SECTION 2
AGENT-BASED MODELING OF ECONOMIC SYSTEM

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1. AGENT BASED MODELING FOR VIRTUAL COMPANY DESIGNING

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Abstract

In a distributed and turbulent business environment, the small and medium companies need to operate as a virtual factory that can react quickly to the market requests and maximize their efficiency and competitiveness. This virtual factory maintains an up-to-date picture of the available production capacity of the individual participants and is able to respond rapidly to orders from customers.

Our paper is part of an ample research which aims to develop a platform for integrating the resources of several independent-manufacturing companies into a virtual factory. An Integrated Platform combines information from the individual companies' existing information systems and from the markets with the virtual factory's own data and knowledge base to drive the configuration, planning and monitoring applications.

The Integrated Platform has three critical management tasks: virtual firm configuration, production planning and operation monitoring. The configuration module of the virtual factory analyzes the orders of product requests from the customers. This proposes solutions (supply chains) that are based on the manufacturing capability of the virtual factory.

The production-planning module tests these solutions against the resources currently available from various partners. It takes account of the all work currently in progress within the virtual factory and produces a plan that meets the customer's requests and optimizes the use of the virtual factory's overall resources.

The operation monitoring module analyses relevant information extracted from the existing information systems and the data base of the virtual factory and, if it identifies problems, it suggests corrective actions. These involve various levels of escalation, from rearranging the supply chains and production schedule to reallocating the tasks between companies within the virtual factory.

One of the main questions here is: could we use the equation-based-modeling for the virtual company building? Isn't it too restrictive for this goal to be accomplished? Because we think so, we will try to offer a viable alternative: Agent-Based-Modeling.

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The Virtual Enterprise (VE) modeling, apparently strongly technology-driven, is more and more integrating contributions from a number of disciplines such as artificial intelligence, management, cybernetics, sociology, law etc.

One of the most advancing method of modeling that have been applied to support VEs is Agent-Based Modeling (ABM), where the entities in a VE are represented by agents. Agents are computational entities that independently operate and decide in distributed environments. They may be heterogeneous routines, often designed and developed by different parties. Thus, there is a need to support the development of these agents to ensure that they be able to collaborate in forming, operating, evolution and dissolution of a VE.

1. Agent Approaches to Modeling and Simulate the VE

Although it represents a growing and multidisciplinary area, it still lacks a precise definition of the VE and an agreement on the used terminology. A commonly used definition of the VE is: " A VE is a temporary alliance of enterprises that come together to share skills or core competencies and resources in order to better respond to business opportunities, and whose cooperation is supported by computer networks" (Camarinha-Matos, 2002).

A more general definition is the following: "A VE is o goal-oriented constellation of (semi)autonomous distributed entities, Each entity which can be an organization and/or individual, attempts to maximizes its own profits as well as contribute to achieving the overall goals of the VE. VEs are not rigid organizational structures within rigid frameworks, but rather (heterogeneous) ensembles, continuously evolving over time" (Petersen,et.al., 2000).

The key elements in these definitions are networking and cooperation. These elements make the VE a suitable candidate for application of multi-agent modeling approaches.

The development of computer science and artificial intelligence has moved from procedural through functional to object-oriented programming, now arriving at the agent-based modeling. Hype has led to the situation where nearly anything can be identified as an agent. For example, in cybernetics agents are simple state-determined systems connected according to various complex temporal or topological schemes in order to demonstrate "emergent behavior" of adaptive complex systems. In distributed artificial intelligence agents are complex software systems with a great deal of on-board computational intelligence and planning ability to interact in small collections and simple environments; and finally in decision theory agents represent individuals engaging in collective choice processes.

In all these different sense of agent we can discern their common proprieties, including asynchrony, interactivity, mobility, spatial distribution and randomness of trials over various initial conditions.

While this list is common to most agent models, they still do not capture the essential qualities that most people bring to the concept of "agency". These qualities are a kind of independence, the fact that the agent is doing something of and by itself. This refers to the auto-control, or, in a word, autonomy.

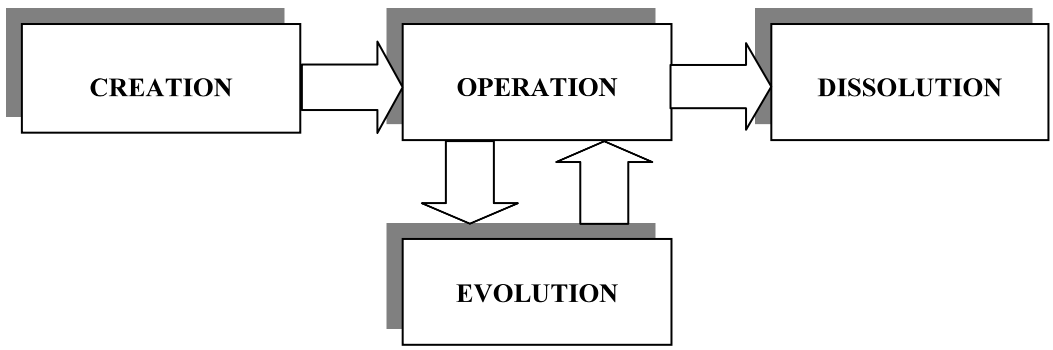
The list of proprieties above is actually quite familiar to us from the system theory and cybernetics. Indeed, based on the above criteria there is very little to distinguish an agent from some general sense of system. In seeking a coherent sense of agent that will be distinguished not only from other software engineering products (agents are not just subroutines or programs), but also from "objects" or "systems" in general (agents are not just systems), we must focus on the concept of autonomy with respect of action. In other words, the concept of agent is a system or object that has an inherent freedom to make choices or decisions over possible actions.

In Agent-Based Modeling, a system or process is modeled as a collection of autonomous (heterogeneous) decision-making entities. Each agent independently assesses its situation and makes decisions on the basis of a set of rules. Agents may execute various behaviors appropriate for the system that they represent, for example producing, consuming or selling. Repetitive competitive interactions between agents rely on ABM to explore complex dynamics out of the equation-based models. At the simplest level, an agent model consists of a system of agents and the relationships between them. Even a simple ABM can exhibit complex behavior patterns and provide valuable information about the modeled system and his environment. Sophisticated ABM sometimes incorporates neural network, genetic algorithms, or other learning techniques to allow realistic learning and adaptation.

One of the principal reasons underlying ABM's popularity is its easy of implementation: indeed, once one has heard about ABM, it is easy to program an agent model. Because the technique is easy to use, one may wrongly think the concepts are simple to master. But although ABM is technically simple, it is also conceptually deep. This unusual combination may often leads to improper use of ABM.

2. Life cycle of VEs and ABM

A VE as a temporary organization evolves along a number of phases requiring different support methods and instruments. In figure 1 are represented the main phases of the life cycle of the VEs. Related to these phases. ABM offers multiple possibilities to solve different problems appearing during the life cycle of a VE. Some of these problems are identified and summarized in figure 2.



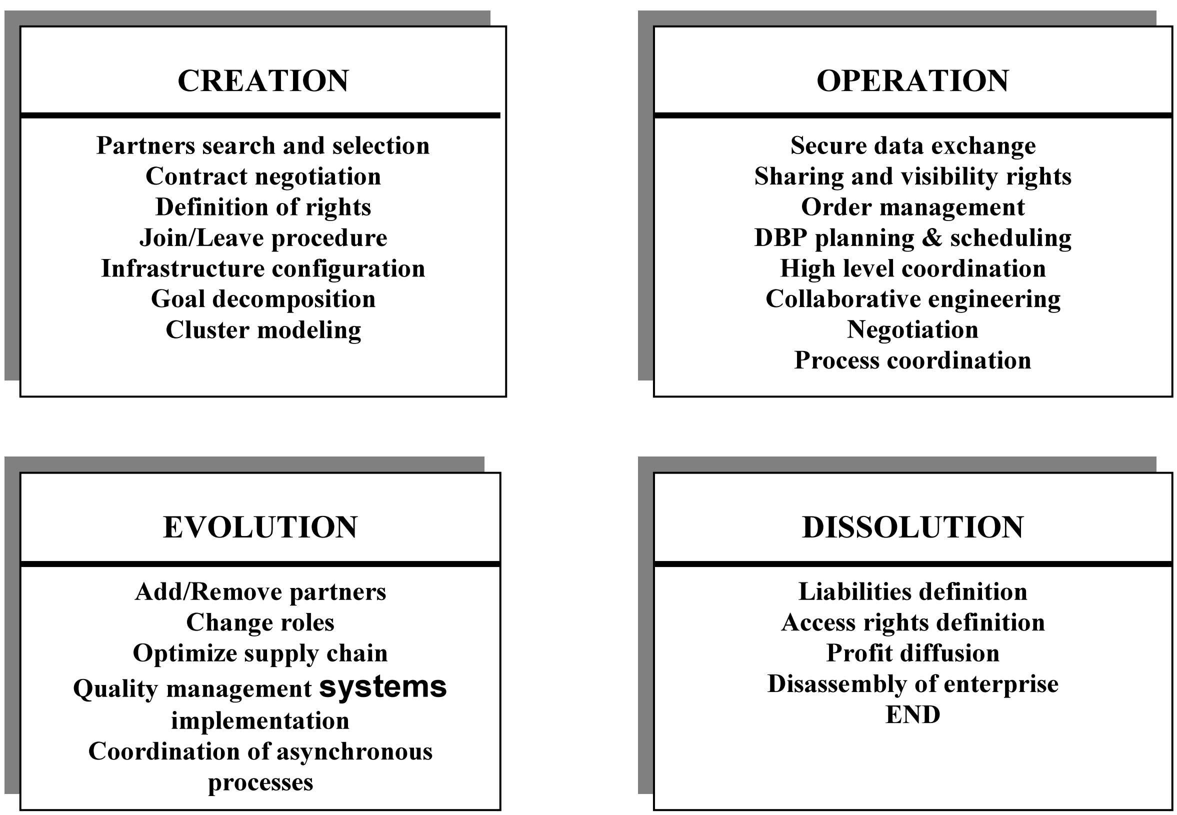


Figure 2

The following properties of the VEs making them adequate for the application of ABM:

1) A VE is composed by an alliance of distributed, heterogeneous and autonomous entities;
2) Coordination and negotiation in problem-solving are critical problems in VE management;
3) Decision making with incomplete information and involvement of network members that are autonomous entities, although willing to cooperate in order to reach a common goal, might be competitors regarding other business goals;

4) The effective execution and supervision of distributed business processes requires quick reactions from VE members;
5) The role and social relationship/contracts modeling, addressing aspects of distribution of responsibilities and knowledge also are common topics in ABM;
6) The scalability property of ABM seems particularly adequate to support dynamic VEs in with different levels of cooperation with different sets of partners might be established at different phases. On the other hand, each enterprise might itself be seen as composed by a network of semi-autonomous entities (departments);
7) Continuous evolution of business models, technologies, organization paradigms and market conditions require effective support for evolution and a high level of modularity of infrastructures;
8) New forms of teamwork, namely cooperative concurrent engineering, are emerging in the context of VEs. Agents can play an important role as "assistants" to the human actors in VEs;
9) Finally, as the VE components are designed and developed independently, it is quite difficult to guaranty coordination unless common rules are adopted. Theoretical foundations of multi-agent systems can be combined with current developments of a legal framework for VE.

3. ABM in VE creation

A growing number of works are being published on the application of ABM for the VE formation (These works assume a virtual market place where enterprises, represented by agents, that are geographically distributed and possibly not known in advance, can meet each other and cooperate in order to achieve a common business goal.

A number of agent models was been proposed to represent the electronic market to support the formation of the VE. In addition to the agents representing the enterprises there is a market agent-coordinator –or broker- that is created and introduced in model when a business opportunity is found.

A multi-round contract-net protocol is followed: the broker send invitations to the electronic market corresponding to each of the VE sub-goals; receivers bids and evaluates them; the most favorable ones are selected based on a multi-criteria mechanism and constrained-based negotiation. Examples of possible considered criteria are : lower cost, higher quality, higher availability etc.

Utility values are associated to each of these criteria and a linear combination of attributes values weighted by their utility values is used.

Multiple negotiation rounds can take place. At the end of each round bidders are notified whether their bids are winning or loosing and a rough qualitative justification is provided, allowing them to change the parameters of their proposals.

In addition to enterprise agents and VE-coordination agent, an information agent can be introduced to keep public information related to common organizational and operational rules, market environments, product or services provided etc.

Another problem in the VE creation modeling is the goal decomposition, leading to a hierarchy of VE goals, for example.

One another important aspect to consider in VE creation is the agility and dynamism required for networked organizations in response to sudden business opportunities appears, in opposition to the process of trust building. Even if flexible support infrastructures become widely available, the aspects of trust building and the required reorganization at the enterprise level are hard to cope with in cooperative business processes.

The realization of the long-term clusters of industry or services enterprises represents an approach to overcome these obstacles and can support the rapid formation of VE according to the business opportunities. The clusters of enterprises represents a pool of enterprises and relating supporting institutions that have both the potential and the will to cooperate with each other through the establishment of a long-term cooperation agreement. Buyer-supplier relationships, common technologies, common markets or distribution channels, common resources or even common labor sources are elements that typically bind the cluster together. For each business opportunity found by one of the cluster members, a subset of the cluster enterprises may be chosen to form a VE for that specific business opportunity.

Current research efforts are devoted to modeling and planning different organizational structures, mechanisms and rules that are adequate for the forming of the VE. The structure of VE is multidimensional and must be defining using many attributes. The Table 1 lists the attributes that different authors use to describe the structure of the VE.

Table 1

Attribute	Definition	Author/year
Goal-specificity	Activities and interactions of participants are coordinated to achieve specified goals. Goals are specific to the extent that they are clearly defined, and provide unambiguous criteria for selecting alternative activities	Scoot,1998
Formalization	The co-operation among participants is conscious and deliberate; the structure of relations is made explicit and can be deliberately constructed and reconstructed. A structure is formalized to the extent that the rule governing behavior are precisely and explicitly formulated and the extent that roles and role relations are prescribed independently	Scoot,1998
Modularity	The extent to which the virtual organization is based on integrated, customer-oriented processes composed of relatively small, manageable units (modules). A decentralized decision-making competence and responsibilities characterize these units. There are units of assignees, which can be belong to different legal institutions	Wigand,et.al., 1997
Heterogeneity	The extent to which the components of the organization have different performance profiles with regard to their strengths and competencies	Wigand,et.al.,1997
Time and spatial dispersion	The extent to which the component of the organization are dispersed in place and time	Wigand,et.al.,1997
Purpose	The objective that provides the incentive for creating the new organization and which serves as the cohesive force to hold the virtual organization components ate least temporary together	Shao,1998
Connectivity	The creation of unity or linkage through structural change, breaking of constraints, or overcoming of previously existing barriers	Shao,1998
Boundary	An indicator for the separation of those who are part of the virtual organization and those are not, in the absence of clearly visible physical border lines	Shao,1998
Technology	The enabling factor that allows the breakthrough and makes the virtual form possible	Shao,1998
Complexity or Diversity	The number of different items or elements that must be dealt with simultaneously by the organization	Scott,1998
Uncertainty or Unpredictability	The variability of the items or elements upon which work is performed or the extent to which it is possible to predict their behavior in advance	Scott,1998
Interdependence or Networking	The extent to which the items or elements upon which work is performed or the work processes themselves are interrelated so that changes in the state of one element affect the state of the others	Scott,1998

The VE creation needs the specification of the tasks necessary to achieve a main business goal. The activities carried out by a company are usually organized in groups of interested activities called processes (business processes - BP). BP can be seen as a set of activities, rules and constraints specifying the steps that must be taken, and conditions that must be satisfied, in order to accomplish a given goal. When a BP is executed by a VE, parts of the decomposition of this BP (i.e. sub-processes) are assigned to different enterprises (and thus different agents), what makes a BP a Distributed Business Process or a virtual BP.

A combination of various processes taking place at different members of the VE will lead to the achievement of the main goal. The problem of modeling of the supervision and coordination of the DBP at its various level of decomposition is quite important in this context where its definition and enactment is not limited to a single organization, but instead to a set of autonomous, distributed, and heterogeneous nodes that meet to cooperate.

4. MBA in VE operation

Regarding VE operation, many agent models are based on simple mechanisms of inter-agent cooperation and negotiation. During the operation of the VE is necessarily to supervise processes and provide to partners that have the appropriate permission with information about the state of partial production and distribution processes.

In the VE cooperation agreements and contracts establish a framework for the general operating conditions. DBP models and mechanisms perform allocation of resources and sequence of tasks for the accomplishment of partial and global goals.

Efficient data exchanged communication services, distributed service management functionalities, support for nodes autonomy/privacy, high level of service quality and accountability have to be guaranteed for the all DBP of the VE.

The decision-making is a hybrid process where it is important to combine human decision with some automatic functions. It is even likely that the level of automatic decision-making will evolve as the trust of humans in the systems increases. But independently of the ultimate decision-making center, there is a need to provide mechanisms to support process coordination, supervision and controlled information and sharing.

5. MBA in VE evolution

Once a basic infrastructure is established, new forms of advanced cooperation among VE members will naturally emerge.

Various tools of modeling can be useful in this area. Because the participants are not located in the same place and eventually their work is developed with different time schedule (asynchronous processes) it is very important to support:

- Sharing of information models and process models, describing the product model and its manufacturing process and the design/planning process itself. The requirement is not only for a bilateral exchange of information but also for the establishment of share work spaces.
- Provision of adequate visibility and access rights definition and management;
- Coordination of (asynchronous) activities performed in different places by different agents;
- Provision of notification mechanisms regarding major events in the design/planning process.

The VE is a dynamic concept, the change processes over time and its temporary structure distinguish its of the classical enterprise. Therefore, there are observable patterns of change over time, or routines of change.

6. MBA in VE dissolution

When the reasons for what the VE was established no longer exist, the disassembly become necessary. In this context, ABM applies to cases where people are influenced by their environment context, that is, what others around them do.

There are very few business applications of dissolution models perhaps because of the “soft” nature of the variables and the difficulty in measuring parameters.

7. Conclusions

The VE modeling represents a fast evolving research domain and a promising application field for ABM. In fact recent VE projects have addressed the applications of the multi-agent systems paradigm and ABM for the partner selection and task allocation during VE creation. Also some attempts to develop Agent Systems Based infrastructures to support the operational phase of the VE have been made.

In the future several challenges remain open for ABM, such as:

- Support for the full life cycle of the VE;
- Integration with several other modeling paradigms;
- Interoperation with legacy systems and enterprise applications;
- Inclusion of specialized standards and protocols.

The emergence of new organizational forms and new cooperation paradigms provides an appropriate ground for the development and implementation of advanced ABM. Furthermore, the progress of advanced simulation tools to support planning, optimization and assessment of operation of VEs and distributed business processes is another open challenge that can benefit from a agent modeling approach.

Finally it is important to stress that in order to be accepted by the industrial community, ABM applications need to be successfully demonstrated in complex real world systems.

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2. ANALITICAL PARADIGM AND HOLISTIC PARADIGM INTERACTION. A THEORETICAL FRAMEWORK AND APPLICATION

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Abstract

*Two paradigms, the Analytical Paradigm (AP) which details the behavior of man, and the Holistic Paradigm (HP) which prescribes the nature of organizations, have evolved as the scientific approach by which management Action and Structure are presently understood. Dialectically, an AP-HP interaction has emerged from the analytic thesis and holistic antithesis. The juxtaposition of the primary elements of axioms of the two paradigms creates a conceptual framework portrayed by a matrix forming A*S specific management Action and Structural Relationships (ASR's). It is the argument of this essay that an essential requirement for understanding management in organizations is to know the nature and significance of these ASR's.*

The application underlines the salience of finding strong or apparently weak connections, hidden or spurious relationships, searching for interactions and informational potentiality of small and dichotomic systems.

3. FROM THE REDUCTIONIST VIEWPOINT OF A REPRESENTATIVE AGENT TO DYNAMICS INDUCED BY HETEROGENEOUS INTERACTING AGENTS

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Abstract

Multi-agent modelling is a relatively new research area intending to build a more realistic theory of financial markets, which are viewed as complex evolutionary systems. Instead of assuming market efficiency (in the sense that market prices instantaneously incorporate all available information) or rational expectations of the market participants, as it is done in the standard equilibrium theory of financial markets, multi-agent models typically incorporate theories of human behaviour that tolerate bounded rationality, several kind of interactions and imperfect information. Such an approach is more likely to reflect the conditions of real-world financial markets. Neural networks, genetic algorithms or hybrid approaches are typically used when modelling heterogeneous interacting agents. The aim of this paper is to evaluate the recent developments in this area and to point out the explanatory role and the predictive power of multi-agent models.

Key words*: Multi-agent modelling, Heterogeneous interacting agents, Neuro-fuzzy methods.*

1. The efficient market hypothesis and some critical viewpoints

According to the concept of rational expectations, financial markets are considered to be efficient in the sense that past prices cannot help in predicting future prices. This standard theory is known as the efficient market hypothesis (EMH). According to the degree to which the information is processed by the market participants, the EMH can be postulated in several forms:

The weak form of the EMH implies that current market prices fully reflect all information about historical price patterns. Since only all information about historical price patterns is incorporated into actual market prices technical trading strategies which are based upon historical asset prices do not allow gaining excess returns. However, it is possible to gain excess returns by evaluating other publicly available information like fundamental data or private information.

The semi-strong form of the EMH assumes that market prices fully reflect *all* publicly available information, including historical price pattern as well as fundamental data. Only trading strategies which rely on private information are able to gain excess profits.

The strong form of the EMH states that actual market prices fully reflect *all* types of information, i. e. public as well as private information are completely incorporated into current market prices. Thus, it is *not* possible to gain excess returns even if private information is used.

In real-world financial markets the underlying assumptions of the EMH, e.g. perfect rationality, common expectations or complete information, are typically not fulfilled, because rationality is difficult to define, human behaviour is often unpredictable, information can be difficult to interpret, technology and institutions change constantly, and there are significant costs of processing information.

Various studies - especially in the new research area of behavioural finance - have shown market anomalies that are not in line with the EMH. Several market anomalies (e.g. overreacting investors, price bubbles or profitability of technical trading) can be explained by agent-based models of financial markets.

2. More realistic trends in financial market theory

There are three important trends allowing a more realistic approach to financial markets: behavioural finance, evolutionary game theory and multi-agent modelling.

While models in behavioural finance typically focus on the manner in which human psychology influences the economic decision making process as an explanation of apparent departures from rationality, evolutionary game theory studies the evolution and steady-state equilibria of populations of competing strategies in highly idealized settings. As concerning the multi-agent models, their importance is to give us a rise to the dynamics of real-world financial markets from the perspective of interacting agents.

In an agent-based model the market is approached from the bottom up. Typically, one starts off with modelling the behaviour and decision making of the agents at the micro economic market level. The resulting decisions (market orders) of the agents are collected at the macroeconomic side of the market. On this basis, a specific price formation mechanism determines the market clearing price. For instance, a so-called market impact function can be applied to compute a price change as a response to the observed market excess. Remarkably, multi-agent models incorporate agents who are heterogeneous in their decision behaviour. In addition, the behaviour of the agents is typically *not* completely rational. In this way, multi-agent models are able to capture complex learning behaviour and dynamics in financial markets using more realistic markets, strategies and information structures.

3. Homogeneous agents vs. heterogeneous interacting agents

Standard macroeconomics is based on a reductionist approach centred on the representative agent. Its reductionism conforms to the Rational Expectation Hypothesis and implies that all agents are homogeneous and do not interact. Under this assumption, the dynamics of the aggregate replicate the dynamics of elements, which are in equilibrium and exhibit only non systematic differences (noises). The *optimal* aggregate solution can be obtained by means of a simple summation of the choices made by each optimizing agent. The standard theory can not explain non-normal distributions, scaling behaviour or the occurrence of large aggregate fluctuations as a consequence of small shocks.

On the contrary, adopting a methodological approach based on heterogeneous interacting agents implies rejecting the reductionist paradigm of a representative agent. Heterogeneity means that the behaviour of the agents differs in a given market situation, as well as the decisions they make.

Heterogeneous decision making can be introduced to the agents' behaviour in four different ways: by a varying information basis; by different parameter settings; by miscel1aneous agent types; by agent learning and evolution.

The heterogeneity of economic agents and the interaction between them are captured by the occurrence of scaling phenomena and the skewed distribution of several variables, such as firms' size, growth rates etc. This affects the concept of macroeconomic equilibrium, which does not require any more that every agent is in equilibrium (i.e., does not depend on "microscopic" details), but stats that the stability is rather an emergent property of the aggregate as a whole. A state of macroeconomic equilibrium can be maintained by a large number of transitions in opposite directions. If the system is far from equilibrium, self-organizing phenomena may also occur. On the other hand, the imperfect information and the systematic interactions among agents may produce output fluctuations. Generally, heterogeneous decision making is required to adapt the underlying market dynamics. If the agents' decisions are too homogeneous, the market tends to be highly volatile. In contrast, if the agents are too heterogeneous, one may only observe small price movements. Both cases do not reflect real-world behaviour.

4. Asset pricing with heterogeneous interacting agents

The EMH assumes identical investors who share rational expectations of an asset's future price, and who instantaneously and rationally discount all market information into this price.

In reality, the traders may exhibit heterogeneous beliefs about future prices of a risky asset that may considerably deviate from fully rational expectations. Essentially, there are two typical investor types. The first type is designated by the "fundamentalists", believing that prices will move towards their fundamental rational expectations value, as given by the expected discounted sum of future dividends. In contrast, the "technical analysts" (also called "chartist") believe that asset prices are not completely determined by fundamentals, but that they may be predicted by simple technical trading rules, extrapolation of trends and other patterns observed in past prices. Financial markets can be viewed as complex evolutionary systems having internal dynamics induced by the two competing trading strategies.

A number of recent papers have emphasized that heterogeneity in beliefs may lead to market instability and complicated dynamics, such as cycles or even chaotic fluctuations, in financial markets. Asset price fluctuations are caused by an endogenous mechanism relating the fraction of fundamentalists and technical analysts to the distance between the fundamental and the actual price. A large fraction or weight of the fundamentalists tends to stabilize prices, whereas a large fraction of technical analysts tends to destabilize prices.

Asset price fluctuations are caused by the interaction between these stabilizing and destabilizing competitors. Experimental evidences show that, under the hypothesis of heterogeneous expectations among traders the emerging dynamics of asset price changes dramatically, with bifurcation routes to strange attractors, especially if switching to more successful strategies becomes more rapid.

5. Explanatory capabilities of multi-agent models

A remarkable property of multi-agent models is that the artificial time series share important characteristics of real-world financial data. These so-called stylized facts of financial markets result endogenously from the interaction of heterogeneous agents within the multi-agent framework. Examples of stylized facts are:

- unit root properties of market prices (non-stationarity);
- leptokurtotic return distributions ;
- volatility clustering (quiet and turbulent periods of volatility tend to cluster together);
- low autocorrelation in time series of returns together with long-term high autocorrelation in series of return volatility (linear dependencies within the analyzed time series;
- complexity (evidence of non-linearity without the presence of a low-dimensional chaotic attractor).

Several researchers pointed out that multi-agent models can exhibit stylized facts of financial markets.

The financial market model of Lux (1998) incorporates two groups of traders: 'noise traders' and 'fundamentalists'. The decision making of the noise traders is based on historical price patterns *and* the majority opinion of the market (behaviour of other agents). The population of noise traders is divided into optimists or pessimists. Optimists believe in upwarding market trends, while pessimists anticipate declining market prices. Fundamentalists expect that the market price has an inherent tendency to follow the fundamental value of the asset. If the actual market price is above (below) the estimated fundamental value, a fundamentalist sells (buys) the asset. As a remarkable property, the agents are allowed to switch between the different groups, i.e. a pessimistic noise trader may become a fundamentalist. Each time period, the agents submit their buying and selling orders to the market. Adjustments of the market price are performed by a market maker in order to absorb unbalances of demand and supply. The agent-based model of Lux (1998) generates all of the mentioned stylized facts of financial markets endogenously through the interaction of the agents. For instance, Lux and Marchesi (1999) argue that the source of volatility clustering and leptokurtotic return distribution is the switching of agents between the population of chartists and fundamentalists. The key feature for the stability of the market dynamics is the development of the noise trader population. Market turbulences emerge when the portion of noise traders is close to a critical value. However, the market dynamics has a globally stable equilibrium in which market prices track fundamental values.

Farmer (1998) investigates a financial market in which the price dynamics is caused by the interaction between ‘value investors' and 'trend followers'. Value investors compare the current market price to the fundamental value of the asset, while trend followers rely on technical trading rules. The behaviour of each agent is described by a single trading rule. A market maker collects the orders of the agents and balances demand and supply by adjusting the market price level. The interaction between value investing and trend following agents gives rise to commonly observed market phenomena such as leptokurtotic distributions of log-returns, correlated volume and volatility and temporal oscillations in the difference between prices and values.

The phenomenon of volatility clustering has been intensively studied by many researchers. It is frequently observed in some economic time series, such as stock returns and exchange rates and seems to be well explained by the behaviour and interaction between agents.

Whereas changes in asset prices themselves appear to be unpredictable, the magnitude of those changes seems to be predictable in the sense that large changes tend to be followed by large changes - either positive or negative - and small changes tend to be followed by small changes. Asset price fluctuations are thus characterized by episodes of high volatility, with large price changes, irregularly interchanged by episodes of low volatility, with small price changes. Using econometric modelling of time series processing such as autoregressive conditional heteroskedastic (ARCH) models and their generalization to GARCH models, volatility clustering has been shown to be present in a wide variety of financial assets including stocks, market indices and exchange rates.

A structural explanation of the phenomenon of volatility clustering has been offered more recently by Arthur et al. (1997), Brock and Hommes (1997, 1998), Farmer (2000), Gaunersdorfer and Hommes (2000), LeBaron (2000), LeBaron et al. (1999), Lux (1995) and Lux and Marchesi (1999a,b) using multi-agent models, where financial markets are viewed as complex evolutionary systems. These researchers have shown that volatility clustering occurs as an endogenous phenomenon characterized by intermittency and coexistence of attractors.

Some other market phenomena that seem to contradict the strong form of the efficient market hypothesis may be pointed out. Market anomalies like the profitability of technical trading or investment strategies that produce excess returns are difficult to explain by traditional economic theories. As we will show, multi-agent models try to explain the observed market anomalies from the viewpoint of interacting agents.

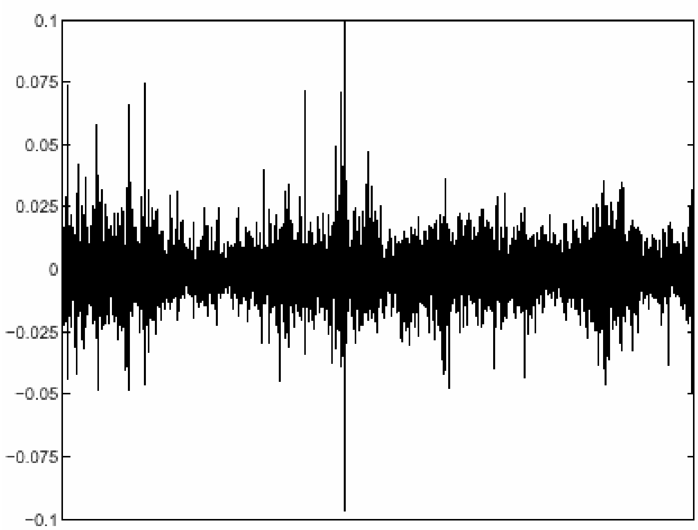

Figure 1. Example of volatility clustering in the time series of daily returns: quiet and turbulent periods of volatility tend to cluster together.

6. Some examples of explanatory multi-agent models

De la Maza and Yuret (1995) present a stock market simulation on the basis of genetic algorithms. The agents refer to trading strategies, which are modified and improved on the basis of genetic algorithms. Each agent computes a fair price for the stock on the basis of historical price patterns and submits his price expectation to the market. The market equilibrium price is the median of the fair prices. Agents who estimated a fair price above (below) the equilibrium price buy (sell) one share at the equilibrium price. In their experiments the authors discovered that "under certain conditions, some market participants can make consistent profits over an extended period of time". This result "might explain the success of some real-world money managers".

Bak, Paczuski and Shubik (1996) construct an artificial stock market, which incorporates agents with imitating behaviour. There are two types of agents, 'noise traders' and 'rational agents'. Noise traders consider historical price patterns and may also imitate the behaviour of other agents. Rational traders optimize their utility functions on the basis of a fundamental analysis of the traded stock. The interaction between agents causes market price series that have the same statistical properties (e. g. volatility clustering or fat-tailed return distributions) as the empirical observations. Another major result is, that "when the relative number of rational traders is small, 'bubbles' often occur, where the market price moves outside the range justified by fundamental market analysis". In other words, the imitative behaviour of the agents can be seen as an explanation for temporary deviations between market prices and the underlying fundamental value.

An explanation for the profitability of technical trading rules is provided by the agent-based stock market model of Joshi, Parker and Bedau (2000). Based on the Santa Fe artificial stock market the authors show that "widespread technical trading can arise due to a multi-person prisoners' dilemma in which the inclusion of technical trading rules to a single agent's repertoire of rules is a dominant strategy".

Chen et al. (2001) study an artificial stock market resting on an evolving agent population. The underlying learning mechanism of the agents is based on genetic programming. As a major result of the multi-agent model, the authors find that the artificial price series follows a random walk process. Insofar, the strong form of the efficient market hypothesis is supported. Interestingly, the random price fluctuations are generated by the interaction of agents who do *not* believe in market efficiency. However, the experimental results of the authors also indicate, that some agents are able to outperform the market on a short-term time scale. This finding can be seen as an evidence of short-term market anomalies.

As it can be seen from these examples, agent-based models provide an experimental framework for studying various market anomalies and stylized facts of real-world financial markets. Multi-agent models provide new explanations of observed market anomalies, which are *not* covered by the theory of efficient markets or the related theory of rational expectations. From this point of view, agent-based markets supplement standard economic theory and provide deeper insights in the dynamics of real-world financial markets.

7. Microeconomic aspects of multi-agent model building

There are many design issues of multi-agent modelling approach.

The first design issue addresses the decision making processes of the agents. In general, one may distinguish between 'rule-based' and 'forecasting' agents. The decision making of rule-based agents is guided by a specific hard-wired or dynamical trading strategy (rule). Forecasting agents deduce their decisions from a specific prediction model. As additional topics of the agents' decision making, inter-temporal decision making schemes and contagious decision making (imitative behaviour) can be taken into account.

The second design issue deals with objective functions which guide the decision making of the agents. The underlying assumption is that the decision making of rational agents is always goal-oriented. This means that the agents always perform their actions in accordance with a specific objective function, e. g. profit or utility maximization.

The third issue addresses the topic of heterogeneity, which is strongly related to the decision making of the agents. In a first shot, heterogeneous decision making is essential for the modelling of the market dynamics. If the agents behave too homogeneous, the market often tends to be highly volatile. On the other hand, too heterogeneous agents may cause a stationary market, which likewise does not reflect real-world behaviour.

The fourth design issue considers the way agents learn and evolve their trading strategies over time. For instance, one may start off with naive agents that rely on simple trading rules. During the market process, the agents learn and may develop advanced trading strategies.

7.1 The decision making process.

The decision making schemes of the agents may either have the same structure or may differ somewhat within the total population. This leads to so-called homogeneous and heterogeneous decision making schemes.

The multi-agent model of Gode and Sunder (1993) is probably one of the simplest examples of *homogeneous* decision making processes. The decision making of the 'zero-intelligence' traders is completely random. Each agent draws his buying and selling decisions from a random distribution over a predefined range. Another example of agents with homogeneous decision making schemes can be found in Levy et al. (1994). Here, all agents are endowed with the same structural type of utility function and rely on identical decision making schemes. This design assumes that all agents have constant absolute risk aversion preferences. A more sophisticated example of homogeneous decision making processes is given in the Santa Fe artificial stock market. Here, each agent is basically composed of a set of forecasting rules.

The most common way of modelling *heterogeneous* decision making schemes is to introduce specific types of agents within the population. Each type is characterized by a different decision making process or trading strategy. Examples of heterogeneous decision making schemes can be found in Bak et al. (1996), Chiarella et al. (2001), Steiglitz (1997), Farmer (1998), or Lux (1998).

Most of these papers introduce two types *of* agents: chartists and fundamentalists. The decision making of these agent types is different. While chartists only concern historical price patterns and related technical indicators, fundamentalists compare the actual market price to an expectation of the underlying fundamental value in order to come to a decision.

Remarkably, the size of the sub-population can either be fixed or may change over time. Fixed sub-populations are used in Farmer (1998), whereas Lux (1998) allow the agents to switch between the different trading strategies. Note, that different structural design of the agents' decision making schemes are also an important source of heterogeneity.

As far as the concrete design of the agents' decision making schemes is concerned, the principal task of an economic agent is to process information and convert this into buying and selling decisions. A simple decision making process typically incorporates three stages: the processing of information; the formulation of a superposition of information; the generation of a trading decision on the latter basis.

There are two major groups of agents with respect to the decision making process.

The so-called 'rule-based' agents decide the actions directly from their information set. The decision making process can be represented by a single trading rule or, alternatively, by a system of trading rules.

The 'forecasting' agents use their information set to forecast a variable which is then processed by exogenous rules. A forecast method is incorporated in the multi-agent model. During the decision making process, trading decisions are derived from forecasts.

7.2 Rule-based models

The trading rules can be classified according to the sort of input information. Typically, one distinguishes between 'technical' and 'fundamental' input information.

Strategies that rely on historical price patterns are called technical trading rules. A common example of a technical trading rule is a trend following strategy, which tries to identify market trends. Remarkably, the long and short positions of a trend following agent show a positive correlation with the most recent market price changes.

In contrast to technical rules, fundamental (or so-called 'value') strategies are based on external information leading to a subjective assessment of the long term fundamental value. The estimation of the fundamental value is typically based on fundamental data like earnings or dividend prospects. The underlying assumption of a fundamental trading rule is that the market price has a specific tendency to revert to the fundamental value. Value investors compare the fundamental value to the actual market price. If the fundamental value is lower (higher) than the market price, value investors take a long (short) position. For simplicity, some multi-agent models assume that the fundamental value is exogenously given. Changes in the fundamental value are introduced by a random noise term.

Within the class of rule-based agents one can distinguish between static and dynamic rule sets. Agents relying on static rules cannot adapt their trading strategies to changing market situations, i.e. the rules are fixed over time. An example of rule-based agents incorporating static rules is the model of Gode and Sunder (1993).

By contrary, agents incorporating dynamic rules are able to modify their rules in order to adapt themselves to changing market conditions. In this case, the dynamic rule set is typically evolved by a form of revolutionary learning. Agents who are endowed with a set of dynamic trading rules can be found in the Santa Fe artificial stock market. The agents in the Santa Fe artificial stock market refer to a set of dynamic trading rules. Each trading rule fits to a specific market situation, i.e. the trading rules which are activated in a trend market are different from those designed for a steady market. The agents try to identify the actual state of the market by analyzing a set of fundamental and technical indicators. The market evaluation leads to the activation of a specific trading rule, which matches the identified market situation. The activated trading rule is directly used to derive the trading decision of the agent. Since the activation of a particular trading rule depends on the condition of the market, these agents are called 'condition action' agents. In an extended version of the Santa Fe artificial stock market the rules are used to *predict* the future return and dividend of the traded asset. The resulting forecasts are evaluated by a risk aversion analysis. These agents are referred to as 'condition forecasting' agents. The trading rule sets are evolved on the basis of genetic algorithms. The performance of the rules is used as a fitness criterion. Superior trading rules have a higher weighting (fitness) than unprofitable rules. Inefficient trading rules are replaced by new rules, which are explored by the genetic algorithm using mutation and crossover operators. Initially, the agents are equipped with little rationality and specialized knowledge about the market. During the market process, the agents learn and thus, become reasonable experts in their domains.

A benefit of simple rule-based agents is that this method can lead to very tractable precise results, which gives insights about the interactions between trading rules. Probably the most important disadvantage of rule based agent modelling is that if an important trading strategy is left out, the interaction of the present strategies may not reflect the dynamics of real-world financial markets. Even if the agents are allowed to explore new rules or to adapt each others behaviour, it is not ensured that missing strategies are discovered by the agents themselves. Another disadvantage of rule based agents is that the decision making is typically not guided by an objective function. Hence, one cannot measure the performance of the agents in terms of their own subjective information processing. Furthermore, without an objective function, the agents may not consider tradeoffs between different investment alternatives or different investment goals. Such tradeoffs are typically incorporated into the agents' decision making by utility concepts or related objective functions.

7.3 Forecasting models

Another way of modelling the agents' decision making is to incorporate a specific forecast model into the decision scheme. The resulting decision scheme typically consists of two steps: first, the agent predicts the future development of the market price; afterwards, the forecast is processed by an additional decision rule or objective function. In this case, one can speak of a 'forecasting' agent.

The major difference between rule-based and forecasting agents is that the former deduce their trading activities *directly* from the input information, while the latter use the input signals to construct a forecast model. The resulting forecast is then evaluated by an additional decision rule or objective function. In other words, forecasting agents deduce their trading decisions *indirectly* from the input data by the construction of a forecast, which is afterwards evaluated by an additional decision rule.

Within the category of forecasting agents, one may distinguish between agents referring to econometric forecast techniques and agents who are modelled by cognitive system based approaches. As a major difference between these sub-categories, cognitive system based agents are modelled by semantic specifications instead of being limited to the assumption of ad-hoc functional relationships. In other words, the cognitive process of an agent is either explicitly modelled or implicitly represented by an econometric forecast model and a related decision rule.

As far as agents relying on econometric forecast techniques are concerned, various methods from the field of time series processing can be applied. For instance, one may refer to simple or multiple regression analysis, nonlinear regression, neural networks or (G)ARCH processes.

7.4 Objective functions

An issue closely connected with the modelling of the agents' decision making processes is the design of an appropriate objective function.

The relationship between the decision making process and the objective function is especially obvious in case of forecasting agents.. Already mentioned, the decision scheme of a forecasting agent incorporates two stages. First, the agent forms an expectation about the future market development. Afterwards, the prediction is evaluated by a specific objective function or decision rule. The objective function is therefore an integral part of the agent's decision making scheme. Since the decisions are always deduced from the objective function, the trading activities of a forecasting agent are always goal oriented.

One may distinguish between two major categories of objective functions frequently used in multi-agent modelling.

The first category refers to objective functions which are explicitly incorporated into the decision making of an agent. This means, that the agent has a well defined objective function which is directly included in his decision making process. Explicitly formulated objective functions can mainly be found in the decision making schemes of forecasting agents.

The second category contains decision making schemes that only implicitly reflect the objectives of the agents. In other words, the objectives of an agent are only indirectly incorporated into his decision making scheme. Such representations are mainly associated with rule-based agents, who adapt real-world trading strategies. For instance, the chartists in the model of Farmer (1998) incorporate a single technical rule that aims to identify market trends. Although these agents have no explicitly formulated objective function, the underlying assumption of the trading strategy is to participate from market trends in order to maximize the trading profit.

Explicit as well as implicit objective functions can be subdivided into expected profit and utility maximization tasks. Typically, multi-agent models incorporate utility functions that only depend on the wealth of the agents, i.e. the total value of their investment portfolio.

8. Routes to chaos and numerical analysis in nonlinear dynamics

So long as nonlinear dynamic models are considered, obtaining explicit analytic expressions for periodic and chaotic solutions is, in general, complicated or even impossible. Therefore, in applied nonlinear dynamics it is common practice to use a mixture of theoretical and numerical methods to analyze the dynamics.

A general strategy for analyzing a nonlinear dynamical system starts with a stability analysis of the steady states. In particular, a comparative static analysis of how a steady state becomes unstable as a model parameter is varied can reveal primary bifurcations in a possible route to complicated dynamics. A bifurcation is a qualitative change in the dynamics, for example concerning the existence or stability of a steady state or a cycle. The way in which the eigenvalues of the corresponding jacobian matrix at the steady state cross the unit circle as a parameter changes, characterizes the type of bifurcation that will occur. At the bifurcation value, three generic cases arise:

- an eigenvalue $\lambda = 1$: a saddle-node bifurcation in which a pair of steady states, one stable and one saddle, is created; or a pitchfork bifurcation in which two additional steady states are created.

- an eigenvalue $\lambda = -1$: a period doubling or flip bifurcation, in which a 2-cycle is created

- a pair of complex eigenvalues on the unit circle: a Hopf or Neimark-Sacker bifurcation, in which an invariant circle with periodic or quasi-periodic dynamics is created.

The stability of cycles created in these bifurcations depends upon higher-order derivatives at the steady state. In order to investigate this stability, in higher-dimensional systems one has to use a so-called centre manifold reduction and compute the corresponding normal form of the bifurcation.

Using local bifurcation theory allows detecting the primary and the secondary bifurcations in the routes to complexity in asset price fluctuations. In addition, phase diagrams, bifurcation diagrams, computation of Lyapunov exponents and fractal dimension are useful numerical tools when intending to prove the occurrence of strange, chaotic attractors. Lyapunov characteristic exponents measure the average rate of divergence (or convergence) of nearby initial states, along an attractor in several directions. Attractors may be characterized by their Lyapunov spectrum. For a stable steady state or a stable cycle, all Lyapunov characteristic exponents are negative. For a quasi-periodic attractor which is topologically equivalent to a circle, the largest Lyapunov characteristic exponent is $\lambda_1 = 0$, whereas all other Lyapunov exponents are negative. An attractor is called a strange or a chaotic attractor, if the corresponding largest Lyapunov exponent is $\lambda_1 > 0$, implying sensitive dependence upon initial conditions. Nearby initial states converging to the strange attractor typically diverge at an exponential rate λ_1.

The notion of strange attractor refers to the fractal geometric structure of attractors exhibiting sensitive dependence. The fractal dimension can be used for quantifying this complicated geometric structure.

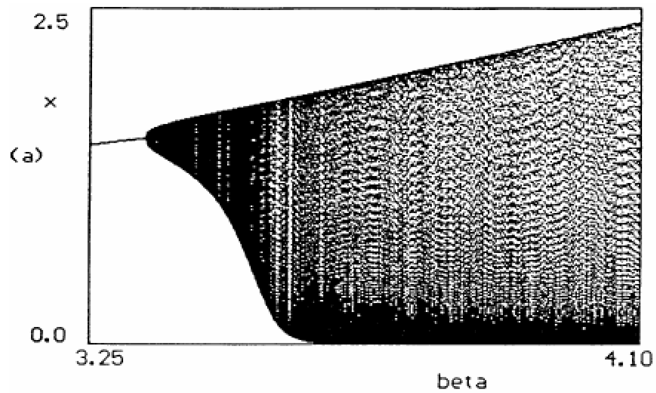

Figure 2: Bifurcation diagram, with periodic and quasi-periodic dynamics

(Brock and Hommes, 1998)

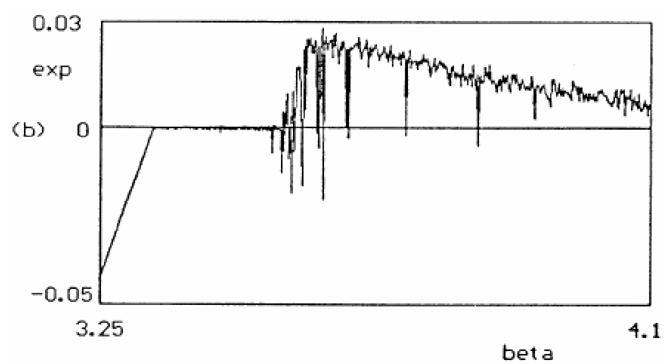

Figure 3: The largest Lyapunov characteristic exponent

(Brock and Hommes, 1998)

9. Neural network based agents

The most important characteristic of neural networks is their capability of being universal approximators. They allow modelling nonlinear characteristics and are able of fitting a wide range of forecast structures. Agents can build a price forecast at time t, $E_t p_{t+1,j}$, using a network training with several inputs including several lagged prices, and trade prices averaged over all agents from earlier periods. Agents can be randomly matched and trade occurs when agent pairs have different expected future prices. They then split the difference and trade at the price in between their two expected values.

Both feedforward and recurrent neural networks can be used for multi-agent modelling, depending upon the dynamic behaviour of the market.

In the model of Beltratti et al. (1996), the agents use feedforward neural networks to predict upcoming stock price movements. Basically, the authors introduce two kinds of market participants: smart and naive agents. Smart agents predict stock price movements on the basis of 3-layer feedforward neural networks with four input signals. Inputs to the 3-layer networks are the most recent market prices π_{t-1}, π_{t-2} and the former transaction prices $P_{ij,t-1}$, $P_{ij,t-2}$. In contrast, the forecast models of naive agents are simplified: Naive agents only rely on the most recent market price π_{t-} in order to forecast the future development of the stock price. The underlying neural network architecture consists only of a single input neuron containing the most recent market price and one output neuron computing the price forecast.

A multi-agent model based on recurrent neural networks is presented in Yang (1999). The Yang's model includes three types of agents, value traders, momentum traders, and noise traders. The agents place there funds either in a risky stock paying a stochastic dividend or in a riskless bond. Value investors believe that the actual stock price reflects the discounted stream of all future dividends. Momentum traders and noise traders are technicians who only consider historical price patterns. While momentum and noise traders are modelled as rule-based agents who refer to technical trading rules, value traders form their expectations on the basis of Elman's recurrent neural networks. These recurrent neural networks incorporate so-called context units, which feed the information of previous activation values back into to the network. More precisely, value investors use recurrent neural networks to predict the dividend growth of the risky asset. Afterwards, the market price of the risky asset is estimated on the basis of the dividend growth by using Gordon's constant dividend growth model.

Another neural network based approach can be found in LeBaron (2001). In this artificial stock market, the agents invest their funds either in a riskless bond or in a risky asset paying a stochastic dividend. As a specialty, the agents have different decision making horizons: Some agents are long-term investors while others rely on short-term planning horizons. According to their planning horizon, the agents choose from a broad spectrum of forecast models that are fitted to historical data. Forecast models and agents are therefore separated. Each forecast model is composed of a simple feed-forward network incorporating one hidden neuron and a limited number of input signals. The input signals consist of technical and fundamental indicators. The neural networks are evolved by using a genetic algorithm.

As it can be seen from these examples, the decision making schemes of econometric agents do not incorporate semantic specifications of the underlying cognitive processes in terms of e.g. perception, internal processing and action. In other words, the econometric forecast models of the agents merely assume ad-hoc functional relationships between the input signals and the target values.

10. Cognitive systems, learning and evolution

Cognitive system based agent models are an approach of capturing the semantic specifications of the agents' decision schemes in a structural framework. More precisely, the decision making of an agent is modelled by a basic cognitive system. The cognitive system incorporates three properties: perception, internal processing and action. These properties constitute necessary conditions for a cognitive system and may include various other features. As a structural representation of such a cognitive system, one may refer to time-delay recurrent neural networks. The cognitive process generates not only expectations of the market price, but also concrete trading decisions. Since a cognitive agent has a specific objective function (e.g. utility maximization), the resulting actions are always goal-oriented. As it can be seen from this outline, the buying and selling decisions of a cognitive agent are *not* deduced from a specific econometric forecast model which only presumes an ad-hoc functional relationship between external influences and the market development. Rather, the decisions of the agent are formulated in terms of the underlying cognitive system. This is truly a more realistic approach of modelling the agents' behaviour.

Heterogeneous behaviour may also originate from the learning and evolution of the agents.

Multi-agent models that refer this source of heterogeneity typically incorporate agents who are endowed with set of dynamic trading rules. The rule sets are evolved by genetic algorithms. In such a model, agents are very homogeneous at the start in their abilities and strategy structures. During the market process, the agents learn and develop more sophisticated trading strategies. In other words, differences in behaviour and strategy evolve endogenously as the market runs, and thus agent heterogeneity becomes a changing feature of the market. Examples including genetic algorithms as a source of heterogeneity are given in De la Maza and Yuret (1995), LeBaron (2001) or the Santa Fe artificial stock market.

Besides genetic algorithms, one may also refer to gradient based learning techniques in order to generate heterogeneous decision behaviour. First, the agents may simply differ in their underlying learning techniques. Different ways of learning should lead to heterogeneous agents.

Even if the applied learning mechanism is the same for all agents, heterogeneous decision behaviour may arise. In this case, the agents are endowed with different learning parameters. An example of such an approach can be found in the model of Beltratti et al. (1996). The stock market is populated with smart and naive agents. Both agent types learn with standard error backpropagation. However, the learning behaviour of smart and naive agents is different. Smart agents can learn faster than naive ones, because they use more effective parameters for the learning.

An interesting question is how the agents evolve their trading strategies, adapt to changing market conditions and learn how to improve their behaviour. Already mentioned, learning is also an important source of heterogeneous decision behaviour. Generally speaking, 'learning' or 'adaptive behaviour' means that the agents are able to modify parts of their decision making schemes in a specific manner. By this, the agents adapt their behaviour to changing market conditions.

The learning and adaptive behaviour has different purposes. For example, rule-based agents may either develop completely new trading strategies or change a few parameters of already existing ones. Another possibility is that rule-based agents switch between different trading strategies as the market evolves. This corresponds to contagious decision making or so-called herding behaviour. Moreover, forecasting agents learn by fitting the free parameters of their forecast models to historical data. During the learning, the agents generate a structural hypothesis of the underlying market dynamics, i.e. they try to identify invariant structures out of varying time series. The generated structures allow the agents to predict the future development of the market price.

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4. THE POTENTIAL OF SOFT COMPUTING METHODS TO CAPTURE NONLINEAR CHARACTERISTICS WHEN MODELING ECONOMIC PROCESSES

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Abstract

1. Introduction

Modelling, optimizing, controlling and stabilizing nonlinear or time-varying economic processes are challenging due to various reasons: the lack of an ex-ante specification of model's structure, high noise levels, non-stationarities induced by structural changes over time, fluctuations and shocks, nonlinear effects of either underlying dynamics or complex human behaviour, and so on. This paper focuses on various soft computing methods that can be successfully applied in economic and financial area when dealing with nonlinear modelling and control.

Soft Computing was originally defined by Zadeh (1994) as a revolutionary computing paradigm whose guiding principle is "... to exploit the tolerance for imprecision, uncertainty and partial truth in order to achieve tractability, robustness, low solution cost and better rapport with reality". According to Zadeh, the main constituents of Soft Computing are Fuzzy Logics, Neuro-Computing, Evolutionary-Computing and Probabilistic Computing, as well as some hybrid approaches (Neuro-Fuzzy, Fuzzy-Genetic, Neuro-Genetic) emerging from the basic ones. An important characteristic of SC is its intrinsic capability to create hybrid systems that allow deriving synergic effects from its components. The advantage of integrating such technologies is to provide mixed reasoning and searching methods for

extracting domain knowledge from empirical data, as well as the opportunity to develop flexible computing tools to solve complex problems.

The potential of soft computing based methods to deal with nonlinear process modeling and control derives from their capability to be universal approximators (i.e., to estimate almost any computable function on a compact set, provided that enough experimental data and enough computing resources are available). Such a natural propensity for supervised learning is most often employed in practical applications.

There is an enormous field of potential applications that soft computing based methods surround in economic and financial area: predicting stock returns and simulation of trading strategies, time series processing for financial and economic forecasting, credit authorization screening, project management and bidding strategy, risk rating of exchange-traded, fixed income investments, prediction of default and bankruptcy, pricing initial public offerings, determining optimal capital structure, flexible estimation of cost functions, and so on.

2. Soft computing modelling versus econometric modelling

The ex ante specification of functional form in nonlinear econometric model building is challenging when the true functional form is unknown. Econometricians considered several relevant criteria for the selection of functional forms: theoretical consistency, domain of applicability, flexibility, computational facility and factual conformity. A large research effort has focussed particularly on the concept of flexibility. The parametric estimation approach (especially guided to provide a sufficiently flexible specification of functional forms) was the classical way to face this challenge. Various so-called "flexible functional forms" were proposed for modelling producer behaviour: TRANSLOG is the most popular one. In contrast, soft computing provides versatile techniques of estimation: instead of dealing with difficult problems as the ex ante specification of functional forms, it allows more tractable solutions: choosing fuzzy partitions and tuning the shape of membership functions, specifying the neural network architecture, etc. Furthermore, the predictive power of such methods is considerably greater when comparing with parametric estimation methods.

3. Time series processing based on soft computing methods

Using soft computing in time series processing is tolerant to nonlinear underlying dynamics, high noise level and do not have to assume stationarity. Neural networks offer a straightforward extension to the classical way of modelling time series. Feedforward networks can use a specific mechanism to deal with temporal information (layer delay without feedback or time window) and can thus extend the linear autoregressive model with exogenous variables (ARX) to the nonlinear ARX form (NARX): $y_t = F^{NN}\left(y_{t-1}, \ldots, y_{t-p},\ u_{t-\tau}, \ldots, u_{t-\tau-m}\right) + \varepsilon_t$, *where* F^{NN} *is a non-linear function (with* NN *being either* MLP *or* RBF*). For other types of models used in time series processing that involve predictors with feedback, one can resort to recurrent networks, where future network inputs will depend on present and past network outputs. A special case of recurrent network that could be used to identify nonlinear ARMAX models is the Jordan network. It consists of a multilayer perceptron with one hidden layer and a feedback loop from the output layer to an additional input (or context) layer. In addition, self-recurrent loops on each unit in the context layer may be introduced. Another type of recurrent network that has been proved to be useful for identification of state space models is the Elman network. It consists of an MLP with an additional input layer, called the state layer, receiving as feedback a copy of the activation from the hidden layer at the previous step. Backpropagation through time (Werbos, 1990) and Time Delay Neural Networks (Lang, Waibel and Hinton, 1990) are some other examples of recurrent neural networks.*

4. Applying soft computing methodology to technical analysis

Predicting price levels is an intriguing, challenging, and admittedly risky endeavour. Under the efficient market hypothesis (EMH) prices should instantly and correctly adjust to reflect all the information available. This means that given the information, no prediction of future changes in the price can be made (or, as Maurice Kendall suggested, the stock returns follow a "random walk"). Despite the traditionally massive support for EMH, there is a majority of market actors believing that they can predict the prices in a way that can make them profit. Technical analysis uses trend following strategies based on *the assertion that price changes have inertia. It involves using past stock prices, volume, and other related data to forecast future price movements and to infer trading decision rules that specify when to buy or sell an investment. A set of such rules or conditions is referred to as an entry/exit system, or a trading system. Upon applying an entry/exit system to a set of data, an entry/exit signal (also called buy/sell signal or trading signal) is generated. Entry/exit signals are indications of the best time to buy or sell a stock based on one or more factors in the market. A trading system should have trading rules that allow the investors to profit from both the cases when prices increase or decrease.*

Neural networks used in conjunction with genetic algorithms have recently provided empirical evidence to be the most efficient tool for technical analysis, especially due to their ability of representing non-linear relationships and to their ability of learning these relationships from the data being modelled. A neural network can be used to generate entry/exit signals directly, or its outputs can be processed by an entry/exit system to produce entry/exit signals. Once the entry/exit system begins to break down, the neural network can improve its performance by re-training on the new collected data. Genetic algorithms can be combined with neural networks to enhance their performance by finding optimal neural network settings or to be used for post-processing optimization.

5. Using fuzzy control techniques for stabilizing economic processes

Various techniques have been used to control or stabilize economic processes: from econometric models based on rational expectations (assuming that shifts in economic policy produce revised expectations of rational agents), to regulatory mechanisms, normally regarded as engineering tools. However, applying nonconventional techniques, such as fuzzy control, provides more flexible and reliable alternatives than the conventional way. The interest in applying fuzzy control to economic processes consists of at least two advantages: on the one hand in prescribing control actions by linguistic descriptions and on the other hand in the capability of transition from linear to nonlinear modes of control, conjugated with fine-tuning procedures. We can benefit from such nonlinear capabilities when designing a fuzzy control strategy to stabilize an economic process, by choosing different shapes of the membership functions, different implication functions, different T-norms and T-conorms to model the logical connectives used in the antecedent of various rules and by scaling the inputs in order to fully exploit the range of universe of discourse. As an application of fuzzy control to economic processes, we provide a fuzzy extension of the Phillips' stabilization model in two variants: for a closed economy (where a fuzzy PID-like controller is implemented) as well as for an open economy (where a fuzzy state-feedback controller is implemented).

1. Introduction

Modelling, optimizing, controlling and stabilizing nonlinear or time-varying economic processes are challenging due to various reasons: the lack of an ex-ante specification of model's structure, high noise levels, non-stationarities induced by structural changes over time, fluctuations and shocks, nonlinear effects of either underlying dynamics or complex human behaviour, and so on. This paper focuses on various soft computing methods that can be successfully applied in economic and financial area when dealing with nonlinear modelling and control.

Soft Computing was originally defined by Zadeh (1994) as a revolutionary computing paradigm whose guiding principle is "... to exploit the tolerance for imprecision, uncertainty and partial truth in order to achieve tractability, robustness, low solution cost and better rapport with reality". According to Zadeh, the main constituents of Soft Computing are Fuzzy Logics, Neuro-Computing, Evolutionary-Computing and Probabilistic Computing, as well as some hybrid approaches (Neuro-Fuzzy, Fuzzy-Genetic, Neuro-Genetic) emerging from the basic ones. An important characteristic of SC is its intrinsic capability to create hybrid systems that allow deriving synergic effects from its components. The advantage of integrating such technologies is to provide mixed reasoning and searching methods for extracting domain knowledge from empirical data, as well as the opportunity to develop flexible computing tools to solve complex problems.

The potential of soft computing based methods to deal with nonlinear process modelling and control derives from their capability to be universal approximators (i.e., to estimate almost any computable function on a compact set, provided that enough experimental data and enough computing resources are available). Such a natural propensity for supervised learning is most often employed in practical applications.

There is an enormous field of potential applications that soft computing based methods surround in economic and financial area: predicting stock returns and simulation of trading strategies, time series processing for financial and economic forecasting, credit authorization screening, project management and bidding strategy, risk rating of exchange-traded, fixed income investments, prediction of default and bankruptcy, pricing initial public offerings, determining optimal capital structure, flexible estimation of cost functions, and so on.

2. Soft computing modelling versus econometric modelling

The ex ante specification of functional form in nonlinear econometric model building is challenging when the true functional form is unknown. Econometricians considered several relevant criteria for the selection of functional forms: theoretical consistency, domain of applicability, flexibility, computational facility and factual conformity. A large research effort has focused particularly on the concept of *flexibility*. The *parametric estimation* approach (especially guided to provide a sufficiently flexible specification of functional forms) was the classical way to face this challenge. Various so-called "flexible functional forms" were proposed for modelling producer behaviour: TRANSLOG is the most popular one. In contrast, soft computing provides versatile techniques of estimation: instead of dealing with difficult problems as the ex ante specification of functional forms, it allows more tractable solutions: choosing fuzzy partitions and tuning the shape of membership functions, specifying the neural network architecture, etc. Furthermore, the predictive power of such methods is considerably greater when comparing with parametric estimation methods.

To facilitate the comparison, let us consider a famous model due to Christensen & Greene (1976), where the total cost of steam generation is defined as a function of the level of output q and a vector p of three factor prices: capital (p_k), fuel (p_f) and labour (p_ℓ). A stochastic specification of the model in a TRANSLOG form is given by the equations of factor shares and cost function:

$$v = \alpha_p + B_{pp} \cdot \ln p + \beta_{pq} \cdot \ln q + \varepsilon_v$$

$$\ln C = \alpha_0 + \alpha_q \cdot \ln p + \alpha'_p \cdot \ln p + \frac{1}{2} \cdot \ln p' \cdot B_{pp} \cdot \ln p + \ln p' \cdot \beta_{pq} \cdot \ln q + \frac{1}{2} \cdot \beta_{qq} \cdot (\ln q)^2 + \varepsilon_c$$

We used a FGLS (Feasible Generalized Least Squares) estimation procedure to compute the TRANSLOG estimates. Alternatively, two soft computing methods were applied to the same dataset: a feedforward neural network based method (implementing a Levenberg-Marquardt training algorithm) and a neuro-fuzzy method (ANFIS). For measuring the accuracy of forecasts we computed the root mean squared error (RMSE). The table below confirms that the soft computing methods produce more accurate results:

Table 1

	TRANSLOG	NN (Levenberg-Marquardt)	ANFIS
RMSE	1.3868	0.8792	0.3545

The goodness of fit (almost perfect in case of ANFIS) can be also compared graphically.

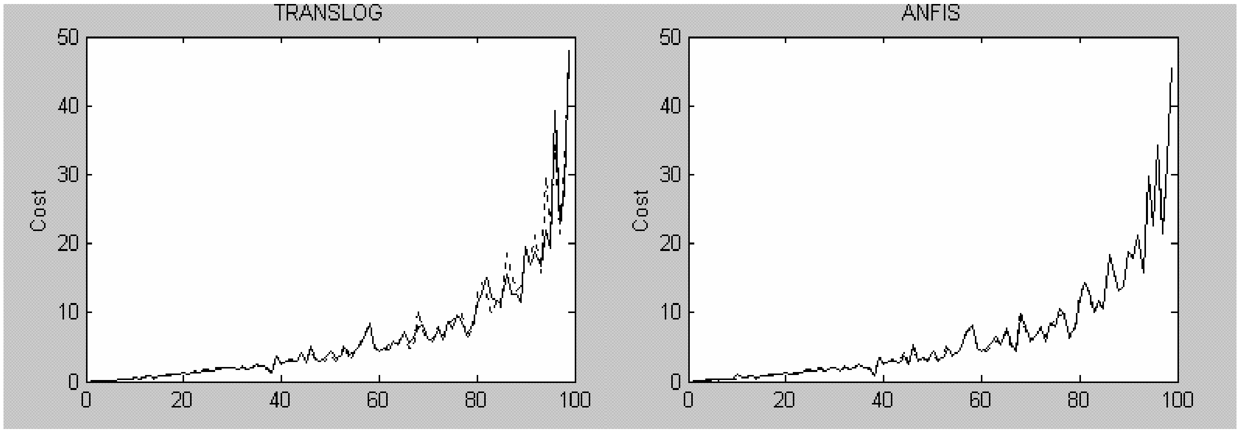


Figure 1: Goodness of fit in case of using TRANSLOG and ANFIS, respectively.

3. Time series processing based on soft computing methods

Using soft computing in time series processing is tolerant to nonlinear underlying dynamics, high noise level and do not have to assume stationarity. Both feedforward and recurrent neural networks offer a straightforward extension to the classical way of modelling time series.

One of the easiest way is to equip *feedforward networks* with a mechanism to deal with temporal information (layer delay without feedback or time window), which can thus extend the linear autoregressive model with exogenous variables (ARX) to the *nonlinear ARX* form (*NARX*):

$$y_t = F^{NN}\left(y_{t-1}, \ldots, y_{t-p},\ u_{t-\tau}, \ldots, u_{t-\tau-m}\right) + \varepsilon_t$$

where F^{NN} is a non-linear function. Capturing nonlinear characteristics of time series is based on the capability of either MLPs (*multilayer perceptrons*, with hidden units having sigmoidal transfer functions) or RBFNs, (*radial basis function networks*, with hidden units using a distance propagation rule and a Gaussian transfer function) to be universal function approximators. This means that they can approximate any computable function on a compact set arbitrarily closely by

$$\hat{y}_i(v, w) = F^{MLP}(z) = \left(\sum_{j=1}^{q} v_{ij} \cdot \sigma_j \left(\sum_{\ell=1}^{m} w_{j\ell} \cdot z_\ell + w_{j0} \right) + v_{i0} \right), \quad i = 1, \ldots, n$$

where σ is a sigmoidal function, q is the number of hidden units, v_{ij} and $w_{j\ell}$ are weights, v_{i0} and w_{j0} are biases (thresholds) – or by

$$\hat{y}_i(v, w) = F^{RBF}(z) = \left(\sum_{j=1}^{q} v_{ij} \cdot \Gamma_j \left(\sum_{\ell=1}^{m} \left(w_{j\ell} - z_\ell \right)^2 + w_{j0} \right) + v_{i0} \right), \quad i = 1, \ldots, n$$

where Γ is a Gaussian function, provided that q is sufficiently large.

For other types of models used in time series processing that involve predictors with feedback, one can resort to *recurrent networks*, where future network inputs will depend on present and past network outputs. A special case of recurrent network that could be used to identify *nonlinear ARMAX models* is the *Jordan network*. It consists of a multilayer perceptron with one hidden layer and a feedback loop from the output layer to an additional input (or context) layer. In addition, self-recurrent loops on each unit in the context layer may be introduced. Another type of recurrent network that has been proved to be useful for identification of *state space models* is the *Elman network*. It consists of an MLP with an additional input layer, called the state layer, receiving as feedback a copy of the activation from the hidden layer at the previous step. *Backpropagation through time* (Werbos, 1990) and *Time Delay Neural Networks* (Lang, Waibel and Hinton, 1990) are some other examples of recurrent neural networks.

4. Applying soft computing methodology to technical analysis

Predicting price levels is an intriguing, challenging, and admittedly risky endeavour. Under the *efficient market hypothesis* (EMH) prices should instantly and correctly adjust to reflect all the information available. This means that given the information, no prediction of future changes in the price can be made (or, as Maurice Kendall suggested, the stock returns follow a "random walk"). Despite the traditionally massive support for EMH, there is a majority of market actors believing that they can predict the prices in a way that can make them profit. While the predictability of prices is assumed, finding methods that improve the predictive power of models becomes crucial. The decision rules that such models incorporate rely on either technical or fundamental analysis of past information.

Technical analysis uses trend following strategies based on the assertion that price changes have inertia. It involves using past stock prices, volume, and other related data to forecast future price movements and to infer trading decision rules that specify when to buy or sell an investment. A set of such rules or conditions is referred to as an *entry/exit system*, or a *trading system*. Upon applying an entry/exit system to a set of data, an *entry/exit signal* (also called *buy/sell signal* or *trading signal*) is generated. Entry/exit signals are indications of the best time to buy or sell a stock based on one or more factors in the market. A trading system should have trading rules that allow the investors to profit from both the cases when prices increase or decrease.

Neural networks used in conjunction with genetic algorithms have recently provided empirical evidence to be the most efficient tool for technical analysis, especially due to their ability of representing *non-linear relationships* and to their ability of learning these relationships from the data being modelled. A neural network can be used to generate entry/exit signals directly, or its outputs can be processed by an entry/exit system to produce entry/exit signals. Once the entry/exit system begins to break down, the neural network can improve its performance by re-training on the new collected data. Genetic algorithms can be combined with neural networks to enhance their performance by finding optimal neural network settings or to be used for post-processing optimization.

Neural networks and genetic algorithms can be used for technical analysis in a variety of ways. *First*, a neural network could be used to create a model for predicting the future price of a financial instrument, given the current and previous prices and other technical and/or fundamental data. The predicted price could then be used within an entry/exit system to produce a signal indicating when to buy or sell. Genetic algorithms could be used to optimize the neural network inputs and parameters in order to produce the best model possible. A *second method* would be to train a neural network to optimally predict an entry/exit signal using only current and historical data as inputs. Since the output of this type of neural model is an entry/exit signal, it can be used directly without the need for further processing by an entry/exit system. Again, genetic algorithms could be used to optimize the inputs and parameters to the neural network in addition to the entry/exit system thresholds. A *third method* could be to use a neural network to create a model for predicting the performance of a stock for a certain period into the future. For example, the inputs to the model could be the current price, the percent gain over the last week, the percent gain over the last month, etc. and the desired output could be the percent gain for the next week. As with the previous two methods for using neural networks, the networks inputs and parameters could be optimized using genetic algorithms.

5. Using fuzzy control techniques for stabilizing economic processes

Various techniques have been used to control or stabilize economic processes: from econometric models based on rational expectations (assuming that shifts in economic policy produce revised expectations of rational agents), to regulatory mechanisms, normally regarded as engineering tools. However, applying nonconventional techniques, such as fuzzy control, provides more flexible and reliable alternatives than the conventional way. The interest in applying fuzzy control to economic processes consists of at least two advantages: on the one hand in prescribing control actions by linguistic descriptions and on the other hand in the capability of transition from linear to nonlinear modes of control, conjugated with fine-tuning procedures. We can benefit from such nonlinear capabilities when designing a fuzzy control strategy to stabilize an economic process, by choosing different shapes of the membership functions, different implication functions, different T-norms and T-conorms to model the logical connectives used in the antecedent of various rules and by scaling the inputs in order to fully exploit the range of the universe of discourse. As an application of fuzzy control to economic processes, we provide a fuzzy extension of the Phillips' stabilization model in two variants: for a closed economy (where a fuzzy PID-like controller is implemented) as well as for an open economy (where a fuzzy state-feedback controller is implemented).

5.1. The fuzzy control algorithm

Consider the input space X as being a N_X-dimensional referential:

$$X = X_1 \times \cdots \times X_i \times \cdots \times X_{N_X}$$

where X_i is the universe of discourse of the input variable x_i.

For any i in $\{1, \ldots, N_X\}$, let us consider a fuzzy covering of the universe of discourse X_i:

$$\{A_{i,j}\}_{j=1,\ldots,m_i}$$

where $A_{i,j}$ are fuzzy sets. Normally, fuzzy partitions are addressed, that is, fuzzy coverings with the additional property:

$$\sum_{j=1}^{m_i} \mu_{A_{i,j}}(x_i') = 1, \quad \forall\, x_i' \in X_i$$

The rule base includes a set of N_r parallel fuzzy rules. Each fuzzy rule is an $if-then$ statement, where the antecedent and the consequent consist of fuzzy propositions. The antecedent contains a combination of propositions by means of the logical connectives and and or. Formally, we have:

r_k : **if** x_1 is $A_{1,k}$ **and** … **and** x_i is $A_{i,k}$ **and** … **and** x_{N_X} is $A_{N_X,k}$ **then** y is B_k

In practice, fuzzy control is applied using local inferences. This means that each rule is inferred and the results of the inferences of the individual rules are aggregated afterwards. According to this approach, the inference in fuzzy control is represented by the following steps:

1. Matching of fuzzy propositions x_i *is* $A_{i,k}$, used in the premises of fuzzy rules r_k, with the numerical data x_i' (controller inputs):

$$\alpha_{i,k} = \mu_{A_{i,k}}(x_i')$$

where $\alpha_{i,k}$ is a numerical value representing the matching.

2. Determining the degrees of fulfillment (DOF) β_k for each rule r_k:

$$\beta_k = \mathop{T}_{i=1}^{N_X} \alpha_{i,k}$$

where T is the T-norm representing the and connective in the premises of the rules. Normally, T is chosen to be either the *min* or the *product* operator.

3. Determining the result B_k' of each individual rule r_k:

$$\mu_{B_k'}(y) = I\left(\beta_k, \mu_{B_k}(y)\right)$$

where I is the implication used to model the fuzzy rule. This can be one of the suitable fuzzy implications. In fuzzy control, a conjunction-based fuzzy implication (also called T-implication) is normally used: either the *min* implication (introduced by Mamdani) or the *product* implication (introduced by Larsen).

4. Aggregation of the partial results B'_k of the individual fuzzy rules r_k into the overall result B' :

$$\mu_{B'}(y) = \bigcup_k \mu_{B'_k}(y)$$

5. Finally, a defuzzification method is needed to obtain a crisp output, starting from the aggregated fuzzy result B'. For example, we can use the center-of-gravity defuzzification method, which is defined by:

$$cog(B') = \frac{\int_Y \mu_{B'}(y) \cdot y \, dy}{\int_Y \mu_{B'}(y) \, dy}$$

Some discrete versions of this method are mostly used in fuzzy control.

The most common inference methods are the *max-min* method, the *max-product* method and the *sum-product* method, where the aggregation operator is denoted either by *max* or by *sum*, and the fuzzy implication operator is denoted either by *min* or by *prod*.

5.2. The linear controller as a subset of a fuzzy controller

The emulation of a linear controller can provide an initial fuzzy controller. The latter can be further used as a starting point to design a more complex fuzzy controller (a nonlinear one), by gradually modifying the initial choices for the shape of membership functions, logical operators, etc. Only numerical inputs are considered.

In the case of a linear controller the input-output mapping is considered as a linear algebraic equation:

$$y = \sum_{i=1}^{N_X} c_i \cdot x_i + d = c' \cdot x + d$$

where d is an offset. The fuzzy controller function $y = f(x)$ can emulate the linear controller $y = c' \cdot x + d$ when meeting the following assumptions:

A1. The membership functions of the fuzzy sets on the universe of discourse of the inputs are triangularly shaped and normal;

A2. The fuzzy sets for each input form a fuzzy partition:

$$\{A_{i,j}\}_{j=1,\ldots,m_i}; \quad \sum_{j=1}^{m_i} \mu_{A_{i,j}}(x'_i) = 1, \quad \forall\, x'_i \in X_i$$

A3. The fuzzy rule base is complete;

A4. A T-norm is used for the implication function (T-implication);

A5. The operator for the conjunction in the premises of the fuzzy rules is the *product* operator;

A6. The *(bounded) sum* operator is used for the aggregation and for the *or* connective if it is used;

A7. Crisp consequents for the individual fuzzy rules are considered and their choice is made in accordance with the linear controller equation $y = c' \cdot x + d$;

A8. The fuzzy-mean defuzzification method is used (this implies the choice for the aggregation operator in A6).

The assumptions A1 to A4 imply that there exists a fuzzy rule for every input combination. The assumptions A5 and A6 (using the *summation* and *product* operators instead of the *max* and *min* operators), are necessary because the emulation of linear controllers requires operators that result in linear interpolation. Actually, there are some reasons to prefer the *bounded sum*, which eliminates the occurrence of supernormal fuzzy sets and thus conforms to fuzzy set theory:

$$\mu_{B'}(y) = \min\left(\sum_k \beta_k \cdot \mu_{B_k}(y),\ 1\right)$$

The most important assumption to be met is A7, because, due to the rest of the assumptions, the output of a fuzzy controller with N_X inputs results in an interpolation between the consequences of at most 2^{N_X} active rules in a N_X-dimensional space. Indeed, if each fuzzy partition contains only normal and convex fuzzy sets, then at any value $x'_i \in X'_i$ there are no more than two consecutive overlapping fuzzy sets $A_{i,\ell}$ and $A_{i,\ell+1}$, such that:

$$\mu_{A_{i,\ell}}(x'_i) > 0 \quad \text{and} \quad \mu_{A_{i,\ell+1}}(x'_i) > 0$$

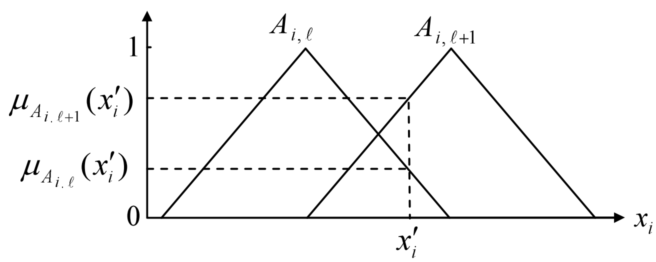


Figure 2. Crisp input matching two consecutive overlapping fuzzy sets of a fuzzy partition

The numerical consequences of the at most 2^{N_X} contributing fuzzy rules determine whether or not a linear relation by interpolating between these points (hyperplane), exists. When this hyperplane exists, the input-output mapping of the fuzzy system satisfies the linear equation $y = c' \cdot x + d$.

5.3. Emulating a PID controller by means of a linear fuzzy controller

An easy and often convenient way to start the design of a nonlinear fuzzy controller is to emulate a conventional PID (proportional-integral-derivative) controller by means of a linear fuzzy controller and to make it progressively nonlinear.

In the case of a conventional PID controller, the control variable $u(t)$ is defined in terms of deviations or errors $e(t)$ between a reference value y_{ref} and the process output $y(t)$ (i.e., $e(t) = y_{ref} - y(t)$):

$$u(t) = G_p \cdot e(t) + G_i \cdot \int_0^t e(\tau)\, d\tau + G_d \cdot \frac{de(t)}{dt}$$

where G_p, G_i and G_d are the proportional, integral and derivative gains, respectively.

When we are concerned with digital control, a discrete approximation of the previous relation is necessary. It can be obtained by replacing the derivative term with a backward difference and the integral with a sum using rectangular integration:

$$u_t = G_p \cdot e_t + G_i \cdot \sum_{\tau=1}^{t} e_\tau T_s + G_d \cdot \frac{e_t - e_{t-1}}{T_s} = G_p \cdot e_t + G_i \cdot ie_t + G_d \cdot ce_t$$

where T_s is the sampling period (in economic applications, T_s is normally assumed to be 1).

In order to emulate the conventional PID controller through a linear fuzzy controller, we have to replace the summation in PID control by a fuzzy rule base acting like a *summation*. The closed loop system should thus show exactly the same step response (this is a check that the implementation is correct).

Hence, a fuzzy PID (FPID) controller use variables as *error* e, *change of error* ce, and *integral error* ie in the antecedent of *if - then* rules and the *control* variable u (which may be replaced by *change of control* cu, when we have to deal with incremental control) in the consequent of rules.

A fuzzy controller based on Mandani-type fuzzy inferences would consist of rules having the form:

r_k : **if** (e is $A_{1,k}$) **and** (ce is $A_{2,k}$) **and** (ie is $A_{3,k}$) **then** (u is B_k)

A PID-like fuzzy controller based on Sugeno-type fuzzy inferences has rules of the form:

r_k : **if** (e is $A_{\ ,k}$) **and** (ce is $A_{\ ,k}$) **and** (ie is $A_{3,k}$) **then** $u = a_1 \cdot e + a_2 \cdot ce + a_3 \cdot ie$

We turn now to the representation of a fuzzy controller as an input-output mapping. In the general case it may result in a nonlinear shaped control hypersurface. When three inputs (e, ce, ie) and one output (u) are considered, this mapping becomes:

$$u = f(e, ce, ie)$$

However, the assumptions introduced in section 3 allow us to design a fuzzy rule base acting like a *summation* and resulting in a linear mapping:

$$u_t = Gp \cdot e_t + Gi \cdot ie_t + Gd \cdot ce_t$$

In conventional control, the gains are mainly used for tuning the response. In fuzzy control, scaling the inputs onto a standard universe of discourse it is also important and suggests to introduce one more parameter to deal with.

So, the next step in the design procedure is to transfer the three gains (Gp **,** Gi **and** Gd **) used in the conventional PID controller into four gains (say** FGp **,** FGi **,** FGd **and** FGu **that are necessary for tuning and scaling the FPID controller. The latter emulates the former if the following condition is met:**

$$u_t = Gp \cdot e_t + Gd \cdot ce_t + Gi \cdot ie_t = \left[FGp \cdot e_t + FGd \cdot ce_t + FGi \cdot ie_t \right] \cdot FGu =$$
$$= FGp \cdot FGu \cdot e_t + FGd \cdot FGu \cdot ce_t + FGi \cdot FGu \cdot ie_t$$

Comparing the gains of the FPID controller with the gains of the conventional PID controller, the following relations can be derived:

$$FGp \cdot FGu = Gp \quad \Rightarrow \quad FGu = \frac{1}{FGp} \cdot Gp$$

$$FGd \cdot FGu = Gd \quad \Rightarrow \quad FGd = FGp \cdot \frac{Gd}{Gp}$$

$$FGi \cdot FGu = Gi \quad \Rightarrow \quad FGi = FGp \cdot \frac{Gi}{Gp}$$

Let us now assume that the error is in the range $[-E, E]$ and for the fuzzy controller we set a standard input universe, say [-100, 100]. In such a case, we have:

$$e \in [-E, E] \quad \Rightarrow \quad FGp \cdot e \in [-FGp \cdot E, FGp \cdot E] = [-100, 100]$$

Thus, we can set:

$$FGp = \frac{100}{E}$$

The other gains are now fixed as follows:

$$FGu = \frac{E}{100} \cdot Gp\,; \qquad FGd = \frac{100}{E} \cdot \frac{Gd}{Gp}; \qquad FGi = \frac{100}{E} \cdot \frac{Gi}{Gp}$$

The conventional PID controller may be tuned using the Ziegler-Nichols frecquency response method, resulting in optimal values for the parameters Gp, Gi and Gd. Afterwards, we will obtain the equivalent FPID controller, deriving its parameters (FGp, FGi, FGd and FGu) from those of the PID one.

5.4. The Phillips' Stabilization Model for a Closed Economy and its Fuzzy Extension

The Phillips' model naturally assumes that the level of aggregate demand determines the level of national income. The former is made up of a part originating from private economic agents and of a part originating from the government. The stabilization policy consists of the adjustment of government expenditure in order to increase or decrease the aggregate demand, resulting in a desired level of the national income. Face to modifications induced in aggregate demand, the producers react by making some adjustments in output: if aggregate demand exceeds the current output, the latter will be increased; otherwise, it will be decreased.

The stabilization model is given by the equations:

$$\dot{Y}(t) = a \cdot \left(D(t) - Y(t)\right); \qquad a > 0 \qquad (1)$$

$$D(t) = (1-\ell) \cdot Y(t) + G(t) - v\,; \quad 0 < \ell < 1 \qquad (2)$$

$$\dot{G}(t) = b \cdot \left(G^*(t) - G(t)\right); \qquad b > 0 \qquad (3)$$

$G^*(t)$ - given in the form of a control policy (4)

where: $Y(t)$ is the national income; $D(t)$ is the aggregate demand; a is a reaction coefficient (representing the velocity of adjustment to a discrepancy between aggregate demand and current output); $(1-\ell)$ is the marginal propensity to spend (i.e. the marginal propensity to consume plus the marginal propensity to invest); v is an exogenous disturbance, indicating a decrease in aggregate demande; $G(t)$ is the actual government demand; $G^*(t)$ is the potential government demand, which stands for the stabilization policy; b is a reaction coefficient, indicating the speed of response to a discrepancy between potential and actual public expenditure.

A. Conventional (PID-like) modes of control

In order to simplify the analysis, the variables are measured in terms of deviation from their desired levels, so that a negative value simply means that the actual value is smaller than the desired value. Thus, we are led to consider the reference value Y_{ref} as being 0 and the error as being:

$$e(t) = Y_{\text{ref}} - Y(t) = -Y(t) \qquad (5)$$

Let us assume that national income is initially at the desired level and that an exogenous decrease in aggregate demand occurs.

The stabilization policy proposed by Phillips, was defined in terms of a proportional (P), or derivative (D), or integral (I) mode of control, or a combination of these three modes, that is in terms of a PID control policy. In the latter case, the relation defining the control variable takes the form:

$$u(t) = G^*(t) = G_p \cdot e(t) + G_i \cdot \int_0^t e(\tau)\, d\tau + G_d \cdot \frac{de(t)}{dt} \tag{6}$$

where G_p, G_i and G_d are the proportional, integral and derivative gains, respectively.

The Phillips' model can be manipulated in order to reduce it to a single equation. Finally we obtain:

$$\ddot{Y} + (a\ell + b)\dot{Y} + ab\ell\, Y - ab\, G^* = -\, ab\, v \tag{7}$$

When we consider one unit decrease $v = 1$ in aggregate demand, the differential equation of the model becomes:

$$\ddot{Y} + (a\ell + b)\dot{Y} + ab\ell\, Y - ab\, G^* = -\, ab \tag{8}$$

Inserting the various modes of control defining $u(t) = G^*(t)$ as is generically expressed by (6), we can determine the time path of national income.

The conventional PID control scheme for Phillips' stabilization model is shown in figure 3:

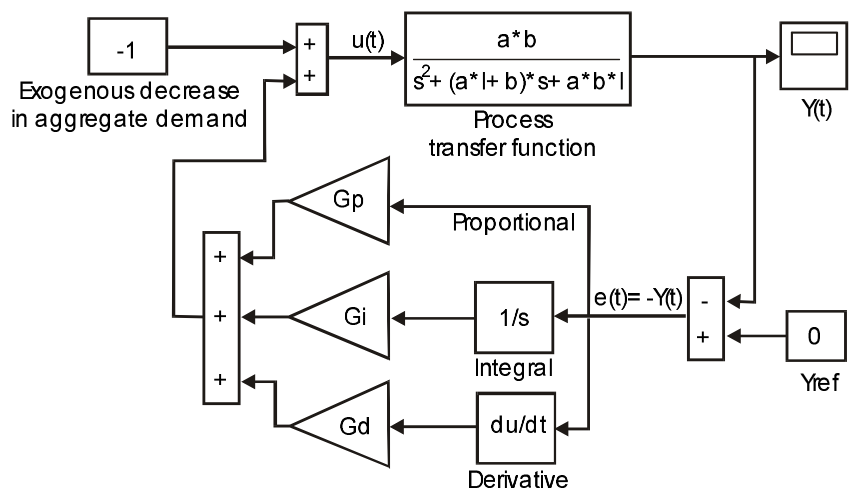
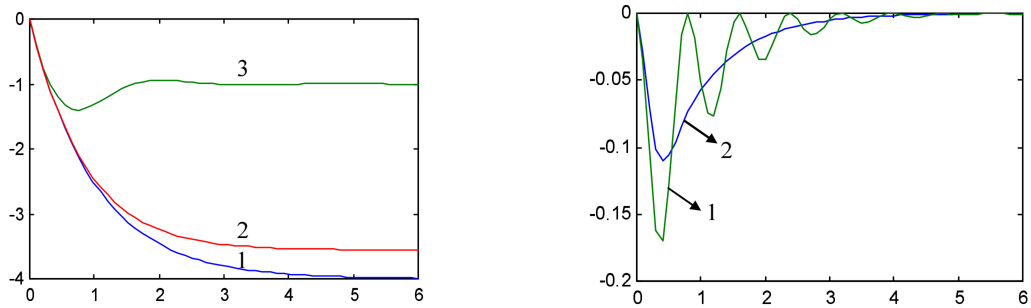


Figure 3. Control scheme for the classical Phillips' model

Let us assume the following parameters for the model described above: $a = 4$, $b = 2$, $\ell = 0.25$.

In figure 4.a., curve (1) depicts the time path of national income (measured in terms of deviation from its desired level), without any stabilization policy (there is a stationary error of -4). Curve (2) depicts the case where $G_p = \frac{(a\ell - b)^2}{4ab}$, indicating the frontier between a monotonic and an oscillatory behaviour. Curve (3) illustrates the case when a steady state solution of $y^* = -1$ is desired, involving $G_p = 1 - \ell = 0.75$. The time paths in figure 4.b. show that the effect of an integral policy is to obtain a null stationary error, while the effect of a derivative policy is to offset the oscillatory bias of other policies.



a. (1) $G_p = G_i = G_d = 0$; (2) $G_p = 1/32$; $G_i = G_d = 0$; (3) $G_p = 0.75$; $G_i = G_d = 0$

b. (1) $G_p = G_i = 8$; $G_d = 0$; (2) $G_p = G_i = 8$; $G_d = 1$

Figure 4. Time paths for specific choices of controller gains

B. The linear fuzzy controller emulating the PID-like Phillips' stabilization model

The design procedure of the FPID controller was exposed in detail in the previous sections. So, we are now in a position to represent the scheme of this fuzzy controller. It is shown in figure 5, where the input range $[-E, E]$ was fixed to $[-4, 4]$.

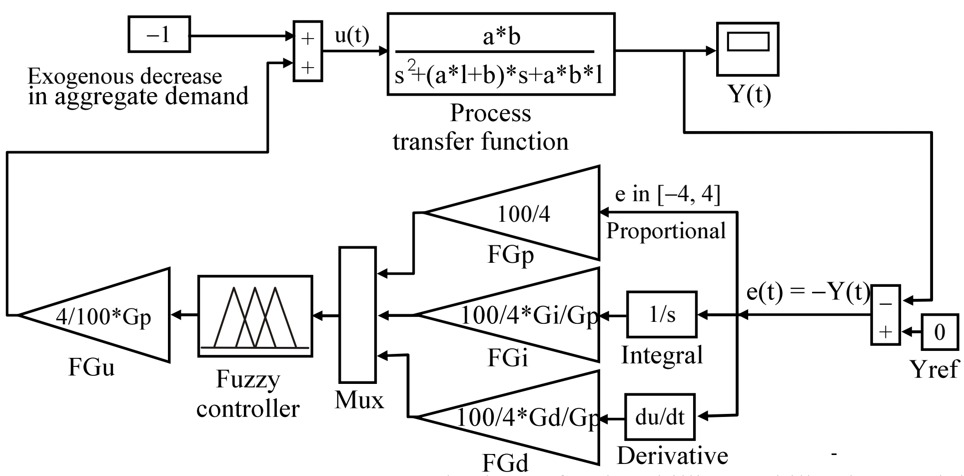


Figure 5. Fuzzy PID control scheme for the Phillips' stabilization model

The FPID controller scheme is shown in figure 6.

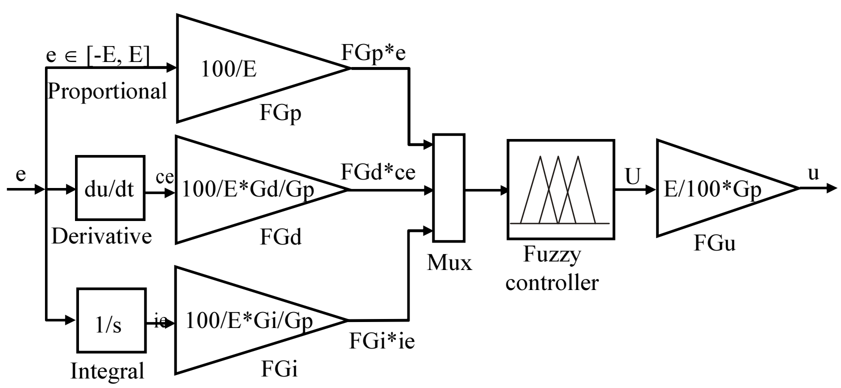


Figure 6. Fuzzy PID controller (FPID)

Sometimes, a rule base with only two inputs is more convenient. An easy way to reduce the number of fuzzy controller inputs is to separate the integral action as in the fuzzy PD+I (FPD+I) controller shown in figure 7.

The controller function is thus split into two additive parts:

$$u = u_{FPD} + u_I = f_{FPD}(e, ce) + f_I(ie) \tag{9}$$

The first one corresponds to the FPD controller and is represented by a surface. In the initial stage of the design, this surface is a plane, but it may be made nonlinear in a subsequent stage. For example, we can modify the shape of the surface by manipulating the membership functions. Its associated plot is a design aid by visual inspection when selecting membership functions and constructing rules.

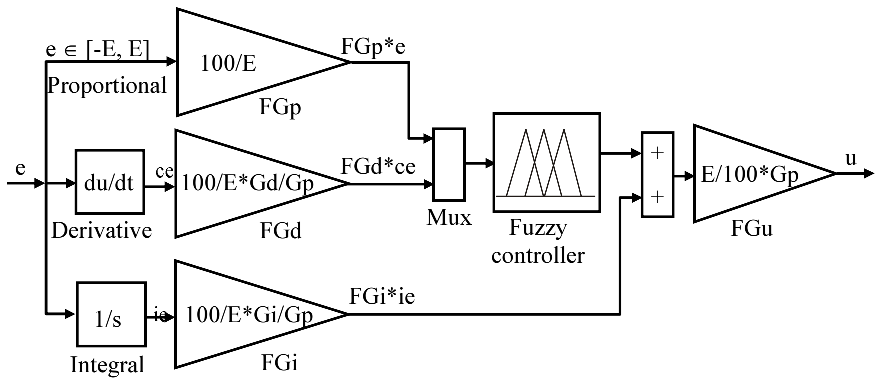


Figure 7. Fuzzy PD+I (FPD+I) controller

Now let us illustrate the construction of a fuzzy rule base for a FPD+I controller.

We consider a standard universe of discourse (say $[-100, 100]$) for both inputs: error and change of error. For the sake of simplicity, the same fuzzy partition will be considered in both cases (see figure 8, where "N", "AZ" and "P" stay for "Negative", "About Zero" and "Positive", respectively).

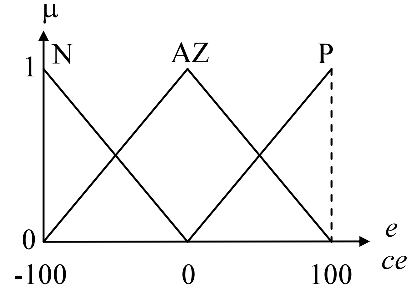


Figure 8. Fuzzy partition on the standard universe of discourse [-100, 100]

Due to the summation, the standard universe for the output variable u will be $[-200, 200]$.
According to the assumption A7 introduced in section 3, fuzzy singletons (whose positions are determined by the sum of the peak positions of the input sets) will be chosen as consequents for fuzzy rules (see figure 9).

μ

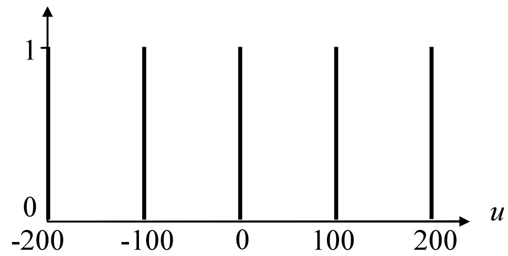


Figure 9. Fuzzy singletons chosen as consequents for fuzzy rules

Choosing the design parameters according to the assumptions A1 to A8, the control surface degenerates to a diagonal plane (figure 10).

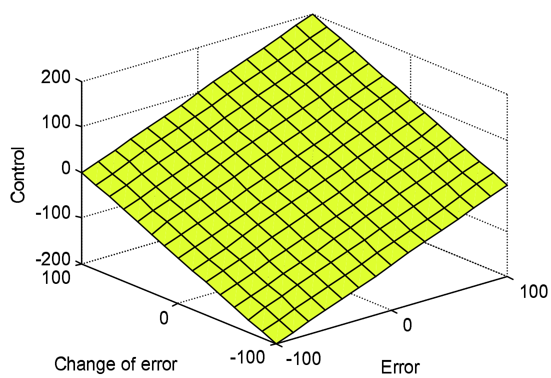


Figure 10. Linear control surface

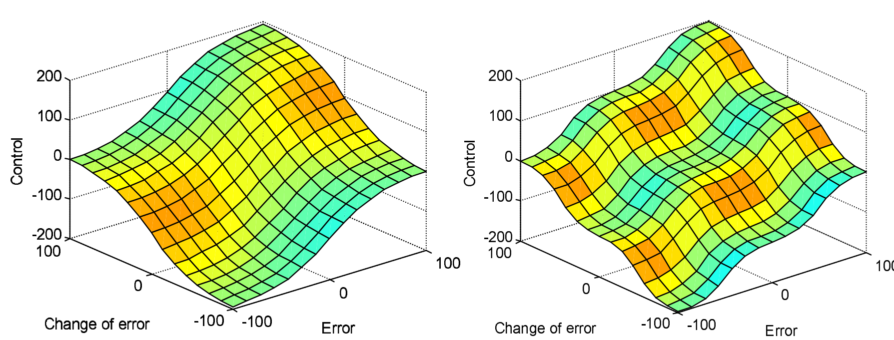
C. Making the Linear Fuzzy Controller Progressively Nonlinear

There are three sources of nonlinearity in a fuzzy controller:

- *The rule base*. The position, the shape and the number of fuzzy sets as well as the nonlinear input scaling cause nonlinear transformations. The rules often express a nonlinear control strategy.
- *The inference engine*. If the connectives *and* and *or* are implemented as for example *min* and *max*, respectively, they are nonlinear.
- *The defuzzification*. Several defuzzification methods are nonlinear.

All the characteristics enumerated above can be used to gradually make the linear fuzzy controller nonlinear. The shape of the sets and the choice of rules are the easiest to be applied.

The shapes of the control surface induced by certain input families of fuzzy sets are shown in figure 11.



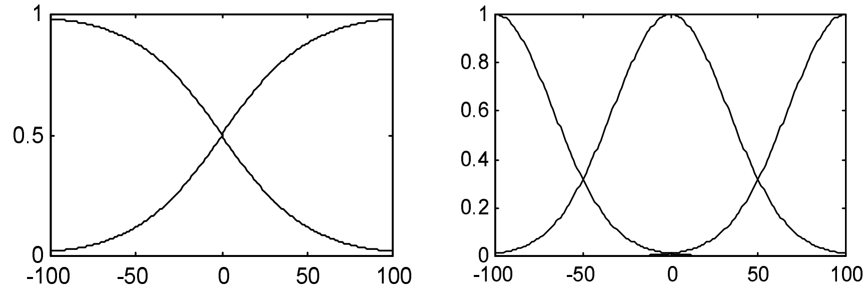


Figure 11. Nonlinear control surfaces induced by different input families

The control characteristics producing nonlinearities that affect the closed-loop system dynamic must be chosen by analysing how the response reacts to each of them.

D. Fine-Tuning the Nonlinear Fuzzy Controller

The final phase in the design procedure is to fine-tune the gains attached to the nonlinear fuzzy controller. This operation combines the intuition with some rules of thumb derived from experience. In simulation it is possible to experiment with different control surfaces and get an idea of the gain margin and characteristics of response.

There is a large potential for the design approach in fuzzy PID controllers, due to the widespread application of PID control and the well-known tuning rules.

A procedure for hand-tuning an FPD+I controller may be sketched as follows:

1. Adjust FGp according to the reference step size and the universe of discourse in order to exploit fully the range of the input universe.
2. Remove integral action and derivative action by setting $FGd = FGi = 0$. Tune FGu to give the desired response, ignoring any final value offset.
3. Increase the proportional gain by means of FGu , and adjust the derivative gain by means of FGd to dampen the overshoot.
4. Adjust the integral gain by means of FGi to remove any final value offset (steady state errror).
5. Repeat the whole procedure until FGu is as large as possible.

5.5. The Phillips' Stabilization Model for an Open Economy and its Fuzzy Extension

A. The control scheme using a conventional state-feedback controller

Now, let us modify the Phillips' model in order to take account of foreign trade flows in economy. We shall consider again the government expenditure as control variable. This time, the aggregate demand is expressed by the equation:

$$D(t) = G(t) + Z(t) - M(t) + C(t) + I(t) \qquad (11)$$

Since the aggregate demand usually differs from the aggregate supply, the stabilization policy has to damp such a difference (expressed by the excess demand $\mathrm{E(t)} = \mathrm{D(t)} - \mathrm{Y(t)}$) whenever it occurs. The following equations complete the model:

$$v \cdot \dot{Y}(t) = I(t) \tag{12}$$

$$I(t) = \sigma \cdot (D(t) - Y(t)) \tag{13}$$

$$C(t) = (1 - s) \cdot Y(t) \tag{14}$$

$$Z(t) = z \cdot Y(t) \tag{15}$$

$$M(t) = m \cdot Y(t) + D(t) - Y(t) \tag{16}$$

where $M(t)$ are imports, $Z(t)$ are exports and $v > 0$, $\sigma > 0$, $0 < s < 1$, $z > 0$, $m > 0$ are constants.

The basic dynamic mechanism of this model is of multiplier-accelerator type (equation (12) being of accelerator type and equation (13) of multiplier type).

After successive substitutions of variables $D(t)$, $Z(t)$, $M(t)$, $C(t)$, $I(t)$ into equations (11)-(16) and some simple manipulations, the dynamic equation of aggregate supply results in the form:

$$\dot{Y}(t) = \alpha Y(t) + G(t) \tag{17}$$

where:

$$\alpha = \frac{\sigma(z - m - s)}{v(2 - \sigma)} \tag{18}$$

$$\beta = \frac{\sigma}{v(2 - \sigma)}; \quad \sigma \neq 2 \tag{19}$$

Let us assume that $Y(0) = Y_0$ at $t = 0$. The equation (17) has a unique solution $Y(t)$, for any fixed control strategy $G(t)$.

An *equilibrium solution* is a solution where all quantities $D(t)$, $Y(t)$, $Z(t)$, $M(t)$, $C(t)$, $I(t)$, $G(t)$ are constant as time functions and the aggregate demand equals the aggregate supply. Thus, a necessary condition for the constants $D^* = Y^*, Z^*, M^*, C^*, I^*, G^*$ to designate an equilibrium solution of the above model is to verify the equations:

$$Y^* = G^* + Z^* - M^* + C^* + I^*; \qquad I^* = 0$$

$$C^* = (1 - s) \cdot Y^*; \qquad Z^* = z \cdot Y^*; \qquad M^* = m \cdot Y^*$$

Solving this system with respect to G^*, we obtain:

$$Y^* = \frac{G^*}{s - z - m}; \; C^* = \frac{(1 - s)}{s - z - m} G^*; \; Z^* = \frac{z}{s - z - m} G^*;$$

$$M^* = \frac{m}{s - z - m} G^*; \; I^* = 0$$

Let us denote by:

$$\underline{D}(t) = D(t) - Y^*; \quad \underline{Y}(t) = Y(t) - Y^*; \quad \underline{G}(t) = G(t) - G^*; \quad \underline{Z}(t) = Z(t) - Z^*$$

$$\underline{M}(t) = M(t) - M^*; \quad \underline{C}(t) = C(t) - C^*; \quad \underline{I}(t) = I(t)$$

the deviations of variables $D(t)$, $Y(t)$, $Z(t)$, $M(t)$, $C(t)$, $I(t)$, $G(t)$ from their equilibrium states. Clearly, such deviations satisfy the equations:

$$\underline{D}(t) = \underline{G}(t) + \underline{Z}(t) - \underline{M}(t) + \underline{C}(t) + \underline{I}(t); \quad \underline{C}(t) = (1-s)\cdot \underline{Y}(t); \quad v \cdot \dot{\underline{Y}}(t) = \underline{I}(t);$$

$$\underline{Z}(t) = z \cdot \underline{Y}(t); \quad \underline{I}(t) = \sigma \cdot (\underline{D}(t) - \underline{Y}(t)); \quad \underline{M}(t) = m \cdot \underline{Y}(t) + \underline{D}(t) - \underline{Y}(t)$$

As previously, by successive substitutions, one can reduce the model to a single differential equation:

$$\dot{\underline{Y}}(t) = \alpha \cdot \underline{Y}(t) + \beta \cdot \underline{G}(t) \tag{20}$$

where α and β are given by (18) and (19).

We denote by $\underline{S}(t)$ the foreign trade balance, cumulated over the time-interval [0, t]:

$$\underline{S}(t) = \int_0^t \underline{S}(\tau)\, d\tau + \underline{S}(0) = \int_0^t [\underline{M}(\tau) - \underline{Z}(\tau)]\, d\tau + \underline{S}(0)$$

Differentiating, we have $\dot{\underline{S}}(t) = \underline{M}(t) - \underline{Z}(t)$. Expressing $\underline{M}(t)$ and $\underline{Z}(t)$ with respect to $\underline{Y}(t)$ and $\underline{G}(t)$ leads to:

$$\dot{\underline{S}}(t) = \gamma \cdot \underline{Y}(t) + \delta \cdot \underline{G}(t) \tag{21}$$

where:

$$\gamma = \frac{(m-z)(1-\sigma) - s}{z - \sigma}; \quad \delta = \frac{1}{2-\sigma} \tag{22}$$

The state-space description of the system is finally given by the equations (20) and (21):

$$\begin{cases} \dot{\underline{Y}}(t) = \alpha \cdot \underline{Y}(t) + \beta \cdot \underline{G}(t); & Y(0) = \underline{Y}_0 \\ \dot{\underline{S}}(t) = \gamma \cdot \underline{Y}(t) + \delta \cdot \underline{G}(t); & \underline{S}(0) = \underline{S}_0 \end{cases} \tag{23}$$

With the following notations:

$$x(t) = \begin{pmatrix} \underline{Y}(t) \\ \underline{S}(t) \end{pmatrix}; \quad u(t) = \underline{G}(t); \quad x_0 = \begin{pmatrix} \underline{Y}_0 \\ \underline{S}_0 \end{pmatrix}; \qquad A = \begin{pmatrix} \alpha & 0 \\ \gamma & 0 \end{pmatrix}; \qquad B = \begin{pmatrix} \beta \\ \delta \end{pmatrix};$$

the state-space description of the system becomes:

$$\dot{x}(t) = A \cdot x(t) + B \cdot u(t); \qquad x(0) = x_0 \tag{24}$$

In order to stabilize the system, we need to design a state-feedback controller, described by the control law:

$$u(t) = -H\, x(t) \tag{25}$$

The feedback gain matrix $H = (h_1 \quad h_2)$ must be determined such that the closed-loop system $\dot{x}(t) = (A - BH)\cdot x(t)$ is asymptotically stable (i.e., all eigenvalues of $A - BH$ have negative real parts).

There are two alternative design methods: the first one is based on a pole placement technique and the second one on a linear quadratic optimization technique. In both cases, the design solution can be easily implemented in Matlab.

The state-feedback control scheme is depicted in figure 12 and can be simulated via Simulink.

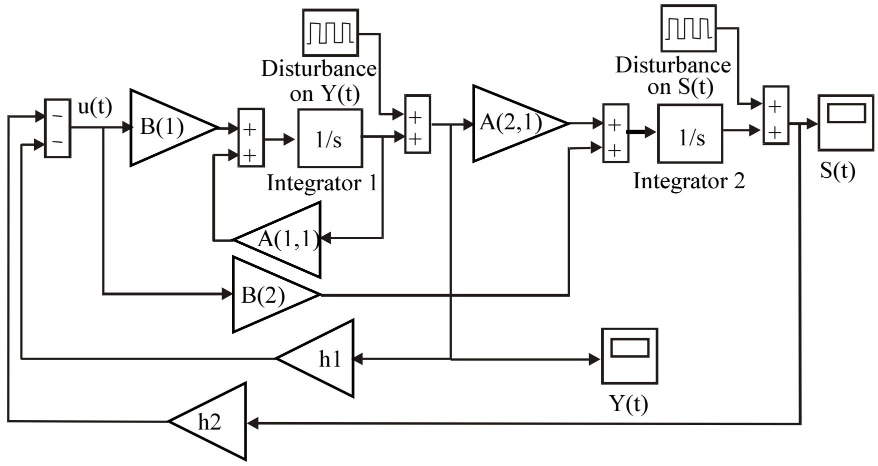


Figure 12. Conventional state-feedback controller

B. The linear fuzzy controller emulating the conventional state-feedback controller

An equivalent fuzzy controller that emulates the conventional state-feedback controller should reproduce the same dynamic behaviour of the closed-loop system; this is checking that the implementation is correct.

In our case, the gain matrix H is of the form $H = \begin{pmatrix} h_1 & h_2 \end{pmatrix}$ and hence, the control law can be written out:

$$u(t) = H \cdot x(t) = \begin{pmatrix} h_1 & h_2 \end{pmatrix} \cdot \begin{pmatrix} \underline{Y}(t) \\ \underline{S}(t) \end{pmatrix} = h_1 \cdot \underline{Y}(t) + h_2 \cdot \underline{S}(t) \tag{26}$$

The feedback gains from the previous control law have to be transferred to the fuzzy controller. However, since the fuzzy controller is normally equipped with input gains as well with as an output gain, this transfer will introduce some degree of freedom. More precisely, the fuzzy controller can be written as:

$$u(t) = f\left(G_1 \cdot \underline{Y}(t),\ G_2 \cdot \underline{S}(t)\right) \cdot G_3$$

and assuming that it acts as a summation, we obtain the following linear control law:

$$u(t) = \left(G_1 \cdot \underline{Y}(t) + G_2 \cdot \underline{S}(t)\right) \cdot G_3 = G_1 \cdot G_3 \cdot \underline{Y}(t) + G_2 \cdot G_3 \cdot \underline{S}(t) \tag{27}$$

Comparing the gains of the conventional state-feedback controller in (26) with the gains of the linear fuzzy controller in (27), the following relations can be determined:

$$h_1 = G_1 \cdot G_3 \quad \Rightarrow \quad G_3 = \frac{1}{G_1} \cdot h_1 \tag{28}$$

$$h_2 = G_2 \cdot G_3 \quad \Rightarrow \quad G_2 = \frac{1}{G_3} \cdot h_2 = G_1 \frac{h_2}{h_1} \tag{29}$$

With three gains to be determined and two equations, there is one degree of freedom. If the input universes are chosen to be standard universes $[-100, 100]$, then we have the following further constraint, in order to avoid the saturation in the universes:

$$\left|G_1 \underline{Y}(t)\right|_{\max} \leq 100$$

Thus, from $G_1 \cdot \underline{Y}(t) \in \left[-G_1 \cdot \underline{Y}^*, G_1 \cdot \underline{Y}^*\right] = [100, 100]$, we deduce:

$$G_1 = \frac{100}{Y^*}$$

The other two gains are now fixed as follows:

$$G_3 = \frac{Y^*}{100} \cdot h_1 ; \quad G_2 = \frac{100}{Y^*} \cdot \frac{h_2}{h_1}$$

With this procedure of transferring gains, the control scheme of fuzzy controller is obtained as in figure 13.

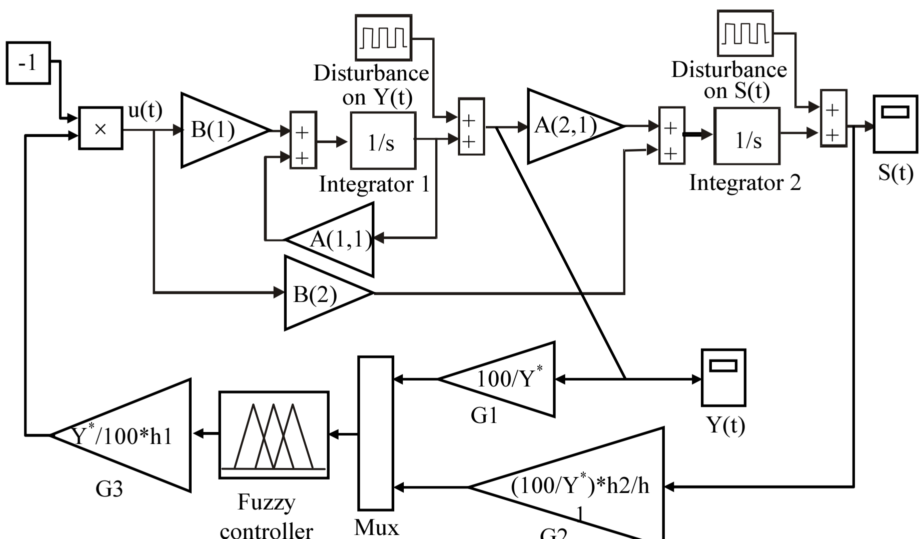


Figure 13. Fuzzy controller emulating a conventional state-feedback controller

6. Concluding Remarks

In this paper we analysed the potential of soft computing methods to capture nonlinear characteristics when modelling economic processes. Soft computing provides more flexible tools for dealing with nonlinearities when considering both econometric and stabilization models.

Applying stabilization strategies to nonlinear economic systems is challenging and advanced control techniques should be addressed in such cases. Since fuzzy control can be described as a non-linear mapping, the corresponding fuzzy controller acts as a non-linear controller and hence provides an increasing flexibility. We introduced a multi-stages methodology. Primarily it focuses on the emulation of a conventional controller (either a PID or a state-feedback controller) through a linear fuzzy controller as a starting point for further exploitations of the full capabilities of the non-linear fuzzy controller. Given that a fuzzy controller contains a linear controller as a special case, it is true to say that it performs at least as well as the latter. We also briefly suggested how to make it non-linear and how to use fine-tuning procedures for achieving the validation objective of the controller. The potential for performing better depends on the designer capability to exploit the non-linear options in the fuzzy controller to his advantage. Of course, this topic needs itself a large discussion, which exceeds the goal of this paper (in this respect, the reader may consult the existing literature).

Our application was inspired by a pioneering work due to A.W. Phillips. In a well-known article published in 1954, he tackled the problem of economic stabilization from the point of view of control system engineering. It is the historical relevance of this model that provided us the main reason for adapting it to incorporate a fuzzy control mechanism.

Fuzzy control could be applied to some stabilization models with current relevance, concerning, for example, the European Monetary Union. This field is of great interest for the financial community and clearly involves a control mechanism. One can try to simulate the consequences of, say, a fixed exchange rate policy versus a fixed inflation policy. The control mechanism may consist on a fuzzy PID controller to begin with. Finally, the effects on model performances of various tuning parameters could be compared and an appropriate control strategy could be derived.

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5. OPTIMIZING THE FINANCE OF COLLECTIVE CONSUMPTION USING EVOLUTIONARY COMPUTATION

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Abstract

On the market of collective goods, the state is a provider of services and the individuals are considered to be the beneficiaries. The correct resizing of public expenses for financing indivisible collective consumption is necessary mostly due to the unproductive character of these costs. The optimization of the public goods supply must take into account the individuals preferences for pure collective goods that are expressed as a collective preferences function. This function, together with the constraints resulting from budgetary equilibrium forms a maximization problem that can be solved using evolutionary algorithms.

1. Introduction

The proper sizing of public budget constitutes a real preoccupation for any public authority. The size of State's budget is a controversial problem especially for a country that had the experience of a centralized economy. This kind of economy means a substantial commitment from the part of the State. The passing to the market economy involve the reconsideration of the part of the State into the economically life.

The fact that the State's interference have a bound is an accepted idea; which is the threshold over that the commitment of the State is excessive is the remaining question. The level of the State's commitment into the economical environment can perturbs the mechanism of the market economy and becomes a problem. This problem is not usually discussed in connection with the commitment of the State as a provider of pure collective goods – national defense, public safety, justice. The proper sizing of State's expenditures with indivisible collective goods is desirable because of the unproductive nature of these expenditures.

Because the State is the provider of public services we can speak about a "market" of collective goods, therefore about the demanding of the individuals (population). The consumer of the public goods pays a masked price – the economics literature admits the tax as a paid price for the individual's advantages after the State activity (Equivalence and safety theory, Tulai C., 2003).

It is known that we have an aggregate management of taxes (together with the other incomes attract to the budget of the State) and it is not allowed to make a special link between a specific income and a specific expenditure of the State. Yet we make the assumption that the income tax due by the wage earners as a "price" paid for having access to the pure collective goods. We make the argumentation that, in Romania the pressure of taxation are supported mostly by individuals not by the companies. Therefore, the resources made from the income taxes of natural person finance a large part of public expenditures (the income tax of the wage earners is 20.5% from the budgetary incomes, the income tax of the natural person is 22.4% while the profit tax is 17.06% - The State Budget 2004). In the meantime, we speak about non-exclusion by price that means that there are individuals who aren't in debt tax, but benefit by collective goods. Non-exclusion by price and rivalry are the attributes of the pure collective goods. They make from the public authority the main provider of these goods. Each consumer uses the entire quantity of the collective good (benefits on the State's expenditure with the collective consumption taken as a whole) and pays the "price": the income tax paid by the society is the sum of all income taxes paid by each individual.

Comparing "the demand" and "the supply" we must have an optimal quantity of the collective goods to deliver.

Generally, the proper sizing of the supply supposes that the demand is known and in our case is also known the individuals' preferences vis-à-vis by the pure collective goods. So that, in order to optimize the collective expenditures financed through the State's budget, we follow three steps:
i). Knowledge of the real individuals' preferences vis-à-vis by the pure collective goods
ii). Determining the function of collective preference on the basis of the individuals' preferences
iii). Producing the optimal quantity of collective goods.

2. Economical problem

Let consider the utility function (Percebois J., 1991) written in the form $U_i(x,y_i)$, where x represents the consumed quantity of a pure collective good (expressed in monetary units), y_i is the annual income after taxes used for buying private goods, i denotes the individual and $i \in \{1,2,...,n\}$, n is the number of consumers from the national economy. The annual income after taxes y_i is computed assuming that the whole income is used for consumption without any savings, as follows: $y_i=z_i-t_i$, where z_i is the income before taxes and t_i represents the taxes.

The mathematical expression of the utility function can have the form:

$$U_i(x, y_i) = x^a \cdot y_i^b, \quad a,b>0,\ a+b=1$$

where a and b show the individual's preference for a collective or private good, respectively.

Knowing the individual utilities obtained after the consumption of common and indivisible goods, a collective preference function (i.e. collective welfare function) can be deduced:

$$W = \sum_{i=1}^{n} \alpha_i \cdot U_i(x, y_i) \qquad (1)$$

where α_i is the weight granted by the State to the satisfaction of individual i in the collective welfare function (the State is the bearer of the interests of certain groups).

The State's target is to maximize the collective welfare function W subjected to the constraint of the budget equilibrium (under the assumption that the State's functions are limited to the production of collective goods):

$$\begin{cases} W \to \max \\ x \le \sum_{i=1}^{n} t_i \end{cases} \qquad (2)$$

Our approach takes in consideration the wage earners from Romania (which pays or do not pay taxes) as the bearers of collective goods demands. In this aim we have made a classification of the wage earners in nine classes according to their income, their family situation (number of persons to support) and the OECD procedure (Table 1). Note that the nine classes considered may not cover all possible situations.

Table 1. The income distribution in nine classes

Class	Income (% from *APW**)	
1.	33	Without persons to support
2.	67	Without persons to support
3.	100	Without persons to support
4.	167	Without persons to support
5.	67	1 child to support
6.	100	1 child to support
7.	67	2 children to support
8.	100	2 children to support
9.	100	2 children and a husband/wife to support

**APW* is the average production worker; in Romania in January 2004 *APW*=6,300,000 ROL

Table 2 comprises the elements used to find the annual income after taxes for each class allocated for acquiring of private goods (expressed in thousands ROL).

According to the above classification, the collective welfare function W becomes:

$$W = \sum_{i=1}^{9} \alpha_i \cdot x^a \cdot y_i^b \cdot p_i,$$

where p_i is the number of wage earners from the class i and $p_1 + p_2 + \ldots + p_9 = n$; n =9,283,000 at the end of 2003.

Supposing that the State is impartial we can consider that $\alpha_1 = \alpha_2 = \ldots = \alpha_9 = \frac{1}{9}$ hence the maximization problem (2) can be written in the form:

$$\begin{cases} W = \frac{1}{9} \cdot x^a \cdot \left(y_1^b \cdot p_1 + y_2^b \cdot p_2 + \ldots + y_9^b \cdot p_9 \right) \rightarrow \max \\ p_1 + p_2 + \ldots + p_9 = n \\ a + b = 1 \\ x \le p_1 \cdot AIT_1 + p_2 \cdot AIT_2 + \ldots + p_9 \cdot AIT_9 \end{cases} \qquad (3)$$

The aim of this paper is to find the optimal quantity of collective goods offered by the State that best responds to individuals' preferences (starting with the assumption of the uniform distribution of the wage earners in the nine classes). The results will be compared with the amounts already existent in the state budget from 2004. After we will determined x optimal, we will look for such distribution of wage earners which maximize the collective welfare function. For this distribution we will find a new value for x optimal.

3. Evolutionary algorithms

During the last years there has been a growing interest in problem solving techniques based on the principles of evolution and hereditary. A lot of computational models have been proposed and studied. The domain covering all these techniques is called Evolutionary Computation (EC) and it is now considered to be a stable sphere of Artificial Intelligence. The techniques that model the evolutionary process are called evolutionary algorithms.

The most employed classes of evolutionary algorithms are: Genetic algorithms (Holland, 1975), Evolutionary programming (Fogel, Owens and Walsh, 1966), Evolution strategies (Rechenberg, 1973), Genetic programming (Koza, 1992).

The common idea of all evolutionary algorithms is to evolve a population of candidate solutions to the problem using search operations inspired by biology, like recombination, mutation and selection. The evolution process takes place until a termination condition is met. The final population is expected to contain the best solutions for the given problem.

Table 2.

		1st class	2nd class	3rd class	4th class	5th class	6th class	7th class	8th class	9th class
(1)	Gross income	2079	4221	6300	10521	4221	6300	4221	6300	6300
(2)	Contributions (CAS, CASS, FS)	353.43	717.57	1071	1788.57	717.57	1071	717.57	1071	1071
(3)	Personal expenses (Dpb)	2000	2000	2000	2000	2000	2000	2000	2000	2000
(4)	Professional expenses (15% Dpb)	300	300	300	300	300	300	300	300	300
(5)	Monthly net income =(1)-(2)-(4)	1425.57	3203.43	4929	8432.43	3203.43	4929	3203.43	4929	4929
(6)	Supplementary personal expenses (Dps)	0	0	0	0	1000	1000	2000	2000	3000
(7)	Annual and global income before tax =12*(5)-12*((3)+(6))	negative	14441.16	35148	77189.16	2441.16	23148	negative	11148	negative
(8)	Annual income tax (AIT)	0	2599.408	6644.040	16692.965	439.408	4166.64	0	2006.64	0
(9)	Annual income after taxes y=12*(1)-12*(2)-(8)	20706.84	39441.752	56103.96	88096.195	41601.751	58581.36	42041.16	60741.36	62748

3.1. Genetic algorithms Genetic algorithms were developed by John Holland (University of Michigan in Ann Arbor) in the early 1960s. Genetic algorithms evolve a population of chromosomes (candidate solutions). Here they are encoded as binary strings. The search operators are typically crossover, mutation and sometimes inversion. Chromosomes are evaluated using a fitness function.

Suppose we have a maximization problem:

$$\begin{cases} f(x) \to \max \\ x \in \Omega \end{cases},$$

where f is a real-valued function $f : \Omega \to R$, $\Omega \subset R^n$.

Genetic algorithms evolve a set of chromosomes that are encoded as binary strings in order to detect the maxima of the function. A fitness function is used in order to evaluate the chromosomes. The evolution process takes place for a number of generations until a termination condition is fulfilled. At each generation *t* a new population of chromosomes is created using genetic operators like selection, recombination and mutation.

The structure of the canonical genetic algorithm is presented here:

Step 1. *t:=0;*
Step 2. Generate randomly population *P(t);*
Step 3. Evaluate *P(t)* by using a fitness function;
Step 4. While not *termination_condition* **do**
begin
Step 4.1. Select from *P(t)* the individuals that will undergo changes using variation operators (recombination, mutation). Let *P'* be the set of selected individuals. Choose individuals from *P'* to enter the mating pool *(MP);*
Step 4.2. Recombine chromosomes in *MP* forming population *P";*
Step 4.3. Mutate chromosomes in *P"* forming *P"';*
Step 4.4. Select for replacement from *P'"* and *P(t)* forming *P(t+1);*
Step 4.5. *t:=t+1;*
end

Remarks:

- **(i)** The size of the population used is a parameter of the algorithm.
- **(ii)** The termination_condition in Step 4 can be a maximum number of generation to be achieved, or some other condition on population *P(t).*
- **(iii)** Another decision that has to be made is which types of genetic operators to use for selection, recombination and mutation.

Genetic algorithms are also very useful for providing a practical insight into the problem. Often they are used to simulate certain real situations in order to better understand the dynamic of the problem. In this particular case we have used a genetic algorithm to simulate and to study the behavior of the collective welfare function.

4. Results

The distribution of the population into the nine classes can not be controlled by the state. This fact makes difficult the estimation of the function of the collective welfare. For theoretical reasons, in order to solve the problem, we started with the assumption that each class has an equal number of individuals $p_1 = p_2 = \ldots = p_9 = p$.

Then the function W becomes

$$W = \frac{1}{9} \cdot p \cdot x^a \cdot (y_1^b + y_2^b + \ldots + y_9^b) \qquad (4)$$

Consider also $a = 0.5$ and $b = 0.5$.

If $p_1 = p_2 = \ldots = p_9 = p$ and $p_1 + p_2 + \ldots + p_9 = 9283000$ (the situation at the end of 2003), then

$$p = \frac{9283000}{9} \Rightarrow p = 1\,031\,444$$

By replacing p, $y_1, y_2, \ldots, y_9$ in (4), we have:

$$W(x) = 7\,335\,827\,736.12 \cdot x^a \qquad (5)$$

subjected to $x \leq p_1 \cdot AIT_1 + p_2 \cdot AIT_2 + \ldots + p_9 \cdot AIT_9$. The function (5) reaches the maximum value for x_{max}=33,572,590,429,555.60 and the maximum value is W_{max}=4.25051E+16.

Using these results we took different values for the parameters *a* and *b* and using a genetic algorithm we estimated the optimal distribution of individuals in classes (as we can see in Table 4). The parameters used to run the genetic algorithm are presented in Table 3.

Table 3. Parameters used to run the genetic algorithm

Nr. Crt.	Parameter	Value
10.	Number of generations	3,000
11.	Population size	200
12.	Crossover probability	0.5
13.	Mutation rate	0.05
14.	q-tournament selection	30

For each pair (*a,b*) we run the algorithm two times. For the cases: $(a,b) \in \{(0.25, 0.75), (0.5,0.5), (0.75, 0.25)\}$ the estimated distribution of individuals in classes was represented in Fig. 1-3. In the last column of Table 4 we presented the corresponding optimum value of *x* for each distribution of individuals in classes.

5. Conclusions

As we can see, if we have an uniform distribution of the wage earners into the nine classes, the collective welfare is maximum for an expenditure of collective goods about 33,572.590 billion ROL. On the other hand we can say that the consumption of a quantity of collective goods about 33,000 billions ROL brings to the wage earners the maximum satisfaction. In fact, this is that part of the public expenditures that they accept to finance through the income taxes. Also they understand the position of the State as a provider of the goods. Beyond this bound we speak about "a compulsion" as a modality of bringing income taxes to the budget for finance the respective goods. The sums from the State's Budget in 2004 are bigger then that optimal value: the expenditure for defense, public order and generally public services are about 99,183.8 billions (increasing: in 2002 around 62,000 billions, in 2003 around 84,000 billions).

Table 4.

		p1	p2	p3	p4	p5	p6	p7	p8	p9	Σ(p)	x_{max}
a	0.25											
b	0.75											
VAL W	3.09E+15	36	20	9,244	6,188,700	1,475	50,925	2920	1998600	1031100	9283020	107,592,526,963,695
VAL W	2.78E+15	21	114,850	75,350	8,008,200	18,103	533,400	26877	63505	442700	9283006	136,837,644,806,127
a	0.33											
b	0.67											
VAL W	7.66E+15	1	1	4,052	7,194,600	1	415,820	114950	547560	1006000	9282985	122,957,458,721,097
VAL W	8.20E+15	1	631	14,044	8,251,600	1,260	97,606	1104	114600	802200	9283046	138,475,822,781,388
a	0.50											
b	0.50											
VAL W	1.12E+17	22	3,028	101,970	8,251,200	6	42,817	12747	300260	570950	9283000	139,203,275,961,958
VAL W	1.12E+17	1	1	114,680	8,251,500	4	28,369	158	89994	798270	9282977	138,802,732,532,064
a	0.66											
b	0.33											
VAL W	9.21E+17	1	1	94,420	8,251,600	12,720	107,430	27335	114610	674900	9283017	139,054,195,278,288
VAL W	8.40E+17	1	5	15,857	7,220,100	2	213,490	13	916840	916680	9282988	123,359,548,805,838
a	0.75											
b	0.25											
VAL W	3.62E+18	1	18	22,821	7,220,100	3	228,140	5663	774960	1031300	9283006	123,182,191,324,911
VAL W	4.02E+18	1	2	111,640	8,251,600	2	114,570	3023	458400	343800	9283038	139,882,632,418,034

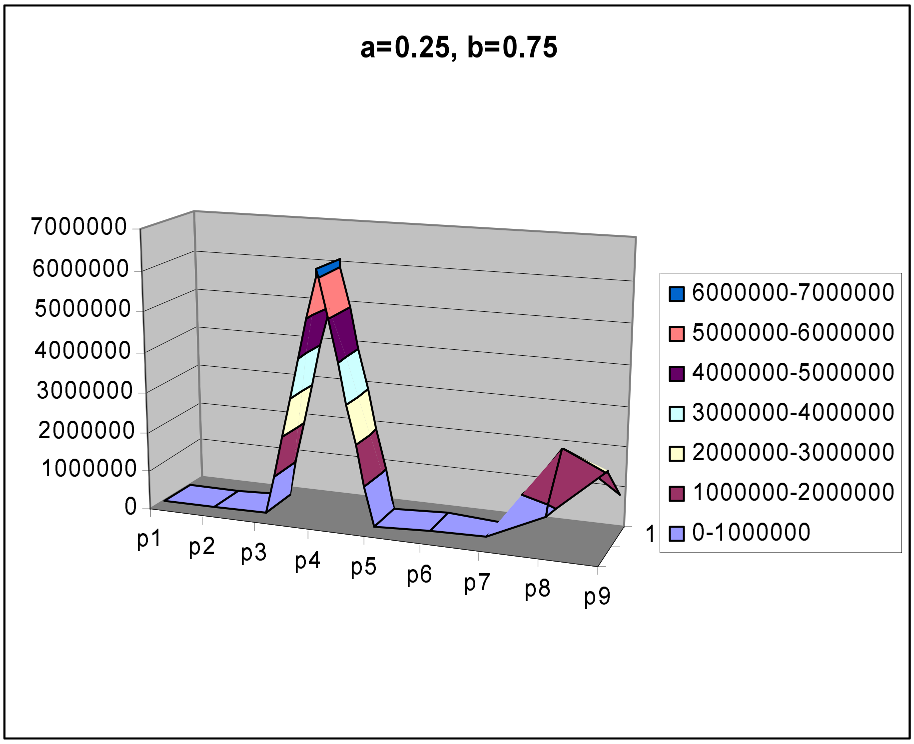
a=0.25, b=0.75
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
p1
p2
p3
p4
p5
p6
p7
p8
p9
1
6000000-7000000
5000000-6000000
4000000-5000000
3000000-4000000
2000000-3000000
1000000-2000000
0-1000000

Fig. 1

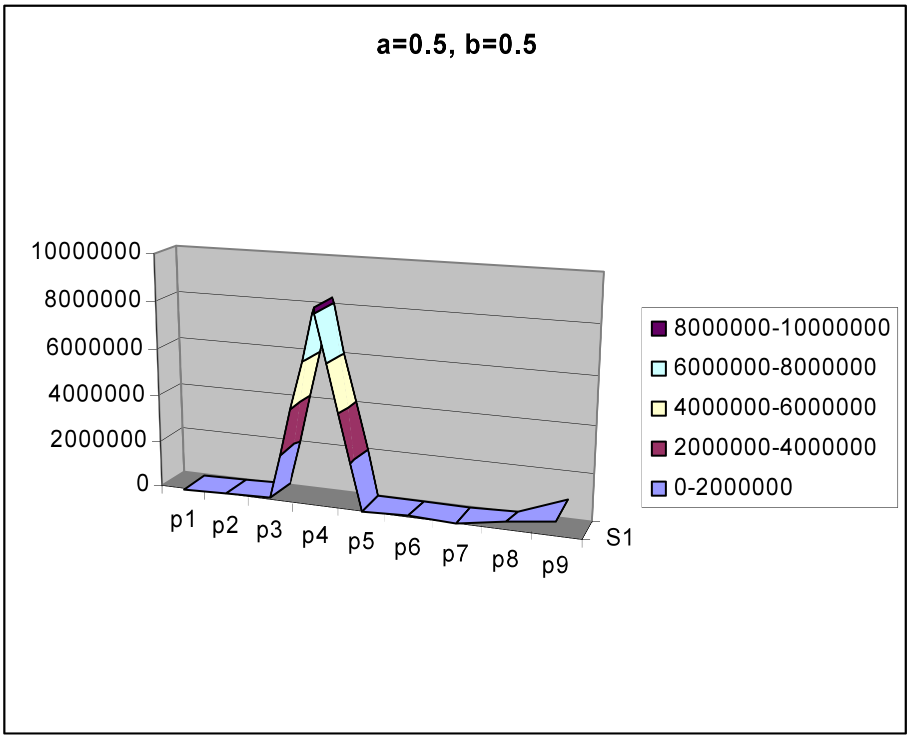
a=0.5, b=0.5
10000000
8000000
6000000
4000000
2000000
0
p1
p2
p3
p4
p5
p6
p7
p8
p9
S1
8000000-10000000
6000000-8000000
4000000-6000000
2000000-4000000
0-2000000

Fig. 2

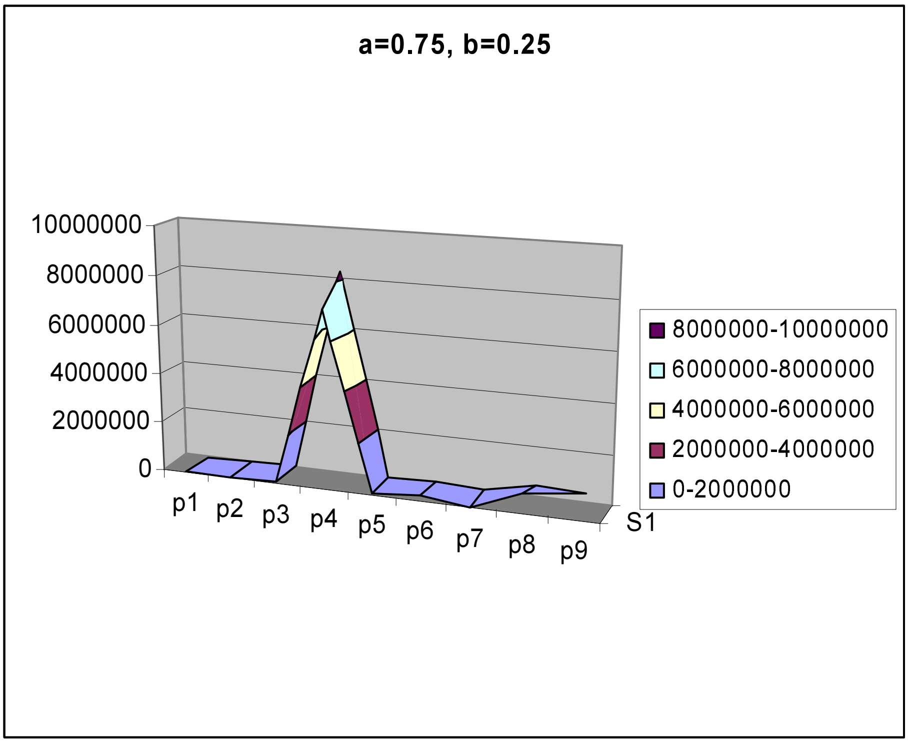

Fig. 3

The comparison leads us to the conclusion of an overrating of the collective goods supply. There is a supply that has no answer in the demand; it does not maximize the collective satisfaction. We are tempted to say that it is a waste of public money but our analysis begins with a hypothetical situation that we have a uniform distribution of the wage earners in the nine classes. In the absence of real data of the distribution we looked for the optimum one in order to have the maximum of the collective welfare function, in the conditions given by the preferences of the wage earners for a public good or a private one (the *a* and *b* parameters). For each optimum distribution we found the new optimal values for *x* and we remark that the values are greater then those assigned in the budget.

Even when the parameters *a* and *b* take different values (we have three situations: $a<b$, $a>b$ and $a=b$), the optimal value of *x* is very big and the optimal distribution indicates the predominance of the individuals with high income and without persons to support (4th class).

Analyzing the results we conclude that the collective welfare reaches a maximum in 2004 in Romania if 77-88% from the wage earners would have incomes about 167%*APW* and have no person to support (belonging to the 4th class). They are willing to pay income taxes big enough to finance a big optimum value for *x*. The first part of the result is obvious. On the other hand we mention that our analysis also is not considering social aspects like birth rate and that explain the part two of the result. The final aspect shows us that the people accept to pay big income taxes when their incomes are big. But the experience shows that this fact is possible only if the people have confidence in the public authority, confidence that the public money will be used in the best interest of the citizen (in this case by offering pure collective goods).

Finally, the mathematical and computational devices proposed in this paper are desired to be a helpful tool to be used in order to improve the macro-economic decisions.

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6. BUILDING CUSTOM HTML FORMS WITH ASP FOR SMALL BUSINESSES

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Abstract

The Publish to the Web Wizard is a great way to get started with Web pages. This is fine for an intranet server in which you control the browser through which surfers can view your pages. However, it is not optimal for an Internet site in which you want to serve pages to just about any browser that shows up at your site. In the latter situation, you can use ASP script on the server along with HTML forms to let users show and edit Access databases via forms on browsers. The May 1998 issue of Microsoft Office & VBA Developer features a whole article demonstrating how to artfully apply this technique.

HTML forms require a round-trip to the server. In this way, they are not unlike the pages generated by the Publish to the Web Wizard. The user completes some information on the form, and then clicks the Submit button. This sends the form's contents off to the server. The server reads the form's contents and does something. (The server-based program can update a database, send a response back to the browser, or both.) Web developers traditionally used CGI code for their server-based programs that read the form and perform a task. Microsoft introduced ASP as a replacement option for that. ASP code places less of a burden on the server than CGI code. ASP can be browser-neutral because it is capable of writing pure HTML back to browsers. This will work in just about any browser.

This article shows a very simple browser application that taps an Access database via an HTML form and some ASP code. This particular application illustrates how to use a drop-down select box, which is a popular means of gathering user input on forms. A hyperlink on the page showing the information the user requested lets the surfer return easily to the original query page.

In the HTML body section of the Web page, a form tag contains both the select tag and the button. However, it dynamically sets the options for the select box inside of a do loop. Each select box option can have a value that it takes when a user makes a selection and a label that it shows when a user clicks it open. A statement in the loop assigns both of these for each record. After performing the assignments, the ASP script moves to the next record. The do loop automatically terminates when it encounters an eof for the recordset.

There are three distinct ways of working with Access databases via Web-based forms. Each of these ways has distinct advantages.

- *First, the Publish to the Web Wizard is exceptionally easy to use. In many situations, you can use it without any coding. In addition, with a little effort you can extend its basic solutions in custom ways. Because the Publish to the Web Wizard relies on ActiveX controls, it restricts the browsers that can use it to Internet Explorer version 3.0 or later.*
- *Second, you can develop custom solutions to tap Access databases over the Web with HTML forms and ASP files. This powerful and robust solution works with all kinds of browsers. However, it requires hand-coding. There are no wizards to simplify this approach. Your code has to mix ASP and HTML in the same file for maximum impact. Although not inherently*

difficult, this kind of coding is a hybrid that requires developers to become proficient at two different coding languages.

- *The third approach is attractive because it builds on Microsoft's most recent client-side development technology -- Dynamic HTML (DHTML). Data binding requires a single scripting language -- pure DHTML. It has the major disadvantage of being restricted to version 4 or later of Internet Explorer. However, if Microsoft continues to develop this innovative Web scripting technology, you will find your initial investment in learning it pays great dividends.*

Many small businesses and departments in large organizations rely on Microsoft Access for data access and data management. One factor contributing to the success of Access in this target market is the depth of its data processing capabilities versus its ease of use. While Access does not scale like some other database managers, for example Microsoft SQL Server, it offers excellent ease of use and flexible procedures for publishing to the Web. The rapidly escalating popularity of the Web makes the database publishing capabilities of Access particularly noteworthy. Access serves well on departmental intranets and Internet sites for small businesses that do not encounter a large number of concurrent hits.

*****

Paginile ASP generate cu Access conțin cod text, în limbajele HTML şi VBScript. Practic partea de design este generată în HTML, iar partea de acces la baza de date este generată în VBScript. Pentru accesul la o bază de date limbajul VBScript se utilizează colecția de obiecte ADO (ActiveX DataBase Object) şi de limbajul SQL.

Generarea propriu-zisă a unei pagini ASP se realizează prin parcurgerea mai multor paşi:

- crearea DSN-ului pentru realizarea legăturii dintre pagina Web şi baza de date;
- se selectează obiectul pentru care se doreşte generarea paginii, din fereastra bazei de date sau se deschide;
- se activează meniul *File*, opțiunea *Export*, se selectează în caseta *Save as Type* varianta Microsoft Active Server Pages; se precizează numele paginii în caseta *File Name*; se acționează butonul de comandă *Save*;
- în fereastra Microsoft Active Server Pages *Output Option* se configurează următorii parametri:
- dacă există un şablon după care se va defini pagina, se indică numele şi calea în caseta *HTML Template*;
- numele DSN-ului este obligatoriu şi se precizează în caseta *Data Source Name*;
- dacă se doreşte conectarea la baza de date un anumit user, terbuie precizat numele acestuia (user to connect as) şi parola (password for user);
- server URL, indică site-ul unde se va găzdui pagina;
- sesion time out (min.) perioadă în care se încearcă realizarea conexiunii cu sursa de date; după expirarea acestei perioade, dacă nu s-a realizat conexiunea este returnată o eroare.

Obiectele de tip Data Access Pages sunt gestionate în secțiune *Pages* din fereastra bazei de date (Database Window). La salvarea unui astfel de obiect se crează automat un fisier separat de baze de date, care va conține pagina Web generată din obiectul Access. Obiectul din baza de date memorează o legătură (shortcut) către acestă pagină. Ştergerea fisierului HTML de disc, este echivalentă pracic cu ştergerea obiectului din baza de date, acesta chiar dacă nu este şters fizic, devenind inutilizabil fără pagina Web. Acest obiect este asemănător cu un obiect de tip *Formular*, numai că se utilizează în contextul accesări bazei de pe Internet. Obiectul salvat în baza de date se poate utliza şi din baza de date Access, însă ele este totuşi conceput pentru a fi accesat de pe Internet, Microsoft Access mai mult pentru proiectarea paginii Web, decât pentru actualizarea datelor. Paginile Web de tip Data Access Pages sunt procesate corect în programul de navigare de Internet *Microsoft Internet Explorer*, începând cu versiunea 5.0. Pentru proiectarea manuală a unui obiect de tip pagină Web este pus la dispoziție un set de controale grupate într-o bară de instrumente *Tool Box*, utilizarea acestora fiind asemănătoare cu a celor din cadrul obiectelor de tip raport sau formular.

Marcajul HTML principal pentru referințe externe este <A>; marcajul ancoră este un marcaj de tip pereche, deci se încheie cu </A>. Marcajul ancoră trebuie să conțină atribute, altfel nu are nici un sens şi nu efectuează formatarea informației. Pentru ca o legătură să fie activă, adică să comande programului de navigare să execute ceva, trebuie să fie specificat un atribut de referință hypertext şi anume HREF= ''valoare''. Valoarea poate fi vidă dacă nu se cunoaşte informația respectivă, dar trebuie specificat atributul HREF (Hypertext REFerence) pentru ca legătura să apară activă în programul de navigare.

Formatul marcajului <A> este :

<A HREF= ''valoare''>Text formatat</A>

Textul ce apare între marcajele <A> şi </A> (marcajele de ancoră) va fi afişat colorat în albastru şi subliniat sau evidențiat într-o altă formă. Informația care apare între ghilimele este URL-ul paginii Web către care se face referința.

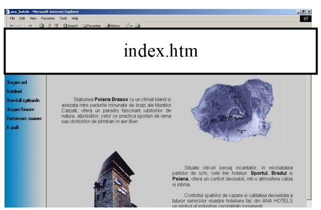
O problemă devenită clasică în codul HTML este utilizarea simbolurilor rotunjite pentru ghilimele; serverele Web nu ştiu ce semnifică acestea. Trebuie verificat dacă ghilimelele din documentele Web sunt toate drepte:''aşa'' şi nu ''aşa''. Acelaşi lucru este valabil şi pentru apostroafe.

Pentru a realiza pagini Web profesionale atât ca înfățişare cât şi ca utilizare este indicată combinarea altor marcaje HTML cu referințe atât interne cât şi externe.

Următorul exemplu prezintă crearea legăturilor către alte servicii :

```
<HTML>
<HEAD>
<TITLE>Destinații pe rețea</TITLE>
</HEAD>
<BODY>
<H1>Multi-Service Travel Destination on the 'Net</H1>
<I>Did I miss one?<A HREF=''mailto:taylor@intuitive.come">Drop me a note </A></I>
<HR>
<B><Gopher></B>
<UL>
<LI><A HREF=''gopher://gopher.loc.gov/ ''>Library of Congress Gopher Service.</A>
<LI><A HREF=''gopher://owl.english.purdue.edu/''>The Purdure University On line Writing Lab.</A>
</UL>
<B>FTP</B>
<UL>
<LI><A HREF=''ftp://gatekeeper.dec.com/''>A visit to the DEC Gatekeeper archive.</A>
<LI><A HREF=''ftp://ftp.eff.org/">The Electronic Frontier Foundation</A>
<UL>
<B>Telnet</B>
<UL>
<LI><A HREF=''telnet://well.com/">zip to the Whole Earth 'Lectronic Link. </A>
<LI><A HREF=''telnet://bbs.packardbell.com/''>… or check in at the Packard Bell BBS.</A>
</UL>
</BODY>
</HTML>
```

Modularizarea aplicației



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7 . PUBLISHING DATASHEETS TO THE WEB IN ACCESS

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Abstract

This presentation focuses on publishing datasheets to the Web. A datasheet is a tabular representation of data. It can be an individual table or a query that extracts results from one or more tables. Datasheets often form the core component of a Web database report. There are at least three

major approaches to publishing Access datasheets. First, you can use the Publish to the Web Wizard in Access. This built-in feature holds a user's hand through the process of publishing data. The wizard offers three distinct ways to publish data. Second, Access developers can write ASP script and HTML code to publish data from a Web server to browsers. Third, you can publish Access data with Dynamic HTML (DHTML). This, again, requires custom code development, but it can speed data access and simplify common data processing tasks.

Static publishing is attractive for data that changes infrequently and for situations where you want to control precisely when a set of pages updates. A price list and a monthly sale report are examples of data sources that might benefit from static reporting. Dynamic publishing best serves situations where the worth of a report depends on its timeliness and where the underlying data changes often.

The Database Access component in ASP permits the generation of datasheets on the fly. This component relies on ActiveX Data Objects (ADO). Microsoft promises to make DAO and RDO obsolete with its newer ADO data access technology. Some of the core benefits of ADO are ease of use, low memory overhead, and a small disk footprint. You can create a recordset reference by setting a reference in a scripting language, defining an SQL statement, and pointing to an ODBC data source.

The .asp file starts by creating a connection or using an existing one. Then, it creates a recordset that includes all the fields in all records of the Shippers table. VBScript codes the connection and recordset specification. Next, HTML code defines the table and column headings. The concluding block of code intimately mixes HTML code and ASP script.

As you can see, there are many ways to publish Access datasheets to the Web. There is no inferior way. Their diversity serves well the collective needs of Access developers and users who want to publish data to the Web.

One obvious distinction is static versus dynamic publishing. Static publishing is like taking a snapshot. It shows the data at a single point in time. A datasheet published with static HTML always returns the same datasheet values. There are some situations, such as a monthly sales report, that require a static publication. Its main strength is that it is easy to do. You do not have to worry about setting and managing ODBC connections. Static HTML can run on any server.

Dynamic publishing is attractive for one obvious reason: Revisions to databases underlying these datasheets appear automatically when visitors link to them. Surfers always get the freshest data without any re-publication of the datasheet. This kind of publication is great for data that changes often or irregularly.

This article shows you how to use Microsoft Access to develop applications that retrieve, publish, and share information on the Internet or a local area network (LAN). For example, you can create applications that display HTML documents in forms, or you can publish or share information from a database located on a Web server. You can also create hyperlinks that you click to navigate to database objects and other Microsoft Office documents located on a local hard disk or a local area network.

The process of converting a Microsoft Access database to a Microsoft SQL Server database is called upsizing. Typically, a Web application using a Microsoft Access back end will be appropriate for a Web site on most corporate intranets or for use on a World Wide Web site in situations where your application will be accessed by a limited number of users. If your Web site grows to the point where it gets thousands of hits per day or has many users accessing and updating the database concurrently, you should consider upsizing the database to Microsoft SQL Server.

Even if you intend to use SQL Server from the start, starting development of an Internet application in Microsoft Access is a good idea for several reasons:

- *You can leverage your knowledge of a familiar tool.*
- *The Microsoft Access interface for developing your tables, relationships, and queries provides graphical design tools and wizards that are easier to use.*
- *Database development typically requires many iterations before completion. Doing so in Microsoft Access is less complex, so you can rapidly prototype the back end for your application.*

Your application can grow with your needs. If the requirements of your application remain small, there is no need to add the additional overhead of SQL Server. If your application becomes more complex and must support more users, you can scale up to the improved performance, security, and reliability of SQL Server.

*****

Formularele asigură construirea unor pagini Web care permit utilizatorilor să introducă efectiv informaţii şi să le transmită serverului. Calea de comunicare între programul de navigare Web şi server se numeşte interfaţă CGI (Common Gateway Interface). Toate formularele Web sunt asemanatoare, dar există numai două căi prin care informaţiile pot fi transmise de la programul de navigare Web la serverul situat în celălalt capăt al reţelei. Dacă informaţiile sunt transmise cuprinse într-un formular, şi URL-ul de destinaţie include informaţiile introduse, avem de-a face cu un formular de tip ''get'' (METHOD=GET). Alternativa constă în transmiterea informaţiilor, URL-ul de destinaţie nu conţine alte elemente suplimentare adăugate la sfârşit, avem de-a face cu un formular de tip ''post'' (METHOD=POST).

Formularele HTML sunt delimitate de marcajul <FORM>, care se specifică prin:

<FORM ACTION=url METHOD=metodă>

…

</FORM>

În cadrul marcajului <FORM>, pagina Web poate cuprinde orice informaţie HTML standard de formatare, grafică, legături către alte pagini şi o mulţime de noi marcaje, specifice formularelor. Un marcaj important prin care se permite introducerea datelor este marcajul <INPUT>. Următorul tabel prezintă atributele marcajului <INPUT> însoţite de semnificaţie.

Atribut	**Semnificaţie**
TYPE=*opt*	Tipul câmpului de intrare <INPUT>
NAME=*nume*	Numele simbolic al valorii câmpului
VALUE=*valoare*	Conţinutul prestabilit al câmpului de tip text
CHECKED=*opt*	Buton/casetă validată în mod prestabilit
SIZE=*x*	Numărul de caractere al casetei de text afişate
MAXLENGTH=*x*	Numărul maxim acceptat de caractere

Programele de navigare Web curente permit lucrul cu două tipuri de <INPUT>, fiecare dintre acestea deteminând un tip diferit de ieşire. Tipurile de intrări-utilizator sunt:

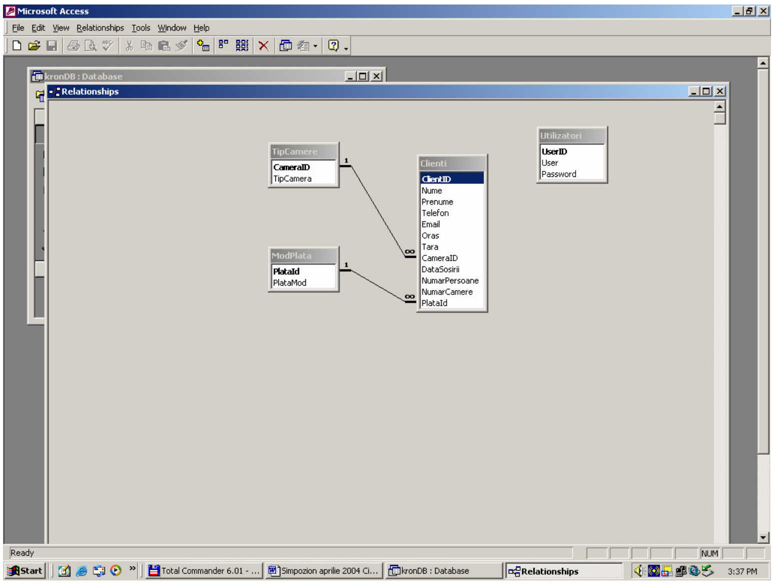
- TEXT este tipul prestabilit, cu SIZE utilizat pentru a specifica mărimea prestabilită a casetei care se creează.
- PASSWORD (parola) este un câmp de text, iar datele introduse de utilizator sunt afişate prin caracterul ''*'' sau alte simboluri, din motive de securitate. Opţiunea MAXLENGTH poate fi utilizată pentru a specifica numărul maxim de caractere permise pentru parolă.
- CHECKBOX (caseta de validare) asigură o singură casetă (negrupată) de validare; opţiunea CHECKED permite să se specifice dacă această casetă urmează sau nu să fie marcată în mod prestabilit. Opţiune VALUE specifică textul asociat casetei de validare.
- HIDDEN (ascuns) permite transmiterea informaţiilor programului care prelucrează datele-utilizator, fără ca utilizatorul să le vadă pe ecran. Este util, în mod deosebit în cazul în care pagina care conţine formularul HTML este generată automat de un script CGI.
- RADIO afişează un buton cu interblocare; diferitele butoane cu interblocare care au acelaşi nume NAME=valoare sunt grupate în mod automat, astfel încat un singur buton din grup poate fi selectat.
- FILE (fişier) oferă posibilitatea de a permite utilizatorilor să transmită serverului un fişier.
- SUBMIT (transmite) determină apariţia în formular a unui buton, care, atunci când este apăsat, transmite conţinutul întregului formular la serverul aflat la distanţă.
- IMAGE este identic cu SUBMIT, numai ca în locul unui buton, permite specificarea unei imagini grafice penru transmisia datelor sau un buton de ENTER. În cazul în care utilizatorii au optat, prin configurarea programului de navigare, pentru neafişarea imaginilor, se poate utiliza atributul ALT ce permite includerea unui text pentru a rezolva această problemă.
- RESET, care permite utilizatorilor să şteargă conţinutul tuturor câmpurilor formularului.

Alte două marcaje specifice formularelor sunt: <SELECT> ce defineşte un grup de casete de validare şi <TEXTAREA> ce defineşte un câmp de intrare de tip text pe linii multimple.

Marcajul <SELECT> defineşte un meniu derulant de opţiuni, având marcajul de închidere </SELECT> şi parametrul <OPTION> care defineşte fiecare opţiune a meniului. Trebuie specificat şi atributul NAME care identifică în mod unic întregul meniu definit de marcajul <SELECT>. În cadrul marcajului se poate specifica un atribut SIZE, care indică numărul articolelor de meniu care vor fi afişate o dată şi atributul MULTIPLE, care specifică dreptul utilizatorilor de a selecta mai mult de o opţiune. Dacă există o valoare prestabilită, trebuie adăugat atributul SELECTED.

Marcajul <TEXTAREA> permite construirea unei casete de intrare pe linii multimple. Trebuie specificat atributul NAME ce reprezintă un nume unic al casetei. Marcajul <TEXTAREA> permite definirea dimensiunilor casetei de intrare de tip text, cu ajutorul atributelor ROWS (linii) şi COLS (coloane). Marcajul <TEXTAREA> are marcajul de terminare </TEXTAREA>.

```
<HTML>
…
<FORM>
<B>Numele</B>:
<INPUT Type=text Name="numele"><BR>
<B>Prenumele</B>:
<INPUT Type=text Name="prenumele"><P>
<B>Post  TV preferate</B>:
<SELECT Name="opţiuni">
<OPTION SELECTED>(alege ceva)
<OPTION>Romania 1
<OPTION>TVR 2
<OPTION>Antena 1
<OPTION>ProTV
<OPTION>Prima TV
</SELECT><P>
<B>Comentarii</B>:<BR>
<TEXTAREA Name="comentariu" ROWS=5 COLS=100>
</TEXTAREA><P>
<CENTER>
<INPUT Type=SUBMIT Value="  OK  ">
<INPUT Type=RESET Value="Cancel">
</CENTER>
</FORM>
…
</HTML>
```




```
<HTML>
    <HEAD>
```

```
        <META HTTP-EQUIV="Content-Type" CONTENT="text/html; charset=iso-8859-1">
    </HEAD>
<BODY bgcolor="861414" LEFTMARGIN="0" TOPMARGIN="0" MARGINWIDTH="0"
MARGINHEIGHT="0">
<table align="center" width="790" border="0" cellpadding="0" cellspacing="0">
    <tr>
        <td colspan="2"><img src="desprenoi/top.gif" width="790" height="171" alt="Pensiunea
Kronstadt" border="0"></td>
    </tr>
    <tr>
        <td background="desprenoi/downButton.gif" width="202" valign="top">
            <TABLE CELLPADDING="0" CELLSPACING="0" BORDER="0">
                <TR>
                    <TD COLSPAN="2" valign="top"><IMG WIDTH="202" HEIGHT="69"
SRC="desprenoi/topButton.gif" BORDER="0"></TD>
                </TR>
                <TR>
                    <TD ROWSPAN="6" valign="top"><IMG WIDTH="50" HEIGHT="132"
SRC="desprenoi/leftButton.gif" BORDER="0"></TD>
                    <TD valign="top"><a href="index.html"
onMouseover="document.images.desprenoi.src='desprenoi/despreNoiOn.gif'"
onMouseout="document.images.desprenoi.src='desprenoi/despreNoiOff.gif'"><IMG WIDTH="152"
HEIGHT="22" SRC="desprenoi/despreNoiOff.gif" BORDER="0" name="desprenoi"></a></TD>
                </TR>
                <TR>
                    <TD valign="top"><IMG WIDTH="152" HEIGHT="22"
SRC="desprenoi/cazareSel.gif"
            BORDER="0" name="cazare"></TD>
                </TR>
                <TR>
                    <TD valign="top"><a href="restaurant.html"
onMouseover="document.images.restaurant.src='desprenoi/restaurantOn.gif'"
onMouseout="document.images.restaurant.src='desprenoi/restaurantOff.gif'"><IMG WIDTH="152"
HEIGHT="22" SRC="desprenoi/restaurantOff.gif" BORDER="0" name="restaurant"></a></TD>
                </TR>
                <TR>
                    <TD valign="top"><a href="turism.html"
onMouseover="document.images.turism.src='desprenoi/turismOn.gif'"
onMouseout="document.images.turism.src='desprenoi/turismOff.gif'"><IMG WIDTH="152"
HEIGHT="22" SRC="desprenoi/turismOff.gif" BORDER="0" name="turism"></a></TD>
                </TR>
                <TR>
                    <TD valign="top"><a href="rezervari.asp"
onMouseover="document.images.rezervari.src='desprenoi/rezervariOn.gif'"
onMouseout="document.images.rezervari.src='desprenoi/rezervariOff.gif'"><IMG WIDTH="152"
HEIGHT="22" SRC="desprenoi/rezervariOff.gif"
            BORDER="0" name="rezervari"></a></TD>
                </TR>
                <TR>
                    <TD valign="top"><a href="contact.html"
onMouseover="document.images.contact.src='desprenoi/contactOn.gif'"
onMouseout="document.images.contact.src='desprenoi/contactOff.gif'"><IMG WIDTH="152"
HEIGHT="22" SRC="desprenoi/contactOff.gif"
            BORDER="0" name="contact"></a></TD>
                </TR>
                <TR>
```

```
                    <TD COLSPAN="2" valign="top"
background="desprenoi/downButton.gif"> </TD>
                </TR>
                </TABLE>
            </td>
            <td valign="top" bgcolor="White">
                <table border="0" cellpadding="0" cellspacing="0">
                    <tr>
                        <td rowspan="3"><img src="restaurant/leftPic.gif" width="34" height="200"
alt="" border="0"></td>
                        <td colspan="3"><img src="restaurant/topPic.gif" width="521" height="34"
alt="" border="0"></td>
                        <td rowspan="3"><img src="restaurant/rightPic.gif" width="33" height="200"
alt="" border="0"></td>
                    </tr>
                    <tr>
                        <td><img src="cazare/pic1.gif" width="173" height="132" alt=""
border="0"></td>
                        <td><img src="cazare/pic2.gif" width="174" height="132" alt=""
border="0"></td>
                        <td><img src="cazare/pic3.gif" width="174" height="132" alt=""
border="0"></td>
                    </tr>
                    <tr>
                        <td colspan="3"><img src="restaurant/downPic.gif" width="521" height="34"
alt="" border="0"></td>
                    </tr>
                    <tr>
                        <td colspan="5"><img src="cazare/title.gif" width="588" height="64" alt=""
border="0"></td>
                    </tr>
                    <tr>
                        <td align="left" colspan="5">
                            <table border="0" cellpadding="0" cellspacing="0">
                                <tr>
                                    <td>
                                             
                                    </td>
                                    <td>
                                        <div align="justify" style="width:520;">
                                <font face="book antiqua,arial" size="-1">
                                Pensiunea dispune de o capacitate de cazare de 28 locuri in 14 camere cu
2 paturi sau pat dublu si
un apartament de 2 locuri.
Fiecare camera este dotata cu televizor color, TV cablu, minibar, telefon international,
mobilier nou, baie cu cabina de dus.                    <br><br>
camera cu 2 paturi .............................. 30 EUR/zi<br>
camera cu pat matrimonial ................35 EUR/zi<br>
apartament.............................................45 EUR/zi
                                        <br><br>
Micul dejun este inclus in costul camerei                   <br>
                                </font>

                                        </div>
                                        <br><br><br><br><br><br><br>
                                    </td>
                                </tr>
```

```
                    </table>
                </td>
            </tr>
        </table>
    </td>
  </tr>
</table>
</BODY>
</HTML>
```

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8. E-BUSINESS PROCESS AND CULTURAL CHALLENGES

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Abstract

The Internet – it is the most innovative way of sharing information. This revolution in the sharing of information represents the best in technological developments of modern history. It has manifested completely new sets of business rules and technological issues. In addition, this multi-phased medium is in its simplest of terms, a brand-building tool, a way of generating sales, leads and enhancing customer support, or all of them.

The new growing Web economy is driving companies' worldwide to develop effective business strategies, and they are now focusing on the need of redefining them. An effective e-business strategy will have to consider not only the existence of a corporate portal to the outside world, but also the entire business process and the ways to improve it.

Some fundamental e-business challenges addressed by this technology is the limited trust in trading partner relationships; poor understanding of existing processes or the inability to automate

them; cultural aspects related to both internal and external customers; but most importantly, by the inadequacies in current business rules.

The modern company's' needs mandates an innovative business model with a globalized system design in mind. The new business model layers of "internationalization", along with those of "localization", need to seriously address cross-cultural communications. The modern company is required to seek the most efficient ways of synchronizing business-modeling objects with strategic business rules.

1. The Promise of E-Business

The rapidly increasing scope and usage of ICT and access to worldwide communication by companies of all sizes across world has already led to incredible changes to the business environment and economic development policy. Despite the Internet promise of collaboration, lowered transaction costs, increased revenues, and mass customization, e-business also raises a completely new set of business and technology issues and is driving companies worldwide to define what opportunities does the Internet offer to improve their business model and to come up with effective e-business strategies, in order to improve existing, traditional business processes. In addition, companies begin to think more strategically and globally and rethink fundamentally the processes by which they identify, communicate, and deliver customer value. Successful companies development efforts look to facilitate a more international orientation.

The Internet capabilities to directly connect market offer to producers the opportunity to open new delivery channels and introduce new exchange methods. The new technology impact depends on the goals of the organization that plan to make use of Internet and the World Wide Web. Some companies benefit by using this revolutionary communication tool for direct sales, others use it for an immediate reduction in the cost of customer service, and others view the Web as an opportunity to develop new markets, to create and sell new services altogether. Businesses also find many uses for communication over the Internet, from lowering the costs of faxes sending, to superior internal communication, which lead to faster time-to-market.

Some of the challenges that companies must overcome to become e-business leaders are:

- Limited trust in trading partner relationships;
- Poor understanding of existing processes or inability to automate them;
- Cultural aspects related to both internal and external customers;
- Inadequacies in current business rules;
- External factors drive (competitors, or a major trading partner dictating that a continued relationship hinges on conducting e-business).

All of these requires a lot of process and cultural changes to be made, before implementing e-business initiatives. An effective e-business strategy will consider a company's business process and the way it can be improved and automated by the instant, global communication mechanism the Internet offers. To succeed, e-business must create and be able to support the electronic dialog. Business performance relies upon the consistency and tone of this dialog.

2. Cultural Challenges

Clearly the Digital Revolution has changed traditional business practices by providing direct global access to products and services. A company's web site can now enable companies to interactive communicate with customers through online discussion groups, bulletin boards, electronic questionnaires, mailing lists, newsletters, and e-mail, these being only some of the opportunities it offer. Companies are able to build now close relationships with their customers and tailor specific behavior to individual customer needs and wants, by interactively involving them in the development, marketing, sales, and support of products and services, along with the company's market researchers, products designers, marketing, sales and technical team.

But a global approach requires a focused integrated strategy among people, languages, economies, nations, cultures and technologies and must be considered from the beginning of any business start up. Definitely, process must not be separated from cultural issues related to both internal and external customers. Everywhere business leaders are fretting about how to address the business process and cultural challenges of *'going global'*. *Globalization* refers to the process of *internationalization* and *localization* of Web sites and of software applications. It demand an infrastructure that can help companies manage the rapid change of content across multiple languages and help them to architect an e-business solution that can scale across various target markets.

Internationalization implies designing a software or Web application to handle linguistic and cultural conventions without additional engineering. Central to internationalization is the separation of language and cultural data from the source code. *Internationalization* involves:

- Ensuring that all localizable elements are extracted from the source code;
- Ensuring that the design of the user interface (UI) is personalized, accessible, dynamic and neutral;
- Ensuring that the relevant character set is supported;
- Ensuring that regional standards are supported (including political and economic ones which may implies specific managerial approaches/practices);
- For Web sites, ensuring that text embedded in graphics is easily localizable.

Localization implies adapting a product to the requirements of a locale market segment. This involves the translation of the user interface (UI) (text messages, icons, buttons etc.) of the online help, and of any documentation and packaging, and the addition of cultural data and language-dependent components, such as spell-checkers, input methods and so forth. *Localizable* includes all messages, icons, buttons etc. of an user interface (UI) and all the other human-readable content that should be translated in the user's language.

Issues that the developer should take into account at UI design:

- Text expansion: extra space should be added to control buttons, menu trees and dialog boxes to account for language-specific text expansion;
- Cultural-dependent or ambiguous symbols should be avoided: body parts (e.g., hand gestures), religious symbols, graphics with more than one meaning and cultural - specific symbol (e.g., the stop sign), as they may lead to misunderstandings.

Additional, the web site hosting must be *regional*, and mirrored, to ensure respectable download times. The necessary *regional* standards, which should be supported by the software and Web application, include:

- Measurement formats (e.g., centimeters vs. inches);
- Number formats (e.g., different thousand separators);
- Time formats (use of the 24-hour or 12-hour clock);
- Date/Calendar formats (e.g., the mm/dd/yy format vs. the dd/mm/yy; the Chinese calendar);
- Currency formats (national currencies, and related issue);
- Phone Number formats (e.g., number separators);
- Sorting rules (different alphabetical orders).

In most developed business environments, regional standards and character encoding are dealt with specific locale standards, rules and data related to a language and geographical area. A French Unicode Locale, for instance, will include regional definitions for currency, the Euro symbol, date, time, numerical notation and text messages. An Asian Locale (e.g. a Japanese locale) will also include input methods and dictionary editing definitions.

A simple demonstration of culturally distinct design is given by Stefan Peterson, Marketing Manager of *Bokus.com*, the largest Scandinavian online bookseller. He points out the clarity and lack of clutter in the Web site design. Even his Danish and Finnish customers tell him that the site looks 'really Swedish'. Comparing it with *Barnes& Noble.com* or *Amazon.com* we can found that the American designs fill the page with every option they can fit in there.

Douwe Mik, Managing Director of Logigo.com, an e-market startup in logistics, offers another example. He had his new company's name checked for worldwide cultural acceptance. The report concluded: "We have looked at this from the Chinese, Malay (snip) and we think that perhaps the pronunciation of the words could be close to a local expression "Lau-chee-ko" which roughly translated in a Chinese dialect used locally means “dirty old man”. Also *Coca-Cola* Company instituted a name change, in China, after it found that in Chinese, “*Coca-Cola*” means “bite the wax tadpole”.

3. Conclusions

Whenever a company will expand across borders, or develop a new e-business, will face with the issue of either sticking to its product without any change, adapting the product to the new market or developing an entirely new product. The decision taken will depend primarily on the preferences of consumers but is also closely linked with the cost of manufacturing and government regulations. Additionally the entire communicational approach with the customers has to be consistent with the language, cultural norms, religious more and perceptive capacities of the society for which it is intended, in order to avoid interpretations of the promotional message in unintended ways. Although this should be obvious, even the most successful marketers occasionally overlook the importance of understanding the intricacies of consumer perceptions.

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9. NUMERICAL METHODS FOR THE STUDY OF LOANS REIMBURSEMENT

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Abstract

In order to establish the reimbursement table, the formulas that appear can be easier calculated using some numerical methods. These procedures may permit to evaluate the cost rate using a polynomial function of n-order, where n is the number of the years in which the loan is reimbursed. Also we can establish the cost rate and the optimal period of reimbursement for the bonds emitting society. For this purpose we have used some numerical methods like linear interpolation and nomographs.

1. Introduction

Let consider a loan with bonds where the number of issued bonds is N.
The bonds are undervalued at the date of issue (underwrite day) and are sold at the issue value V_e. The registered value is $V_n \geq V_e$ and the redeemable value is $V_r \geq V_n$. Usually, the bonds are liquidated over value. With the registered value V_n is computed the interest coupon: $C = V_n \cdot I$, where i is the interest rate.

At the underwrite day, the company (or the government) collect the gross amount $N \cdot V_e$. In the mean time, the company make some expenditure for the issue of securities denoted by F. In fact, the company collect the net amount $N \cdot V_e - F$.

The rate of return for the company can be express as a cost rate. The cost rate is the bring up to date rate used in order to express the present value (at the underwrite day) of the cvasi-constant instalments used for the bonds pay off. The present value of the cvasi-constant instalments had to be equal with the net amount borrowed by the company.

The following relation define the cost rate, denote by t

$$N \cdot VE - F = r \cdot \frac{1 - \frac{1}{(1+t)^n}}{t} \tag{1}$$

where n is the number of years between the date of issue and the settling day and r is the cvasi-constant instalment which is given by the expression:

$$r = N \cdot V_n \cdot \frac{i}{1 - \frac{1}{(1+i)^n}} \tag{2}$$

in the case when $V_n = V_r$ (the registered value is equal with the redeemable value), or

$$r = N \cdot V_n \cdot \frac{i'}{1 - \frac{1}{(1+i')^n}} \tag{3}$$

in the case when $V_n < V_r$ (the registered value is less then the redeemable value), where the rational interest rate is given by the relation

$$i' = \frac{V_n}{V_r} \cdot i \tag{4}$$

Consider now the equation (1) with the expression (2) for the cvasi-constant instalment r. We obtain

$$N \cdot V_e - F = \frac{1 - \frac{1}{(1+t)^n}}{t} \cdot N \cdot V_n \cdot \frac{i}{1 - \frac{1}{(1+i)^n}} \tag{5}$$

$$\frac{1 - \frac{1}{(1+t)^n}}{t} = \frac{N \cdot V_e - F}{N \cdot V_n} \cdot \frac{1 - \frac{1}{(1+i)^n}}{i} \tag{6}$$

$$c_1 = \frac{N \cdot V_e - F}{N \cdot V_n} \cdot \frac{1 - \frac{1}{(1+i)^n}}{i} \tag{7}$$

This equation is an n – degree equation with the unknown t. The other variables are known. The problem is to solve the equation (5).

First, we have applied the linear interpolation in order to obtain an approximate solution of the equation (5)..

For example, as starting values we consider $N = 10{,}000$ bonds having the registered value $V_n = 50{,}000$ *ROL*, the issue value $V_e = 45{,}000$ *ROL*, the expenditure for the issue of securities $F = 1{,}000{,}000$ *ROL*, the number of years until the settling day $n = 4$, the interest rate $i = 0.1$ and the redeemable value equal with the registered value $V_r = 50{,}000\ ROL = V_n$, we obtain the cvasi-constant instalment $r = 157.73532 \cdot 10^6$ *ROL.*

Noting by

$$h(t) = \frac{1 - \frac{1}{(1+t)^n}}{t}$$

we obtain from (6) the equation

$$h(t) = c_1 \tag{8}$$

where c_1 is given by (7) and can have different values depending on different starting values.

For the above example we find $c_1 = c_1^0 = 2.8465406$, hence (8) becomes

$$h(t) = 2.8465406$$

In this equation the variable c_1 being known we looking for the variable t. For this purpose we can find an approximate value for t, using linear interpolation. Computing $h(t)$ for different values of t we try to obtain two values c_1^1 and c_1^2, i.e. $c_1^1 \le c_1^0 \le c_1^2$, as near as possible.

In our example, for $t^1 = 0.15$ it is $c_1^1 = 2.8549793$ and for $t^2 = 0.2$, $c_1^2 = 2.5887360$.

In order to apply the linear interpolation we consider the equation of straight line determined by two points of coordinates (t^1, c_1^1) , (t^2, c_1^2). Considering now that the point (t, c_1^0) belongs to this line, we are able to find the unknown value of t (Fig. 0). Using this procedure we obtain $t = 0.1515847$.

For the same example but having the redeemable value $V_r = 55{,}000$ *ROL* we obtain $t = 0.1894725$.

The aim of this paper is to apply other numerical methods for solve the equation (8). An interesting idea is, from the point of view of the company, to adjust some data like V_e, V_n, V_r, i, n in order to minimise the cost rate.

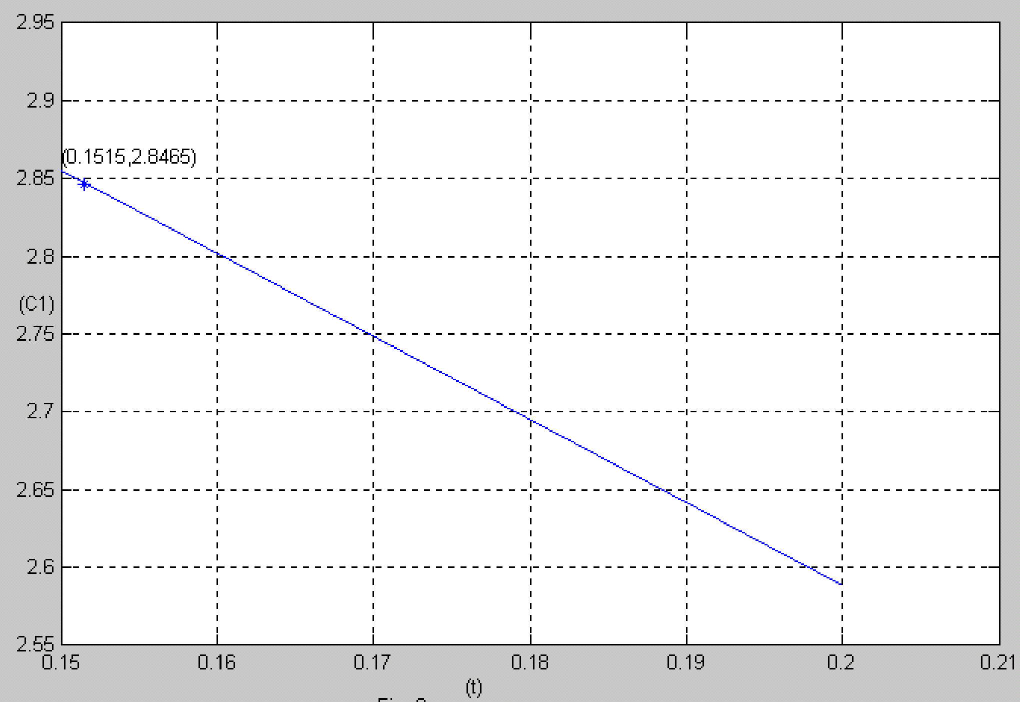

Fig. 0

One of the numerical methods, which permit us to make such adjustment, consists in nomographical procedures.

2. The nomographical method.

We will apply a nomographical procedure for solving the equation (8), written in the form

$$1-\frac{1}{(1+t)^n}=c_1 t \qquad (9)$$

To be more specific, we will build a nomogram for this equation.

Certain methods for solving the equations with more variables are the nomographical procedures, e.g. the nomograms. In this case, the functional relations between the variables become the geometric ones. For example: the "alignment" points, equalities of segments, parallelism of straight lines, etc. We obtain a nomogram, which consists of scales, family of marked curves, unmarked curves, parallel plane and so one. The analytical equations of the nomogram's elements depend on the functions from the given equation. These functions may have one or two variables. Using the nomograms we find the value of the variable (variables) as being an alignment points, equalities of segments, contact points of two planes, points situated in the same plane, and so one.

For nomographical representation, the equations have to be in a canonical form. There are known multiples canonical forms for the equations with three or more variables. Also, we have the necessary conditions to obtain these forms. The nomograms allowed us to vary the values of the variables within the specific bounds. These bounds belong to the definition domain of the functions. For each value of the known variables, we obtain the values of unknown variables. Hence, we have more values of the unknown variables and so we can chose the most convenient values for the practical problem.

Although the nomograms are easy to use and the results are quickly obtained, there is a small disadvantage. It consists in reduced accuracy of results comparing to those obtained with the computer aid. The reduced accuracy can be accepted in practical problems or can be improved by enlargement certain parts of nomogram. So, we can obtain a new nomogram with diminished bounds of the variables.

In this paper we follow to join the building and the using of the nomogram with the accuracy and the speed of the computer for drawing as much as complicated curves. To achieve this we have drawn up programs in MATLAB Programming Language.

Let consider the equation with three variables, where c_1 is given by (7). The bounds of the variations for the equation variables are:

$2 \leq c_1 \leq 3$ $1 \leq n \leq 10$ $0.01 \leq t \leq 0.9$

By applying the natural logarithmic function to the both members of the equation (9) we obtain

$$n \ln[1/(1+t)] = \ln(1 - c_1 t) \tag{10}$$

We will build for the above given equation (9) a nomogram with the nets, which consists from three-marked family of curves. For the simplicity of building and using of the nomogram we consider that two families of the net are straight lines marked families, with the parametric equations considered in the rectangular system of the coordinated *XOY*:

the family (c_1) : $x=c_1$

the family (n) : $y=n$

the family (t) : $y \ln [1/(1+t)] = \ln (1-xt)$

The straight lines (c_1) is formed from parallel straight lines with the OY axis and the straight lines (n) is formed from parallel straight lines with the OX axis.

The family of curves (t) will be built for the bounds of the variable t, with the step 0.05 .

The corresponding nomogram is represented in the Fig. 1.

The family of curves (t) will be constructed for the bounds $0.01 \leq t \leq 0.1$, with the step 0.01 , then for $0.1 \leq t \leq 0.25$ with the step 0.02 , then for $0.25 \leq t \leq 0.4$ with the step 0.03 and the last one, $0.4 \leq t \leq 0.9$ with the step 0.05 .

The corresponding nomogram is represented in the Fig. 2.

The using of the nomogram is simple. The values of the known variables are given:
$c_1^0 = 2.84$, $n^0 = 4$. We ask for the values of the variable t.

The straight lines of marked $c_1^0 = 2.84$, $n^0 = 4$ from the families (c_1) and (t) are crossing in a point P. Through this point pass a curve from the family (t), marked by $t^0 \approx 0.15$ which is the looking for value of variable t. The same value of t was obtained through a direct calculation by linear interpolation if $c_1=c_1^0 = 0.8465406$ (Fig. 0).

For other pairs (c_1, n) we obtain new points. The marked curves, which pass trough these points, allow the looking for values of t.

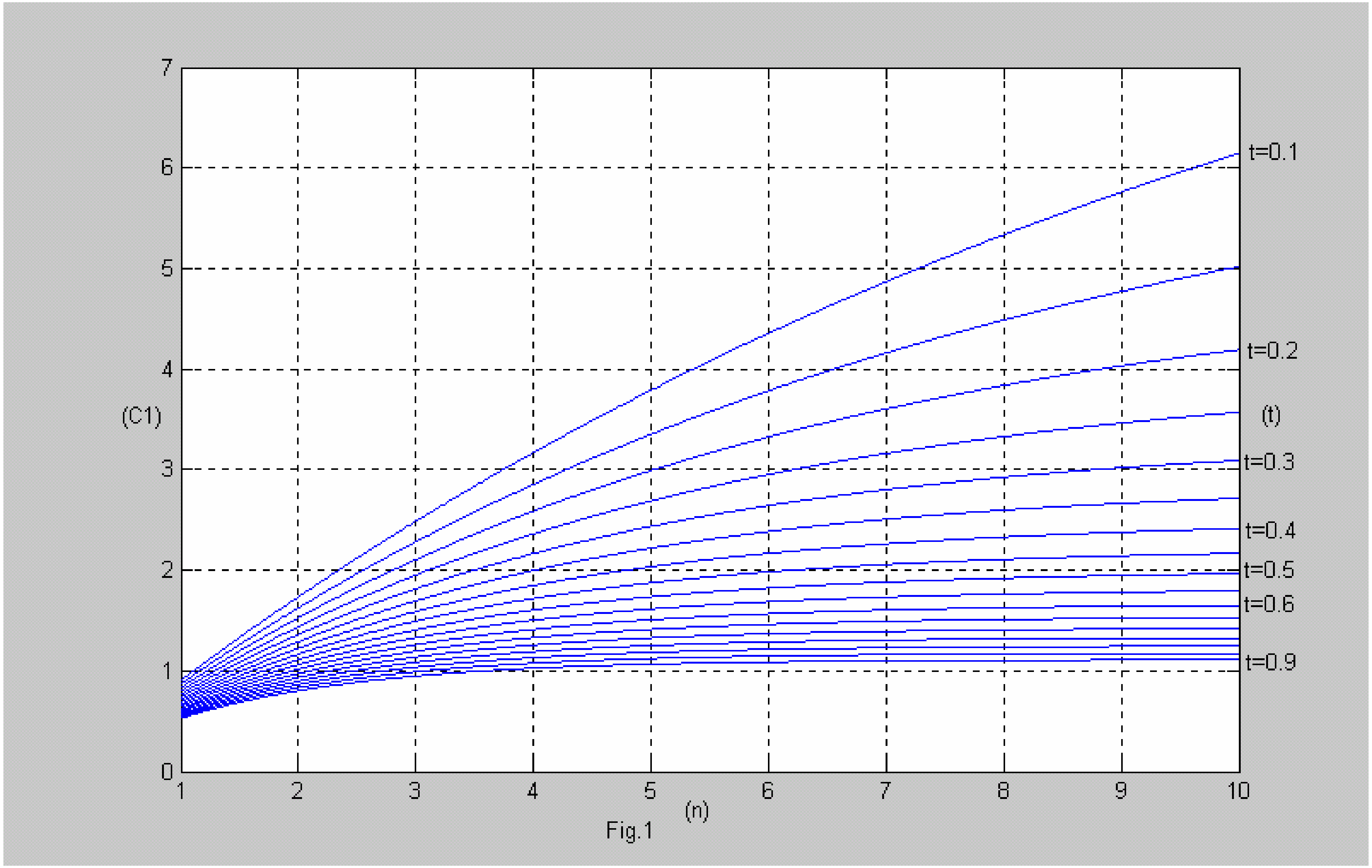

Fig.1

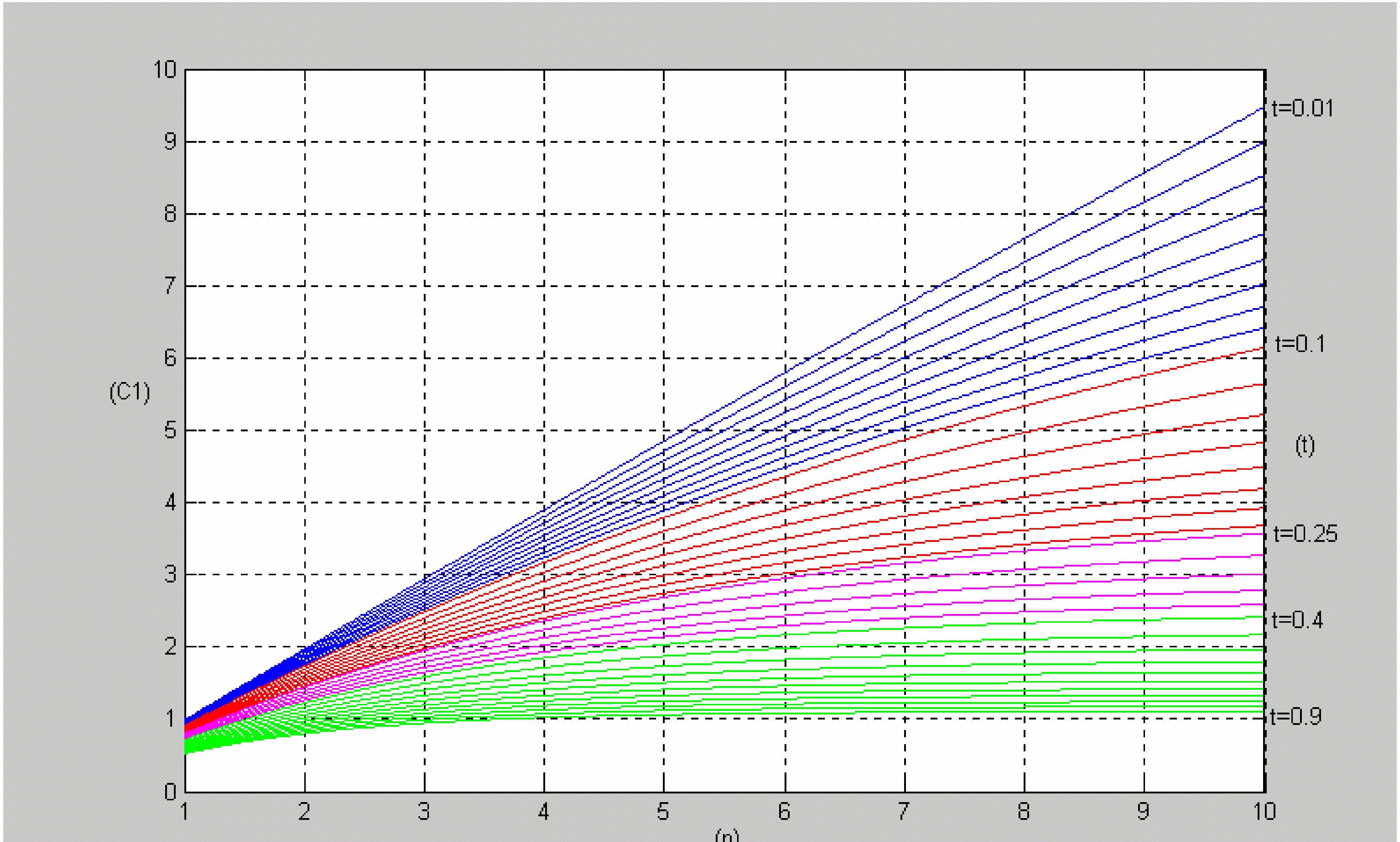

Fig.2

3. Remarks and conclusions.

i) As we mention before we can diminish the bounds of the variables from the equation (9). We obtain an enlargement of a certain part of the nomogram, corresponding to the values of the variables:

$2.5 \leq c_1 \leq 2.9$ $\qquad$ $3.7 \leq n \leq 4.7$ $\qquad$ $0.12 \leq t \leq 0.25$

In this case we obtain (Fig. 3):

$t^0 = 0.15$, for $c_1^0 = 2.855$, $n^0 = 4$ and $t^0 = 0.2$, for $c_1^0 = 2.588$, $n^0 = 4$

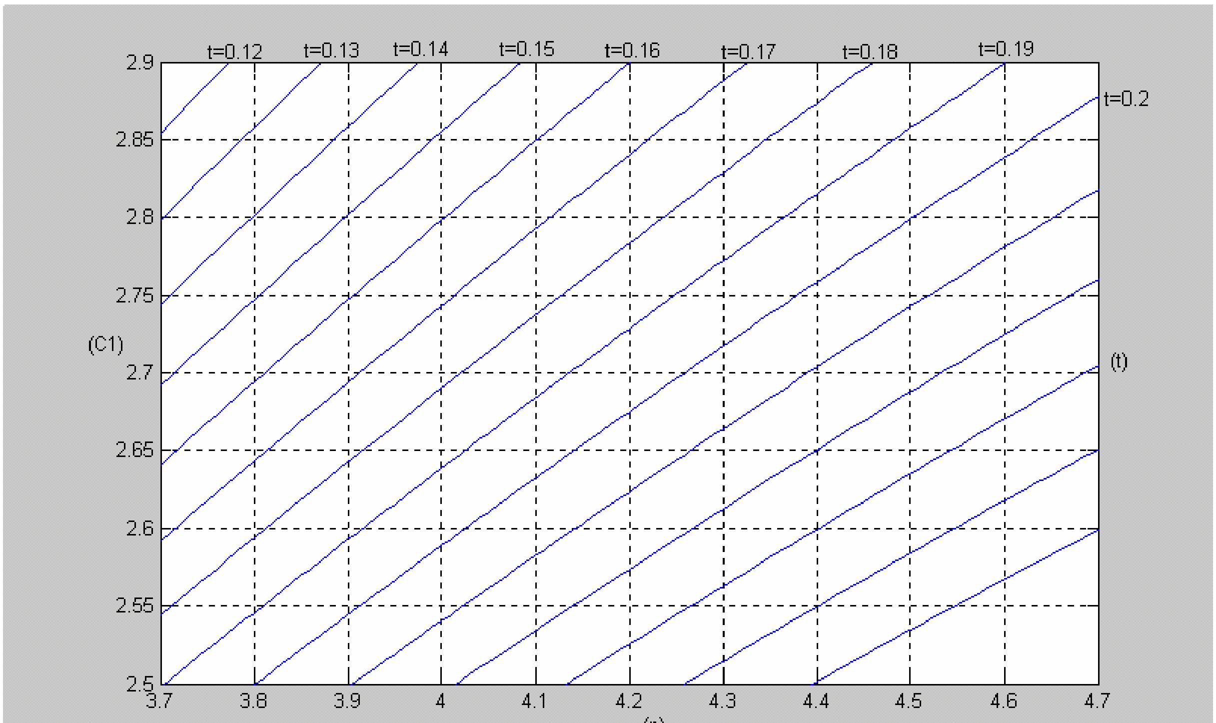

Fig.3

In Fig. 4 the nomogram are more enlarged with the bounds varying between:

$2.55 \leq c_1 \leq 2.9$ $\qquad$ $3.9 \leq n \leq 4.1$ $\qquad$ $0.14 \leq t \leq 0.20$

So, the value of the variable t is $t^0 = 0.1515$.

ii) An advantage of the building nomogram consists in the fact that any values given at two variables of the equation (9) permit us to find the third variable. For example, if $c_1 = 2.86$ and $t = 0.15$ it result $n = 4$ (Fig. 4); if $n = 5$ and $t = 0.12$ we get $c_1 = 3.6$ (Fig. 5).

iii) For the cost rate equal with interest rate $t = i = 0.1$ it can be notice the biggest variation of c_1 depending on n. The cost rate increase as well as the variation of c_1 decrease. For example, if $t = 0.5$ and $1.9 \leq c_1 \leq 2.2$ any values of n between 5 and 10 can be considerate convenient. Further for $t = 0.9$ and $1.0 \leq c_1 \leq 1.2$ any values of n between 3 and 10 can be considerate convenient. In conclusion for small cost rates the increasing of the number of the years until the settling day involve significant changing of c_1. On the other hand, for bigger cost rates the increasing of the number of the years until the settling day involves insignificant changing of c_1. (Fig.1, Fig. 2).

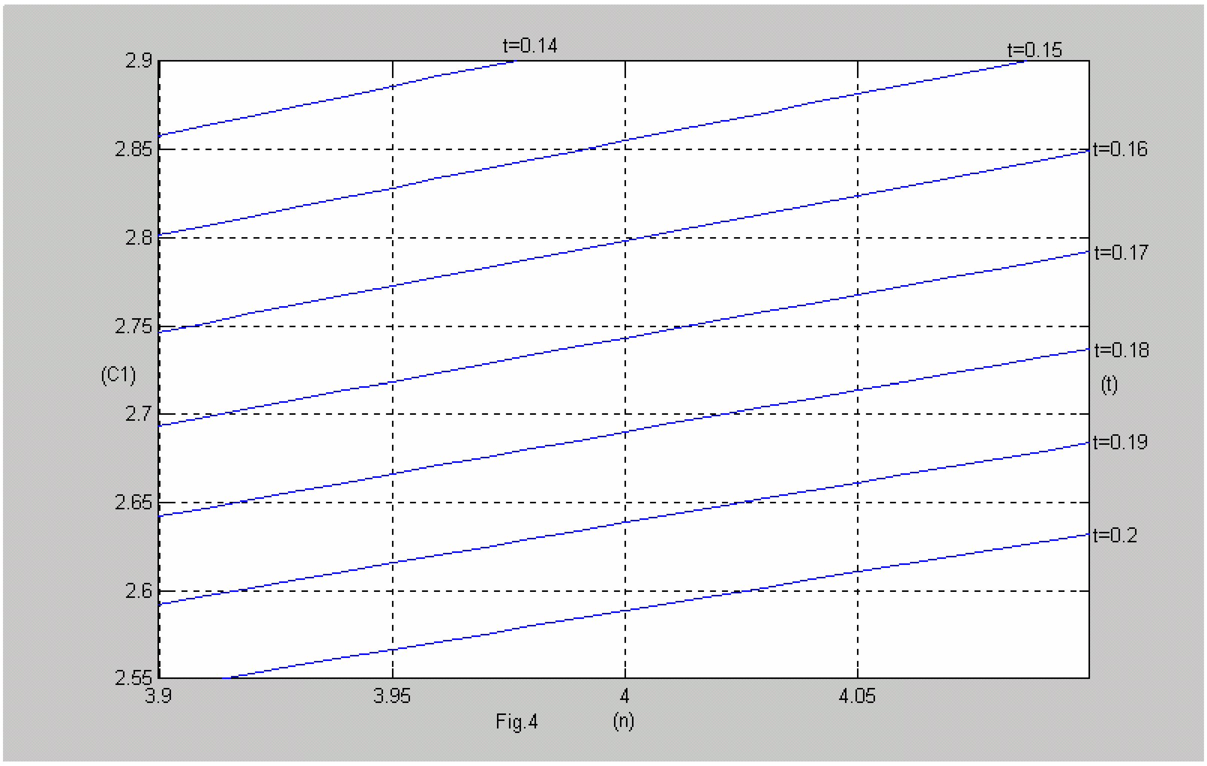

Fig.4

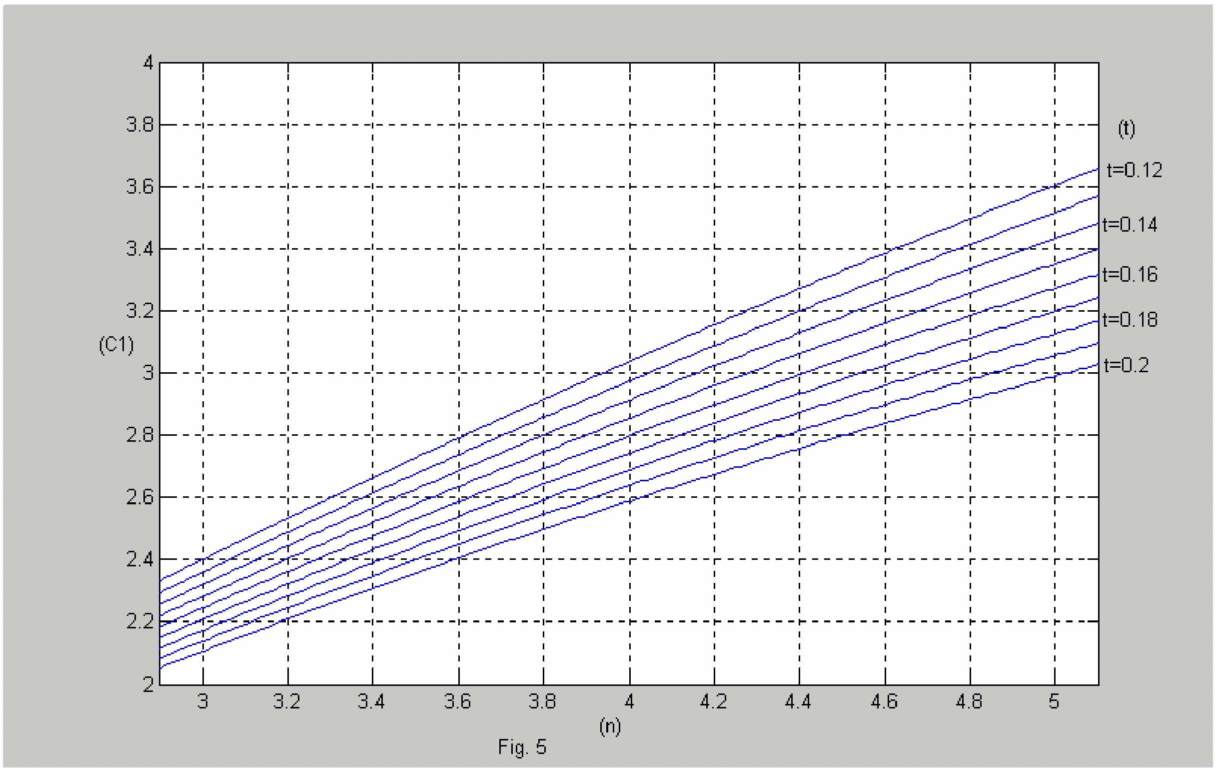

Fig. 5

iv) Looking at the Fig. 5, at the family of curves of the nomogram, it can be easily establish that for a cost rate $0.12 \leq t \leq 0.20$ and for the number of year $n = 3$ we find a variation for c_l of 0.3 $(2.1 \leq c_l \leq 2.4)$; for $n = 4$ a variation of 0.46 i.e. $2.59 \leq c_l \leq 3.05$; and for $n = 5$, the variation is 0.62 $(3.03 \leq c_l \leq 3.65)$.

4. Future research

We mention that for equation (9) other types of nomograms can be built. One is the nomogram with mobile plane and the other one with two parallel scales and a binary net.

The research for equation (9) can be extended in order to analyse the dependence of the variable c_1 on the other variables from the equation (7). Then we will study the equation with five variables:

$$\frac{1-\left(\frac{1}{1+t}\right)^n}{t} = \frac{N \cdot V_e - F}{N \cdot V_n} \cdot \frac{1-\left(\frac{1}{1+i}\right)^n}{i} \qquad (6)$$

where N and F are given constants.

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10. STASTISTICS' ROLE IN THE EUROPEAN INTEGRATION PROCESS

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Abstract

European Union is an integrationist economic formation which reunites an important number of national economies. It's imagine is known in world through its major developmental economic result and social prosperity too.

The international economics integration idea appears as a complex process of uses the interdependences among the international economies. The aim of this process is the achievement of a number of objectives by common interest. For a scientific knowledge of national economies a the basic cells of various international integrationist forms, ONU, FMI, BIRD, etc. classifies these economies depending on a lot of criteria.

These criteria are:

- the economic potential;

- the degree of capitalization of potential.

The developmental level of a country is characterizes of a macroeconomics indicators system. The evaluation of these is the attribute of social and economics statistics. The determination of these is done with the help of National Account System (NAS). This is a statistic tool, which permit the whole presentation of fundamental equilibrium of a national economy.

For the harmonization and settlement relations between NAS of the different European countries, was elaborating a reference frame - The European National and Regional Account System –

1995. This has a statistical role which is permits an analytic and systematic description of what are appointed as "total economy", of her components and relations with other economies.

For decision's basement of economic politics is required:

- *the analysis and knowledge of social and economic phenomena;*
- *the relationship between these;*
- *the original causes of these;*
- *these manifestation forms.*

The main international paths of the different economics statistics are in total parallelism with de concepts which are use in SEC. This coherence of the concepts is essential for statistics comparative evaluation of the different countries.

NAS is represent the spinal column of statistics , both of them are situate in a reciprocal relationship

Key Words: *Statistics, European Integration, National Account System, European National and Regional Account System*

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A major objective of EU is to create one Europe which respect the identity and freedom of whole peoples compose it and to be a strong group of states as a part of irreversible process of globalization. The economic interstate integration is output interdependences as a result of international division of labor and international specializations.

The realization for objectives which are mentioned in the Agreement about EU, especially about Economic and Monetary Union, require quality statistical tools. These instruments permit to the Communitary Institutions, Governments and Economic Agents to take decisions on the strength of a harmonized and reliable statistics.

Internationally since year 2000 with the occasion of European Council Special Session from Lisbon was recognized a new facto New Economy, his objective is the settlement of system Europe on-line to contain persons companies and public jobs.

Thus we put the problem if statistics can answer to requirement of informations demanded by governments. Statistics can tackle new economy from different points of view:

- of bid (statistics about societies and products involved)
- of infrastructure which create the conditions to penetrate new economies (busy population, education, professional preparation)
- of impact analyses(market labor indicator, prices, the labor productivity)

Near all statistical areas will prepare records to new economy and shall change the way we work, learn and think. Romanian preparation for the entrance in European Union must to contain the accommodation of Statistical Institution to Eurostatistics requirement to micro and macroeconomics level. The institute of statistics must create a statistical system with a functional conception and a general structure. The communitary statistics Eurostat must have a general structure which contains: -the infrastructure part (classifications, registers);

-demographic and social statistics (population, labor, education statistics);

-regional statistics (environment statistics, regional and geographic statistics, science and technology statistics);

-economic statistics:

- macroeconomics statistics;
- business statistics;
- monetary, financial and commercial statistics;
- Agriculture and fishing statistics.

Macroeconomics statistics as a part of communitary statistics, has as first part the economies account (yearly and carry to contain European Account System-(EAS). The National Institute of Statistics has to implement the EAS through a rational and complex process, presupposed the interpretation of specific concepts and providing an operative informational base from statistically report or from another source of date. Although the economists distinguish two levels for analysis:

-Microeconomics -for the interpretation of individual behaviors

-Macroeconomics-for the examination behaviors to collective level .

Only that macroeconomics space remains the special place of reflection, offering a coherent ensemble for analysis an incorporate market, monetary unit the field of a political power.

The National Account System (NAS) were created just for macroeconomics analysis an instrument for the verification his hypotheses and proposed economic measures. NAS give statistics a durable utilization, opening a space of reflection for statistical production.

Thus, the utilization of NAS is expanded:

-inform us about structure and evolutions of a strong economy;
-is an instrument used in economic prevision (supply macroeconomics models) ;
- is a pedagogic instrument for learning macroeconomics;
- is an instrument used in international comparing.

The Maastricht Treaty represents a new stage in the NAS utilization-because he establishes the convergent criteria's based on national account indicators. Among international comparison principles of macroeconomics dates, can establish:

-the oneness condition for every indicator contained in compares,
-the oneness conditions for statistical calculation methods,
-the same reference year for all compared dates;
-the expression of all economic aggregates in a unique currency.

The macroeconomics calculation problems are resolved by using NAS.

But international comparisons must limited in real terms at structure and dynamic comparing. We can't do comparisons in absolute digits because the macroeconomics indicators are expressed in every national currency. The indicators expression in unique currency (USA dollar as a rule) achieved:

- through middle currency rate of exchange implement, or
- through using national currency purchasing power parity in report with USA dollar.

The middle currency rate of exchange is an unlike process, because one country currency rate of exchange is influenced by demand and capital movement.

In order to realize price and volume comparisons to international level are used price and volume indexes established for country couples. We apply same index formulas like in case of fluctuations from a period to another.

ENRAS"95 recognizes the necessity of prices and volumes international comparisons.

If the prices are in national currency the interpretation of price coefficients cause the introduction notion of: purchasing power parity (PPP).For a given product PPP between currency A and B can be define as a number of units from B currency needed to buy in country B the same quantity of goods which is buyed in country A with a unit of A currency.

PPP evaluation method consist in using price indexes calculated on the strength of goods and services price from country which does the comparative calculus reported goods and services price from standard currency country.

Thus we can use price indexes PAASCHE and LASPEYRES :

- Price index Paasche :

$I_{1/0}^{PP} = \Sigma p_1 q_1 / \Sigma p_0 q_1$

Which will be for A and B countries:

$I_{A/B}^{PP} = \Sigma p_A q_A / \Sigma p_B q_A$

- Price index Layspeyres:

$I_{1/0}^{PL} = \Sigma p_1 q_0 / \Sigma p_0 q_0$

Which will be for A and B countries:

$I_{A/B}^{PL} = \Sigma p_A q_B / \Sigma p_B q_B$

Due to a different weights implement the results are different to eliminate these influences we have to use the price index FISCHER, which is a geometric average of Paasche and Laspeyres indexes.

$$I_{A/B}^{PF} = \left(I_{A/B}^{PP} \times I_{A/B}^{PL}\right)^{1/2}$$

Fischer index satisfies differently tests such as: "time reversibility" and „factors reversibility" and is used mainly in economic statistics. This index presents also a conceptual and practical disadvantage such as:

- require as both Laspeyres and Paasche index to be calculate –what leads to growth costs and delay results publication,
- the Fischer index is not easy to construe as the Laspeyres and Paasche indexes.

But the Fischer index, being a symmetrical average of Laspeyres and Paasche indexes, can estimate correct the theoretical index. In specialty studies is spoken about another symmetrical index, the Tornqvist index which is a geometric well-balanced average of individual volume indexes.

$$I_{1/0}^{PT} = \Pi\left[\left(i_{1/0}^{q}\right)^{1/2\left(g_1^v + g_0^v\right)}\right]$$

g_1^v and g_0^v are share value $\frac{v}{\Sigma v}$ calculated for each product.

The price index Tornqvist can be obtained replacing the relative amounts **(q1/qo)** through the relative price **(p_1/p_o)** thus the Fischer index can be obtained:

$$I_{A/B}^{PF} = I^{PL}\left(I_{A/B}^{PP} \times I_{A/B}^{PL}\right)^{1/2}$$

Which is equivalent to:

$$I_{1/0}^{PF} = I_{1/0}^{PL}\left[\left(I_0^{PT}/I_{1/0}^{PL}\right)\left(I_1^{PT}/I_0^{PT}\right)\left(I_{1/0}^{PP}/I_1^{PT}\right)\right]^{1/2}$$

$\mathbf{I}^{\mathbf{PL}}$ and $\mathbf{I}^{\mathbf{PP}}$ - price indexes Laspeyres and Paasche

I_0^{PT} and I_1^{PT} - price indexes Tornqvist calculated in the current year and respective basic year conditions

If we take into account that:

$\left(I_{1/0}^{PP}/I_1^{PT}\right)$ **and** $\left(I_0^{PT}/I_{1/0}^{PL}\right)$ **are < 1,** that mean Fischer index is bigger then Laspeyres index, only if $\left(I_1^{PT}/I_0^{PT}\right)$ **is** bigger then $\left(I_{1/0}^{PL}/I_0^{PT}\right)\left(I_1^{PT}/I_{1/0}^{PP}\right)$

From this result the importance of correlations between the Fisher index and the Tornqvist index among the basic year of the indicator analyzed.

- increasing or decreasing weight of indicator components which analyses the higher values indexes,
- increasing or decreasing concentration degree of the analyzed indicator.

Economic theory suggests that a symmetrical index which utilize equal weights in two situations is preferable both Laspeyres and Paache.

Practical choose symmetrical indexes Fischer and Tornqvist has a secondary importance, because all symmetrical indexes are estimated each other.

For settlement PPP, the collected prices use to the prices report calculus for each good and service. Then we calculate averages for these reports in order to obtain the un-weighted parities elementary rubric level. The parities elementary rubrics parities are aggregates, using as weights the national expenditures structure.

For each couple of countries (A and B), we have the following stages of parities estimation.

- the un - weighted geometric average estimation for individual price reports, estimative for illustrative products in the country A (base of compare) – Laspeyres parity;
- the un – weighted geometric average estimation for individual price reports, estimated for illustrative products B - Paasche parity);
- obtain of parity (Fischer-type) as geometric average parities of Laspeyres and Paasche parities.

Therewith method, is obtained for each primary group a matrix of binary un-transitive parities (the parity between the country A and C is no equal with the produced among the parity for the countries A and B and respective the parity for the countries B and C). Throughout EKS (Elteto-Kovez-Szule) procedure caused a positive parities matrix. The parities of primary groups are weighted then, on each aggregation level from down up to GDI level.

Settlement of PPP, in the European Compare Program (ECP) is a part of United Nation's International Compare Program, which was launched in 1979. The aim of this program is to realize an international compares of GDI volume and its expenditures components. ECP represent a volume compares of GDI realize after expenditures method, with the identification of ultimate demand components: consumption, investment, import and export.

International GDI compare presupposes the achievement of three conditions:

- The utilization of the same definition for GDI
- the same currency evaluation for GDI,
- the same price level for GDI estimation.

The countries which assist in European GDI compare carry out generally first condition. The other conditions are not available because GDI value is shown in national currency. PPP does feasibly these conditions achievement.

The main expenditures elements of GDI are:

- the ultimate consumption of house-keepings, of public administrations and of private administrations:
- the gross formation of capital (contains the gross formation of fixed capital and stocks variation):
- import/export balance (the net export). In the case of final consumption, the classification achieved after aim. For the gross formation of fixed capital, the classification is realized by product's type. The general classification shall be alike for the countries of a certain group.

For illustrate the in table 1 Romanian's GDI elements:

Table 1	GDI [1)]	mil. USD
	2001	2002
1.Ultimate consumption (UC)	34.211,2	37.825,3
2.Investments (I) [2)]	9.038,3	10.525,8
3.goods and services export (E)	-3.084,0	-2.602,0
4. GDI (UC+I+E)	40.165,5	45.749,1

Source: RNB – annual report – 2002
1) GDI calculates to the average course USD – ROL
2) The investments containing: The gross formation of fixed capital, stocks variation and statistical difference.

For the year 2002 we can observe a growth of GDI against 2001. This fact confirms a growth of Romanians economy.

2002 - GDI was with 4, 9 % bigger then 2001, on the background of goods and services export and private investments development.

GDI increasing was initially prognosed to 5%, subsequently revised to 4, 7%, arrived in the last to 4, 9% - the highest rhythm of growth registered in the candidate countries for the espousal of EU.

Relation GDI with another economic indicator points us the importance of it's calculation in a unitary way. Thus in the internal and external publications is spoken of equilibrium relation among the saves up investment and the current accounts balance.

	2001	2002
GDI	40.165,5 (mil$)	45.745,1(mil $)
Current account balance (CAB)	- 2223	-1525
Gross saves up (GS=CAB+I)	6.815,3	9000,8

Source: NRB – annual report 2002

In this mode we can calculate the saves up rate (SR):

SR = GS/GDI X

2001	2002
17,0	19,7

100

The investment rate (IR):

IR = I/GDI X

2001	2002
22,5	23,0

100

Current account balance weight in GDI (CABW):

CABW = CAB / GDI x 100

The equilibrium

2001	2002
-5.5	-3.3

relation will became:

CAB/GDI = GS /GDI- I/GDI CABW = SR - IR

The obtained results points that in 2002 the equilibrium relation was registered the lowest level of current account deficits in GDI (3, 3%) of the previous two years, due to positive evolutions of the two components: saves up rate which arrived at 19, 7 % (the highest value after 1994) and investment rate which arrived at 23% in 2002

International comparison of Romanian economy must do mainly in with the economies of the countries from the Central and Eastern Europe.

In the year 2002, the economies of these countries evolved favorably in comparison with USA and EU. The economic dynamics of these countries maintained the rhythm of growth to approximate 3% as and in the year 2001 (illustrate in the table 3)

Table 3: GDI (increasing rates), the foreign trade and the current account balance for the Central and Eastern European countries.

Countries	GDI (increasing rates) %		Export (increasing rates) %		Import (increasing rates) %		Currency account balance mil. USD		Currency account balance weight in GDI %	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Bulgaria	4,1	4,8	6,0	11,2	11,6	8,8	-842,2	-677,4	-6,2	-4,4
Czech Rep.	3,1	2,0	14,9	14,6	13,2	11,2	-3272,5	-3807	-5,7	-5,3
Poland	1,0	1,3	7,1	8,8	1,3	3,2	-7166	-6700	-3,9	-3,6
Romania	5,7	4,9	9,8	21,9	19,1	14,9	-2223	-1573	-5,5	-3,3
Slovakia	3,3	4,4	6,4	13,7	15,5	11,7	-1755,9	-1938,9	-8,6	-8,2
Slovenia	3,0	3,1	6,1	12,1	0,2	7,6	30,9	375	0,2	1,7
Hungary	3,8	3,3	10,9	6,1	7,9	4,9	-1967	-2771	-3,4	-4,0

Source: RNB –annual reports 2002, annual and monthly reports of these countries national banks – 2002, IMF and others papers.

From analysis GDI increasing rates are noticed the low performance of Poland (1,3%) and Czech Republic (2%) , the others countries registering rates between 3,1% and 4,9% .

Czech Rep., Slovakia and Hungary tried to pass the economic growth from one based on export, to one stimulated by internal demand, led to the growth of budgetary deficits and internal unbalances. Romania and Bulgaria registered the highest economic growth rates (4, 9% and respective 4, 8%) on the background consolidation investments consolidation, of reduce the net imports and private consumptions stimulation.

The exports of the countries from Central and Eastern Europe increase significantly. Their average was exceeded the world exports average. This due to USD depreciation compare to Euro and of the advantages of the forces of labor costs. Analyze of the current accounts balance show the deficits of current account increasing, in majority of countries

Weight deficits of current account in GDI show us as that:

- Only Hungary is the country which bred in order for they diminished The incomes from touring; good and services imports increasing
- In Poland was held below check through proper monetary politics;
- Czech Republic and Slovakia are registered easy diminutions of deficits with help Commercial balance improvement;
- Romania and Bulgaria registered the biggest decreases ale deficits: Romania due to diminish the imports and breed the current transfers, Bulgaria by reason of diminution commercial deficits, breed the incomes from touring and reduce the interest pays;
- Slovenia finishes the current account with surplus in the last two years, due to breed else quick exports against import.

Thus as the size deficits (-) or surplus (+) permits us to asses Eastern and Central European countries in hierarchic order. But the graveness unbalance compared with GDI been better expressed in percents (current accounts balance weight in GDI – CCB / GDI) - in this mode the hierarchy between these countries changes. Beginning with the year 1999, calculus concerning the PPP did yearly, this fact permits us a good analysis of countries development levels.

From analysis results the role of statistics in the future development of economies and is obvious as the statistics is a future science. Thus statisticians shall prepared answers to new economic problems: Indicators for the characterization of the new style of, increasing and deliver the incomes, the inequalities in the incoming level, new communities, etc. Just as Grigore C. Moisil said, " statistics is the strongest mode to research the social facts " .

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11. KNOWLEDGE AND MEANING OF FORMATION: A POSSIBLE CHRISTIAN MODEL OF INTERPRETATION

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Abstract

If the measure of the science in the enlargement of the horizon of knowledge makes good effects and maybe the same number of destructive effects, the moral rate-setting of the cognitive act is imposed not only from religious prospective. The meaning of human formation is fundamentally conditioned by an ethical invariant system and the sciences are called to bring their contribution in its reaffirmation. An ethic system marks out the knowledge meaning, the deviations producing the perturbation, the crisis, the collapse.

An ethic system in knowledge keeps the human being in the normality space. The realty of the world is not only a scientific one but a religious one. The world reality is integral. The scientific knowledge does not exclude another order of reality, but puts it in evidence, emphasizes it continually. The relation between the world reality and its normality determines the co-ordinates of human formation. Speaking of an ethic of science, we speak about an ethic of knowledge. There is a positive, benefic knowledge and there is also a malefic, destructive knowledge. The normality seems to be the most faithful way to follow.

What would be, but forbidden in knowledge? Does the normative ethic system transmitted by revelation conserve the being normality? Can science ignore the spiritual fundamentals of world it is researching and discovering? At least on these questions it can be interdisciplinary discussed the knowledge and the meaning of formation of human being.

1. INTRODUCERE

Dacă demersul ştiinţei în lărgirea orizontului cunoaşterii produce efecte benefice şi poate tot atâtea efecte distructive, normarea morală a actului cognitiv, se impune nu doar din perspectivă religioasă. Sensul devenirii umane este în mod fundamental condiţionat de un sistem etic invariant şi în reafirmarea acestuia, sunt chemate ştiinţele să-şi aducă aportul. Un sistem etic jalonează însuşi sensul cunoaşterii, abaterile producând perturbaţia, criza, colapsul.

Un sistem etic în cunoaştere păstrează fiinţa umană în arealul normalităţii. Realitatea lumii nu este una doar ştiinţifică sau doar religioasă. Realitatea lumii este integrală. Cunoaşterea ştiinţifică nu exclude o altă ordine a realităţii, ci dimpotrivă o relevă, o evidenţiază necontenit. Relaţia dintre realitatea lumii şi normalitatea sa, determină coordonatele devenirii umane. Vorbind despre o etică a ştiinţei, vorbim despre o etică a cunoaşterii. Există o cunoaştere pozitivă, benefică, după cum există şi o cunoaştere malefică, distructivă. Normalitatea pare a fi indicatorul cel mai fidel al căii de urmat.

Ce anume ar fi, dar, interzis în cunoaştere? Sistemul etic normativ transmis prin revelaţie conservă normalitatea fiinţei? Există o alternativă viabilă în timp care să excludă normalitatea? Poate ignora ştiinţa fundamentele spirituale ale lumii pe care o cercetează şi o descoperă? Cel puţin pe aceste întrebări se poate problematiza interdisciplinar *cunoaşterea* şi sensul *devenirii* fiinţei umane, în fapt un dialog implicit între religie şi ştiinţă, în contextul permanentelor transformări petrecute în câmpul cunoaşterii, în care fiinţa umană îşi reafirmă permanent şansa libertăţii şi a progresului.

2. CUNOAŞTEREA
- scurtă incursiune în timp -

O scurtă incursiune în istoria cunoaşterii ne va trimite mai întâi în timp prin secolul al VI-lea î.d.H, atunci când ştiinţa, filozofia şi religiile ocupau acelaşi loc în gândirea vremii. Singurul scop al căutărilor era *aflarea esenței tuturor lucrurilor*, despre care încă de pe atunci se intuia că este *adevărul absolut*. Pe acesta filozofii școlii din Milet îl numeau „physis", astfel, din acest cuvânt grecesc derivând termenul de „fizică".

Adepții școlii din Milet nu făceau distincție între *spirit* și *materie*. Din acest motiv filozofia lor avea un pronunțat caracter mistic. Universul era văzut ca un imens organism animat de respirația cosmică, toate lucrurile fiind îndumnezeite (la Anaximandru și Thales).

Heraclit din Efes credea într-o schimbare perpetuă a lumii („devenirea" eternă). El admite asemenea misticilor orientali că toate schimbările își au izvorul într-un dinamism ciclic al contrariilor care formează o unitate, și această unitate transcendentă a lucrurilor el o numește *logos*.

Prima scindare survine în gândirea școlii eleate care fixează un Principiu Divin deasupra tuturor zeilor și oamenilor, principiu luat ca zeitate definită și inteligentă care conduce lumea. Apar astfel zorii dihotomiei caracteristice gândirii occidentale – separarea spiritului de materie.

Parmenide introduce principiul conform căruia Ființa este unică și indivizibilă, opunându-i-se astfel lui Heraclit. După Parmenide, toate schimbările sunt iluzii datorate simțurilor. Substanța este indestructibilă, condensată în forme cu proprietăți diferite și acest concept se va regăsi la baza gândirii occidentale.

Ființa unică și indivizibilă (la Parmenide) și Eterna Devenire (la Heraclit) au reușit o conciliere prin secolul V î.d.H. la filozofii greci. S-a ajuns la conceptul de atom – unitate indivizibilă a materiei, admițându-se că „Ființa" se manifestă în forme imuabile ale căror combinație și separare generează transformarea.

De aici, în secolele următoare s-au fixat și mai mult elementele esențiale azi în gândirea occidentală – dihotomia *spirit-materie*, *corp-suflet.*

Aristotel este cel care creează sistemul ce constituie cadrul concepției occidentale asupra lumii până în zilele noastre. Încă de atunci însă, filozofia lui considera că problema spiritului și contemplarea perfecțiunii divine sunt mult mai importante decât investigarea lumii materiale.

De-a lungul Evului Mediu concepția aristoteliană a fost sprijinită de Biserica Creștină, însă în epoca renașterii se produce prima desprindere din cadrul filosofico-teologic în gândire, astfel ideile speculative despre natură încep să-și găsească verificarea în experiență.

Se naște astfel știința prin îmbinarea experimentului cu aparatul matematic (pur teoretic) punându-se la punct teorii științifice riguroase.

Precedând nașterea științei moderne și chiar însoțind-o, gândirea filozofică formulează un dualism extrem spirit-materie. Prin secolul al XVII- lea, Descartes produce un concept care divizează lumea în spirit și materie permițând oamenilor de știință să trateze materia ca fiind „moartă", lumea fiind un ansamblu uriaș alcătuit din mici părticele diferite necesare întregului.

Dacă știința modernă se naște cu Galileo Galilei, ea găsește la Newton susținătorul și fondatorul concepției mecaniciste – fundament al fizicii clasice – model care domină gândirea științifică până în pragul secolului XX.

Imaginea lui Dumnezeu rămânea în continuare nealterată. Legile naturii erau acceptate ca legi ale lui Dumnezeu, eterne. Lor, lumea li se supune.

De la Descartes, gândirea occidentală identifică *ființa* cu *rațiunea*, dar aceasta a dus la separarea spiritului de corp, primul controlându-l pe cel de-al doilea, rezultând de aici un conflict aparent între voință și instinct. Fragmentarea interioară determină nefast o viziune asupra lumii „exterioare" ca o multitudine de obiecte și fenomene separate. Astfel noi am fi alcătuiți din fracțiuni, mediul înconjurător, societatea fiind independente. Aceasta a dus la înțelegerea greșită a lumii, la neparticipare prin înțelegere la armonia întregii creații.

S-a asociat de-a lungul timpului, cunoașterii raționale – știința și cunoașterii intuitive – religia, aceste două forme de cunoaștere fiind caracteristice mentalului uman. Cunoașterea rațională o vom pune în legătură cu experiența, cu percepția obiectelor, fenomenelor prin cele cinci organe de simț cu care am fost înzestrați. Astfel actul de cunoaștere rațională se desfășoară într-o zonă a intelectului care operează în acest sens cu divizarea, compararea, evaluarea și clasificarea.

Cunoașterea rațională abstractizează. Abstractizarea presupune selecția doar a unor proprietăți semnificative dintr-un ansamblu de structuri sau fenomene, prin comparare și clasificare. Abstractizând însă, diminuăm enorm înțelesul realității, aceasta neîmpiedicându-ne ca prin alcătuirea unor sisteme de concepte abstracte, unor modele, să ne putem comunica unii, altora experiențele, gândurile.

Reprezentarea aproximativă a realităţii prin sistemul nostru abstract de gândire face ca acest gen de cunoaştere să fie limitat. Însă, pentru că ne este mult mai uşor să cuprindem cu mintea reprezentarea realităţii decât realitatea însăşi, aproape în mod firesc tindem să le confundăm pe acestea două, confundând simbolurile noastre cu realitatea.

Experienţa la altă scară de înţelegere a făcut însă ca realitatea să fie cunoscută printr-o transcendere atât a intelectului cât şi a percepţiei senzoriale. Ea a fost numită *cunoaştere absolută* pentru că nu are la bază discriminări, abstracţii, clasificări relative şi aproximative. O experienţă în întregime non-intelectuală, experienţă care se naşte dintr-o stare deosebită a conştiinţei, numită stare de meditaţie sau stare mistică.

Asociind acest fel de cunoaştere, cunoaşterii de Dumnezeu, vom constata diferenţe categorice între experienţa teologică creştină şi cea mistică orientală. Dacă în doctrinele spiritualiste orientale desăvârşirea prin cunoaştere absolută şi unirea cu Dumnezeu implică eliberarea omului de propria natură, prin abandonarea naturii ca atare, teologia dogmatică ortodoxă are în vedere transfigurarea însăşi a naturii în Hristos – Dumnezeu prin Duhul Sfânt. Deci, o cunoaştere ce depăşeşte şi simţirile şi raţiunea, cunoaştere ce nu purcede nici din realitatea sensibilă, nici din argumente omeneşti, fiind întemeiată pe Cuvântul revelat. De aceea Dionisie Areopagitul spune că „modalitatea de a-L cunoaşte pe Dumnezeu cea mai demnă de El este cunoaşterea în felul necunoaşterii, într-o unire mai presus de înţelegere” în accepţiunea sa adevărata teologie apofatică identificându-se cu uniunea mistică, cu pătrunderea omului de energiile dumnezeieşti care îl transfigurează.

Iată de ce cunoaşterea în Duh înseamnă mult mai mult. Dacă raţiunea nu ar fi sprijinită de lucrarea Duhului Sfânt, poarta spre Adevăr ar rămâne închisă. Nu există evoluţie spirituală în afara cadrului substanţial –energetic după cum nici cercetare ştiinţifică în lipsa mecanismelor psihice prin care sunt posibile intuiţia, observaţia şi experimentul, mecanisme pe care însuşi spiritul le produce şi le perfecţionează. Ştiinţa ar trebui sa dea raţiunii ceea ce în teologie se numeşte *căldura dragostei şi lumina credinţei.* Pe temeiul acesta clădeşte Biserica învăţăturile sale care se adresează omului, dându-i acestuia nădejdea că prin *iubire* şi *credinţă* se poate înainta la infinit în cunoaşterea lui Dumnezeu şi a creaţiei Sale. În lumina acestui adevăr, ştiinţa devine o treaptă importantă a cunoaşterii, care îl poate aduce pe omul veşnic căutător în apropierea adevăratelor răspunsuri. Din acest punct, mintea omenească trebuie să-şi recunoască neputinţa şi să se lase călăuzită de lucrarea harului. Cercetând amănunţit tainele vieţii, omul de ştiinţă găseşte acelaşi răspuns pe care credinciosul simplu îl ştie de la bun început: există Dumnezeu!

Dacă la temelia ştiinţei este aşezată aspiraţia umanităţii spre a se descoperi pe sine şi materialitatea în care se manifestă, tainele adevăratei cunoaşteri despre lume sunt revelate în referatul Sfintei Scripturi: *"Ziua zilei spune cuvânt si noaptea nopţii vesteşte ştiinţă"* (Ps. 18, 2).

Noi creştinii credem că toate însuşirile spiritului omenesc, ce se pot manifesta în domeniul ştiinţific, toate facultăţile umane creatoare de cultură sunt inspirate şi călăuzite de puterea proniatoare a lui Dumnezeu. Noi credem că omul are menirea de a fi colaboratorul si continuatorul creaţiei, sublimând natura ce i-a fost încredinţată. De aceea, măsura în care omul va înţelege să colaboreze la creaţie, va da sens şi finalitate operei sale.

Doar aşa putem înţelege de ce, încă din primele veacuri creştine, Biserica s-a manifestat ca un aşezământ cosmic, spiritual, de pietate şi cultură. Doar aşa ne explicăm de ce pe zidurile altarelor noastre sunt uneori zugrăviţi Homer, Pitagora, Socrate, Plutarh, Platon, Aristotel, Filon sau Sofocle. Prezenţa acestor înţelepţi ai lumii vechi în pictura sacră a Bisericii noastre nu este o dovadă de ignoranţă, ci arată limpede că lumea veche precreştină participa la nădejdea în venirea Mântuitorului. În cultura antică, îndeosebi în literatură şi filozofie, găsim multe idei morale care se apropie sensibil de învăţătura creştină. Astfel, Clement Alexandrinul încercând o savantă asimilare a culturii profane în creştinism, declară că filozofia greacă joacă pentru antichitate rolul Vechiului Testament, de *"călăuză către Hristos"*; Fericitul Augustin desluşeşte în filozofia lui Platon ideea de Treime; Eusebiu de Cezareea descoperă la Platon elemente ale doctrinei creştine; Justin Martirul si Filosoful consideră că Logosul - Fiul lui Dumnezeu - S-a revelat în mod parţial şi filosofilor păgâni, ca o lumină aşezată în raţiunea filosofică. În sfârşit, Sfântul Vasile cel Mare, în discursul despre educaţia tinerilor, spune că orice lumină naturală a spiritului omenesc care confirmă adevărul, binele si frumosul - revelate de Biserică - poate fi socotită ca o lumină dăruită de Dumnezeu spre a lucra asupra făpturii Sale.

Este drept, uneori din grija prea mare de a nu pune în pericol puritatea credinței, au apărut în lume unele curente religioase care negau cultura profană. S-a spus chiar că filozofia nu este indispensabilă şi că un creştin, şi fără filozofie, ştie că Dumnezeu este Creatorul lumii. Dar Sfinții Părinți precum Grigorie de Nazianz, Grigorie de Nyssa, Grigorie Palama, Maxim Mărturisitorul şi Ioan Damaschin au pus în valoare atât în latura gândirii mistice, cât şi în cea a formulărilor dogmatice - influența culturii filozofice. Însăşi ideea că ştiințele profane sunt auxiliarele necesare Teologiei era îmbrățişată de şcolile catehetice antiohiene şi alexandrine. În "Hexaimeron", Sfântul Vasile cel Mare face apel la ştiințele naturale, la cosmologie, la antropologie şi la gândirea aristotelică. Sfantul Ioan Damaschin, în capitolele cosmologice şi antropologice din "Dogmatica" sa, utilizează toate datele ştiințelor profane ale timpului, de la psihologie şi medicină, până la geografie şi astronomie. Exemplele pot continua.

Este bine să precizăm însă că niciodată Părinții Bisericii n-au confundat ştiința cu credința şi nici n-au substituit Revelației divine biblice filozofia antică sau ştiințele profane ale timpului lor. Ei ştiau că "raționalizarea excesivă a misterului existenței duce la reducționismul care împiedică adevărata cunoaştere."[1]

Dacă Părinții Bisericii, găsesc în vremea lor maniera de a interacționa constructiv şi progresist cu ştiințele profane, vom întâlni însă de la Descartes până în timpurile moderne preocuparea multor savanți şi gânditori de a-l defini pe Dumnezeu, de a-l postula, de a-i demonstra într-un fel sau altul, existența.

Descartes (1596-1650) de pildă, asemănându-se ca metodă lui Nicolaus Cusanus, cu privire la metafora perfecțiunii, corelează existența ca perfecțiune cu existența lui Dumnezeu. Dumnezeu există deoarece existența este o perfecțiune. Şi cum perfecțiunea poate decurge numai dintr-o ființă infinită, Dumnezeu este infinit[2].

Spinoza (1632-1677) urmând modelul de gândire al geometriei lui Euclid afirmă că Dumnezeu este singura substanță, singura ființă, cu infinit de multe atribute, din care noi cunoaştem doar extensia şi gândirea. Este desigur cea mai riguroasă formă de panteism[3].

Newton (1642-1727) îl va reprezenta pe Dumnezeu cu ajutorul metaforei mecanicii deterministe. Leibnitz (1646-1716) va crede că existența lui Dumnezeu decurge din posibilitatea sa[4].

Kant va susține că "rațiunea practică" ne obligă să postulăm atât pe Dumnezeu cât şi imortalitatea. Hegel va spune că Dumnezeu este Spiritul Absolut. Einstein va crede că Dumnezeu este revelat în legile naturii şi în coerența lor.[5] (Interesant de văzut că exact în acest fel, dar cu paisprezece secole mai devreme îşi propovăduia Maxim Marturisitorul (580-622) învățătura sa).

Exemplele vor continua şi pentru timpuri mai recente când Odifreddi (1994) va lega existența lui Dumnezeu de ultimele descoperiri din logică şi din informatica teoretică, timp în care alți autori fac referiri la fizica cuantică, biologie, cosmologie şi filozofie. De pildă Frijof Capra armonizează mistica orientală cu noua fizică; Bernard d'Espagnat îl vede pe Dumnezeu în spatele inteligibilității totale a lumii; Jean Kovalevski aduce argumente că revelația este, pentru religie ceea ce sunt modelele cognitive pentru ştiință; Thierry Magnin, acționând prin intermediul logicii lui Lupaşcu a terțului inclus şi al transdisciplinarității lui Basarab Nicolescu (1996), "raportează perechea (Iisus-Dumnezeu, Iisus-ființă umană) la metafora complementarității cuantice"[6]; Jean Francois Lambert îl raportează pe Dumnezeu la fenomenul incompletului; David Bohm îl priveste pe Dumnezeu prin metafora hologramei, etc. Ar mai fi de adăugat aici abordarea extremă a problemei prin prisma metaforei autoorganizării pe care o fac autori importanți cum ar fi Ilya Prigogine sau Francisco Varella, pentru ei Dumnezeu fiind identic cu creația sa.

Fără a comenta acum panteismul lui Spinoza, neopanteismul lui Prigogine sau Capra, viziunea holistă a lui Bohm care apelează frecvent la diverşi termeni new-age, trebuie remarcată preocuparea la scară istorică atât a teologilor cât şi a oamenilor de ştiință pentru realizarea unei inedite întâlniri în cunoaştere.

3. Posibile direcţii pentru un dialog posibil

a. Semnificaţia şi scopul universului[7]

O primă iniţiativă în angajarea unui dialog util poate face ca pe baza cercetării şi analizei ştiinţifice asupra *structurii* universului pe de o parte şi prin credinţă pe de altă parte, în lumina Revelaţiei divine, să discernem *scopul ultim* al său. Să înţelegem de pildă, cum prin combinaţia elementelor structurale de bază ale universului, luată ca limbaj informaţional multiplu (non-verbal), Creatorul însuşi comunică sensuri şi intenţii creaţiei sale, dezvăluindu-se ca Inteligenţă creatoare transcendentă[8]. În acest fel atât ştiinţa cât şi religia pot rămâne fiecare în arealul său de dezbatere, cu metodele şi instrumentele de lucru specifice. Fără depăşirea competenţelor, fapt care, după cum arată Einstein ar descrie raportul ştiinţă - religie în termenii unui conflict fără soluţie. Astfel după opinia lui, „Ştiinţa este strădania seculară de a aduna laolaltă, cu ajutorul gândirii sistematice, fenomenele perceptibile ale acestei lumi într-o corelaţie cât mai deplină…. religia este strădania de veacuri a omenirii de a deveni clar şi deplin conştientă de aceste valori şi scopuri (suprapersonale) si de a întări şi lărgi în mod constant efectele lor… un conflict între ele ne apare imposibil. Căci ştiinţa nu poate decât să stabilească ce este, nu şi ceea ce trebuie să fie…Religia, pe de altă parte, are de-a face doar cu evaluări ale gândirii şi acţiunii umane: ea nu poate vorbi cu temei despre fapte şi relaţii dintre fapte."[9]

b. Comuniune dintre inteligenţa necreată şi inteligenţa creată[10]

Raţiunea umană activă în cercetarea ştiinţifică poate fi de asemenea interpretată ca reflex şi dar al Raţiunii divine, în permanent drum către Aceasta. Scopul nu poate fi altul decât "comuniunea de iubire multiplă şi inepuizabilă în noutatea ei, care nu desfiinţează raţiunea ci o trans-fiinţează ca, din forţă de căutare şi cuprindere exterioară, să devină capacitate de împărtăşire din interioritate reciprocă dintre Creator şi creaţie."(Mitropolitul Daniel). Astfel, interioritatea spirituală a persoanei reflectându-se în comportamentul ei exterior, se va înţelege mai bine şi mai responsabil pericolul *desfigurării* în creaţie precum, la fel de clar, şansa *transfigurării* vieţii, naturii, omului[11].

c. Spre o etică a ştiinţei

Dacă ar fi să-l credem pe Jacques Monod, apelul la religiozitate nu va rezolva criza de valori a societăţii, ştiinţa fiind aceea care este chemată să formeze un nou sistem etic. Este puţin probabil însă ca ştiinţa să poată împlini singură acest deziderat pentru că însăşi poziţia sa etică este ambiguă şi controversată[12]. Dacă ne referim doar la „duplicitatea" rezultatelor sale, care pot fi benefice şi distrugătoare în acelaşi timp, angajarea unei anumite pietăţi în actul de cunoaştere poate desigur înclina balanţa în interesul fundamental al vieţii şi libertăţii. Chiar dacă în mod paradoxal „multe din aplicaţiile paşnice ale ştiinţei cad de la masa îmbelşugată a cheltuielilor militare de cercetare, … exemplul zborurilor cosmice sau al internetului"[13](M. Maliţa)

Există desigur resurse în acest sens. O etică profesională a omului de ştiinţă: probitate, respect pentru adevăr, rigoare, perseverenţă, dăruire etc. Pe de altă parte, faptul că anumite teoreme au stabilit limitele sau contradicţiile modelelor raţionale (ex. Teorema lui Godel), faptul că a fost demonstrată puterea redusă a raţionamentului din înzestrarea naturală a minţii omeneşti, au făcut ca omul de ştiinţă responsabil să devină mai modest, mai umil în actul de cunoaştere. Zilnic putem urmări în documentarele ştiinţifice difuzate pe posturi de televiziune dedicate, mărturisiri pline de uimire ale unor oameni de ştiinţă din domenii foarte variate în faţa vastului spaţiu al cunoaşterii. Un singur exemplu ar fi edificator aici, şi anume, revelaţia pe care au produs-o astronomilor din întreaga lume, primele imagini transmise de telescopul Hubble după ce oglinda acestuia a fost re-aliniată printr-o intervenţie în spaţiu cu un efort şi cu riscuri de neimaginat. Un lucru pare să rămână incert pentru omul de ştiinţă religios, după un astfel de experiment la limită şi anume: cât este precizie ştiinţifică şi cât este ajutor de la Dumnezeu ?

Credem că, spre deosebire de secolul trecut, în relaţiile cu religia, omul de ştiinţă este acum pregătit să manifeste toleranţă şi înţelegere, deschidere spre un dialog necesar şi sincer, dar purtat în limitele de competenţă. Credem că omul de ştiinţă este pregătit să ţină cont în demersul său şi de fundamentele spirituale ale lumii pe care o cercetează şi o descoperă.

d. O lume unică pentru o omenire solidară

Să fie oare nevoie de momente de criză pentru ca omenirea să-şi reevalueze apartenenţa la aceeaşi mare şi unică familie? Din păcate 11 septembrie 2001 a probat aceasta. Într-o lume ce parcă îşi pierduse reperele morale, o lume ce părea că-l uitase de mult pe Dumnezeu, *„tragedia americană a făcut din trei sute de milioane de oameni o mână strânsă pe inimă... Ce Dumnezeu poate să-i unească pe americani într-un asemenea "hal"? Pământul acela? Istoria lor galopantă? Puterea economică? Banul? ...Numai libertatea poate face asemenea minuni!"*[14](Cornel Nistorescu) După 11 septembrie 2001, întreaga comunitatea internaţională s-a mobilizat în apărarea civilizaţiei unice. Nu pentru un popor anume ci pentru ideea solidară de *umanitate*. Astfel toate ale lumii părând în pericol, conştiinţa omenirii s-a sprijinit pe factorii integratori, pe unitate. Unitate în apărarea aceluiaşi patrimoniu cultural universal, aceluiaşi sistem de valori. Timp în care unanim, în publicul larg al tuturor ţărilor lumii este respinsă ferm orice asociere a terorismului cu religia, credinţa religioasă fiind primul comandament în recuperarea din situaţia de criză. În fapt şi prin aceasta religia îşi va fi redimensionat misiunea militantă pentru construirea unei lumi unice pentru o omenire solidară. Acum mesajul de pace şi toleranţă al tuturor religiilor poate fi subiectul reconcilierii lor. Însuşi conceptul de concililiere însă, cere un areal mai larg de dezbatere şi ştiinţa nu poate lipsi de la acest dialog.[15]

4. Cunoaşterea transdisciplinară – spre o nouă înţelegere a *sacrului*

Basarab Nicolescu dezvoltă conceptul de cercetare transdisciplinară[16] din dorinţa de a înţelege complet lumea actuală. Transdisciplinaritatea vizează ceea ce este între discipline. Traversând disciplinele, se va situa dincolo de oricare disciplină. Ca metodă, cercetarea transdisciplinară este total diferită de cercetarea disciplinară, fiindu-i complementară acesteia. Ea ţine cont de dinamica generată prin acţiunea simultană a mai multor niveluri de Realitate, încercând să rezolve corespondenţa dintre lumea exterioară a Obiectului şi lumea interioară a Subiectului. În această abordare se impune să facem distincţia dintre Real (ceea ce este) şi Realitate (ceea ce percepem). Realul este ascuns, Realitatea este accesibilă. Nivelul de Realitate este un ansamblu de sisteme invariante la acţiunea unui număr de legi generale. Două astfel de niveluri ale Realităţii sunt diferite dacă, prin trecerea de la unul la celălalt are loc o ruptură a legilor şi conceptelor fundamentale.[17] Astfel două niveluri adiacente sunt legate prin ele prin logica terţului inclus[18]. În virtutea acestui proces de a lega între ele niveluri de realitate adiacente, cunoaşterea Realităţii este practic nelimitată, *deschisă*. Aceasta vine în acord cu una dintre cele mai importante rezultate ştiinţifice ale secolului XX: teorema lui Godel, care afirmă că un sistem de axiome suficient de bogat duce inevitabil la rezultate fie indecidabile, fie contradictorii. În această corespondenţă, este imposibil să se construiască o teorie completă pentru descrierea trecerii de la un nivel al Realităţii la altul. Şi dacă există o unitate care uneşte toate nivelurile Realităţii, atunci aceasta trebuie să fie deschisă. Implicaţiile de aici sunt deosebite. Coerenţa dintre nivelurile Realităţii (cel puţin în lumea naturală) implică o zonă de non-existenţă în care nu există nici un nivel de Realitate. Ea este numită *zonă de transparenţă absolută* şi este asociată *sacrului*. Ansamblul nivelurilor de Realitate şi această zonă complementară corespunzătoare *sacrului*, constituie *Obiectul transdisciplinar*. Se deschide astfel o nouă perspectivă asupra culturii, religiei, politicii, artei, educaţiei şi vieţii sociale prin introducerea unui nou *Principiu al Relativităţii*: nici un nivel de Realitate nu este un loc privilegiat din care ar putea fi înţelese toate celelalte niveluri ale Realităţii.[19]

Asociind acum fiecărui nivel de Realitate un nivel de percepţie. În virtutea coerenţei nivelurilor de percepţie, ar trebui să existe o echivalentă zonă de transparenţă la percepţie. Ansamblul nivelurilor de percepţie şi zona sa de transparenţă vor constitui *Subiectul transdisciplinar*. In sfârşit, pentru ca Subiectul transdisciplinar să poată comunica cu Obiectul transdisciplinar, cele două zone de transparenţă trebuie să fie identice. Comunicarea ar presupune o intersecţie dintre buclele asociate de informaţie şi conştiinţă. Această intersecţie şi buclele asociate de informaţie şi conştiinţă descriu *termenul Interacţiunii dintre Obiect şi Subiect* şi el este al treilea termen al cunoaşterii transdisciplinare.

Construcţia lui Basarab Nicolescu, îmi sugerează acel *„attingitur inattingibile inattingibiliter"* concluzionat de Nicolaus Cusanus, în demersul său de a-L cuprinde conceptual pe Dumnezeu, pentru că Cel care nu poate fi atins, trebuie atins într-un fel în care nu este atins.

De fapt, transdisciplinaritatea încearcă să unifice două tipuri de cunoaştere: cunoaşterea apofatică, mistică a Părinţilor răsăriteni în latura ei experimentabilă dar non-raţionabilă, şi cea non-experimentabilă şi non-raţionabilă, *supra-raţională (transraţională)*. „Cunoaşterea în felul necunoaşterii, într-o unire mai presus de înţelegere"(Dionisie Areopagitul), unifică necontenit contrariile, depăşindu-le. În acest mod putem înţelege cunoaşterea apofatică. Ea, în mod structural este o cunoaştere a terţului.[20]

5. Prefigurând o teologie a informaţiei

-un posibil model creştin-

Teologia este disciplina care se ocupă cu expunerea şi justificarea raţională a izvoarelor, a dogmelor şi riturilor unei religii.[21] Dealtfel mai poate fi înţeleasă terminologic drept *vorbire despre Dumnezeu.* Utilizat în extensie, interdisciplinar, termenul poate acoperi un domeniu nou de abordare a relaţiei Creator – creaţie, din perspectiva *fiinţei informaţionale*.

Aflată într-o permanentă relaţie de schimb informaţional cu mediul său de viaţă, fiinţa umană – *sistem informaţional complex*, ne dezvăluie raporturi speciale pe care le are cu lumea şi Creatorul său.

Mai întâi vom face apel la modelele noi de interpretare a lumii micro şi macrouniversului. Ele ne vor deschide perspectiva unei analize sistematice a raportului în care, sistemele în general, se află cu realitatea. Astfel prin prisma *structuralităţii* lumii pot fi remarcate două tipuri de cuplaje de interes major în înţelegerea atât a genezei cât şi a dezvoltării sistemelor în cauză: cuplajul *substanţă - câmp*; cuplajul *energie - informaţie*.

Din punct de vedere al *funcţionalităţii* lumii, unitatea acesteia rezultă din :*legea circuitului entropic* ; *legea continuităţii informaţionale*.

Viziunea *structural - funcţională* asupra lumii atribuie celor trei paliere materiale ale realităţii câte un plan nestructurat profund (ortoexistenţa) şi un plan structurat de suprafaţă (existenţa). Astfel putem vorbi despre corespondenţele :

- materie minerală - plasmă fizică;
- materie vie (biosică) - bioplasmă;
- materie psihică - psihoplasmă.

Sistematizând aspectele **informaţional - energetice** care intervin în interacţiunea sistemelor vii cu realitatea lumii, am propus un model[22] ce evidenţiază atât planurile realităţii cât şi **influenţele** induse sistemelor respective pe aceste planuri.

Vom avea astfel o influenţă totală P specifică oricărui sistem viu, cu componente pe fiecare palier indicat.

Corespunzător componentelor sale, influenţa totală P va necesita un număr de căi de transfer informaţional - energetic. Căi specifice (în subdomeniul fizic) sau nespecifice (în subdomeniul bioplasmatic sau psihoplasmatic). Însăşi stuctura unui astfel de sistem este alcătuită de aşa manieră încât să păstreze logica spectrului de influenţe în toate palierele considerate.

Aplicând modelul în cazul fiinţei umane, vom descrie practic în limbaj informaţional interacţiunea unui sistem deschis cu o *realitate integrală.* Problema teologică se va pune în măsura în care fiinţa ne dezvăluie potenţialităţi evaluate informaţional care trimit în teologia morală. Astfel, întreaga teologie morală creştină poate fi reconfigurată în limbaj informaţional, în aceleaşi semnificaţii dogmatice[23], putându-se dezvălui „informaţional", spre exemplu, „cămara de sus" despre care vorbesc Părinţii ortodoxiei, „locul" special care leagă fiinţa umană de Creatorul său prin energiile necreate, semnificaţia şi rolul tainelor ortodoxe în viaţa creştinilor, sensul lucrării harului în lume.

O extindere a acestei metode asupra textului sacru va duce desigur la descoperirea de sensuri noi care privesc Decalogul, regulile de viaţă transmise de către Dumnezeu lui Moise pentru poporul ales. (vezi Leviticul, cap. 8,11,12,15,18,20,26)

Teologia informaţională ar îndeplini astfel atât criteriul de *contact*, cât mai ales pe acela de *confirmare* propuse de Haught[24]. Ea poate rămâne deopotrivă în cadrele *transdisciplinarităţii* descrise de Basarab Nicolescu, operând cu nivelurile realităţii *bio* şi *psiho-plasmatice* , cele ale realităţii *trans-fizice* şi *trans-psihice* ale căror coerenţă şi extensie asigură întâlnirea miraculoasă dintre *sensibil* şi *inteligibil*, acolo unde *fiinţa* îşi întâlneşte Creatorul într-o unire mai presus de înţelegere. Coordonatele ei de dezbatere, repotenţând morala creştină, pot fundamenta o morală mai accesibilă omului modern, mult mai explicită, dar negreşit, mult mai radicală. Este o cale nouă de a ne redescoperi interioritatea, de a ne reevalua raporturile în lumina energiilor transfiguratoare, de a ne regăsi normalitatea - libertatea în comuniunea cu Dumnezeu.

6. Concluzii

Sensul devenirii umane este unul teandric. O miraculoasă şansă acordată fiinţei create de către însuşi Creatorul ei. Teandria este dimpreună-lucrarea energiilor necreate cu cele create. Este o prezenţă dinamică de natură informaţional-energetică, având un singur scop: *normalitatea*. Aceea gândită de Creator mai înainte de a fi lumea. Astfel sensul devenirii umane este unul propriu stării de *normalitate*. Orice exces, orice insuficienţă depărtează persoana de comuniunea promisă, vestită, propovăduită. În afara asistenţei harice trăim anormal, gândim anormal, săvârşim lucruri anormale. De aceea un sistem axiologic de valori trebuie să perfecteze actul de cunoaştere în perspectiva păstrării acestei stări de *normalitate* a fiinţei umane. Ca virtute teologică a raţiunii, credinţa "funcţionează" ca un "regulator". Dincolo de îndoiala filosofică, credinţa potenţează nădejdea, altă mare virtute, împlinind fiinţa în lucrarea iubirii, cea de-a treia virtute care ridică omenitatea la înălţimea purtării de Duh Sfânt. Miracolul acesta este starea de normalitate ontologică a lumii. Este oare prea mult spus că miracolul devine astfel stare de normalitate? Nu, desigur. Abaterile ce survin, producând adevărate mutaţii în toate planurile acestei realităţi integrale a fiinţei umane sunt mai degrabă restul neîmplinirii. Acestea trebuie, nu atât denumite, cât înţelese şi asumate. Bilanţul, până la "acţiunea" miracolului iertării din iubirea Creatorului pentru creaţia Sa, trebuie evaluat, si normat. Comuniunea presupune în primul rând responsabilitate şi aceasta nu poate fi edificată decât prin actul de cunoaştere. Cunoaşterea însă, ar trebui să ne readucă la "starea de echilibru" pierdută cândva. Cine, când şi cum va decide asupra acestei "stări de echilibru" ? Acest feedback ne readuce în lucrarea comuniunii. De aceea este atât de necesar dialogul dintre omul de ştiinţă şi mărturisitorul de Dumnezeu. De aceea, ieşind din tipare, va trebui să vorbim în limbaj ştiinţific conscrat despre lucruri greu de numit şi de experimentat, de aceea, surmontând uneori dogmele, va trebui să refacem echilibrul lăuntric al fiinţei-persoane şi al lumii.

1. *Conflictul.* Convingere conform căreia ştiinţa şi religia sunt fundamental ireconciliabile. Are la bază argumentul că religia nu poate demonstra în mod direct adevărul ideilor sale în timp ce ştiinţa o poate face. Religia se bazează pe presupuneri şi o imaginaţie fără margini în timp ce ştiinţa se limitează la fapte ce pot fi observate.
Pe de altă parte, mulţi creştini învaţă că ştiinţa trebuie respinsă dacă nu corespunde literei Scripturii. Uneori ştiinţa este percepută ca o forţă demonică ce a golit cultura de substanţa spirituală.
2. *Contrastul.* Punct de vedere potrivit căruia nu există vreun conflict real între cele două, religia şi ştiinţa răspunzând, fiecare, la întrebări total diferite. Ele nu trebuie judecate după aceleaşi standarde. Întrebările pe care şi le pun fiecare sunt complet deosebite, comparaţia nu are sens. Religia şi ştiinţa nu trebuie să se amestece una în treburile celeilalte. Astfel opoziţia lor nici nu se pune. Contradicţia le-ar ţese pe amândouă în acelaşi material, în care se vor pierde una în cealaltă. Ştiinţa şi religia sunt modalităţi de cunoaştere independente şi autonome. Metoda contrastului interzice combinarea metodei ştiinţifice cu orice alt sistem de credinţă, religios sau laic, deoarece, mai devreme sau mai târziu, o unire atât de superficială duce la un conflict inutil.
3. *Contactul.* Abordare în care se caută dialogul, interacţiunea şi o posibilă consonanţă între ştiinţă şi religie, şi, mai ales, căile prin care ştiinţa poate modela înţelegerea religioasă şi teologică. Teologia nu se poate baza prea mult pe ştiinţă, dar trebuie să acorde atenţie celor ce se întâmplă în lumea oamenilor de ştiinţă. Presupune o discuţie deschisă între oamenii de ştiinţă şi teologi. Este exclusă atât combinaţia cât şi separarea. Contactul susţine ca ştiinţa poate lărgi orizontul credinţei religioase şi că perspectiva credinţei religioase poate adânci înţelegerea universului. Se propune un „joc" al realismului critic. Participarea la deschiderea critică spre realitate asigură baza unui contact veritabil între ştiinţă şi religie.
4. *Confirmarea.* Este perspectiva paşnică. Extrem de importantă. Ea clarifică modalităţile prin care religia sprijină şi alimentează, în profunzime, întreaga activitate ştiinţifică. Religia validează chiar impulsul care dă naştere ştiinţei. Prin confirmarea pe care o dă ştiinţei ea nu

se implică în nici un fel de combinare sau fuziune cu vreo ipoteză sau teorie ştiinţifică. Ştiinţa s-ar putea dezvolta având înrădăcinată „credinţa” *a priori*, potrivit căreia universul este o totalitate de lucruri ordonată în mod raţional. Prin această abordare religia rămâne strâns legată de ştiinţă, fără a se amesteca în vreun fel cu aceasta.

Trebuie remarcat că autorul însuşi va pleda pentru ultimele două metode. După părerea sa abordarea *contactului*, completată de cea a *confirmării*, oferă problemei răspunsul cel mai fructuos şi rezonabil.

Pluridisciplinaritatea *se referã la studierea unui obiect dintr-una si aceeasi disciplinã prin intermediul mai multor discipline deodatã.* De exemplu, un tablou de Giotto poate fi studiat din perspectiva istoriei artei intersectatã de aceea a fizicii, chimiei, istoriei religiilor, istoriei Europei si geometriei. Sau, filosofia marxistã poate fi studiatã din orizontul filosofiei încrucisat cu acela al fizicii, economiei, psihanalizei ori literaturii. Obiectul va iesi astfel mai îmbogãtit în urma încrucisãrii mai multor discipline. Cunoasterea obiectului obtinutã în cadrul propriei discipline de studiu este adîncitã de un aport pluridisciplinar fecund. Cercetarea pluridisciplinarã aduce un *plus* disciplinei în cauzã (istoria artei sau filosofia în exemplele de mai sus), dar acest "plus" se aflã în slujba exclusivã a disciplinei respective. Cu alte cuvinte, demersul pluridisciplinar se revarsã peste limitele disciplinelor dar *finalitatea sa rãmîne înscrisã în cadrul cercetãrii disciplinare*.

Interdisciplinaritatea are o altã ambitie, diferitã de aceea a pluridisciplinaritãtii. *Ea se referã la transferul metodelor dintr-o disciplinã într-alta.* Se pot distinge trei grade de interdisciplinaritate: a) *un grad aplicativ*. De pildã, metodele fizicii nucleare transferate în medicinã duc la aparitia unor noi tratamente contra cancerului; b) *un grad epistemologic*. De exemplu, transferul metodelor logicii formale în domeniul dreptului genereazã analize interesante în epistemologia dreptului; c) *un grad generator de noi discipline*. De exemplu, transferul metodelor matematicii în domeniul fizicii a generat fizica matematicã, al metodelor din fizica particulelor în astrofizicã a dat nastere cosmologiei cuantice, al matematicii în studierea fenomenelor meterologice sau de bursã a generat teoria haosului, al informaticii în artã a dus la arta informaticã. Ca si pluridisciplinaritatea, interdisciplinaritatea debordeazã limitele disciplinei însã *finalitatea sa rãmîne de asemenea înscrisã în cercetarea interdisciplinarã*. Prin al treilea grad al sãu, interdisciplinaritatea contribuie chiar la *big-bang* -ul disciplinar.

Transdisciplinaritatea priveste - asa cum indicã prefixul "trans" - ceea ce se aflã în acelasi timp si *între* discipline, si *înãuntrul* diverselor discipline, si *dincolo* de orice disciplinã. Finalitatea ei este *întelegerea lumii prezente*, unul din imperativele sale fiind unitatea cunoasterii.

(Extras din carta TRANSDISCIPLINARITATE - Manifest, de Basarab Nicolescu Editura Polirom, Iasi, România).

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7. Mitropolit Daniel Ciobotea, idem p. 24
8. Idem
9. Albert Einstein, „Cum văd eu lumea”, Ed. Humanitas, Bucuresti 2000, p. 306-307
10. Mitropolit Daniel Ciobotea, idem p.25
11. Ibidem
12. Mircea Maliţa, „Unicitatea ştiinţei şi varietatea religiilor” în „Ştiinţă şi religie, antagonism sau complementaritate?”, Basarab Nicolescu, Magda Stavinschi, Ed. XXI Eonul Dogmatic, Bucureşti 2002.
13. Idem
14. Cornel Nistorescu „Cantarea Americii”, www.nexfit.as.ro

15. Mircea Malița, idem p. 92
16 .Termenul de „transdisciplinaritate" este introdus în 1970 de către Jean Piaget
17. Basarab Nicolescu, „Nivelurile de realitate şi sacrul" în „Ştiinţă şi religie, antagonism sau complementaritate?", Basarab Nicolescu, Magda Stavinschi, Ed. XXI Eonul Dogmatic, Bucureşti 2002.
18. Ştefan Lupaşcu (1900-1988) arată că logica terțului inclus este o logică veritabilă, formalizabilă şi formalizată, multivalentă (cu trei valori: A, non-A şi T)
19. Basarab Nicolescu, idem p. 48
20. Idem p.49
21. Dicționarul explicativ al limbii române, Editia a II-a, Editura Univers Enciclopedic, Bucureşti, 1998
22. D. Grigore „Un model informațional al influențelor pe sisteme vii" Conferința Națională de Cibernetică, Bucureşti, 1998
23. De ex. păcatul va fi evaluat în perspectiva unei abateri sistemice prin schimb informațional – energetic, pe căile specifice sau nespecifice de transfer informațional, etc.
24. . John F. Haught, n. 1942, teolog, doctorat în 1970 la Catholic University of America. Din 1996 este fondator şi director al Georgetown Center for the Studz of Science and Religion (GCSSR).Haught propune o sistematizare de intenţie a oricărui discurs referitor la raportul religie – ştiinţă clasificând următoarele patru raporturi: (John F. Haught „Ştiinţă şi religie de la conflict la dialog", Ed. XXI: Eonul dogmatic, 2002).