The Treatment of Business Risks Has Always Been an Important Tool for Business Success: Utility Function Method

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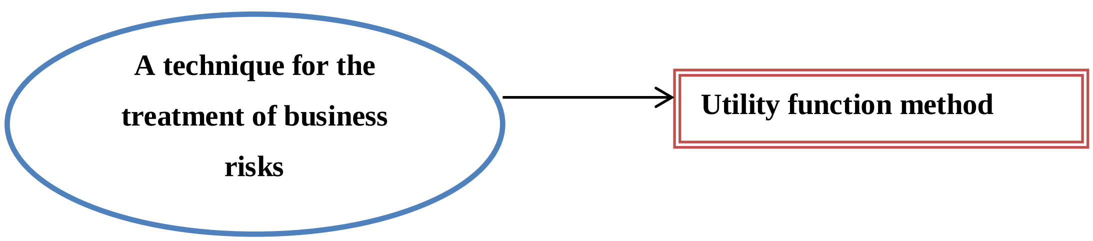
Abstract
The business risk is a topic that is very rarely spoken, but that is essential for those who have to make decisions concerning the life of a company: incorrect choices can shortly lead to business failure. Basically important is the activity of the Risk Manager. It is oriented to identify, evaluate, manage and control corporate risks. The efficacy of risk management also depends on the information available for the decision: more information available, the best risk response. To effectively manage risks, a systematic and organized approach is required and specific methodologies and techniques are needed. In this paper we will propose the method of utility function: an effective and efficient method to deal with business risks by limiting its negative effects.

Keywords: risk management, risk treatment, business

1. Introduction: Choices of techniques for the risk treatment



In this paper we will examine the Utility function method. It is a method that allows the company to achieve the objectives established by the company by trying to establish the minimum risks of the company. Through the method we will examine how it is a valid tool that allows the company to achieve its objectives by evaluating the risks to which it exposes itself to achieve its business objectives.

2. Utility function method

The studies conducted so far lead to the affirmation that people with regard to risk do not act in accordance with the hypothesis of rational behavior, which would presuppose to give the same answer to the same question regardless of the context in which it is posed. The conclusion that can be drawn from all this is that individuals are not so much risk averse as loss averse: losses always appear to be greater than gains. To describe inconsistent (but not necessarily incorrect) choices in cases where the same problem is posed in different contexts Kahnemann and Tversky use the expression invariance failure. Transitivity as a requirement of rationality in the coherence-based approach means that if A is preferred to B and B preferred to C, the rational behavior would want A to be preferred to C: this is among other things the core of Von's theory Neumann and Mongenstern on utility. But that's not what happens. The failure of invariance is a much more widespread phenomenon than is usually realized. One of its most noticeable manifestations is in equity market behavior: profits come as much from gains as from reduction of losses, but investors hate liquidating their assets at a loss because that is tantamount to admitting mistakes. Loss aversion coupled with self-esteem problems leads investors to cling to valuation errors made in the past in the hope that one day the market will agree with them and make up for the current loss. The behavior of individuals in conditions of uncertainty - that is, in the majority of cases - reveals repeated patterns of irrationality, inconsistency and incompetence about the ways in which human beings arrive at decisions and choices. But this should by no means lead to the conclusion that human actions are completely dominated by irrationality. The authors Kahneman and Tversky, in their work entitled Judment under Uncertainity, underline how empirical evidence shows that human choices are ordered, even if not always rational in the traditional sense of the term. Since ordered decisions are predictable, it cannot be argued that decision-making behavior is erratic and random just because it does not conform to the rigid theoretical assumptions of rationalistic theories. Ultimately, the working hypothesis can be formulated according to which choices and decisions always derive from a mix of rational and irrational factors, a mix whose composition is strongly influenced by chance and context. Both in theory and in practice it is almost always impossible to explain even vitally important decisions without referring to the "ideas about the world" of the decision maker and in particular about his antagonists. In other words, the factors that govern decisions are subjective and, in this sense, unique: but this, as just observed, does not mean that they cannot conform, to a certain extent, to rational patterns of reasoning. Consequently, the calculations underlying a decision are probabilistic: the decision makers act as if they chose the alternative that contains the maximum expected value and the decisions to act in a given way should not necessarily be interpreted as errors of assessment or as irrational behavior. . The values that a decision maker attributes to a given set of possible outcomes reflect objective assessments that take into account the attitude of the decision maker towards risk. The approach to decisions that best takes these aspects into account is the expected utility. The theory of expected utility postulates that decision makers choose among the various alternatives in order to maximize the net results they will obtain. In analytical terms, the preferences of the decision maker are quantified by means of a utility function$u$ which assigns a real value to any consequence of a decision so that, if and only if consequence a is preferred over consequence b:

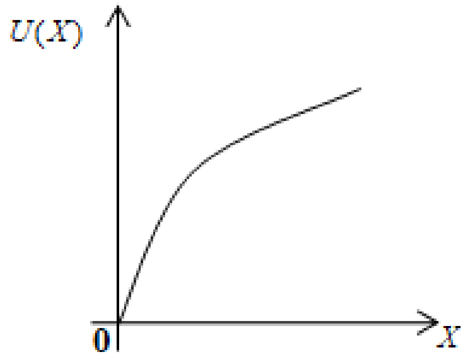
$$u(a) > u(b)$$

The theory also assumes that decision makers make their choices with reference also to a common axiom, whatever their differences in terms of orientations, preferences and culture. An important factor in this regard is the risk measurement method used, as this reflects the perception that the decision maker has about the reference environment. Another factor to take into account are the precedents the decision maker draws in the development of his or her decision-making process. The theory therefore postulates that the decision maker has a measure of the risks associated with each decision according to his subjective opinions on them. Therefore, if a decision problem does not involve uncertainty, rationally one must prefer the decision that will have the consequence characterized by the maximum possible result, which is known. If, on the other hand, and it is the more general case, the problem involves uncertainty, rationally, the decision that maximizes the expected utility must be preferred. The utility function is a mathematical expression that provides a formal description of the preference relationship between the different alternatives that each individual can express In analytical terms, if A and B are alternatively risky, the theory of expected utility allows us to state that:

$A < B \Leftrightarrow E[U(A)] < E[U(B)]$

Where the symbol $<$It indicates the function of $B$with respect to A and the function $U(.)$ Represents the utility function. Graphically, called $U(X)$ the utility function with respect to the monetary amount X and assuming that for $X = 0$ it results$U(X) = 0$, the function $U(X)$ can be presented, with respect to the abscissa axis:

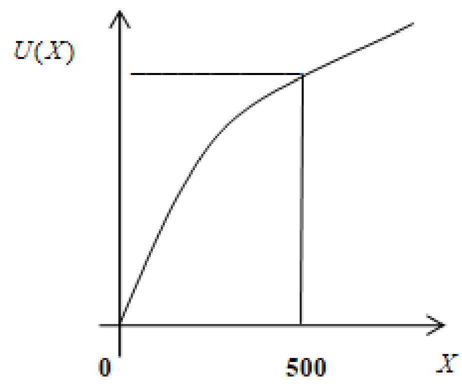
a) **with the concavity turned downwards** if the utility grows less than proportionally with respect to the increases in X (decreasing marginal utility):



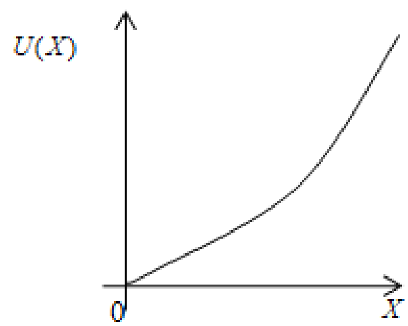
Suppose, for example, that an individual has € 500 and that, having to decide on the convenience to make an investment, he has a probability of 0.5 to gain or lose € 100. In the presence of risk aversion, the rational decision is not to invest. Indeed, the following figure shows that, by gaining its usefulness it would increase by$u''(x) - u'(x)$, while, losing, it would decrease by $u'(x) - u''(x)$:

$u''(x) - u'(x) < u'(x) - u''(x)$

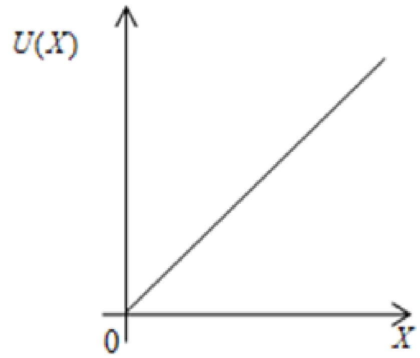
The rationality of the decision not to invest is evident. In other words, the loss of a sum of money will involve a greater sacrifice than the utility that would be gained by earning the same sum. In this case we speak of *risk aversion*



b) With the concavity upwards (decreasing marginal utility):



c) as a straight line (constant marginal utility):



The last figures represent, respectively, the case of risk appetite and indifference to risk. The utility function method is based on the different individual attitude towards risky situations and therefore requires the capacity for subjective utility function. In risk management, this can be done in order to identify the threshold for the value of the expected loss, with reference to which the decision maker will prefer to resort to insurance transfer rather than conservation. The methods used are the following:

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- the Maximum Possible Loss is identified;
- a scale of utility scores from to 100 is used and a score of 100 is assigned to the Maximum Possible Loss and of a to a zero loss;
- the decision maker is asked about how much he would be willing to pay in order not to run the risk of having the MPP with probability 0.5 or no loss with the same probability;
- the utility of the sum S that the subject would be willing to pay to avoid the risk indicated above is calculated using the formula:
  $\mathrm{u}(\mathrm{S}) = 0{,}5 \cdot \mathrm{u}(\mathrm{MPP}) + 0{,}5 \cdot \mathrm{u}(0)$
- the decision maker is asked again how much he would be willing to pay in order not to run the risk of suffering a loss S with probability 0.5 or no loss with the same probability;
- continuing in the same way it is possible to assign to all the values between the MPP and zero the corresponding scores in terms of utility, the function of which can then be obtained by interpolation;
- to this point with the probability distribution of the losses, for each value of the latter, the relative expected utility score can be calculated, the sum of which, expressed in monetary terms, can be compared with the average expected value of the losses, which it should also correspond to the pure premium charged by an insurer;
- in this way it will be possible to verify what margin there is for loading the insurer, or whether retention is preferable.

Let's see an example 1

Extent of the loss (1)	**Points of utility (2)**	**Probability (3)**	**Expected value of the loss (4)=(1) x (3)**	**Expected utility(5)=(2)x(3)**
500.000	100,00	0,001	500	0,100
300.000	50,00	0,008	2.400	0,400
200.000	25,00	0,030	6.000	0,750
110.000	12,50	0,200	22.000	2,500
70.000	6,25	0,500	35.000	3,125
50.000	3,12	0,200	10.000	0,624
30.000	1,56	0,050	1.500	0,078
20.000	0,78	0,011	220	0,008
Totals		1,000	77.620	7,585

By way of example, let's assume we have the probability distribution reported in example 1, with an MPP of € 500,000 and in relation to which we proceeded in the manner indicated above to assign the utility scores starting from 100 (in correspondence of the MPP). As can be seen, the average expected value of the losses is equal to € 77,620, which corresponds to an average expected utility, equal to 7,585 points. We can value this score by proportioning it to the value of € 70,000, which corresponds to a score of 6.25. We thus obtain the value of € 84.952. This value is obtained by solving the following proportion:

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7.585:6,25=x: 70.000.

This means in other words that the decision maker in question will be willing to pay the sum of € 84,952, in order to avoid running the risk of having a loss of € 77,620. Obviously, in this case, we are faced with a risk-averse individual, who will agree to make an insurance transfer if he finds an insurer willing to contain his charge for management costs within the difference between the two sums. This method also allows for further analysis in relation to a possible combination of retention and insurance transfer. In fact, it is possible to calculate with reference to the various levels of loss, which could at the same time represent as many insurance limits in the form of deductibles. Let's assume that the margin left to the insurer for total coverage is considered insufficient by them, we can verify the hypothesis of introducing a deductible of€ 70,000. In this case the utility loss in points will be equal to the maximum score of 7.585 minus the utility score of the losses withheld, ie:

$$7.585 - (3.125 + 0.624 + 0.078 + + 0.008) = 3.750$$

and the average expected value of the losses, which for losses exceeding € 70,000 will be equal to:

$$€\,77620 - €\,(35{,}000 + 10{,}000 + 1{,}500 + 220) = €\,30{,}900$$

As you can see, the decision maker and in this case, in order not to bear the risk of losses exceeding € 70,000, is willing to take a preventive action, leaving in this case a much wider margin to a possible insurer.

Let's see an example 2:

Extent of the loss (1)	**Points of utility (2)**	**Probability (3)**	**Expected value of the loss (4)=(1) x (3)**	**Expected utility (5)=(2)x(3)**
600.000	100,00	0,001	600	0,100
400.000	50,00	0,008	3.200	0,400
180.000	25,00	0,030	5.400	0,750
120.000	12,50	0,200	24.000	2,500
75.000	6,25	0,500	35.000	3,125
40.000	3,12	0,200	8.000	0,624
20.000	1,56	0,050	1.000	0,078
10.000	0,78	0,011	110	0,008
Totals		1,000	77.310	7,585

As a further example, suppose we have the probability distribution shown in example 2, with an MPP of € 600,000 and in relation to which we proceeded according to the methods indicated above to assign the utility scores starting from 100 (corresponding to of the MPP). As can be

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seen, the average expected value of the losses is equal to 77,310 euros, which corresponds to an average expected utility, equal to 7,585 points. We can evaluate this score by proportioning it to the value of € 75,000, which corresponds to a score of 6.25. We thus obtain the value of € 91.020. This value is obtained by solving the following proportion:

7.585 :6,25=x: 75000

This means in other words that the decision maker in question will be willing to pay the sum of € 91.020, in order to avoid running the risk of having a loss of € 77.310. Obviously, in this case, we are faced with a risk-averse individual, who will agree to make an insurance transfer if he finds an insurer willing to contain his charge for management costs within the difference between the two sums. This method also allows for further analysis in relation to a possible combination of retention and insurance transfer. In fact, it is possible to calculate with reference to the various levels of loss, which could at the same time represent as many insurance limits in the form of deductibles. Let's assume that the margin left to the insurer for total coverage is considered insufficient by them, we can verify the hypothesis of introducing a deductible of€ 77.310. In this case the utility loss in points will be equal to the maximum score of 7.585 minus the utility score of the losses withheld, ie:

$$7.585 - (3.125 + 0.624 + 0.078 + + 0.008) = 3.750$$

and the average expected value of the losses, which for losses exceeding € 75,000 will be equal to:

$$€\,77310 - €\,(35{,}000 + 8.000 + 1.000 + 110) = €\,33.200$$

As you can see, the decision maker and in this case, in order not to bear the risk of losses exceeding € 75,000, is willing to take a preventive action, leaving in this case a much wider margin to a possible insurer.

Let's see an example 3:

Extent of the loss (1)	**Points of utility (2)**	**Probability (3)**	**Expected value of the loss (4)=(1) x (3)**	**Expected utility (5)=(2)x(3)**
800.000	100,00	0,001	800	0,100
600.000	50,00	0,008	4.800	0,400
180.000	25,00	0,030	5.400	0,750
120.000	12,50	0,200	24.000	2,500
100.000	6,25	0,500	50.000	3,125
50.000	3,12	0,200	10.000	0,624
30.000	1,56	0,050	1.500	0,078
10.000	0,78	0,011	110	0,008
Totals		1,000	96.610	7,585

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As a further example, suppose we have the probability distribution shown in example 3, with an MPP of € 800,000 and in relation to which we proceeded according to the methods indicated above to assign the utility scores starting from 100 (corresponding to of the MPP). As can be seen, the average expected value of the losses is equal to 96,610 euros, which corresponds to an average expected utility, equal to 7,585 points. We can evaluate this score by proportioning it to the value of € 120,000, which corresponds to a score of 6.25. We thus obtain the value of € 91.020. This value is obtained by solving the following proportion:
7.585 :6,25=x: 120,000
This means in other words that the decision maker in question will be willing to pay the sum of € 145.632, in order to avoid running the risk of having a loss of € 96.610. Obviously, in this case, we are faced with a risk-averse individual, who will agree to make an insurance transfer if he finds an insurer willing to contain his charge for management costs within the difference between the two sums. This method also allows for further analysis in relation to a possible combination of retention and insurance transfer. In fact, it is possible to calculate with reference to the various levels of loss, which could at the same time represent as many insurance limits in the form of deductibles. Let's assume that the margin left to the insurer for total coverage is considered insufficient by them, we can verify the hypothesis of introducing a deductible of€ 96.610. In this case the utility loss in points will be equal to the maximum score of 7.585 minus the utility score of the losses withheld, ie:

$$7.585 - (3.125 + 0.624 + 0.078 + + 0.008) = 3.750$$

and the average expected value of the losses, which for losses exceeding € 75,000 will be equal to:

$$€\,96.610 - €\,(50{,}000 + 10.000 + 1.500 + 110) = €\,35000$$

As you can see, the decision maker and in this case, in order not to bear the risk of losses exceeding € 100,000, is willing to take a preventive action, leaving in this case a much wider margin to a possible insurer.

3. Conclusion

The company must be careful in the choice of its activities to contain the risk of business. If the risk is not managed, it can expose the company to a strong risk that in time it can also decree the bankruptcy of the company. In this work we presented the method of utility function that can help the company in business risk management. The graphic representations, illustrated in paragraph 2 show how there is a different trend of indifference curves for each decision. The examples, first examined, have shown that the company manager when the risks are elevated is willing to follow a preventive action, leaving an action margin for the much larger insurer. Finally, it is necessary to highlight that the basis of decision-making dynamics is the problem of deciding and what to decide and only after choosing the criterion to be adopted to minimize business risks. The knowledge of the psychological elements, in this context, is as important as that of the objective elements, so that the choice of the decision derived from the joint assessment of the two.

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