Sunshine Effect on Stock Market Return: A Case Study

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December 19, 2007

Abstract

In order to verify the interesting relationship between sunshine and the stock market return, we backtest several trading strategies on Dow Jones Industrial Average and S&P 500 data from 2002 to 2007 using daily cloud cover data measured in Central Park of New York City. The results fail to confirm any profitable trading strategy based on sunshine.

1 Motivation

In a 2003 article[1], David Hirshleiffer and Tyler Shumway argue that sunshine is highly significantly correlated with daily stock return and by trading weather an investor with very low transaction costs would improve the Sharpe ratio modestly. Their conclusion is based on statistical analysis of 26 stock exchanges internationally from 1982 to 1997 and weather observation data during the same period.

We are most interested in whether the sunshine near a stock exchange can predict the stock market return on that day. We will focus on the exchanges in New York City because the weather data we can get are not complete in other cities, such as London or Hong Kong. We will backtest several trading strategies based sunshine. The market data include both indices and single name stocks dating from 2001 to 2007.

Since the circulation of the draft of Hirshleiffer and Shumway's paper should have been earlier than 2003, we should expect that there is little chance for profiting during 2001 to 2007 if there was any mispricing before that. Further, Hirshleiffer and Shumway use the market data from 1982 to 1997. The trading activity has been significantly electronified in the new century and a lot of orders to NYSE and NASDAQ are sent from hedge funds based in Connecticut or places even further. Therefore it is doubtful whether the sunshine in New York City can affect the overall mood of market participants.

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2 Data

We are unable to describe the trading strategies without introducing the data first.

The weather observation data used to quantify sunshine is cloud cover. As define in Wikipedia[2]

> Traditionally, cloud cover is estimated by trained observers from a meteorological station on the ground and expressed either in oktas (or eighths of the sky) or in tenths. These visual estimates are given to the closest value only. A value of 0 refers to clear sky, while 8 oktas or 10 on the decimal scale indicates overcast. Such estimates are representative of conditions within the range of visibility of the observer.

The current cloud cover in any US city could be found at the website of National Weather Service, http://weather.noaa.gov/weather/metar.shtml. We can retrieve the historical daily cloud cover data back to 2000 at Weather Underground, http://www.wunderground.com/history/. This is the finest free data we can get on the Internet. Hirshleiffer and Shumway use hourly observation data and average the cloud cover levels in the morning. Weather Underground does not indicate whether the daily cloud cover level is an average or an arbitrary observation at sometime on that day. This may distort the backtesting results. Originally we wanted to use data in New York, London and Hong Kong. However, only the data in New York is complete. Thus we focus solely on New York. The data ranges from Dec 18, 2000 to Dec 14, 2007.

In order to evaluate the sunshine effect on the mood of market participants and thus their decisions, we need intraday return series. We simply use the open and closing prices. We will backtest our strategies on two indices, S&P 500 and Dow Jones Industrial Average. The market data also range from Dec 18, 2000 to Dec 14, 2007.

3 Trading Strategy

We will backtest seven trading strategies involved with long/short. The initial capital is set to $1. One is able to long/short only when the running capital is positive. If there is a trade signal, the trade will be entered at the open price using all existing capital and exited at the closing price. The leverage ratio for long is 1 but for short it can vary. We will not compute the carry.

Because the cloud cover data is highly seasonal, in the following strategies except the last one, we will calculate the average cloud cover in each week of the past year and substract the weekly mean from the historical

daily cloud cover. Also this mean we are going to backtest from 2002 as we will use the the first one year data to deseasonalize the daily cloud cover and regression at the start.

The seven (slightly different) trading strategies are

1. Run linear regression of intraday log return against deseasonalized cloud cover and long when the predictor at that day is positive.
2. Run linear regression of intraday log return against deseasonalized cloud cover and short when the predictor at that day is negative.
3. Run linear regression of intraday log return against deseasonalized cloud cover and long/short when the predictor at that day is positive/negative.
4. Run linear regression of intraday log return against deseasonalized cloud cover and long when the predictor at that day is higher than a benchmark rate.
5. Run linear regression of intraday log return against deseasonalized cloud cover and short when the predictor at that day is negative and its absolute value is higher than a benchmark rate.
6. Run linear regression of intraday log return against deseasonalized cloud cover, and long when the predictor at that day is higher than a benchmark rate and short when the predictor at that day is negative and its absolute value is higher than a benchmark rate.
7. Long at perfectly sunny day (cloud cover is 0) and short at perfectly cloudy day (cloud cover is 8).

The benchmark rate in use is 1-month USD LIBOR from Federal Reserve Statistial Release, http://www.federalreserve.gov/releases/h15/data.htm.

4 Backtesting Results

We assume zero transaction cost and leverage ratio equal to 1.

Table 1 shows the daily return series statistics of the backtests. The results are very disappointing. Most of strategies show negative mean return and all return are much smaller than standard deviation. The 7th strategy is completely a disaster in the backtesting.

By looking at the portfolio value plots in Figure 1 and Figure 2 it seems that the short strategies perform better in recession and long strategies perform better in boom (refer to Figure 3 for the level of S&P 500 in the same period). We decompose the return into yearly return in Table 2 and

	S&P 500		DJI	
Strategy	Mean	Std	Mean	Std
1	9.76×10^{-7}	4.42×10^{-3}	6.95×10^{-5}	7.12×10^{-3}
2	-2.59×10^{-4}	9.10×10^{-3}	-2.33×10^{-4}	6.61×10^{-3}
3	-2.58×10^{-4}	1.01×10^{-2}	-1.64×10^{-4}	9.72×10^{-3}
4	-4.15×10^{-5}	3.24×10^{-3}	3.08×10^{-5}	6.55×10^{-3}
5	-1.18×10^{-4}	8.65×10^{-3}	-9.66×10^{-5}	6.16×10^{-3}
6	-1.60×10^{-4}	9.24×10^{-3}	-6.58×10^{-5}	8.99×10^{-3}
7	-1.53×10^{-4}	6.51×10^{-3}	-1.87×10^{-4}	6.28×10^{-3}

Table 1: Annualized Daily Return Statistics of Backtesting Results

Year	1	2	3	4	5	6
2002	0	18.5%	18.5%	0	17.0%	17.0%
2003	0.6%	-25.2%	-24.6%	-2.0%	-25.7%	-27.7%
2004	-1.8%	-11.6%	-13.4%	-1.8%	-6.6%	-8.4%
2005	-2.5%	-6.7%	-9.3%	-0.9%	-1.8%	-2.7%
2006	11.4%	-2.9%	8.5%	2.0%	0.6%	2.6%
2007	-5.6%	-11.3%	-16.9%	-3.4%	-1.0%	-4.4%
Cumulative	0.1%	-38.9%	-38.8%	-6.2%	-17.8%	-24.0%

Table 2: SPX Yearly and Total Return

Year	1	2	3	4	5	6
2002	-15.2%	-3.3%	-18.5%	-17.7	8.0%	-9.6%
2003	8.5%	-17.0%	-8.6%	8.5%	-13.4%	-5.0%
2004	-2.0%	-6.5%	-8.5%	1.2%	-5.8%	-4.6%
2005	5.3%	2.2%	7.5%	2.7%	-1.4%	1.3%
2006	12.9%	-3.9%	9.1%	13.4%	0.8%	12.6%
2007	3.0%	-6.4%	-3.5%	-1.7%	-1.1%	-2.9%
Cumulative	10.4%	-35.0%	-24.6%	4.6%	-14.5%	-9.8%

Table 3: DJI Yearly and Total Return

Table 3. The results are mixed except that the long only strategies look consistent for DJI.

It is worth to note that the results of long/short strategies are similar to the ones of short only strategies.If we increase the leverage ratio, they will become indistinguishable since leverage effect will make short trades dominate the PnL.

In addition, the benchmark rate provides some help in short only and long/short strategies since the portfolio values are above the ones without benchmark rate for almost all the time.

As noted in Hirshleiffer and Shumway's paper, the strategies based on

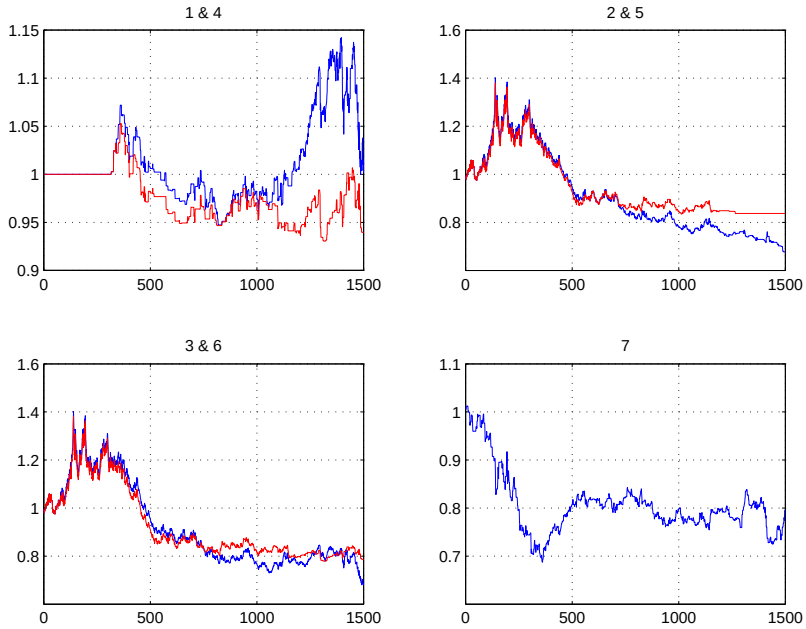

Figure 1: SPX Portfolio Value (red stands for with benchmark rate)

sunshine, even if they actually work, are only profitable for the traders with very low transaction cost since one has to trade very frequently (twice a day for most of the year). We try to increase the percentage transaction cost in short only strategy on S&P 500. When the transaction cost is 15bps, the strategy becomes surely losing.

5 Conclusion

We perform a series of backtests of trading strategies based on cloud cover level in New York City. We focus on indices, which include S&P 500 and Dow Jones Industrial Average. This is because we think single name stocks are subject to various idiosyncratic risks which are difficult to observe.

The results confirm our previous conjecture that if there was any mispricing 2001, the trading strategies based on sunshine stop working now, at least for New York City. The return is not consistent and the noise (standard deviation) is much bigger than the mean. As we mentioned before, when most of listed stocks are traded electronically and a lot of traders are working outside New York City, it seems weird to us that sunshine in New York would affect the stock market performance.

However, there are several explanations why we failed to prove a exist-

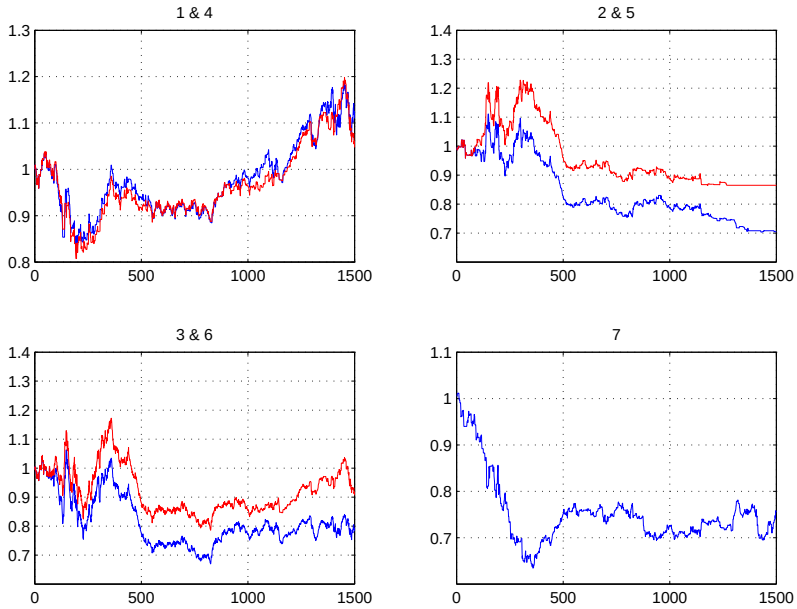

Figure 2: DJI Portfolio Value (red stands for with benchmark rate)

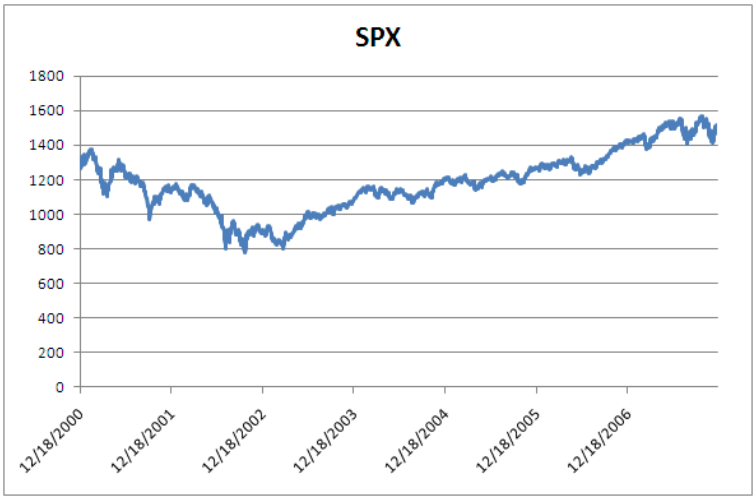

Figure 3: SPX

ing relationship. First, our weather data is not perfect. We do not have to access to the historical hourly cloud cover level. Second, our history for running regression is not long enough to provide predictive power. Third, the strategies could be further fine tuned, for example running more sophisticated regression. And fourth, there are enough arbitrageurs, presumably

hedge funds, in the stock markets to eliminate such mispricing.

In summary, our backtesting results fail to prove the relationship between sunshine and stock market return. We need more and better data to derive any affirmative conclusion.

References

[1] Hirshleiffer, D., and Shumway, T., Good Day Sunshine: Stock Returns and the Weather, *Journal of Finance* 58(3), June 2003, 1009-1032.

[2] Wikipedia, http://en.wikipedia.org/wiki/Cloud_cover