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The Discovery of Fat-Tails in Price Data

Fat-tails is one of the most important topics in financial economics, in particular for derivatives valuation and hedging, but also for risk management and almost any aspects of the investment process. The early discoveries of fat-tails in price data have in my view received too little attention. Thousands and thousands of papers have been written related to fat-tails; time-varying volatility, stochastic volatility, local volatility, jumps-diffusion, implied distributions, and alternative theoretical fat-tailed distributions are all important tools in derivatives valuation and financial risk management. Few or none of these books and papers refer to the early discoveries on fat-tails in price data,[1] and few traders and quants I have talked with seem to even be aware of that the discovery of fat-tails in price data at the time of writing goes back almost 100 years.[2]

Wesley C. Mitchell (1874–1948) seems to be the very first to empirically detect and describe both time varying "volatility" and high-peaked/fat-tailed distributions in commodity prices. Mitchell was not the first to point to fat-tailed distributions; Vilfredo Pareto had looked at the fat-tailed distributions of income already in the late 1800s and had even developed a theory for such distributions. Mitchell was however the first to empirically show that we had fat-tailed distributions in price data. All this he published in his work titled "The Making and Using of Index Numbers" published in 1915 and updated and re-printed in 1921 and 1938. I am tempted to say that Wesley C. Mitchell in many ways was to empirical finance what Bachelier was to theoretical quantitative finance. They where both far ahead of their time, and some of their most important discoveries was re-discovered long after they were first published. In 1954 Leonard Savage[3] and Paul Samuelson re-discovered in a library a thesis by Bachelier that he defended on March 19, 1900. Since then Bachelier slowly seems to have regained his position in financial economics. One of the reasons for his strong "comeback" is that his thesis was re-printed in the book by Cootner (1964) that was re-printed in 2000. Without access to what the early masters actually wrote how can we give them full credit?

I am the lucky owner of a copy of Cootner's original 1964 version. In Cootner's book there is re-print of several important papers that relatively early on describe fat-tails. One of the papers re-printed in this book is Benoit Mandelbrot's famous 1962/63 paper: "The Variation of Speculative Prices" where he focuses on fat-tailed distributions and also tries to come up with theoretical models that are consistent with fat-tails. Mandelbrot refers to Mitchell (1915) as probably the first to note the existence of high-peaked (fat-tailed) distributions.

Recently I got hold of the 1938 version that is a pure re-print of Mitchell's 1921 version that is described as a update of his 1915 version. The 1938 re-print is 114 pages long with the title "The Making and Using of Index Numbers" and with the text "This is a Reprint of Part I

From Bulletin No. 284 of the Bureau of Labor Statistics". Mitchell's booklet is mainly about how to look statistically at fluctuations in commodity prices, what we today would call volatility. I am not thinking about the statistical measure of variance and standard deviation, but volatility in a broader sense as a measure of price fluctuations. In his introduction "The History of Index Numbers" Mitchell is referring to the earliest work to his knowledge on this subject

> The honor of inventing the device now commonly used to measure changes in the level of prices probably belongs to an Italian. G. R. Carli. In an investigation into the effect of the discovery of America upon the purchasing power of money, he reduced the prices paid for grain, wine, and oil in 1750 to percentage of change from their prices in 1500, added the percentages together, and divided the sum by three, thus making an exceedingly simple index number. Since his book was first published in 1764, index numbers are over 150 years old.

Mitchell also refers to similar work done in England by Sir George Schuckburg-Evelyn 1798, and also to:

> The generation that created the classical political economy was deeply interested in the violent price fluctuations that accompanied the Napoleonic wars and the use of an irredeemable paper currency from 1797 to 1821. Several attempts were made to measure these fluctuations, and in 1883 G. Poulett Scrope suggested the establishment of a 'tabular standard value'.

For Mitchell the main interest in understanding price fluctuations in commodity prices is motivated by political economy. For this reason he and the researcher he refers to were interested mainly in how to come up with a good measure for fluctuations/volatility in the overall commodity market and not so much in individual commodities on their own. Mitchell was clearly aware that fluctuations could be of interest far outside the topic of political economy. For this reason he points out that there are many ways to calculate fluctuations, and what is the best measure will depend on what the measure will be used for.

Mitchell starts out by looking at percentage changes in 252 commodities during the years from 1891 to 1918. He points out that the fluctuations can vary widely from year to year and from commodity to commodity. Next, Mitchell arranges the price changes in the following manner:

> ...from 1891 to 1918, on which the changes from prices in the preceding year were entered in the order of their magnitude, beginning with the greatest percentage fall and running up through no change to the greatest percentage of raise. Then the whole number of recorded for each year was divided in 10 numerically equal groups, again beginning with the greatest fall and counting upward. Finally the nine dividing points between these equal 10 groups were marked off in the percentage scale of fall, 'no change,' or rise.

In this way Mitchell is in what I would consider a quite sophisticated way getting a very good indication for the fluctuations/volatility in the overall commodity market. This method is in many ways more informative than simply calculating the variance (or standard deviation) as we often do today, as this method does not make any theoretical assumptions about the distribution of the commodity prices. The method Mitchell explains here can be seen as a rough way of looking at the whole distribution, and as he does this for every year he is looking at fluctuations/volatility/distributions over time. Mitchell gives a table of this (Table 1 re-print) that he again plots in a very interesting diagram, see Chart 1 that basically shows how the fluctuations vary over time. Mitchell is pointing out

TABLE 1.—CHAIN INDEX NUMBERS OF PRICES AT WHOLESALE IN THE UNITED STATES, BY YEARS, 1891 TO 1918.

[The decils are those points in the percentage scale of rise or fall in price which divide the whole number of price changes recorded each year into 10 equal groups. Based upon the percentages of increase or decrease in price from one year to the next, computed from Table 9 of Bulletin of the United States Bureau of Labor Statistics, No. 269, May, 1920.]

(− indicates a fall; + indicates a rise; ±0 indicates "no change.")

Year.	Greatest fall.	1st decil.	2d decil.	3d decil.	4th decil.	Median.	6th decil.	7th decil.	8th decil.	9th decil.	Greatest rise.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1891	−30.5	−13.2	− 8.0	− 4.8	− 1.4	± 0	± 0	+ 1.5	+ 5.0	+15.3	+ 53.0
1892	−41.2	−16.0	−11.2	− 8.5	− 5.4	− 3.1	− 0.5	± 0	+ 1.1	+ 5.5	+ 28.0
1893	−27.5	−11.9	− 8.0	− 5.5	− 2.4	± 0	± 0	+ 1.1	+ 4.8	+11.0	+ 59.1
1894	−44.3	−21.4	−15.8	−13.4	−10.8	− 7.1	− 5.0	− 3.3	− 1.3	± 0	+ 31.1
1895	−38.0	−14.0	− 9.6	− 6.5	− 4.1	− 2.4	± 0	+ .7	+ 4.2	+12.1	+ 61.9
1896	−54.6	−17.8	−11.3	− 7.5	− 3.0	− 1.2	± 0	+ .3	+ 4.3	+10.2	+ 41.5
1897	−50.9	−11.5	− 7.2	− 4.4	− 1.7	± 0	± 0	+ 2.9	+ 6.2	+12.7	+101.6
1898	−21.9	− 7.0	− 3.3	− .4	± 0	+ 1.8	+ 5.0	+ 8.3	+13.3	+19.8	+ 60.4
1899	−20.2	− 3.8	± 0	± 0	+ 2.6	+ 5.5	+ 7.6	+10.6	+16.4	+30.8	+103.3
1900	−29.2	− 3.6	± 0	+ 3.2	+ 5.1	+ 7.5	+ 9.6	+12.7	+17.4	+25.6	+ 72.8
1901	−42.6	−15.0	−10.2	− 6.1	− 3.7	− 1.5	± 0	+ 1.3	+ 4.9	+13.2	+ 53.0
1902	−40.6	− 7.4	− 1.6	± 0	± 0	+ 2.2	+ 4.7	+ 7.1	+12.1	+20.4	+ 58.9
1903	−33.7	−12.6	− 5.3	− 2.1	± 0	+ 1.3	+ 3.7	+ 5.3	+ 8.3	+14.1	+ 37.4
1904	−43.8	−15.0	− 7.6	− 3.5	− .6	± 0	+ 1.3	+ 3.0	+ 5.9	+11.7	+ 39.9
1905	−44.9	− 7.6	− 3.9	− 1.0	± 0	+ .7	+ 3.2	+ 5.9	+ 9.6	+15.9	+ 46.0
1906	−39.1	− 4.8	± 0	± 0	+ 2.8	+ 5.1	+ 6.4	+ 9.7	+14.5	+18.9	+ 40.7
1907	−43.0	− 3.2	± 0	± 0	+ 1.2	+ 3.9	+ 6.6	+ 8.9	+12.3	+17.6	+ 67.8
1908	−39.5	−21.3	−16.0	−10.8	− 5.8	− 3.8	− .9	± 0	+ .8	+ 6.2	+ 44.9
1909	−29.8	− 7.7	− 3.7	− 1.1	± 0	± 0	+ 1.7	+ 5.0	+ 8.1	+16.0	+ 70.1
1910	−37.7	− 6.1	− 2.4	− .4	± 0	+ 1.5	+ 3.6	+ 6.3	+ 9.2	+18.6	+ 49.5
1911	−47.4	−15.1	− 9.8	− 7.0	− 4.2	− .9	± 0	± 0	+ 2.9	+11.0	+ 86.1
1912	−36.1	− 6.8	− 2.9	− .5	± 0	+ 1.0	+ 3.6	+ 6.7	+11.0	+17.7	+ 46.2
1913	−38.5	−10.4	− 3.7	− 1.0	± 0	+ .5	+ 2.4	+ 4.5	+ 7.5	+12.7	+ 58.5
1914	−37.3	−12.0	− 7.4	− 4.1	− 1.3	± 0	± 0	+ 1.5	+ 5.0	+ 9.1	+ 76.4
1915	−60.4	−12.0	− 5.9	− 1.9	− .1	± 0	+ 2.7	+ 6.0	+10.1	+18.7	+172.9
1916	−19.1	+ 2.1	+ 6.7	+10.5	+14.4	+18.6	+24.0	+30.1	+38.7	+53.4	+155.1
1917	−34.1	+ 8.7	+19.4	+25.1	+28.6	+34.8	+42.1	+49.3	+57.5	+69.3	+151.2
1918	−51.0	− 6.0	+ 2.0	+ 8.6	+14.8	+18.5	+22.1	+28.6	+36.1	+46.3	+118.0
Average	−31.9	−10.1	− 5.0	− 2.9	+ .9	+ 3.0	+ 5.1	+ 7.3	+11.5	+19.0	+ 71.0

> Time is well spent in studying this chart . . . The wide range covered by these fluctuations, the erratic occurrence of extremely large changes, and also the fact that the greatest percentages of rise far surpass the greatest percentages of fall are strikingly shown; but so also are the much greater frequency of rather small variations, the dense concentration near the center of the field, the existence of a general drift in the whole complex of changes, and the frequent alternations in the direction and the degree of this drift.

The way he connects the median of each year makes him incorporate the drift over time in the diagram. This is probably the first empirical description of time-varying fluctuation/volatility as well as indication of fat-tails/high-peak and skewed "distribution". Mitchell does not stop here, but also plots the historical distribution based on 5,578 observed percentage price changes as a histogram. He also compares it with the theoretical normal distribution. Mitchell's histogram is re-printed as Chart 2. Among many things Mitchell points out:

> The actual distribution is much more pointed then the other, and has much higher mode, or point of greatest density. On the other hand the actual distribution drops away

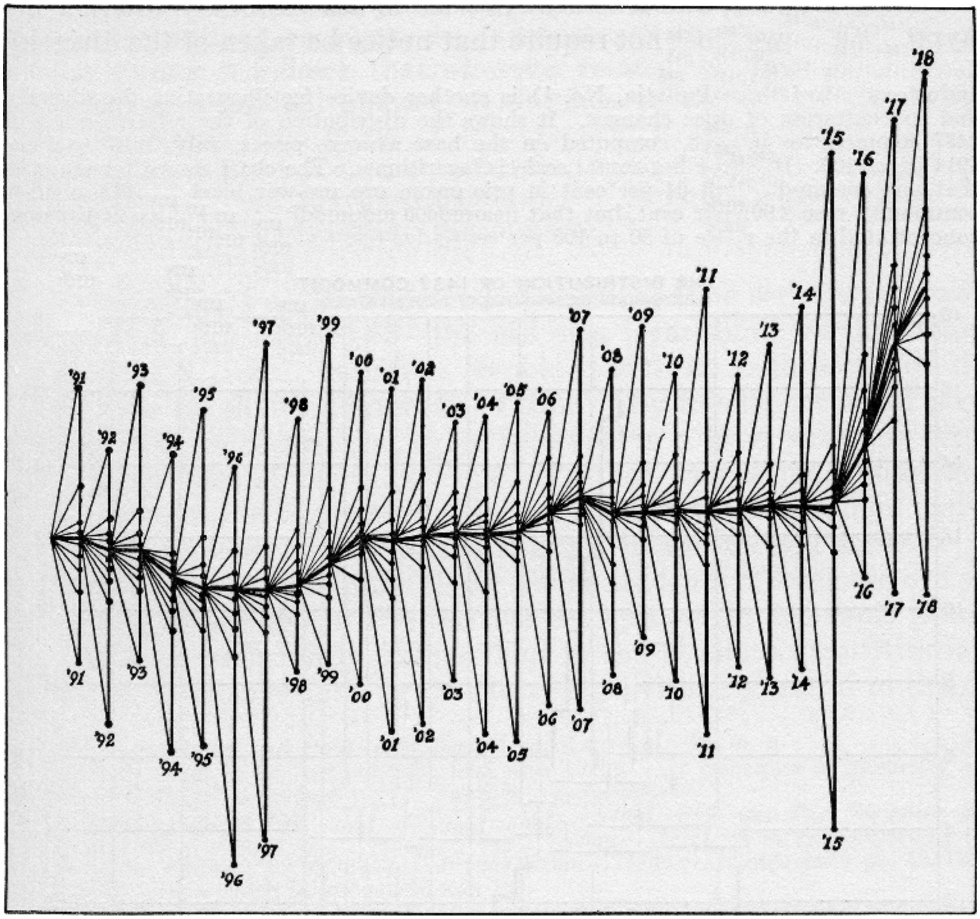

Chart 1.1: How fluctuations vary over time

> rapidly to either side of this mode, so that the curve representing it falls below the curve representing the normal distribution. The actual distribution is skewed instead of being perfectly symmetrical.

Mitchell is focuses mainly on the high-peak, and is not saying that the real histogram also seems to have fat-tails as we can see from studying the "far-out" tails from his histogram. However, he has already pointed this out indirectly with regard to the extreme observations in his time-varying chart and table. The strong positive skewness that he observes both in Chart 1.1 and Chart 1.2 he explains by the fact that the data is from a period when there was a strong positive upward trend in commodity prices. This can naturally be important when the data points are so far apart in time. Another factor that he comments on in a different part of his booklet is that if you simply look at percentage changes then you can not truly expect normal distribution. This is naturally because the maximum drop only can be 100 %, but the maximum increase can be higher. Only if we look at the logarithm of percentage changes we can get a theoretical symmetrical normal distribution. This is pointed out more or less directly by Mitchell.

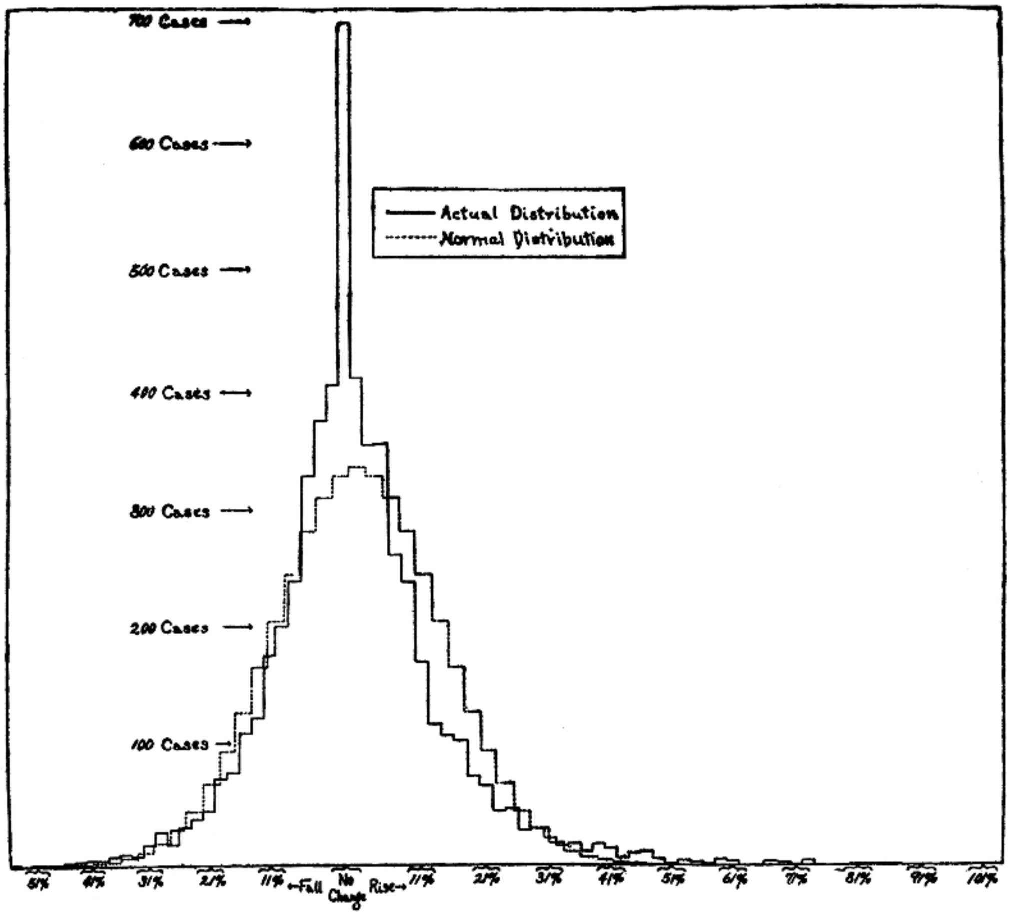

Chart 1.2: Mitchell's histogram

Mitchell also discusses what he calls interrelations (co-movements) between price fluctuations in commodity prices. His conclusion is basically that many commodities have complex forms of interrelations that are too difficult to calculate statistically. However, he is calculating linear correlation between some price indexes and is referring to that which is well known from standard text books on statistics.[4]

To summarize what already is a summary: Wesley C. Mitchell seems clearly to be the first I am aware of that have published empirical statistical findings of time-varying fluctuations/volatility and also the first one to detect and point out that the distributions of real price data have high-peak (and fat-tails) compared to the theoretical normal distribution. His empirical research is quite amazing for his time.

Henry Ludwell Moore was a Professor in political economy at Columbia University. In his book "Forecasting the Yield and the Price of Cotton" published in October 1917 he draws a histogram of spot cotton prices changes relative to the mean. In the same diagram Moore compares the real distribution to the theoretical normal distribution. Even if the histogram from real price changes clearly has high-peak and fat-tails compared to his Gaussian curve, Moore concludes that the real distribution is approximately normally distributed, in other words he ignores the high-peak and fat-tails that he just has detected in his histogram. Moore describes in detail how to measure fluctuations as standard deviation from the mean. Further, he has a lengthy mathematical and empirical discussion on measuring linear correlation in price data.

According to Mandelbrot (1962/63) the first unquestionable proofs for empirical distributions being too "peaked" relative to the Gaussian hypothesis was given by Oliver (1926) and also Mills (1927). At the time of writing I have not been able to get hold of Oliver's work, but I have the book by Mills. His book is 598 pages long and is also mainly about price fluctuations. Mills calculates the skewness and kurtosis from logarithmic returns on a large number of commodities. Based on the skewness and kurtosis numbers in combination with a statistical test that only will reject the normal distribution if the historical distribution is statistically significantly different from it, Mills rejects the Gaussian hypothesis. He concludes that leptokurtic distributions are a characteristic of the distribution of price relatives. Mills not only points out the high peak compared to Gaussian, but also points specifically to the likely reason for fat-tails:

> A distribution may depart widely from the Gaussian type because the influence of one or two extreme price changes.

Then there seems suddenly to be a period with little focus[5] on high-peak/fat-tailed distributions until the late 1950's and the beginning of the 1960's when several papers look into re-discovering fat-tailed distributions. Osborne (1959) detects fat-tails in price data, but basically ignores them and he seems to be a strong believer in normal distributed returns. Larson (1960) looks at the price changes in Chicago corn futures from 1922 to 1931 and from 1949 to 1958 and clearly finds indications of fat-tails:

> The distribution for each 10-year period has mean near zero, and is symmetrical and very nearly normally distributed for the central 80 per cent of the data, but there is an excessive number of extreme values. Also some of these values are quite extreme, being 8 or 9 standard deviations from the mean.

Alexander (1961) looks at observed distributions versus the theory of normal distributed returns and rejects normal distributed returns. He also points out that Osborne (1959) would have needed to dismiss his hypothesis of normality had he done a more rigorous test.

In his doctoral thesis at Yale University 1960:[6] Sprenkle (also re-printed in Cootner (1964)) extends Bachelier's work to log-normal, and is probably also the first to discuss fat-tails in relation to options. Sprenkle rejects log-normal and normal distribution for several stocks based on calculating skewness and kurtosis, but still sticks to log-normal distribution (log-normal price, normal distributed logarithmic returns) in his option formula:

> The ideal distribution would seem to be one which is slightly more peaked than a normal distribution and slightly more skewed than a log-normal distribution. A distribution with these characteristics is not immediately obvious.

Sprenkle rejects normal distributed returns, after skipping the crash of 1929. Sprenkle calculates skewness and kurtosis until just before the crash and then after the crash. Had he included crash he must of course (?) have known that he would have observed even higher kurtosis and probably negative skewness, but it is possible that he thought it was extremely unlikely that such an event would happen again.

In his famous 1962/63 paper Mandelbrot focuses on fat-tails, and tries to come up with a consistent theory based on observed high-peak fat-tailed distribution in price data. Most of the pieces were there before Mandelbrot, but Mandelbrot was one of the first to put together the bits and pieces and to understand the important implications of fat-tails observed in price data. Mandelbrot shows that the second moment of the distribution is highly unstable when one has fat-tails, he suggests replacing the Gaussian distributions with another family of probability distributions: stable-Paretian. Mandelbrot also seems to be one of the few that did his homework by digging out the old texts describing fat-tails before he simply came up with conclusions ignoring the facts that were already known. There is still today a great discussion as to whether or not stable-Paretian is a good solution (Rubinstein, 2006, p. 176: "Unfortunately, it is fair to say that the stable-Paretian assumption has been abandoned by later research, which now seems to favor nonstationarity as the principal source of fat-tails".) However, looking through the recent literature the stable-Paretian hypothesis seems far from dead, see for example Rachev and Mittnik (2000), Mittnik and Schwartz (2002), Rachev, Schwartz, and Tokat (2003).

Ayres (1963) points out that assumptions of normal distributed returns used in option pricing have the great virtue of mathematical simplicity and tractability, but that there is evidence that it is sometimes too simple and are referring to Mandelbrot (1962) in order to point to the problems with fat-tails.

In the 1960's and 1970's there was at the same time a substantial literature on theoretical financial economics that more or less ignored fat-tails and stuck to the Gaussian hypothesis. Many of these models have become very famous, clearly not for their distribution assumptions, but for bringing in other ideas. Probably also on the basis of many researchers being tempted to come up with mathematical simplicity and tractability, unfortunately in many cases at the cost of ignoring well known and observed facts. This has again led to a whole research industry trying to extend Gaussian based models/ideas to apply also to fat-tails. Option valuation and hedging fat-tails in the underlying asset are typically even more important than for investments in the assets themselves, and since the mid 1970's there has been a rapidly expanding literature on jump-diffusion, stochastic volatility, implied distributions, as well as alternative fat-tailed distributions (including the stable-Paretian). Over the last 10 to 30 years there has also been an increase in literature on how to take into account fat-tails in risk-management, asset allocation and capital asset pricing, but this process has in many ways been very slow taking into account that high-peak/fat-tails was an empirically stated fact established in the early 1900s or at least by the late 1920s.

As we have seen, the history of the discovery of high-peak/fat-tailed distributions goes back almost 100 years, but I say that some of the greatest discoveries around our understanding of fat-tailed distributions still lies ahead of us, discoveries that could possibly shake the foundations of financial economics and have consequences far beyond what we can imagine. Are you trying to tell me that the probability for this is extremely low? Yes it is probably low, but when an extreme event first shows up in the form of a stock market crash or a revolutionary idea it often carries with it great power and influence. So look out for the fat-tails, they are here to stay, the question is rather if you and I and our ideas will survive the next tail event.

FOOTNOTES & REFERENCES

1. An exception is Rubinstein (2006) that briefly mentions that Mandelbrot refers to Mitchell (1915) as the first one to discover fat-tails.
2. Or even longer, who knows if I have got hold of the first source? If you are aware of earlier works on discovery of fat-tails in price data I would be more than happy to know.
3. See Poundstone (2005) for more details on the rediscovery of Bachelier's work.
4. Mitchell refers to Yule, Udney G. (1912) "Introduction to the Theory of Statistics", 2nd edition.
5. Or alternatively I am not aware of any work done on fat-tails in this period.
6. According to Cootner this work was submitted to Yale University in 1960, but was probably first published in 1961.

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Ed Thorp is playing cards, using probability theory and taking home some money! This is before he started to concentrate on the Game of all Games – the financial market.

Edward Thorp on Gambling and Trading

Ed Thorp was the first to develop a wearable computer, he made money in Las Vegas using quantitative methods, he was the first to start a market neutral derivatives hedge fund: Princeton Newport and he knew about market neutral delta hedging years before Black, Scholes and Merton published their work. Edward Thorp has published the best selling books "Beat The Dealer" and "Beat The Market" together with Sheen T. Kassouf. He has published numerous articles on gambling, trading and hedge funds. Ed Thorp is a columnist for Wilmott Magazine.

Haug : Where did you grow up?

Thorp : First 10.4 years in Chicago IL then in Southern CA.

Haug : What is your educational background?

Thorp : B.A. and M.A. Physics, Ph.D. Mathematics, all at UCLA. More in "Who's Who in America".

Haug : Why did you decide to give away many if not most of your Black-Jack tricks in the best selling book "Beat the Dealer"?

Thorp : I had no intention of becoming a professional gambler. I was mainly interested in the science of the subject, and figured that I'd collect enough money prepublication to satisfy me. I also wanted to fill a void in the mathematical knowledge of this game and more generally of gambling games in general.

Haug : You worked as a mathematics professor at the University of California at Irvine, why did you decide to leave academia and go into professional trading?

Thorp : "Some are born professional traders, some become professional traders, and some have professional trading thrust upon them." I was in the last category. My increasing success and interest in the markets and the intellectual puzzles that they endlessly present gradually drew me towards full time investing, but my love of academia kept me there until 1983, some 19 years after I became seriously interested in the markets.

Haug : When did you first start trading options?

Thorp : Common stock purchase warrants in 1966 and options in 1967.

Haug : When did you first get in contact with Black and Scholes?

Thorp : The CBOE started trading in, as I recall, March 1973. In anticipation I earlier programmed my options formula into an HP9830A. Then I got a preprint in the mail from someone called Fischer Black with an options formula. It was equivalent to the one I was using and had programmed in preparation for the CBOE opening.

Haug : I heard rumours that you once were betting on horses at Saratoga with Fischer Black, why was this and did you win or lose?

Thorp : I believe this is a story told to Aaron Brown, recounted in his book, without an assertion that it is true or false. It is false. However, I did go to the track (Santa Anita, Hollywood Park) with Bill Ziemba a couple of times to use his system (which worked).

Haug : Do you regret that you were not more involved in publishing more of your ideas in mathematical finance early on rather than trading on them, you could potentially have been close to a Nobel Prize?

Thorp : I wasn't part of the economics/finance tribe so was unaware at the time of the Nobel Prize potential of the discovery. Had I been, I probably would have gone for it, but I have no regrets. Reasoning and history show that there was a tradeoff between fame and money and I prefer having enough money so that I and my family can live comfortably in perpetuity and free ourselves to explore our personal potentials.

Haug : When and how did you first learn about fat tailed distributions?

Thorp : When I devoted the summer of 1964 to reading and learning about the stock market.

Haug : In the late 1970s you also got involved in statistical arbitrage, how is this different from advanced technical analysis?

Thorp : Stat arb, as initially conceived, used price and volume information primarily, so could be called a type of "technical analysis" but wouldn't be grasped by the "chartists". However, as I practiced it, stat arb incorporated other kinds of financial information. The only limits were that it could be reduced to computer algorithms and automatically processed, analyzed and traded.

Haug : When doing statistical arbitrage do you follow it as a "black-box" or do you still use judgment and potential fundamental analysis in addition to the quantitative models?

Thorp : No "extra model" judgments except to decide that a security is, for the time being, to be taken off the trading list because important events (merger, takeover, etc.) have occurred which the model can't evaluate.

Haug : Did your firm ever get involved with the junk bond King Michael Milken?

Thorp : Like most of Wall Street at the time, we did trades with Drexel.

Haug : Your hedge fund Princeton-Newport had great returns also in 1987, how did you manage to do this when most investors lost their shirt?

Thorp : We wore a different kind of shirt.

Haug : At some point you were offered the position to invest as a limited partner in LTCM, why didn't you?

Thorp : Merriweather was a risk-taker and the Nobelists didn't, in my opinion, have trading savvy.

Haug : Basically all research on derivatives valuation assumes efficient markets, how can this be consistent with your experience of making good returns in trading since the 1960s?

Thorp : Efficient market theory tells us what the price should be, if it's assumptions are satisfied. In that world, deviations from that price are arbitrageable.

Haug : What about survivorship bias, if we include the many traders and hedge funds that never made it, blew up or closed down because of low returns and then could not attract enough capital can this be the simple explanation why someone supposedly seems to beat the market?

Thorp : A weak analogy: think of all the kids who want to be pro basketball players. Most perform below this level and most eventually give up the chase. If we judge performance of the group by that of the survivors, we greatly overestimate. But, does this mean the survivors have little skill? For more thoughts, see my Wilmott articles on market efficiency.

Haug : Since you started trading do you think the markets have become more efficient over time, or does market efficiency come and go?

Thorp : Old inefficiencies are (often very slowly) understood and disappear; new ones appear. I'm reminded of the electrical concepts of steady state and transients. New transients are always appearing and disrupting any evolution towards steady state.

Haug : The number of hedge funds has exploded, in the town where I live Greenwich Connecticut (USA) there are supposedly 330 hedge funds managing more than 150 billion USD, the returns seem to have gone down, is there now an over establishment in the hedge fund business?

Thorp : Perhaps we'll see some individual funds explode as well? Demand for alpha increases, supply doesn't keep up, amount per buyer decreases. See also my comments in "Time" February 12, 2007, page 54.

Haug : Back in time you developed systems that gave you a large positive edge in casinos, with Black-Jack and roulette, is this still possible or are the rules now tilted in favor of the casinos?

Thorp : Looks tight now, but who can say? If I were 20 again I might disagree.

Haug : Do you still go to casinos gambling?

Thorp : Not interesting – pales before the greatest game, the markets.

Haug : Are you still involved in trading?

Thorp : Not at the moment but this could change.

Haug : What are your hobbies outside quantitative finance and gambling?

Thorp : Astronomy, reading (like Charlie Munger's described by his children, some think I'm a book with legs).

Haug : Where do you think we are in the evolution of quantitative finance?

Thorp : Too many quants with hammers whacking too few nails too hard.

For an interesting story about quantitative finance applied in practice and a lot of information about Ed Thorp I will recommend the book "Fortune's Formula" by William Poundstone.

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In option trading you need to know your weapon inside out! The author used to be one of the best pistol shooters in Norway.