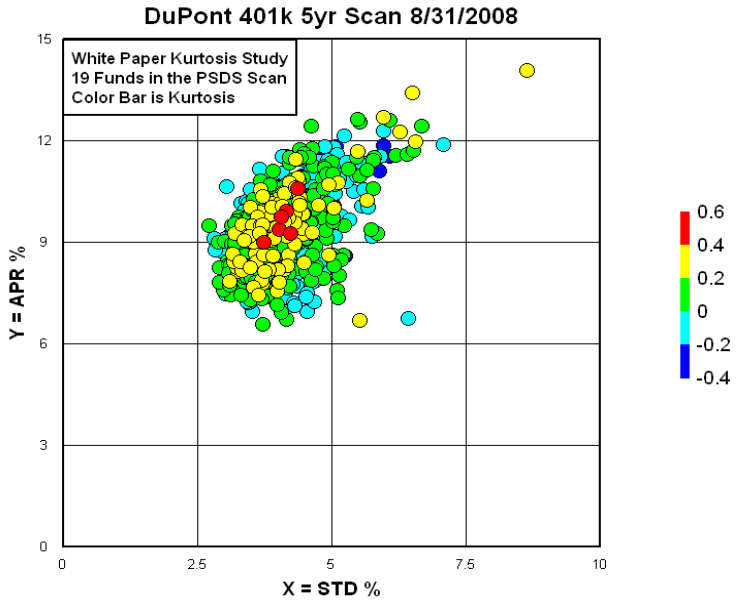
Skew and Kurtosis are the third and fourth moments of the portfolio scan returns about the mean return. If you're not into statistics these are measures of the shape of the scan probability distribution function. Skew is a measure of asymmetry and Kurtosis is a measure of so called fat tails. Wikipedia has illustrated brief articles on both and The Hyperpatch Chronicles used actual data for one of the better funds in my IRA, SGENX, to compute *daily* probability distributions for a 10yr period that included 9/11/2001. Note, this chart for 5yr *annual* data would have very little asymmetry.



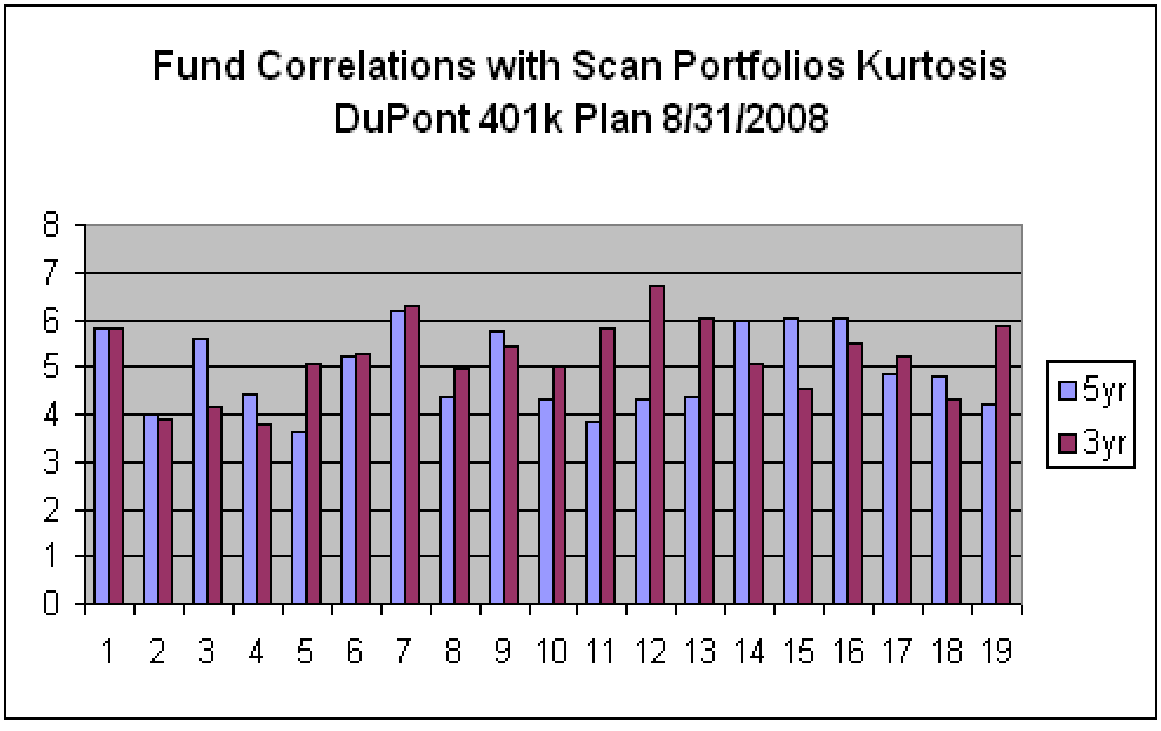
This gets a bit technical but if you want to include stress testing in your design process extreme value statistics is one way engineers use test data to increase the accuracy of failure predictions. The scatter plot of scan Skew vs. Kurtosis clusters about the origin, (0,0), which is their values for a Gaussian probability distribution.



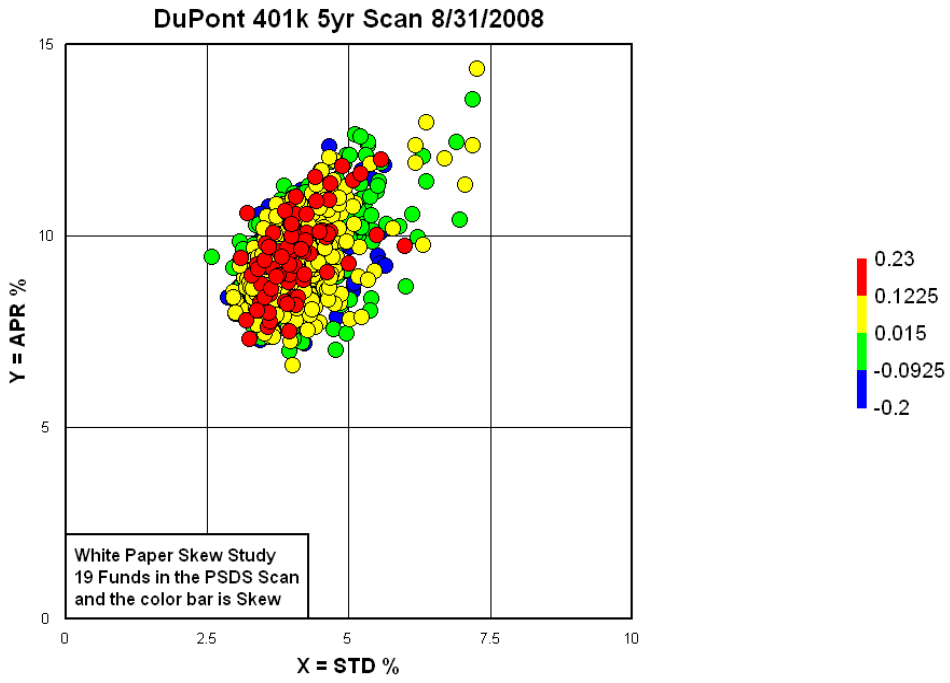
The cluster has no large numbers, which is good. A large positive Kurtosis for example would indicate fat tails exist which is not the case for the DuPont plan. The Balanced portfolios Kurtosis values for 3yr and 5y scans are KRT = -.056 and -.080 which are close to the origin. In my opinion this parameter is not too important for well-designed investment portfolios like this. Kurtosis seems to be of interest to mostly traders who worry about "fat tails" for time periods that range from day trading to microsecond arbitrage trading. In 3D with Kurtosis the third dimension the cloud of points is just a cloud not a surface. To close this discussion here is a 2D image of risk vs. reward with a color bar for Kurtosis.



Note the efficient frontier has near zero values and the Kurtosis correlation chart is not very useful in ranking funds compared to PSR, APR and STD.



The story is much the same for Skew in the DuPont model and the other 401k plans I have looked at. The Skew data are slightly different but again the Balanced portfolio has very small Skew values as you see in the image below for 5yr data.

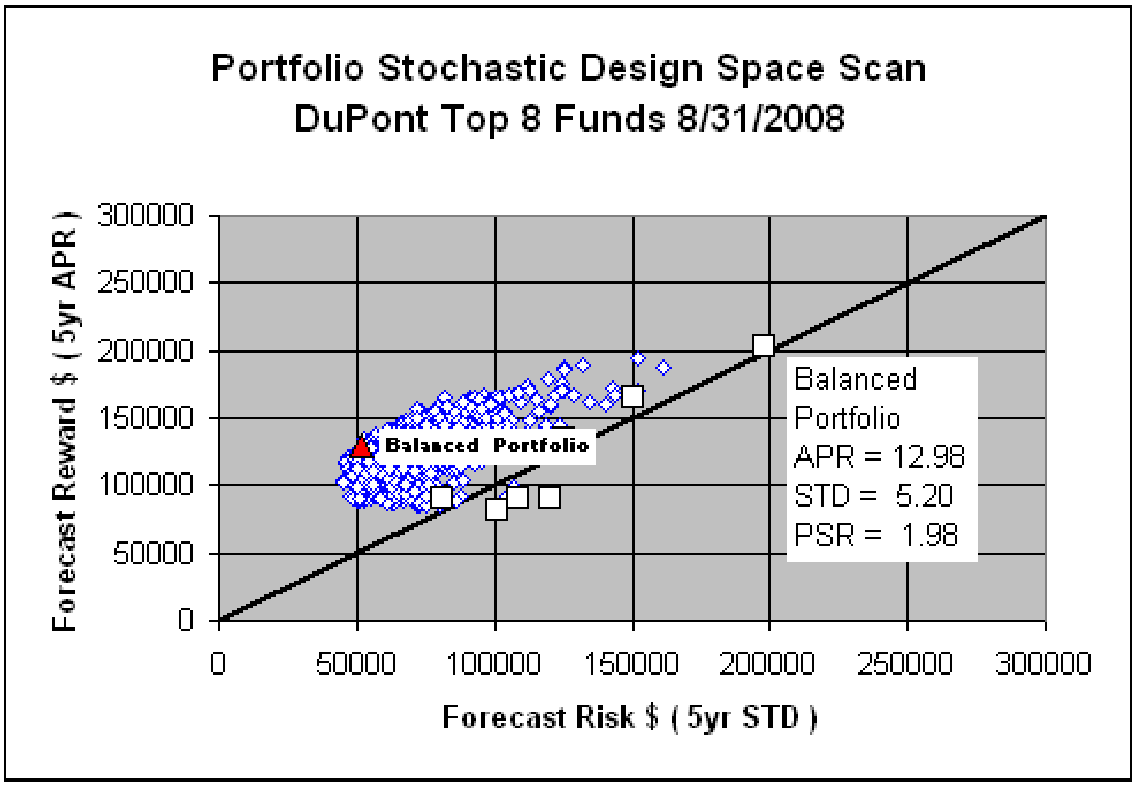


The message seems to be that Balanced portfolios, i.e. high Sharpe ratio portfolios, have low values for Skew and Kurtosis. That leaves PSR, APR and STD as parameters to use in ranking funds in a 401k plan, which is what most use today. I did not look at Treynor ratios or risk-grades in this study but would expect results similar to the Sharpe ratio results.

A Ranking Process Recommendation

When the 401k plan has more funds than you want or can manage in your portfolio this study indicates three scan parameters; PSR, APR and STD are useful but if you had to pick one it would be PSR. The correlation

charts are fairly easy to create from a scan and I look at the all 3 of them. Most portfolio managers probably would want to keep it to simply one. In the model plan the top 8 funds would be, including the emerging market fund; CHTVX, FFIDX, FCGAX, JAENX, JAMRX, MAGGX, MAIVX, TEEMX. I hasten to add that none of these are in my actual retirement portfolio and that these 8 funds are a subset of the 19 funds in the plan. That means if the scan coverage is good the best we can hope for with 8 funds is about the same return but with more volatility.



The Top 8 fund scan was compared to a 19-fund scan with 5yr 8/31/2008 data. The Balanced portfolio of the 19-fund scan is more diversified hence less volatile with APR = 10.62, STD = 3.05 and PSR = 2.60. Future scans posted on psdscanner.blogspot.com will include fund correlations with scan portfolios PSR in a bar chart.