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A Very Brief History of Risk Idea

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Editorial
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Editorial

Since its beginning, humankind has been aware of its finitude and feeling threatened by the surrounding's hazards and has learned to be consistently careful with those acts that present low "risk" but have to be done frequently (as had been witnessed by anthropologist when studying traditional societies around the world).So, risk was an idea that had been sleeping in human minds since the advent of humankind, until the Renaissance period. Why was risk idea awaiting during millennia? Hundreds of years before Christ' birth skies were mapped, Euclid's geometry, trigonometry and arithmetic's were developed and taught, Alexandria's library was built and iron and copper were put at humankind' service.

As to my best knowledge, Greeks were the first ones to approach risk idea. Greeks had thought about life limits and what could be done about that. They pointed out two ways to break free of the dead: to breed offspring or by heroic action. These were the two only ways to escape from oblivion and to be remembered forever. For the Greeks, time was, at once, a factor of life and a factor of all disorders, confusion and disturbs. All creatures, Gods and mortals, face the same dilemma: 1) to avoid any change its consequent disturbances possibility (bearing a boring life of total immobility) or 2) face the challenges of life and to cope with the treats (hazards) and rewards, always searching for the right balance. They thought that risk as a result of disorder, disharmony and disturbances and, that it was unavoidable. No risk means the end of time. In fact, the world would be a dull place if persons do not have conceit and self- confidence in their own good fortune (nobody takes a risky endeavour in the prospect that it will flop).

"Modern" risk is rooted in the Hindu-Arabic numbering system – which enables to calculate instead of just record the activities numeric results. So, it was necessary to wait until it reached Europe about eight hundred years ago (more exactly in 1202, when the book titled "Liber Abaci", written by Leonardo Pisano - known in history by Fibonacci - appeared in Pisa).It was another cultural leap that human kind had to do in its attitude toward the future before taming the risk idea: let go from Gods' mercy and capriciousness of nature. Who does determine somebody's future: Gods, fate or oneself? Risk idea only emerged when people believed in their self-determination. Only free (from Gods) folks could grasp the risk concept. The current concept of risk had its birth during the Renaissance (historically the term "risk" first appeared in overseas trading and insurance) within the gambling of chance context (it is important to note that there is a difference between games of chances, in which the outcome is determined by luck, and the other kind of games in which choice makes a difference).It was a time of exploration and experimentation, which stimulated changes in every domain.

Girolamo Cardano wrote his book (Liber de Ludo Alae) between 1525 and 1565 about the frequency of outcomes in games of chance. It was the first attempt to "measure the risk", but the work was not once printed during his lifetime (he died in 1571). Around1610, Galileo wrote an essay titled "Sopra le Scopertedei Dadi" about trials of throwing one or more dice. In 1619, Thomas Gataker (a Puritan minister) published the study "Of the Nature and Use of Lots" where he argued that it is a natural law (not a divine one) that determines the outcome of games of chance. In 1654, a French aristocrat (Chevalier de Méré) challenged the, also French, mathematician Blaise Pascal to solve the problem posed two hundred years before by the monk Luca Paccioli, about how to divide between two players the stakes of an unfinished game of chance, when one of the players is ahead. This problem is about measuring our confidence that something is going to come about and marked the threshold

of risk quantification.

Pascal asked the help of Pierre de Fermat (a French lawyer that was one of the most brilliants' mathematicians of history); together they created a methodical framework to analyse future outcomes when multiple events can happen and to determine the likelihood of each possible event. A little later, on 1662, a group of monks from Port-Royal monastery published "La logique, ou l'art de penser", where, in the final chapter, there was an important statement: "Fear of harm ought to be proportional not merely to the gravity of the harm, but also to the probability of the event." For the first time (in a published work) appears the idea that both, probability and gravity, ought to influence a risk-taking decision.

Still, in 1662, John Graunt published his book "Natural and Political Observations made upon the Bills of Mortality" in which there was a leap into the use of sampling methods to calculate probabilities. It launched a new field of study: the statistic. Besides putting forward the basic concepts (such as: sampling, averages and the notion of normal) for decision-making in uncertainty contexts, he makes a statement reasoning on the same line of the Port-Royal authors, namely: "Whereas many persons live in great fear and apprehension of some of the more formidable and notorious diseases, I shall set down how many died of each: that the respective numbers, being compared with the total 229,520 (bill of mortality in 20 years), those persons may the better understand the hazard they are in." In 1693, Edmund Halley published (in the scholarly journal Transactions – edited by the Royal Society) a paper with life tables (and the mathematical techniques for raw data analysis), in which he established the basic principles of risk management applied to life-insurance industry.

At the beginning of the XVIII century, in 1711, the French mathematician Abraham de Moivre published his book "De MensuraSortis" where he defines risk, for the first time, as a chance of loss. Later (around 1730) he demonstrated that a set of random drawings distributed themselves around their average value; this distribution is known as a normal curve or (due to its resemblance) as a bell curve. The normal curve enables to determine the statistical dispersion around the mean – standard deviation – which is of paramount importance to validate a set of observations as a representative sample of the entire universe. At the same time, an innovative form to support risk-taking and protecting oneself against possible losses was developed in maritime trading when traders held together in order to manage the always severe risk of losing a ship (and its precious cargo).

In 1713 the book "Ars Conjectandi" of Jacob Bernoulli was published (by his nephew Nicolaus after Jacob dies in 1705) where he stated "under similar conditions, the occurrence of an event in the future will follow the same pattern as was observed in the past." For the first time, it is assumed that the past could be a reliable guide to the future. Jacob Bernoulli's theorem to calculate probabilities using past data become known as the Law of Large Numbers.

Afterwards, in 1738, the Swiss mathematician Daniel Bernoulli (Jacob's nephew), published in the Papers of the Imperial Academy of Sciences in St. Petersburg the essay "Specimen Theoriae Novae de Mensura Sortis" where he presents two impressive innovations: 1) the concept of "utility" – to "measure" preferences (how much someone like one thing more than another) and, 2) the concept of "expected value". In addition, two important insights into the nature of man reasoning are, also, introduced: 1) different people ascribe different values to risk, and 2) the utility resulting from any small increase in wealth will be inversely proportional to the quantity of wealth previously possessed." For the first time, subjective considerations - somewhat that cannot be counted - were taken into account for decision-making in uncertain contexts. In 1764 (two years after his death), the Royal Society published in Philosophical Transactions the Thomas Bayes essay titled "Essay Towards Solving a Problem in the Doctrine of Chances" where he presents a mathematical technique that uses new information to revise probabilities estimated based on old information – the Bayesian analysis. His method combines beliefs, which may be pre-existing, with observations or another kind of new information. From a philosophical point of view, this work introduces an important achievement: under uncertain conditions, there isn't a sole solution.

At the turn of the XIX century, in 1809, Carl Friedrich Gauss (who was not particularly interested in risk) published "Theoria Motus" about how to estimate heavenly bodies orbits based on the paths that appeared most recurrently over a lot of separate observations. The mathematical framework that Gauss developed is still used today to determine the accuracy of the information in hand and to decide to take (or not) a certain risk. Also in 1809, the Marquis Pierre Simon de Laplace set forth the theorem known as a central limit theorem, dealing with averages of averages.

In 1835, the Belgian scientist Lambert Adolphe Jacques Quetelet, in his "A Treatise on Man and the Development of His Faculties" tried to define the "average man" and presented a study of causes and effects.

Later, in 1877, Francis Galton (as a curiosity, Charles Darwin's first cousin) in his paper "Typical Laws of Heredity" put forward the general principle that became known as regression (or reversion) to the mean. Alluding to is written words "regression is the tendency of the ideal mean filial

type to depart from the parental type, reverting to what may be roughly and perhaps fairly described as the average ancestral type".

At the beginning of the XX century, the mathematician Jules-Henri Poincaré affirmed that every effect has a cause and "what is chance for the ignorant it is no chance for the scientist".

World War I produced the second great leap in risk history. Like the Renaissance, it was a time of radical transformations in societies and the world was no longer what it had been. Changes converted the World into something less rational. Decisions could lead to results that were not even anticipated in the analysis or low-probability outcomes occurred more frequently than expected. Uncertainty was everywhere. The notion that risk is probability and men have no control over the next throw of dice was left behind. From now on, decisions matter. Uncertainty makes man freer. Researchers searched for new ways to execute systematic analysis of the unexpected. The risk concept comes close to how it is understood today.

In 1916, Frank Knight in his doctoral dissertation (published in 1921 as a book titled "Risk; Uncertainty and Profit") establishes a distinction between risk and uncertainty. In 1921, he stated, "There is much question as to how far the world is intelligible at all". Also in 1921, John Maynard Keynes finished his book "A Treatise on Probability" where he wrote "There is little likelihood of our discovering as a method of recognizing particular probabilities, without any assistance whatever from intuition or direct judgement" and "A proposition is not probable because we think so". He preferred the term "propositions" instead of the term "events" (which he rejected). Keynes introduced the weight notion in probability theory "Weight has to do with the evidence or which the probability relation is based. Weight represents either the amount of relevant evidence (as opposed to probability, which depends on the balance of favourable and unfavourable evidence) or the evidence's degree of completeness". Reasoning about uncertainty he wrote: "By 'uncertain' knowledge it does not means merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty…" Or "… the expectation of life is only slightly uncertain. Even the weather is only moderately uncertain. The sense in which I am using the term is that in which the prospect of an European war is uncertain, or the price of copper and the rate of interest twenty years hence ... About these matters, there is no scientific basis on which to form any calculable probability whatever. We simply do not know". For Keynes, uncertain events are those which we don´t have scientific bases to attribute a probability. So, to him, risk is about decision-making related to events for which it is possible to attribute a probability for the different outcomes; uncertainty is about decision-making related to events for which it is not possible to attribute a probability for each different outcome. In short, for Keynes, risk is a measurable probability and uncertainty it´s a non-measurable probability, in 1926, John von Neumann sent to the University of Göttingen the paper where he presented the basis of his Theory of Games. The possibility of loss appears, for the first time, in a risk management theoretical work. John Nash (1994 Nobel Prize winner on economics) contributed to the theory with the Equilibrium theorem according to the outcome, although stable, is less than optimal.

Kenneth Arrow (a Nobel laureate) researched about uncertainty and the human unwillingness to accept it, and declared: "a society in which no one fears the consequences of risk-taking may provide fertile ground for antisocial behaviour". In 1963, Edward Lorenz published his article "Deterministic non-periodic flow" launching the chaos theory, which affirms that there is order disguised in chaos (despite the fact that is difficult to identify chaos in real-world data – it stressing the need of high accuracy in the data measurements related to chaotic system parameters). In 1979, Daniel Kahneman and Amos Tversky published the first paper of their Prospect Theory where they described the asymmetrical behaviour: when a decision involves the possibility of winning, people are risk-seeker; when a decision involves the possibility of loss, people are risk-averse. They conclude that our major driving force is loss aversion; losses loom more than gains. During the last decades of XX century, researches on the subject were multiplied; more sophisticated models and procedures to perform risk analysis were developed, techniques for eliciting the subjective probability distributions and utility functions necessary for a comprehensive risk analysis were proposed and refined by practice. New mathematical tools for dealing with non-random uncertainties start to arise.

Now we are beginning to understand the intricate interplay between reason and emotion and its importance to rational behaviour, the major challenge that risk poses nowadays is to go forward toward a dynamic and creative direction, in order to address risk issues in a continuously evolving environment, integrating rational and emotional forms of reasoning and overcome limitations of conventional techniques. The Living Probabilistic Safety Analysis theorized for the nuclear sector in 1999 could be the start of such advancement.