SUMMARY OF PHD THESIS
"USE OF STATISTICAL METHODS IN MANAGEMENT DECISIONS"

PHD thesis titled "Use of statistical methods in management decisions " of the doctoral student Alice Dalina Matei-Cernaianu, with the scientific coordinator Prof. Vasile Georgescu, Ph.D., is structured in five chapters and ends with the bibliography as follows:

INTRODUCTION

Chapter 1

GUIDELINES IN RECENT ECONOMIC MODELING NONLINEAR PROCESSES: METHODS OF ESTIMATING THE PARAMETERS OF THE MOST COMPUTATIONAL INTELLIGENCE

1..1Quality and statistical information in decision-making role
1..2The role and methods of statistical inference based on classical theory estimate
1..3Methods based on Computational Intelligence Role
1.4 Experimental approach of the thesis: the analysis of the accuracy of the forecasts based methods on computational intelligence, compared with the estimate based on the classical theory

Chapter 2

MANAGEMENT DECISIONS BASED ON THE THEORY PRODUCTION COST -DUALITY

2.1 Principles of cost-production duality
2.2 Production Functions
- 2.2.1. Properties of production functions
- 2.2.2 Indicators of marginal production functions
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- 2.2.4. Production Izocuante
- 2.2.5. Marginal rate of technical substitution of inputs
- 2.2.6. The coefficient of elasticity of the marginal rate of substitution

2.3. Cost Functions
- 2.3.1.Definition of cost function
- 2.3.2The optimal combination of factors. Competitive equilibrium condition in a production system
- 2.3.3. Causes influencing the choice of the optimal mix of factors
- 2.3.4. Deduction of cost function of the production function. Conditional demand functions of the factors
- 2.3.5. Deduction of the production function of the cost function
- 2.3.6. Short-term cost function
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  - 2.3.7.1. TRANSLOG production function
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Chapter 3

METHODS OF ESTIMATION OF MODELS BASED THE THEORY OF CLASSICAL OF ESTIMATES

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- 4.1.6. Issues related to learning: the ability to generalize suprainstructure
- 4.1.7. Development of applications based on feedforward neural networks

4.2. Flexible estimation techniques based on fuzzy models
- 4.2.1. Estimation of fuzzy logic model
- 4.2.2. Model structure identification scheme
- 4.2.3. Optimization models based on fuzzy logic

4.3. Estimation models based flexible neuro-fuzzy methods
- 4.3.1. Characteristics of neuro-fuzzy models
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Chapter 5

THE ESTIMATES ACCURACY ANALYSIS METHOD BASED ON COMPUTATIONAL INTELLIGENCE, COMPARED WITH THOSE BASED ON THE CLASSICAL THEORY ESTIMATES

5.1. The purpose of the experimental approach
5.2. Predictive performance of methods based on computational intelligence in relation to the standard model proposed by Christensen and Greene
- 5.2.1. Specifying the Christensen-Greene classic model with a flexible functional form type TRANSLOG
- 5.2.2. Efficient procedures for estimating the cost function TRANSLOG: Estimator of the feasible generalized least square
- 5.2.3. Implementation procedure for estimating the cost function
- 5.2.4 Christensen-Greene estimation model modeling method based on fuzzy inference systems
- 5.2.5. Christensen-Greene model estimation by neural networks feedforward (multilayer perceptrons type)
- 5.2.6. Christensen-Greene model estimation by hybrid methods neuro-fuzzy (ANFIS)

The information content of the thesis developed can be summarized by the following **keywords**: quality and the role of statistical information in decision-making role of the statistical inference, statistical inference and role-based methods to estimate the classical theory, role-based computational intelligence methods, analysis of the accuracy of the forecasts for methods based on Computational Intelligence, compared with the estimate based on classical theory, principles of duality cost - production, production functions, cost functions, multiple linear regression model, statistical inference in multiple linear regression model; Nonlinearity of dependence relations between economic variables, estimation based on flexible neural network models, flexible estimation techniques based on fuzzy models, estimation models based flexible neuro-fuzzy methods, the predictive performance of methods based on computational intelligence in relation to the model standard proposed by Christensen and Greene, production cost modeling Energy Complex Turceni S.A

Summaries of the main parts of the PhD Thesis

Questions put doctoral research is to substantiate the managerial decisions at the firm level, using modeling techniques of production and cost functions that define the behavior of the manufacturer, in agreement with the theory of cost-production duality.

In accordance with objective, experimental approach of the thesis tests the accuracy of the forecasts obtained by computational intelligence techniques, versus the estimate based on classical theory, using common data sets obtained samples of the nonlinear processes inherent characteristics.

Traditionally, these processes are modeled by flexible functional forms, associated with complex dependencies, strongly nonlinear, a typical example of this kind is based on function TRANSLOG parametric model, whose flexibility is recognized complex combination of linear and logarithmic functions squares. The accuracy obtained by using such parametric models was then compared to that resulting from the use of models based on computational intelligence (neural networks, fuzzy inference systems, neuro-fuzzy mixed models respectively).

In this context, the sentence is structured in five chapters which approach, in summary, are as follows:

Chapter 1 - GUIDELINES IN RECENT ECONOMIC MODELING NONLINEAR PROCESSES: FROM MODEL TO THE ESTIMATION OF PARAMETERS COMPUTATIONAL INTELLIGENCE - points out that management systems are by their nature, information systems - decision-making, dealing with statistical information in real time. Taking as a basis, a certain amount, a certain structure, and a certain mode of presentation of statistical information, management decision appears as a dynamic and rational manager calls the ability to master the complex mechanism of the whole system of business management. In this respect, computer subsystems, information - statistics and make a fundamental contribution to its decision.

Decision-making processes are based on using statistical data to develop mathematical models of economic phenomena and processes, to make a contribution to their subsequent statistical inference, the inductive method of research to ensure and validate mathematical criteria shift from private to general. In the model, information is circulated via exogenous or endogenous variables. Some random variables may have the character and intervention model that allows this kind of variables is an econometric model, as appropriate explanatory models aimed to study various functional relationships between variables that express a particular type of economic behavior.

The relations what defining explanatory models generally take the form of equations in which we must distinguish both a deterministic, functional expressing some causal link between endogenous and exogenous variables and a deterministic part, summarized in the equation variable error. These explanations emphasize the role of asymmetry of different economic variables in the explanatory model. This type of model must be specified (the role of economics is essential to provide criteria for logical consistency), estimated (determination of its structure), validated factual (predictive power of acceptable tolerance limits) and can be effectively used (either purpose of explanation or prediction purposes).

A challenge but even to the most advanced econometric techniques to estimate a nonlinear process modeling is the problem with complex structure and a large number of variables. Classical manner to meet this challenge has been to refine the estimation methods and specifications provide enough elastic priori functional forms, which according to traditional accepțiunii period were not specified ex ante, making calls only the experience and intuition.

Starting from the assessment but that flexibility is the ability of the functional form (defined parameters) - be it a production function or a function of cost - to approximate the various behaviors, but theoretically consistent with an appropriate choice of parameters, one of the most popular functional forms proposed for modeling the behavior of the producer, is the TRANSLOG function (transcendental logarithmic function), whose flexibility has been proven theoretically and practically justified.

Recent scientific research highlighting the nonparametric estimation methods, designed to achieve adjustment of the regression functions subject to structural restrictions of monotonicity and concavity. It is based on computational intelligence techniques which use different ways to meet the requirement of flexibility (note neural networks, fuzzy logic models, neuro-fuzzy models). The intelligence and adaptability are two essential attributes of intelligent systems (such as decision-making). Ability to learn and adapt to the emergence and development underlying computational intelligence, perception of the system are that it possesses certain attributes that make possible or facilitate reasoning an intelligent behavior in complex and changeable, autoorganizându himself into complex structures even in the presence of permanent forces that tend to deconstructed.

Methods based on computational intelligence are currently considered the best techniques for estimating the nonlinear models, both in terms of predictive power (superior) and in terms of flexibility, proven universal approximators in nonlinear process modeling.

The process of creating such models modeling through the following steps: construction, evaluation and integration. In such an architecture model allows analysis of the accuracy of intelligence estimates based on computational methods, compared with the estimate based on classical theory.

Chapter 2 - MANAGEMENT DECISIONS BASED ON THE THEORY OF PRODUCTION COST-DUALITY.

Production and cost management are inextricably linked, representing two facets of the same process-oriented decision-making resource efficiency in relation to the production possibilities frontier. These dual objectives are divided nature into two categories: minimizing costs to achieve a certain level of production and maximize production achieved a given level of costs.

Dual formulation of the models which define the system production cost, to resolve to achieve these requirements, based on analytical modeling methods based on the specification, estimation and testing econometric fucțiilor production and cost of different forms accepted economic theory. Modeling dual-cost production system involves the identification of cost functions while reflecting the influence of factor prices, depend explicitly on the volume of production, given the natural assumption that a certain level of output is only possible by ensuring a certain consumption factors , combine in a fixed proportion for "prescription" given the production function.

Through a detailed theoretical approach and practical exemplified, we emphasized the concept, properties, and elasticity of marginal indicators of production functions Cobb - Douglas and CEZ (Constant Elasticity of substitution). With the same scientific rigor we analyzed the function and pursuing cost expansion path in accordance with cost-production duality theory.

Based on theoretical and in relation to the limited resources available, managers must take a decision to choose the optimal mix of resources through which to obtain a certain level of production with minimum cost or maximum production with a cost given track changes over time, generated by causes that influence the choice of combination of factors such as price and / or level of technology. We consider for example, changing the relationship between resources used in production following a change in the price of one of them, something that causes the substitution effect, each combination of resources contributed to the production of large quantities of products.

Analysing the causes that influence the choice of the optimal mix of factors, and assuming that the organization wants to minimize cost management skills necessary to achieve a certain total level of production, based on duality theory of production cost function we defined the cost as a function of input prices and production levels and I then deducted from the production function. Based on Cobb-Douglas production function with the objective of finding the optimal level of capital stock (K) and labor (L), which ensures minimization of total variable cost, under the restriction of a level (Y) production, we inferred the conditional factor demand functions KSI L and we determined the total variable cost function, concluding that the conditional factor demand functions can be expressed as partial derivatives of the cost function of the prices of factors. In the short term, some production factors can be considered fixed at predetermined levels.

At the end of Chapter 2, I approached TRANSLOG functions, production and cost, the flexible functional forms. TRANSLOG production function (transcendental logarithmic) is a generalization of Cobb-Douglas model in the sense that tells restrictive assumption about the elasticity of substitution unit. A cost function TRANSLOG specification, the system appears to us as a logarithmic function describing the total cost of both variable and variable weighting factors in the total cost.

Chapter 3 - METHODS FOR ESTIMATING MODELS BASED ON CLASSICAL THEORY OF ESTIMATES

They are subject research: the least squares estimator and its properties for multiple linear regression model, statistical inference in multiple linear regression model and specific methods of treating the nonlinearity of dependence relations between economic variables (non-linearity and nonlinearity in the arguments parameters). arguments nonlinear models, but linear in parameters, is an extension of the linear model. Regarding the nonlinearity in the parameters I mentioned a distinction being made between linear models, but the logarithm linearized and nonlinear so-called models . One of the major issues considered when used multiple regression methods is to ensure stability estimators, because one of the main elements of instability is the presence multicoliniariate, a phenomenon that occurs when independent variables are highly interrelated. Although multicoliniariate not affects the accuracy of this forecast, but rather the interpretation of the independent variables, the literature presents a grouping of solutions to mitigate or even eliminate the effects of multicoliniariate.

Chapter 4 - FLEXIBLE METHODS FOR ESTIMATING MODELS BASED ON COMPUTATIONAL INTELLIGENCE, addresses flexible methods for estimating models based on computational intelligence methods to modern alternative to the estimate based on classical theory. Three areas are described, namely: flexible estimation models based on neural networks, flexible estimation techniques based on fuzzy models flexible models and estimation methods based on neuro-fuzzy.

The analysis highlights trends in the field of research concerns the neural highlights basic principles and properties of neural calculation generated by a neural network, defined as a class of methods based on computational intelligence. Interest in use across a broad spectrum of practical applications, has the motivation, the effectiveness of these methods to provide solutions, in particular issues such as predictive of greater complexity. Forecast accuracy of neural networks on gas prices for a horizon of one month (in a North American companies), reached an average of 97% (ninty-seven per cent). Other typical cases of successful use of neural networks include: real estate pricing, changes in financial markets quotes, analysis of loan applications etc .

Unlike classical methods to estimate based on the theory, neural networks, simulating the behavior of an ensemble of neurons connect with each other synapses in the brain affect human analogue, mimicking its operation. Created a new paradigm based on computer models to calculate conversioniste. Artificial neural networks as defined by the scientists of the domain models are networks of neurons connected through synapses adjustable. Artificial neural networks are characterized by capacity for learning, high parallelism, robustness and fault tolerance and disturbance. Plus: information and knowledge are distributed across the network (the values of synaptic weights) neural network provides a global response has resilience, and recovery associative generalization.

Knowing that a neural network is stored becomes more precisely the neural synapses, the weights of connections between neurons. Such a system learns by modifying the strength of connections between elements by changing the weight associated with these connections. Learning is always associated with neural network's ability to represent knowledge. In a diffuse neural network information is stored across the network but only in areas not well defined, as in standard computers.

Due to the intrinsic nature of a neural architecture based on connectivity and parallel processing, neural recipes give high levels of computing, have a high degree of robustness and

disturbance are fault tolerant, allowing accumulation possible associations, the knowledge stored in associative memory in which to address their retrieval is done by content, etc .
The last two decades have witnessed an explosive growth of many neural network architectures, including dynamic ones (recognized) with feed-back type connections, have gained importance. Artificial neural networks learn through three distinct ways:
a) direct calculation of the weights (by simple transposition, by minimizing a function, or by finding solutions for a system of equations);
b) supervised learning (application data entry volunteer network and get its exit);
c) Unsupervised learning (without user intervention).

A neural network consists of many processing elements (neurons, cognitive units or nodes of the network) highly interconnected. Each neuron calculates its internal state or activation (arousal) as the sum total weighted input signals. The Mc Culloch-Pitts model each neuron is characterized by a threshold of excitation. We distinguished non-threshold neuron with an input excitation, with an input neuron and excitation threshold.

The advantage of this approach is that the threshold can be adjusted along with the other weights during training. Form response function depends on neural network model studied. Please Note: threshold function, signum function, the function type identity and sigmoidal function, indicating that the sigmoidal functions are forms smoothed linear threshold function. They are continuous functions, differentiable and monotonically increasing and these properties are suitable for applications with analog calculation and modeling of a multivalent logic.

The stone of which have developed neural networks is the perceptron model. Its standard architecture is the simplest possible configuration of a network. It allows training to achieve it using a simple and efficient training algorithm, which belongs to a class of training. (It was detected a wide range of training algorithms).
perceptron with a single layer neural network is the simplest. This basic network is able to learn to recognize shapes. Since a single layer Perceptron can only discriminate linearly separable classes, applying this algorithm in solving concrete problems is severely limited. Instead the problem can be solved by a multi-layer perceptron. Neurons can be connected in various ways to form a neural network. A typical topology model considers neurons organized in layers. In such a network, the first layer of environmental inputs, the outputs of this layer is the input for the next layer neurons. The output network consists of the last layer output neurons. The reason of the complicate neural architecture is related to the fact that sometimes the simplest architectures prove unable to solve a problem or a particular class of problems.

If a network can not solve a problem is sometimes enough to increase the number of neurons in the network, preserving the old architecture. In other situations, it is necessary to change the network architecture by introducing one or more layers neural us, except that it may consider network architectures, there are connections between neurons in the same layer, or from one neuron to the previous layer neurons are or connections that can link the two neurons wich is not necessarily in adjacent layers.

One of the most important and commonly used algorithms for training neural networks is back propagation algorithm errors. This is a training method for multilayer neural networks with transmission before (unidirectional networks) which aims at minimizing the mean square error by a gradient method. Not sure but that the optimization technique used to determine the global minimum of criterion function (back propagation algorithm requires that the response functions are derived). What we get is generally an acceptable solution and not necessarily an optimal solution.

An important problem is related to the possibility of training during the error minimization process, a phenomenon known as superinstruction..

Training algorithms designed to minimize the error in network performance. It requires that before the operation of the network to determine how it is able to properly handle data that has not "seen" during the performance of networks trained instruire.Validarea (system testing) is performed using test instances structure similar to the training. Neural network that can provide acceptable results in training but not testing, is the fact that the network can not generalize, that can not handle input correctly that it has not previously worked in the training phase. These data suprainstruire produce negative phenomenon, namely network performance degradation, a phenomenon that can be avoided through a series of actions such as for example the provision of appropriate training data volume and quality.

Another flexible method for estimating models based on computational intelligence, fuzzy logic is the modeling. Fuzzy logic modeling is based on the idea that a global nonlinear model with unknown functional form can be approximated by several simple local relationships, each valid only in a small region of the domain variables are defined. The definition of each relationship is given by local rules (implications) fuzzy.

The estimated nonlinear fuzzy logic can be used to optimize the representation of business processes accurately analyzed. By hybridization techniques based on neural network-based fuzzy inference systems are obtained and are becoming increasingly used methods based on neuro-fuzzy models. They describe systems by means of rules of "if condition", "then action" represented in a network-type structure in which learning algorithms known from neural networks can be applied. Neuro-fuzzy model has a high degree of interpretation and analysis to explain phenomena that can not be represented by a classical operational model. An Architecture ANEFIS Takagi-Sugeno type, with two inputs and nine rules presented in the paper, proves the above assumptions.

Chapter 5 - ANALYSIS BASED METHODS FOR ACCURACY THE ESTIMATES COMPUTATIONAL INTELLIGENCE, COMPARED WITH THOSE BASED ON THE CLASSICAL THEORY ESTIMATES

In this chapter we propose two case studies on energy modeling producer behavior. Both methods aim to analyze the accuracy of estimates based on computational intelligence, compared with the estimate based on classical theory. The principle common to both case studies is that the subject methods apply the same comparison data sets. The first case study is a starting point using a standard model proposed by Chiristensen and Green, a classic model specified flexible functional form cost function represented by TRANSLOG. Due to its flexibility recognized standard model has been used as the main basis of comparison in relation to computational intelligence techniques. Accuracy obtained by estimating models using methods from both classes mentioned comparative study subject.

Please note that the estimated cost function parameters, in option-based modeling TRANSLOG functional form and in those based on neural networks and fuzzy logic hybrid neuro-fuzzy methods were based on algorithms and their implementations in MATLAB language, propose in literature

By gradually getting through efficient processes, a certain level of accuracy of estimates of cost functions and Coob Douglas, followed by a comparative analysis of its results by estimating the level of accuracy Chiristensen-Green model in fuzzy logic modeling method, the network neural feedforward (multilayer percepton type) and hybrid neuro-fuzzy methods (ANEFIS), I highlighted the performance of predictive methods based on computational intelligence in relation to those of classical methods of estimation.The coefficient of determination obtained for the five types of models as well as visual inspection of the differences between observed and estimated values support this scientific truth.

Respecting the scientific rigor of a classical analysis comparing computational manner, we illustrated the practical usefulness of our proven and supported above by a second case

study in the Energy Complex Turceni - SA, which is composed of the large power plant in Romania, which provides about 10% of annual electricity consumption. In the current financial crisis, of a continuing effort to reduce costs and budgetary support for investment in upgrading energy blocks depends on the continued operation of the thermal power station.

Specifically, our experimental approach consisted of modeling the dual system at the unit production cost based on the two classes of methods (classical, that is based on computational intelligence) obtaining the corresponding accuracy estimates for both production functions and cost for the estimated production function Cobb - Douglas production by only two factors provide poor quality information, the predictive power of such a model is therefore very weak. The main reason is that, in the production of electricity is an essential share of fuel, which acts as a genuine input.

It is also why in our experimental approach we took into account this aspect, including fuel (in its two forms: coal and oil) between the factors of production, moving to Cobb-Douglas function tests, by estimating its four factors (labor, capital, fuel consumption, coal consumption).

The accuracy estimate Cobb-Douglas function with four factors is slightly higher than in the case of two factors, but poor quality, with a predictive power but still very low. Testing predictability of alternative estimation techniques based on computational intelligence found that such methods provide estimates with an accuracy superior conventional methods. Coefficient of determination value obtained ahead of the net production obtained for the Cobb-Douglas function with four factors. By visual inspection of the differences between observed and estimated values, the quality estimate is eloquent and graphically. If the production function estimate using neuro-fuzzy methods for example (ANEFIS) estimate is almost perfect (very different than the ideal one), confirming in an exemplary manner based on comparative analysis, quality universal approximators based on computational intelligence methods.

The same conclusions were separated by estimating Cobb-Douglas cost functions and TRANSLOG, compared with the estimates made by computational methods. Resulting values of the coefficients of determination, both for estimates of production functions and those functions cost, computational methods are almost identical and very close to that ideal.

Given the theoretical and practical approaches that one of our nonlinear modeling business processes with complex structure and behavior of the manufacturer, the following conclusions:

1. The strength of the nonlinear functional dependence of economic variables involved, the estimation of parametric models to represent a continuing challenge. Traditional methods do not provide an adequate solution to this problem.

2. Although the use of functional forms has led to a significant improvement in predictive performance of classical models in many practical situations, they were not properly adjusted survey data; the accuracy of estimates is rather modest

3. For the reasons above, the research effort was directed toward finding alternative paths, the conventional type for modeling nonlinear processes. The most important line of research has centered around methods and techniques based on computational intelligence, they use different ways to meet the requirement of flexibility, and make available the means of calibration and fine-tuning of structural models by the option to type progeny (top-down).

4. Typical of classical Artificial Intelligence approaches are based mainly on formal logic, intelligent system designer shall forward its entire body of knowledge to solve a problem, since the construction phase (construction) of the system. Conversely, if the computational intelligence approach is rather bottom (bottom-up) in the sense that algorithms are designed to teach themselves (through the accumulation of experiences).

5. As a result of the bill inspiration from biological and cognitive brain imposes its superiority in computational intelligence, intelligent systems that have the ability to learn to adapt to self organize and make generalizations.

6. The experimental approach undertaken for the thesis I test the predictive power of performance compared to methods based on computational intelligence. Experimental approach was based on the use of common data sets obtained samples of the nonlinear processes inherent characteristics, as well as those that describe the behavior of the manufacturer.

Evaluation of predictive performance of the two classes of methods (classical and computational parametric) was achieved through two case studies.

In the first case study were used as a model for traditional parametric estimation, by Christensen and Green model. Reputation model for the first time due to the introduction of a flexible functional forms TRANSLOG type function in order to obtain a function of cost for the electricity industry. Public availability of the set consisting of the 99 observations of the original application has allowed its use in estimating the appropriate cost function by both classes of methods (classical and parametric-based computational intelligence). The case study was completed by a comparative assessment of curateței estimates, indicating differences notabile.Cel second case study was the production cost modeling system Turceni Thermal Power, the main component of the largest Romanian energy complex. Comparative analysis of two classes of methods was performed both for a set of production functions and a set of cost functions.

8. Both case studies showed clear superiority of the predictive power of such methods Computational Intelligence, compared with classical parametric estimation.

The obtained conclusions in this thesis validated once more unconventional modeling techniques based on Computational Intelligence and open doors in their systematic research and application of their economic modeling nonlinear processes.