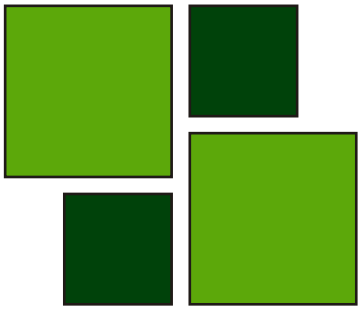

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the ***2010 JAQM Distinction***

HAZARD MORAL MODELS WITH THREE STATES OF NATURE

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Abstract:

The paper analyses a moral hazard model with three states of nature. The model is solved using as variables the informational rents and effort levels. Finally, we determine the features of the optimal contracts in asymmetric information.

Key words: *moral hazard; asymmetric information; informational rents; optimal contract*

Despite 30 years of studies in economics of information, the effects of asymmetric information on different markets are far to be complete known. In fact, this asymmetric information constitutes the central point in economics of information and corresponds to the situation where a contractual partner has more information or better information that the other partner about the transaction characteristics. The economics of information concentrates on studying the incentives to get some potential gains from having private information in a transaction. The incentives are present in almost all economic activities: there are incentives to work with high productivity, to produce good quality products, incentives to study, incentives to invest or to save money.

A different part of economics of information corresponds to moral hazard models. This type of models analyses the economic agents' behavior when acting on different markets: labor market, financial markets, insurance markets, agriculture contracting etc. The macroeconomic literature about the problem of efficient wages correlated with the Agent's effort started with the papers of Solow and Salop (1979), Shapiro and Stiglitz (1984) and

was later developed by Carmichael (1985), McLeod and Malcomson (1987), Saint-Paul (1996), Krishnan (2007). Holmstrom and Tirole (1994) developed a credit rationing theory based on moral hazard models. Dave and Kaestner (2009) analyzed the effects of pure ex-ante moral hazard on health insurance market, and Duhnam (2003) proposed a moral hazard model for the leasing market.

Recent research shows that the models became more and more complex, most of them being mixed models with moral hazard, signaling or screening. Fudenberg and Tirole (1990) proposed a mixed model where the Agent's actual choice regarding the effort is an endogenous adverse selection variable at the renegotiation stage and this aspect generates inefficiency. This problem was partially solved by Matthews (1995) and Ma (1994). Page (1991, 1997) presented a mixed model with moral hazard and adverse selection, and Jullien and Salanie (2007) extended the moral hazard model for the situation where the Agent's risk aversion constitutes his private information, such that the model presents also an adverse selection problem. Such approach was also used by Reichlin and Siconolfi (2004); they generalized the pure adverse selection model of Rotschild and Stiglitz, including some moral hazard variables. Mylovanov and Schmitz (2008) studied a two period moral hazard model, where the Agents are risk neutral, with limited liability and three identical activities.

Introduction

The most used models of hazard moral are the models where the Principal doesn't have direct control on the Agent's effort. There are also some models of hazard moral, not so used in the literature – the Agent's behavior constitutes hidden information either because this behavior is not observable, or, even it is observable, the Principal can not know exactly which is the best Agent's decision regarding the level of effort. [2]

In the later situation (the second type of moral hazard), once the contract is signed, the Agent gets information about the states of nature and knows which is the best choice regarding the effort he exerts. This information is not observable or verifiable by the Principal.

From this point of view, there are two types of hazard moral models:

- the models with an ex-ante participation constraint. In this type of models, the Agent has a given expected utility when signing the contract, and, if he accepts the Principal's offer, he can not breach the contract in the future.

- the models with ex-post participation constraints (the number of constraints is equal to the number of unknown or unpredicted situations), such that, the Agent gets an expected utility which is always equal or greater than his reservation utility, for such unpredicted situation.

We will analyze a model from the first type presented above (this model is not so often discussed in the literature) with three states of nature. The structure of the paper is as follows. Section 1 presents the model. In Section 2 we transform the model using a well known concept in economics of information literature – informational rents. Section 3 studies the optimal contract in the situation of asymmetric information and in the last part (Section 4) we present the features of the optimal contract and some concluding remarks.

1. The model

We suppose that after signing the contract, the Agent observes (knows) the market conditions – if these conditions are good or bad.

We denote by θ the parameter that characterizes the market conditions, with $\theta \in \{\theta^G, \theta^M, \theta^B\}$. A high level of this variable, $\theta = \theta^G$, indicates a favorable situation for the business, while $\theta = \theta^M$ corresponds to a medium situation (a medium state of nature) and $\theta = \theta^B$ (bad situation of unfavorable situation on the market) implies some decisions regarding the effort with a higher cost than the other ones. It is obvious then that $\theta^G > \theta^M > \theta^B$.

We also suppose that the Agent will exert a total level of effort denoted by *E*, but this effort level costs more when the market conditions are bad.

We consider that $E = \theta + e$, where the Agent's decision regarding the effort level *e* is costly, but θ doesn't. The Agent will choose the costly effort *e*, with respect to the information he gets from θ.

The Agent, after signing the contract, observes the true value of the variable θ (θ^B, θ^M or θ^G). The Principal observes the total decision *E*; because he cannot distinguish between the market conditions, the Principal doesn't know the effort level exerted by the Agent. This means that the later could exerts a high level of effort or a medium or low level of effort.

The Principal faces six types of incentives constraints (3 pairs of constraints), some of them being local constraints (4 upward and downward incentive constraints), and the other two constraints being global incentive constraints (one upward constraint and one downward constraint).[2, 7]

The first type of constraints shows that the Agent does not pretend that the market conditions are G (or M, or B) when the true conditions are M or B (or (G or B) or (G or M)).

The second type of constraints shows that the Agent does not announce that the market conditions are M (or G, or B) when the true conditions correspond to the other types.

Subject to these constraints, the Principal will offer a menu of contracts $\{(e^G, W^G), (e^M, W^M), (e^B, W^B)\}$, where *e* and *W* represent the costly effort and the Agent's wage for each state of nature (favorable, medium or unfavorable), with $\theta^B < \theta^M < \theta^G$.

We consider that the respective probabilities of the three nature states are π^B, π^M and π^G (strictly positive), with $\pi^B + \pi^M + \pi^G = 1$.

If the Principal is risk neutral and the Agent is risk adverse, than - using the usual notations - the mathematical model (P) for deriving the optimal contract in the situation of asymmetric information is:

$$\underset{\{(e^G,W^G),(e^M,W^M),(e^B,W^B)\}}{Max} \left\{\pi^G\left[e^G + \theta^G - W^G\right] + \pi^M\left[e^M + \theta^M - W^M\right] + \pi^B\left[e^B + \theta^B - W^B\right]\right\}$$

s.t. (1)

$$\pi^G\left[U(W^G) - V(e^G)\right] + \pi^M\left[U(W^M) - V(e^M)\right] + \pi^B\left[U(W^B) - V(e^B)\right] \geq \underline{u} \quad (2)$$

$$U(W^G) - V(e^G) \geq U(W^M) - V(e^M + \theta^M - \theta^G) \quad (3)$$

$$U(W^G)-V(e^G)\geq U(W^B)-V(e^B+\theta^B-\theta^G) \quad (4)$$

(P) $U(W^M)-V(e^M)\geq U(W^B)-V(e^B+\theta^B-\theta^M)$ (5)

$$U(W^M)-V(e^M)\geq U(W^G)-V(e^G+\theta^G-\theta^M) \quad (6)$$

$$U(W^B)-V(e^B)\geq U(W^M)-V(e^M+\theta^M-\theta^B) \quad (7)$$

$$U(W^B)-V(e^B)\geq U(W^G)-V(e^G+\theta^G-\theta^B) \quad (8)$$

Remarks

The objective function maximizes the Principal's expected net profit. The expression $e+\theta-W$ represents the difference between the total revenue $e+\theta$ (the equivalent of the total effort $e+\theta=E$) and the wage received by the Agent (paid by the Principal) if the state of nature is characterized by the parameter θ.

The constraints given by (3), (5) and (6), (7) are local constraints (upward and downward constraints), and the constraints (4) and (8) are global constraints (one upward constraint and one downward constraint).

The utility function $U(\cdot)$ characterizes the Agent's risk aversion and has the following properties: $U'(\cdot)>0$ and $U''(\cdot)<0$ (strictly increasing and strictly concave).

The function $V(\cdot)$ represents the cost function of the effort (the effort disutility) and has the following properties: $V'(\cdot)>0$ and $V''(\cdot)>0$ (strictly increasing and strictly convex). For example, the term $V(e^B+\theta^B-\theta^M)$ represents the cost of effort when the total effort is $E^B=e^B+\theta^B$ and the state of nature is described by the parameter's value θ^M.

The transformed model – using the variables: informational rents and costly effort levels

Let U^G, U^M, U^B be the Agent's utility levels obtained in each state of nature. Therefore, we can express these informational rents as:

$$U^G=U(W^G)-V(e^G)$$
$$U^M=U(W^M)-V(e^M)$$
$$U^B=U(W^B)-V(e^B)$$

We also consider the function $f:R\to R, f(e)=V(e+\Delta\theta)-V(e)$, with (for simplicity and without any loss of generality) $\Delta\theta=\theta^M-\theta^B=\theta^G-\theta^M$ (the spread of uncertainty on the market conditions).

Now, the constraints (3)-(8) become:

$$U^G\geq U^M+f(e^M-\Delta\theta) \quad (9)$$

$$U^G\geq U^B+f(e^B-\Delta\theta)+f(e^B-2\Delta\theta) \quad (10)$$

$$U^M\geq U^B+f(e^B-\Delta\theta) \quad (11)$$

$$U^M\geq U^G-f(e^G) \quad (12)$$

$$U^B \geq U^M - f(e^M) \quad (13)$$

$$U^B \geq U^G - f(e^G) - f(e^G + \Delta\theta) \quad (14)$$

These new constraints are easy to derive. For example, the constraint (10) is a transformation of the relation (4), as we can see below:

$$U^G = U(W^G) - V(e^G) \geq U(W^B) - V(e^B + \theta^B - \theta^G) =$$
$$= U(W^B) - V(e^B) + V(e^B) - V(e^B - \Delta\theta) + V(e^B - \Delta\theta) - V(e^B - 2\Delta\theta) =$$
$$= U^B + f(e^B - \Delta\theta) + f(e^B - 2\Delta\theta)$$

Or, the constraint (14) (the global downward constraint) is a transformation of (8), as we can see below:

$$U^B = U(W^B) - V(e^B) \geq U(W^G) - V(e^G + \theta^G - \theta^B) =$$
$$= U(W^G) - V(e^G) + V(e^G) - V(e^G + \Delta\theta) + V(e^G + \Delta\theta) - V(e^G + 2\Delta\theta) =$$

$$= U(W^G) - V(e^G) - \left[V(e^G + \Delta\theta) - V(e^G)\right] - \left[V(e^G + \Delta\theta + \Delta\theta) - V(e^G + \Delta\theta)\right] =$$
$$= U^G - f(e^G) - f(e^G + 2\Delta\theta)$$

We must note, for the following propositions, that the function $f(\cdot)$ has the properties:

i) $f(e) > 0$

ii) $f'(e) > 0, \forall e$.

These features are easy derived using the effort cost function.

Proposition 1. If the set of feasible solutions of the program (P) is nonempty, then the following inequalities are satisfied:

i) $e^G + \theta^G \geq e^M + \theta^M \geq e^B + \theta^B$;

ii) $W^G \geq W^M \geq W^B$.

Proof

i) We use the local upward and downward constraints. Summing up the relations (9) and (12) we get:

$$U^G + U^M \geq U^M + f(e^M - \Delta\theta) + U^G - f(e^G)$$

or:

$$f(e^G) \geq f(e^M - \Delta\theta)$$

From the properties of the function $f(\cdot)$ it follows that:

$$e^G \geq e^M - \theta^G + \theta^M \text{ or } e^G + \theta^G \geq e^M + \theta^M$$

Next, from the constraints (11) and (13), by summing up we get:

$$U^M + U^B \geq U^B + f(e^B - \Delta\theta) + U^M - f(e^M)$$

or:

$$f(e^M) \geq f(e^B - \Delta\theta)$$

Using the monotonicity of the function $f(\cdot)$, the later inequality yields to:

$$e^M \geq e^B - \Delta\theta = e^B - \theta^M + \theta^B \text{ or } e^M + \theta^M \geq e^B + \theta^B.$$

The condition $e^G + \theta^G \geq e^M + \theta^M \geq e^B + \theta^B$ represents *the implementability condition (or monotonicity constraint)* for the second best contracts (in the situation of asymmetric information).

ii) Now, using the constraint from (3) and the implementability condition we obtain:

$$U(W^G) - U(W^M) \geq V(e^G) - V(e^M + \theta^M - \theta^G) \geq 0$$

Then, $U(W^G) \geq U(W^M)$ and so $W^G \geq W^M$.

From (5) we get:

$$U(W^M) - U(W^B) \geq V(e^M) - V(e^B + \theta^B - \theta^M) \geq 0$$

It is obvious now that $W^M \geq W^B$.

To conclude, we can state that $W^G \geq W^M \geq W^B$.

The optimal contract in the situation of asymmetric information

Coming back to our settings from Section 1, we are now interested in solving the incentive problem (P). To simplify the analysis and find the relevant binding constraints we proceed as follows. First, we ignore for the moment the local and global downward incentive constraints given by (6), (7) si (8). It is almost obvious that the most efficient types would want to lie upward and claim that they are less efficient. Second, in the final step we check ex post that the incentive constraints are indeed not binding (nonrelevant) and are satisfied by the optimal solution.

We need first to proof the following proposition.

Proposition 2. The global upward constraint (4) is implied by the two local upward constraints (3) and (5), when the monotonicity constraint holds.

Proof

To show this result, we use the constraints (9) and (11), which are equivalent with the constraints (3) and (5) and were obtained using the change of variables.

Suppose that the following inequalities

$$U^G \geq U^M + f(e^M - \Delta\theta)$$

and

$$U^M \geq U^B + f(e^B - \Delta\theta)$$

are satisfied.

Summing up the above two relations we get:

$$U^G + U^M \geq U^M + U^B + f(e^M - \Delta\theta) + f(e^B - \Delta\theta)$$

or

$$U^G \geq U^B + f(e^M - \Delta\theta) + f(e^B - \Delta\theta).$$

It easy to show that $f(e^M - \Delta\theta) + f(e^B - \Delta\theta) \geq f(e^B - \Delta\theta) + f(e^B - 2\Delta\theta)$. This is because $e^M - \Delta\theta \geq e^B - 2\Delta\theta$ or $e^M \geq e^B - (\theta^M - \theta^B) = e^B - \theta^M + \theta^B$ or $e^M + \theta^M \geq e^B + \theta^B$. This last expression corresponds exactly to the implementability condition, assumed to be true

With this simplification of the Principal's program, the only remaining relevant constraints are (2), (3) and (5).

The corresponding Kuhn-Tucker multipliers for the constraints (2), (3) and (5) are denoted by α, λ and μ. Therefore, the Lagrange function it is written as:

$$\begin{aligned} L(e^G, W^G, e^M, W^M, e^B, W^B; \alpha, \lambda, \mu) &= \pi^G\left(e^G + \theta^G - W^G\right) + \pi^M\left(e^M + \theta^M - W^M\right) + \\ &+ \pi^B\left(e^B + \theta^B - W^B\right) + \alpha\left\{\pi^G\left[U(W^G) - V(e^G)\right] + \pi^M\left[U(W^M) - V(e^M)\right] + \right. \\ &+ \left.\pi^B\left[U(W^B) - V(e^B)\right] - \underline{u}\right\} + \lambda\left[U(W^G) - V(e^G) - U(W^M) + V(e^M + \theta^M - \theta^G)\right] + \\ &+ \mu\left[U(W^M) - V(e^M) - U(W^B) + V(e^B + \theta^B - \theta^M)\right] \end{aligned}$$

The first order (the optimality conditions) Kuhn-Tucker conditions are:

$$\frac{\partial L}{\partial e^G} = 0 \Rightarrow \frac{\pi^G}{V'(e^G)} = \alpha\pi^G + \lambda \qquad (15)$$

$$\frac{\partial L}{\partial e^M} = 0 \Rightarrow \frac{\pi^M}{V'(e^M)} = \alpha\pi^M + \mu - \lambda\frac{V'(e^M + \theta^M - \theta^G)}{V'(e^M)} \qquad (16)$$

$$\frac{\partial L}{\partial e^B} = 0 \Rightarrow \frac{\pi^B}{V'(e^B)} = \alpha\pi^B - \mu\frac{V'(e^B + \theta^B - \theta^M)}{V'(e^B)} \qquad (17)$$

$$\frac{\partial L}{\partial W^G} = 0 \Rightarrow \frac{\pi^G}{U'(W^G)} = \alpha\pi^G + \lambda \qquad (18)$$

$$\frac{\partial L}{\partial W^M} = 0 \Rightarrow \frac{\pi^M}{U'(W^M)} = \alpha\pi^M - \lambda + \mu \qquad (19)$$

$$\frac{\partial L}{\partial W^B} = 0 \Rightarrow \frac{\pi^B}{U'(W^B)} = \alpha\pi^B - \mu \qquad (20)$$

Proposition 3. The participation constraint (2) and the local upward constraints (3) and (5) are binding at the optimum.

Proof

Adding up the relations (18)-(20) :

$$\frac{\pi^G}{U'(W^G)}+\frac{\pi^M}{U'(W^M)}+\frac{\pi^B}{U'(W^B)}=\alpha\left(\pi^G+\pi^M+\pi^B\right)=\alpha\,.$$

From this it results that $\alpha>0$ and so the ex-ante participation constraint is binding. Therefore, we get:

$$\pi^G\left[U(W^G)-V(e^G)\right]+\pi^M\left[U(W^M)-V(e^M)\right]+\pi^B\left[U(W^B)-V(e^B)\right]=\underline{u} \qquad (2')$$

Next, we analyze the optimal value of the two variables (λ,μ) and we consider the following cases:

Case 1. $\lambda=\mu=0$. This is not an interesting situation, since it corresponds to the case of symmetric information.

Case 2. $\mu=0$ and $\lambda>0$

The first order conditions from (18), (19) and (20) yield to the inequality:

$$\pi^G\left(\frac{1}{U'(W^G)}-\alpha\right)=\lambda>0 \text{ and so } \alpha<\frac{1}{U'(W^G)}.$$

In the same way we also obtain $\alpha>\frac{1}{U'(W^M)}$ and $\alpha=\frac{1}{U'(W^B)}$.

We can write then:

$\frac{1}{U'(W^M)}<\frac{1}{U'(W^B)}<\frac{1}{U'(W^G)}$ or $W^G>W^B>W^M$, but this contradicts the result $W^M\geq W^B$ from *Proposition 1*.

Case 3. $\mu>0$ and $\lambda=0$

Using the same relations as above we obtain:

$$\frac{1}{U'(W^B)}<\frac{1}{U'(W^G)}<\frac{1}{U'(W^M)}$$

or $W^B<W^G<W^M$, being a contradiction of the result $W^G\geq W^M$ from *Proposition 1*.

Case 4. The first three cases are not possible solutions. Therefore, the only possible case corresponds to ($\lambda>0$ and $\mu>0$). The immediate consequence is that the local upward incentive constraints are binding. Another consequence follows: it is impossible that the global upward incentive constraint to hold with equality (to be binding).

More, using the implementability condition and the previous results, we can state that the downward incentive constraints hold strictly. We proof this statement in the next proposition.

Proposition 4. If the multipliers λ and μ are strictly positive, then the following are true:

i) $U^M\geq U^G-f(e^G)$

ii) $U^B\geq U^M-f(e^M)$

iii) $U^B \geq U^G - f(e^G) - f(e^G + \Delta\theta)$

Proof

i) If $\lambda > 0$ and $\mu > 0$, then the corresponding constraints are binding:

$$U^G = U^M + f(e^M - \Delta\theta) \text{ and } U^M = U^B + f(e^B - \Delta\theta).$$

Using the first equality we obtain:

$$U^M = U^G - f(e^M - \Delta\theta) \geq U^G - f(e^G)$$

This is true due to the implementability condition $e^G \geq e^M - \theta^G + \theta^M$ or equivalently $e^G \geq e^M - \Delta\theta$.

Remark:

More than it was shown, the constraint holds strictly, meaning that the Agent is not interested to claim (to announce) the best state of nature when the true state is the medium one.

Indeed, if $e^G = e^M - \theta^G + \theta^M$, then from (3) or from the equivalent relation (9) we get $W^G = W^M$.

From (16) and using (19) it results:

$$\frac{\pi^M}{V'(e^M)} > \alpha\pi^M - \lambda + \mu$$

and so:

$$V'(e^M) < U'(W^M)$$

or

$$V'(e^M) < U'(W^M) = U'(W^G) = V'(e^G)$$

Therefore, we have $e^M < e^G$. But $\theta^G > \theta^M$ and this implies that $e^M + \theta^M < e^G + \theta^G$, which is a contradiction to $e^G = e^M - \theta^G + \theta^M$.

The conclusion is immediate, $U^M > U^G - f(e^G)$.

ii) The binding constraint (11) yields to:

$$U^B = U^M - f(e^B - \Delta\theta) \geq U^M - f(e^M)$$

The latter inequality is true because we know from the implementability condition that $e^M \geq e^B - \Delta\theta = e^B - \theta^M + \theta^B$.

We have already proved that the relations (i) and (ii) are satisfied. Summing up the terms from the two sides we get:

$$U^B > U^G - f(e^G) - f(e^M) \geq U^G - f(e^G) - f(e^G + \Delta\theta)$$

where $f(e^G + \Delta\theta) \geq f(e^M)$, corresponding to the implementability condition $e^G + \theta^G \geq e^M + \theta^M$ or $e^G + \Delta\theta \geq e^M$.

4. Conclusions

We derived in the last section the optimal solution of the Principal's problem. We can now summarize the characteristics of this optimal solution in the following theorem:

Theorem. The main features of the optimal contract in the situation of asymmetric information are:

A. The Agent's expected utility is exactly the outside opportunity level of utility, $\underline{u}$ (the reservation utility level).

B. If the market conditions corresponds to θ^G (the most favorable situation), the contract is Pareto-optimal, i.e. $V'(e^G) = U'(W^G)$. In this case, there is no distortion with respect to the first best solution.

C. For the other two market conditions (states of nature), the contract is no longer Pareto-optimal. In this case, the following relations are satisfied:

$$V'(e^M) < U'(W^M) \text{ and } V'(e^B) < U'(W^B).$$

Indeed, using the relations (16) and (19) and the above result $\lambda > 0$ we get:

$$\frac{\pi^M}{V'(e^M)} = \alpha\pi^M + \mu - \lambda\frac{V'(e^M + \theta^M - \theta^G)}{V'(e^M)} > \alpha\pi^M + \mu - \lambda = \frac{\pi^M}{U'(W^M)}$$

or $V'(e^M) < U'(W^M)$.

On the other hand, using (17), (20) and $\lambda > 0$ we get:

$$\frac{\pi^B}{V'(e^B)} = \alpha\pi^B - \mu\frac{V'(e^B + \theta^B - \theta^M)}{V'(e^B)} > \alpha\pi^B - \mu = \frac{\pi^B}{U'(W^B)}$$

or $V'(e^B) < U'(W^B)$.

D. If the state of nature is θ^G, the Agent gets positive informational rents with respect to the states θ^M and θ^B. The Agent gets also a positive informational rent in the state θ^M with respect to the least favorable state of nature θ^B.

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ON FUZZY REGRESSION ADAPTING PARTIAL LEAST SQUARES

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Abstract:
Partial Least Squared (PLS) regression is a model linking a dependent variable y to a set of X (numerical or categorical) explanatory variables. It can be obtained as a series of simple and multiple regressions of simple and multiple regressions. PLS is an alternative to classical regression model when there are many variables or the variables are correlated. On the other hand, an alternative method to regression in order to model data has been studied is called Fuzzy Linear Regression (FLR). FLR is one of the modelling techniques based on fuzzy set theory. It is applied to many diversified areas such as engineering, biology, finance and so on. Development of FLR follows mainly two paths. One of which depends on improving the parameter estimation methods. This enables to compute more reliable and more accurate parameter estimation in fuzzy setting. Second of which is related to applying these methods to data, which usually do not follow strict assumptions. The application point of view of FLR has not been examined widely except outlier case. For example, it has not been widely examined how FLR behaves under the multivariate case. To overcome such a problem in classic setting, one of the methods that are practically useful is PLS. In this paper, FLR is examined based on application point of view when it has several explanatory variables by adapting PLS.

Keywords : *Fuzzy regression, partial least squares, fuzzy number*

1. Introduction

Fuzzy set theory (FST) was introduced by Zadeh (1978) in order to model uncertainty in linguistic imprecision. Then, this theory draws attention in many diverse fields. One of the easily applicable areas is the subject of modeling such as regression. FLR was first proposed by Tanaka (1982). In the last three decades, FLR was studied by many researchers in terms of improving parameter estimation. Although several researches have been conducted in order to improve more reliable parameter estimations, the issues emerging from modeling several explanatory variables with respect to application have not been widely examined in FLR. Various methods such as PLS by Garthwaite (1994), Principal component analysis are developed to overcome this issue in classic regression. In this paper, PLS is adapted to fuzzy case when the dependent variable and independent variables are crisp.

To illustrate why FLR as an alternative modeling tool is employed, instead of using classic regression, two data sets are employed. In the first data provided by Tanaka and Guo (1999), which is called Houses Data, it is shown that the classic regression failed since some variable that will be explained in Section 4 is inconsistent with the intuition. Tanaka and Guo (1999) suggested that FLR can be used as an alternative technique to model price against five explanatory variables. Then they used linear programming formulation, that will be given in detail in Section 4, to estimate the fuzzy parameters of the independent variables in the FLR model. However, it also fails since the value of some of the parameters are zero. Therefore, the number of independent variables decreases in FLR when the motivation of explaining the price with those variables is aimed . Hence, despite of the fact that FLR suggested by Tanaka and Guo (1999) as an alternative modeling technique, it still has some issues that should be resolved. For this purpose, a very useful technique called PLS is employed to construct new variables that will used in FLR. PLS end up with one variable which is a linear combination of five independent variables. Then, this new constructed variable is used against the price to estimate FLR model. Following the similar steps in the second data set, which is called *Chocolate Data*, we shown that the same problem has existed. Therefore, the technique called PLS used in classic regression can be adapted to FLR when the dependent and independent variables are crisp.

The rest of the paper is organized as follows. Sections 2 and 3 give a brief description about Partial Least Squares Regression and fuzzy regression respectively. Section 4 gives a concrete example why classic regression fails and explains why fuzzy regression as an alternative technique can be used when assumptions are violated and the functional relationship is unknown. Section 5 gives details of the application of combining PLS and FLR. The last section is the conclusions.

2. Partial Least Squares or Projection to Latent Structure

Partial Least Squares Regression (PLS-Regression) is a statistical method that bears some relation to principal components regression; instead of finding hyperplanes of maximum variance between the response and independent variables, it finds a linear regression model by projecting the predicted variables and the observable variables to a new space. Because both the **X** (explicative variables) and **y** (response variable) data are projected to new spaces, the PLS family of methods are known as bilinear factor models.

PLS-regression is particularly suited when the matrix of predictors has more variables than observations, and when there is multicollinearity among **X** values. By contrast, standard regression will fail in these cases. The goal of PLS regression is to predict **y** from **X** and to describe their common structure. When **y** is a vector and **X** is full rank, this goal could be accomplished using multiple regression. When the number of predictors is large compared to the number of observations, **X** is likely to be singular and the regression approach is no longer feasible (i.e., because of multicollinearity). Several approaches have been developed to cope with this problem. One approach is to eliminate some predictors (e.g., using stepwise or forward methods) another one, called Principal Component Regression, is to perform a Principal Component Analysis (PCA) of the **X** matrix and then use the principal components of **X** as regressors on **y**. The orthogonality of the principal components overcomes the multicollinearity problem. But, the problem of choosing an optimum subset of components remains. Different approaches had been proposed in the past to select the optimal number of PCs (Valle et al, 1999): Akaike information criterion, minimum description length, imbedded error function, cumulative percent variance, scree test on residual percent variance, average eigenvalue, parallel analysis, autocorrelation, cross validation based on the PRESS and R-ratio and variance of the reconstruction error.

Following one of the cited methods, it is possible to keep only a few of the first components.

But they are chosen to explain **X** rather than **y**, and so, nothing guarantees that the principal components, which "explain" **X**, are relevant for **y**.

By contrast, PLS regression searches for a set of components (called latent vectors) that performs a simultaneous decomposition of **X** and **y** with the constraint that these components explain as much as possible of the covariance between **X** and y. This step generalizes PCA. It is followed by a regression step where the decomposition of **X** is used to predict **y**. Simultaneous decomposition of predictors and dependent variables PLS regression decomposes both **X** and **y** as a product of a common set of orthogonal factors and a set of specific loadings. So, the independent variables are decomposed as **TP**′ where **T** and **P** are the score and loadings matrices respectively with **T′T**=**I** with **I** being the identity matrix. By analogy with PCA, **T** is called the score matrix, and **P** the loading matrix (in PLS regression the loadings are not orthogonal). The columns of **T** are the latent vectors. When their number is equal to the rank of **X**, they perform an exact decomposition of **X**.

2.1 PLS regression and covariance

The latent vectors could be chosen in a lot of different ways. In fact in the previous formulation, any set of orthogonal vectors spanning the column space of **X** could be used to play the role of **T**. In order to specify **T**, additional conditions are required. For PLS regression this amounts to finding two sets of weights *w* and *c* in order to create (respectively) a linear combination of the columns of **X** and **y** such that their covariance is maximum. Specifically, the goal is to obtain a first pair of vectors **t**=**Xw** and **u**=**Yc** with the constraints that **w**′**w** =1, **t**′**t**=1 and **t**′**u** be maximal.

When the first latent vector is found, it is subtracted from both **X** and **y** and the procedure is re-iterated until **X** becomes a null matrix.

The number of latent variables to be retained in the model can be selected according to different tools. In cross-validation (Wold, 1975), the training data set is split into a number

of subsets, say *r*. Initially, for a model comprising one latent variable, the first subset of data is omitted and a PLS model is built on the remaining (*r-1*) subsets of data. The prediction error sum of squares (PRESS) for the omitted subset of data is then computed and the omitted subset restored. The procedure is repeated until every individual subset has been left out once. The *r* individual PRESS's are then summed to give the total PRESS. The procedure is repeated for $i=\{2,3,\ldots, a\}$ latent variables and a corresponding total PRESS is calculated. The optimal number of latent variables is chosen to be that which minimizes the total PRESS. A nice description of PLS Regression can be found in Tenenhaus (1998) and Camminatiello (2006).

3. The review of fuzzy linear regression

Since the first FLR model proposed by Tanaka (1982), the fast growing literature has followed two paths. One of which merely depends on developing new parameter estimation methods which enable to compute less fuzzier and more useful parameter estimates. Some of them mentioned are given in Soliman et.al. (2002), Toyoura et. al. (2004), Chang (2001), Alex (2006), Ishibuchi and Nii (2001), Tran and Duckstein (2002). In general, these methods can be categorized into two classes, which are called mathematical programming based parameter estimation methods and fuzzy least squares method, respectively. Former ones are those that are based on mathematical programming. Later ones are based on the method proposed by Diamond (1988). Both aim to improve parameter estimates. Second of which is based on application of the model. However, this aspect of FLR has not got much attention. Generally speaking, the issues emerging from applications such as modelling several explanatory variables, interactions among them have been avoided. FLR is a method which is more suitable when one or more of the violations occur simultaneously, for example, the assumption of linearity between dependent and independent variables may not be observed, or instead of numeric data values, data related to one or more variables can be described as words such as "*bad*" or "*good*" or there exists small data set which does not satisfy the normality assumption. Under these circumstances, classic regression is observed to fail. This situation is exemplified with a solid example in the next section.

Also, Kim et. al. (1996) investigated various circumstances where classic regression excels fuzzy regression or vice versa.

Fuzzy linear regression model is generally given as follows:

$$\hat{\tilde{Y}}_i = \tilde{A}_0 + \tilde{A}_1\tilde{X}_1 + \tilde{A}_2\tilde{X}_2 + \ldots + \tilde{A}_n\tilde{X}_n \qquad (3.1)$$

where $\hat{\tilde{Y}}_i, \tilde{X}_i, \tilde{A}_j$ denotes fuzzy numbers which can be symmetric or asymmetric or trapezoidal fuzzy numbers.

Symmetric or asymmetric or trapezoidal fuzzy numbers can be chosen based on information which will be believed that it represents inherent uncertainty in FLR. For example, it is believed that asymmetric fuzzy numbers represent uncertainty in parameters. Then, the model

is constructed based on those numbers. As it can been seen, the expression in (3.1) exhibits the generic case for FLR. The model given in (3.1) does not have error term since it is included in the parameters of model. The special forms of model (3.1) can be written

depending on the type of variables. The Table 1 summarizes the cases which should be used in modeling.

Table 1: *Type of variables*

Y	X	A
Reel	Reel	Fuzzy
Fuzzy	Reel	Fuzzy
Fuzzy	Fuzzy	Fuzzy

Throughout the paper symmetric triangular fuzzy numbers are employed for the sake of simplicity. Linear programming based method is used in order to estimate parameters.

4. Implementing fuzzy linear regression

The parameter estimation method used in this paper is based on the method proposed by Tanaka (1982). For this purpose, the formula below is employed to estimate parameters of FLR.

$$
\begin{aligned}
&Min\ \mathbf{c}^t |\mathbf{X}| = Min \sum_{j=0}^{n} c_j \sum_{i=1}^{m} |x_{ij}| \\
&\sum_{j=0}^{n} \alpha_j x_{ij} + (1-h)\sum_{j=0}^{n} c_j |x_{ij}| \geq y_i + (1-h)e_i \\
&\sum_{j=0}^{n} \alpha_j x_{ij} - (1-h)\sum_{j=0}^{n} c_j |x_{ij}| \leq y_i - (1-h)e_i \\
&c_j \geq 0,\ \alpha \in \Re,\ x_{i0} = 1\ (0 \leq h \leq 1;\ \forall i = 1,2,...,m)
\end{aligned}
\qquad (4.1)
$$

To illustrate why classic regression failed, we used a data set (Tanaka and Guo, 1999) whose name is *House price* which is given in Table 2.

Table 2: *house price data*

N	y	x_1	x_2	x_3	x_4	x_5
1	606	1	38,09	36,43	5	1
2	710	1	62,1	25,5	6	1
3	808	1	63,76	44,71	7	1
4	826	1	74,52	38,09	8	1
5	865	1	75,38	41,1	7	2
6	852	2	52,99	26,49	4	2
7	917	2	62,93	26,49	5	2
8	1031	2	72,04	33,12	6	3
9	1092	2	76,12	42,64	7	2
10	1203	2	90,26	43,06	7	2
11	1394	3	85,7	31,33	6	3
12	1420	3	95,27	27,64	6	3
13	1601	3	105,98	27,64	6	3
14	1632	3	79,25	66,81	6	3
15	1699	3	120,5	32,25	6	3

The explanatory variables $\mathbf{x}_1$, $\mathbf{x}_2$, $\mathbf{x}_3$, $\mathbf{x}_4$and $\mathbf{x}_5$ are quality of the construction material, area of the first floor, area of the second floor, total number of rooms, number of Japanese room, respectively. The response variable **y** is the price of houses whose last four digits are dropped for the sake of simplicity.

When classic regression analysis is used, the model is obtained as follows:

$$\mathbf{y}=-112.4+236.48\mathbf{x}_1+9.3568\ \mathbf{x}_2+8.2294\ \mathbf{x}_3-37.889\ \mathbf{x}_4-17.253\ \mathbf{x}_5 \quad (4.2)$$

It is observed that as the x_4 (total number of rooms) increases**, y** (price) decreases. This is contradictory to common sense. Therefore, FLR can be substituted as an alternative modeling approach. However, this also creates problems which should be addresses too. The same data produce FLR as follows:

$$\hat{\tilde{y}} = (45.167,37.634)x_1 + (5.833,0)x_2 + (4.786,0)x_3 \quad (4.3)$$

Also, this model explains response variable using fewer variables although there is no procedure available in FLR which can be used as variable selection method. Therefore, when several explanatory variables exist in FLR, it should be expected that some problems similar to those in regression or the problems related to FLR may emerge. To overcome these kinds of problem, PLS is an alternative method that can also be used in FLR. In order to illustrate the usage of PLS in FLR, a data set consisting of seven variables given in Table 3 are used. Based on the results of PLS, just one variable (component) which can be written in the form of other variables is obtained as combination of other variables. Then FLR is conducted for this variable.

5. Implementing PLS into fuzzy linear regression

On consider the following data sample. The data consisting of the price, weight and nutritional information was gathered for a number of chocolates commonly available in Queensland stores. The data was gathered in April 2002 in Brisbane. There are 7 varieties and 7 variables, plus the names of the chocolates are row names**.**

Table 3: *Chocolates Data*

N	Unit.Price	Size	Energy	Protein	Fat	Carbohydrate	Sodium
1	1,76	50	1970	3,1	27,2	53,2	75
2	2,56	45	2250	7,2	30,1	59,4	110
3	1,62	60	1890	4,7	19,5	67,9	160
4	2,56	50	2030	5,6	20,4	67,4	250
5	2,33	55	1623	2,2	9,2	73,3	90
6	2,58	60	1980	8,5	20,6	63,3	130
7	2,78	42.5	1970	5	20	69	148

As it can be seen in the previous section, FLR may fail if some of the explanatory variables are correlated when independent and dependent variables are crisp. This situation also creates problems for FLR. To overcome this kind of a problem, a method called PLS used

in classic regression can also be used in FLR. The Chocolate Data consists of six independent and one dependent variable. The dependent variable price is tried to be explained by independent variables such as size, energy and so on. In this example, the classic regression failed. Then FLR is run to estimate parameters but the similar situation observed in the previous example is encountered. One of the frequently faced problems in classic regression has appeared. It is called correlated explanatory variables. This problem is expected since independent and dependent variables are crisp values. Then PLS is used to construct new variables (components) to be used in FLR model. For our case, After running PLS, one independent variable (component) is obtained which is denoted by X*.
When the linear programming formula is run for the data obtained after PLS, the resulting fuzzy regression model is obtained as follows:

$$\hat{y} = (2.14,0.78) + (4.27,1.12)X^{*} \tag{5.1}$$

where X* is the component which is a linear combination of the independent variables after PLS is calculated.

The constant term of FLR is (2.14, 0.78) and the coefficient of X is (4.27, 1.12). These are symmetric fuzzy numbers which can be written as (1.36, 2.92) and (3.15, 5.39). Suppose that X*=0.25, then the predicted price is (2.14, 0.78)+(4.27, 1.12)0.25= (3.21, 1.06) is obtained. This means that the price ranges between 2.15 and 4.27 when X*=0.25.

Instead of using correlated explanatory variables, the component, which is a linear combination of six independent variables such as size, energy, protein, fat, carbohydrate, and sodium, is used to estimate the price by using FLR.

6. Conclusion

When the assumptions related to classic regression are violated such as correlated independent variables or correlated errors or other types of violations that can be found in the literature, some type of remedies are suggested. When functional relationship is not known in advance, FLR is introduced as an alternative method which helps model crisp/crisp or crisp/fuzzy data. On the other hand, PLS is used for reducing number of independent variables to obtain components. What it is observed in classic regression as problems is also observed in FLR as well. Thus, the methods used for regression can be used for FLR. In this paper, we use PLS for FLR. In the first data set which is house data set, first of all, parameter estimates are calculated for regression model but there is contradiction between one of the independent variable and dependent variable which is that when the number of rooms increase, the price of house decreases. Also, the correct functional relationship between dependent variable and independent variable is not know. Then, the parameters of FRL is calculated. This model has three independent variables. However, FLR is more realistic than classic regression. In the second data set which is called Chocolate Data, the similar problem is encountered. We followed the similar steps to reach the final regression model since the relationship between the dependent variable and the interdependent variables are unknown. Therefore, this led to choose the FLR as an alternative modeling tool. Before running FLR, PLS is employed to reduce the number of independent variables. Then based on the reduced number of independent variable, which is one component consisting of

linear combination of independent variables. Then we predicted FLR model using component as an independent variable and the price as a dependent variable. Therefore, what model suggested is that the component variable as a combination of independent variables explains the price in the interval. As a further study, extending PLS method to be used for the case of fuzzy/fuzzy is a subject which should be examined.

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INFORMATION ENTROPY AND OCCURRENCE OF EXTREME NEGATIVE RETURNS[1]

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Abstract:

This study is intended to investigate the connection between the complexity of a capital market and the occurrence of dramatic decreases in transaction prices. The work hypothesis is that such episodes, characterized by sudden and dramatic decreases in transaction prices mostly occur in period of market inefficiency, when the level of complexity reaches a local minimum. In this regard, we introduce a complexity estimator, through differential entropy. The connection between the market complexity level and the appearance of extreme returns is illustrated in a logistic regression model.

Key words: *differential entropy; stock market crash; logistic regression*

1. Introduction

The work hypothesis tested in this paper consists in the fact that the phenomenon of capital market crashes is mostly manifested when the market registers a significant decrease in the complexity level as against to the efficient market hypothesis.

The connection between a certain extent of complexity and the efficient market hypothesis is quite obvious: if we assume an efficient market (weak form) then the price of an asset which follows a random walk model, i.e. the series of returns is a white noise process. From the quantitative measurements point of view, a white noise process is the most complex process possible; on the contrary, if the efficient market hypothesis is not respected, than the price is no longer a random walk process and consequently, the market complexity level is lower.

For instance, if the price is purely deterministic process, completely predictable, then we can speak of reaching a minimum complexity level; if however, the price is purely random, completely unpredictable we can speak of a maximum complexity level. Our study is intended to prove that episode such as stock market crashes, characterized by sudden and dramatic decreases in transaction prices mostly occur in periods of market inefficiency, when their complexity level reaches a local minimum level.

Risso (2008) uses entropy as a complexity measurement in order to investigate the hypothesis according to which stock market crashes are associated to low entropy periods. The connection between information efficiency and stock market crashes is the following: if the market is inefficient, thus the information not being reflected instantaneously in prices there can be created trends in price evolution. However, when information reaches investors, the price can resettle, leading to significant crashes.

2. Information entropy as a measure of complexity

Entropy is measure of complexity, having numerous applications in physics, information theory, biology, medicine, and economics.

In its classical formulation, entropy can be defined in a discrete space.

If we have a discrete random variable X, with the distribution $X:\begin{pmatrix} x_1.....x_n \\ p_1.....p_n \end{pmatrix}$,

where $p_i = P(X = x_i)$, $0 \le p_i \le 1$ and $\sum_i p_i = 1$, then the Shannon information entropy is defines as:

$$H(X) = -\sum_i p_i \log_2 p_i .$$

We notice that for a uniform distribution, we obtain the maximum value for entropy: $H(X) = -\sum_i (1/n)\log_2(1/n) = \log_2 n$; the minimum value is obtained for a distribution like $X:\begin{pmatrix} x_1.....x_n \\ 1.....0 \end{pmatrix}$, $H(X) = 0$.

In other words, larger values of the entropy are obtained for situations with high certainty, while smaller values are associated with low certainty situations.

The application in case of stock markets is immediate.

Let $r_t = p_t - p_{t-1} = \log P_t - \log P_{t-1}$ be the return associated to an asset and $s_t = \begin{cases} 1, r_t > 0 \\ 0, r_t < 0 \end{cases}$ a variable which defines the „bull-bear" statuses.

Then, for a certain period of time, we can define information entropy of a sequence of 0 and 1: $H = -p\log_2 p - (1-p)\log_2(1-p)$, where $p = P(s_t = 1) = 1 - P(s_t = 0)$.

3. The theoretical model of the connection between complexity and stock exchange market crashes

Risso (2008) uses this measure of complexity to investigate the hypothesis according to which stock exchange market crashes are associated especially to low entropy periods.

In fact, entropy can be looked upon as a measure of information efficiency in capital markets: if the market is efficient in its weak form, then the price is a random walk process, and bull and bear market situations are consequently equally probable. In terms of information entropy, market efficiency is equivalent to the situation of maximum entropy, of maximum complexity. On the contrary, situations characterized by ascendant or descendant trends, situations when price predictability is hinted, are characterized by a lower complexity level, and thus, a smaller entropy value.

In order to verify this hypothesis, we can estimate a logistic model:

$\log\frac{P(y^*=1)}{1-P(y^*=1)}=\beta_0+\beta_1 H$ or equivalently, $P(y_t^*=1)=\frac{\exp(\beta_0+\beta_1 H_t)}{1+\exp(\beta_0+\beta_1 H_t)}$.

In the equation above, we have:

- $y_t^*=1$ for the smallest 1% of the returns ($y_t^*=\{1\,|\,r_t<r_t^*, P(r_t<r_t^*)=0.01\}$)
- H_t Is market information entropy at moment t.

The issue that is imposed is how to measure information entropy. The methodology used by Risso (2008) is the following:

- For a certain time interval *T*, we define the values $s_t=\begin{cases}1, r_t>0\\0, r_t<0\end{cases}$, obtaining a succession of zeros and ones.
- We define a rolling window $\nu << T$ for which we compute the probability $p_\nu=P(s_t=1)$
- The entropy for the entire time interval will then be $H=-p_\nu\log_2 p_\nu-(1-p_\nu)\log_2(1-p_\nu)$. Also, the normalized Shannon entropy can be computed as $NH=\frac{H}{\log_2 n}$.

Risso applies this methodology on various time intervals *T* and various windows ν, obtaining statistically significant results for stock market indices in Russia, Japan, Mexico, Malaysia and the USA.

From our point of view, the methodology should be extended, considering the fact that in the present stage we only take into account information contained in 0 and 1 sequences defined above, without return values for the analyzed period.

In other words, information entropy is computed on the discrete case, ignoring the continuous nature of the distribution of returns.

In the followings, we propose a methodology which takes into account this aspect.

4. Differential entropy

Unlike the case of a discrete random variable, the entropy of a continuous random variable is much harder to quantify.

For instance, if *X* is a random variable with a density function of $f(x)$ probability, then we can define, by analogy with Shannon information entropy, the differential entropy:

$H(f) = -\int_A f(x)\log_2 f(x)dx$, where A is the support set for X.

Unfortunately, the differential entropy doesn't have all the properties of Shannon entropy: it can take negative values and moreover, is not invariant to linear transformations on variables.

Moreover, there are difficulties when it comes to estimating differential entropy in a sample.

We can define a naïve estimator of differential entropy in the following manner (Lorentz, 2009):

- Let $h>0$. For any i, there is $x_i \in [(i-1)h, ih)$ so that $f(x_i)h = \int_{(i-1)h}^{ih} f(x)dx$. This process transforms a continuous variable X into a discrete variable X_h, with $P(X_h = x_i) = f(x_i)h$.

- In the conditions above, we can define the entropy for X_h as: $H(X_h) = -\sum_i f(x_i)h\log_2(f(x_i)h) = -\sum_i f(x_i)h\log_2 f(x_i) - \log_2 h$.

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- We have: $\lim_{h\to 0} H(X_h) = \lim_{h\to 0}\left[-\sum_i f(x_i)h\log_2 f(x_i)\right] - \lim_{h\to 0}\log_2 h = H(f) + \infty$.

Consequently, the naïve estimator of differential entropy does not converge, which can raise serious issues when h is close enough to 0.

Nonetheless, we can define the entropy of a function which fulfills certain properties through a transformation called quantization (this process will constitute the subject of a future study).

In reality, most of the times we don't know the expression of the probability density function, this being precisely the case of the series of returns on capital market.

On the other hand, we can estimate this density using a non-parametric approach, such as the kernel density estimation (KDE).

In essence, KDE assumes the discretization of the continuous distribution and then the estimation of a continuous density around each point x_i of the discretized distribution.

Thus, the KDE estimator has the shape $f(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right)$.

In the previous expression, K is a real function, with the following properties:

i) $K(x) \geq 0, \forall x \in \mathbf{R}$.

ii) $K(x) = K(-x), \forall x \in \mathbf{R}$.

iii) $\int_{\mathbf{R}} K(x)dx = 1$.

iv) $\int_{\mathbf{R}} xK(x)dx = 0.$

Such a function is called *kernel* and is usually chosen among the known probability density functions. For instance, there are frequently used:

- Uniform kernel: $K(x) = \frac{1}{2}\mathbf{1}_{(|x|<1)}$;
- Epanechnikov kernel: $K(x) = \frac{3}{4}(1-x^2)\mathbf{1}_{(|x|<1)}$;
- Gaussian kernel: $K(x) = \frac{1}{\sqrt{2\pi}}\exp(-\frac{1}{2}x^2)$;
- Triangular kernel: $K(x) = (1-|x|)\mathbf{1}_{(|x|<1)}$

In order to estimate the differential entropy, we estimate the probability density function of returns, using Kernel Density Estimation(KDE).

Basically, our methodology assumes following the next steps:

- Let r_t be a return series for a time period *T*.
- We choose $n = 2^k$ and estimate probability density function through the formula above, obtaining the $f(x_i)$ values for $i = 0,..,n-1$.
- We estimate the differential entropy with the formula:

  $H(X_h) = -\sum_i f(x_i)h\log_2(f(x_i)h) = -\sum_i f(x_i)h\log_2 f(x_i) - \log_2 h$,

  where $h = 1/n$.

In the actual estimation of differential entropy, we considered a Gaussian kernel and chose $n = 2^7 = 128$ (such that the smoothing factor *h*, is not very close to zero).

5. Results

In order to assess the level of complexity of Bucharest Stock Exchange, we estimated the value of the differential entropy and those of normalized Shannon entropy for various rolling-windows and sub-periods in the case of the daily BET returns in the period 1997-2011 (January 31st 2011 is the last value of the series).

Also, we have estimated the following model of logistic regression:

$$\log\frac{P(y_t^*=1)}{1-P(y_t^*=1)} = \beta_0 + \beta_1 H_t \text{ or } P(y_t^*=1) = \frac{\exp(\beta_0+\beta_1 H_t)}{1+\exp(\beta_0+\beta_1 H_t)}.$$

In the equation above we have:

- $y_t^* = 1$ for the smallest 1% of returns ($y_t^* = \{1 \mid r_t < r_t^*, P(r_t < r_t^*) = 0.01\}$). In the case of BET index for the analyzed period, $r_t^* = -0.05516$.
- H_t is the information entropy of the market at moment *t*, measured successively through the differential entropy previously defined and through the normalized Shannon entropy.

Since we are in the situation of choosing one of more models, we will have to use a performance indicator for the logistic regression model.

In general, such an indicator is defined by comparing the verosimility function of the model with the verosimility function of the model which excludes the exogenous variable.

Thus we have, *pseudo-* R^2, a measurement of model performance (Nagelkerke, 1991): $R^2 = 1 - \exp\{2[\log L(M) - \log L(0)]/n\}$, where $L(M)$ and $L(0)$ are the verosimility functions of the model with and without the exogenous variable.

This indicator cannot be interpreted as the weight of variance explained by the model like in the case of classical regression.

If we rewrite the relation above $-\log(1-R^2) = 2[\log L(M) - \log L(0)]/n$ it can be interpreted as the information surplus brought by the exogenous variable.

Unfortunately, R^2 in the case of the logistic regression doesn't reach the value 1 in the perfect model either, which is why an adjustment has been proposed (Nagelkerke, 1991):

$$R^2_{adj} = R^2/[1-\exp(2\log L(0)/n)].$$

Table 1. Adjusted R^2 for the two estimators of complexity

	Normalized Shannon Entropy					Differential Entropy				
	$\nu=1$	$\nu=2$	$\nu=3$	$\nu=4$	$\nu=5$	$\nu=1$	$\nu=2$	$\nu=3$	$\nu=4$	$\nu=5$
T=60	0.021	0.012	0.019	0.031	0.02	**0.083**	0.052	0.014	0.015	0.021
T=100	0.031	0.026	0.035	0.036	0.009	0.046	0.032	0.008	0.006	0.022
T=150	0.017	0.01	0.015	0.032	0.009	0.028	0.015	0.002	0.002	0.012
T=200	0.017	0.009	0.013	0.022	0.01	0.008	0.003	0.00	0.00	0.005
T=240	0.001	0.001	0.004	0.011	0.007	0.001	0.00	0.001	0.002	0.00

As can be seen in the R^2_{adj} values for the estimated logistic regression models, the best performances are offered by the differential dntropy estimator, for $T = 60$ and $\nu = 1$.

The fact that the best results in the case of the BET index were obtained for $T = 60$, suggests that the Romanian market doesn't present persistent memory in time, the local temporal context being the predominant one.

Also, estimating complexity using the differential entropy of returns offers better results than the classical Shannon entropy.

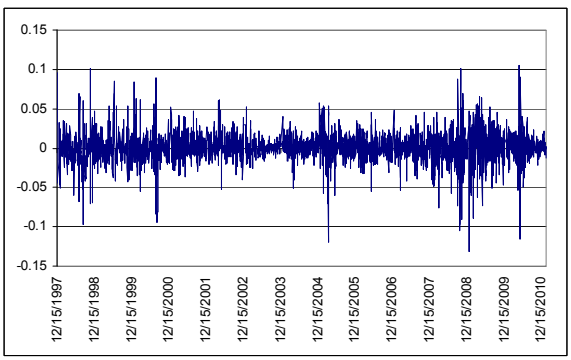

Fig.1. Daily logreturns of BET Index

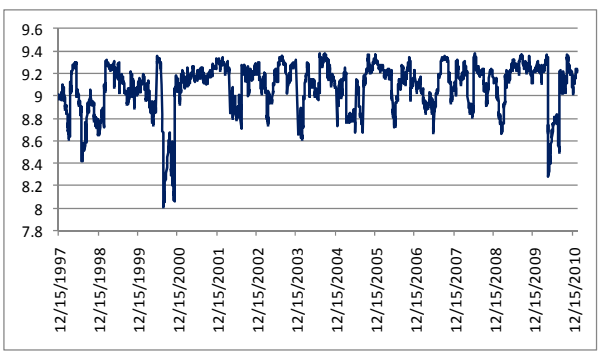

Fig.2. Differential Entropy($T = 60$, $\nu = 1$)

The results of the optimal model estimations, for differential entropy, $T = 60$ and $\nu = 1$ are presented below.

Table 2. Logistic regression model for differential entropy with $T = 60$ and $\nu = 1$

Response Profile		
Ordered Value	y_t	Total Frequency
1	1	32
2	0	3234

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	361.723	335.218
SC	367.814	347.400
-2 Log L	359.723	331.218

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	28.5054	1	<.0001
Score	41.6738	1	<.0001
Wald	36.0161	1	<.0001

R-Square	0.0087	Max-rescaled R-Square	0.0833

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	23.5458	4.6265	25.9016	<.0001
Differential Entropy	1	-3.1368	0.5227	36.0161	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Differential Entropy	0.043	0.016	0.121

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	70.8	Somers' D	0.500
Percent Discordant	20.8	Gamma	0.547
Percent Tied	8.4	Tau-a	0.010
Pairs	103488	c	0.750

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
8.6280	8	0.3746

From analyzing the estimation results, we can observe that entropy has a negative influence on the probability of stock market crashes. In fact, an increase of one unit in entropy leads to a decrease of approximately 95% of the chances of crash appearance.

Considering all other indicators which verify the significance of the regression model, we conclude that it is possible to use the differential entropy behavior to anticipate a possible crash.

To illustrate the previous statement, we have studied the behavior of entropy around the main crashes of BET.

Table 3. The main crashes at Bucharest Stock Exchange

Date	Logreturn
1/7/2009	-0.13117
3/28/2005	-0.11902
5/25/2010	-0.11612
10/10/2008	-0.10454

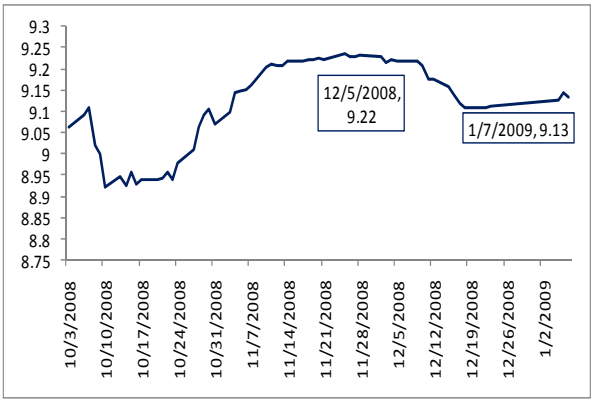

Fig. 3 The crash from 7 january 2009

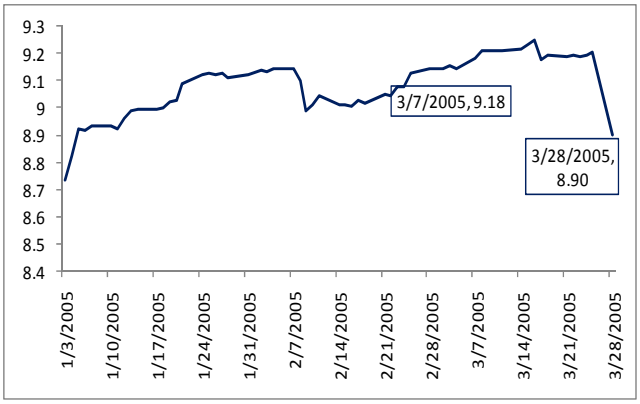

Fig.4 The crash from 28 march 2005

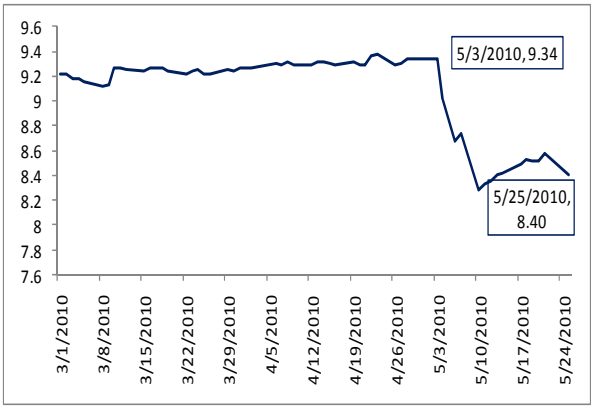

Fig. 5 The crash from 25 may 2010

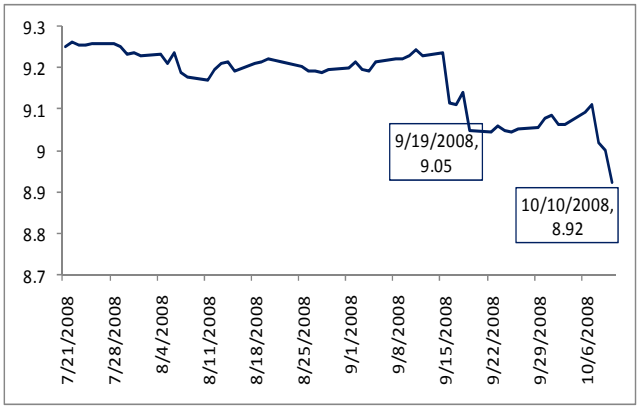

Fig. 6 The crash from 10 october 2008

After analyzing the entropy behavior before crash incidence we can observe that such an event is preceded by an entropy local minimum, but the transmission is not instantaneous. This can also be an effect of the Romanian market efficiency deviation from the efficient market hypothesis.

6. Conclusions

Capital market information efficiency is a subject intensely debated in the last few years, especially due to the present economic and financial crisis. The connection between capital market efficiency and the predictability of stock market crashes can be illustrated through a complexity measurement, starting from the hypothesis that large decrease episodes in the price of an asset precisely exploit a certain context of efficiency weakening.

In this study, we have analyzed the connection between capital market complexity and stock market crash predictability using the differential entropy of returns as measurement of complexity. The results of the estimated model show that this measurement of complexity generates better results than the classical estimator of Shannon entropy, as it makes it possible to go from a discrete estimator of entropy to a continuous one.

The analysis performed in the case of BET index of Bucharest Stock Exchange has led to the conclusion that the main depreciations of BET have been preceded by episodes of dramatic decreases in the entropy level. In this respect, the entropy behavior can be constituted in a early warning system on the possible negative evolutions of the capital market.

Unfortunately, this method has certain limits, because the entropy differential estimator does not have the required convergence properties.

The natural development of this study is taking into consideration an entropy estimator which considers the continuous nature of returns and has the optimality properties.

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JOURNAL OF APPLIED QUANTITATIVE METHODS

Quantitative Methods Inquires

TECHNOLOGY ADOPTION, INDUSTRIAL STRUCTURE, AND GROWTH IN EMERGING ECONOMIES

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Abstract:
This paper explores the link which is often neglected in the literature between the industrial structure and the aggregate economic growth in emerging economies (EE) that are implementing an openness trade policy. Based on the Schumpeterian technological paradigm concept, we show the relevance of the technology adoption hypothesis rather than the innovation hypothesis in an EE's context. We develop an endogenous deterministic growth model for small open economies in which domestic agents adopt technology incorporated in equipment import. Through the model, we prove that equipment import, technological externalities, and the fall in relative prices are the sources of openness growth effects. In this paper we determine endogeneously the minimal efficiency threshold of entry and exit dynamics in the domestic industrial structure within an endogenous growth framework. We show that the consumption goods diversity improves the growth rate of consumption and welfare by its negative action on the surviving firms monopoly power. We argue that for intermediate goods, the agents heterogeneity is negatively correlated with stationary state growth rate. From an economic policy point of view, it would be recommended to intervene by improving the performance of the domestic firms before implementing the trade openness policy, and after its implementation by controlling the markets to avoid the monopolistic structure that is negatively correlated with economic growth at the aggregate level.

Key words: *Technology Adoption; Heterogeneous Agents; Monopolistic competition; Efficiency Threshold; Entry-Exit Dynamics*

I. Introduction

The link between trade openness and economic growth has been reviewed in the literature based upon two types of research work. The first studies the link between trade openness and the growth rate of per capita GDP as illustrated in the endogenous growth models which allow to establish the transmission channels of trade policy dynamic effects as argued in Baldwin (1998), Romer and Batiz (1991), and Martin and Barro (1995). These channels result in the spread of various forms of technology and in types of externalities, international capital flows, prices adjustment, and adequate macroeconomic policies.[1] But these models retain the restrictive assumption of homogeneous agents behaviors in a perfect market final goods context. Consequently, a symmetric equilibrium may be achieved. The

results obtained from these models in there majority indicate the positive effect of trade opppenness on GDP and its growth. But the extent of this effect and its relevance remain mainly dependent on homogeneous agents assumption and thus on symmetric equilibrium. However, the behavior of agents is indeed not identical for at least two reasons. First, the industrial and technological strategies carried out separately by the agents are to give place to product differentiation (Chamberlin, 1933).[2] Second, the non-uniform costs undergone by firms lead to specialization (Stigler, 1949). In this context, each agent positions herself as a monopoly of her own innovation. A monopolistic structure is established and a symmetric equilibrium is then evacuated from the analysis.

The second type of studies, initiated more recently by Bernard et al. (2000), Melitz (2002), and Yeaple (2002), emphasize the microeconomic bond between the exporting firms and their productivity. Within this analysis framework, J. Bradford et al. (2003) explore the productivity evolution in industry resulting from the firms reallocation in response to changes in the trade costs (*i.e,* tariffs and costs of transport). Others treated the structure of the market endogenously, namely, Katja (2006) for space endogenous location, and Mazzeo (2002), for endogenous quality choice. However, they did not treat economic growth. Finally, Holmøy (2003) is interested in an evaluation of the standard Dixit-Stigliz model when the asymmetry is taken into account. However this second type researchers were not interested in economic growth at the aggregate level.[3]

We will retain the assumption of heterogeneity to analyze the market structure, and to describe the entry and exit agents dynamics. This dynamics is determined by the efficiency, profitability and competitiveness of the various agents operating in such a heterogeneous structure (Montagna, 1995).

The trade openness makes it possible for the EEs to take advantage of the volume of imported equipment goods as well as the technology which they incorporate. The structure of their industry will then be modified and efficiency conditions will be imposed on the economic agents. In fact, diversified products and competition in terms of efficiency between the agents will characterize their industrial structures.

It would be then interesting to adapt this approach of heterogeneous agents to the problems of endogenous growth in an open EE which chooses trade liberalization. In this paper we study the effects of diversified equipment goods import on industry structure in EE imitating foreign technology and on their economic growth. For the industry entry-exit dynamics and heterogeneity effects on growth, we use a framework for an economy witch has two sectors. The intermediate good sector has imported goods together with foregone output to produce the large number of durable goods that are available for use in final goods production at any time. We adopt the hypothesis of all intermediate goods being imported. This hypothesis may be questionable when we consider all the developing countries. But for the Middle East countries in specific, the weight of domestic equipments is negligible compared to that of imported equipment. This assumption is not unrealistic when technological innovation is taken in the sense of Schumpeter as presented in the previous section[4]. Our analysis separates the case of consumption goods diversity and imitated goods diversity so that a simple model is established for each.

Essentially, our idea is to investigate the following issues: Is there a relationship between the degree of agents heterogeneity and their individual efficiency? What are the consequences on the efficiency threshold necessary for the access to industry, and what are the effects on the economic growth rate in a stationary state?

This paper is organized as follows: In the second section, we show that the assumption of technology adoption is more realistic compared to its innovation in some LDC's. The third section is devoted to the study of a stationary state equilibrium in the case of the consumer goods variety. We should note that in our formulation heterogeneity of agents is not considered in intermediate production sector. The fourth section introduces heterogeneity into the sector of imitation of the technology incorporated in the imported intermediate goods. Sensitivity analysis by numerical simulations will be carried out at the end of each section. The last section concludes the paper findings and suggests recommendations of economic policy for the EEs.

II. Imitation *Versus* Innovation of Technology in EEs

The imitation assumption of foreign technology is more suitable than that of technological innovation in developing countries. This is due to two main reasons. The first is related to the technology concept and the second may be explained by the huge innovation costs.

First, technology paradigm according to Schumpeter means a succession of stages. Each one is defined by processes leading to the innovation. These stages start by rising a new question related to the limits charged to the present technology. The answer to this question results in a technological patent generating revenue. Next, this patent is implemented by a new tool giving its producer a monopoly rent. Once this new tool is standardized by the externalities which it generates, competition on its market is no longer monopolistic. To avoid losing its monopolistic position and thus its rent, the innovator starts another technological paradigm. The technological innovation results in the means leading to lower cost or at least the same level of output. In reality, they are modern organisational forms, sophisticated tools, and differentiated products. Grossman and Helpmann (1991) show that the differentiation of inputs (which results in technological progress) prevents the decrease of their marginal productivity.

It is in this context of technological paradigms that Schumpeter as well as the pioneer authors of the endogenous growth (Romer, 1986 and 1987) justify the innovation mainly by the revenue which it allows. Aghion and Howitt (1992) introduce the concept of the creative destruction through anticipations that the innovator formulates in connection with the future standardization of technology.

It is with a view to keep its monopolistic power and thus its revenue that the innovator launches on the market his new technology before it is standardized. In addition, one should note that this production of technology depends basically on material and social conditions of knowledge production. Furthermore, the compliance with intellectual copyrights suggests that human capital accumulation requires the distinction between the "lab equipment model" and the "knowledge driven model". The first supposes the combination between the physical capital and preliminary knowledge (initial human capital endowments), while the second supposes the combination between the various types of available knowledge (Barro, 1996, and Romer and Batiz, 1991).

In this way, the technology production according to Schumpeter becomes a very difficult task to achieve in EEs because of the absence of a knowledge production sector as well as social conditions for the implementation of the technological paradigms. The foreign technology transfer in EEs should not therefore be intended as a simple transfer of its output

only (technological product, sophisticated equipment, etc.). According to Schumpter, that should be equivalent to a transfer of the *whole process* allowing technology production and as was the case of a very reduced number of countries in the world, that benefited from this type of transfer (for example Japan).

The second reason in favour of the technology imitation in EEs is the huge cost which it generates (Easterly, King, Levine and Rebelo, 1994) and the divergence in growth rates that it would be likely to generate, as shown in Barro and Batiz (1995) with reference to the catch-up argument. Through a model of technology diffusion based on imitation, Barro and Batiz (1995) show that the relatively low cost of imitation implies that the followers grow relatively quickly and tend to catch up the leaders.

We should add that trade liberalization in the developing countries targets the externalities generated by the technology incorporated in imported equipment. In what follows we keep the assumption of technology imitation rather than its innovation for somme LDC's specific context. In this paper we deveop two models. The first considers the variety of goods and agents heterogenity only in the final goods sector. The second takes into account the heterogenity of agents only in imitated-intermediate goods sector.

III. Final good varieties, agents heterogeneity, and economic growth

We begin with the case where heterogeneity of agents in imitation sector is not considered. Suppose that each agent produces only one final good. The production technology is described according to the following CES function:

$$Y_t = BL_t^{\alpha}\left[\int_0^A x_t^{\gamma}(j)dj\right]^{\frac{1-\alpha}{\gamma}} \qquad (1)$$

where, Y_t is the final good, B is a productivity parameter, $x_t(j)$ denotes the input (*j*) imported at time *t*, such as $j \in [0,\ A]$, and L_t is the volume of homogenous labor assumed constant. A is an indicator of horizontal differentiation of the inputs *x(j)*, $\gamma \prec 1$ and $0 \leq \alpha < 1$.

Imported capital varieties are given by $\int_0^A x(j)dj$. In this economy, income Y_t is allocated between final consumption, investment in the adoption of technology denoted by $\frac{dA}{dt} = \dot{A}$, and the import of intermediate goods $\int_0^A x(j)dj$. As mentioned above, we refer to technology as the differentiation of product which is defined similarly as in Grossman and Helpmann (1991). This can be explained by horizontal diversity of the imported equipment goods $x_t(j)$. A constant share μ of output is devoted to the financing of technology adoption:

$$\frac{dA}{dt} = \dot{A} = \mu BL_t^{\alpha}\left[\int_0^A x_t^{\gamma}(j)dj\right]^{\frac{1-\alpha}{\gamma}} \qquad (2)$$

The producer maximizes profit π and the resulting necessary condition of equilibrium is given by:

$$\frac{\partial \pi}{\partial x} = \frac{1-\alpha}{\gamma} P_f(j) B L_t^{\alpha} \left[\int_0^A x_t^{\gamma}(j) dj \right]^{-1+\frac{1-\alpha}{\gamma}} \gamma x_t^{\gamma-1} - P_I(j) = 0 \qquad (3)$$

where $P_f(j)$ and $P_I(j)$ are the prices of the final and the impoted goods, respectively. From the symmetry assumption, $i.e., x(j) = x, \text{and } P_I(j) = P_I, \forall j \in (0, A)$, the producer equilibrium condition gives the following demand function:

$$P_I = (1-\alpha) P_f B L^{\alpha} A^{-1+\frac{1-\alpha}{\gamma}} x^{(1-\alpha)-1} \qquad (4)$$

where time subscripts are omitted whenever no ambiguity results.

It follows that,

$$x = \frac{P_I^{-\frac{1}{\alpha}}}{\left[(1-\alpha) P_f B L^{\alpha} A^{-1+\frac{1-\alpha}{\gamma}} \right]^{-\frac{1}{\alpha}}} \qquad (4-a)$$

From (4) we may get the equation of output Y for a fixed employment to the unit:[5]

$$Y = (1-\alpha) B^{1-\alpha} A^{\sigma} \left(P / P_f \right)^{-\frac{\frac{1}{\alpha}}{\alpha}} \qquad (5)$$

$\sigma = \frac{(1-\alpha)(1-\gamma)}{\alpha\gamma}$ is the elasticity of output to the varieties of imported goods. It is inversely related to the share of imported equipment goods in income[6].

In this model heterogeneity is due to non-uniformity of costs which are specific to each type of product. We therefore consider a monopolistic structure of the consumer goods market where competition is based on costs.

The representative consumer maximizes the following intertemporal utility function U_t on an infinite time horizon,

$$U_t = \int_0^{\infty} e^{-\rho t} \frac{C_t^{1-\theta} - 1}{1-\theta} dt \qquad (6)$$

where C_t is a composite consumer good defined by:

$$C_t \equiv \left(\sum_i^N \left[C_t^{\varepsilon}(i) \right] \right)^{\frac{1}{\varepsilon}} \qquad (6-a)$$

The intertemporal utility function (6) becomes then as follows:

$$U_t = \int_0^{\infty} e^{-\rho t} \frac{\left(\sum_i^N \left[C_t^{\varepsilon}(i) \right] \right)^{\frac{1-\theta}{\varepsilon}} - 1}{1-\theta} dt \qquad (7)$$

M is the number of varieties of consumption goods, C_i denotes the consumption of good i, ρ is the discount rate, θ is the risk aversion parameter, and $\in$ is an intra-temporal substitution parameter. Since labor supply is constant it will not be introduced in the utility function because inter-temporal arbitrage between leisure and consumption is beyond the scope of this paper, and also because aggregate and per capita growth rates of consumption are identical.

The general price index P may be expressed by:

$$P \equiv \left[\frac{1}{M}\sum_{i}^{M} P_i^{1-\frac{1}{1-\varepsilon}}\right]^{1-\frac{1}{1-\varepsilon}} \qquad (7-1)$$

We suppose that accumulation is financed by households savings. To estabilish the equilibrium conditions in a stationary state we maximize (6) subject to the following accumulation constraint:

$$\dot{a} = wL + ra - PC \qquad (8)$$

Equation (8) describes the dynamic budgetary constraint of houshold. The economic agent owns financial assets a, and labor L. Assets yield a rate of return r while labor is paid the wage rate w. Then the total income received by houshold is the sum of asset and labor income, $ra + wL$.

Each houshold uses the income that she does not consume to accumulate more assets, $\dot{a} \equiv da/dt$. Equation (8) shows that investment $\dot{a}$, and saving (the difference between labor and asset revenues $wL + ra$, and consumption exenditure, PC) are equal. Debt is not considered in the model.

The solution to this optimization program is carried out in two stages. We begin with the determination of the static optimal demand functions and how they are related, and then we compute the growth rate of control variables in a stationary state.

A. Stationary state equilibrium

In order to show just the effect of diversity consumption goods on welfear we assume perfect competition. The stationary state is defined where the control and state variables in the system (7)-(8) change at the same constant rate (the proof is in Appendix A-1). The static demands (demand functions) are determined as follows:

$$C_i = \frac{E}{M}\left[\frac{P_i}{P}\right]^{1-\varepsilon} P_i^{-1} \qquad (9)$$

Equation (9) shows that the demand for each variety i depends negatively on the number of varieties M and positively on the consumption expenditure E. In addition, due to substitution between the goods the demand for each variety depends positively on the relative price of the composite good (P_i/P). To determine the stationary state equilibrium in the second step we initially remove the heterogeneity assumption of agents and we only keep

the assumption of diversity of consumer goods. Heterogeneity will be introduced later in the paper.

In order to isolate the effect of diversity of products on the growth rate we assume that the marginal costs are identical for all firms ($v_i = v$ for any $i \in [1,M]$). Later we relax this assumption and we introduce the asymmetry of equilibrium ($v_i \neq v_j \quad \forall i \neq j$) for the purpose of analytical comparisons.

In the symmetric equilibrium case the prices of various consumer goods C_i become equal and the goods enter the function of utility symmetrically, and the consumption quantities of each variety are identical:

$P_i = P^*$

$C_i^* = C^* = \frac{C_t}{M}, \forall i \in [1, M]$

.

The growth rate of homogeneous C_i in a stationary state may be written as follows:

$$\frac{\dot{C}_i}{C_i} = \frac{1}{\theta}\left[r - \rho + (\frac{1-\theta-\in}{\in})\frac{\dot{M}}{M} \right] \qquad (10)$$

We substitute the interest rate $r = \partial Y / \partial A$ in (10) and we obtain the growth rate expression for a fixed labor level to unity, $L_t \equiv \bar{L} = 1,$ in a stationary state given by:

$$\gamma = \frac{1}{\theta}\left[\sigma B^{\frac{1}{\alpha}} (1-\alpha) A^{\sigma-1} \left(P / p_f \right)^{-\frac{1-\alpha}{\alpha}} + \frac{(1-\theta-\epsilon)}{\epsilon} \gamma_M - \rho \right] \quad (11)$$

where $\gamma_M = \frac{\dot{M}}{M}$ is the growth rate of differentiated consumer goods[7].

Equation (11) shows that when $(\theta + \in)$ is less (more) than one the change of consumer goods differentiation $\dot{M}/M$ has a positive (negative) effect on the growth rate of consumption. The sign of this effect depends on the preference parameters. We study this sign with simulation experiments in the next section.

According to Equation (11) when the consumer goods are perfect substitutes $\in=1$, diversity is no longer relevant. Its evolution γ_M will not affect the growth rate of the stationary state. When these goods are perfectly complementary ($\in=0$) the effect of their diversity on the growth rate is maximum for a given elasticity of intertemporal substitution θ. In fact, following Grossman and Helpman (1991) diversity of goods in the consumption basket avoids the fall of marginal utility and improves the consumer surplus. In this case when the number of varieties increases, the growth rate of per capita consumption and consequently the growth rate of per capita income both increase.

Equation (11) is important because it shows also that if domestic agents make an effort to differentiate their final goods and an effort to adopt imported technology their growth rate and welfare will improve. This happens due to the role of the adopted foreign technology in growth. Therefore, trade openness leads to a decrease in relative prices of imported goods and thus contributes positively to growth and better resource allocation through a growing volume of equipment goods, as argued in De Long and Summers (1991)

and Tai and Klenow (2002). In fact, not only trade liberalization decreases price distortions, it may also trigger higher growth rate stemed from the lower relative prices of equipment goods and the spread of technology expressed here by the diversity of imported equipements. These positive dynamic effects of trade openness policy are shown in the following equation, including a reduction of the rate of customs duty τ which is referred to as a proxy of trade openness policy:

$$\gamma = \frac{1}{\theta}\left[\sigma B^{\frac{1}{\alpha}}(1-\alpha)A^{\sigma-1}(1+\tau)^{-\frac{1-\alpha}{\alpha}}\left(P/P_f\right)^{-\frac{1-\alpha}{\alpha}} + \frac{(1-\theta-\epsilon)}{\epsilon}\gamma_M - \rho\right] \quad (12)$$

Set $\sigma=1$, we obtain :

$$\gamma = \frac{1}{\theta}\left[B^{\frac{1}{\alpha}}(1-\alpha)(1+\tau)^{-\frac{1-\alpha}{\alpha}}\left(P/P_f\right)^{-\frac{1-\alpha}{\alpha}} + \frac{(1-\theta-\epsilon)}{\epsilon}\gamma_M - \rho\right] \quad (12-a)$$

Equation (12-a) shows that *trade openness* policy results in a decrease of τ and impies a higher growth rate (*i*.e. $\frac{\partial \gamma}{\partial \tau} \prec 0$). This type of result is established within the framework of a consumption goods market where producers are *homogeneous*. We are turn to the case of heterogeneous producers.

B. Agents heterogeneity, entry-exit dynamics, and industrial efficiency threshold in industry

Heterogeneity allows us to analyze the industry structure, to describe the suppliers behavior, and to establish the conditions of exit and entry in industry. Each firm *i* has a variable specific cost per unit produced v_i and a constant cost K_e which is identical to all firms for a given industrial activity. The constant cost is the expenditure in physical and human or financial capital which is necessary to enter the industry. The quantity and the quality of K_e account for the specificity of the industrial activity that each agent targets. The irreversible cost K_e is then the first necessary condition for the firm to be considered as "potential candidate" to access the industry. We show in what follows that the industry cost structure plays a key role for the demand of each variety of consumer goods by its action on the prices and the number of varieties.

Let TC define the total cost,

$$TC = K_e + v_i Y_i \quad (13)$$

where Y_i is the specific output produced by agent *i* such as $i \in [1, M]$. The fixed cost K_e involves the need for *specialization* in *a particular product* (Stigler, 1949). Thus it can partially explain the heterogeneous structure of the production in industry once the final output is produced. This heterogeneous structure gives necessarily place to a framework of imperfect competition analysis. For a cost function given by (13), let $Y_i = C_i$ for any given M, then the mark-up price of the monopoly denoted by P_i is given by:

$$P_i = \frac{v_i}{\epsilon} \quad (14)$$

Since the marginal cost v_i is specific to each firm, it follows that for a given market structure there is an asymmetric equilibrium that results in as many prices, quantities and profits, as products.[8]

Within a monopolistic structure and the given the characteristics of costs, only the most efficient firms will survive in the industry and there will be no long term profit. Agents will to decide to enter the market according to the expected profit which in turn is non predictable and follows a stochatic process generated by the variable costs. These costs vary in the interval $[1-\delta, 1+\delta]$. The limit values of this interval are indicative of the firm's technological heterogeneity degree. In other words, the degree of heterogeneity of the firms increases with higher values of δ. When $\delta=0$ we go back to the case where all firms are homogeneous.

Faced with given values of cost opportunity *r*, a firm that has already incurred the fixed-cost equipement in imitation will choose a level of output to maximize its revenue mins cost at every date,

The profit for firm *i*, for a given price P_i is given by:

$$\pi_i = P_i Y_i - v_i Y_i - K_c \qquad (15)$$

We focus the analysis on the partial equilibrium where the opportunity cost *r* is given for each firm.[9] As usually, equilibrium production in equation (15) is obtained by taking into account labor and capital cost. For now, this is all we need to study the effect of consumer goods diversity on growth.

Substitute the expression of P_i from equation (14) in equation (15), and use equation (9) to obtain:

$$\pi_i = \eta \left(E \Big/ (M) P^{\frac{1}{1-\epsilon}} v_i^{-\frac{1}{1-\epsilon}} - K_c \right) \qquad (16)$$

where $\eta = (1-\epsilon)\left(\frac{1}{\epsilon}\right)^{-\frac{\epsilon}{1-\epsilon}}$ and $\epsilon < 1$

It is clear that the profit of firm *i* decreases with the number of varieties *M* and with the variable costs, and it increases with the general prices index *P*. Hence, the higher the price index, the more tempted the firm will be to enter the market because it anticipates a high profit. In addition, if there are more agents that specialize in the production of only one good then the conditions of comparative competitiveness will be more difficult. In fact these conditions are directly related to the variable costs, and it is interesting to find the value of v_i that matches the minimum threshold of technological efficiency from which the firm decides to enter the industry. This threshold is determined by a null profit that corresponds then to a threshold of variable cost v^*, such as:

For $\pi_i = 0$, we have the variable threshold of cost:

$$v^* = \left[M.K / \left(\eta . P^{\epsilon/(1-\epsilon)} \right) \right]^{(1-\epsilon)/\epsilon} \qquad (17)$$

For a given number of varieties, firms whose marginal cost is lower than v^* will have a positive profit and those firms which have $v_i = v^*$ will have a zero profit.[10] Lastly, firms with variable cost exceeding v^* will leave the industry because they are not efficient.

For a given price, there is a number of potential candidates who expect a null profit. We can write equation (9) in terms of growth rates to describe the dynamics of firms entry to and exit from the industry:

$$\frac{\dot{C}_i}{C_i} = \frac{\in}{(1-\in)}\frac{\dot{P}}{P} - \frac{1}{(1-\in)}\frac{\dot{P}_i}{P_i} - \frac{\dot{M}}{M} \qquad (18)$$

Both P_i and C_i decrease with the subtitution between goods when M increases. Also, notice that for a given C_i which corresponds to the increase in the number of varieties, the general price index P drops along with the price P_i of each variety. To complete the description of global market action on individual price, we can rearrange terms in equation (18) to obtain an expression of growth rate of variety *i* price as follows:

$$\frac{\dot{P}_i}{P_i} = -(1-\epsilon)\left[\frac{\dot{C}_i}{C_i} + \frac{\dot{M}}{M}\right] + \frac{\dot{P}}{P} \qquad (18-a)$$

Intuitively, equation (18-a) means that following a decrease of good's price which is caused by a surge in the number of varieties, the profit of firm *i* falls until the firm exits the industry. In addition this exit impacts M negatively and this is likely to generate an increase in C_i and P_i rather than an increase in the profit of the remaining firms. As a consequence, there will be new entries to the industry. We can then describe the stationary state by an expected null profit of the last firm where this entry-exit dynamic stops.

It should be noted however that before their entry, all firms have the same uncertainty about their technical efficiency. But once access cost to industry K and marginal cost (v_i) are undergone, any uncertainty will disappear**.** Lastly and following Jovanovic (1982), it is supposed that each agent who is a potential an entry candidate does not consider their influence on the market structure and on the minimum threshold of efficiency. Therefore the agent maximizes expected profit π^a as follows:

$$\pi^a = \int_{1-\delta}^{1+\delta} \pi f(v)dv \qquad (19)$$

Then,

$$\pi^a = \int_{1-\delta}^{1+\delta}\left[\frac{\eta E}{M}P^{\left(\frac{1}{1-\epsilon}\right)-1}v^{-\frac{1}{1-\epsilon}} - K_c\right]f(v)dv \qquad (19-a)$$

Where *f(v)* $\equiv 1/(2\delta)$ is the probability density of a random variable v and δ is the standard deviation of *v*. This term indicates the disparity of firms in terms of technological efficiency.

Now it it shown that new entries will have a negative impact on the price since the demand for each variety decreases and so does the firm's income. This is likely to raise the minimum efficiency threshold and forces non-efficient firms to leave the industry. The stationary state is then characterized by: $\begin{cases}\pi^a = 0 \\ \pi = 0\end{cases}$ (20)

Combining Equations (17-18), the solution to this system is given by:

$$\begin{cases} \dot{M} = 1/(2\delta)\dfrac{\eta E}{K}P^{\frac{\in}{1-\in}}\left[(1+\delta)^{\frac{1-2\in}{1-\in}} - (1-\delta)^{\frac{1-2\in}{1-\in}}\right] \\ \dot{v} = \left[1/(2\delta)\dfrac{1-\in}{1-2\in}\left[(1+\delta)^{\frac{1-2\in}{1-\in}} - (1-\delta)^{\frac{1-2\in}{1-\in}}\right]\right]^{\frac{\in-1}{\in}} \end{cases} \qquad (20\text{-a})$$

The solution gives the number of firms M^* and the level of efficiency v^* and therefore we obtain what is known as the stable structure of industry.

Finally, by combining the two equations of this system with equation (17) we get the expression of the general price index:

$$P = P v^{-1} \eta \frac{\epsilon - 1}{\epsilon} [M K]^{\frac{2(\epsilon - 1)}{\epsilon}} \qquad (21)$$

C. Simulation Experiments

The simulation experiments that we have conducted relate the effect of firm δ heterogeneity to the threshold of efficiency v^* for various values of degrees of intra-temporal substitution ϵ. The results are obtained in the Figure-1[11]:

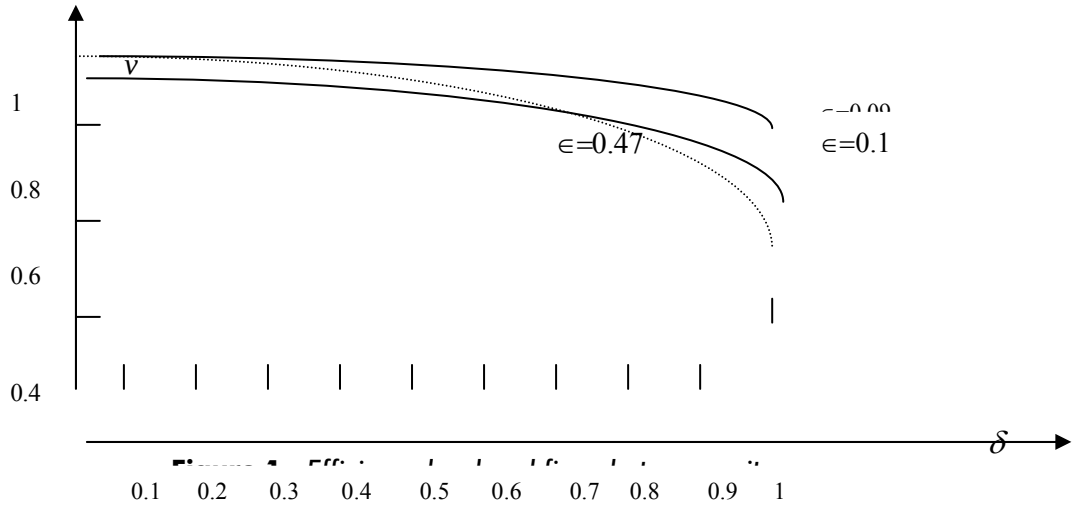

Figure-1- shows a negative correlation between the minimal degree of efficiency v^* in the industry and the degree of firm's heterogeneity. This negative relationship is due to competition costs for firms in the same industry. In fact, competition is tougher when the difference in efficiency between firms δ is higher. Thus, only the more efficient firms may survive in an industry that is more heterogeneous. Moreover, in a heterogeneous industry the conditions of access become so difficult because the price of variety is lower and the marginal cost v is weaker. As a consequence, this situation results in a lower profit.

We also simulate the degree of intra-temporal substitution between goods. The results show that efficiency level is low to the extent that varieties are substitutable. In fact, monopoly price and profit decrease as the varieties are substitutable (this can be seen from equation (14) when ϵ is high). Cost competition becomes harder and the conditions of marginal firm's survival become increasingly difficult. This is illustrated in the efficiency curve where the dotted lines are lower than the solid lines for the highest values of ϵ. We can draw from this observation an interesting results that shows two negative effects on the efficiency of surviving firms. The effect of heterogeneity and the effect of goods substitution.

Agents heterogeneity and substitution between final goods decrease the monopolistic power of firms that are carrying out competition by costs, since in this case the

margin on the price (and thus on the revenue) may decrease. This could result in a positive effect on consumption and on welfare. Heterogeneity of agents who specialize in final consumer goods production will result in an asymmetric equilibrium and thus will provide a spectrum of prices, quantities and profits. It becomes now possible to establish the minimal threshold of technological efficiency for the access to production activity. The diversity of consumer goods improves the growth rate of consumption not only by its negative action on the monopoly power of the firms and thus on the prices, but also by its positive effect on welfare. As a policy implication, it is shown that trade openness that allows more diversified final goods will have a positive impact on consumption an welfare.

IV. Heterogeneity of agents and economic growth

We now present a second model that addresses the issue of industry structure with agents heterogenity in the imitation sector. We introduce agents heterogeneity only in the sector of technology imitation of imported equipment, while agents in the sector of final goods are still homogeneous. What are then the effects of imitators heterogeneity on economic growth? Are there technological conditions to access this type of activity? If so, how are they established? What are the economic policy implications of trade liberalization?
Following Spence (1976), Dixit and Stiglitz (1977), and Ethier (1982), the technology of production in imitation sector is given by:

$$Z_t = L_t^{\alpha} \int_0^A x_t^{1-\alpha}(i)di \qquad (22)$$

Z_t is the imitated good produced, L_t is (constant) labor used in the sector, $x_t(i)$ is the intermediate good used in the imitation sector, and A denotes the number of *imported* $x_t(i)$ varieties at time *t*.

Following Romer (1990), we assume that the final good market is perfectly competitive, whereas the market of internediate goods is not. Agents differ by a specific marginal cost. We keep the same cost expression as in Romer (1987), namely:

$$\zeta_i = \frac{1}{2} V_i x_i^2 + K \qquad (23)$$

V_i denotes the coefficient of marginal cost $C_m = V_i x_i$

K is the fixed cost which is a prerequisite to access the imitation sector.

To determine the economic growth rate in a stationary state, we determine the prices, the profits, and the quantities at equilibrium in order to lay out the conditions of access to industry. Next, we determine the growth rate of per capita income in order to obtain the links between heterogeneity and growth.

In the imitation sector each agent maximizes profit π_{Zi} as follows:

$$\pi_{Z_i} = L_t^{\alpha}\left[\int_0^A x_t^{1-\alpha}(i)di\right] - wL_t - \int_0^A P_i x_i di \qquad (24)$$

The inverse demand function of the variety $x_t(i)$ resulting from profit maximization *in perfect competition is given by:*

$$P_{x_i} = (1-\alpha)L_t^{\alpha} x_t(i)^{-\alpha} \qquad (24-a)$$

$$x_t(i) = P_{x_i}^{-\frac{1}{\alpha}}(1-\alpha)^{\frac{1}{\alpha}} L_t \qquad (25)$$

In the imitation sector of *imperfect competition* each agent maximizes its profit π_{x_i}:

$$\max_{x_i} \pi_{x_i} = R_{x_i} x_i - r\left(\frac{1}{2} V_i x_i^2 + K\right) \quad (26)$$

where *r* is the opportunity cost of capital which is introduced in a general equilibrium framework and which is determined endogenously.

We make use of the above equations to obtain the profit function as:

$$\pi_i = (1-\alpha)\ x_t^{1-\alpha}(i)\ L^{\alpha}\ - r\ (\frac{1}{2} V_i\ \ x_i^2 + K) \quad (27)$$

It follows that

$$\frac{\partial \pi_i}{\partial x_i} = (1-\alpha)^2 x_i^{-1-\alpha} L^{\alpha} - rV_i = 0 \quad (28)$$

From equations (25) and (28) we can determine each variety's monopoly price for a fixed value of labor as follows:

$$P_i = \left[(1-\alpha)^{\frac{1-\alpha}{\alpha}} rV_i\right]^{\frac{\alpha}{1+\alpha}} \quad (29)$$

The monopoly price for each variety is an increasing function of the corresponding variable cost and interest rate. As shown in Appendix A-2, we can write firm *i*' s profit as follows:

$$\pi_i = h\ \ (r.V_i)^{\frac{\alpha-1}{1+\alpha}}.-r.K \quad (30)$$

where $h \equiv \frac{(1-2\alpha)}{2}(1-\alpha)^{2(2-\alpha)/(1+\alpha)}\ L^{2\alpha/(1+\alpha)}$

Equations (28-30) satisfy the general structure of the industry established in the first section. This structure is characterized by a spectrum of prices, quantities, and profits. Equation (30) shows the relationship between the profit of firm *i* and its technological efficiency *Vi*. It is then a matter of comparing the firms with repect to technological efficiency whose threshold of entry to industry is to be determined thereafter.

The dynamics of the imitated intermediate goods market in which agents are heterogeneous is similar to the market of final goods developed in the the preceeding section. We follow the same approach to determine the economic growth rate in a stationary state.

Each agent *i* wishing to enter the market should have an expected profit $\pi_i^a \geq 0$:

$$\pi_i^{\ a} = \int_{1-\delta}^{1+\delta} \pi_i f(V_i) dV_i \geq 0 \quad (31)$$

From (30) and (31), the profit equation becomes:

$$\pi_i^{\ a} = \int_{1-\delta}^{1+\delta} \left(h\ \ (rV_i)^{\frac{\alpha-1}{1+\alpha}} - rK\right)(1/2\delta) dV \geq 0 \quad (32)$$

It is now possible to determine the interest rate *r** of the long term equilbrium where entry and exit of agents in the industry stops when the expected profit $\pi_i^{\ a}$ becomes null. The solution to (32) and the condition $\pi_i^{\ a} = 0$ give the interest rate as follows:

$$r^* = (2\delta K)^{-(1+\alpha)/2}\ \Psi^{(1+\alpha)/2} \quad (33)$$

where $\Psi \equiv h\frac{(1+\alpha)}{2\alpha}\left[(1+\delta)^{(2+\alpha)/(1+\alpha)} - (1-\delta)^{(2+\alpha)/(1+\alpha)}\right]^{(1+\alpha)/2} L^{-2\alpha/(1+\alpha)}$

It should be noted that *r** is determined by the specific market structure and the technological conditions of efficiency to enter the industry. It is determined, as shown in equation (33), by the degree of heterogeneity of the firms and of the fixed cost.

As for the minimal threshold of efficiency *V**, it corresponds to a zero profit obtained by the marginal firm.

Given *r** , the expected profit of the marginal firm is:

$$\pi^{a} = \int_{1-\delta}^{1+\delta} \left(h \left(r^{*} V_i \right)^{\frac{\alpha-1}{1+\alpha}} - r^{*} K \right) (1/2\delta) dV = 0 \qquad (34)$$

Thus *r** determines the threshold of efficiency *V**. Firms for which *Vi* exceeds *V** (*Vi* between *V ** and $1+\delta$) will leave the market since they become noncompetitive. Only firms with *Vi* in the interval [1- δ , *V **] will stay. The profit of surviving firms may be determined as follows:

$$\pi^{a^{*}} = \int_{1-\delta}^{V^{*}} \left(h \left(rV_i \right)^{(\alpha-1)/(1+\alpha)} - rK \right) 1/(2\delta) dV_i = 0 \qquad (35)$$

$$\pi^{*a} = h \frac{r^{*-2(1+\alpha)}}{2\alpha} [\left(V^{*2\alpha/(1+\alpha)} - (1-\delta)^{2\alpha/(1+\alpha)} \right) - \left(V^{*} - 1 + \delta \right) K] = 0 \qquad (36)$$

This result shows that the relationship between threshold of efficiency *V ** and heterogeneity of the firms is ambiguous. The simulation results for α = 0.3 and a constant capital stock indicate that the effect of agents heterogeneity on efficiency threshold is negative as shown in Figure 2:

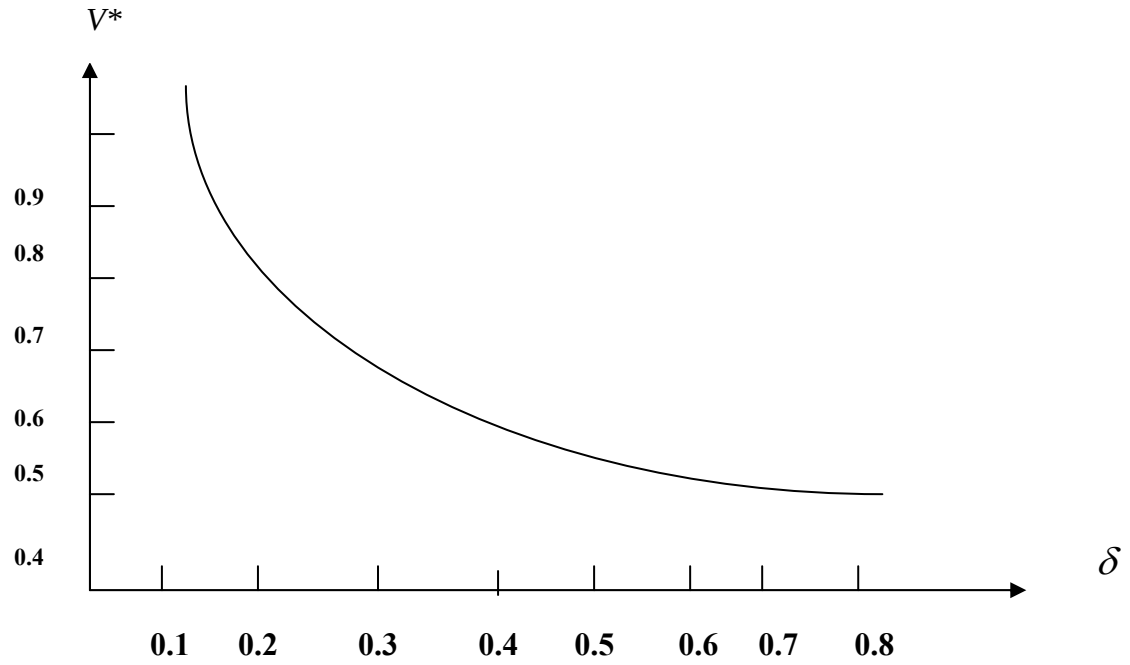

Figure 2. Efficiency threshold and agents heterogeneity

It is now clear that we obtain the same type of heterogeneity effect on the efficiency threshold as in the case studied in the first section. The higher is the variation of efficiency between the firms, the more difficult are the survival conditions, and the more intense becomes the competition through costs.

So what are the consequences on growth rate?

From the expression of growth rate at the stationary state shown in Appendix A1 and for homogeneous consumer goods (*M=0*) we have:

$$g = \frac{1}{\theta}\left[r^* - \rho\right] \qquad (37)$$

Substituting equation (33) in equation (37), we obtain:

$$g^* = \frac{1}{\theta}\left[\left(2\delta K\right)^{-(1+\alpha)/2}\Psi^{(1+\alpha)/2} - \rho\right] \qquad (38)$$

It can be seen that per capita income growth rate has changed by agents heterogeneity in the imitation sector compared to the homogeneity case. In fact, even compared to the case of consumer goods heterogeneity the stationary state per capita growth rate is negatively correlated with the degree of agents heterogeneity in the imitation sector. This negative correlation is shown in our simulation results as depicted in Figure 3 below:

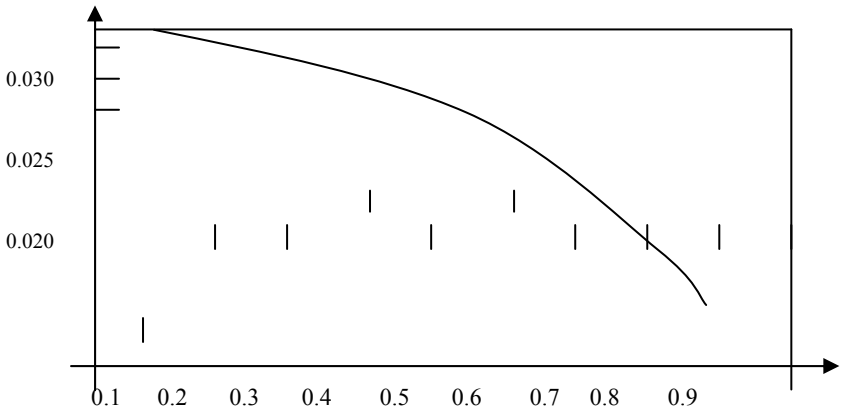

Figure 3. Stationary state growth rate and agents heterogeneity

Therefore, as the stationary state growth rate becomes weaker the disparity in terms of technological efficiency of the imitating firms becomes higher. We can lay out two features that characterize the imitation technology sector. First, the minimum threshold of irreversible capital which is necessary to access the imitation activity reduces the number of candidate firms and creates competition through costs. Second, this competition occurs in a monopolistic context. The resulting aggregate equilibrium is non optimal because of imperfect competition corresponding to prices higher than in perfect competition. It is the agents' heterogeneity and thus the imperfect structure which is at the origin of a non-optimality. With higher degree of heterogeneity we have lower economic performance as a whole and a resulting lower growth rate. Finally, from equations (33) and (36) and also from figure 2, our results show that for a given degree of heterogeneity the threshold *V** would be the equivalent barrier to entry since marginal costs are increasing and thus would have a negative impact on profit progressively with the accumulation of capital as interest rate decreases.

V. Conclusion

In this paper we shed some light on the important link between industrial structure and aggregate economic growth for emerging economies seeking to implement openness in their trade policy.

Our results show the relevance of the technology adoption hypothesis as opposed to the traditional hypothsesis of innovation. Following Romer (1990), we develop an endogenous growth model for small open economies where domestic agents adopt technology incorporated in imported equipment. In the model, equipment import coupled with technological externalities and with the fall in relative prices explain the growth effects of openness.

Entry and exit dynamics in industry depend on expectations that heterogeneous agents form about future profit and also on their technological competitiveness. The market structure characterized by a spectrum of prices and pofits is given *endogenously*. In such a structure, competition takes place through costs. In the long run, surviving firms would make some non-zero profits. Minimum efficiency threshold of entry and exit dynamics in the domestic industrial structure are then endogeneously determined. The diversity of consumption goods improves the growth rate of consumption and welfare by its negative action on the monopoly power of the surviving firms. The results seem to be consistent with those established in the basic models of endogenous growth with differentiated products.

In the case of intermediate goods, agent's heterogeneity is negatively correlated with stationary state growth rate. In fact, monopolistic competition leads to a non-optimal growth equilibrium at the aggregate level although it will result in a reduced number of agents.

For the decision maker, we argue in this paper that openness trade policy shows mixed results. Specifically, there are two opposite effects on economic growth. A positive effect described by the fall in relative prices of the equipment which leads to an increase in imports and allows more technology to be adopted. A negative effect described by exit of domestic firms from industry as their efficiency decreases compared to foreign firms, making the market structure more monopolistic.

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Appendix

A-1: Solution to optimization program (7)-(8) and determination of equation (9)

a) *First solution stage: determination of static demand*

$$\begin{cases} \max U \quad = \left(\sum Ci^{\in}\right)^{\frac{1}{\in}} \\ S/C \quad E = \sum PiCi = PC \end{cases} \qquad \text{(A-1.1)}$$

E is the total revenue allocated to consumption.

The number of varieties *M* is supposed sufficiently high such that the variety *i* producer neglects the effect of P_i on household total expenditure by variety of goods.

Let *L* the Lagrange function:

$L=\left(\sum_{i}^{M} Ci^{\in}\right)^{\frac{1}{\in}}+\lambda\left(E-\sum Pi.Ci\right)$. The necessary condition is:

$$\frac{\partial L}{\partial Ci}=\left(\sum Ci^{\in}\right)^{\frac{1}{\in}-1} Ci^{\in-1}-\lambda.Pi=0$$

Let $X=\left(\sum Ci^{\in}\right)^{\frac{1}{\in}}$, then $X^{1-\in} Ci^{\in-1}=\lambda.P$, and $X^{\frac{-1}{1-e}}=C_i P_i^{\frac{1}{1-e}}$ is constant.

Observe that $P^{\frac{1}{1-\epsilon}}.C_i.\sum_i^M P^{1-\frac{1}{1-\epsilon}}=E$ and $\sum_i^M P_i.C_i=E$. Mmultiplying and dividing by $P^{\frac{1}{1-\epsilon}}$, we obtain the following expression of variety *i* static demand, equation (9) in the text: $\sum_i^M P^{\frac{1}{1-\epsilon}}P^{1-\frac{1}{1-\epsilon}}.C_i=E$. Then,

$$C_i=\frac{E}{M}.\left(\frac{P_i}{P}\right)^{1-\epsilon}.P_i^{-1}.$$

b) *Second resolution stage (symmetric equilibrium case)*

In this case the prices of the various consumer goods are equal. *Ci* enters the utility function in a symmetric and the consumed quantities of each variety are identical. In other words *Pi* ≡ *P**, and,

$$C_i^*=C^*=\frac{C_t}{M}\forall i\in[1,M]$$

.

The Hamiltonian is given by:

$$H=e^{-\rho t}.\left[\frac{\left(\sum_i^M C_i^{\epsilon}\right)^{\frac{1-\theta}{\epsilon}}-1}{1-\theta}\right]+\lambda\left[wL+ra-\sum P_iC_i\right] \qquad \text{(A-1.3)}$$

The necessary conditions are as follows:

- ✓ $\frac{\partial H}{\partial C_i}=0 \quad \Rightarrow e^{-\rho t}\left[M.C_i^{\epsilon}\right]^{\frac{1-\theta}{\epsilon}-1}.C_i^{\epsilon-1}=\lambda.P_i$
- ✓ $\frac{d\lambda}{dt}=\dot{\lambda}=\rho\lambda-r\lambda$, thus $\frac{\dot{\lambda}}{\lambda}=\rho-r$

The growth rate of homogeneous C_i, in a stationary state is thus:

$$\frac{\dot{C}_i}{C_i}=\frac{1}{\theta}\left[r-\rho+\left(\frac{1-\theta-\epsilon}{\epsilon}\right)\frac{\dot{M}}{M}\right] \qquad \text{(A-1.4)}$$

The equation (A-1-4) is not other than the equation (10) of the text. We replace the yield $r=\partial Y/\partial A$ by its value from equation (8) in equations (5)-(12) and we obtain the stationary state growth rate expression,

$\gamma_{C_i}\equiv\dot{C}i/Ci$,

$$\gamma_{C_i}=\frac{1}{\theta}\left[\sigma B^{1/\alpha}L^{\alpha}(1-\alpha)A^{\sigma-1}\left(P^*/P\right)^{-(1-\alpha)/\alpha}+\frac{(1-\theta-\epsilon)}{\epsilon}\gamma_M-\rho\right] \qquad \text{(A-15)}$$

Where,

$\gamma_M=\frac{\dot{M}}{M}$ is the growth rate number of the of differentiated consumer goods. Equation (A-15) is numbered (11) in the text.

A-2- Determination of the profit expression in equation (29)

The profit, price, and demand expressions are respectively as follows:

$$\pi_i=P_ix_i-r\left(\frac{1}{2}V_ix_i^2+K_c\right),P_i=(1-\alpha)x_i^{-\alpha}L^{\alpha}, \text{ and } x_i=(1-\alpha)^{\frac{1}{\alpha}}\left[(1-\alpha)^{\frac{1-\alpha}{\alpha}}rVL\right]^{-\frac{1}{1+\alpha}}$$

We replace the input demand and the price of each variety by their values in the profit equation to obtain the expression (29) in the text:

$$\pi_i=-\frac{(1-2\alpha)}{2}(1-\alpha)^{2(2-\alpha)/(1+\alpha)}L^{2\alpha/(1+\alpha)}\left(r.V_i\right)^{\frac{\alpha-1}{1+\alpha}}.-r.K \qquad \text{(29)}$$

With $h \equiv \frac{(1-2\alpha)}{2}(1-\alpha)^{2(2-\alpha)/(1+\alpha)} L^{2\alpha/(1+\alpha)}$

A-3- Matlab program

The simulations results obtained in section 3 of this paper are performed with the following Matlab program:

```
%diary aly.out
clear
%epsilon1=0.01 ;
%epsilon2=0.03 ;
%epsilon3=0.05 ;
epsilon1=0.09 ;
epsilon2=0.35 ;
epsilon3=0.49 ;
sigma=1 ;
amaj=1 ;
kmaj=2 ;
etat1=(1-epsilon1)*((1/epsilon1) ^ (-1/(1-epsilon1))) ;
etat2=(1-epsilon2)*((1/epsilon2) ^ (-1/(1-epsilon2))) ;
etat3=(1-epsilon3)*((1/epsilon3) ^ (-1/(1-epsilon3))) ;
delta=0.01 :0.01 :0.99 ;
%
a1=1./(2.*delta) ;
a21=(1-epsilon1)/ 1-2*epsilon1) ;
a22=(1-epsilon2)/ 1-2*epsilon2) ;
a23=(1-epsilon3)/ 1-2*epsilon3) ;

a31=(1+delta). ^ (1/a21) ;
a32=(1+delta). ^ (1/a22) ;
a33=(1+delta). ^ (1/a23) ;
a41=(1+delta). ^ (1/a21) ;
a42=(1+delta). ^ (1/a22) ;
a43=(1+delta). ^ (1/a23) ;
a51=a31-a41 ;
a52=a32-a42 ;
a53=a33-a43 ;
a61=(epsilon1-1)/ epsilon1) ;
a62=(epsilon2-1)/ epsilon2) ;
a63=(epsilon3-1)/ epsilon3) ;
vmaj1=(a21.*(a1.*a51)). ^ a61 ;
vmaj2=(a22.*(a1.*a52)). ^ a62 ;
vmaj3=(a23.*(a1.*a53)). ^ a63 ;
%
%
a11=(etat1*amaj/kmaj) ;
a12=(etat2*amaj/kmaj) ;
a13=(etat3*amaj/kmaj) ;
a21=pmaj1. ^ ((1/1-epsilon1))-sigma ;
a22=pmaj2. ^ ((1/1-epsilon2))-sigma ;
a23=pmaj3. ^ ((1/1-epsilon3))-sigma ;
a31=(1/1-epsilon1)/(1-2*epsilon1) ;
a32=(1/1-epsilon2)/(1-2*epsilon2) ;
a33=(1/1-epsilon3)/(1-2*epsilon3) ;
a4=1./2.*delta) ;
a51=(1+delta). ^ (1/a31) ;
a52=(1+delta). ^ (1/a32) ;
a53=(1+delta). ^ (1/a33) ;
a61=(1-delta). ^ (1/a31) ;
a62=(1-delta). ^ (1/a32) ;
a63=(1-delta). ^ (1/a33) ;
a71=a51-a61 ;
a72=a52-a62 ;
a73=a53-a63 ;
mmaj1=(a4.*(a11*a21*a31)).*a71 ;
mmaj2=(a4.*(a12*a22*a32)).*a72 ;
mmaj3=(a4.*(a13*a21*a33)).*a73;
%%%
subplot(2,1,2) ;
```

```
plot(delta,vmaj1'-',delta, vmaj2,'.',dalta,vmaj3,'-') ;
title(FIG.1.Efficiency level')
xlabel ('delta') ;
ylabel('V') ;
legend('- :epsilon=0.09','.. ::epsilon=0.3','-- :epsilon=0.47')
subplot(2,1,2) ;
plot(delta,mmaj1'-',delta, mmaj2,'.',dalta,mmaj3,'-') ;
title(FIG.2.firms number')
xlabel ('delta') ;
ylabel('M') ;
legend('- :epsilon=0.09','.. ::epsilon=0.3','-- :epsilon=0.47')
diary off %
```

---

[1] See Baldwin (2003) and J.Temple J (1999) for syntheses of the empirical literature.

[2] From this point of view, some authors explain that heterogeneity comes from the asymmetry of information and uncertainty about technological efficiency as argued in Lippman and Rumelt (1982), Lippman et al. (1991), and Hopenhayn (1992).

[3] Note in addition that the question of industrial structure in connection with trade brought about a great deal on interest in recent empirical literature. The reader may be referred to Guadalupe and Wulf (2008), and Gorodnichenko, et al. (2008) for more detail.

[4] It would be possible to take into account also a domestic production of equipment as in Benigno and Theonissen (2008) that seems more realistic for countries in witch a weight of domestically produced intermediate goods is not negligible compared to that of imported intermediate. These authors develop an interesting macroeconomic model which analyzes the relationship between the real exchange rate and the ratio of home to foreign consumption under supply side shocks, taking into account both the domestically produced and imported equipments.

[5] Labor demand is such for a given real wage ω, prices P_f and P_I, we have $\omega = \alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}} B^{\frac{1}{\alpha}} A^{\sigma} P_I^{\frac{1-\alpha}{\alpha}}$.

[6] In fact, σ is decreasing with □□.

[7] See proof in Appendix (A-1)

[8] It is assumed that each firm will not affect significantly the price index.

[9] In the next section we introduce a general equilibrium analysis to study the outcome of opportunity cost endogeneity of capital as in Romer (1987) and (1990)

[10] In industrial organization, firms whose marginal cost is equal to v^*, are referred to as *marginal firms*.

[11] It should be noted that the sign of the effect of the heterogeneity of firms on the threshold of efficiency is ambiguous: $\frac{\partial v}{\partial \delta} = [\frac{1}{2\delta}(1-\epsilon)/(1-2\epsilon)]^{(\epsilon-1)/\epsilon} \frac{(\epsilon-1)}{\epsilon} [(1+\delta)^{(1-2\epsilon)/(1-\epsilon)} - (1-\delta)^{(1-2\epsilon)/(1-\epsilon)}]^{-1/\epsilon}$.

All the simulation experiments are carried out in Matlab.

ANALYSIS AND MODELLING OF A SOCIO-TECHNOLOGICAL FRAMEWORK FOR SCIENTIFIC COLLABORATION[1]

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Abstract:
The scientific development of different disciplines at the beginning of the 21th century can only be conceived in an interdisciplinary context. This fact implies both an in-depth documentation and cooperation among the scientists in the diverse knowledge spheres. Knowledge workers are not linked to a unique organization, but they are in touch with persons belonging to other organizations. In this complex relation system, the employers are involved concurrently in similar working situations, but, at the same time, they are permanently learning. That is why, Internet technologies are improved to sustain this net society, being adapted, at the same time, to individual needs and profiles. The creation of conditions for organizational culture of academic communities' development presupposes a suitable socio-technological framework. The paper analyzes the challenges and introduces models for a knowledge management experimental system for scientific communities, proposing the use of Service Oriented Architecture for the composition of knowledge, defining a modular architecture and an algorithm of collaborative knowledge generation.

Key words: *socio-technological framework; Knowledge Management (KM); Service Oriented Architecture (SOA); Knowledge Worker (KW); Next Generation Collaborative Working Environments (NGCWE); collaborative knowledge generation*

1. Introduction

The creation of conditions for development organizational culture of academic communities presupposes a suitable technological framework allowing for the knowledge worker's (KW) creativity, besides the improvement of the value system and managerial ethics based on transparency, communication and understanding. On the other side, nowadays, in the network economy, persons are not linked to a unique organization, but are in touch with persons belonging to other organizations. In this complex relation system, the employers are involved concurrently in similar working situations, but at the same time they are permanently learning [7]: on-the-job, just-in-time, just-as-required, on-demand, learning-

by-doing. That is why, Internet technologies are improved to sustain this net society, being adapted, at the same time, to individual needs and profiles.

The knowledge management system (KMS) architecture is a fundamental issue in the area of KM (knowledge management) that must be well resolved in order to deliver competitive services to the users as well as to the organizations.

Müller and Schappert [19] proposed a generic architecture for knowledge management that is grounded on the basic insights of information theory respecting the division of data, information and knowledge and it offers clear interfaces to the different levels and dimensions through an abstract set of objects and operators.

Meso and Smith [18] proposed a KMS architecture that processes a combination of technology, function and the knowledge itself as well as other components which are able to perform according to the requirements of the organization. In terms of technology, KM should have features such as computer-mediated collaboration, e-mail, video-conferencing, web browsing, search engine, intelligent agent, and document management. Furthermore, in terms of its functionality, KM involved the processes for acquiring or collecting, organizing, disseminating or sharing knowledge and using knowledge among the stakeholders.

Collaboration environment provides a framework for bringing minds together, organizing their efforts, managing the process and producing outstanding results. When each member of a team collaborates on a mission or project, each would be able to contribute his or her own strength, skills and knowledge, to ensure the best results for the project [3].

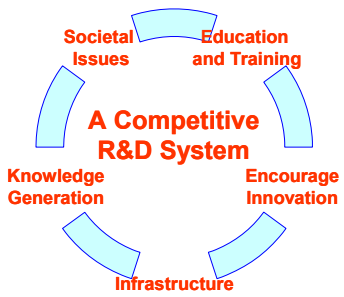
Abdullah et al. [1] proposed a KMS architecture that is developed by using four layers, which includes a protocol layer as a top level, in order to allow a user interface application with the community, and a technology layer that facilitate the community to work together, to share, re-use and generate knowledge among them. They also found that the KMS model includes the functionality and system architecture as the backbone to support the KMS process, taxonomy deployment, and cultural aspects as well as the knowledge strategies and measurement or system auditing. The functionality of system may consist of a portal, electronic document management system, workflow management, data warehouse and artificial intelligence (such as agent technology).

In nowadays economic development six main changes are to be relieved [2]:

- from linearity to complexity;
- from individual to system competitiveness;
- from resources-based to knowledge-based economy;
- from macro to micro;
- from top down to bottom up production systems;
- from mono-disciplinarity to multi- and trans-disciplinarity.

In the same symposium [2], Andreta illustrates the areas for research and development (R&D) system as in Figure 1.

Figure 1. Areas for R&D System [2]



Collaboration at work has at least four dimensions [20]: users and group members (co-workers), working processes, technologies and application areas. From the new technologies point of view, the next generation collaborative working environments (NGCWE) have to integrate all these dimensions into a suitable collaboration at work platforms, based on flexible service components, interoperable at syntactic, semantic and protocol level.

In this context, the paper proposes a modular architecture of a collaboration platform, namely a knowledge management experimental system (KMES) dedicated to research virtual communities. This collaboration platform is seen as a socio-technological framework.

The portal KMES needs to support researchers with a knowledge building architecture (KBA), which provides databases, virtual libraries and applications for collaboration, coordination, education, training and publishing. Interoperability and semantic integration will lead to an activity-based collaboration support.

2. Analysis of the Socio-technological Framework

This subchapter outlines the scientific and technical objectives that led to the conception of the Knowledge Management Experimental System (KMES) (see 2.1) and then analyses the opportunity of using Service Oriented Architecture (SOA) for designing the platform, as opposed to other approaches based on components or publish/subscribe mechanism (see 2.2).

2.1. Scientific and Technological Objectives

The proposed multilingual research portal for scientific organizations, with enabling applications for national and cross-border academic activities based on standardized and user-friendly technology has to meet the needs of persons involved in the research sector. The objectives of the framework are:

1. to support the development and management of a *common body of knowledge* shared within the research community as a way of creating a community of experts linked by their common focus on research, education and training;
2. to facilitate the development of *a new working model* for the distributed research units where the emphasis lies on creating multi-functional, highly flexible knowledge workers, on actively creating and working with knowledge resources in a participatory fashion rather than as passive information consumers;
3. to ensure *quality and relevance* of all knowledge content created and stored within the platform by creating a system that allows access to the platform in a managed and multi-layered manner;
4. to provide *a ubiquitous, user-friendly point of access* allowing access from anywhere and at any time with minimal technical requirements and knowledge on the part of the participant;
5. to allow knowledge worker's creativity, besides the improvement of the value system and managerial ethics based on transparency, communication and understanding.

2.2. Service Oriented Architecture for the Composition of Knowledge

Complexity has always been addressed according to the "divide ed impera" maxim. Division seeks to decompose the problem in independent and smaller parts, therefore easier to solve individually. The composition of knowledge is based on the composition of subsystems dedicated for managing, storing and retrieving information. The deployment of KMES components, presented in detail in chapter 4, can be done on different processing nodes, which can be hosted by different organizations, with a high geographical distribution. The question is: "which is the best solution to compose these subsystems, such as to allow KMES to adapt easily to new requirements and to assimilate new knowledge and workflows for specifying the work for creating it?".

The classical composition mechanism is the procedure call, where the target can pertain to another part, eventually a remote one. The linker is in charge of realizing the composition, either statically or dynamically, at execution. Object Orientation (OO) lightly improves dynamic linking by adding polymorphism. The component technology pushes the same logic one step further, imposing that components are treated as black boxes and only expose their interfaces. Initially, component models provided abstraction at a single level, but then they have introduced composite components, supporting the creation of hierarchies, like in Fractal [5] or SOFA [23]. The drawback is that the code explicitly refers to required interfaces and calls are always synchronous; it also determines the propagation of an interface change to all the client and required components, such that the source code of these components must also be changed. In order to improve reliability in component composition, one associated to each component a number of contracts, based on issues like interface signature, behaviour, interaction and quality [17]. In order to improve independence, some component models have proposed the connector concept, and classic wrappers or adapters serve exactly the same purpose as in Enterprise Application Integration (EAI) [16], but the direct connection still involves difficulties of evolution and adaptation. To improve the independence between components that publish and those interested in what is published, one introduced the publish/subscribe approach[4], with the advantage that parts do not have to know each other explicitly. However, there is still the problem that composition logic is spread between components; it is not clearly defined and cannot be changed without modifying the component code.

To improve flexibility and independence, control flow should not be the responsibility of each component. Such an approach is orchestration, which extracts the control flow from the components and considers that composed parts provide services. This approach has been made popular by the web service domain [22] but spans to any applications built out of components that do not call each other, irrespective to the nature of the component (service or not) and irrespective of the communication means: method call or messages, synchronous or asynchronous. Orchestration hypothesizes that services have the same nature, have been developed to be composed, do not overlap in their functionalities and do not need to be synchronized during their execution. The service oriented architectures support a wide geographical distribution of the deployed software artefacts and of the actors participating at the collaborative creation of knowledge, based on the technologies characteristic for the Internet of the Future [9]; the flexibility and extensibility of platforms increase by adopting new generations of web services - discovered at runtime, on the basis of semantic web.

A similar approach was proposed by Pohl in [24], where he calls it Knowledge Management Enterprise Services, meaning an implementation of SOA, focusing on the

exchange of data within the context of a particular knowledge domain. However, Pohl does not intend to use these services for a collaborative working environment, but for the rapid development of applications based on reusing code based on sharing an information model.

3. Multiple Actors for Knowledge Management

The proposed architecture, fully based on XML standards, is a completely decentralised one, allowing participants to access the platform from anywhere using a simple browser interface. This interface allows for remote administration, control, content creation etc.

Four main KW types are addressed, corresponding to multiple knowledge platform actors: content manager, community manager, information resource facilitator and project manager. They are depicted in *Figure 2*, together with their associated use cases with the Unified Modelling Language (UML). Experts in the interdisciplinary research fields are also considered knowledge workers, which are both consumers and creators of knowledge; they can play various roles in respect with the platform.

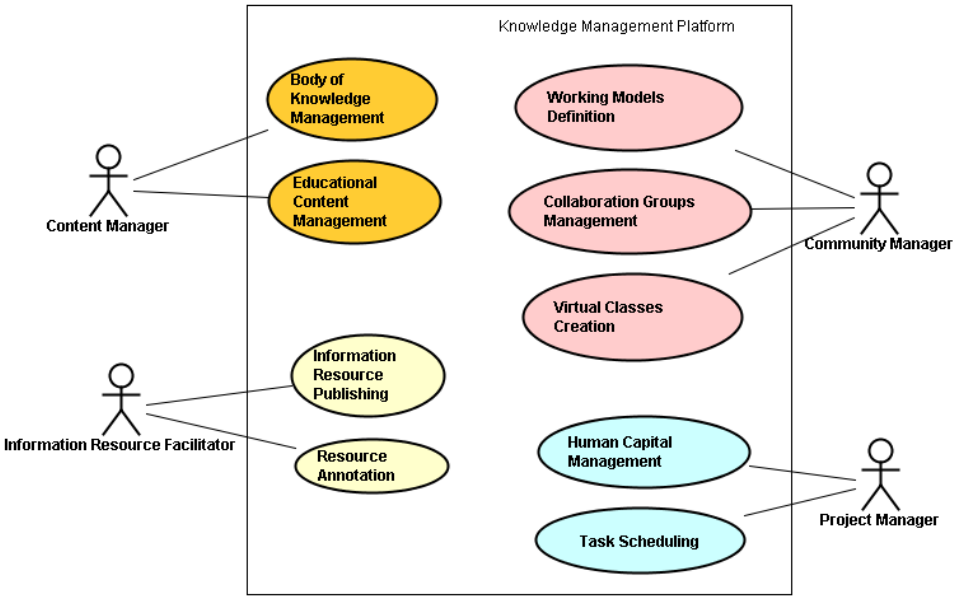


Figure 2. UML Use Case Diagram for the Knowledge Management Platform

The difficulty stands in the fact that complex systems based on SOA, as the one designed here, generally have multiple actors, assigned for the various competencies that are required. Similarly, the LD-CAST system described in [12], dedicated for supporting entrepreneurs and enterprises with legal and fiscal information, has 5 actors for the platform administration and management: Business Process Designer, Knowledge Engineer, Service Provider Administrator, Service Provider Clerk, and Administrator.

Several attempts for classifying these roles have been done. Lin and Krogstie [15] identified social and technical actors, for a framework for semantic annotation of business processes. Kajko-Mattsson et al. [13] defined 24 roles for the development, evolution and maintenance of SOA-based systems, which are classified into 7 categories: front-end and back-end support, management, design, quality assurance, administration, and strategy. Such studies prove that new platforms have different actors that the traditional IT systems, which have a common responsibility for maintaining the system up-to-date and coherent. As

they work with different tools, languages and they focus on different architectural views, new procedures are necessary for assuring the system evolution.

4. Modelling the Architecture of the Socio-technological Framework KMES

Knowledge building in the research community has inherent knowledge management problems due to its global dimensions and high degree of complexity. The growing body of information with little or no quality control may in fact lead to increasingly uninformed decision making resulting in confusion and ultimately poor outcomes. The management challenge is not only to find ways to conserve the use of a scarce resource, but to cope with its over-abundance.

Partnerships in research rely on information sharing and active networking. Collaborative efforts reduce duplication, increase transparency and work against the fragmentation of research. It is more effective if the results of past efforts are readily available to inform new programmes. The effective use of ICT can address many of these problems by putting in place systems, which recognize the role of experts in this field, as knowledge workers who are both consumers and creators of knowledge. In *Figure 3* there is an overview of the scientific collaboration portal architecture.

Knowledge work necessitates continuous learning as well as constant teaching and knowledge sharing. The functional application modules are: *KMES-Factory* for content production, *KMES-CSCW* for communication, collaboration and coordination, *KMES-People* for community management, *KMES-Lib* for library and resources management and *KMES-Edu* for adaptive e-learning. They are presented in detail in 4.2. The KMES architecture is based on modularity and integration, configuration and security, adaptability and availability, expert collaboration and knowledge management. The modules of the architectural structure are foreseen as an integrated collection of Web services that allow flexible access to the relevant knowledge resources in the system. The proposed architecture, fully based on XML standards, is a completely decentralised one, allowing participants to access the platform from anywhere using a simple browser interface. This interface allows for remote administration, control, content creation etc.

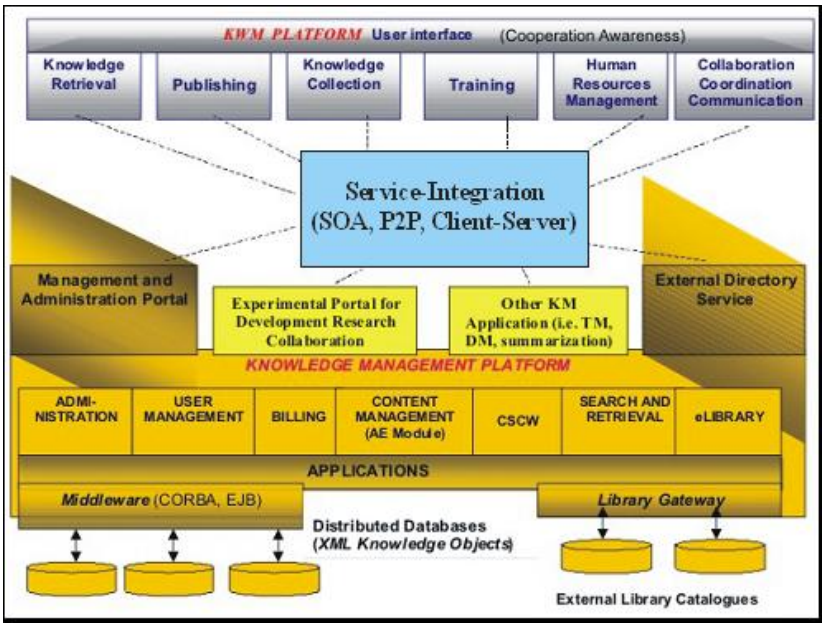


Figure 3. Architecture of the Socio-technological Framework KMES

4.1. Applied Principles and Architectural Styles

The term *knowledge work management* (KWM) denotes all activities of an organisation, on a strategic and operational level, that aim to create optimal conditions for efficient, effective and attractive knowledge work. There are six fields of activity that are of special relevance in the realm of KWM and learning arrangements [11]: new work organisation, knowledge product management, organisational learning, competence development, knowledge worker performance and productivity, performance management.

A SOA (Service Oriented Architecture) separates functions into distinct units, or services, which developers make accessible over a network in order to allow users to combine and reuse them in the production of applications. XML is used for interfacing with SOA services.

P2P (peer-to-peer) architecture is any distributed network architecture composed of participants that make a portion of their resources (such as processing power, disk storage or network bandwidth) directly available to other network participants, without the need for central coordination instances (such as servers or stable hosts). Peers are both suppliers and consumers of resources, in contrast to the traditional client-server model where only servers supply, and clients consume.

The research portal offers participants a common multi-lingual application environment for the creation and development of digitalized, granulated knowledge, its conveyance and its permanent storage. The management challenge is not only to find ways to conserve the use of a scarce resource, but to cope with its over-abundance. Partnerships in research rely on information sharing and active networking. Collaborative efforts reduce duplication, increase transparency and work against the fragmentation of research. It is more effective if the results of past efforts are readily available to inform new programmes.

4.2. Description of KMES Subsystems

Knowledge work is a creative work and requires creation, acquisition, application and distribution of knowledge, using intellectual abilities and specialized knowledge, requiring a high level of education, training and experience resulting in workers' skills and expertise and a strong and flexible support by ICT (*Information and Communication Technologies*). Knowledge work necessitates continuous learning as well as constant teaching and sharing of this learning with colleagues.

The application subsystems of the proposed socio-technological framework KMES are:

- *KMES-Factory* for content production,
- *KMES-CSCW* for communication, collaboration and coordination,
- *KMES-People* for community management,
- *KMES-Lib* for library and resources management,
- *KMES-Edu* for adaptive e-learning.

According to the mappings of the "4+1" Views model to UML diagrams proposed in [10] the development view can be illustrated as a UML component diagram (see *Figure 4*) with connectors that can be later realized through Web services; it shows the point of view of the developers at a high level of abstraction.

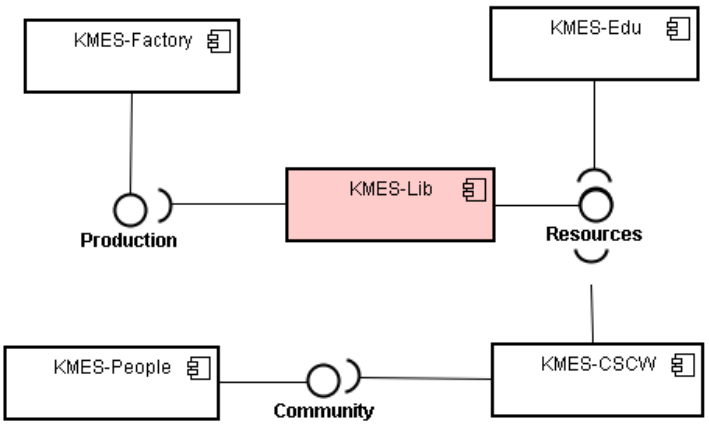


Figure 4. UML Component Diagram of KMES

KMES-Factory manages the production, publication and quality management of multi-lingual XML based content within the research community. Specific objectives include: definition and establishment of a workflow management system that will shorten and simplify the typical content production process – the adoption of structured processes can significantly increase the efficiency of work [26]; development of a template database alongside the content database which will allow for the creation of fully reusable and standardised (XML-based) content products; provision of an efficient content creation mechanism, which will ensure a balance between quality and costs.

KMES-CSCW deals with the creation, management and integration of a common communication and collaboration platform amongst the research community. Specific objectives include: the creation of conditions whereby participants are able to build collaboration groups in the context of research teams; the promotion of active participation

in the overall communication process through the provision of a responsive and easy-to-use communication platform linked to the other components of the research platform allowing e.g. collaborative knowledge creation between different organisations; an improvement in the collaboration process through the creation of interactive, decentralised participatory work spaces; evolution of improved work practices, which enhance creativity, innovation and responsiveness. The definition of working models, which is the responsibility of the Community Manager, will orchestrate the way a group of individuals work on a shared task and will increase the awareness of the collaboration process, as shown in [14].

KMES-People is the organizational DIRECTOR component and reflects the need to put in place a knowledge-based system, which will allow for the decentralised management of human capital within the research community. This component will store general information about a scientist and his/her rights in the system and will be linked to the other components. It has as specific objectives: development of a sophisticated multi-lingual search tool which allows participants the search for individual and highly granulated specialist knowledge and experience; provision of a mechanism whereby individuals and organisations can track and update information about contacts and where such tracking is linked to other components of the platform; automation of this system, which ensures that information is managed in a way that is acceptable to the participants with appropriate control and management layers to ensure proper use. A common ontology of competencies is absolutely necessary for this purpose, as the problem arises from the fact that different communities use different classification criteria for characterizing their skills and work. A similar problem was treated by the FP7 project called SEEMP, creating such a core ontology for allowing the interoperability between non-homogenous e-Government systems for the employment sector, pertaining to different countries among Europe [8]. These were concepts were mapped on those used in the current work inside various employment agencies.

KMES-Lib component allows publication and universal access to a rich resource of journals and other publications, reports and documentations. The specific objectives for this component are: establishment of a meta-database of European multi-lingual documentation in the field of research and to use this as a tool for librarians in this sector; creation of a powerful interface within the research platform where library collections throughout the region can be searched from one place and linking this to a centralised document delivery and electronic billing; developing a specialised set of multilingual thesaurus tools allowing participants to search for material catalogued and indexed in other languages.

KMES-Edu component offers flexible learning solutions to the users. The specific objectives of this component are: creating possibilities of virtual users for selection of their instructional components, personalizing their learning environments; offering flexible solutions for dynamic adaptation of the instructional content according to the individual needs in real-time education. Traditional Learning Management Systems (LMSs) are currently replaced by e-Learning 2.0, supporting collaborative learning through blogs, wikis and social software [25]. For this purpose, the functionality of KMES-Edu will be leveraged by those offered by KMES-CSCW for collaboration between researchers, educators and students.

5. Collaborative Knowledge Generation

This framework is built on a technological infrastructure, a KBA, which addresses modern demands in expert collaboration and knowledge management. Rather than creating

a sophisticated technological platform remote from the targeted institutions that are seen simply as consumers or 'end-users', the proposal takes the innovative approach that by using the proposed workbench, the target workforce bring their own knowledge resources to the wider research community. Thus, they become *an integral part* of the knowledge platform itself.

Content modules are produced and managed by *KMES-Factory*. *Annotation Engine Module* (*AE Module* in *Figure 3*) is the part of *KMES-Factory* that classifies and organizes dispatched texts, using XML. It has an important role in the *KMES-Factory*: without a good design of this software module, the user could be "lost" in the information of the previous text discussions. Diversity and the great volume of information of the discussion bases for research collaboration claim a good classification for relevant content filtering. The filter is built on a number (greater than 50) of discussion databases, already classified by a human expert. The filtering algorithm computes the similarity of a new text with the texts in the knowledge base.

Here are the processing steps:

- *Identification of the users' language*. For each language "known" by the filter (e.g. English and Romanian) dictionaries with more than 500 frequent words (conjunctions, prepositions, articles, adverbs, auxiliary verbs, etc.) are stored. The segmented text is compared with each word in these dictionaries and the best score identifies the language; if there are identical scores for different languages, Cavner and Trenkle's method may be used [6].
- *Text segmentation in lexical units*. The new text is "cleaned" by taking out the functional words (those more than 500 frequent words in the dictionary). A parser has to identify types of tokens of the text: natural language words, URL-s, calendar dates, e-mails, IP addresses, DNS (*Domain Name Server*). Segmentation means parsing the cleaned text. The initial text will be annotated by these tags.
- *Comparison between the new segmented text and the knowledge base texts*. The order of the words of the text is not maintained; a profile is computed by sorting the words according to their frequency of appearance. These profiles are computed for the new segmented text and for the texts from k**nowledge base (**KB), too. The "distances" between the profile of the new text and the profile of each KB texts are computed. This "distance" is computed as the sum of the differences of the ranks (positions) of the same word of the two profiles.

The text of KB with the less "distance" is chosen as the best match of the profiles. Therefore, *an automatic classification of the texts* can be processed.

Example:

N Profile = {w1, w2, w3, w4}; N-Rank=p => pw1=1, pw2=2, pw3=3, pw4=4
// The new text contains the words: w1, w2, w3, w4, with this frequency order K1Profile = {w4, w7, w9, w1, w10}*
K1-Rank =p' => p'w4=1, p'w7=2, p'w9=3, p'w1=4, p'w10=5
K2Profile = {w3, w1, w5, w7, w2}
K2-Rank =p" => p"w3=1, p"w1=2, p"w5=3, p"w7=4, p"w2=5
Distance (N, K1) =Σ (pwi-p'wi)=pw1-p'w1+pw2-p'w2+pw3-p'w3+pw4-p'w4=1-4+2-0+3-0+4-1=5
Distance (N, K2) =Σ (pwi-p"wi)=pw1- p"w1+pw2-p"w2+pw3-p"w3+pw4-p"w4=1-2+2-5+3-1+4-0=2
=>NProfile matches to K2Profile and the text N will be in the same category as the text K2.

The system provides an automatic link between the *creation of content* and *collaboration amongst authors* by putting in place a functionality that allows authors of a common piece of content or knowledge chunk to link discussion groups with individual

pages or elements of a document. The record of communication amongst collaborators following the creation of such a knowledge chunk can in turn be archived within the overall knowledge platform and becomes, in turn, part of the systems overall knowledge repository. Such efforts include the exchange of information and experience, the building of consensus, the creation of new knowledge through collaboration and rapid decision-making. Our framework gives the possibility of collaborative knowledge generation: innovative solutions in unpredictable situations, provided by human and social factors. This genuine social capital must include spiritual and mental dimensions.

6. Conclusions and Further Work

This paper proposes an architecture that addresses the needs for finding and maintaining information for users in scientific collaborative settings and that helps to structure and share new knowledge in working environments. Our architecture also facilitates the building of a value and norm based system of knowledge transfer and learning for human agents.

The KMES architecture is based on modularity and integration, configuration and security, adaptability and availability, expert collaboration and knowledge management. The modules of the architectural structure are foreseen as an integrated collection of Web services that allow flexible access to the relevant knowledge resources in the system.

Collaborative web portals provide enhanced support for users within the restricted domain of a collaborating community or an organisation. However, the growth of web-based communities outside of formal organisations, the emergence of virtual organisations and the growth of dynamic team-based working within organisations means that users increasingly have to manage their involvement in a number of separate web portals as well as with the publicly available Web.

Our framework is not only a sum of communicational and informational technologies; it is also seen as a "human" net that integrates in its structure and functionality the users' interaction. Thus, it has an "integrating vocation" for scientific research, connecting results of different research processes, developed with diverse methods. The outcome of this process is a level of knowledge that is not identical with the sum of knowledge parts, being superior. The leap is from a mechanical level of totalling to a holistic one of a spiritual type.

The proposed architecture raises several issues that require further investigation in order to assess usability and scalability of this architecture for deployment on the Internet. The further investigations are concerned with integrating this platform with the capabilities of Semantic Web ontologies and of artificial agents.

Development of a KMS implies [21], as a first stage, creating the initial knowledge building architecture that consists of infrastructure evaluation and alignment of the KM to the business strategy. The second stage is dedicated to analysing, designing and implementation of the knowledge management socio-technological system. The installation of the software tools in an operational environment is the third phase. The last stage consists of performance evaluation and measure of the return on investment (ROI). Socio-technological systems architectures development has to be linked to the organizational KM objectives. These objectives can be achieved through a hierarchical, top-down or decentralized communication structure, and/or process guided, and/or as a support for communities of practice.

Developing a functional system in accordance with the proposed architecture of the framework, involves the phases outlined above. A project of this size requires special financial and human resources, as an European research project is.

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INTELLIGENT SOLUTION FOR FUTURE DEVELOPMENT

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Abstract:
This paper discusses whether the ability to use intelligent solutions in a locality (a transportation system smarter, faster and more effective interventions in emergencies, a more intelligent management of water and electricity, a more intelligent administration and health and education systems more intelligent one) is a significant part of future development.

Key words: *intelligent locality; smart solutions; local development; regional development*

1. Introduction

Spectacular development of technology in recent decades has been accompanied by many changes and important information and communication technology. According to the World Information Technology and Services Alliance (Wits, Digital Planet 2009), information and communication technology has a significant contribution in developing the current company driving innovation and creativity. According vision Information Society Technologies Advisory Group (ISTAG) for 2010, new-generation technologies will be characterized by connectivity, mobility and scalability, giving consumers the option of universal connectivity "anytime, anywhere, any".

Technology knowledge society is an integral part of the life of any consumer, the result of exponential growth in the number of users. This is why the telecommunication networks have steadily progressed, and lately even spectacular. They are always created new services and new technologies are developed and new networks to face the market demand for telecommunications services.

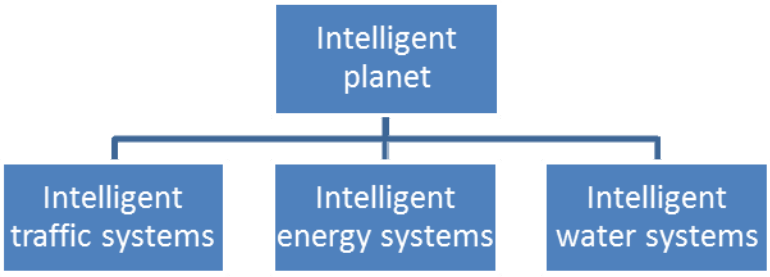

Figure 1. Intelligent planet

In our society is essential to use intelligent systems, synthesize and apply information to change the way in which entire industries operate. Through this intelligent solution in all important sector of our life we will have an intelligent planet (Figure. 1). So, an intelligent planet means an intelligent traffic system (use real-time traffic prediction and dynamic tolling to reduce congestion and its byproducts while positively influencing related systems), an intelligent energy system (analyze customer usage and provide customized products and services that help to boost efficiency from the source through the grid to the end-user) and intelligent water systems (apply monitoring and management technologies to help reduce the use of water, as well as related energy and chemicals). On the other hand intelligent planet is centered on creating intelligent or sustainable cities.

Globalization, ever more sophisticated technology and exploding bandwith have made the world a smaller, smarter, more connected place. Yet the systems on which the world depends such as – food and water systems, transport, energy, healthcare – remain inefficient. IBM's Smart Planet initiative aims to foster the thinking, provide the tools and help create strategies that will drive positive change across these systems on a global scale.

2. Virtual networks

For certain geographical areas, the existence of telecommunications networks offer possibilities for remote communication, remove the differences caused by lack of information and isolation. Appropriate use of modern technologies in order to increase the accessibility of quality information can lead to reduced administrative and social costs.

Future developments in localities will have virtual networks, the growing dependence of modern technologies [20], but also the elimination of bureaucracy, to reduce working time in exchange increase free time. In a intelligent locality the time and space restrictions are virtually nonexistent thus contributing to reducing social division. The creation of such places requires the construction of transportation systems, government, education, health and public policy more intelligent and also uses energy and water resources in an efficient manner.

According to the latest in the field [19], unprecedented urbanization that we face is both a symbol of economic and social progress and a huge burden on infrastructure planet. This is particularly a problem experienced by drivers of economic departments, school administrators, police officers and other persons in positions of leadership. Tasks that these leaders have met them - educating young people, maintain safety of citizens, attract and facilitate trade, implement a safe system of public transport are particularly difficult to manage in these times of economic decline. None of these systems is the responsibility of one entity or decision maker, all involving leading institutions, companies, communities and civil society, which are interconnected. For why, we need an infusion of intelligence in how our cities work. This infusion is currently producing the systems, processes and infrastructure that make it possible for physical property to be developed, produced, bought and sold, services are provided, everything from people and money to oil, water and electrons to move and billions of people to work and live. Indeed, almost anything - person, object, process or service to any organization, large or small - can become aware of the prospects digital infrastructure and can be connected in a network.

3. Intelligent locality

In IBM's vision of 2009, requires a intelligent locality: a transportation system smarter, faster and more effective interventions in emergencies, a more intelligent management of water and electricity, a more intelligent administration and health and education more intelligent systems. This vision brings a new level of intelligence on how the world works - how each person, company, organization, government, natural and artificial system interactions. Each interaction is a chance to do something better, more efficient, more productive. But more than that, as all systems are intelligent planet, we have a chance to open up significant new opportunities for progress. Knowledge, application and technology increase the society evolution. The use of them efficiently in our society is an important step of innovation and evolution. Everybody use the new technology and Internet application in everyday, so the dynamics of use and produce knowledge is important for our society. Thus, all this intelligent systems solutions through their impact on our life put their imprint on the individual environment, but also the physical, economic and social environment (Figure 2).

There are five main reasons that could be invoked in support of intelligent systems:

- Flexible

Firstly, information and documentation can take place anytime, anywhere. Information can happens across locations, or intelligent solution takes advantage of information and documentation opportunities offered by portable technologies. People are overtime in go, so they are interested by more flexible kind of inform.

- Collaboration

Secondly, through intelligent solution everyone uses the same content, which will in turn also lead to receiving instant feedback and tips. This solution will reduce cultural and communication barriers between administrations and people by using communication channels that people like.

- Motivation

Thirdly, multimedia resources can make documentation fun. With this kind of evolution, it is much easier to combine a lot of solution for a more effective and entertaining experience.

- Accessible

Fourthly, new solutions are accessible virtually from anywhere which provides access to all the different information and documentations available.

- Portability

Moreover, the possibilities to use these solutions for everywhere make this very interesting.

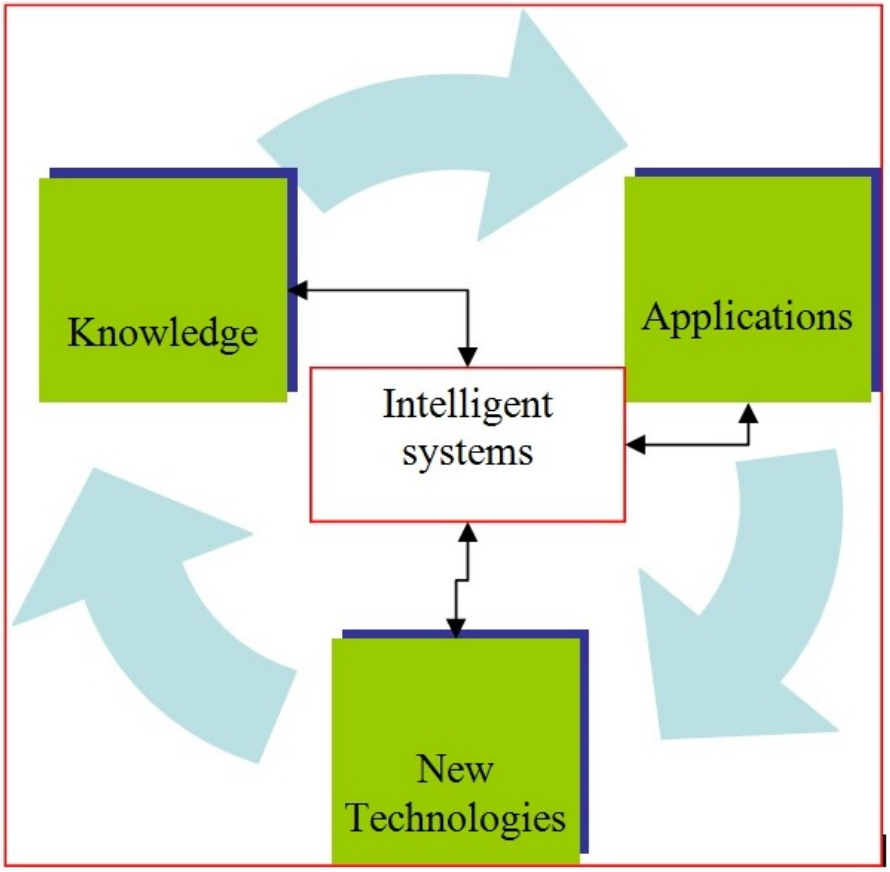

Figure 2. Intelligent systems solutions

Enormous potential of modern information and communication technologies are deployed throughout the world, being implemented in many systems that are interconnected and subject to an infusion of intelligence [9] led and lead conversion important activities from a locality in operations smarter.

For some localities, the modern society which is based on the use of modern information technologies constitute new possibilities for expression of identity and cultural traditions, and for other regions an opportunity to minimize inconvenience related to distance and isolation.

Centers of knowledge, an important step towards the area of intelligence, is the facility to use new technologies in a public place by members of a community. Local knowledge centers, spaces available to citizens, equipped with at least two telephone sets, two computers and a fax enable initiating and receiving telephone calls, facsimile and data communications at a data rate sufficient for functional internet access. Knowledge centers have appeared in all countries, regardless of development, following the desire of removing the negative effects: lack of training opportunities, employment, migration of rural population to urban centers due to lack of access to information on benefits offered by new information technologies. In 2007 there were 700 rural telecentres in Hungary and at present there are around 1000. Important to note is that remote areas (islands) can have such access to modern information technologies. Projects and implementation of knowledge centers exist in most countries, such as those developed and the developing. For centers known to exist in time [20] have to consider how funding and evolution of these in relation

to changes that occur constantly in the society. Centers of knowledge are a real support for localities to build a smart being a window into training, training and knowledge. The next step is to be made is to increase the efficiency of these centers of knowledge thus leading to an increase in the level of training, the knowledge acquired by members of the society which opens perspectives for the knowledge society. The qualitative improvement of knowledge centers become virtual networks, within which is becoming increasingly used in today's society. Each center has its own guidance and the knowledge center focused on areas of activity: medicine (Knowledge Center - Texas Medical Association), education (University of Illinois Educators' Knowledge Center).

We are currently talking more and more interconnected virtual networks of local communities to provide information and online services to citizens and businesses. Networks set up according to the needs of each community, city and ensure, through broadband connections, access to information and electronic services for the main institutions of the locality. Virtual network serving as knowledge centers provide access to telephone services, Internet and computer use, providing a great educational value. By building specific skills, students will be able to contribute actively to the value added of the educational process and to develop personal criteria for the selection and use of information. To adapt new technologies to social needs to be able to exploit the potential must first be possible staff training institutions and enterprises and the population. Appropriate use of modern technologies in order to increase communication, accessibility can lead to reduced administrative and social costs.

4. Solution for future development of our society

Future developments will have virtual networks, the growing dependence of the applications of modern information and communication technologies, but also to eliminate bureaucracy, by reducing working time in exchange increase free time. In a virtual network restrictions of time and space are virtually nonexistent thus contributing to reducing social division. Thus, virtual networks through their impact on the town put their imprint on the individual, but also the physical environment, economic and social. Modern information technologies lead to major changes on activities, on society, but also the environment that interact. Important component of development is a computerization of their villages, meaning the implementation and use of modern information and communication technologies in all economic sectors and linking them in a virtual network. The concept of virtual network refers to the response to complex social problems, economic and urban policy in relation to use of the true value and implementation of modern technologies. The existence of a single point of access to local knowledge center detailed information that can be stored in the various local institutions may be a first step towards a local virtual network and an intelligence locality.

European Union uses the names of "Telecities", "Cities On Line", "Intelligent Cities", "Digital Cities", etc., for projects in the United States are known as "Freenets. Terms listed above are used for local programs to foster the idea of efficient use of modern technologies, which in turn would stimulate development.

Amsterdam, Birmingham, London, New York are just some of the locations where they see the results of implementation solutions to a location intelligence evolution. They

have implemented various intelligent solutions. Interconnections of all intelligent systems implemented locally go to a intelligence locality.

City of Stockholm, for example, developed a traffic surveillance system, allowing its citizens to decision makers. In Germany, MVV Energie AG, a company providing electricity, created the "market" energy based on the collaboration of all elements that are part of the supply chain, from suppliers and to consumers who wanted a change. In London, the desire of citizens for improved public safety led to the installation (by groups of private and public) has over 10,000 surveillance cameras that provide information 24 hours a day [35].

City intelligence provides a clear on all local issues, on how you can communicate more intelligently the necessary information and people seeking to visit a place, giving them accurate information about climate change, health care, education and banking, those related to transport systems and water management systems and electricity supply, as well as 3D image elements of local interest. In addition, various products made available to guide how best to those who are for the first time in this village but also for those who want to quickly reach a certain point.

According to [12] all developed countries have developed and implemented government policies supported the development and adoption of modern information and communication technologies, strengthening the national information infrastructure, training and attracting specialists in modern technologies, the adult education, cooperation with private sector and encourage investment in this new economic branch, promoting government projects designed to demonstrate the utility of current society services.

Everybody use the new technology and Internet in everyday for inform about news, for email, for keep in tuck with friend. Intelligent solutions represent the most important result of use efficiently of the new technology and Internet. Intelligent solutions increase the economy rates. The use of intelligent solutions in our society is an important part of evolution and development. The new technology has become a fundamental part of our economic and social infrastructure, yet its potential as an engine for growth, has only begun to be realized. The intelligent solutions can make a serious change in economic performance, employment, education, health care, government, the environment and in the delivery services for everybody.

In addition, the contribution of knowledge-intensive and skills-intensive sectors, such as modern manufacturing and internationally traded services, to overall economic activity in urban and regional economies has increased. During the next 20 years, this trend will continue to gather momentum. As gross domestic product (GDP) is increasingly based on the knowledge, creativity and ability of workers to innovate, the direct contribution of talent to economic value is expanding.

Knowledge society is characterized by the rapidity of change information and knowledge in services and products fields. In this economy is important to remark that the barriers of communication and the physical distance are lowest, the value of knowledge and information depends on the situation they are used but the mode in which they are understand by the citizen is important too.

As a result, investment in innovation, research, education and technological changes have the most central point to economic performance (Figure 3).

The growth of economy can be analyzed by the investments in higher education, innovation and research, and software. Measurement the performance of economy is based on the Gross Domestic Product (GDP) indicator.

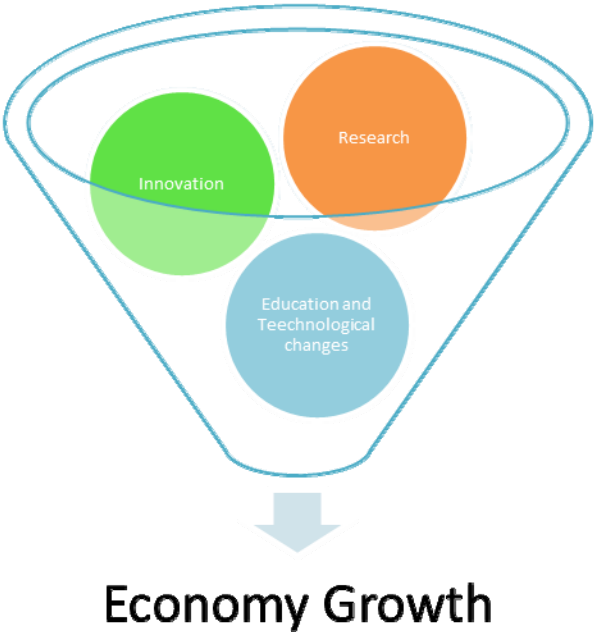

Figure 3. The factors how determinate the Knowledge Society Growth

In generally GDP is the value of total production of goods and services in an economy during a particular period (normally a year). These traditional indicators guide the policy decisions of governments. But to the extent that the knowledge economy works differently from traditional economic theory, current indicators may fail to capture fundamental aspects of economic performance and lead to misinformed economic policies.[1] The traditional indicators can't measuring the performance of knowledge economy because the knowledge isn't a quantitative product.

In [1] GDP for measuring knowledge economy are needed for the following tasks:

- measuring knowledge inputs;
- measuring knowledge stocks and flows;
- measuring knowledge outputs;
- measuring knowledge and learning (human capital).

To **measure knowledge inputs** is similar to measure the investment in the production of scientific and technical knowledge, including research and development (R&D)

Development of knowledge flow indicators would yield better measures of the R&D and knowledge intensity of industries and economies.

Statistical techniques could be developed to **estimate knowledge stocks** based on current R&D input and flow measures.

To **measure knowledge outputs** and evaluate the performance of knowledge-based economies, priority should be placed on developing improved indicators of the private and social rates of return to R&D and other knowledge inputs. This includes measuring returns to individuals, firms and societies in terms of employment, output, productivity and competitiveness, and could be based on both macro-level econometric analyses and firm-level surveys. One of the great challenges is to develop indicators and methodologies for analyze the impact of technology on productivity and economic growth.

Human capital indicators, particularly those relating to education and employment, are central measures for the knowledge-based economy.

To study the evolutions of knowledge economy we can use Harrold-Domar [31] model. The model implies that economic growth depends on policies to increase investment, by increasing saving, and using that investment more efficiently through use intelligent solution and technological advances.

Let Y represent output, which equals income, and let K equal the capital stock. S is total saving, s is the savings rate, and I is investment. δ stands for the rate of depreciation of the capital stock. The Harrod-Domar [31] model makes the following *a priori* assumptions:

$Y = f(K)$	1: Output is a function of capital stock
$\frac{dY}{dK} = c$	2: The marginal product of capital is constant, the production function exhibits constant returns to scale
$\frac{d^2Y}{dK} = 0 \Rightarrow \frac{dY}{dK} = \frac{Y}{K}$	3: Since the marginal product of capital is constant, it equals the constant ratio Y/K
$sY = S = I$	4: The product of the savings rate and output equals saving, which equals investment
$\Delta K = I - \delta K$	5: The change in the capital stock equals investment less the depreciation of the capital stock

Derivation of output growth rate:

$$g = \frac{dY}{dK} = \frac{Y(t+1) - Y(t)}{sY(t) - \delta K(t)}$$

If the marginal product is constant:

$$g = \frac{Y(t+1) - Y(t)}{sY(t) - \delta \frac{dK}{dY} Y(t)}$$

$$c\left(sY(t) - \delta \frac{dK}{dY} Y(t)\right) = Y(t+1) - Y(t)$$

$$cY(t)\left(s - \delta \frac{dK}{dY}\right) = Y(t+1) - Y(t)$$

$$cs - c\delta \frac{dK}{dY} = \frac{Y(t+1) - Y(t)}{Y(t)}$$

The marginal product of capital is constant:

$$s\frac{dY}{dK} - s\delta \frac{dK}{dY}\frac{dY}{dK} = \frac{Y(t+1) - Y(t)}{Y(t)}$$

$$s\frac{dY}{dK} - \delta = \frac{\Delta Y}{Y}$$

In summation, the savings rate times the marginal product of capital minus the depreciation rate equals the output growth rate. So, increasing the savings rate, increasing the marginal product of capital, or decreasing the depreciation rate will increase the growth rate of output, these are the means to achieve growth in the Harrod-Domar model. We can say that the economic growth depends on policies to increase investment, by increasing saving, and using that investment more efficiently through use intelligent solution and technological advances.

The economy growth depends on investment and using that investment more efficiently through use intelligent systems.

5. Intelligent locality solution in our country

Although Romania is not in a very advanced on the use of modern information and communication technologies, there are some tests and some achievements which are increasingly approaching knowledge society. Projects directory computerized of prefectures and town halls, designed by professional bodies at national level, are a first point of departure in the use of modern technologies. Current national developments were due in large measure both technological advances and new economic policies of privatization and promoting competition in the market of new information technologies and communications, new technical and legal regulations in the field, new national and regional strategies of development of society. In Romania, the general issue of information society, virtual town, the digital economy has been studied since the early 2000s and then continued and continues to study the knowledge society, knowledge economy, as well as intelligent villages is a research topic point.

Now in our country through a new concept, leading information technology firm IBM aims to provide a new arena for the world that is becoming more intelligent. The intelligent city concept offers new ways for both governments and the private sector through the convergence of the digital and physical worlds [30].

Advantages and benefits of intelligent locality: Alignment with the latest technologies in the field of information; Example openness to modern technology, reducing costs, degree of sports in case of disasters, better communication with citizens and gain a picture, the transparency achieved; awareness of citizen participation in community life economic, social, cultural, democratization of information by providing data coherent, consistent, updated, improved access to national and universal culture by accessing databases of information and documentation, reducing the amount of work attributed to public servants and default time for solving citizens, reduce errors, than the information's security and transactions entered effectuate, training human resources on a large scale, the phenomenon of mass.

6. Conclusion

City today is the result of remarkable progress made as a result of using information and communication technologies. Society changes caused by the transmission, storage, processing and access to information and knowledge put their imprint on locality

development. Locality aims to become intelligence through intelligent systems, modern information and communication technologies. These solutions make daily activities more easily and efficiently.

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GEOSTATISTICAL ANALYSIS OF TIME SERIES: AN EXPLORATORY ANALYSIS OF CLIMATOLOGIC AND ECOLOGICAL DATA USING A SPATIAL INSTRUMENT

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Abstract:
The extensive use of the Geographical Information Systems, but also of their extensions, in fields that do not necessary connect to geography, but allow for the implementation of methodologies based on the analysis of spatially referenced data, had resulted into new applications and methodological approaches to answer specific research questions. This paper proposes such an extension from the real space define by longitude and latitude to a virtual space defined by two time parameters, month and year, in order to reveal specific temporal patterns of climatologic and ecological phenomena. The methodology is applied in two studies, one aiming to analyze temperature and precipitation data in Romania over a long period, and the other to analyze the effects of anthropic impact and ecological restoration on the density of specific groups of aquatic organisms. In the first study, the method was able to detect climate hazards, while in the second the results had shown different behaviors of analyzed groups, relevant to their ecology. In both cases, the proposed methodology proves its potential for being used as an exploratory research tool in climatology, ecology, and other fields as well.

Key words: *exploratory data analysis; geostatistics; kriging; GIS; time series*

1. Introduction

Within inferential statistics, authors distinguish two chapters: confirmatory and exploratory statistics. Most applied statistics professionals are familiar with the confirmatory data analysis, dealing with the confirmation of statistical hypotheses, estimation, and prediction under very specific circumstances [3, 12]. However, this paper could be placed into the framework of the second chapter, exploratory data analysis (EDA). EDA means simply looking at the data to see what it seems to say, *i.e.*, offer partial descriptions and new insights beneath them, regardless of the statistical criteria used in confirmatory settings [12]. Testing statistical hypotheses is not always possible in EDA, as the aim is to explain and not to confirm [9].

Particular attention is given within the EDA to the analysis of temporal and spatial data. Spatial analysis had been placed under the generic name of kriging, attributed to G. Matheron, and also known under the initial name "theory of regional variables" or as geostatistics [7]. The technique had been developed by D. G. Krige as an optimal interpolation method in the mining industry and named in his honor. Kriging relies on the rate at which the variation between locations changes in space, represented in a graph called semivariogram [9]. Therefore, the mathematical model of kriging is:

$$Z(s_i) = \mu(s_i) + \square(s_i),$$

where $\mu(s_i)$ is a deterministic term, and $\varepsilon(s_i)$ is the sampling error, depending on the coordinates where the value $Z(s_i)$ is measured [9].

The semivariogram is:

$G(s, u) = ½ \times Var(Z(s)–Z(u))$ for any two locations *s* and *u*.

Normally, the semivariogram is assumed to be known and approximated by different mathematical models (linear, spherical, exponential, Gaussian etc.). However, even in these cases parameters must be known. In reality, the semivariogram is not known; therefore, the empirical semivariogram is used instead:

$$\hat{\gamma}(h) = \frac{1}{2N_h} \sum_{(i,j)\in G_h} \left[z(s_i) - z(s_j) \right]^2,$$

where G_h is the set of locations for which $s_i - s_j = h$, and N_h is the number of distinct pairs of elements from G_h [9].

It appears to be simpler to describe the empirical semivariogram than to calculate it: for some value *h*, identify all locations situated at the distance *h* and compute half of their mean square error. However, not every *h* could be represented for all locations (unless exhaustive data is used), and the semivariogram is limited to available values. Problems appear when there are too few or too many locations for a given value of *h* [9]; in these situations, computations are limited to a set of discrete values $h_1, h_2, \ldots, h^*$, where:

$$h^* = \frac{1}{2} \max_{i,j} \left| s_i - s_j \right|$$

The SAS® program groups observed distances $||s_i–s_j||$ in *B* classes ranging between *0* and h^*, such that $10 \le B \le 30$, *i.e.*, choose $B \ge 10$ such that there are at least 30 distances in each class used cu compute $\hat{\gamma}(h)$ [11].

Currently, three types of kriging are used: (a) ordinary - assumes that the average of the random variable is known and constant, and its fluctuations depend only on the location of the sampling stations; (b) simple - assumes that the average of the random variable is unknown and constant, and its fluctuations depend only on the location of the sampling stations; and (c) universal - assumes that the average of the random variable depends of at least another variable, but also on the location of the sampling stations [8]. All techniques are available in an ArcGIS extension called "Geostatistical Analyst", used for the analysis of spatially referenced data.

Geographical Information Systems (GIS) can represent, correlate and assess the relationships between large amounts of data, referenced to a known spatial and temporal framework. Hence, besides being a powerful cartographic tool, a GIS can store, retrieve and combine data to create new representation of geographic space, provides tools for spatial analysis and performs simulations [10].

All the techniques presented above had been developed for georeferenced data, *i.e.*, data for which two coordinates are recorded: X, the longitude, and Y, the latitude, defining the real space. This paper proposes an extension of the real space to a virtual space, in which X and Y are any two variables defining the virtual space. We analyze two examples (one from climatology and one from ecology) in which time periodicity is explored by defining a space where the two coordinates are the year and month when observations are recorded.

2. Methods

Both examples provided used the same methodology. Ordinary kriging was used employing the Geostatistical Analyst available with ArcGIS (version 8.x in the first study and 9.x in the second). Default values proposed by the software were accepted. The first study used data on monthly precipitations and temperature collected in Romania at five stations during 1961-2000 and grouped in arrays having the year on the vertical axis and the month on the horizontal one. The second study used data on the density of primary and secondary consumers from two lakes in the Danube Delta (Matiţa and Merhei) collected at five stations in each lake during 1980-2007 and grouped in arrays having the month on the vertical axis and the year on the horizontal one.

3. Results and Discussion

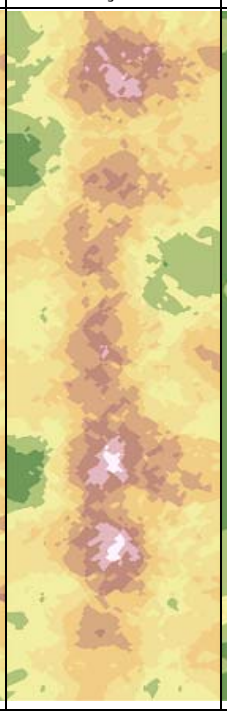
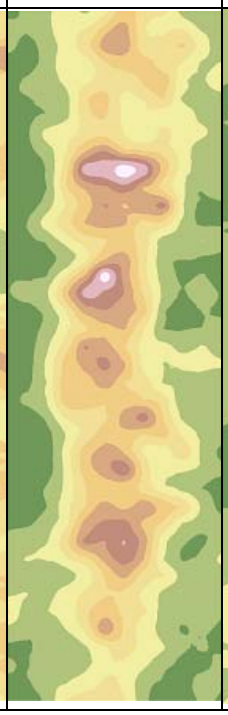
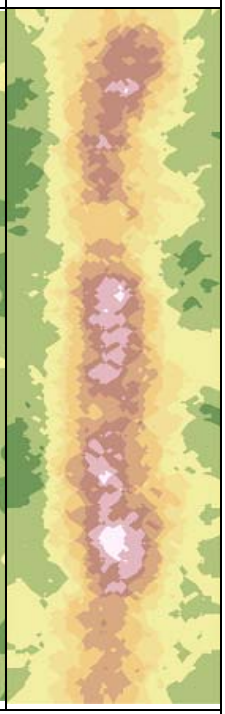
3.1. Example #1: Analysis of climate time series using the Geostatistical Analyst

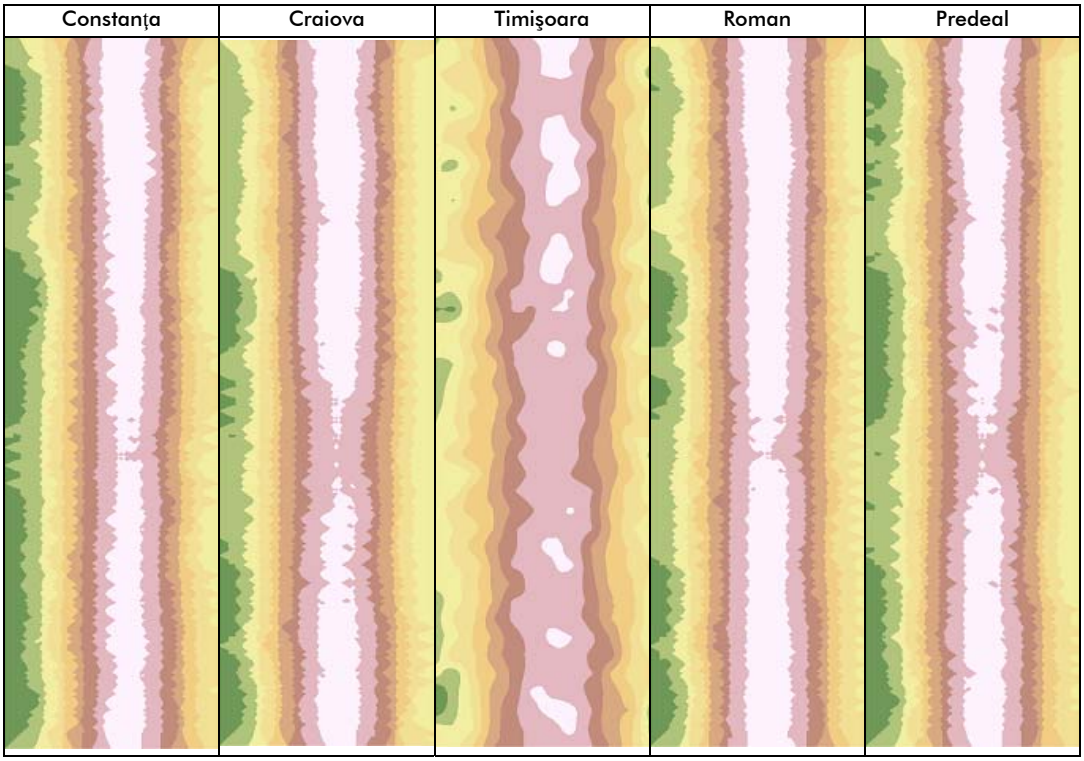
The temporal dimension of climatologic phenomena is one of the most important factors that bias the scientific approach, therefore the integration, analysis, and visualization of spatial data that has a significant temporal component has become a priority in environmental sciences [5, 6].

The first study aimed to create a prediction model for weather hazards (periods with extremely low or high temperatures, and with very low or high amounts of precipitations) based on data collected in Romania at five stations, located in the cities Constanţa, Craiova, Timişoara, Roman, and Predeal (*Fig. 1*), during 1961-2000 [1, 2, 4].

Figure 1. Location of the five sampling stations described in the climate time series analysis using the Geostatistical Analyst (gray dots, black text) and of the two lakes described in the analysis of the effects of anthropic environmental impact and ecological restoration on biodiversity (red/orange dot, red text)

Table 1. Ordinary kriging prediction maps of the precipitations and temperatures in five Romanian cities, based on 1961-2000 data. The color ramp ranges from dark green (abundant precipitations, respectively low temperatures) to bright pink (low precipitations, respectively high temperatures) in the order dark green - light green - yellow - beige - orange - brown - purple - bright pink.

Precipitations				
Constanţa	Craiova	Timişoara	Roman	Predeal
				
Temperatures				



In addition to kriging, the first study used several other interpolation methods: spline fitting, inverse distance weighting, and filtering. Out of all interpolation methods, given its mathematical foundation, kriging yielded the most significant and sound results. The methodology was able to pinpoint one of the most debated issues, climate changes (*e.g.*, cycles of "green" spots for Predeal temperatures, while "bright pink" is apparently wider towards the end of the 1990s).

The study indicated that temperatures follow an easily predictable pattern, with slight variations corresponding to lengths of the cold or the warm season. The four seasons characteristic to Romania are easily noticeable: white and purple indicate the summer and green points to the winter, whereas the other colors correspond to the transition seasons.

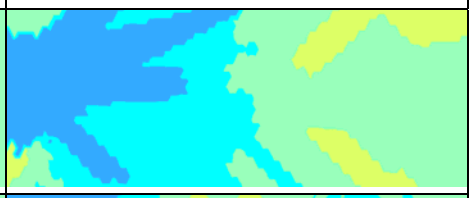
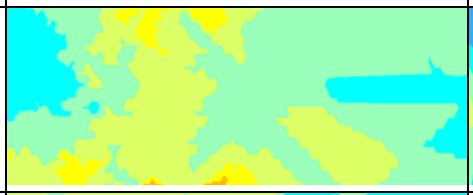
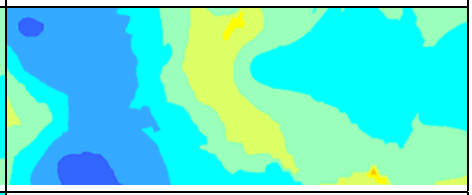
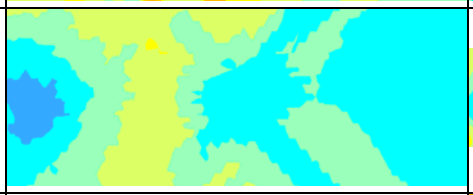
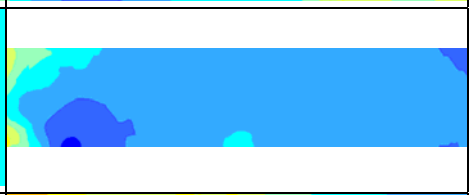
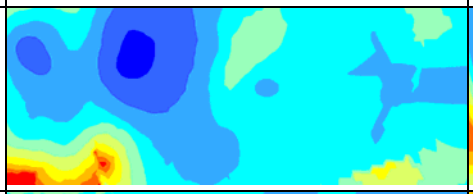
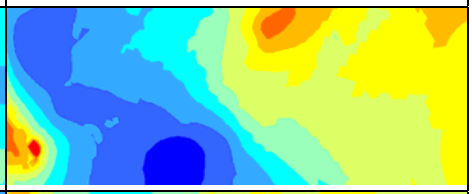
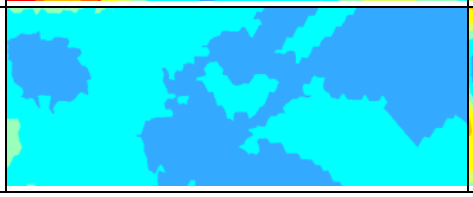
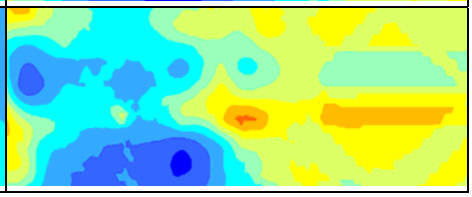
Precipitation clusters appeared more relevant. In our setting, they pointed out dry and wet spells, suggesting the occurrence of hazard events such as floods or droughts. This was particularly obvious in naturally dry/wet regions.

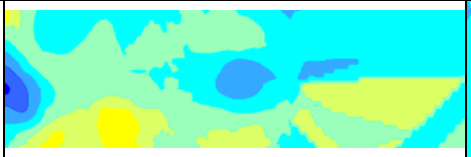
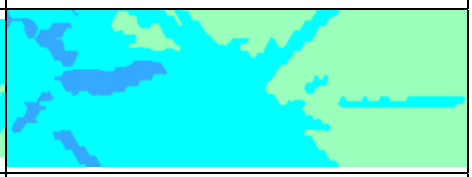
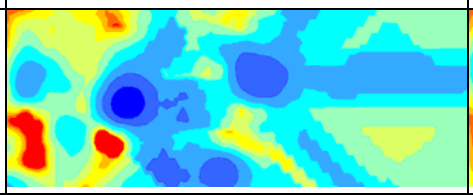
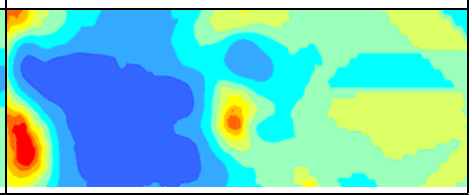
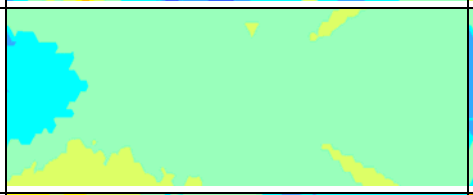
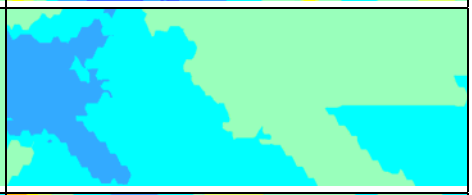
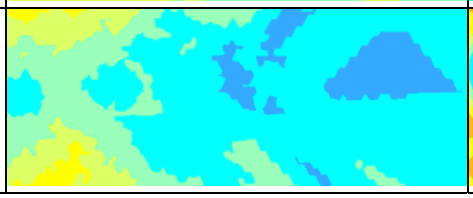
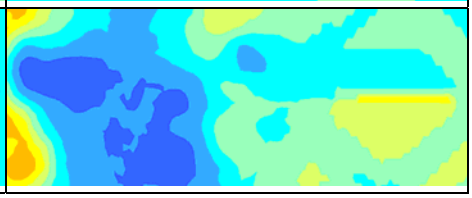
3.2. Example #2: Analysis of the effects of anthropic environmental impact and ecological restoration on the biodiversity of lakes in the Danube Delta

Data were the result of a study aiming to look at the dynamics of several environmental variables in two Danube Delta lakes (Matiţa and Merhei) over a period starting in 1980 and ending in 2007 (*Fig. 1*). The period was marked by three moments. 1980 is the only year in the reference period; 1981 marks the beginning of a deficit in the circulation of water and severe eutrophication due to nitrates and phosphates used in agriculture. The situation improved starting in 1995, when ecological restoration started naturally. Data analyzed in this paper refers to the density of specific groups of organisms, placed from an ecological standpoint on two trophic levels (primary and secondary consumers). Density changes in time were analyzed using the Geostatistical Analyst and the results are displayed in *Table 2*, showing 11 figures for each lake. The first nine figures

correspond to the taxonomic groups (first six to the primary consumers or phytophagous organisms, and last three to the secondary consumers or zoophagous organisms), while the last two summarize all groups by trophic levels.

Table 2. Ordinary kriging prediction maps of the densities of primary and secondary consumers in Lakes Matiţa and Merhei, Danube Delta, based on 1980-2007 data. The color ramp ranges from red (low densities) to dark blue (high densities) in the order red - orange - yellow - green - light blue - dark blue.

Taxonomic Group		Lake Matiţa	Lake Merhei
		Year	Year
Ciliata, phytophagous	Month		
Testacea, phytophagous	Month		
Lamellibranchia, phytophagous	Month		
Rotatoria, phytophagous	Month		
Cladocera, phytophagous	Month		
Copepoda, phytophagous	Month		

Taxonomic Group		Lake Matiţa	Lake Merhei
		Year	Year
Rotatoria, zoophagous	Month		
Cladocera, zoophagous	Month		
Copepoda, zoophagous	Month		
All phytophagous	Month		
All zoophagous	Month		

The results suggest that some groups were more abundant in the beginning, but anthropic impact had caused their extinction (phytophagous *Ciliata*, *Lamellibranchia*, and all phytophagous organisms together), while the restoration had favored other groups (phytophagous *Testacea* and *Rotatoria*, and zoophagous *Cladocera*, especially in Lake Matiţa). Some other species seem not to be affected by either the impact or restoration (phytophagous *Lamellibranchia*, and all zoophagous organisms together), or seem even to strive during the impact period (zoophagous *Copepoda* in Lake Matiţa). With respect to the month, results show that most groups reach their maximum density during the warm season, but some others are more abundant in the cold periods (phytophagous *Copepoda*, *Testacea*, and *Lamellibranchia* in Lake Merhei). Also, differences between the time distributions could easily be seen between the two lakes; these differences are attributable to the geography and biophysical parameters of the two sites.

4. Conclusions

The proposed methodology emphasized in the first study the temporal variability of

the climatologic phenomena, and could provide an approach to the identification and qualitative prediction of one of the most debated issues, climate changes. In the second study, the proposed approach allowed for the exploration of the reaction of analyzed species to both anthropic impact and ecological restoration, leading to conclusions relevant to the ecology of the groups. Therefore, the methodology had shown a significant potential for being used as an exploratory research tool in climatology, ecology, and other fields as well.

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STATISTICAL DETERMINATION OF THE SEQUENCE AND CHRONOLOGY OF THE ERUPTION OF THE FIRST PERMANENT MOLARS AND INCISORS IN ROMANIAN CHILDREN

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Abstract:

Teeth eruption is a dynamic, genetically dictated process which is a part of the odontogenesis and comprises all of the tooth's movement from the bone crypt where it formed until reaching the occlusal plane and starting its function. Chronologically normal eruption is defined as the situation in which dental eruption takes place at time moments placed around the medium eruption age calculated on large population samples. Determining the medium eruption age of the teeth emerging in the first stage of the permanent teeth eruption (incisors and first molar) in children from Bucharest, Romania. The retrospective transversal study was conducted on a sample of 2139 Caucasian children aged between 5 and 10 years who presented to the Paedodontics Clinic for consultation and treatment in the period 2006-2011. The statistical analysis used specific descriptive and interferential (confidence intervals) methods. The order and timing of eruption in girls was: IClo (5.8-5.10 years), M1lo (5.10-6 years), M1up (6-6.2 years), ICup and ILlo (7-7.2 years) and ICup (8-8.2 years). (p=0.01) The order and timing of eruption in girls was: IClo, M1up and M1lo (6-6.2 years), ICup (7-7.2 years), ILlo (7.2-7.4 years) and ILup (8.4-8.6 years). (p=0.01) The results of the study confirm data from literature in terms of faster eruption in girls. Permanent incisors and first molars erupt between 5.8 and 8.2 years in girls and between 6 and 8.6 years in boys.

Key words: chronology and sequence of eruption; permanent incisors; first permanent molars

Introduction

Tooth eruption is a long and complex physiological process which is responsible for the tooth's movement from its site of development in the jaw's bone where it formed until reaching the occlusal plane and starting its function [1][3].

The process of teeth eruption and occlusion development lasts (excluding M3) for approximately 13-15 years, during which period teeth erupt successively, at time moments placed around the eruption medium age specifically for every dental group, in the primary dentition as well as in the permanent dentition [2, 3].

This process suffers a wide individual variability, especially in the permanent teeth. The timing of tooth eruption is influenced by various factors: physiological factors (i.e. heredity, constitution, geographic factors, sex, race, nutrition, climate, urbanisation a.s.o.), pathological systemic factors (various diseases i.e. endocrine diseases, cerebral palsy, severe intoxications, severe renal diseases, genetic disorders a.s.o.) and pathological local factors (local eruption obstacles, hypodontia, lack of space a.s.o.) [4, 5].

The time and sequence of the eruption of the first permanent molars and incisors has been studied by several researchers in many areas of the world with similar results to other studies. Thus, Moslemi in Iran (2004) showed that, with the exception of the maxillary second premolars, the average age at eruption of permanent teeth in girls is less than in boys [3]; Lee et al. in Hong Kong (1965, cited by Nizam et al., 2003) as well as Jaswal (1983) and Gaur and Singh (1994) in India reported earlier eruption in girls than in males [6, 7, 8]. Nizam et al. in Malaysia (2003) reported for both genders that most of the mandibular teeth erupted earlier than the maxillary teeth, the first tooth which erupted was the lower first permanent molar (mean eruption time of lower first molar is 6.0 years) [6]. The sequence and chronology of tooth eruption for both sexes were: m1 (mean age 6 years), M1 (mean age 6.3 years), i1 (mean age 6.35 years), I1 (mean age 7.15), i2 (mean age 7.4 years), I2 (mean age 8.55 years).

Koch et al. (2001) in Denmark and Pahkala et al. (1991) in Finland, have reported that Caucasians have a delayed time of eruption and Stewart R (1982) suggested that negroes have been shown to have an earlier eruption pattern when compared to other ethnic groups [1, 3].

The order and chronology of the permanent teeth eruption is a major factor in the development of the permanent teeth and in the establishment of a correct occlusion [6].

Adequate knowledge of the timing and pattern of tooth eruption are important for diagnosis and treatment planning in paediatric dentistry [6].

The purpose of this study was to determine the sequence and chronology of the eruption of the permanent incisors and first permanent molars by gender in a Romanian children group from Bucharest and other parts of the country.

Material and method

The cross sectional, retrospective study was carried out on a number of 2139 Caucasian children aged between 5 and 10 years. The children were randomly selected. The study group was selected out of all the patients consulted over a period of 5 years in the Paedodontics clinic of the Faculty of Dental Medicine within "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania, by one of the authors of the paper.

The inclusion criteria were:

- all healthy patients between 5 and 10 years of age

- all children with complete dental records
- all children who presented at the dental visit for other reasons that those related to the chronology and sequence of teeth eruption

General data and the cross-sectional data on the first permanent molars and permanent incisors eruption were collected from the dental records of the patients.

The recorded data consisted of the patient's name, date of birth, date of the dental visit and records of the present teeth (central upper and lower incisors – ICup, IClo; lateral upper and lower incisors – ILup, ILlo; upper and lower first molar – M1up, M1lo). An erupted tooth was defined as any tooth with any part of its crown penetrating the gingiva and becoming visible in the oral cavity.

The variables taken into account were: age, sex, tooth type and dental arch. In order to facilitate age computation, patients were divided into age groups of 2 months intervals. Taking into account the fact that most of the time symmetrical and homologues teeth erupt at similar moments in time, the study did not take into account the hemi-arch on which a particular tooth was located. Instead, similar teeth on the left and right hemi-arch were observed as pairs [9, 10, 11, 12, 13]. The median time of onset of the eruption of a particular tooth was considered to be situated in the age interval in which the consulted patients presented 50% of the possible number of teeth of the respective pair.

The statistical analysis used specific descriptive and interferential (confidence intervals) methods.

Results

1. From the total of 2139 children, 47.8% were girls (n=1022) and 52.2% were boys (n=1117).
2. The mean age of the children was 7.48 years (SD = 1.45 years), with the mean age of the girls 7.50 years (SD = 1.45 years) and of the boys 7.46 years (SD = 1.44 years). The patients' distribution by age groups is showed in Table 1.

Table 1. The patients' distribution by age groups (in years and months)

Age group	Number of patients	Age group	Number of patients
5 – 5.2	62	7.6 – 7.8	72
5.2 – 5.4	72	7.8 – 7.10	71
5.4 – 5.6	78	7.10 – 8	67
5.6 – 5.8	75	8 – 8.2	83
5.8 – 5.10	69	8.2 – 8.4	74
5.10 – 6	72	8.4 – 8.6	70
6 – 6.2	75	8.6 – 8.8	71
6.2 – 6.4	69	8.8 – 8.10	69
6.4 – 6.6	65	8.10 – 9	69
6.6 – 6.8	73	9 – 9.2	71
6.8 – 6.10	79	9.2 – 9.4	73
6.10 – 7	66	9.4 – 9.6	71
7 – 7.2	72	9.6 – 9.8	71
7.2 – 7.4	61	9.8 – 9.10	72
7.4 – 7.6	70	9.10 - 10	70

3. The sequence of eruption for both sexes are shown in Table 2.

Table 2. The sequence of eruption by gender

Age group (in years and months)	5.8 – 5.10	5.10 – 6	6 – 6.2	7 – 7.2	7.2 – 7.4	8 – 8.2	8.4 – 8.6
Girls	IClo	M1lo	M1up	ICup ILlo		ILup	
Boys			IClo M1lo M1up	ICup	ILlo		ILup

Discussion

Time of emergence of teeth (mean age of eruption) is determined by specific statistical methods based on data collected from population-wide samples. This process suffers a wide physiological individual variability depending on heredity, constitution, geographic factors, sex, race, nutrition, climate, urbanisation a.s.o.

The present study employed specific descriptive and interferential (confidence intervals) methods. The study's results reveal several concordances and inconsistencies with data in other reports.

The sequence and timing of dental eruption in girls was as follows: IClo (5y 8m - 5y 10m), M1lo (5y 10 m - 6y), M1up (6y - 6y 2m), ICup and ILlo (7y - 7y 2m) ILup (8y - 8y 2m). The sequence and timing of dental eruption in boys was as follows: IClo (6y - 6y 2m), M1lo and M1up (6y - 6y 2m), ICup (7y - 7y 2m), IClo (7y 2m - 7y 4m), ILup (8y 4m - 8y 6m). These results differ from other studies in what concerns the eruption of the lower central incisors before the first permanent molars [14, 15]. However, this is in agreement with many previous studies carried out in several countries and this has been reported as a global phenomenon with a reversal in the order of eruption between the M1lo and IClo [13, 16].

The present study is in agreement with the vast majority of existing reports with regard to the earlier onset of the permanent teeth's eruption in girls [12, 13, 16, 17].

As generally accepted, in both sexes, the mandibular teeth erupted earlier than the maxillary teeth, with the exception of the upper and lower first permanent molar in boys, that erupted concomitantly [9, 10, 12, 13, 18, 19]. The biggest difference between the ages of eruption of maxillary and mandibular teeth was recorded at the central incisors in girls (approximately 1 year). This significant difference is supported by several studies, although the values obtained by other authors are generally lower [12, 20].

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THE INVESTMENT IN EDUCATION AND IN CONTINUOUS TRAINING, AT EU-27 LEVEL

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Abstract:
The fundamental role that education has in the development of human fundamental values is to form, nurture and develop spirit. The aim of this paper is to highlight the role of the investment in education and continuous training at EU level. The results presented in the article, are in most part obtained on the basis of specific data series sat EU level, data that have been considered significant. The techniques used, besides those of elementary statistic, are a series of econometric techniques base don autoregressive models, systems with simultaneous equations, time series etc. The major findings drawn refer to the following aspects: the early XX-th century European Union was clearly surpassed by the North American States regarding the development dynamic, productivity and economic competitiveness, the discrepancies being continuously amplified; the reasons for the low European performances in comparison to the North American States are found in obvious inconsistencies between the qualifications offered by the actual education systems and the labor market needs; the low level of participation to education of the working population; in the European countries with less rigid waging systems, an extra education year increases the level of the individual wage with approximately 6,5% to 9%; tertiary education is recognized as being a crucial strategy for stimulating innovation, productivity and growth in a knowledge-based society etc. The basic conclusions drawn, are strongly related with the following aspects: the employment rate grows according to the education level attained, even when it comes to elderly persons; the Europeans with ages between 55 and 64 have big gaps regarding qualification and training, although everyone agrees that the persons with higher education are easier to be absorbed by the labor market, earn more money and benefit from a better social status; even though there

are less and less children, the enrollments in education have not generally decreased; the widening of the European Union has not eased, but rather aggravated all these problems because even the recently integrated countries have a negative natural population growth; preschool education helps the children that come from disadvantaged families at socio-economic level to continue their studies and not least the fact that the immigrants are not well represented in education and additional training, presenting an increased rate of withdrawal from studies.

Key words: *investment; education; professional training; EU-27; labor market; work places; carrier development; communication techniques; human capital development; medium and long term*

1. Introduction

The fundamental role that education has in the development of human fundamental values is to form, nurture and develop spirit. Both meanings highlight the capacity of education to transform continuously, an attribute highly important if we analyze the significations, functions and the investment in education along the whole evolution of human society.

Platon, for example, considered that a good education consists in offering the body and soul all the beauty and perfection the human needs.

2. The objectives of the education and continuous training systems, at EU-27 level

The development of an union of the European states, as an objective necessity in front of the dynamism and competitiveness of the United States of America, but also of the entrance of the Asiatic states in the arena of economic games, has obliged the governments of the countries members of the European Union to reconsider the political and social systems, systems where education has been identified as being the instrument whereby there can accomplished in the long term the proposed changes.

At the 4th Conference[1] of the education ministers from the European countries that was held in 1988, the participants have highlighted the necessity to develop the human capacity to adapt to changes – especially those of the labor market, with its unemployment problems – and also of the capacity to foresee the changes and to prepare in this new perspective.

The conclusions of this important meeting emphasized the multiplication of education roles and the diversification of its functions in contemporary society. The subsequent meetings of Heads of State and Government, during the European Councils of Lisbon (2000), Stockholm (2001), Barcelona (2002), Berlin (2003), Maastricht (2004), Brussels (2005), came to strengthen the role and importance to be given to education and training in the context of making the EU a competitive and dynamic system of organization and development.

3. The investment in education and in continuous training, in the context of the European Union extension

The contribution of education and training to achieve the 2010 strategic objective set by the representatives of the powers of a United Europe can not be addressed without an analysis of the investment involved in the programs proposed in the light of the major changes to occur.

At the beginning of XXI century the European Union is clearly surpassed the United States in the dynamics of development, productivity and economic competitiveness, and discrepancies have continued to increase. Therefore, governments of developed European countries have begun to face problems in retaining talent and attracting human capital necessary for the proposed strategies. Exodus of highly qualified specialists in Europe, especially to America, is increasing, affecting especially science and technology. In order to stop these losses of "brains", the European Union has decided to invest 1.6 billion euros through the Sixth Framework Programme for research and technology development.

But representatives of the Member States are aware that surpassing these difficulties requires not only massive investment in research, development or in the communication technology but also in the human capital development.

Studies to date[2] indicate that the reasons for the low European performances in comparison to the North American states are found in obvious mismatches between the skills offered by the current systems of education and the labor market needs. They are rooted in the low level of participation in education of working-age population. For European Union many years were necessary to extend the average length of schooling from 70% in the year 1971 to 87% in 2000 compared to the duration of schooling in the U.S..

The research undertaken lead to the fact that in the countries with less rigid wage structures from Europe, an additional year of schooling increases the individual earnings level by about 6.5% to 9%. The strong link between education and wages is better highlighted starting with training at secondary level.

This is a threshold from which any form of further education implicitly draws a salary increase[3]. Bourguignon and Morrison[4] show that an one percent increase in the workforce segment with secondary education increases the income of the poorest two-fifths of the population by 6% and that of the poorest three-fifths of the population by 15%, thus contributing to an equalization of incomes.

Table1. The proportion between education and income[5]

Education Level	Income Deciles										Total
	1	2	3	4	5	6	7	8	9	10	
Without secondary education	**31%**	**24%**	17%	12%	7%	4%	3%	1%	1%	1%	100%
Complete secondary education	13%	**20%**	**23%**	17%	11%	7%	3%	2%	2%	1%	100%
Apprentice school	15%	13%	**16%**	**16%**	14%	10%	5%	4%	2%	2%	100%
Stage I high school	11%	11%	**16%**	**16%**	**15%**	11%	8%	6%	3%	2%	100%
Vocational school	7%	8%	10%	11%	10%	**13%**	**14%**	11%	10%	8%	100%
Complete high school	7%	10%	12%	15%	**16%**	10%	10%	8%	5%	5%	100%
College	4%	5%	8%	10%	12%	**15%**	**14%**	**14%**	9%	9%	100%
Faculty +	5%	5%	9%	11%	**13%**	**13%**	11%	11%	9%	**14%**	100%
Total	11%	12%	14%	14%	13%	10%	9%	7%	5%	5%	100%

Comparative analysis of indicators can easily draw the conclusion that the employment rate increases with the level of education attained, even when it comes to

elderly people[6]. This aspect is very important, given the low level of employment opportunities for this category of persons in the EU area, an area already experiencing serious problems arising from population aging continuously.

Higher educational level implies a higher amount of labor reflected in enhanced productivity. Despite the measures taken, Europeans with ages between 55 and 64 have large gaps in the qualifications and education, although everyone agrees that people with higher education are more easily absorbed into the labor market, earn more money and enjoy a better social status. Currently, only 49% of people aged 55 to 64 have completed secondary education, while only 33% of young people aged between 25 and 29 have completed studies at this level. To this situation adds the fact that there are fewer young people in Europe than in the U.S. or in the Asian countries except Japan. In addition, the differentiation between the sexes regarding access to employment and career development persists and is increasing. Elimination of gender and age would create a significant opportunity to raise workforce, highly qualified on the European market.

Taking into account the low birth rate in the European Union countries, one might conclude that the reduction of population contributes to the reduction of expenses, as a consequence to a lower participation at all levels of education and training. In reality, although there are fewer children, school enrollments have not overall declined. At this time, more and more young people extend their postgraduate studies and enter the labor market later on.

This new form of approaching education and career, given the demographic decrease, determines the increase of investment in education in Europe. The target of the representatives of the European countries is represented by the persons who have left the formal education system. Governments are making efforts to enhance the participation of these groups at higher levels of education and training (even lifelong), to assist them to remain as much as possible active.

Many EU countries are obliged to make investments in the integration of immigrants and their children and families. In the projections of demographic development it is anticipated that approximately 73% of the population growth will be due to immigration.

Enlarging the European Union has not eased, but rather aggravated all these problems because the countries that have recently been integrated also have a negative natural population growth. Population decline on the one hand, and the loss rate of youth participation in the labor market, in particular, require radical reforms and firm investment decisions in education and training, medium and long term, wide world.

Table2. The rate o workforce participation in economic activity[7]

%

Population total	1995	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	66,9	66,7	66,4	66,2	66,1	66.0	65,8	65,7	65,6	65,5	65,4	65,3	65,2
Youth	58,9	57,8	56,6	56,2	55,6	55,2	54,7	54,3	54,1	54,2	54,3	54.4	54,5
Adults	69,7	69,7	69,7	69,6	69,6	69,6	69,5	69,4	69,3	69,3	69,4	69,5	69,6

4. The importance of investing in students

Education policy makers have an incentive to increase coverage and rigorous pre-school and childcare services for all residents. Early education provides the best possibilities for children. Children who attend kindergartens and nurseries develop better skills of

reasoning and problem solving, are more cooperative and attentive to others, have more self confidence and are better equipped for the transition to primary school to be effective. Benefits of early education continue to grow in primary and secondary education, making transition harmonious to further education and the labor market. At the same time, kindergartens and nurseries leave time for mothers to be more active in society and the labor market.

Studies confirm that early education helps children from disadvantaged families in socio-economic level to continue their studies. Equally, those who come from families who communicate in a foreign language may provide an early and frequent contact with the language of instruction of the host country, precisely the age at which they are most receptive to learning a language.

Families with low incomes, including many families of immigrants are less likely to give their children to nurseries and kindergartens. All parents experience difficulties in accessing early education of children if places are limited and costs are high.

Immigrant parents and those with low incomes may also not be sufficiently informed about existing options, may have less confidence in the childcare leave on account of strangers and may prefer the advantages of informal education at home, provided by family members. Immigrant parents who use day care and childcare services may find that there is a lack of dialogue, understanding and empathy between them and the staff when the staff has not any intercultural experiences and, more importantly, the skills to teach the host country language as a second language. In addition, many nurseries can not adequately assess the language skills of immigrant children to ensure they benefit from appropriate support programs and learning a foreign language (if any).

Kindergartens and nurseries have to respond to the needs of these families linguistically diverse and disadvantaged at social and economic level. Authorities can ensure effective participation of low income families by giving them specific financial support or free access to preschool services.

5. Facilitating the transition towards higher education and employment on the labor market, at EU-27 level

Within the EU, tertiary education is recognized as a crucial strategy to boost innovation, productivity and growth in a knowledge society. Percentage of young immigrants who complete a form of tertiary education varies considerably across immigrant communities. These differences can arise when young people are faced with an interruption of studies (as happens to many asylum seekers and refugees) and / or those that are from countries where few people have access to education and therefore are not deemed to enter into academic tertiary education. The differences also reflect the value that parents give to higher education.

The govern, educational institutions, civil society organizations, foundations and private companies can increase the number of scholarships and programs offered to young talents from migrant families (and to their parents).

6. The role of education and vocational training, at EU-27 level

The increase in the number of high school graduates is part of the 2000-2010 goals of the Lisbon Agenda to make the EU the most dynamic and competitive knowledge-based economy in the world. Higher education is the most desirable way to obtain the necessary skills for a knowledge society. Every effort can be made in order to ensure that young migrants acquire skills necessary to successfully complete secondary education, but education and vocational training is the second option for those who, despite the support offered, may not finish high school and leave school with very limited prospects.

Immigrants are not well represented in education and additional training and present a high rate of study withdrawal. Communication programs that offer extensive information on available courses to immigrants may be ineffective or inexistent, the courses may not be well adapted to different educational backgrounds, cultural and / or language skills of immigrants. Courses may not be structured in a flexible manner to ensure that students are able to strike a balance between commitments to the family and towards work. Work to overcome these barriers will help to encourage young immigrants to continue their education and to encourage the return to school for those who have withdrawn from their studies or abandoned them.

7. Conclusions

The main conclusions drawn, are strongly related with the following aspects: the employment rate grows according to the education level attained, even when it comes to elderly persons; the Europeans with ages between 55 and 64 have big gaps regarding qualification and training, although everyone agrees that the persons with higher education are easier to be absorbed by the labor market, earn more money and benefit from a better social status; even though there are less and less children, the enrollments in education have not generally decreased; the widening of the European Union has not eased, but rather aggravated all these problems because even the recently integrated countries have a negative natural population growth; preschool education helps the children that come from disadvantaged families at socio-economic level to continue their studies and not least the fact that the immigrants are not well represented in education and additional training, presenting an increased rate of withdrawal from studies.

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SUBJECTIVE PROBABILITY ASSESSMENT OF ORGANISATIONAL RISKS IN EDUCATION – AN APPROACH TO SCHOOL POLICIES

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Abstract:
This paper proposes a method for consultants dealing with organisational problems in schools. The method is useful for school governing bodies too, subjective risk assessment of the key issues of the school being a way to generate strategic organisational answers/papers. The method is based on the Risk Priority Number (RPN) calculation for events or situations having negative impact on school's organisation.

Key words: *subjective probability; risk assessment; emotional factor; school policies; prioritizing alternatives*

Subjective probability assessment have its importance for organisational decision-making, especially in situations where it is the only way to have an idea about the impact of hidden or concealed factors – corruption, mistrust or illegal actions. The exercise itself of organisational assessment is a mean to alignment of people's goals, desires and motivations; also, asessing risks creates significance for some fenomena that, otherwise, would silently do their distructive work, with no means of measurement.

Knowlege utility of the decision-makers subjectivity. Behavioral economics[2] considers that managers' decisions are influenced by emotional factor and they make systematic errors due to the cognitive models and representations they use to analyze financial data and facts. Many times the value of a prior investment, even though this investment is not profitable anymore, influences decisions. At the same time, the lack of objective judgment plays a crucial role in strategic management. The managerial vision is determined by the dominant values of the subject and by the decisional models he/she adheres to. In order to gain a more in depth knowledge of the this subjective approach an exercise of estimating the risk was conducted in 17 schools. At the beginning, all respondents have been focused by a short trainig session, that clarified the definitons of the categories, ant the way of work - examples have been given.

The short description of the exercise is the following: Exercise for estimating risks: this paper is a starting point for discussing some standards regarding the dysfunctions and aggregating the level of severity for each problem category. The "risk priority number" will be summed in order to analyze the risk associated with the identified problems. The worksheet is used for the following:

- prioritizing the risks associated with various actions/ processes

- examining and comparing decisional alternatives
- application of correctional measures

For calculating the RPN related to the potential failure we use the following formula:

RPN = Severity X Occurrence X Detection

Severity, which rates the severity of the potential effect of the failure.
Occurrence, which rates the likelihood that the failure will occur.
Detection, which rates the likelihood that the problem will ***not*** be detected before it reaches the student, as end-user.

Each factor that leads to RPN and that has a value attributed on a scale of 1 to 5 according to the description below:

Severity

Score	Effects	Consequences
1	Very weak or inexistent	The activity/process/result are affected to a small extent
2	Weak or minor	The process can still take place, the product can still be used with a diminishing of performance
3	Medium or significant	A diminishing of performance, quality and value
4	High, strong	The products cannot be utilized anymore, the process cannot take place and utility is compromised
5	Very high, catastrophic	Affects the security of the individual, institution, system in an irreversible way with influence on adjacent domains of activity

Occurence

Score	High probability
1	Very small/inexistent
2	Small or minor
3	Medium or significant
4	High
5	Very high almost certain

Detection

Score	The probability of not detecting the frequency cases get omitted
1	Very small/inexistent
2	Small or minor
3	Medium or significant
4	High
5	Very high

The form that subjects completed contains the following categories: The problem category, the topic, the principle that is overlooked, the legislation that is overlooked, the administrative level the process takes place. The subjects estimated the frequency of the signals, the severity of the law trespassing, the possibility of not detecting or the frequency with which the cases get omitted, the level of trust of the public, the persistency in time of the problems using scales created before. The severity of the law trespassing, the level of public trust and the problem persistency can be measured with certain standards. The current state if research consists in consulting the school authority and objective manifestation.

Categories of problems

1. Concepts, planning, projections
2. Information management ; includes issuing documents
3. Information Transparency
4. Low Efficiency of the System
5. System Inefficiency (discrepancies between objectives and accomplishments
6. Human Resource Management- having the necessary personnel with the adequate knowledge, training, personnel review
7. Financial Management- Budget, Social Assistance- Scholarships of various kinds
8. Safety
9. Human Rights
10. Rules

Principles that are bent:

1. Merit Principle
2. Equality of chances
3. Equity Principle
4. Retributive justice (JR)
5. Procedural justice (JP)

Legislation bent- this is where the legislation will be explained, the article, the quantified description of the act

The level of public trust- subjective manifestation – 5 steps 1-very small-to 5 very large

The administrative level of control:

1. School- internal monitoring (NCS)
2. Local level – local monitoring (NCL)
3. County – monitoring at a county level (NCJ)
4. Region- Monitoring at regional level (NCR)
5. National – Monitoring at national level (NCN)

The persistence in time of problems**:** from 1- accidental- to 5- permanent

The utility of the instrument for the school was tested also by the utilization of the trainees during the financial management course. The trainees' presentation of the risks represented a topic of analysis for the school administrative council. A calibration of the instrument at school level allows an evaluation of educational risks. For the use of the trainers in order to increase school autonomy, the instrument allows systematic activities of the school bodies. The instrument is at the same time detailed in matters of risk and enough focused on risk issues used to determine the main problems of the school. The school principals have signaled the way that the rules are bent, the most frequently being bent the meritocratic principle, followed by the principle of equality of chances.

Overview of results of the research

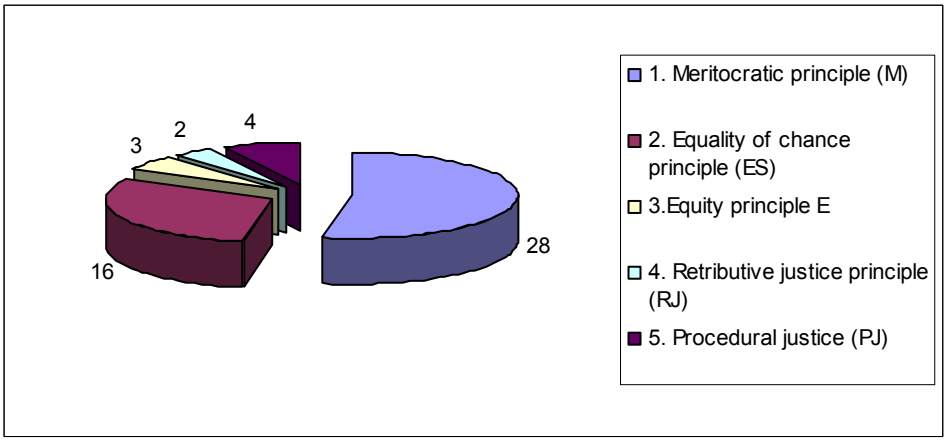

Figure 1.

The statistical results of the survey conducted among the school principals through the risk exercise (the full results can be found in the complete research document) show that the principle most frequently bent is the meritocratic one followed by equality of chances.

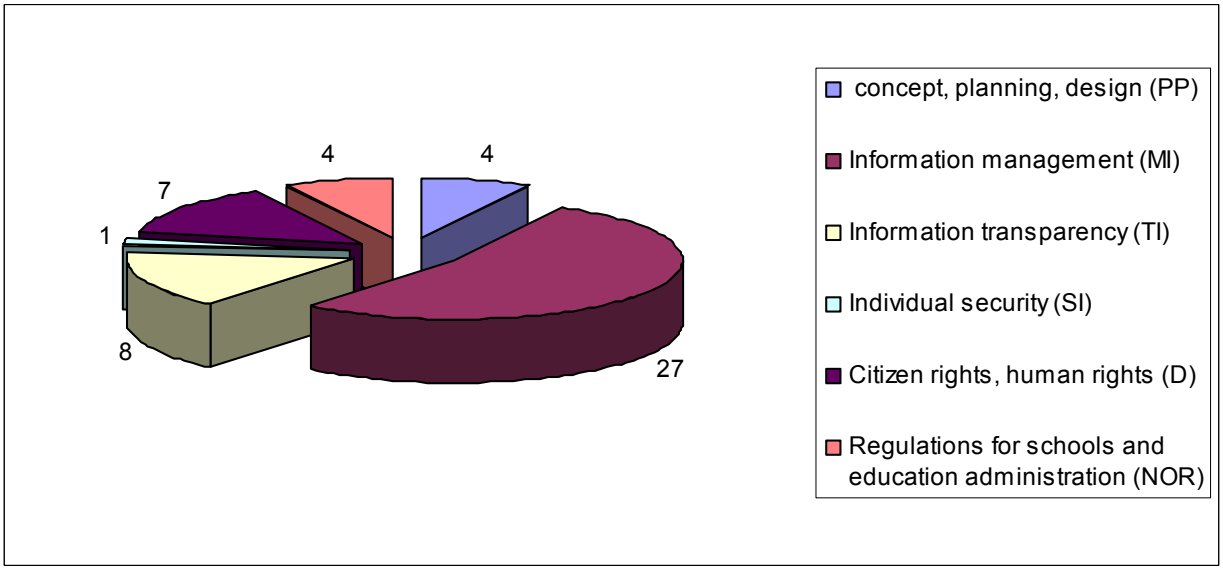

Figure 2.

From the categories mentioned above, the most frequent references are towards information management, followed by transparency in information and human rights. After applying the instrument, the consultant can opt for detailing the results through additional investigations of the fields that appear frequently. The consultant should use the right methods in order to solve the identified issues. The methodological approach of the instruments and regulations that the consultant can suggest must answer a set of questions, together with the decisive factors within the school.

Verification list

- The method corresponds to the cost indicators- allows spending and brings along financial and labor efficiency
- Will surpass organization barriers- perception and communication
- If the method chosen will surpass the legal obstacles and personnel qualification
- Is suited to the size and purpose of the organization
- Will help the organization to improve its results
- Are cost drivers taken into account?
- Will the chosen method surpass the identified obstacles(legal, organizational, personnel qualification and cultural)

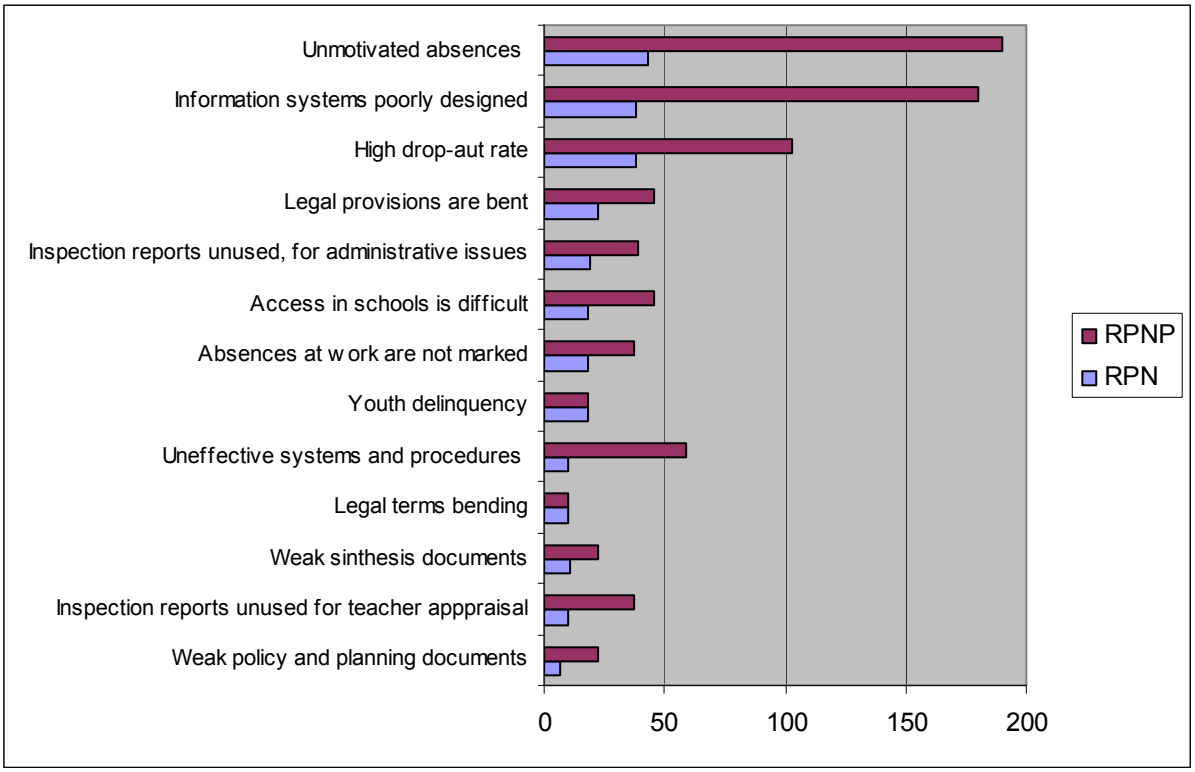

Figure 3.

An interesting statistic of the risk factors, estimated both by the RPN and the RPNP (RPN multiplied by Persistance in time factor) shows that the statistics doesn't change depending on the order of the risk factors, but the emphasis on one or the other shows the deficiencies of the administration in making decisions.

After the previous exercise, the subjects build a check-list of the necessary activities in the course of their daily agenda. The purpose of it is to prevent the major risks for both the school and its own carrier.

Agenda Content

1. Checking: the school's material goods, situations that occur during the night shifts, the condition of the building, the report of the maintenance and surveillance

personnel, the secretary's report who received important and time sensitive documents- situation similar to the report presented by the emergency personnel in the medical system

2. The time the school principal spends in the office: kindergarden 50% of the time spent in the institution and 30% for school and high school
3. We recommend around three cycles in which the school principal should respect precise moments of the agenda. In order to better accustom the personnel that in that time frame
4. It is recommended to have three time frames in which the school principal should respect precise agenda items in order to accustom the personnel that in that time frame there should be no interruption and that certain activities take place regularly. In general these are activities related to risk management – checking teacher's timeliness, verifying important documents, safety and various incidents that occur.

The impact of unforeseen events, cause and consequences

Fact: All school principals from the sample are delegated. This means that they can be released from the position by the General Inspector of Education at any time without any justification

Consequences named by the subjects:

- Long term plans that are not needed because the principals know that they won't get to implement them and their successors won't agree with the plans
- The plan for developing the institution is not assumed by the local authorities. It cannot be efficiently implemented because the decisional factors are unknown. These factors lead to a superficial drafting and a lack of meaning for the principal, and an incoherent approach in the development of the institution
- The strategic plans, deadlines and responsibilities are not important for the school personnel
- A school principal in this situation is uncertain of the results of its effort therefore he/she is uncertain if it worth building something; the easiest solution is to turn to defensive strategies in order to keep its position
- The uncertainty of the job becomes an unnecessary stress factor. The frustrations pile up negatively impacting the next future principals as well, who will be confronted with the same situation
- If you invested in a job it is important to be rewarded
- You have no incentive to take an initiative
- The personnel of the school won't respond to your suggestions
- There is a big difference between the status of a principal that is appointed and one that competes for the position

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THE RELIGIOUS AFFILIATION STRUCTURE OF THE VILLAGES FROM ROMANIA[1]

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Abstract: *This article aims to sketch some typologies of Romanian communes from the perspective of religious affiliation of the population. All data used comes from the last population and housing census (2002) from which information is available. The main new element refers to the village level approach according to the historical regions they belong to. The most heterogeneous communes are the ones from Transylvania while the ones from Oltenia, Muntenia and Moldova are on the opposite side.*

Key words: *religious affiliation; villages; Romania; religious structure*

Introduction

The rural area in Romania is divided in almost 2700 administrative units which are called „communes". These units, in accordance with the existing regulations in Eurostat[2] are situated at the lowest level on the administrative units hierarchy: LAU2 (Locale Administrative Units 2). Until July 2003 the LAU2 level has been called NUTS5[3]. Here we will analyze inferior settlements named villages[4]. In 2002, in Romania there were 12.591 villages. We aim to distinguish some typologies which are present in the villages of Romania from the religious affiliation point of view self-declared at the census. The start premise is that there are differentiations between the villages of Romania according to their former historical regions. In this context, we consider that the most heterogeneous villages will be

located, mainly in the historical regions of Transylvania and Banat while the communes located in the former regions of Moldova, Muntenia and Oltenia will be the most homogenous from an religious point of view. Due to the fact that the territorial division in eight development regions (NUTS2) is currently used, we have opted for this version detrimental to historical regions.

Methodology and data sources

The main statistical information source used in this article is the one obtained from the 18th March 2002 population and housing census. It is obvious that the affiliation to a religious denomination, according to the census rules, has been established on a free statement basis. In terms of statistical methodology, descriptive statistics methodology is mainly used. Where relevant[5] the option was for association testing using the χ^2 test and the associated coefficients (Pearson's φ or Crammer's V). In terms of specialized software the option was SPSS.

Data Analysis

In 2002 the villages from Romania were, in terms of population, very diverse. Very small villages were registered (for example: Geamana village from Lupsa commune from Alba county which was registered as having only 1 – one – inhabitant) to very large communes[6] (Voluntari village/ commune from Ilfov county was registered with over 30 000 inhabitants). The average level of the population of a village from Romania was in 2002 a level a bit bigger than 800 inhabitants while median was located near 500 inhabitants. In the next table the villages' distribution by the population amount on development regions at the 2002 population and housing census is presented.

Table 1. The villages' distribution by size on development regions (%)

Size / Region	under 150 inh	151-300 inh	301-500 inh	501-800 inh	801-1400 inh	over 1400 inh
North East	11,0	15,4	15,9	18,6	19,3	19,7
South East	15,1	14,8	15,8	17,3	18,4	18,5
South	10,0	13,2	14,8	17,2	21,6	23,3
South West	16,5	18,8	22,4	18,1	14,2	10,0
West	25,0	21,3	16,4	14,2	12,6	10,5
North West	14,2	17,5	18,7	19,4	18,1	12,2
Center	32,8	15,6	14,9	14,0	11,2	11,4
Bucharest - Ilfov	5,0	6,0	9,0	13,0	16,0	51,0
National	**16,9**	**16,4**	**17,0**	**17,2**	**16,8**	**15,7**

Source of data: Own processing of statistical information from RPL2002.

Firstly it is ascertained that Bucharest-Ilfov region strikes an extremely discordant note compared to the other development regions. A portion of 51% of villages from this region had over 1400 inhabitants and there was only 11% of villages having under 300 inhabitants. Due to the fact that, practically, a lot of villages from this region are in the metropolitan zone of Bucharest[7], this high density is normal. Due to the fact that the

geographically so called "dispersed village"[8] is mainly encountered in the mountain area (especially in Apuseni mountains) the development regions with a higher share of small villages are the ones from the South Transylvania (Center Region) and the East part of Banat (West Region). In these two regions the share of villages under 150 inhabitants is 32,8% respectively 25%. Over 23% of the villages from South Region and almost 20% of North-East Region has over 1400 inhabitants which illustrates that in these regions the predominant settlements are the ones which are sized some more than the national average. These differences between the distribution of villages by size which are observed among the different development regions are statistically significant (after performing the χ^2 test) with a probability of more than 99,99%, the association coefficients (Pearson's φ and Crammer's V) values being 0,27 and 0,12 which points out a moderate intensity between the development region and the size of the communes.

In 2002 a percent of 10,25 millions of inhabitants (which represents 47,26% out of the total inhabitants number) was living in the rural area. Out of this percent, without major differentiations compared to urban area, 86,31% said they are Eastern Orthodox, 4,93% Roman Catholics, 3,34% Reformed, 1,9% Pentecostals, 0,71% Greek Catholics, 0,59% Seventh Day Adventists, 0,57% Baptists and the rest of 1,64% opted out for another situation. Although the Eastern Orthodox Church dominance is categorical, in Figure 1 we tried to capture the situation of one religion dominance by the size of the village.

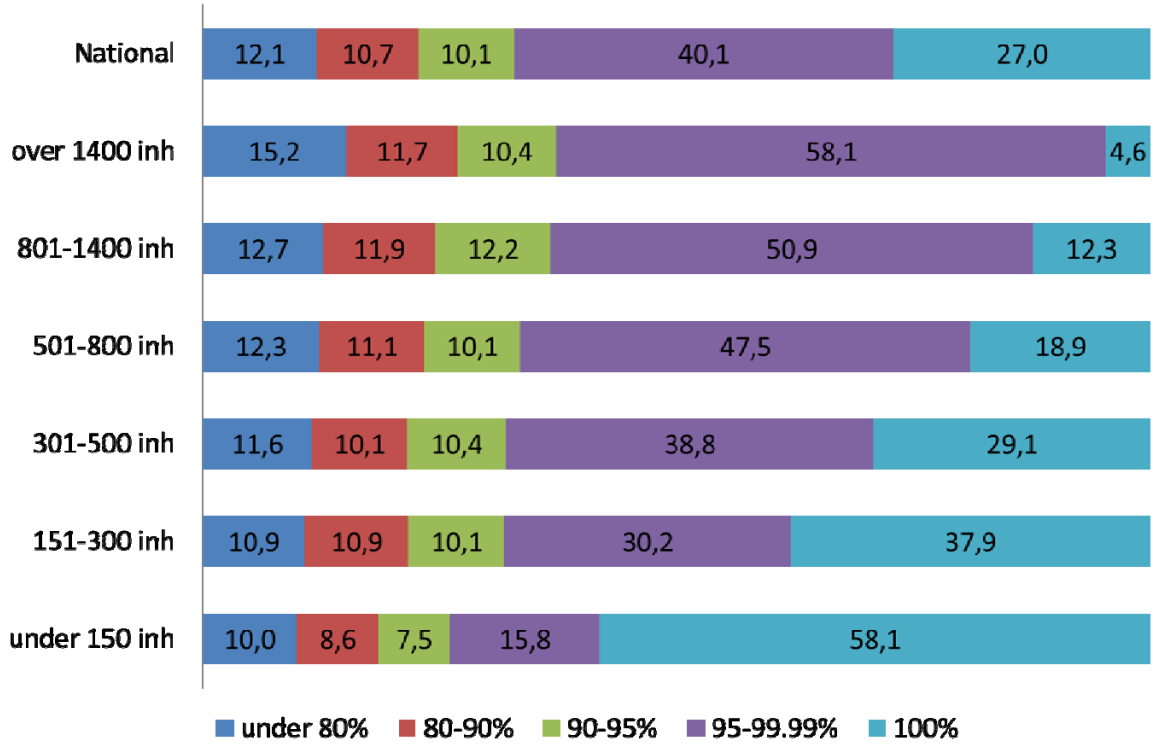

Figure 1. Maximum share from religious affiliation viewpoint by different villages' size

Firstly it is worth to mention the fact that in 92,5% of the villages, the Eastern Orthodox Church is the one which has the maximum value of the share a religion could have. Out of the 7,5% (945) villages in which the dominant religion is not the Orthodox one, the majority (476) are localized in the Center Region, while the next positions are occupied

by the North West Region (274 villages) and North East Region (114 villages). The "one religion" villages are the 99,4% ones where the dominant religion is Eastern Orthodox. The other 0,6% (19 villages) are located mainly in Transylvania (most of them in Harghita county) being Roman Catholics (16 villages) and, the balances, being Reformed (3 villages). It is found as well that with the increase of the size of a village, the chance that a villages is mono-religious decreases significantly (from 58,1% in the case of a village under 150 inhabitants) to 4,6% (in the case of a village over 1400 inhabitants). These differentiations visible in figure 1 are significant from a statistical viewpoint with a probability higher than 99,99% (after performing the χ^2 test) Pearson's association coefficient φ being 0,41 while Crammer's V had the value of 0,21.

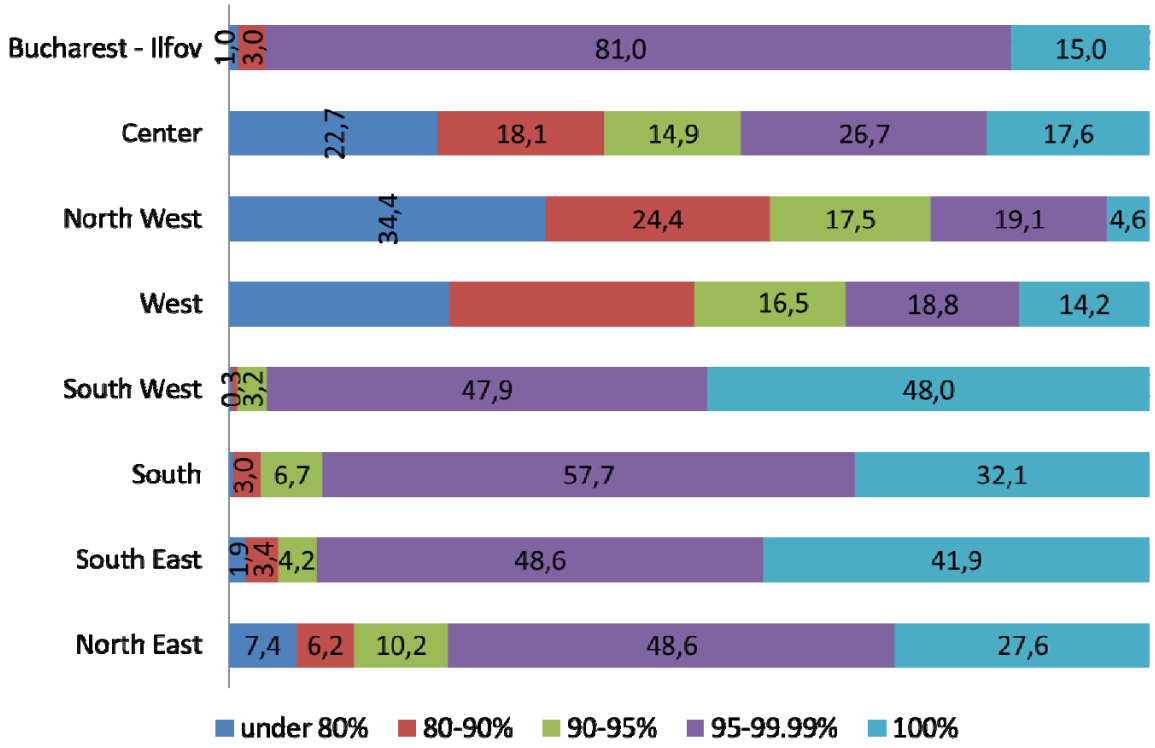

Figure 2. Maximum share from religious affiliation viewpoint by regions

From the maximum share of a religion distribution way by development regions, figure 2 shows us that there are a number of four development regions (South-West, Bucharest-Ilfov, South and South-East) where the dominant religion of a village has values, most often, over the 95% level. In the four previous mentioned development regions the probability that in a village the dominant religion share is over 95% has the next levels: Bucharest-Ilfov 96%, South-West 95,9%, South-East 90,5% and South 89,8%. The development regions from the historical areas of Banat and Transylvania have the most heterogeneous communes. Thus the probability not to have a dominant religion's share bigger than 90% in one of these villages is 598,8% in North-West, 50,6% in West and 40,8% in Center. All these differences are significant from a statistical point of view with a probability over 99,99% (after performing χ^2 test). The intensity of the association,

measured with the Pearson's coefficient φ has a quite strong level (0,62) while Crammer's V has the value of 0,31.

In the next stage of the statistical analysis we measured the heterogeneity of the villages from Romania from a religious affiliation viewpoint by simple metering (without taking the shares in consideration) of the present denominations. The grouping was realized in Figure 3 considering the size of the village.

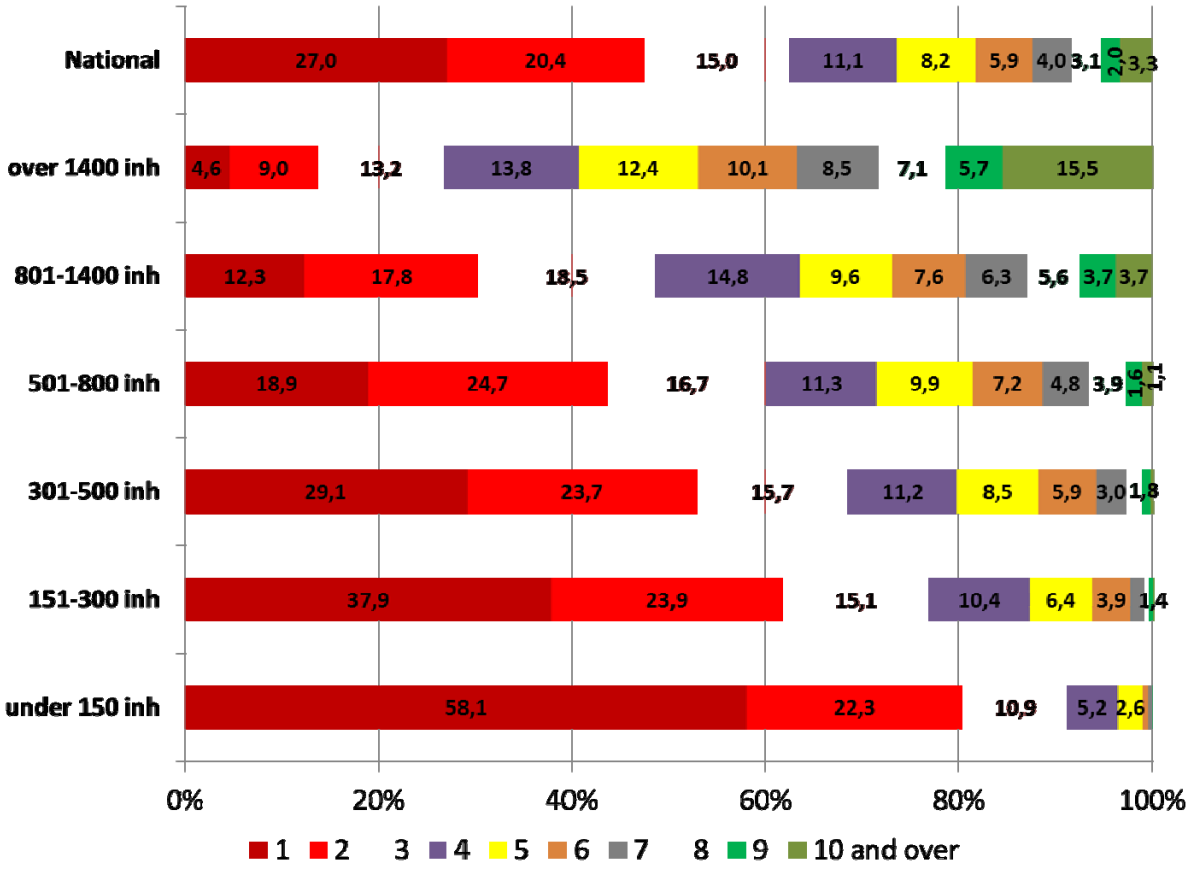

Figure 3. Number of denominations by villages' size

As expected we could notice that there is a direct proportionally connection between the two variables. Thus, while the size of the village increases, the number of its religions tends to increase. The probability for a village under 150 inhabitants to have 6 denominations is 1% but it is constantly increasing with the population volume to a level of 46,9% for a village over 1400 inhabitants. The differences are significant from a statistical viewpoint with a probability bigger than 99,99% (χ^2) even if the Pearson's φ coefficient (0,56) and Crammer's V (0,25) are pointing an average intensity association.

A last approach targeted the number of denominations by the village's region. The outcomes for this grouping are available in Figure 4.

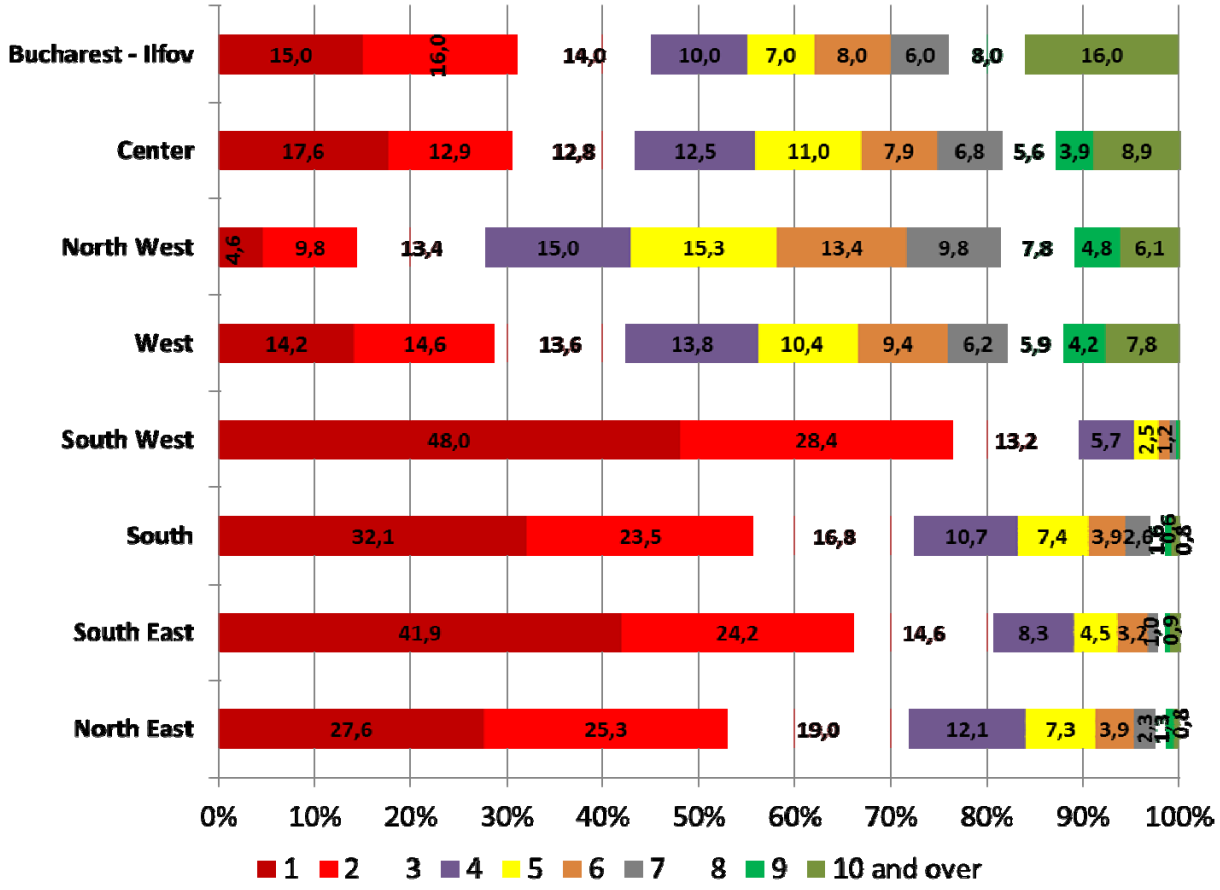

Figure 4. Number of denominations in a village by regions

The differentiations between the development regions are persistent in this case as well. Thus, in the group of the regions with small religious diversity, the probability to meet at most three denominations in a village has a level of 89,6% in South West, 80,7% in South-East and 72,43% in South and 71,84% in North-East. Although from the viewpoint of the domination of one religion the Bucharest-Ilfov region was in the same group, following the proximity to Bucharest, the probability of maximum three denominations in a commune from this region is not bigger than 45%. This level is, rather close to the level of regions with multi-religious tradition. Indeed, the probability of maximum three denominations in a commune has a level of 27,8% for the North West Region, 42,32% for the West Region and 43,35% for Center Region. Moreover, for the last four enumerated regions, the probability of at least 7 denominations in a village is around 25%[9].

Conclusions

In conclusion we could assess the fact that the preliminary assumptions have been confirmed. Thereby in the villages from outside the Carpathian Arch it is recorded a higher homogeneity from the religious affiliation viewpoint. The villages from Banat and Transylvania (now re-labeled as Center, West and North West regions) have the highest

heterogeneity from a religious viewpoint. This heterogeneity is inducted by the ethnic diversity as well, diversity more pronounced in this geographical area. Another factor which has a positive influence to a village's denominational heterogeneity is the size of the population. Naturally, the villagees with a bigger population have more chances to record more religious groups. However, overall, the religious diversity in the rural area is quite low[10]. The Orthodox Church categorically dominates the religious spectrum in the rural area, in almost 92,5% out of the total number of the communes being the main religion. If we ignore the share of each denomination and we simply count the presence of a denomination in a village, the religious effervescence seems to increase. Knowing that the hardest thing is to enter a market, there is the possibility that in a big period of time, the structural mutations of the population, from the religious affiliation point of view, to be more profound and for us to be in front of a painting with different nuances than the present ones.

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[2] http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/local_administrative_units

[3] Nomenclature of Territorial Units for Statistics (NUTS) in Romania it has the following levels: NUTS1 – Macroregions, NUTS2 – Development Regions, NUTS3 – Counties. Lower levels are LAU1 (former NUTS4) without a correspondence in Romanian administrative system and LAU2 – communes.

[4] In Romania, a village cluster formes a commune (having a city hall and one mayor). There are villages directly subordonated to town/cities next located to. Our paper included only rural villages.

[5] Crosstab statistical groups.

[6] Many of them are now towns. Knowing the fact that the legal limit of population for starting the transformation process from commune to town is 10 000 inhabitants.

[7] This process is publicly being debated but has not yet been legislative concretized.

[8] A village specific for mountain areas where the households are at a considerably distance from one another.

[9] It almost reaches 30% in Bucharest-Ilfov Region.

[10] In fact, the same specific is present in the urban areas as well.