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MATHEMATICS :
THE RELUCTANT STAR OF THE FINANCIAL MARKET ?

by

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(*Le Cygne noir. La puissance de l'imprévisible,* pub. Les Belles Lettres, 2008)

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(pub. Le Seuil, 2001)

October 20th, 2008
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Overview

Since it first appeared in trading rooms, the discipline of mathematics has had an important role. It has given rise to the development of such a wide range of sophisticated products that many people have blamed it for the recent difficulties associated with banks and credit derivatives. Nassim Taleb argues that the only problem is the inappropriate use of mathematical models which have been unwisely applied to the tails of probability distribution curves. Alexis Bonnet contends that it is quite simply the lure of profit which has prompted the deliberate implementation of extreme leverage techniques which, even though they are ingenious, are simply dishonest. Pierre-Noël Giraud suggests that by giving the impression of propping up financial forecasts which subsequently become predictions, mathematics has a calming effect on our contemporaries who have to deal with a future which is uncertain. Extremely high salaries earned by traders are proof of the extent to which the seemingly important element of prediction has become established in our society's unconsciousness.

TALK : Nassim Nicholas Taleb

The critical analysis which I developed in my book does not concern the use of mathematics in finance in general, but the mistakes made in the prediction of highly improbable events which I refer to as 'black swans'. In the northern hemisphere, all swans are white, which may lead us to conclude that they do not exist in any other colour, until one day one travels to Australia and discovers that all the swans there are black.

My book was published in 2006. At the time I wrote that Fannie Mae (Federal National Mortgage Association, FNMA), a mortgage corporation sponsored by the American government, was sitting on a time bomb which could be triggered by the slightest twitch. However, I wrote that there was nothing to fear because many mathematicians in the corporation thought that such a possibility was improbable. However, in July 2008, the American government had to make major changes to prevent Fannie Mae going bankrupt.

Globalisation, concentration, vulnerability

For the past few decades, there have been ever-increasing numbers of mergers between financial institutions. As a result, there are fewer institutions and they have become closer to each other. We have moved from a diversified ecology of small banks with different loan policies, to a more homogenous group of companies which all look alike. The effect of this increased concentration has been to make financial crises less likely. Globalisation has given rise to a vulnerability which can be felt as a domino effect, but which decreases volatility and appears to create stability. Because of this concentration of companies, there are now fewer bankruptcies, but when crises do take place, they do so on a global scale and are more profoundly felt.

The tragedy of small probabilities

If events are rare, it follows that we are less likely to know the chances of them taking place. Mathematicians who use probabilities, including Value at Risk (VaR), (supposed to demonstrate the amount of losses which should only be exceeded according to a given probability on a given timeline), are crooks. Their probabilities are to financial reality what Mickey Mouse is to real life : they oversimplify it.

In 2007, when the crisis had only just begun, someone in the Wall Street Journal wrote 'the events which we are witnessing should only take place once every 10,000 years'. This assertion is completely ridiculous. One look at the author's photograph beside the article was enough to determine that he was not 10,000 years old and that therefore he was not writing from personal experience, but had based his comment on mathematical calculations. Clearly, he knew nothing of the tragedy of small probabilities. This can be summarised as follows : the smaller the probability, the more it depends on calculation (because it is not observed very frequently) and, unfortunately, the greater the number of events associated with this probability are likely to be serious.

One memorable event disrupts the probabilities

The graph for the S&P 500 (the American stock market index for 500 large-cap stocks) on the yield of OTM (out-of-the-money) options between 1986 and 2006 shows very small variations for the whole period, with a huge peak which coincides with the 1987 economic crisis. The probabilities change greatly if one takes 1987 into account. Unfortunately, most financiers who experienced the events of the 1987 crisis subsequently went bankrupt and disappeared from the scene. Those who remain are those who can only see the small variation throughout the entire period rather than realising that in fact that a huge event may change all the probabilities.

Volatility and 'leaps' in the Poisson distribution

Some processes are volatile; others include unpredictable 'leaps'. These are very different phenomena even if, when represented by probability curves, they describe trends which are quite similar.

Saudi Arabia has virtually no political volatility. The same family has been in power for more than a century. However, this does not necessarily rule out the possibility of a sudden change. Italy has had 105 different governments over a period of 50 years but it is a much more stable country politically. It could adopt Paris' motto *'fluctuat nec mergitur' ('it may fluctuate but it will not sink').*

Ben Bernanke, Chairman of the United States Federal Reserve, clearly made a mistake when he announced in August 2008 'an era of Great Moderation and a generalised decrease in volatility' for the end of the year. He did not realise that the environment was changing from a very volatile one to an even more dangerous situation where events are less frequent, more unpredictable and more serious.

The thousandth day of the turkey

Do you know the story of the turkey and the butcher ? A turkey was fed every day for one thousand days. On the thousandth day, just before Thanksgiving, the turkey was no longer fed. This was a surprise for the turkey, but not for the butcher.

Between 1998 and 2006, the net annual revenue of the IndyMac bank consistently increased and rose to 400 million dollars. In 2007, it made a loss of 615 million dollars. Many hedge fund managers earn colossal sums for years until they make mistakes and lose much more money than they have ever earned in one fell swoop.

The problem with the turkey is that as time goes by, the more secure it feels : data accumulates and the model is consistently borne out. The day one's risk department indicates that the most stable position, with the most comfortable statistical significance threshold, has been reached, is the day that the butcher stops feeding the turkey and prepares it for slaughter.

Predicting the past

Some people try to predict the future by looking back to the past. In fact, they are using past predictions which are not scientifically based in the same way as one might say 'the man who won the lotto wore a red shirt the day he won ; let us take a look at the colour of the clothes which other winners wore.'

Take the example of a commentator on the eve of the 1987 stock market crash. The biggest fall he had ever known was 10 %. In 1987, in a single day, the stock market fell 23 % : the past does not predict the future.

The fourth quadrant

The American Statistical Association published a diatribe against my book and invited me to answer my critics. As a precaution, I chose to explain to the audience the cases for which the statistics work rather than list the cases where they do not.

There are two types of decisions : simple and complex. There are also two types of distribution : distributions with fat tails, and Gaussian distributions (so-called 'normal' distributions) with thin tails. In the case of a situation with a simple decision and a Gaussian distribution (or another member of the Gaussian or Poisson family), all the methods work. This is also true for a simple decision and a distribution with a fat tail. When I was a derivatives trader and I had to work with binary options, whether the S&P 500 dropped 30 % or 3 % had the same effect as far as I was concerned. In the case of a complex decision and a

Gaussian distribution, there is no problem either. However, with respect to the fourth quadrant, in other words, the case of a complex decision and a distribution curve with a fat tail, it is like the signs in the underground transportation system warning travellers that their tickets are not valid beyond a certain point : the methods no longer work, science is no longer science. There is no typical event in 'Extremistan' (Taleb's unpredictable, 'black swan' environments). My audience was delighted because I explained that statistics work in three out of four cases, despite the fact that the majority of decisions taken in the world of finance come from situations which take place in this fourth quadrant.

Mathematics which we master

My conclusion is that instead of 'twisting' mathematics in order to apply it to a particular case, one should only take risks when these risks are compatible with the mathematics which we are able to master. Probabilities apply perfectly to casinos and to quantum mechanics but they cannot predict either typhoons or terrorist attacks.

TALK : Alexis Bonnet

The current crisis, where costs will be astronomical, is linked to the massive sale of insurances concerning rare events, in other words the sales of Out-of-the-money options with no correct provision for future financial commitments. How could such a large number of well regulated financial institutions take part in this kind of activity to such an extent ? This is all the more surprising because, contrary to Nassim Taleb, I actually think that there are good mathematical analysis tools for these operations.

Implicit and real probability

A client who has an eye on the stock markets asks a trader to sell him a product which, in a month's time, will pay 100 Euros if the CAC 40 (index of 40 companies listed on the Paris stock exchange) closes between 3,300 and 3,400 points on that given date. The price the trader offers him will give him an indication of the probability that the index will lie between 3,300 and 3,400 points on the aforementioned date. If the trader asks for a commission of 4 Euros (payable regardless of what happens on the date of the contract), this suggests that the implicit probability that the index closes between 3,300 and 3,400 points is 4 %. The difference between this implicit probability and the real probability justifies the investment (4 Euros). If, for 4 Euros the client has effectively (a real probability) 4 chances out of 100 to make 100 Euros, his gain is zero on average. The client will prefer to invest his money in Treasury bonds.

All investment or proprietary trading activity is based on the fact that the distribution of implicit probabilities, in other words those indicated by the price, is different from that which takes place in reality (real probabilities).

Risk aversion

The initial difference between these two probability distribution curves is risk aversion. When one buys shares in a company whose prosperity varies with the global economy, one has to hope for some sort of reward. When the risk aversion changes, prices may vary a great deal regardless of whether any new information may affect the real probability. The greater the risk aversion, the further prices fall. Conversely, in a situation where stock prices are artificially high, risk aversion is replaced by an appetite for risk which leads to product overvaluation. Hedge fund managers try to identify the differences between the two probability curves in the hope of finding a profit level on a given horizon.

The infernal machine

Between 2003 and the first six months of 2007, share markets registered an annual profit of between 15 and 20 %. Investors asked financial advisors, banks and hedge funds for even higher rates, saying 'Why give money to a manager if he does not give me more than what I would earn myself if I bought a random handful of shares ?' They were encouraged to do so by a multitude of justifications given at this time predicting durable growth, including new sources of growth, the continued development of the BRIC countries (Brazil, Russia, India and China), reduced inflation, the particularly low level of interest rates and wealth effect of property (home equity withdrawal). With respect to this, Nassim Taleb talked about 'narrative fallacy'. I found an article from May 2007 which predicted that during the first six months of 2008, the CAC 40 would reach 7,000 points : this is not exactly what happened...

During this period, risk aversion diminished and the difference between the distributions of implicit and real probability became very small, and even dried up market opportunities. As a result, one resorted to leverage. This is when an operator, who has a capital of 100, borrows 1,900 and invests 2,000. Even if he only makes a net return of 1 % on the 2,000 he invested, the leverage will still give him a profit of 20 % on the capital.

When these strategies (which are still relatively simple) were exhausted, the operators considered that the implicit volatility of the market was too expensive and started to sell volatility, the mechanical effect of which was to reduce volatility. The operators then tackled the distribution tails whose probabilities are very difficult to estimate and which therefore offered a source of unlimited opportunities, but which included commensurate risks.

During the subprime crisis, six successive levels of leverage were implemented. Firstly, loans were offered to help people buy houses without the need for capital input and included deferred payment (this is an example of extreme leverage : the capital becomes negative very quickly). Subsequently, different types of loans were grouped together in CDOs (Collaterised Debt Obligations, in other words, bonds linked to assets) which were then divided up and served to isolate events contained in distribution tails. Next, automatic scaling was added : this is both very clever and profoundly dishonest. It involves increasing the leverage as a result of the deteriorating situation and is in fact a new form of selling volatility without acknowledging it. Because of this stratagem, the operators received triple A assessments from the rating agencies for obligations which earn an interest rate of up to 200 basis points (ie. 2 %) more than the LIBOR (London Interbank Offered Rate), whereas normally triple A risks generally earn less than the LIBOR. This led people to believe that these obligations were more secure than Italian or Japanese treasury bonds. Then these obligations were used as security to borrow an amount of money equivalent to their value. This was a sort of leveraged purchase on an overleveraged asset. Finally, extra insurance products (sold by under-capitalised insurance companies) were used to raise credit, and CDOs of CDOs were created.

Initial difficulties

Obviously, this pyramid was unstable because it was built on sand. It included loans with deferred payments, and without justification of revenues, frauds, and so on. In the CDOs, a huge mistake was made regarding the risk of the collateral. Correlation of rare downside events was underestimated and has sometimes been increased by the banks themselves which, within the same products, had mixed different credits which were historically independent. This diversification did not work, when the crisis hit, they all depreciated in value. Finally, the leverage and non-linear effects were largely underestimated, and yet the further out-of-the-money the option is, the greater the non-linear effects can be felt and the greater the asymmetry of small gain versus huge (though rarer) losses.

The most surprising factor is that all this was able to take place despite the fact that it was clearly untenable and could not last. Why was this the case ? Quite simply because it allowed the operators to offer their clients regular and very high revenues, while providing the operators with a comfortable bonus at the end of the year. The traditional risk measures were

not well adapted because, as Nassim Taleb explained, none of the probability calculations take into account the phenomena which we are witnessing today. Finally, even if the distributions had been modelled perfectly, measures, such as the Sharpe ratio, encourage operators to sell Out-of-the-money options, whereas good managers know that strategies to preserve capital should be adopted. For some banks, the sum of their recent losses is greater than the combined sum of all their profits since their creation.

Insufficient monitoring and glaring mistakes

Until 1998, the large hedge funds did not really have a limit to the leverage they used. After the resounding bankruptcy of the US hedge fund LTCM in 1998, they were only allowed to practise leverage with systematic, initial margin calls which acted as solvency ratios and which, in any case, are calculated by banks. Hedge funds are also subject to 'mark to market', in other words, the obligation to register in their accounts the value of their assets in almost real time. The funds which did not adhere to the imposed limits were liquidated. The problem is that banks do not apply the same rules to themselves which they apply to hedge funds…

Other mistakes were made. Some institutions had felt – rightly or wrongly – that they were 'too big to die'. The risk of liquidity was neglected. Some operators balked at considering the solvency ratios as absolute limits which they were not supposed to approach and tried to convince their regulators, once they reached the limit, to renegotiate accounting rules and limits. This made the situation even more difficult to handle since many others had probably also reached the limit at the same time. With this knowledge, interbank lending dried up. Bankers contacted the Treasury secretary or Finance Minister of their respective countries to be bailed-out and were relatively successful.

A few dangerous remedies

Some analysts recommend remedies which seem dangerous to me, such as the idea of abolishing credit derivatives (Credit Default Swaps). Studies have shown that CDSs were much more accurate in their predictions than rating agencies which sometimes predicted a downturn up to six months too late. A clearing house would be a good idea.

Some banks recommend abolishing the 'mark to market' which would mean allowing more leverage and making the taxpayer the sole guarantor. At a time when Japan refused to impose reserves on debts, it experienced a crisis the cost of which was estimated to be 25 % of its GDP (Gross Domestic Product). Are the banks, which no longer want to be subject to mark to market, ready to grant the same favour to hedge funds, which would be sure to ask for it ? In my opinion, the mark to market was the telltale sign in this crisis, and not its cause. It would be extremely dangerous to give it up.

The end of the ball

In July 2007, Charles Prince, CEO of Citigroup, said 'When the music stops, things become very complicated. But as long as the music keeps going, we must keep dancing.' He was made redundant well before the end of the ball.

TALK : Pierre-Noël Giraud

Following these two talks about financial techniques, let me adopt a very different approach based on the implicit epistemology of *The Black Swan*, before commenting on the place of mathematics in the economy and finance, and concluding with an ontological question.

A little epistemology

Is the phenomenal and justified success of *The Black Swan* itself a black swan, an unlikely event ? Perhaps it is for its author, but I do not think so. This book was as predictable as the fact that thirty years after May '68, there would be a novel which was critical of the young generation of that era, and would probably be written by an unloved child whose parents had been part of the student generation. As it happens, that person was Michel Houellebecq : had he not written such a book somebody else would have certainly done so.

The same is true of *The Black Swan*. This book follows the same line of thought as the intellectual trend which sounds the death knell for nineteenth-century determinism and which was expressed in science (in the writings of Poincaré) and in philosophy (in the works of Deleuze, and in Badiou's theory of the improbable emergence of the event). Nassim Taleb found an original way of presenting his ideas about the end of determinism to the general public. Had Nassim Taleb not written this type of book, somebody else would have.

In summary, an event can be improbable at a certain level and predictable at another. One cannot define a black swan by itself. One cubic metre of earth includes billions of bacteria which carry out physicochemical processes about which we still know very little. Were a black swan to enter into this cubic zone, the event would pass totally unnoticed at our level. Similarly, the oil and financial markets are the arena for black swans which have practically no impact on the global GDP since it is a huge entities which evolves extremely slowly and with a great deal of inertia. This prompts the question : is the black swan phenomenon fractal ?

Mathematics in the economy and finance

In my book *Le commerce des promesses,* I tackled financial questions like an economist.

Financial markets make people face up to their future, and as they are not totally predictable, they are therefore a source of anxiety. When faced with this anxiety, there are two types of reaction. The scholar makes various calculations and realises that in certain cases, which are part of Nassim Taleb's fourth quadrant, it is absolutely impossible to predict anything. But in general, only a small minority of people is aware of this impassable limit. The alternative reaction is that most people seek reassurance and therefore do not need forecasts which they consider insufficient, but require predictions. In ancient times, people went to Delphi to consult the Oracle. Nowadays, in view of the scientific and determinist period in which we live, it is not enough to stand up surrounded by smoke and give credible predictions in a hollow voice. One has to back them up with mathematical calculations. People therefore talk to financial analysts who are well paid to make predictions. The principal use of mathematics in finance is to make predictions credible and thereby ease our worries.

Because these predictions are based on false science, the majority are imitative. Since each person is worried about the validity of his own predictions, he gets his inspiration from the predictions of others and copies them. From time to time, unexpected information may destabilise the dominant model of interpretation which people use to predict the future. For example, until 1997, it was widely thought that the economies of Asian countries were well managed ; all the analysts gave them triple A ratings. Overnight, however, people realised that they were examples of 'crony' capitalism between 'pals', and that they were totally impenetrable. Consequently, all the evaluations of these countries became unreliable.

A trader in New York or a taxi driver in Paris ?

Let us be fair : mathematics is not just a means of enhancing the effect of an anxiolytic drugs to ease anxiety. In a recent interview, Nassim Taleb said 'Do not trust an expert wearing a tie : the predictions of your taxi driver are likely to be just as good.' I like this vision of a taxi driver who is as brilliant as the best financial analyst but unfortunately this vision is false. If it were true, taxi drivers would be as rich as analysts. A taxi driver can earn a fortune on a single bet, and a trader can ruin his client if he makes a mistake, but, generally speaking, most traders earn more than most taxi drivers who dabble in stocks and shares quite simply because traders are better informed and, thanks to their mathematical models, they handle the information that they are given much better.

This does not mean that mathematical models allow them to make 'safe' predictions and to appreciate reality more objectively. But in a world where share value depends on what people think that this value will be, where traders make money because they take part in operations which other traders believe in, and where at the end of the day it is what people think that becomes reality, if one wants to be rich, it is better to be a trader on Wall Street than a Parisian taxi driver. I pay tribute to mathematics : this discipline allows some traders and their 'quants' to earn a great deal of money.

The wisdom of Seneca

In the interview I mentioned, Nassim Taleb draws a practical conclusion from his analyses. He advocates trusting people who have proved themselves and trusting what has been demonstrated to exist, rather than taking risks. I think it is a shame that he produced such a standard proposition from an analysis which I think is absolutely remarkable.

As far as I am concerned, I have a very different conclusion. Nassim Taleb was forced to call his book *The Black Swan* because most swans are white, at least those in the northern hemisphere. However, black is a colour associated with crises and catastrophes. Yet it is possible to have black swans which are positive and make good contributions, such as the invention of the Internet and Viagra. In such circumstances, rather than adopting an attitude where one is wary of everything which is unpredictable, one can choose instead to move forward, because one does not know whether the future will be good or bad. As Seneca wrote 'What I cannot overcome, I ignore'.

DISCUSSION

The cost of traders

Nassim Nicholas Taleb : Although we give traders and their entourage the outrageous sum of 110 billion Euros each year, studies have shown that entrusting one's investments to traders or managing them oneself in a random fashion and asking one's taxi driver for advice produced – more or less – the same results. Traders have every right to practise their profession rather than be taxi drivers, but we are crazy to ask for their advice when taxi drivers can give us the advice for free. And that's not to mention the thousand billion Euros which taxpayers will have to pay to cover the debts caused by traders.

Question : *There are good ways of using analysts : many of these poor people might well become taxi drivers in the coming months. One must carefully consider what shares they recommend selling or buying. On average, one comes out the winner.*

Pierre-Noël Giraud : As a group, if we are capable of paying analysts and their entourage 110 billon Euros, it is because they serve some purpose either because, according to Smith's principle of the division of labour, they are specialists and are better placed than anyone else to accumulate the necessary information and process it thanks to their mathematical models, or because they carry out an essential function of adjusting imitative and automatic self-

realising expectations. Human beings are rational. They would not keep sponsoring this army of analysts if analysts were mere parasites.

Sheep psychology

Q. : *A market is always a construction built by humans. It is based on what some people think others will believe. People act like sheep, following those in front, blindly. They do not act like a group of molecules agitated by Brownian motion. Nassim Taleb's talk advocates global unpredictability but, in view of these imitative phenomena, it might be more reasonable to support a theory which incorporates a certain degree of predictability.*

N. N. T. : You are right in principle, but actually these psychological phenomena are so non-linear and so complex that there is absolutely no way of predicting them. Thousands of articles have been written on this subject. The phenomenon is well identified, but no-one is able to produce figures based on these analyses.

How does one restore trust ?

Q. : *Since the beginning of 2008, China's financial reserves have increased from 1.5 to 1.9 billion dollars, and OPEC's (Organisation of Petroleum Exporting Countries) income, which was 600 billion in 2007, topped 900 billion in 2008. The asymmetry between Western assets, which we consider to have depreciated in value, and very important resources situated in other regions of the world, might lead to a significant shift of the axes of decision-making on a global scale and this might happen suddenly.*
Are there any imitative ways to recreate trust, or will the average shareholder necessarily be the victim of a few, important and well informed operators whose motivation from now on is, for the most part, generated from outside Western countries ?

N. N. T. : If one wants to re-establish trust in an imitative way, the first step is to stop Ben Bernanke, president of the Central American Bank, from appearing on television attempting to reassure people, because his face shows the opposite of what he is supposedly doing. In the past, people knew how to hide the fact that they had gone bankrupt in the time it took them to get back up on their feet : when they saw a crisis coming, they bought themselves an even more expensive car. The people who manage our economy do not have this same sense of commerce.

Why not close nuclear power stations ?

Q. : *I am a mathematician specialising in probabilities and I teach financial mathematics. One of the principles I try to instil in my pupils is that one must always know exactly the limits of the models one wants to apply. A model is simplistic by definition : it cannot explain the world.*
My question is the following : since we know that the losses in distribution tails cannot be estimated and that they are often huge, why does the financial world continue to exist ? In the same way, why does one not close nuclear power stations ? Improbable events which might take place there are even less common and more catastrophic than in the financial world.

N. N.T. : This is a question I was often asked. Three months ago I was asked 'How can we still work in finance when we cannot even master small probabilities ?' The story of the turkey at Thanksgiving is an example. Today, people do not ask me this question any more because finance has practically disappeared ! Banks and financial institutions have lost more than they have ever done before in their history.
However, your remark is very important. In France, when one goes to the chemist to pick up a prescription, one is never given 1,000 pills at one time. The chemist can only sell 25 to prevent the patient consuming medicine inappropriately and running the risk of overdosage. The same risk exists with models, but central banks, which should have played the role of regulator, applied the models in a way which is even worse than the other financial institutions.

Genuine regulation ought to be implemented so that certain people are forbidden to apply certain models. For example, I asked for the value and risk model to be forbidden because it does not work. Until 1998, people could still use it in good faith because they had not yet understood its destructiveness, however, since 1998, in my opinion those who still use the value at risk model are committing a genuine professional mistake. My view has been severely criticised in the past, but today many people have come round to it. It is illegal to drive at 200 kms/hour, after all !

Was the crisis predictable or unpredictable ?

Q. : *I do not understand why people say the current crisis was unpredictable. One could easily predict that the excess of liabilities was going to cause a crisis, just as it was predictable that property speculation in the 1980s was going to end in catastrophe. Where is the black swan in these examples ?*

N. N. T. : There were actually white swans. It is people's incompetence which made them black swans. If a pilot thinks that storms do not exist and flies an aeroplane without paying attention to the bad weather forecast, his ignorance is directly responsible for any disaster. Some people say that the crisis is officially over, but perhaps it has only just begun. We are not very well informed. It is very dangerous to make everyday shareholders dependent on phenomena which we do not understand at all. We should stop using probabilities with regard to distribution tails unless we are capable of understanding how they work better. And this may not be for several centuries.

Forecasting and prediction

Q. : *What is the difference between forecasting and prediction ?*

P.-N. G. : Financial crises are predictable because they are inevitable. Fundamental mechanisms supplied by monetary creation make the price of assets inflate necessarily beyond the future revenues promised by these assets. After a while, one realises this. As a result, expectations are reversed and all the surplus value is destroyed. This phenomenon is therefore perfectly *foreseeable*. However, it is not *predictable*, in other words, one does not know either in which month or on which day it will take place. Similarly, one knows that sooner or later the movement of the earth's tectonic plates will give rise to a serious earthquake in California, but we do not know when this will take place.

Alexis Bonnet : Even if it is true that one cannot predict at what moment an economic bubble will burst, there is a moment when it is clear that one cannot aim for an annual yield of 20 % unless one takes huge risks. It is then time to stop playing the game. However, one needs the courage to forego easy fees and a share of the market whilst others get rich easily.

What regulation ?

Q. : *In your opinion, what regulation will emerge from the current crisis ? The regulation which enabled people with few financial resources to be given property loans dates back to the end of the 1970s. It took us thirty years to realise that it was catastrophic. Will new regulations not cause other disastrous effects ?*

N. N. T. : I admit that I am going through a personal political crisis. Until now, I was a libertarian, I found the regulators stupid and, as a trader, and I felt able to get around any rules. Today, I realise that the market is even more stupid than the regulators. My mother-in-law lost 75 % of her money because a broker made her invest in convertible securities and preferred stocks : I would like to see him sent to prison ! I used to hate governments and now I adore governments, including the Bush administration : when I see George W. Bush on the television, I heave a sigh of relief that he is still around.

Q. : *George W. Bush nationalising the banks is really a black swan. No-one could have predicted that !*

Capitalism and double security

Q. : *Faced with the risks of earthquakes or nuclear accidents, the only viable solution is to stock up on parachutes which suitable in different circumstances but serve the same purpose. However, these safety devices are very expensive and in a sector as competitive as the financial sector, no-one has the means to afford such luxuries.*

N. N. T. : This is a very fair observation. Nature adores double or over-protection ; capitalism detests it. If you work for Merrill Lynch and you take too many precautions, your superiors will notice that you are making less profit than your neighbour (whose methods are less sturdy and less secure), and you will not keep your job for much longer. Optimisation is the enemy of over-protection, and capitalism is a very forceful optimiser. China has only to buy an additional 1 % of wheat in order for wheat prices to increase fivefold. Today, if we find ourselves with 1 % of overproduction, prices start collapsing. The growing disappearance of over-protection, linked to the Internet and globalisation, will perhaps end up by killing capitalism.

In my next book, I study double protection as if it were a stock option. One can imagine paying a premium in order to benefit from double protection. For example, double protection is having cash when others do not have any more, buying shares – whose price may vary greatly – at a fixed price, and agreeing to lose 2 or 3 % in some years in order to come out on top in the long term. For this, one has to be able to tolerate the gibes and insults that are part of it.

Capitalism will not die

P.-N. G : I do not think for one second that capitalism is in danger. It will continue to alternate between periods of getting around the rules and the rottenness of the rules, for one simple reason : if there is no risk-taking, there is no capitalism, and one might even say that the more capitalism takes risks and the more it encounters problems, the more efficient it is.

This does not prevent us from inventing different financial systems. The Professor Allais, with his theoretical radical views, explained that one had to create deposit banks which were only authorised to grant loans over a shorter period of time than their deposits in order to avoid any risk of liquidity, and to leave financial markets to those who want to have fun. But even in this way, there will always be as much volatility and as many stock market crashes and improbable events which will cause reversals in the real economy. The reforms which have been announced will probably be purely cosmetic.

A. B. : After the LTCM crisis in 1998, the funds' leverage was controlled by the banks, institutions which had comprehensive knowledge of the markets. However, the problem shifted to the banks. The banks had no reliable set limit for their leverage capacities. I am not sure that a regulator has the means, even the financial ones, to hire the talents which would enable him to implement a bank monitoring as strict as that which banks imposed on hedge funds.

N. N. T. : As far as I am concerned, I hold out the hope that we will all be able to create a society which is more conscious of certain risks and that mathematics will be at the centre of this mission.

Presentation of the speakers :

Nassim Nicholas Taleb : former options trader, specialist in the epistemology of chance events, distinguished professor at the Polytechnic Institute of New York University. He is the author of the book *The Black Swan, The Impact of the Highly Improbable* (French version published by Les Belles Lettres, 2008).

Alexis Bonnet : graduate of the École Polytechnique and École des Mines, co-CEO of Methodology Asset Management (London). He carries out research in mathematics and received the Prize of the European Mathematical Society in 1996 for his work on partial differential equations. He subsequently joined the investment bank Goldman Sachs, and was one of the founders of the management company, Methodology Asset Management, in 2005.

Pierre-Noël Giraud : economics professor at Mines ParisTech (Paris). He is an engineering graduate from the École Polytechnique and the École des Mines. His latest publication is entitled *La mondialisation, émergences et fragmentations* (Éditions Sciences Humaines).

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