Decizii economice in conditii de incertitudine

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Economic Decisions in Uncertainty Conditions

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Abstract. *Uncertainty means partially or totally knowing the probabilities to accomplish an action's potential results.*

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Economic decision making is the action direction chosen consciously when managing an enterprise among a certain number of possibilities with the purpose to achieve goals in maximum efficiency contexts.

When trying to formalize economic behaviour, it is essential that facts should be inserted about uncertainty's being inseparable from human thinking and dominating most judgments. Since one should give up the objective measure concept, there has to be an assessment, comparison, graduation or relation. Incorporating these concepts with subjective nature is a basic activity for the better knowledge of the analyzed phenomenon. Thus, a state which cannot be measured but preferred to another goes up to a higher knowledge level [5].

A model of economic decision making in uncertainty conditions can only be drafted by including the utility function. It is based on organizing decision maker's preferences according to the risk he/she associates with the set of pursued goals.

Let us consider the mere case of selection decisions of one potential variant out of two. The former utility concept used is "ordinal utility" [10], which has the exclusive task to arrange preferences without specifying how high the utility of the formerly selected variant is as compared to the utility of the latter variant. The latter concept is "cardinal utility" [10] which states the idea that the utility difference of the two variants might have a certain significance. Decision making means stating that a certain variant has a higher utility than another one.

Consumers' preferences and their related utilities are the nucleus of an uncertain economy. In order to understand how preferences form, it is fundamental the notion of nature state should be defined [1] – the potential configuration of decisional environment which, along with knowing individual actions, entirely causes all consequences. Uncertainty is found in the fact that one can never tell which state is going to intervene. That particular state shall be precisely known subsequently and one shall consider uncertainty being solved entirely at that time.

Uncertainty can be specified by means of probabilities' theory. The expected utility is defined as a probabilistic construction where the "expectation" operates by including the uncertainty due to nature states. The theory of expected utility was originally created by Bernoulli, and the axiomatic growth was stated by Von Neumann and Morgenstern in 1944. Therefore, utility function is defined on the set of goods[1], not on the corresponding

[1] « Goods » generically mean the complete list of products, services, revenue or time units involved in decision making, Bogdan-Constantin Andronic, *Company Performance*, Polirom Publishing House, Iaşi, 2000, p. 157

configurations. Arranging preferences is done according to the expected value of utility function.

In uncertain conditions, events are the potential states of nature and therefore decision making involves considering their $p(x_i)$ probabilities meaning a unit partition. The amount of average information a decision maker receives is the well-balanced average of information amounts that each nature state associates with $p(x_i)$ probabilities and it bears the name of informational entropy which is a concept defined by Shannon, involving probabilities both in the stage of information spring seen as a random process, and in the stage of gathering the results of transformations upon information.

Let

$$x = \begin{pmatrix} x_i \\ p(x_i) \end{pmatrix}_{i=\overline{1,m}}, \ \sum_{i=1}^{m} p_i = 1$$

be a discrete random variable with x_i values. A Shannon mere entropy associated with x random variable or probabilistic repartition $P = (p_1, p_2, ..., p_m)$ [189] is the expression:

$$H = \sum_{i=1}^{m} p(x_i) \times h(x_i) = -\sum_{i=1}^{m} p(x_i) \times \ln p(x_i), \ \sum_{i=1}^{m} p_i = 1 .$$

Defining entropy according to the amount of information, to the information based on probabilities and taking account of the fact that probabilities' classical theory is one of the methods to approach decision making in uncertain conditions make entropy an operational instrument for decision making when uncertainty is present.

Decisional subjectivity corresponds to uncertainty when either the chances of nature states' occurrence cannot be objectively assessed – partial uncertainty, or there are no data on nature states – pure uncertainty. The preferences associated with each decision maker intervene in both situations.

There are two main categories of subjective influences upon individual decision making:

- The influences exerted by other players of decision making;
- Subjective probabilities.

  According to Knight [6], the first category includes involvement as a measure of existing internal and external concerns, direction which can generate conflicts due to divergent trends and the way to exert authority.

Among the elements in the process of subjective estimation of decisional probabilities, one should mention the decreasing balance of remote events in a geometrical progression, the selective perception of reality, the varying degree of information's representativeness, the scope of decision making reasonableness concept. Decisional reasonableness is regarded in three ways: logically – subject to the principles of decisional identity, excluded third party and sufficient reasoning - , informationally – a decision may seem irrational if its assessor does not have the additional information that a decision maker has – and the regulatory and social way – the rules of economic behaviour are regarded as restrictions by economic decision making.

Several specifications have been made regarding significant parties, making generalization come true [3] in terms of probabilities' subjective approach:

- Decision makers estimate that an event which has not occurred within a longer period of time has higher occurrence probability in the future;
- Decion makers overestimate the probabilities of favourable events and underestimate the probabilities of unfavourable ones;
- Decision makers tend to overestimate the occurrence of low probability events and underestimate the occurrence of events having high emergence probability.

If nature is one of the participants, decision making can enter the realm of uncertainty when there are no data about the probabilities to achieve nature states.

Decisional matters in uncertain conditions can be settled by several criteria:

1. The pessimistic criterion (the rule of Abraham Wald – 1950)

It starts from the idea that the best variant is the one supposing maximum advantages when optimal conditions are most unfavourable. Thus, considering the decisional matrix such as:

V_i/C_j	C_1	C_2	C_n
V_1	R_{11}	R_{12}	R1n
V_2	R_{21}	R_{22}	R_{2n}
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
V_n	R_{m1}	R_{m2}	R_{mn}

where: V_i – decisional variant;

C_i – nature's objective state;

R_{ij} – decisional consequence related to variant *i* and objective state *j*.

The strategy chosen corresponds to value

$$V_{opt} = \max_i \min_j (R_{ij})$$

or, in other words, the possible minimum efficiency maximizes. Some authors [48] also identify a choice for exceedingly prudent managers: $v = \min_i \left(\min_j R_{ij} \right)$. It is thought that such prudence can be associated to small companies whose survival depends on the size of losses.

2. The optimistic criterion aims at choosing the optimal variant when optimal conditions are most favourable.

$$V_{opt} = \max_i \max_j (R_{ij})$$

3. The criterion of average optimism (the rule of Leonid Hurwicz – 1951) associates each strategy with a pair of complementary probabilities $(p_1 + p_2 = 1)$ so that p_1 should describe the most advantageous situation and p_2 the least advantageous one. p_1 coefficient is also called players' optimism. Applying the criterion supposes several iterations:

- adopting optimism coefficient:

$$0 < p_1 < 1$$

- setting up H_i elements according to the formula:

$$H_i = p_1 A_i + (1 - p_1) a_i$$

where: A_i – the element of maximum utility;

a_i – the element of minimum utility on each line;

- choosing the best variant which corresponds to the variant having the highest H_i:

$$V_{opt} = \max_i H_i$$

It is important to notice that if extreme values are given to p_1 optimism coefficient, one reaches the solutions given by the pessimistic $(p_1 = 0)$ or optimistic criterion $(p_1 = 1)$:

$$H_i = 1 \cdot A_i + 0 \cdot a_i = A_i$$

$$V_{opt} = \max A_i = \max_i \max_j R_{ij}$$

$$H_i = 0 \cdot A_i + 1 \cdot a_i = a_i$$

$$V_{opt} = \max a_i = \max_i \min_j R_{ij}$$

The result of this criterion depends on the value of optimism coefficient which is closely related to decision makers' behaviour. By comparing H_i values, the optimism coeficient can be set up which involves the fact that a variant becomes more preferred than another. It is interesting that if a strategy corresponds to more than two decisional consequences leaving the most advantageous and disadvantageous ones aside, the others receive zero obtaining probability. According to Hurwicz's criterion, a decision maker behaves as if there were only two potential extreme manifestations.

4. The proportionality criterion stated by **Bayes – Laplace** in 1825 starts from the idea that each state of objective conditions has the same occurrence probability and the best variant is the one for which the mathematical average of results corresponding to the considered state is most favourable.

$$V_{opt} = \max \frac{1}{n} \sum_{j=1}^{n} R_{ij}$$

5. The criterion to minimize regrets stated by **Leonard F. Savage** – 1951. A strategy must be therefore chosen after assessing the difference between the best result's value corresponding to nature state and the other results' value according to which the best variant is the one involving the least regret.

This criterion's functioning involves:

- setting the regrets' matrices where every element is obtained by subtracting the maximum element in the column from its original value (the regrets' matrix is obtained according to the dimensional matrix).

$$r_{ij} = R_{ij} - \max_j R_{ij}$$

- setting the maximum values of regrets obtained and, among them, the minimum value in each variant.

$$V_{opt} = \min_i \max_j \left(r_{ij} \right).$$

This criterion applies to certain investment projects during a longer period of time.

Numerical application exemplifying the five decisional criteria:

A large-size commercial company manufacturing basic food products, non-food products and related services wants to market its goods following the alternatives below:

- ✓ direct sales in its own stores;
- ✓ sales by means of intermediaries;
- ✓ sales on foreign markets.

Taking account of the domestic and foreign markets' conjecture, the following profit growth rates are estimated by product categories and sale methods.

Nature states / Variant	Own stores	Sales by intermediaries	Sales on foreign markets
Food products	10	6	- 3
Non-food products	15	- 9	2
Services	18	4	2

1. **The pessimistic criterion**:

$$\max(-3, -9, -5) = -3$$

best variant – selling food products on foreign markets.

2. The optimistic criterion:

$$\max\{10, 15, 18\} = 18$$

best variant – selling services in own stores.

3. The criterion of average optimism:

a) $p_1 = 0,5$

b) $H_1 = [10 \cdot 0,5 + (0,5 \cdot (-3))] = 5 - 1,5 = 3,5$

c) $H_2 = [15 \cdot 0,5 + (0,5 \cdot (-9))] = 7,5 - 4,5 = 3$

d) $H_3 = [18 \cdot 0,5 + (0,5 \cdot (-5))] = 9 - 2,5 = 6,5$

$$V_{opt} = \max\{3,5; 3; 6,5\} = 6,5$$

$$V_{opt} = V_3$$

4. **The proportionality criterion**:

$$S_n = \frac{1}{n}\sum a_{ij}$$

$$S_n = \frac{1}{3} \cdot (10 + 6 - 3) = 4,33$$

$$S_n = \frac{1}{3} \cdot (15 - 9 + 2) = 2,66$$

$$S_n = \frac{1}{3} \cdot (18 + 4 + 2) = 5,66$$

$$V_{opt} = \max\{4,33; 2,66; 5,66\} = 5,66$$

$$V_{opt} = V_3$$

5. The criterion to minimize regrets:

$$R_{ij} = \max(a_{ij}) - a_{ij}$$

$$R_{ij} = \begin{pmatrix} 8 & 0 & 5 \\ 3 & 15 & 0 \\ 0 & 2 & 7 \end{pmatrix}$$

$$V_{opt} = \min\ \max\ R_{ij} = \min(8; 15; 7) = 7$$

$$V_{opt} = V_3$$

References

Andronic B.-C. (2000) *Company Performance,* Polirom Publishing House, Iaşi.

Belu N. and Co. (2002) *Management. Applications, Case Studies and Practical Exercises,* Independenţa Economică Publishing House, Piteşti.

Cooke S., Slack N. (1991) *Making Management Decisions,* Prentice Hall International, U.K., Coşea M., Nastovici L. (1987) *Risk Assessment. Analysis Methods and Techniques at Micro- and Macro-Economic Level,* Lux Libris, Braşov.

Gil Aluja J. ”*Towards a New Concept of Economic Research*”, Fuzzy Economic Review, no. 10/1985, Spain.

Knight F.H. (1985) *Risk, Uncertainty and Profit,* University of Chicago Press, Chicago.

Pérez R. (1981) *Como decidir,* Editorial Cangallo, Buenos Aires.

Raţiu-Suciu C. (1995) *How to Model and Simulate Economic Processes,* Didactic and Pedagogical Publishing House, Bucharest.

Raţiu-Suciu C. (1993) *Economic Modelling*, Sylvi Publishing House, Bucharest.

Varian R. Hal (1996) *Intermediate Microeconomics. A Modern Approach*, Fourth Edition, W.W. Norton, New York.