A statistical analysis of the shareprice of the SAIR group (1996-2001) from a risk manager's point of view.

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Abstract

Over the recent years, Extreme Value Theory (EVT) has been used in order to statistically analyse financial data showing clear non-normal behaviour. Several examples coming from market, credit and operational risk have been discussed. In the present paper we look at the particular case of Swissair and quantify, using EVT, the extremal behaviour of the returns. For this, we go beyond the traditional EVT and introduce new methodology such as smoothing and more advanced maximum likelihood techniques.

Introduction

Around the 15th of October 2001, a group of young people have a glass of Champagne at the piano bar of the Central Plaza Hotel of Zürich, but surprise the waiter doesn't accept the Swissair Qualiflyer MasterCard. The once Swiss pride Swissair is grounded. The shares have lost nearly all their value. When the airline was grounded at the beginning of October, its shares were taken off the stock exchange for two days to avoid panic. Such drastic failures do not happen from one day to the other. It all started before..."The losses, which were incurred following a massive expansion push, were greater than analysts had expected" (BBC News, 3rd of April, 2001). In this paper we show that the first massive alarm signals of bigger and bigger risk of SAIR going under were already predictable from a purely statistical viewpoint, ignoring specific domain knowledge of the airline industry, at the end of December 1999. We compare the results with other airlines for the same period of time.

We first start with some basic graphs that help to understand the behavior of the share prices and some of their movements in relation with certain events of the related period of time.

Figure 1 shows the opening prices for SAIR Group N traded at the SWX, Zürich from the 2nd of August 1996 to the 29th of October 2001. The points mark the maximal and the yearly minimal values. The graph highlights the global trend and fluctuations of the shares. Its comparison with the XAL Airline Index (Figure 2) is interesting as the Airline Index is designed to measure the performance of highly capitalized companies in the airline industry. It tracks the aggregate performance of major U.S. and overseas airlines (e.g. KLM, Northwest, Southwest, Delta, ...) but not Swissair. Both curves show an increasing trend from August 1996 to July 1998 with a maximal value on the 15th of July for Airline Index and on the 16th of July for Swissair. The shares of Swissair start to fall from the beginning of 2000.

Figure 3 shows the daily percentage changes for the same period of time. This is the relative difference in percentage from the share prices at day i and at day $i + 1$, such that the down falls are positive percentages. Figure 4 is the same graph as Figure 3 without the negative outlier value corresponding to October 2001 when the share price was close to 1 and then rise by a factor of 7. Compared to Figure 1, this graph gives evidence of the sudden down falls (with amplitude shown by the bars above 0) from one day to the other. The points above the line 0 show the yearly maximal percentage falls and the points

below 0 the yearly minimal percentage falls. The dates are written as month/day/year. It is interesting to see that the most important daily decreasing jumps arise most of the time in October or December. No wonder people speak about October crashes.

Among others, here again we can spot some important dates that show the influence of news. The downward jump (hence upward movement in the share price) at the beginning of August 1996 could be the consequence of the beginning of the Crossair venture in July. The sudden and sporadic down fall of the share price on the 28th of October 1997 coincides with the new agreement stipulating the reduction of salaries by three percent and the concurrent extension of the working week by one hour. The maximal daily jump of shares at the beginning of January 1999 might be a consequence of the special offered fares to 99 destinations starting at 99 CHF. The maximal percentage loss of 1999 recorded the 15th of October should correspond to the event of the 13th October when Delta quits the alliance with Swissair. Some other jumps or falls are hidden by the amount of data, but we can note some events like the acquisition of LTU on the 12 of November 1998. This caused a jump of the shares from 328 to 341 CHF, corresponding to a negative value of the percentage change of -4% which is rather high and shows the shareholders trust in that decision. We also notice that the fatal crash at Peggy's Cove (SR 111 from New York to Geneva) during the night from the 2nd to the 3rd of September 1998 led to a percentage fall of only 3.2% which is surprisingly little. This shows that the event didn't affect Swissair's reputation too much. At least the event was very well managed and the shareholders kept there trust in the airline. It was the first crash in 19 years. The 2nd of October 1998 the first estimation of the Swissair disaster is announced leading to a sudden down fall of the shares on the 5th of October. We could continue commenting dates with events that were important for the airline. However the strong influence of the shareholders on the daily changes is not something new, though the impact of some events on changes is of crucial importance and needs careful analysis. In the next section we show that careful statistical risk measurement is crucial to arrive at a worst case prediction. The latter analysis may even lead to an estimation of insolveney.

On Extreme Value Theory and Swissair

"What we want is an opportunity–and–risk radar, which will emphasize both the positive and negative sides to risk" says Schorderet the firm's CFO, in January 2000. And he adds: "Shareholders increasingly require risk–related information. The financial markets are tend-

ing towards paying a premium for companies that can demonstrate good business risk management." In this study we show that the use of Extreme Value Theory might already at the end of 1999 have been a useful risk radar alert.

Extreme Value Theory for financial risk management is an emerging discipline of statistics that looks at extreme events, and concentrates on the risk of extreme cases that might have never happened before. EVT has yet to make it into mainstream risk management methodology. There is also a growing interest in the subject from insurance, and this in particular for high layer excess–of–loss reinsurance business. For an in depth review of this topic we suggest the book of Embrechts *et al.*[1]. A summary of EVT techniques with several risk management applications is the edited volume Embrechts[2].

It is the 31st of December 1999, and among his good intentions for the new millennium, an investor decides to evaluate the risk he takes with his own portfolio. In the past, he used to say that if he would suggest only one share, it would have been Swissair. Comparing the trend of the Swissair quotes (Figure 1) with the trend of the Airline Index from 1996 to 1999 (Figure 2), he has no real reason to worry about his Swissair shares. The market in general looks however rather unstable since the middle of 1998, with several larger up and down movements.

Looking at the daily percentage falls (Figure 4), 1999 seems to be more stable than 1997 and 1998, in the sense that daily surprises are rare. That is exactly he decides to focus on. He concentrates on these catastrophic falls which have the most important impact on the value of his shares. ¿From the daily percentage falls of the period of the 2nd of August 1996 to the 31st of December 1999, he retains the monthly maximal percentage falls of the opening share values represented in Figure 5. The line is a smooth curve on the trend. The reason why he studies maxima is that normal daily movements and extreme events (like the market's reaction to bad news or a crash) are of an entirely different nature.

As data are not abundant he decides to apply EVT to the monthly percentage falls supposing that they are sufficiently separate by news (events) and time to be independent. He knows that this might not be true, but is the best he can do. His aim is to calculate the return level, which is a risk measure. The T–monthly return level is the level which, on average, should only be exceeded in one month every T months. The choice of the level T is a risk management decision, similar to the choice of attachment point for an excess–of–loss reinsurance treaty.

Our investor uses a generalized extreme value distribution to estimate the return levels;

see Embrechts[2] for details. The upper panels of Figure 6 are used to assess the model. If the generalized extreme value model is correct, the points should fall along the line. In our case, the model seems fine though it doesn't well capture the outlier of more than 15% of October 28, 1997. The bottom left panel shows the estimated return level and the 95% confidence intervals for different return periods (in months) given by the abscissa of the graph. The confidence interval gives an indication of how much uncertainty there is in our estimate of the return level. The intersection of the vertical line with the return level line gives the estimate of the 600–month return level, that is the value exceeded once on average every 50 years. Of course he could have estimated the 300 or 3000–month return level but this is more a personal and sometimes political/strategic decision. It goes without saying that an investor would typically chose a lower return period than a risk manager in a bank. It very much depends on how often we could sustain (psychologically as well as financially) the worst case occurring.

The estimated value for the 600–month return level is around 20% and the confidence interval about (2%, 42%). As he also decided to be very reasonable this new year, it is the more conservative value of 42% that he decides to consider though it is more than 12 times as large as the mean values of the monthly maxima for that period (from the 2nd August 1996 to the 31st of December 2001). In order to calibrate this risk measure, he repeated the same analysis for the Airline Index over exactly the same period of time. The resulting plots are shown in Figure 8, computed from applying the EVT method on the monthly maxima of Figure 7. It shows an estimated value of around 14% for the 600–month return level, with a confidence interval (1%, 27%). The upper bound of 27% compared to the 42% for Swissair would mean that the Airline Index is 36% less risky than Swissair shares using the 600–month return level as our risk measure.

What happened finally? On the 3rd of April 2001, the Swissair share opened at 28.73% below its closing price of the day before.

Time is passing. May 2001 records a maximum percentage fall around 5%, June around 11%, July around 6%, and August around 11%. Swissair is on the cover pages of the newspapers and uncertainty increases day by day. Our investor made a second analysis based on the data from the 2nd of August 1996 till the end of August 2001. Figure 9 shows the monthly maximal percentage falls for that period of time. Again he fits a new model including the new data and calculates the return levels. The resulting graph is shown in Figure 10 and the estimated 600–months return level is now about 41% with an upper

bound of the 95% confidence interval around 80%, a value he decided to retain. For the sake of comparison, Figure 11 gives the monthly maxima of the Airline Index for the same period. The results from the application of EVT are shown in Figure 12. The same method has been applied on the monthly maxima of Lufthansa (Figure 13) for which the graphical results are presented in Figure 14.

After two days of closure of the SAIR group's shares, the 3rd of October 2001, the share value is 1.27, leading to a "percentage fall" of 96%. This is not really a percentage fall as the market was closed for 2 days, and it would have been wrong to say that our risk manager underestimated the risk. The 80% he obtained was simply a most serious warning.

Conclusion

This paper gives a posterior analysis of the shares of Swissair. We specifically looked at extreme moves in the data considered from some risk measures suggested by EVT. Of course EVT cannot do magic and we are far from saying that it predicts the future with certainty. But EVT can play an important role in risk management, providing sensible tools to measure risk by modelling extreme events. The financial industry (banking, insurance, regulators) is grasping the value of EVT to model risk from a quantitative point of view. The above discussion only gives a minimal analysis and could have been fine tuned in several directions. For instance by taking dependence within the time series into account or by looking not just at the largest moves but at the r–largest ones ($r \geq 2$), say, over a certain period of time. We also could have EVT–modelled several airline shares jointly. The way we presented the analysis reflects our view on how EVT can be used as a day–to–day exploratory risk management tool. Much of finance, and hence of quantitative risk management, is caught in the straightjacket of the (multivariate) normal distribution where extreme moves simply do not occur. ¿From practice, as for instance shown in the Swissair example and many more, we know that extremes do occur. EVT gives a way of breaking out of the normal world and entering into a more realistic world where extremes are more likely to happen.

Acknowledgement

References

1 Embrechts, P., Klüppelberg, C. and Mikosch, T. (1997) *Modelling Extremal Events for Insurance and Finance.* Springer, Berlin.

2 Embrechts, P. (2000) *Extremes and Integrated Risk Management.* Risk Waters Group, London.

Figure 1: Opening SAIR Group N prices at the SWX, Zürich from the 2nd of August 1996 to the 29th of October 2001, in CHF.
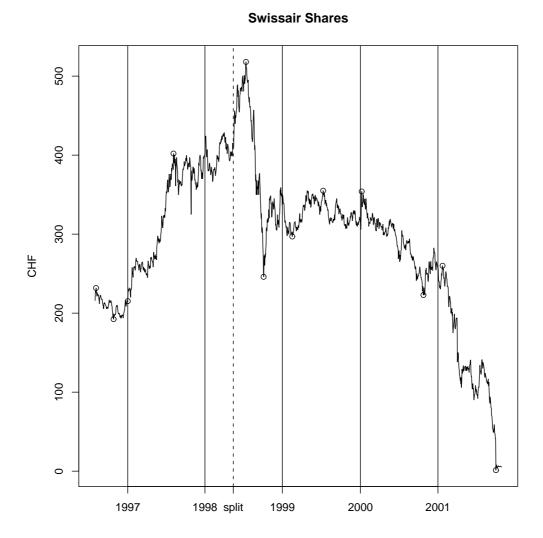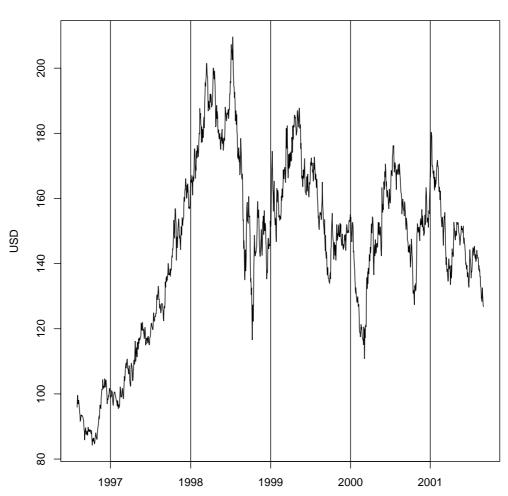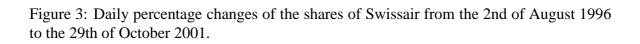
Swissair Shares

Figure 2: Opening prices of the XAL American Stock Exchange, from the 2nd of August 1996 to the 29th of October 2001, in USD.

Airline Index Shares

Figure 3: Daily percentage changes of the shares of Swissair from the 2nd of August 1996 to the 29th of October 2001.

Daily Percentage Changes

Figure 4: Daily percentage changes of the shares of Swissair from the 2nd of August 1996 to the 29th of October 2001 without the outlier of October 2001.

Daily Percentage Changes

Figure 5: Monthly maximal percentage falls of the opening shares of Swissair from the 2nd of August 1996 to the 31st of December 1999.
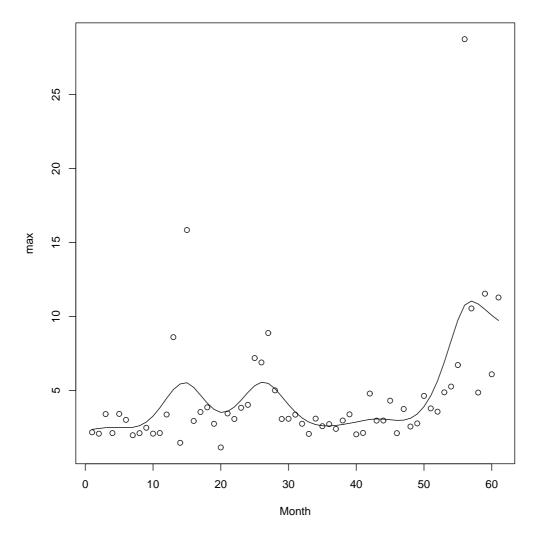
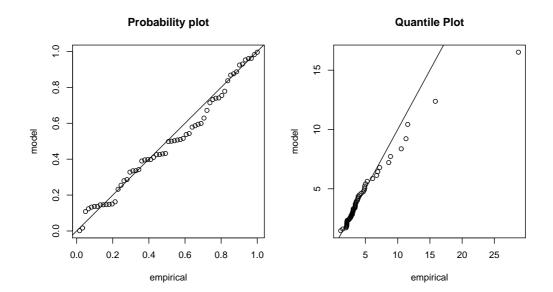Figure 6: Diagnostic plots for the EVT fit to Swissair data from the 2nd of August 1996 to the 31st of December 1999.

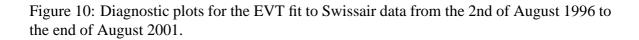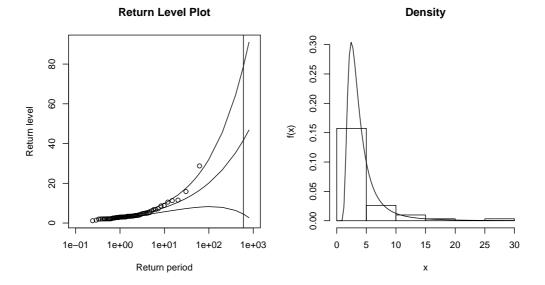Figure 7: Monthly maximal percentage falls of the opening values of the Airline Index from the 2nd of August 1996 to the 31st of December 1999.

Figure 8: Diagnostic plots for the EVT fit to Airline Index data from the 2nd of August 1996 to the 31st of December 1999.

Figure 9: Monthly maximal percentage falls of the opening shares of Swissair from the 2nd of August 1996 to the end of August 2001.

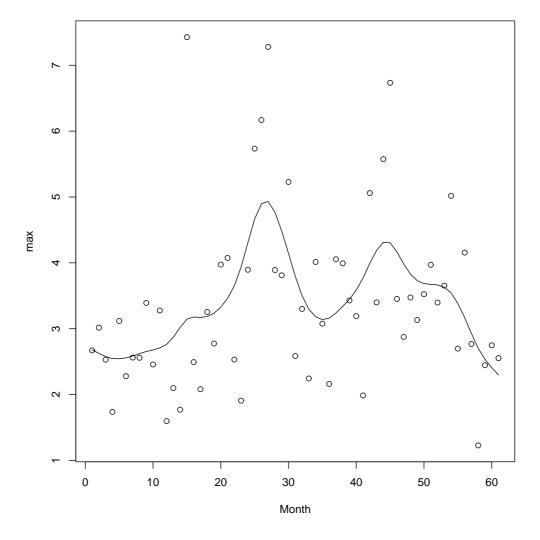Figure 10: Diagnostic plots for the EVT fit to Swissair data from the 2nd of August 1996 to the end of August 2001.

Figure 11: Monthly maximal percentage falls of the opening values of the Airline Index from the 2nd of August 1996 to the end of August 2001.
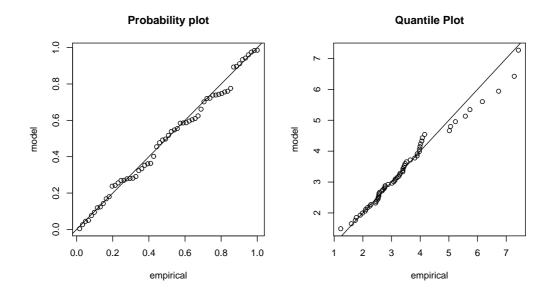
Figure 12: Diagnostic plots for the EVT fit to the Airline Index data from the 2nd of August 1996 to the end of August 2001.
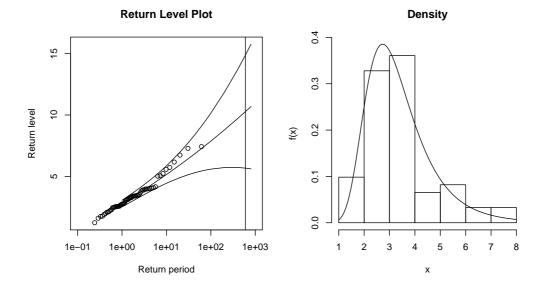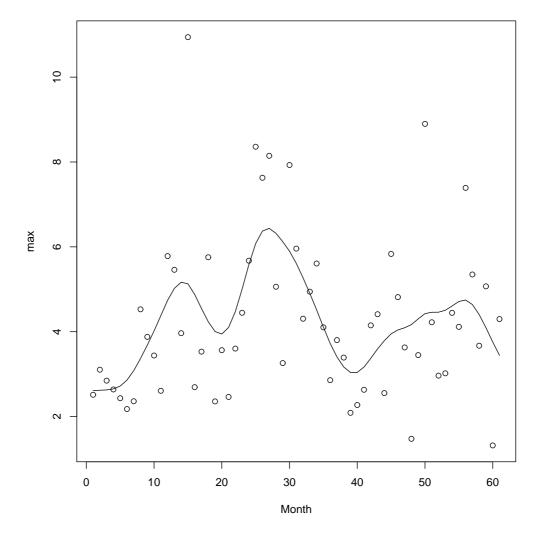
Figure 13: Monthly maximal percentage falls of the opening shares of Lufthansa from the 2nd of August 1996 to the end of August 2001.
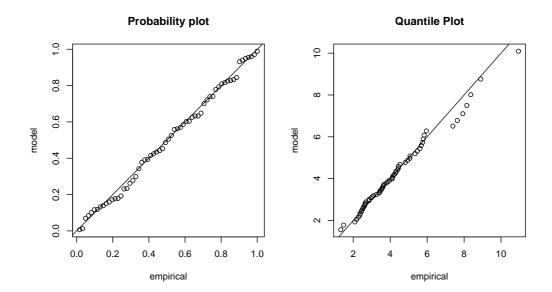
Figure 14: Diagnostic plots for the EVT fit to the Lufthansa data from the 2nd of August 1996 to the end of August 2001.