CONCLUSIONS ON MODELING DEVELOPMENT PROGRAMS WITHIN ECONOMIC ORGANIZATIONS

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ABSTRACT
In a globalized economy, economic organizations must be prepared to handle a wide range of economic turmoil that can disrupt the domestic economic environment and compels managers to adjust their strategies and actions accordingly. In the recent years, the financial and economic crisis has monopolized economies all around the world, having a negative impact on the evolution of the whole economic environment and especially on the activity of the economic organizations. In such circumstances, the economic organizations must establish adaptive evolutionary trajectories as soon as possible taking into account the economic environment and the markets they operate in. Managers will be faced with unprecedented problems of adaptation and this is the reason why a suitable tool in their support is needed. One such tool is management forecasting. The authors of this paper highlight the conclusions they reached after experimenting with mathematical methods on the modeling of development programs, integral part of management forecasting.

KEYWORDS : *Development programs, Economic development, Fuzzy sets, Linear programming, Optimal control,.*

JEL CLASSIFICATION : C61, C63, O021

1. INTRODUCTION

It is known that the main components of management forecasting are strategic and budgetary management. In turn, strategic management consists of two phases: a *strategic* one in which there are developed forecasts and plans, which are often found by the terminology of *development programs*, and the second one is the *operational phase* in which the operational programs and the budget management interface are made. Budget management is achieved through a system of budgets and it is implemented only in the first year of activity (Andreica, 2006).
Basically, in order to implement management forecasting in a corporation, firstly, the time frame must be specified and then the corporations initial state. Then the following steps are made: define the objectives, identify the strategies, analyze the strategies and choose one (Badea et al., 1999; Carnot et al., 2005; Chauchat, 2006).
Action strategies are either of specialization, diversification or restructuring, either expansion, merger etc. In practice, multiple strategies can be used in order to achieve the chosen objectives. For each strategy a number of assumptions are made for the forecast period and long-term prediction variants are carried out (Drucker, 2001; Gervais, 1998; Ilie & Stefanescu, 2004). The plausibility of the assumptions are determined by the viability of each variant. Usually, optimistic, pessimistic and likely assumptions are used.

2. SIMULATION MODELS OF LONG-TERM DEVELOPMENT PROGRAMS

In most cases, modeling the long-term development programs is reduced *to simulate the structure of economic indicators that reflect the organization's activity*. Usually, this implies a way of structuring the indicator and prior knowledge (with some tolerance) of the functional and statistical correlations between them. For example, the production activity will be represented in the indicator system by commodity output and global production, eventual production of the major product groups (physical indicators) expressed in terms of value or conventional units. In such cases, the connection with the other synthetic indicators of the system will be made using parameters (the cost and profit per 1 euro or measure unit of the physical indicators) (Andreica & Andreica, 2006).

2.1. Simulation algorithms of the structure of a system of economic indicators

We emphasize that: *a)* in economic practice, this objective lies on the decision makers (forecasting the economic indicators evolution); *b)* each decision maker has his own "algorithm", based on experience; *c)* the amount of information they use is inversely proportional to the forecast horizon; *d)* the level of aggregation of indicators is approximately proportional to the forecast horizon; *e)* behind this activity lies the methodology of calculation of indicators.

The diversity of ways of solving the structure prediction of economic indicators by the decision makers requires the development of procedural simulation models that integrates a large number of them.

The problem to be solved is the following: *given the system of indicators at baseline (base year),* $M_0 = \{M_k^0\},\ k = \overline{1,n}$, *it is required to determine their evolution until T,* $M_t = \{M_k^t\},\ t = \overline{1,T}$, $k = \overline{1,n}$.

Possibilities for solving the problem and the necessary minimum information

Assumptions: *a)* between the economic indicators there are total or partial relations of functional or statistical dependences, but it is also possible to take an independent approach for some of these; *b)* the evolution of these indicators can be simulated: based on their trend; in correlation (dependence) with other indicators already estimated; based on rates (indices) or exogenous data paths.

Simulation algorithms will have a finite number of steps. By steps (iterations) we mean the establishment of a finite number of indicators (if at every step the evolution of one indicator is established for the whole period) or a finite number of units of time by which the forecast horizon ***T*** is divided (if for every step the structure of the whole system of indicators is determined for that subdivision of time). In essence, the content of the first algorithm that we will point out is **(A1)**:

Step 1 One of the economic indicators (M_k) will be chosen and its evolution will be determined, independently of the others, for the whole time horizon $\overline{1,T}$ or in conjunction with the base year values of the other indicators.

Steps 2÷n Having determined the evolution of the indicator M_k, at the next step, the evolution of another indicator will be estimated, M_f, in relation to the first or independently. Since the simulation model is procedural, it does not automatically select the order in which the indicators will be simulated, this task being assigned to the decision makers. They will establish a priority order valid for the entire forecast horizon. For example, if the decision makers seek to increase the financial strength of the organization, then the first indicator to be simulated will be the profit. The second and third ones will be the production of goods and costs, in structural correlation with previous indicators (simulated).

Solving the problem formulated above requires the development of a comprehensive simulation model, all-inclusive, to facilitate the "entry" into the system of indicators and to simultaneously ensure the possibility of obtaining some indicators as a result of the ones which correlate or to transform them from "effects" into "causes", with the possibility of establishing the level and structure of the other indicators.

An estimate number of procedural chains existing in a procedural simulation model of the indicators system can be $m^n P_{(n)}$, where *n* represents the number of indicators and *m* the number of variations of independent simulation of their level.
In practice, things are simpler because the interdependencies that occur between indicators are sufficient to simulate part of their development (*n´«n*), the other ones being determined by as consequences of the level of indicators already estimated.
Certainly the role of "factorial" indicators and "result" indicators may vary, the "privilege" of formulating the work hypothesis lying on the shoulders of the decision makers.
However, the presented algorithm is not the only possible solution for the given problem. Another option for solving the problem is using step by step simulations of the system of indicator (**A2**).
In this case, the evaluation of each indicator is specified only for the next moment of time, $(t \rightarrow t+1)$ and assumptions are valid only for that phase of problem solving.
In fact, in this way, for each time point *t*, we have to solve a problem equivalent to the given one, only that the time interval for which it is resolved is one unit (year, quarter, etc). Such problem solving is adequate particularly when the time period taken into consideration is smaller than a year or when ***T*** is maximum 5 years, and the indicators priority or evolutionary assumptions change from one time unit to another.
In addition, on reduced time horizons it is easier to correlate value indicators with physical ones, because the company's manufacturing nomenclature is pretty much all known. For large time horizons, simulation of physical indicators of production is more difficult in that it will include large product groups or base products but with a large share in the activity of those corporations.
We emphasize that the level of aggregation of physical indicators is closely related to the time horizon size in which the simulation is carried out.
Mixed algorithm (**A3**) involves simulating the development of some indicators across the forecast horizon - in an iteration - and "fixing" them for future iterations, while other indicators will be simulated step by step. The advantage of this method is that decision makers can stagger in time the indicators priority. Thus, if in the early years of activity the profit will have a high priority, in the coming years investments will have higher priority.
But, when structural analyzing the indicators system, we will notice that it contains several synthetic indicators which are in functional but not structural correlation.
For example the global production and the number of staff workers. Synthetic indicators may include tree structures of other indicators.
Value indicators integrated into the global production are connected to the higher-level of indicators of decomposition by means of the structure coefficients (share). Knowing these coefficients at a given time of the forecast horizon means that the problem is almost solved, remaining only to determine the level of a single indicator from the tree structure, whichever it may be.
So if we know the exogenous variables (share coefficients) from the structure of the synthetic indicator (which either is generated, whether it is considered equal to the previous period) to determine the level of the indicators from the tree structure, it is sufficient to know the level of a single indicator value, regardless of the level of decomposition it is on.
Particular case: assuming that the structure of the indicator is constant for the whole period, it is sufficient to simulate a single economic indicator from the structure for the given period, and the rest can be determined in conjunction with this one.
Determining the level of the other indicators will be done as follows: for those on the lower level on the basis of the relation

$$M_f = \gamma M_k \ (1)$$

(where M_f M_f is the estimated level, M_k the level of the indicator previously determined and γ the share coefficient through which the direct link between the two indicators is made) or

$$M_f = (1-\gamma) M_k \ (2).$$

The value indicators that are on a higher level of decomposition will be determined with the relation

$$M_f = \gamma^{-1} M_k \quad (3) \text{ or}$$

$$M_f = (1-\gamma) M_k \quad (4)$$

whereas the indicators on the same level of decomposition will be determined only after the establishment either of the indicator on the higher decomposition level, either of the ones on the lower decomposition level by adding or applying another composition operator.
The multitude of variants for exploring the structure of an aggregate indicator or a system of indicators depends on its form.

3. MODELS OF HARMONISING THE OBJECTIVES WITH THE RESOURCES

As stated, planning includes the decision makers will to achieve the forecasted objectives. This is done by detailing the company's objectives, forecasts and plans on short-terms and harmonizing them with the available resources. Practically, *planning models* are models of harmonizing objectives, determined by forecasts, with the available resources given on a time horizon. One of the most important roles is played by the production plan because based on it there will be determined the raw materials and work force required, the production costs and not least the profit and return.
The architecture of linear models for harmonizing the objectives with the resources. The main types of restrictions that are part of linear models architecture for planning in the economic organizations are: *a)* resource restrictions (on conductive rings, on processing capacity, on workforce for groups of trades, on raw materials and deficient materials); *b)* restrictions on products, subgroups and groups (the products must be in the contracted quantities, subgroups and groups must not exceed the production capacity); *c)* restrictions for admission to higher level of aggregation of indicators; *d)* indicator restrictions (value, resource recovery, etc).
The objective function has either one criterion (maximizing an indicator of effects or minimizing an indicator of efforts) or more criteria by combining several indicators.
The linear-dynamic models architecture for harmonizing the objectives with the resources. Production planning can be approached as a process divided into several stages, which can be optimized using dynamic programming, because it can be regarded as a discrete system. For each subsequence of the plan horizon a distinct model of optimization will be resolved. Using dynamic linear programming models we can make these corrections to the production plan. The output evolution is shown by a series of dynamic equations, with the addition of an objective function and a set of constraints. Thus, the final outcome is the basic shape of the optimal control problem.
Dynamic equations capture the dynamics of production of goods and the stocks of raw materials. Then a set of restrictions aimed at framing the production in the available resources or the achievement of specific economic performance. The objective function aims to minimize the total costs of stocking and production on the entire horizon of plan.
Limits of the production planning that are based on linear programming. Planning models based on linear programming provide an optimal plan structure, but only from the point of view of the analysis criteria. The multitude of admissible solutions must be bounded, non-empty and convex, but the last criterion cannot always be achieved in practice. Another limitation is the fact that considered variables remain constant throughout the production horizon, thus being unable to capture the changes that occur when new products appear during the plan. Linear programming models have a static character due to the fact that the variables refer to the period considered.
Most models of planning do not define a gap between the point of supply and the output and also do not take into account any defects of finished products, quality conditions being considered achieved by default.
Due to the time gap between formulating the plan alternatives and choosing the final version of the plan, not all goals and constraints can be formulated accurately and we do not have exact information

about the company's available resources, development of demand on certain types of products, the time of initiation of investments or the delivery due dates that have not been specified so far.

Furthermore, for the resources that we do not create limitations, it is considered that the corporation has infinite amounts of these ones, which leads to the conclusion that the starting hypothesis for solving the problem is false. It is understood that whoever develops the model is constrain by its size, but with successive verifications necessary restrictions can be added in order to create a higher accuracy model.

Another limitation is due to the fact that in some models average prices for economic indicators are used or the number of variables is much greater than the restrictions, situation in which many variables will receive zero in the optimal solution.

Models of flexible harmonization of objectives with the resources. It is known that, irrespective of the economic process's nature, when the complexity increases above a certain threshold, precise statements about this process cannot be made or if they are made, they are not significant (according to Zadeh's comparability principle). The inefficiency of some methods presented used for planning process modeling is caused by the failure in handling vague concepts, that commonly occur in the absence of clear transitions from membership to a particular class to non-membership. The degree of approximation of one class to another, according to a certain criterion, is expressed by the value of a function called the membership function of element $\boldsymbol{x}$ of the process to the process class $\boldsymbol{X}$. This function takes values in the range (0,1) representing a characteristic function, and the set $\boldsymbol{X}$ will be called a vague set (fuzzy) (.

Introducing uncertainty (relaxation of inexact data) leads to *robust programming* in which the unknown coefficients and/or the vector of free terms are vague sets. Robust programming problem may be replaced by a family of inexact programming problems. Therefore, we can say that the vague model is compact representation of a family of deterministic models. This is the process thought which the decision-maker tackles the complexity: as it increases, the scale of representation of the process is reduced, details disappear in the face of essentials. Often in business practices situation arise where restrictions are vaguely formulated like "no more than..." or goals are expressed through vague assertions like "about...". In such cases we need to resort to flexible planning and the models of harmonization of objectives to the resources will also be vague. Most often, in economic practice incompatibilities appear between the objective's constraints and the resource ones. For example, questions such as " what is the minimum addition of a resource that can be used to complete a certain objective" or "how much should an objective be reduced in order to fit the maximum available resources". The answers for these questions can be obtained by resorting to flexible planning.

This will facilitate the association of tolerances to the free term vectors and/or to the objective function in order to ensure restriction compatibility and the economic problem solving.

When simultaneous relaxation of two sets of restrictions is allowed we focus on obtaining the smallest deviation from the objectives by adding the necessary resources with the smallest quantities possible.

Flexible programming does not cover all the types of fuzzy linear programming problems which may arise in practice. For example: unit consumption of a given resource cannot always be accurately quantified as this method assumes. It is known that it depends on the quality of the resource (if it is material), the technology used and even a series of psycho-social factors. In such cases, it is more convenient for the decision makers to associate to these costs a set of values indicating the possibility of their achieving (or a variation interval). The same thing happens for the estimation of medium prices for base products (if the plan substantiation is done at this level of aggregation of plan information). It is known that a basic product consists of several assortment variations each of them having different prices. Even if they are known, the quantity in which every assortment will be used is not known; thus, we do not know the frequency which the unit prices will appear in order to determine the medium price. In this case, it will be assumed that the average price will take a set of possible values (it will be associated with a vague set). Returning to the consumption of resources, if it will be quantified for high aggregation levels of resources, then the decision maker will be in the same dilemma as the estimation of average price. So robust programming models have resources

consumption coefficients and resource vector (objectives) defined by a set of possible values. We emphasize that the advantage of incorporating imprecision in this method has the consequence of increasing the size of the problem.
Fuzzy linear programming methods offer many advantages for the users, but also a series of inconveniences. One of them was mentioned earlier: they are very laborious, reason for which it will be analyzed when it will be applied to see if the results that we are hoping to obtain are worth the effort, in comparison to conventional optimizing models. Moreover, although they manage to capture the imprecision in formulating the problem and quantification of parameters, in the end, in order to solve them we rely on "classic" resolving methods. In this way, from imprecise data or formulations we achieve "precise" results. In logic, an argument based on a false assumption will lead to false conclusions. By analogy, when we use imprecise formulations, the results will have some degree of imprecision. The imprecision degree of the results of some of the methods presented can be quantified, although the solving method doesn`t always associate it directly. Many papers stop at identifying methods of solving the problems without handling the implication issued (fuzzy) of the input date on the achieved results. Also, the vague formulation of objective functions needs further studying.

4. CONCLUSIONS

Considering the current conditions of economic instability and the lack of some material resources, the activity for program development needs to be improved continuously by increasing the strictness of the adopted decisions. A good way to increase the scientific nature of the work to establish development programs is through widespread promotion of modern methods of analysis, decision and automatic data processing.
When implementing these methods, we need to take into account that the elaboration of programs takes several steps, in which the degree of knowledge varies based on certain information (signed contracts or pending ones, the availability of human resources etc.). Awareness in the preliminary stage of program development is limited and some information is uncertain or vague. However, even if the degree of knowledge should be greater, due to the large volume of information that need to be processed to obtain the optimum variant, difficulties still arise in founding the program. Most of this information is obtained through statistical surveys made by decision makers from the set of elements that characterize the earlier processes.

1. By treating the process of development plans elaboration like a process divisible into phases, it can be treated as a discrete system and it can be optimized using dynamic programming.
2. Because some formulations of restrictions and objectives are imprecise or the fact that some parameters of the models are also quantified with low precision, it is necessary to use fuzzy mathematical programming methods: robust and linear programming.
3. The large number of used models for substantiating development programs reflects the variety of content of this issue in enterprises, which are generated in large part due to the specific production process. In order to create software products that automate the process of planning, we need to determine what all these variables have in common. In this way, the software will include a set of standardized elements. But until now, there is no type of statement of the type of problems that arise in the planning activity, their content, or their characteristics in different contexts.
4. When implementing these models several difficulties arise due to the complexity of the development process of development programs, the limits of models and solving the ones developed, hardware limits etc. In order to be used successfully, we must ensure the priority of the economic problem and the real conditions in which the production process runs, in creating the models. But modifying the creation conditions of a model means changing its manner of creation.

5. Reported models are only a small part of the set of possible models used to model development programs. Each of them has different characteristics, treat certain aspects of the economic process, offer information and action options, but none of them can cover all the relevant aspects of this process. But thanks for the complex structure of models developed based on game simulations, they could be a more efficient alternative if they it were not for their aspect of sliding the user's interest more on extrapolation of virtual conditions of evolution of the analyzed process [11]. Due to this, in order to capture the elaboration process of development programs in their complexity, a model system will have to be built.
6. But one of the major disadvantages of this system is that procedural models encompasses both knowledge and ways to use them in order to solve the problem, thus, any attempt to separate them is in vain. Any change will result in the change of the user program. One way to overcome this drawback is by separating the knowledge and methods of solving the problems from the user program and the input data. In other words, an expert system can be created.
7. However, there remain a number of problems which are especially generated by the lack of methods to treat the hybrid nature of the data from the models that substantiate development programs, the rigidity of some models, the specialized language used by computer products and the absence of effective methods of aggregation or disaggregation of models and economic information.

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