Black swans, antifragility and pattern recognition at the German stock market

von Prof. Dr. Thomas Holtfort | Prof. Dr. Jarek Krajewski

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» Executive Summary

» Die Studie beschäftigt sich mit der Relevanz von Schwarzen Schwänen im Zeitraum November 1990 bis Juni 2014 für den deutschen Aktienmarkt, um einerseits deutlich zu machen, dass solche Extremereignisse häufiger vorkommen als es nach der Normalverteilung zu erwarten wäre und andererseits Handlungsempfehlungen abzuleiten. Die Ergebnisse belegen den Einfluss von Schwarzen Schwänen, wonach allein in den letzten 24 Jahren fünf Ereignisse zu einer Renditeabweichung von mindestens vier Standardabweichungen geführt haben.

» The study deals with the relevance of Black Swans at the German stock market for the period from November 1990 to June 2014, to decide to what extent very negative yield deviations occur more frequently than would be expected for a normal distribution and to derivate recommendations for investors. The analyzes show that the negative impact of Black Swans is given clearly, according to five events which have led to a daily loss of more than four standard deviations only in the last 24 years.

» AUTOREN Prof. Dr. T. Holtfort | Prof. Dr. J. Krajewski

Prof. Dr. Thomas Holtfort, Professur für Finanz- und Wirtschaftspsychologie/Verhaltensökonomie, FOM Hochschule.
Prof. Dr. Jarek Krajewski, Experimentelle Wirtschaftspsychologie, Bergische Universität Wuppertal und Wirtschaftspsychologie, Rheinische Fachhochschule Köln.

I. Introduction

Today's view of the capital markets has changed since at least the scientific knowledge and new approaches of Nassim Taleb[1]. After that, the prices at the financial markets are less normal distributed than previously assumed but rather fractal, so with larger random jumps[2]. Such price distortions caused by so-called Black Swans are events that lie outside the expectations firstly, secondly, have enormous positive or negative effects and thirdly, they seem to be explainable in hindsight (according to the narrative fallacy). The aim of this paper is an empirical analysis of the pricing behavior at the German stock market in terms of extremely negative and thus rare events (at least 4 standard deviations) and the derivation of recommendations for investors and risk managers.

II. Overview

Looking at the capital market activity and its effects with the view of an outsider, there are some anomalies. Firstly, investors and analysts need to justify their decisions, causal relationships between causes and consequences. The problem of these facts is, however, if these linear relationships are evoked only by our mind, but do not reflect reality. Mostly exist for the occurrence of a condition (consequence) number of possible causes that can even relate to each other. This error is referred to narrative fallacy[3]. Especially in the complex financial world, the narrative fallacy is to be found varied. Closely related with the search for causality is also the problem of induction, which many confirmations from the past do not increase the probability of a future general assumption[4]. The concept of fragility is also directly related to causality, since it is not linear or causal (*Fig. 1*) but much more vulnerable to extreme events than by a sequence of average incidents[5].

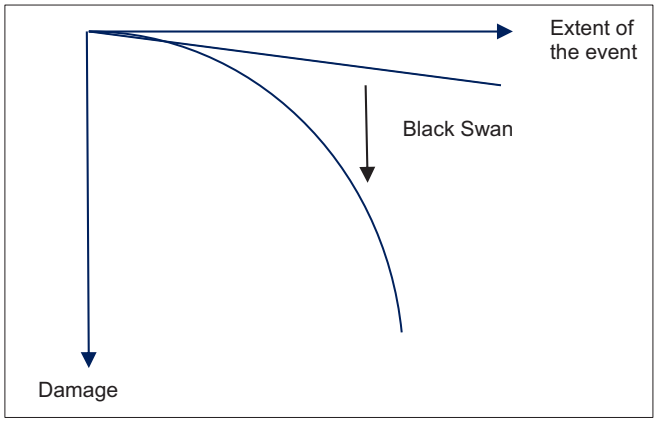

Fig. 1: Disproportionate effects of unexpected events in the presence of non-linearity

Second problem is the poor predictive power of financial market experts. Things that are influenced by humans (eg stock markets and policy) and thus are exposed to strong movements, can be predicted significantly worse than for example a chess game. So the studies of Gigerenzer[6] and Guedj/Bouchaud[7] show exemplary that both foreign exchange experts of banks and security analysts are no better than naive predictions in their forecasts. In the analyzes it was found even a herd behavior such that the mistakes of the experts were significantly greater than the average difference between the individual predictions. One possible reason for the homogeneity in the forecasts is that we know too much[8]. Thus it is with information so that the more of them are considered, the more hypotheses are, which ultimately do not include valuable information but only noise.

Problem 1 and 2 thus show the limits of pattern recognition especially in the financial markets with the help of statistical methods. Taleb calls this statistical regression fallacy or circularity of statistics, so the belief that the essence of a

1 Taleb, The black swan: The impact of the highly improbable, 2007 and Taleb, Antifragile: Things that gain from disorder, 2012.
2 See also Mandelbrot, The variation of certain speculative prices, Journal of Business 1963 pp. 394 (419).
3 Taleb, The black swan: The impact of the highly improbable, 2007.
4 Russell, The problems of philosophy, 1912.
5 Taleb, Antifragile: Things that gain from disorder, 2012.
6 Gigerenzer, Risk savvy: How to make good decisions, 2014.
7 Guedj/Bouchaud, Experts' earnings forecasts: Bias, herding and gossamer information, International Journal of Theoretical and Applied Finance 2005 pp. 933 (946).
8 Gigerenzer, Gut feelings, Short cuts to better decision making, 2007.

random issue can be taken through a series of measurements[9].

Ultimately mentioned is the rigid adherence to the relevance of the normal distribution with respect to the price behavior at the stock markets and the associated use of risk indicators, such as the value at risk for example. Many issues that are influenced by people are less normal distributed but follow rather a Pareto-distribution and are scale-invariant[10]. Thus, the distribution of wealth worldwide for example is rather fractal[11] and power-law ($y = ax^b$) induced so that a few people have almost everything and they are also getting richer faster. Similarly Pareto-distributed is the proportion of the most positive trading days in relation to the total performance of an index. So the ten most extreme days in the last 50 years of the american stock market account for about half of the total return[12]. These are ultimately evidences that in the financial world people acting unfortunate with the concept of chance. Random in reality is thus not as in a casino calculated on the normal distribution, also called ludic fallacy[13], but occurs spontaneously and dynamically.

III. Data and Methodology

The capital market data used in the present study were taken from the database Bloomberg. The daily closing prices of the German stock market DAX for the period November 1990 to June 2014 were used. The period was chosen to have a sufficiently long history with external shocks. So the Asian and Russian crises, the collapse of the LTCM hedge fund, Sept. 11 2001, the outbreak of the financial crisis and the European debt crisis belong as examples of negative Black Swans in this period. As an extremely rare event a price loss of at least four standard deviations of the daily returns (4 σ) was chosen, which statistically according to the normal distribution (*Tab. 1*) should occur only every 31,560 trading days or even once in 126 years (see also *Dowd et al. 2008*).

k	Probability in a given day	Expected occurrence: once in every
3	0.135%	740.8 days
4	0.00317%	31559.6 days
5	0.000029%	3,483,046.3 days
6	0.00000099%	1,009,976,678 days
7	0.000000000129%	7.76e+11 days

Tab. 1: Probabilities of k-sigma events for the normal distribution

IV. Results and Recommendations

The results of *Tab. 2* show that the average negative return of Black Swan-events is at 6.11%. As a daily volatility for the total observation period of 1.44% is reached, results in 5 of 6 cases (except LTCM hedge fund) a 4-σ event (5.76%) within a period of almost 24 years. The average value of 6.11% represents even a 4.24 σ event. Since the value of 1.44% of the volatility applies for the entire period and so the results involving himself, the respective volatility to the event is used in a second analysis (*Tab. 3*). The results show due to lower individual volatilities compared to the whole period an even stronger k-sigma effect (mean 5.89). *Fig. 2* shows in addition to the six events listed and the 4 σ limit yet the Gorbachev-Putsch on 19.08.1991 (-9.40%), which represents a 6.53 σ event (due to the short time series it was not included).

Event	Date	Performance day
Asian crises	28.10.1997	–5.83%
Russian crises	21.08.1998	–5.92%
LTCM hedge fund	01.10.1998	–5.54%
World Trade Center	11.09.2001	–6.44%
Financial crises	21.01.2008	–7.16%
European debt crises	18.08.2011	–5.82%
		mean –6.11%

Tab. 2: Black Swan events and day returns at the German stock market

Event	Date	Performance day	Volatility	k-sigma
Asian crises	28.10.1997	–5.83%	1.05%	5.55
Russian crises	21.08.1998	–5.92%	1.04%	5.69
LTCM hedge fund	01.10.1998	–5.54%	1.03%	5.38
World Trade Center	11.09.2001	–6.44%	1.01%	6.38
Financial crises	21.01.2008	–7.16%	1.02%	7.02
European debt crises	18.08.2011	–5.82%	1.10%	5.29

Tab. 3: k-sigma of Black Swan events at the German stock market

The analysis shows that negative Black Swans occur much more frequently for the German market than it would be expected from the normal distribution. This in turn has on the one hand practical consequences for the portfolio and risk management, and on the other hand for dealing with knowledge in financial markets. At the portfolio level Markowitz[14] described the findings of its portfolio theory by means of the benefits of diversification, so that this could be a solution against negative Black Swans. According to Taleb diversified portfolios prevent if at all fragility and provide robustness[15]. Thus, such a normative strategy is not sufficiently suited to create opportunities in the form of positive Black Swans.

In practical investment behavior, there is evidence that investors are looking and implementing also due to loss aversion[16] strategies with little volatility[17]. However, this means that investors believe regarding to risk/return relationships to be in the probable range of the normal distribution (*Fig. 3*), because they want to avoid big losses, but actually expose themselves in crises negative Black Swans due to the structure of the portfolio. An antifragile investment strategy (a kind of barbell strategy) will reap the benefit of random or volatility[18] and uses the two ends of the normal distribution by 90% of the assets are invested very sure to avoid extreme losses, but at the same time 10% of the capital for the purpose of use of positive Black

9 Taleb, The black swan: The impact of the highly improbable, 2007 and Taleb, Antifragile: Things that gain from disorder, 2012.
10 Taleb, The black swan: The impact of the highly improbable, 2007.
11 Mandelbrot, The fractal geometry of nature, 1982.
12 Taleb, The black swan: The impact of the highly improbable, 2007.
13 Taleb, The black swan: The impact of the highly improbable, 2007.
14 Markowitz, Portfolio selection, Journal of Finance 1952 pp. 77 (91).
15 Taleb, Antifragile: Things that gain from disorder, 2012.
16 Kahneman, Thinking fast and slow, 2011.
17 Taleb, Antifragile: Things that gain from disorder, 2012.
18 Taleb, Antifragile: Things that gain from disorder, 2012.

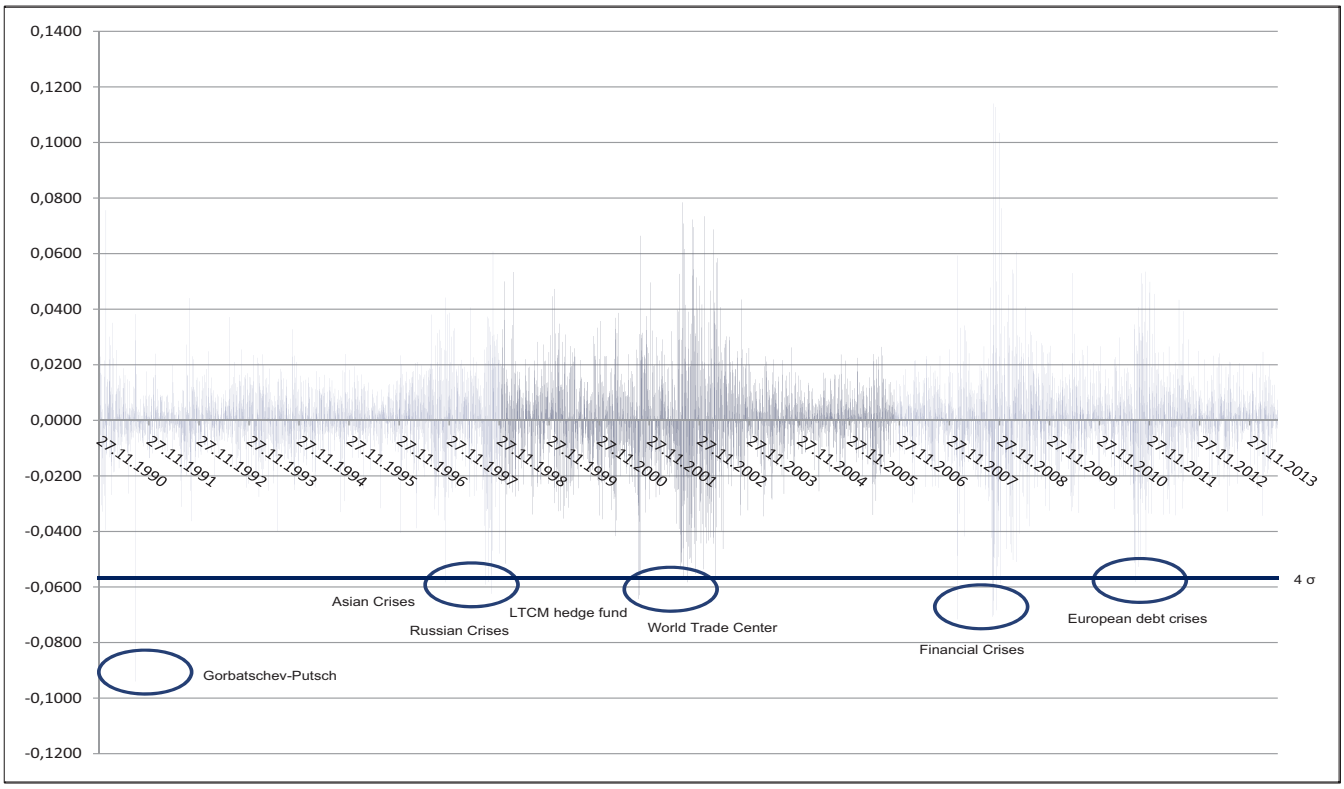

Fig. 2: Volatility of daily returns and 4 sigma events at the German stock market (November 1990 to Juni 2014)

Swans are created possible risky (e.g. in form of venture capital or warrants).

Besides the relevance for portfolio and risk management there is also a consequence of the knowledge level at the financial markets. Due to the complexity of the financial markets results according to Taleb an overestimation of academic knowledge (it is rational and for-mal), while the non-codifiable knowledge is underestimated[19]. The German coach Andreas Zeuch discussed in this context, the concept of non-knowledge[20], which plays an important role in complex systems. According to that show the two previously mentioned studies by Gigerenzer[21] and Guedj/Bouchard[22] examplary that financial experts are facing a high degree of non-knowledge. What lessons can be concluded from it regarding the investment behavior and the use of financial information? First, we know too much and therefore also for the future irrelevant. Second, we know better what is wrong (which does not work) than what is right. Third, the consequences of Black Swans are dependent on our knowledge.

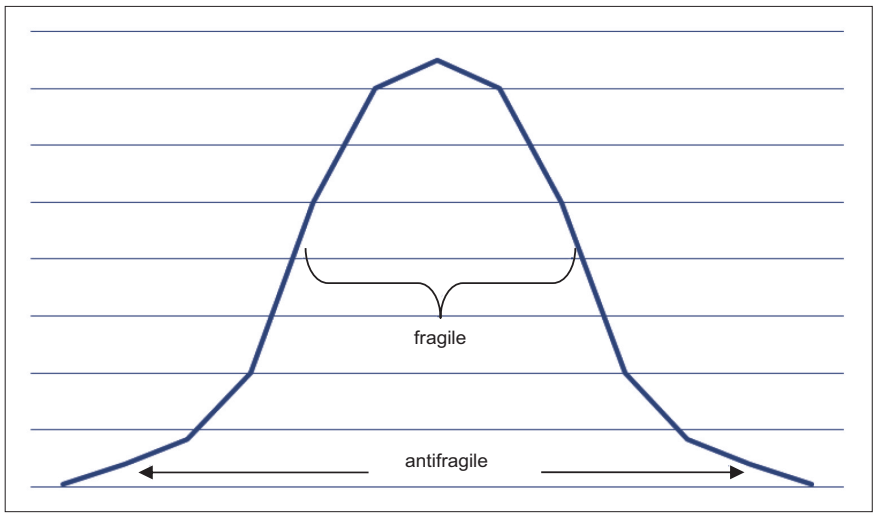

Fig. 3: Fragile- and antifragile relevant areas of the normal distribution

V. Summary

The study deals with the relevance of Black Swans at the German stock market for the period from November 1990 to June 2014, to decide to what extent very negative yield deviations occur more frequently than would be expected for a normal distribution. A Black Swan was defined as the daily return variance in the amount of at least 4 standard deviations, which may occur statistically only once every 126 years.

The analyzes show that the negative (and unexpected) impact of Black Swans is given clearly, according to five events which have led to a daily loss of more than four standard deviations only in the last 24 years. Derived from these results the paper highlights the importance of the two terms fragility and antifragility on the one hand for portfolio and risk management and on the other hand for dealing with knowledge at the financial markets, and generates recommendations for trading with volatility and random.

19 Taleb, Antifragile: Things that gain from disorder, 2012.
20 Zeuch, Management von Nichtwissen in Unternehmen, 2007.
21 Gigerenzer, Risk savvy: How to make good decisions, 2014.
22 Guedj/Bouchaud, Experts' earnings forecasts: Bias, herding and gossamer information, International Journal of Theoretical and Applied Finance 2005 pp. 933 (946).