A systemic approach for managing extreme risk events – dynamic financial analysis

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Abstract :*Following the Black Swan logic, it often happens that what we do not know becomes more relevant that what we (believe to) know. The management of extreme risks falls under this paradigm in the sense that it cannot be limited to a static approach based only on objective and easily quantifiable variables. Making appeal to the operational tools developed primarily for the insurance industry, the present paper aims to investigate how dynamic financial analysis (DFA) can be used within the framework of extreme risk events.*

Key words*:* dynamic financial analysis, extreme risk events, risk management.

1. Introduction

Most classical economic and managerial theories are built on an analytical structure characterized by isolated analysis of the components, precise mathematical models, change of one variable at a time an so on. Many advances were made by choosing this linear way of action but the evolution of cybernetics and system theory has also revealed other angles of analysis: complex and expert systems (Matsatsinis et al., 1998), dyamic cognitive networks (Koulouriotis et al., 2005), fuzzy logic in decision making (McIvor et al., 2004) etc. Nowadays, the systemic perspective has found aplicability into a vaste range of academic and practical segments, among which we will focus on a specific risk management technique - dynamic financial analysis (DFA). The main goal of the paper is to discuss the DFA principles in extreme risks cases, filling the existing gap between singular case studies and a more solid theoretical background on the subject. The importance of such a demarche rezides in the fact that indiferent to what philosophy of risk we prefer, an extreme risk event has an ontological component that reduces the risk management question to a structural response from societies, organizations and individuals (Bostrom, 2002).

Following the introductory section, the literature review is focused on the traits and typologies of extreme events, underlying the need for a more comprehensive managerial approach. The third section discusses the differences between static and dynamic analysis, drawing heavily on the main components of the last category and their fit to the previously described paradigm. The conclusions are restating the benefits of multidisciplinary views on the subject of extreme risk.

2. The particularities of extreme risks events

For a proper understanding of an extreme event it is essential to begin with the theoretical distinction between objective risks - characterized by statistical estimates of the negative impact of the event - and perceived risks - determined by their understanding of the likelihood of negative outcome (Boholm, 1996). Thus, on the one hand, natural sciences identify specific risk using statistical and mathematical device to make assessments of toxicological and epidemiological threats in order to calculate the risks associated with technical systems or those generated by the interaction between individuals and machines. On the other hand, social anthropology research in the area claim that the subjective perception of risk is independent of current exposure (current sense of the risks perceived by different experts) but is based on institutional attitude typical for a particular social group. Another interesting theory is Niklas Luhmann's (2005) that analyzes risk in relation with time, probability and decision making. The theory is based on a representation of risk as a result of individuals concern with uncertainty looming in the future. In other words, a risk is a way to face potential future problems, nothing else than a time management tool.

Based on these conceptual delimitations, we can further consider the sometimes daily used confused meanings, which are the extreme, catastrophic or unexpected events. Therefore, it is no wonder that so far we can say only that a risk event is a very vague concept receiving a wide range of definitions based on specific cases and contexts (Wyatt, 2009). Ranging from earthquakes to falling stock market, these events can have numerous coordinates that can be taken into account to characterize them. Thus, we can talk about natural or anthropogenic events of various sizes, measured in human lives and monetary costs, etc. Another definition of Bier et al. (1999) is an indication that the attributes inherent in such an event have a very low frequencies and very high impact severity. It should be noted that these features must exist simultaneously for a very rare event and is not necessarily one extreme risk.

2.1 Extreme risk taxonomy

In the context of current problems of economic systems, national and global classification of Wyatt (2009) focused on the risks faced by investment is an important point of departure for the representation showed below:

- extreme financial risk events
- extreme economic risk events

- extreme political risk events

Figure 1 illustrates the extreme risk categories that define extreme events risk in terms of two dimensions: likelihood and impact.

Figure 1. *Extreme risk - likelihood and impact*

		Risk		
	Impact	Low	Very low	Very, very low
Financial	High			
	Medium	Excessive leverage	Banking crisis	
	Low		Insurance crisis	
Economic	High	Depression	Hyperinflation	
	Medium	Currency crisis	Sovereign default	
	Low			End of fiat money
Political	High		Climate change	End of capitalism
	Medium	Political crisis	Disunity in Europe	Major war
	Low	Protectionism		Killer pandemic

Risk	
Low	Could be expected once every 10 years from current conditions
Very low	Could be expected once every 20 years from current conditions
Very, very low	Could be expected once every 100 years from current conditions
Impact	
High	Direct and significant impact on most asset and liability values
Medium	Direct and material impact on some asset and liability values
Low	Direct impact on few values, variable significance

Source: Wyatt, Watson, Extreme risks, p. 3

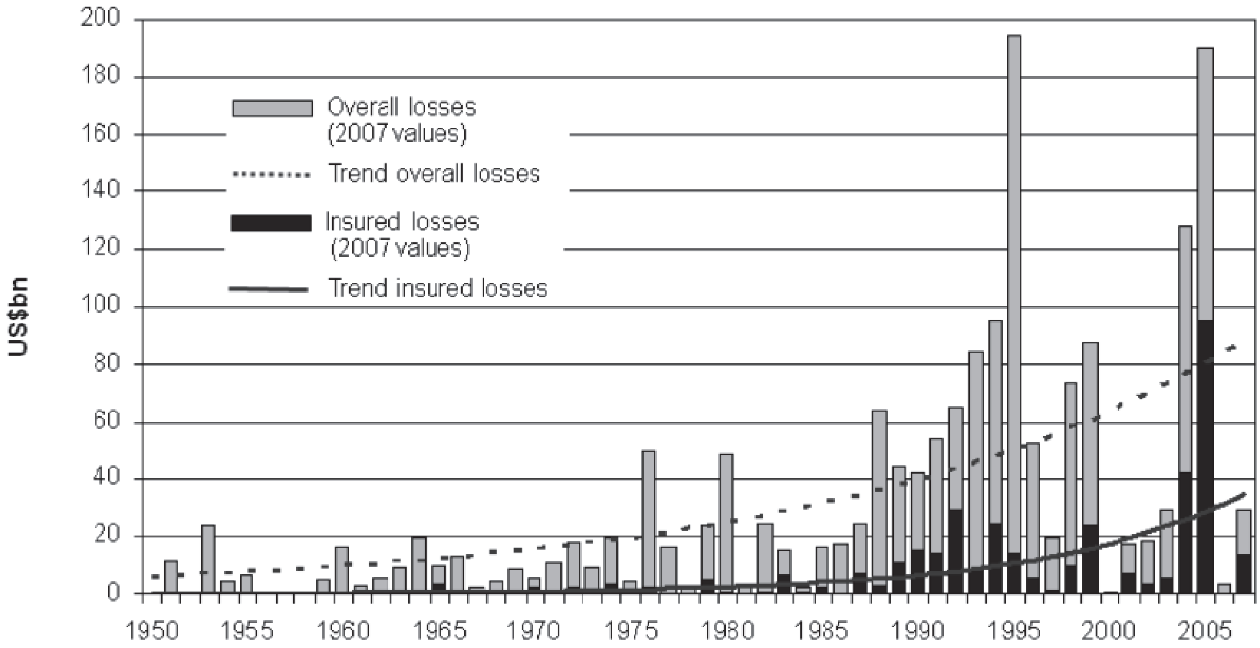
From a different angle we find disasters and their associated risk issues as point of interest for many scientists, politicians, economists, representatives of public institutions which are or may be affected directly or indirectly by the production of such events. Lately, the number of extreme disasters is most likely to occur is highly alarming, as, indeed, it is also their variety. Richard Posner classified disasters into two types: natural disasters and catastrophic human fault.

The category of natural disasters represents, as we shown in the paragraph above, unprovoked extreme events by our peers. The disasters are natural phenomena having destructive geological origin, or illness of a large number of people and animals suddenly produced as a mass phenomenon. In the category of natural disasters are included: pandemics, asteroids, volcanic eruptions and earthquakes. The second type of disaster is divided into three subcategories: scientific accidents, catastrophes and man-made disaster unintentional and intentional.

Richard Posner mentions several types of accidents that can cause major scientific human damage. Out of them we should point out: the strangelet scenario, laboratory accidents involving omnivorous nanomachines, genetically modified crops, and artificial intelligence. By the same token, the manmade disasters are: nuclear attack, bioterrorism, cyber-terrorism and digitization.

Research and analysis draws attention to the changes and their extreme events impact in recent years. Significantly, both for their evidence, and for losses caused by them, is the report by the Wharton Risk Management and Decision Processes Center. The authors report highlights the fact that worldwide economic losses and the insurance companies losses have increased significantly in recent years, as shown in Figure 2 (each vertical bar represents the total economic losses, the dark bar is the insurance amount). A comparison of these economic losses over time reveals a huge increase: $ 53.6 billion (1950-1959), $ 93.3 billion (1960-1969), $ 161.7 billion (1970-1979), $ 262.9 billion (1980-1989) and $ 778.3 billion (1990-1999). In the last decade there is a loss in value of $ 420.6 billion due mainly to hurricanes which occurred in 2004 and 2005.

***Figure 2** The evolution of major natural disasters in the world, 1950-2007. Economic impact on insurance*



Source: Managing large-scale risks in a new era of catastrophes, Insuring, Mitigating and Financing Recovery from Natural Disasters in the United States

According to research referred above, the catastrophes that have occurred over the past 15 years have had the most devastating impact on the insurance system than in the entire history of the system. Between 1970 and mid-1980s, annual losses caused by natural disasters (including forest fires) were in the range of 3-4 billion dollars. Losses that occurred in Hurricane Hugo (September 1989) exceeded $ 4 billion. It was the first great natural disaster that caused more than a billion dollars of losses by the insurance system in the United States of America. A radical increase in loss was recorded in the early 1990s. In 2000 there are marked great damages by the Hurricane Andrew recorded in Florida ($ 23.7 billion in 2007) and Northridge earthquake in California ($ 19.6 billion in 2007). The four hurricanes in Florida in 2004 (Charley, Frances, Ivan and Jeanne) totaled about $ 33 billion loss for the insurance system and once with the Hurricane Katrina events was a radical change in terms of damages filed by the insurers and reinsurers (about 46 billion). The total losses paid by private insurers as a result of major natural disasters were about 87 billion dollars in 2005. Catastrophic events that caused major loss for insurance system usually occurred in developed countries where activity of the insurance system is high. In developing countries where insurance system is usually absent or is in development, these disasters can cause severe economic and human impact.

3. Static versus dynamic financial analysis

After acknowledging the numerous categories of extreme risks, it is only natural to imagine that an organization dealing with such level of uncertainty has to pay great attention to it financial affairs. Thus, financial analysis becomes a key activity, challenging the traditional assessment of solvency performed through static accounting.

In recent years, non-life insurance companies in the U.S., Canada and Europe have experienced changes that led to finding new methods of analysis and forecasting of their work. Initially, the dynamic financial analysis (DFA) has been developed to serve as a regulatory tool for the authorities concerned to monitor solvency. Nowadays, Casualty Actuarial Society defined DFA as a systematic approach to financial modeling where financial results are designed in accordance with a variety of scenarios that show how the results could be affected by changing internal conditions and / or external (Burkett et al., 2001). Susan Szkoda enriches the definition by pointing out that the financial situation refers to the amount of capital and surplus of the company to adequately support its operations in a uncertain future (Szkoda, 1995).

In simpler terms, DFA promotes the transition from existing structures designed to evaluate and reward individual pieces of business in a structure that encourages and rewards the evaluation of strategic decisions in a holistic, total company (Blum, 2004).

Among the trends that led to the development of DFA were as follows:

- increased financial risk that began in the 1970s - a period in which inflation and interest rates have become increasingly volatile;
- development of IT technology, a computer powerful enough to accommodate sophisticated mathematical techniques used in the DFA;
- using similar analysis in banks and other financial institutions.

The development of this model was influenced by:

- constraints on regulations and globalization;
- increased competition, aggressive strategies, mergers;
- the emergence of new risks: demographic changes, social and political change risk characteristics (eg liability), the emergence of new, more complicated (in particular financial ones).
- increasing demands of investors;
- growing importance of shareholder-s;
- the emergence of capital losses due to reduced performance;
- the need to manage the full emergence of several types of risks;
- creating new products requiring new methods of analysis.

At present, current models focus more on the strategic planning side, this being one reason for which we consider them appropriate in handling extreme risk events. DFA models allow managers to test various operational strategies and adopt those that have potential. For this to happen, the situation is modeled, and a large number of possible scenarios are simulated on the computer. These scenarios are used for decision-making processes, facilitating the risk management strategies. The "dynamic" attribute indicates that this approach reflects the uncertainty involved in modeling an insurance company or, in our case, an extreme event. Stochastic variables are used to represent factors that will influence the company. The method leads to a ranking or a distribution of possible outcomes with associated probabilities, leading more than a simple estimate of the outcome. Factors that will affect operations or balance a company can vary more than the singular value estimated from the selected parameters. DFA is dynamic in reflecting the range of possible outcomes in relation to the underlying stochastic variables. On the other hand, the term "financial" guarantee integration and investments reflect variables such as interest rates that affect both values and guaranteed investment returns.

In the random sources of uncertainty in terms of losses, the theory explicitly considers DFA losses from catastrophes (storms, floods, earthquakes, etc.) as a separate category, with losses from other causes, subscription cycles and payment patterns. Modeling the number of disasters can be achieved by several methods, starting either from different distributions binomial or the Poisson distribution type, with an average dispersion m^M and v^M.

m^M = estimated number of disasters, based on historical data

v^M = variance estimated based on historical data

The difference from modeling other types of loss (non-catastrophic) is that they proceed to simulate total loss (and not only that the insurance company concerned must pay) for each catastrophic event and $i \in \{1, \ldots, Mt\}$ separately. In practice using different probability distributions, especially GDP (generalized Pareto distribution), proved useful in the theory of extreme values. This theory is itself an effective tool for estimating the risk of catastrophic events, providing relevant ways to characterize the fluctuations of a temporary phenomenon stochastic behavior. Within the theory we find two main classes of models: maximal models (generalized extreme value distribution) and POT models (peaks-over and threshold, with a generalized Pareto distribution). From an operational point of view, the analysis aims to determine the distribution functions of overruns (exceedance distribution function), mean excess function and hazard function type. As a method it is employed the maximum verisimilitude method but also functions and regular variation method of moments. There are also some software characteristic for the extreme values theory to model the available data: Extremes, Xtremes, R, S, R-Plus, S-Plus, etc..

4. Conclusions

The study of extreme risk events assumes a continuous oscillation between normality as a reference point and accidental as a reorganization of the benchmarks. It certainly needs an interdisciplinary approach, because it deals with a remarkably broad category, the risk, but also requires a unified perspective that can allow the movement from theory to feasible measures implemented in concrete reality.

Dynamic financial analysis provides a clearer and wider vision of the risks and potential benefits of business strategies, than do technical testing scenarios. The perspective given by this analysis focuses both on details and on the big picture, thus meeting multiple objectives: preventive, operational and strategic ones.

Acknowledgements: *This work was supported by the PNII Partnership grant nr. 32143/2008 "Cercetări interdisciplinare pentru proiectarea strategiilor economico-financiare de acţiune în evenimentele de risc extrem. Hazarde naturale şi accidente tehnologice (PROSTRACT)"*

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