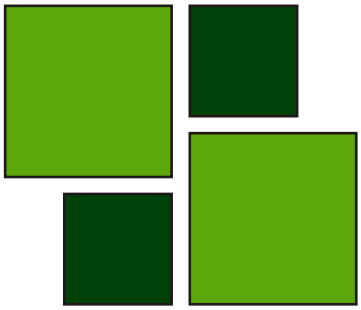

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Quantitative Methods Inquires

AN ANALYTICAL METHOD FOR DETECTING THE CHANGE-POINT IN SIMPLE LINEAR REGRESSION MODEL. APPLICATION AT WEIBULL DISTRIBUTION

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Abstract

In this paper we studie an analytical method to detect the change-point in the model of simple linear regression. The study method is used to estimate the parameters of a Weibull model represantative a change-point. The procedure proposed in this paper is illustrated through a classical change-point data. For the accuracy of the method a simulation study is performed.

Key words: Change-point, simple linear regression model, Weibull distribution

1. Introduction

Change-point models have originally been developed in connection with applications in quality control, where a change from the in-control to the out-of-control state has to be detected based on the available random observations. Up to now various change-point models have been suggested for a broad spectrum of applications like quality control, reliability, econometrics, medicine, signal processing, meteorology, etc.

The general change-point problem can be described as follows: A random process indexed by time is observed and we want to investigate whether a change in the distribution of the random elements occurs.

Formally, let $X_1, .. , X_n$ denote a sequence of independent random variables, where the elements $X_1, .. , X_k$ have an identical distribution function f_1 and $X_{k+1} , .. , X_n$ are distributed according to f_2 and the change-point k is unknown.

The change point problem has been considered and studied by several authors. Change-point analysis concerns with the detection and estimation of the point at which the distribution changes. One change point problem or multiple change points problem have been studied in the literature, depending on whether one or more change points are observed in a sequence of random variables. Several methods, parametric or nonparametric, have been developed to approach the solution of this problem while the range of applications of change point analysis is broad.

There is an extensive bibliography on the subject and several methods to search for the change-point problem have appeared in the literature. The CUSUM (cumulative sum) approach: Basseville & Nikiforov [1], Lucas & Crosier [12], Ritov [15] and Yashchin [16]. The maximum-logarithm of the likelihood ratio approach: Guralnik & Srivastava [10], Gustafsson [11] and Ghorbanzadeh [7]. The Bayesian approach: Bradley & all [5], Barry & Hartigan [2] and Ghorbanzadeh & Lounes [9]. The Non-Parametric approach: Pettitt [13], Dehling & all [6] and Ghorbanzadeh & Picard [8].

In this work we consider the change-point model for a simple linear regression with one change point. Consider n pairs of observations (X_i , Y_i) and we suppose that the relationship between X and Y can be described by a simple linear regression, where the structure changes after a change point k in {4, …, n-4 }. This restriction on k is needed to ensure that the parameters in the model are estimable. Thus, the observations (X_i, Y_i) follow a linear model for i<= k and another linear model for i > k. Therefore, the model is given by

$$\begin{cases} Y_i = B_1 + A_1\, h(X_i) + \varepsilon_{1,i} & \text{if } i = 1, \dots k \\ Y_i = B_2 + A_2\, h(X_i) + \varepsilon_{2,i} & \text{if } i = k+1, \dots n \end{cases} \qquad (1)$$

where A_j and B_j (j = 1, 2), are the unknown parameters, $\varepsilon_{j,i}$ are independent errors and h is a known function.

The methode proposed in this paper is illustrated through a classical change-point data from Quandt [14]. We use the model (1) to estimate the parameters of a Weibull model represantative a change-point. For the accuracy of the method a simulation study is performed.

2. Analytical method for the chage-point estimate

For k_0 in {4, …, n-4}, we construct n-7 two subsamples as follows :

Table 1. Distribution of data in two subsamples

k_0	$sample_1(k_0)$	$sample_2(k_{0)}$
4	$X_1, \dots, X_4$	$X_5, \dots, X_n$
5	$X_1 , \dots, , X_5$	$X_6, \dots, X_n$
⋮	⋮	⋮
n-4	$X_1 , \dots, X_{n-4}$	$X_{n-3} , \dots, X_n$

For each k_0 in {4, …, n-4}, we consider the following models

$$\begin{cases} Y_i = B_1(k_0) + A_1(k_0)\, h(X_i) + \varepsilon_{1,i}(k_0) & \text{if } i = 1, \dots k_0 \\ Y_i = B_2(k_0) + A_2(k_0)\, h(X_i) + \varepsilon_{2,i}(k_0) & \text{if } i = k_0 + 1, \dots n \end{cases} \quad (2)$$

For each k_0 in {4, …, n-4}, $A_1(k_0)$, $B_1(k_0)$, $A_2(k_0)$ and $B_2(k_0)$ solve the following minimization problem:

$$\min_{(A_1(k_0), B_1(k_0), A_2(k_0), B_2(k_0))} D\big(k_0, A_1(k_0), B_1(k_0), A_2(k_0), B_2(k_0)\big)$$

where

$$D\big(k_0, A_1(k_0), B_1(k_0), A_2(k_0), B_2(k_0)\big) = \sum_{i=1}^{k_0} \varepsilon_{1,i}^2(k_0) + \sum_{i=k_0+1}^{n} \varepsilon_{2,i}^2(k_0) \quad (3)$$

By classics calculations, we obtain the estimator of $A_1(k0)$, $B_1(k0)$, $A_2(k0)$ and $B_2(k0)$

$$\begin{cases} \hat{A}_1(k_0) = \dfrac{\sum_{i=1}^{k_0} \big(h(X_i) - \overline{h}_{k_0}(X)\big)\big(Y_i - \overline{Y}_{k_0}\big)}{\sum_{i=1}^{k_0} \big(h(X_i) - \overline{h}_{k_0}(X)\big)^2} \quad , \hat{B}_1(k_0) = \overline{Y}_{k_0} - \hat{A}_1(k_0)\, \overline{h}_{k_0}(X) \\ \hat{A}_2(k_0) = \dfrac{\sum_{i=k_0+1}^{n} \big(h(X_i) - \overline{h}^{\star}_{k_0}(X)\big)\big(Y_i - \overline{Y}^{\star}_{k_0}\big)}{\sum_{i=k_0+1}^{n} \big(h(X_i) - \overline{h}^{\star}_{k_0}(X)\big)^2} \quad , \hat{B}_2(k_0) = \overline{Y}^{\star}_{k_0} - \hat{A}_1(k_0)\, \overline{h}^{\star}_{k_0}(X) \end{cases} \quad (4)$$

where

$$\begin{cases} \overline{h}_{k_0}(X) = \dfrac{1}{k_0} \sum_{i=1}^{k_0} h(X_i) \quad , \overline{h}^{\star}_{k_0}(X) = \dfrac{1}{n - k_0} \sum_{i=k_0+1}^{n} h(X_i) \\ \overline{Y}_{k_0} = \dfrac{1}{k_0} \sum_{i=1}^{k_0} Y_i \quad , \overline{Y}^{\star}_{k_0} = \dfrac{1}{n - k_0} \sum_{i=k_0+1}^{n} Y_i \end{cases} \quad (5)$$

Let $D(k_0) = D\big(k_0, \hat{A}_1(k_0), \hat{B}_1(k_0), \hat{A}_2(k_0), \hat{B}_2(k_0)\big)$ and

$$k^{\star} = \underset{k_0}{\operatorname{argmin}}\ D(k_0) \quad (6)$$

By equation (4), we deduce the estimators of A_1, B_1, A_2 and B_2

$$\hat{A}_1 = \hat{A}_1(k^{\star})\ ,\ \hat{B}_1 = \hat{B}_1(k^{\star})\ ,\ \hat{A}_2 = \hat{A}_2(k^{\star})\ ,\ \hat{B}_2 = \hat{B}_2(k^{\star}) \quad (7)$$

and the chang-point time is estimated by

$$\hat{k} = \text{length of Sample}_1(k^\star) \qquad (8)$$

3. Application to Quandt's data

This data was illustrated by Quandt [14]. He considered a simple linear regression model with one point-change. The data, listed in Table 2.

Table 2. Quandt's data

i	1	2	3	4	5	6	7	8	9	10
X_i	4	13	5	2	6	8	1	12	17	20
Y_i	3.473	11.555	5.714	5.710	6.046	7.650	3.140	10.312	13.353	17.197
i	11	12	13	14	15	16	17	18	19	20
X_i	15	11	3	14	16	10	7	19	18	9
Y_i	13.06	8.264	7.612	11.802	12.551	10.296	10.014	15.42	15.60	9.871

The results obtained by the model (1) show a change after the first k = 12 observations, giving

$$\begin{cases} Y_i = 2.2215 + 0.6912\, X_i & \text{if } i = 1, \dots 12 \\ Y_i = 5.9141 + 0.4787\, X_i & \text{if } i = 13, \dots 20 \end{cases}$$

The following graph shows the estimation results.

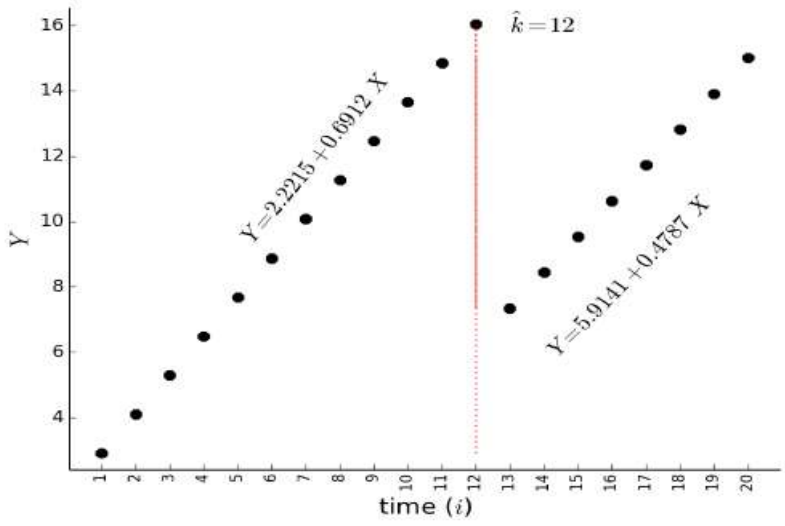

Figure 1. Estimation results for Quandt's data

4. The change-point detection model for the Weibull distribution

In the following, we note W(a,b) the Weibull distribution with the cumulative distribution function

$$F(x) - 1 - \exp(-(\frac{x}{a})^b)$$

In this section We assume that a sequence of observations $X_1, \ldots, X_n$ represents a Change-point with :

$$\begin{cases} X_i \sim W(a_1, b_1) & \text{if } i = 1, \ldots k \\ X_i \sim W(a_2, b_2) & \text{if } i = k+1, \ldots n \end{cases} \quad (9)$$

For k_0 in {4,… , n-4 }, we build n-7 two subsamples and we order they as the Table 3.

Table 3. Distribution of data into two subsamples ordered. $X_j^{(i)}$ denotes the i-th order statistic of $sample_j(k_0)$ (j=1,2).

k_0	$sample_1(k_0)$ ordered	$sample_2(k_0)$ ordered
4	$X_1^{(1)}, \ldots, X_1^{(4)}$	$X_2^{(1)}, \ldots, X_2^{(n-4)}$
5	$X_1^{(1)}, \ldots, X_1^{(5)}$	$X_2^{(1)}, \ldots, X_2^{(n-5)}$
⋮	⋮	⋮
n-4	$X_1^{(1)}, \ldots, X_1^{(n-4)}$	$X_2^{(1)}, \ldots, X_2^{(4)}$

For each subsample, we use the Benard's approximation (Bernard & Bosi-Levenbach [4]) for median ranks, given by:

$$\begin{cases} MR_1(i) = \dfrac{i - 0.3}{k_0 + 0.4} & i \in \{1, \ldots, k_0\} \\ MR_2(i) = \dfrac{i - 0.3}{n - k_0 + 0.4} & i \in \{k_0 + 1, \ldots, n\} \end{cases} \quad (10)$$

The cumulative distribution function of Weibull distribution will be transformed to a linear function:

$$\ln\Big(-\ln(1 - F(x))\Big) = b\ln x - b\ln a$$

Let $Y = \ln\Big(-\ln(1 - F(x))\Big)$, $A = b$ and $B = -b\ln a$.

To estimate the values of the cumulative distribution function, we use the median rank. For each subsample, we have

$$\begin{cases} Y_i = \ln\Big(-\ln(1 - MR_1(i))\Big) & \text{if } i = 1, \ldots k_0 \\ Y_i = \ln\Big(-\ln(1 - MR_2(i))\Big) & \text{if } i = k_0 + 1, \ldots n \end{cases} \quad (11)$$

Then the model (9) is written:

$$\begin{cases} Y_i = B_1(k_0) + A_1(k_0)\ln(X_i) & \text{if } i = 1, \ldots k_0 \\ Y_i = B_2(k_0) + A_2(k_0)\ln(X_i) & \text{if } i = k_0 + 1, \ldots n \end{cases} \quad (12)$$

By the equations (6), (7) and (8), we deduce the estimators of a_1, b_1, a_2 and b_2 :

$$\hat{a}_j = \exp\left(-\frac{\hat{B}_j(k^\star)}{\hat{b}_j}\right) \quad , \quad \hat{b}_j = \hat{A}_j(k^\star) \ (j = 1, 2) \qquad (13)$$

5. Illustrative data, simulations and application

5.1. Illustrative data

To illustrate all the steps of the method studied in this paper, we propose the data presented in the Table 4. These data have been simulated from Python 3.3. This is a sample with size 30 representing a point-change. The first 13 data are simulated according to the Weibull distribution W(6; 3) and the remains are simulated according to the Weibull distribution W(10; 9).

Table 4. Illustrative data

i	1	2	3	4	5	6	7	8	9	10
X_i	5.66	4.78	5.49	6.30	4.69	7.29	4.02	5.01	5.59	3.79
i	11	12	13	14	15	16	17	18	19	20
X_i	5.48	5.48	6.37	8.94	8.81	11.09	8.17	9.86	10.31	9.72
i	21	22	23	24	25	26	27	28	29	30
X_i	10.12	9.66	9.89	10.40	10.01	8.47	7.14	10.30	11.20	10.44

The steps of the study method are illustrated in the Table 5.

Table 5. The steps of the calculations for the data in the Table 4

k_0	$sample_1(k_0)$ ordered	Y	$sample_2(k_0)$ ordered	Y	D
4	4.78, 5.49, 5.66, 6.3	-1.75, -0.72, -0.05, 0.61	3.79, 4.02, 4.69, 5.01, 5.48, 5.48, 5.59, 6.37, 7.14, 7.29, 8.17, 8.47, 8.81, 8.94, 9.66, 9.72, 9.86, 9.89, 10.01, 10.12, 10.3, 10.31, 10.4, 10.44, 11.09, 11.2	-3.62, -2.71, -2.23, -1.89, -1.63, -1.41, -1.23, -1.06, -0.92, -0.78, -0.65, -0.54, -0.42, -0.31, -0.21, -0.1, 0.0, 0.1, 0.21, 0.32, 0.43, 0.55, 0.68, 0.82, 1.01, 1.29	2.1898
5	4.69, 4.78, 5.49, 5.66, 6.3	-1.97, -0.97, -0.37, 0.14, 0.71	3.79, 4.02, 5.01, 5.48, 5.48, 5.59, 6.37, 7.14, 7.29, 8.17, 8.47, 8.81, 8.94, 9.66, 9.72, 9.86, 9.89, 10.01, 10.12, 10.3, 10.31, 10.4, 10.44, 11.09, 11.2	-3.58, -2.67, -2.19, -1.85, -1.59, -1.37, -1.18, -1.02, -0.87, -0.73, -0.6, -0.48, -0.37, -0.25, -0.15, -0.04, 0.07, 0.18, 0.29, 0.4, 0.52, 0.66, 0.81, 0.99, 1.28	2.3498
⋮					
13	3.79, 4.02, 4.69, 4.78, 5.01, 5.48, 5.48, 5.49, 5.59, 5.66, 6.3, 6.37, 7.29	-2.93, -2.0, -1.49, -1.13, -0.84, -0.59, -0.37, -0.16, 0.05, 0.25, 0.47, 0.72,	7.14, 8.17, 8.47, 8.81, 8.94, 9.66, 9.72, 9.86, 9.89, 10.01, 10.12, 10.3, 10.31, 10.4,	-3.19, -2.27, -1.78, -1.43, -1.16, -0.92, -0.72, -0.54, -0.37, -0.2, -0.05, 0.11,	1.3247

		1.08	10.44, 11.09, 11.2	0.27, 0.44, 0.62, 0.84, 1.17	
		⋮			
25	3.79, 4.02, 4.69, 4.78, 5.01, 5.48, 5.48, 5.49, 5.59, 5.66, 6.3, 6.37, 7.29, 8.17, 8.81, 8.94, 9.66, 9.72, 9.86, 9.89, 10.01, 10.12, 10.31, 10.4, 11.09	-3.58, -2.67, -2.19, -1.85, -1.59, -1.37, -1.18, -1.02, -0.87, -0.73, -0.6, -0.48, -0.37, -0.25, -0.15, -0.04, 0.07, 0.18, 0.29, 0.4, 0.52, 0.66, 0.81, 0.99, 1.28	7.14, 8.47, 10.3, 10.44, 11.2	-1.97, -0.97, -0.37, 0.14, 0.71	3.0564
26	3.79, 4.02, 4.69, 4.78, 5.01, 5.48, 5.48, 5.49, 5.59, 5.66, 6.3, 6.37, 7.29, 8.17, 8.47, 8.81, 8.94, 9.66, 9.72, 9.86, 9.89, 10.01, 10.12, 10.31, 10.4, 11.09	-3.62, -2.71, -2.23, -1.89, -1.63, -1.41, -1.23, -1.06, -0.92, -0.78, -0.65, -0.54, -0.42, -0.31, -0.21, -0.1, 0.0, 0.1, 0.21, 0.32, 0.43, 0.55, 0.68, 0.82, 1.01, 1.29	7.14, 10.3, 10.44, 11.2	-1.75, -0.72, -0.05, 0.61	3.1428

The following figure represents the sum of squared errors defined in equation (3).

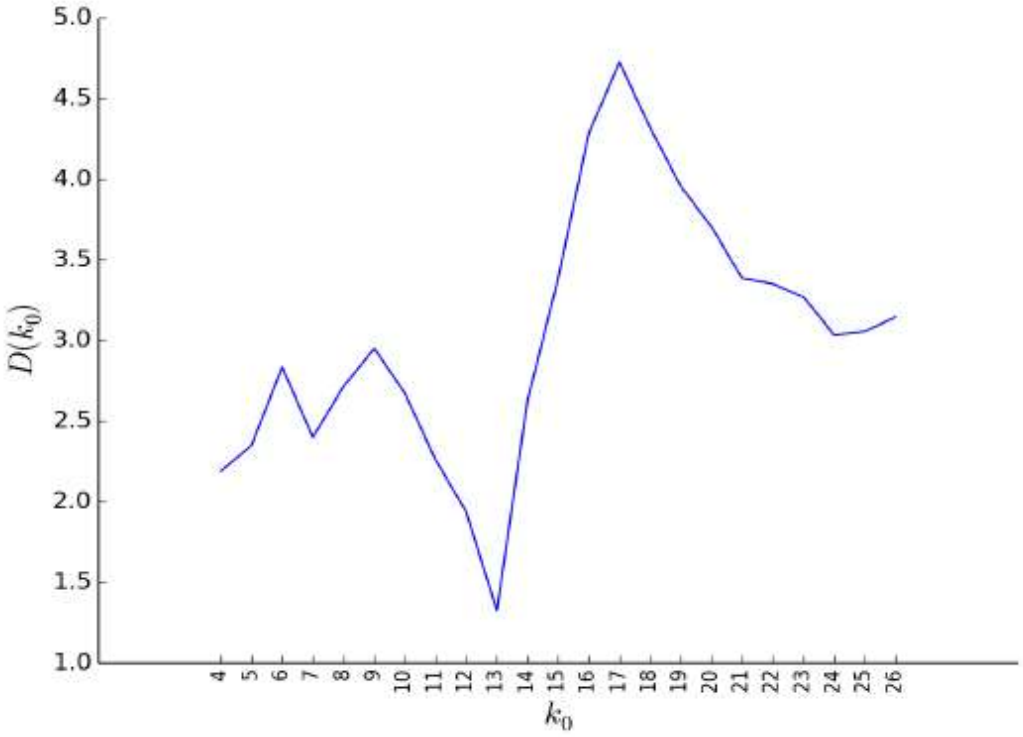

Figure 2. Sum of squared errors defined in equation (3)

The following figure shows the weibull probability plot.

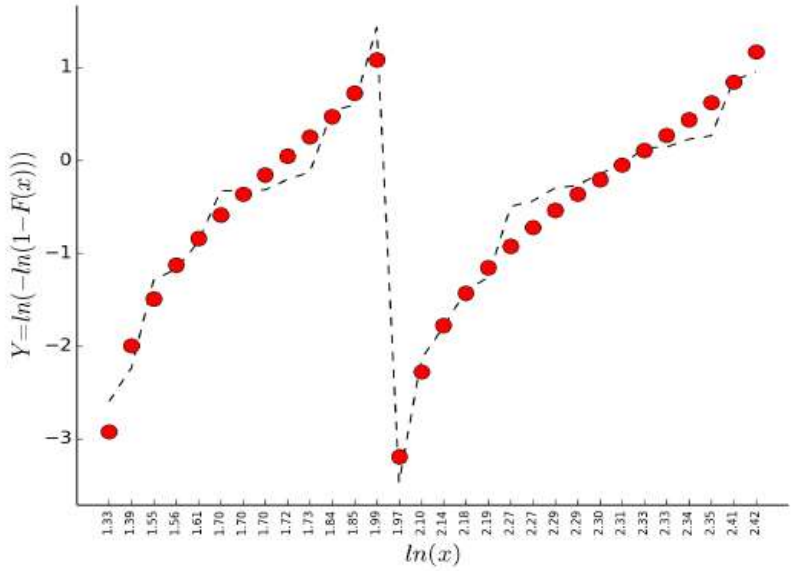

Figure 3. The Weibull probability plot for the illustrative data. The estimators are the values: $\hat{a}_1 = 5.78, \hat{b}_1 = 6.15, \hat{a}_2 = 10.16, \hat{b}_2 = 9.83$ *and* $\hat{k} = 13$.

5.2. Simulations

In order to study the performance of the method, we simulated 1000-samples of sizes: n = 30 and 100 with a change-points k = 13 and 41. We considered three cases: the first relates to the change in the second parameter of the Weibull distribution, the second case, the change in the first parameter and the third case, the change in both parameters.

For each sample we calculated the parameter estimators, the following table summarizes the results obtained for different values of a_1; a_2; b_1 and b_2.

Table 6. Statistics of estimators of a_1 , a_2, b_1 , b_2 for size n=30 and change-point k=13.

$a_1 = a_2 = 6$, $b_1 = 2$, $b_2 = 5$							
Mean of $\hat{a}_1$	6.1633	Mean of $\hat{a}_2$	6.0181	Mean of $\hat{b}_1$	2.0747	Mean of $\hat{b}_2$	4.8576
Std of $\hat{a}_1$	1.0793	Std of $\hat{a}_2$	0.4221	Std of $\hat{b}_1$	0.7989	Std of $\hat{b}_2$	2.2538
$a_1 = 6$, $a_2 = 10$, $b_1 = b_2 = 4$							
Mean of $\hat{a}_1$	6.5194	Mean of $\hat{a}_2$	9.3962	Mean of $\hat{b}_1$	4.1095	Mean of $\hat{b}_2$	3.4012
Std of $\hat{a}_1$	0.9955	Std of $\hat{a}_2$	0.8481	Std of $\hat{b}_1$	2.1639	Std of $\hat{b}_2$	1.2270
$a_1 = 6$, $a_2 = 10$, $b_1 = 3$, $b_2 = 9$							
Mean of $\hat{a}_1$	7.0964	Mean of $\hat{a}_2$	9.9036	Mean of $\hat{b}_1$	2.7622	Mean of $\hat{b}_2$	9.0453
Std of $\hat{a}_1$	1.0870	Std of $\hat{a}_2$	0.4775	Std of $\hat{b}_1$	1.2196	Std of $\hat{b}_2$	4.8527

Table 7. Statistics of estimators of a_1 , a_2, b_1 , b_2 for size n=100 and change-point k=41

$a_1 = a_2 = 6$, $b_1 = 2$, $b_2 = 5$							
Mean of $\hat{a}_1$	6.116	Mean of $\hat{a}_2$	6.0298	Mean of $\hat{b}_1$	1.9759	Mean of $\hat{b}_2$	4.8201
Std of	0.6597	Std of $\hat{a}_2$	0.2304	Std of $\hat{b}_1$	0.5492	Std of $\hat{b}_2$	1.4703
$a_1 = 6$, $a_2 = 10$, $b_1 = b_2 = 4$							
Mean of $\hat{a}_1$	6.2783	Mean of $\hat{a}_2$	9.9860	Mean of $\hat{b}_1$	4.2397	Mean of $\hat{b}_2$	3.4163
Std of $\hat{a}_1$	0.8557	Std of $\hat{a}_2$	0.7253	Std of $\hat{b}_1$	1.5346	Std of $\hat{b}_2$	0.9326
$a_1 = 6$, $a_2 = 10$, $b_1 = 3$, $b_2 = 9$							
Mean of $\hat{a}_1$	6.8058	Mean of $\hat{a}_2$	9.9860	Mean of $\hat{b}_1$	2.7517	Mean of $\hat{b}_2$	8.7966
Std of $\hat{a}_1$	0.8215	Std of $\hat{a}_2$	0.2530	std of $\hat{b}_1$	0.4662	Std of $\hat{b}_2$	1.7604

5.3. Application

We apply the method to study data used by Bhattacharya & Bhattacharjee [3] which represents the Average MonthlyWind Speed (m/s) at kolkata (from 1st March, 2009 to 31st March, 2009).

The following figure represents the sum of squared errors for the Average Monthly Wind Speed (m/s) at kolkata data.

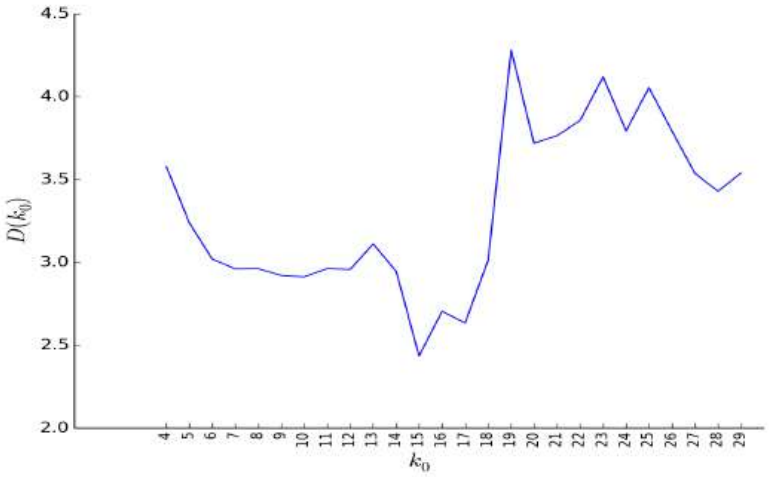

Figure 4. Sum of squared errors defined in equation (3)

The following figure shows the weibull probability plot for the Average Monthly Wind Speed (m/s) at kolkata data.

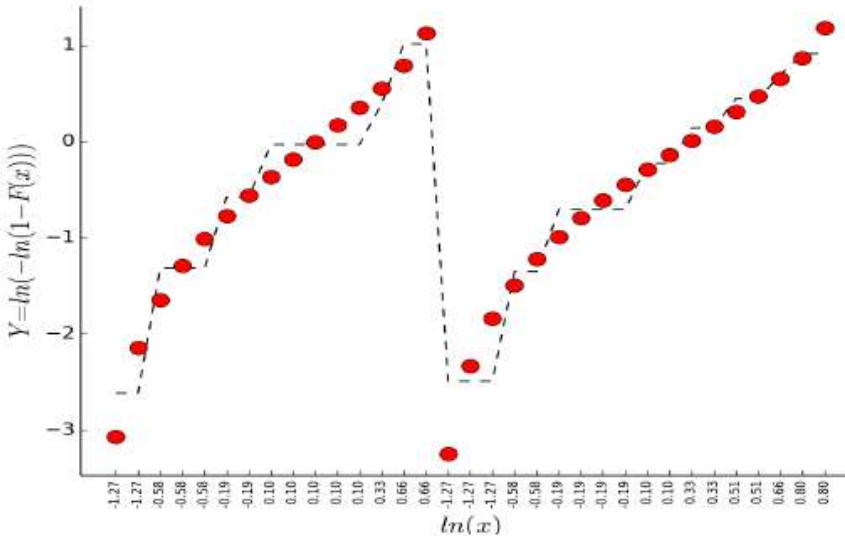

Figure 5. The Weibull probability plot. The estimators are the values: $\hat{a}_1 = 1.13, \hat{b}_1 = 1.88, \hat{a}_2 = 1.27, \hat{b}_2 = 1.65$ *and* $\hat{k} = 15$.

6. Conclusion

In this paper, we presented an analytical method of estimating change-point parameters. The results obtained for the Weibull distribution are satisfying. The proposed method is very simple to program that could be easily adapted to other distributions.

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STATISTICAL TECHNIQUES FOR DETECTING ANTICOMPETITIVE BEHAVIORS OF THE ENTERPRISES[1]

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Abstract

Anticompetitive agreements are usually made by enterprises that interact frequently during their day by day activities. Although some agreements are necessary for the good development of their businesses, some economic operators are concluding secret agreements that are harmful for competition as well as for the final consumers. Detecting such behaviors is in the responsibility of the worldwide competition authorities. They are using either direct proof, got through down raids, or through indirect evidences, obtained by using analytical methods for detecting anticompetitive behaviors. This research paper reveals a series of quantitative methods for detecting cartels and some case studies where these methods have been applied.

Keywords: *anticompetitive behavior, quantitative techniques, enterprises, market shares*

1. Introduction

Cartels between enterprises can be achieved in several ways, among the most well-known ones being: price fixing, bid rigging, output limitation and market sharing. For to find out different techniques and methodologies of cooperative games can use [5,6]

Among the factors that favor cartels' formation, we mention: the elasticity of the demand, the degree of buyers or sales concentration, highly bankruptcy risk markets, market entry barriers, the existence of exchanging information of the undertakings, declining or stable demand, markets with a history of cartelization multiple interactions between the firms and declining or stable demand on a specific market.

2. Literature review in detection of cartels

Even though there are many studies in the area of cartel detection, there is not a certain method for determining cartels. So far, there are four principal methods on detecting anticompetitive behavior.

(i) First approach would be to see if the undertaking's behavior is consistent with the competitive market (method A);

(ii)Second method would be to make an analysis whether there are structural failures in the behavior of the undertaking (method B);

(iii) Third method is to verify the differences in behavior among the undertakings which we assume they are part of a cartel and the other undertaking which are activating on a competitive market (method C);

(iv) Fourth method consists in analyzing if a collusive model is fitting much better to the involved data than to a competitive market model (method D).

As a general rule, the first two methods (in their simplified form) don't provide straight evidence that the firms participated in a cartel. Methods A and B are based on observing the undertaking's behavior and try to explain it by using a competitive model. However, if that does not lead to a conclusion through such model, it does not mean that we should conclude that the company's behavior is a competitive one, and hence the company did not participate in a cartel.

Regarding the first method, Abrantes-Metz et. al [1] stated that the principal problem is to make sure that the formulated competitive model is correctly applied. If the model's specification is not correct, that might be due to the not realistic assumptions which were formulated in terms of demand and costs function, or maybe because some variables were missed.

Further we will describe several ways by which economists implemented some analytical methods to identify the existence of anticompetitive concerns. We will give some examples such as: price fixing, bid rigging, coordination ways for selling prices and for sharing a market.

Bajari and Hortacsu [3] are comparing the competitive and collusive structural methods in order to compare which ones are able to explain in a better way the given data sets. The authors study is referring to the *first-price auction sealed*, where the products are homogeneous and the costs of the bidders are independent. The bidder *i*'s cost function is belonging to a population with a cumulative distribution function $F\left(c_i|z_i,\theta\right): t\left[\underline{c},\bar{c}\right]\to\left[0,1\right]$, in which ϑ is a vector parameter, same for all bidders, and z_i is a vector of observable independent variables, which are unique to each firm (although they are correlated). However, the independence of the variables is essential.

The competition model is attained at the equilibrium point of the game: the profit expected by the bidder *i* from an auction is $\left(b_i-c_i\right)\prod_{j\neq i}\left[1-F_j\left(B_j^{-1}\left(b_i\right)\right)\right]$ and this is when the bidder is winning the auction. $B_i(\cdot)$ is the strategy of the undertaking *i*. Consequently, the profit expected by undertaking is equal to the difference between the auction's winning and the undertaking's cost, multiplied by the probability of winning the auction by the undertaking.

The implementation of a model as described, assumes the estimation of a value capacity for every firm and after that, the testing of the autonomy and compatibility comparing to organizations' cost capacities. The reason for applying a test for independence comprises in confirming whether the unexplained part fitting in with firms' offers is autonomous or not. The part of the compatibility test is to examine whether the assessed coefficients of cost capacities are the same on account of all organizations or for a specific piece of organizations taking an interest at the sale.

Bajari and Hortacsu utilized this model to analyze the general population auctions whose subjects were streets remodels in Minnesota, North Dakota and South Dakota during the period 1994 - 1998. The dataset have included 138 auctions at which 11 organizations

were involved. These auctions were won on the rule of lowest price. The mathematical statement of the offer which ought to have been assessed was:

$$\frac{BID_{i,t}}{EST_t} = \beta_0 + \beta_{i1} LDIST_{i,t} + \beta_{i2} CAP_{i,t} + \beta_{i3} MAXP_{i,t} + \beta_{i4} LMDIST_{i,t} + \beta_{i5} CON_{i,t} + \varepsilon_{i,t}$$

The dependent variable is defined as the ratio between the *i*'s undertaking offer for the project t and the estimated cost of the firm for that project. The LDIST variable is measuring the distance of the undertaking *i* from the project t, CAP is representing the capacity of the undertaking involved in the project, CON is the percentage from the achieved turnover in the state in which the firm is deploying its project. That means, the CON variable is quantifying the degree to which the firm *i* is familiar with local regulators and suppliers of raw materials. The authors draw the attention on the fact that if two undertakings are using the same subcontractor to compute their costs, then they cannot consider that their offers were independent to each other, even though there is no signed agreement between those them.

The other two methods, C and D, allow the economists to make comparison between the collusion and competition in different ways. Method C is making a benchmark with a competitive market or with a number of undertakings in the market which are not part of a cartel (for example, undertakings which are activating on different geographical market). Hence, we will underline the importance of including in data a pre-cartel period, to avoid the inapplicability of this method. Another issue coming from this method is that it refers to the endogeneity of this benchmark. In the case when the benchmark is not coming from two firms who did not take part of the agreement, there is a possibility that these companies different characteristics with respect to the other ones who were participated in the cartel [8].

In the case when the benchmark is situated in a different geographical market on which an agreement was not existent, it is possible that the two markets are not comparable [4]. As an example, if two undertakings do not have motivation and capacity to collude on one of the market, but not on the second.

Lorenz [7] made a comparison of the performance of competitive and anticompetitive models within the auctions that took place in India on wheat market. Before this study, it was stated it took place collusion among the three major buyers who shared 45% of the whole market.

For the competitive market, the authors have chosen the IPV (independent and private values) model with asymmetric distributions: the data coming from three firms, which were suspected of collusion, were part of distributions which were different from the ones belonging to the players of other markets (they all have the same distributions). The anticompetitive model was chosen as the model of rotating the offers.

In the empirical analysis of this study there were involved 421 auctions which took place in 1999. Data had both qualitative and quantitative variables. Athey and Haile [2] came up with a structural model to identify the latent distributions.

3. Practice examples of analytical methods used for detecting cartels

3.1. Detection of bid rigging based on improbable events

An application of the previously described example is the investigation of offers which are identical.

We will take the case when eight companies were participants of a bid. Their offers are independent to each other and the winning bid is the lowest price. The offers were

placed by the eight competitors in different envelopes and are independent to each other. When the envelopes were opened, it came out that all eight bidders offered the same amount: 342,725. The probability for each undertaking to bid on the same amount, considering all the possibilities: $\left(\frac{1}{9}\right)\times\left(\frac{1}{10}\right)^{5}=1{,}11\times10^{-6}$

Now, if we assume that all of the bids were independent to each other, in other words they do not have information about the competitor's offers, the probability that all the seven participants would have chosen the same value becomes $\left[\left(\frac{1}{9}\right)\times\left(\frac{1}{10}\right)^{7}\right]^{8}=\left(1{,}11\times10^{-7}\right)^{8}=1{,}88\times10^{-56}$.

The probability that the eight bidders, behaving independently to each other and making an agreement on their six digit numbers is almost zero and it sends a strong sign that the undertakings which were involved, have had implicitly and explicitly reached a coordination mechanism in the case of their bids.

3.2. Analytical methods based on prices and cost information

We will consider an oligopoly market case with four undertakings. We have computed the weekly average of prices. We will place in the same graph the costs of the raw materials. Thus, the following graph has been obtained.

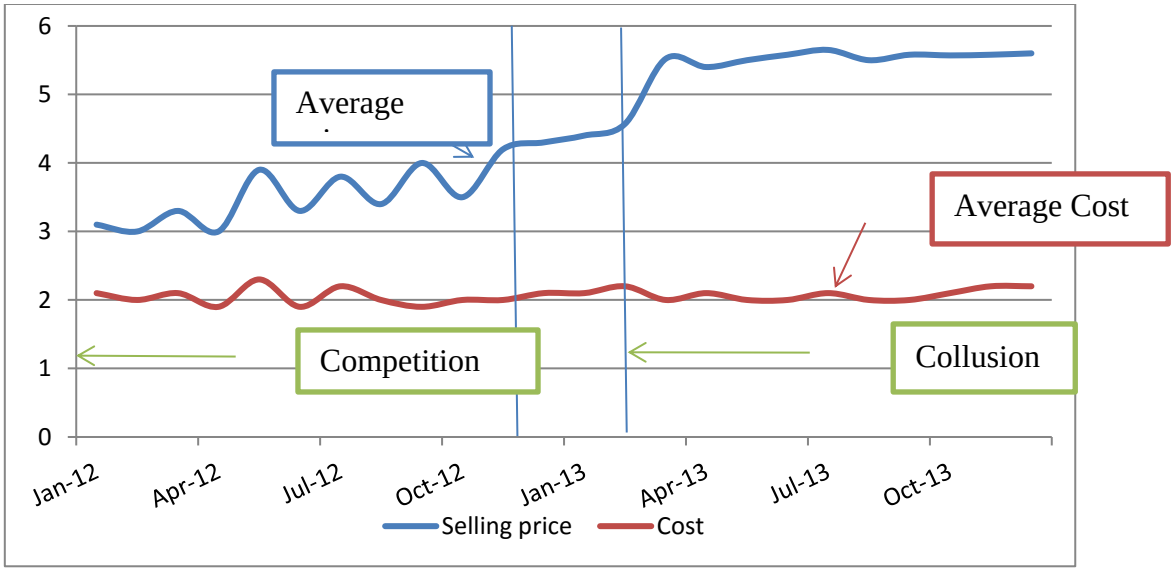

Figure 1. The prices and costs evolution corresponding to the analyzed undertakings, during 2012-2013

Source: own processing of the data

The figure from above is showing us the ending moment of the anticompetitive agreements between the four undertakings. Then we compare the costs and prices of the two distinct periods: the anticompetitive period (on the right side of the picture) and the left period which corresponds to the competitive period. We also assume that between the two lines there is a period of transition.

We observe that the average price of the sold product dropped dramatically and then remained much lower compared it to the anticompetitive period. During the anticompetitive behavior, the prices started to move accordingly with the costs and it had greater variations. The table from below is giving us a better picture of the mean prices and costs' variation as they show in the period analyzed.

Table 1. Distribution of market shares during 2010-2013

Statistics	Competition	Collusion	Differences
Price			
Average	3.35	5.44	62.65%
Standard deviation	0.36	0.07	-76.56%
CV= Std. Dev./ average	0.12	0.03	-85.15%
Cost			
Average	2.04	2.16	1.47%
Standard deviation	0.13	0.11	-38.12%
CV= Std. Dev. / average	0.06	0.039	-38.89%

Source: own processing of the data

The table above is showing us the facts that, while mean prices increased by 62.65%, the standard deviation dropped by 76.56%. During the same time period, the coefficient of variation dropped by 85.16%.

3.3. Detecting the agreements on sales prices coordination

We will make an analysis which is based on a research of large and small price variations of 36 undertakings in a given metropolitan area. The undertakings are selling a homogenous product.

Our analysis is based on graphical method in which the horizontal axis represents the average prices, while the vertical axis highlights the standard deviation of the homogenous product. Our goal consists in observing a group of undertakings for which the sale price has a high mean and small standard deviation compared to the other undertakings. This makes us think that the investigated undertakings agreed to have maintained a high mean price of its products, while the variation was small during the same period of time. That makes us think that the undertakings collude to keep a high mean price for its products, while the variations of the prices were low.

In other words, the investigation was performed on the data on the 36 subjects. For all of them, one by one, we have computed the mean price, the dispersion of prices and the coefficient of variation of the data.

The following graph is showing us the oscillation of the standard deviation in the case of the mean prices of the homogenous product.

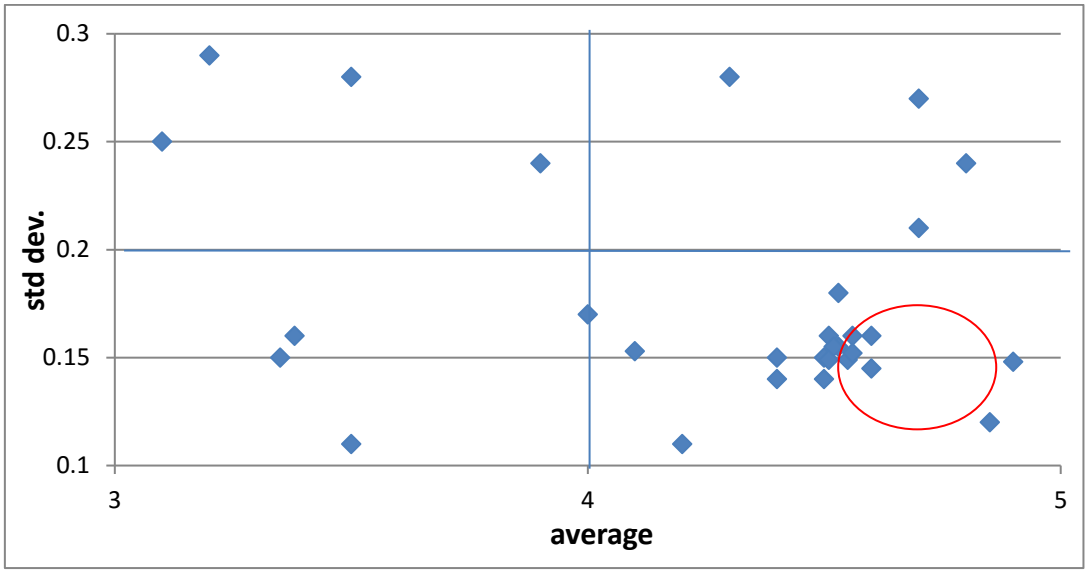

Figure 2. Variation of standard deviation in the case of homogenous product (36 undertakings)

Source: own processing of the data

As we could see, the undertakings which have high mean prices also have a high value of the standard deviation. We will start with looking at the outliers, but such outliers do not exist.

If there was collusion between the analyzed undertakings on the homogenous product, they would have been placed on the bottom right of the chart. As we stated before, that would correspond with high prices and low variations compared to others. The statistical analysis on prices would indicate the possibility of market coordination regarding the prices. It is about the price coordination between the undertakings where the prices were grouped.

3.4. An analysis of the evolution of the market shares

Another method used for analyzing the collusions, is given by the evolution of the market shares of the undertakings. We will start with considering a case in which, on some given market, there are four undertakings with market shares given in the following table.

Table 2. Market shares distribution during 2012 – 2015

	Market share %			
	2012	**2013**	**2014**	**2015**
Enterprise A	33	32	33	33
Enterprise B	23	24	23	23
Enterprise C	19	19	18	18
Enterprise D	16	16	17	17
Others	9	9	9	9

Source: own processing of the data

The evolution of the market share could be shown into the graph below:

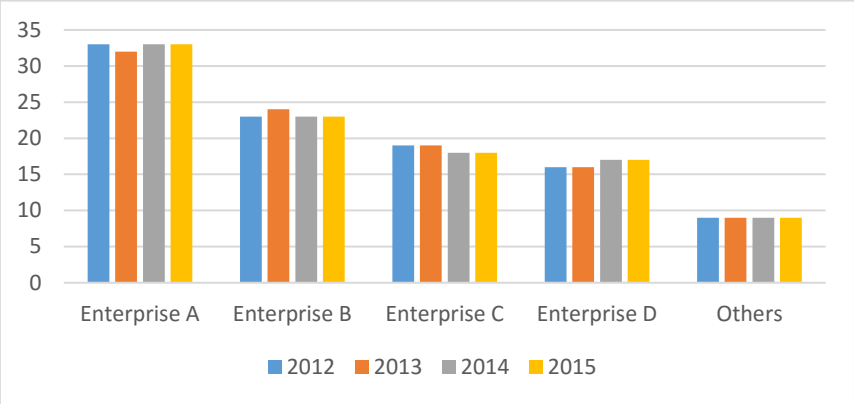

Figure 3. Market share evolution of the analyzed undertaking during 2012-2015
Source: own processing of the data

From the graph above, we could conclude that:

(i) The market shares of the undertakings appear to be stable over the analyzed period of time, and

(ii) The market shares of all undertakings on the given market are negatively correlated.

This statistical method could make us conclude that, there is a potential agreement between the undertakings in terms of sharing the market.

4. Conclusions

The statistical methods for detecting cartels are used more and more often by the competition authorities all over the world in their work of investigating anticompetitive agreements and also by the undertakings which could apply for compensation whenever they are harmed by the existence of a cartel on the market they are operating. The use of statistical models based on time series data could be a useful method to observe the anticompetitive behavior on any market. By using these methods the competition authorities cannot prove directly the anticompetitive behavior of the investigated undertakings, but they could highlight the improbable results which require careful attention. These methods are primarily used to avoid the false negative and false positive results. A false negative result states that there is not an anticompetitive behavior on the market, while actually is, and a false positive result are those in which is stated that there exists a cartel on the market although it does not exist, actually. Moreover, the use of all these statistical methods must have an empirical support, not being too costly to be implemented, and be easily to be implemented.

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INTEGRATED SUPPLIER SELECTION MODEL USING ANP, TAGUCHI LOSS FUNCTION AND PROMETHEE METHODS

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Abstract

*Supplier evaluation and selection process is one of the most important decision problem for companies. **S**upplier selection is a Multi-criteria decision making (MCDM) process, since the problem involves both tangible, intangible and also conflicting criteria. In this study a group of main criteria; "quality", "delivery", "price", "environmental health", "financial status", "managerial capabilities" and "working conditions" are searched for their interrelations and importance degrees. Analytic network process (ANP) is used for calculations of the weights of the criteria and these weights have been transferred to quality loss via Taguchi loss functions. A case study in automotive industry is presented and finally a comparison with PROMETHEE method is discussed. This study presents a delicate and precise solution to a complex selection problem by comparing traditional and non-traditional methods.*

Keywords: *ANP, MCDM, Supplier selection, Taguchi loss function, PROMETHEE*

1. Introduction

In recent years, evaluating and selecting the best supplier has become a strategic decision for companies. With the increased level of outsourcing, much attention needs to be paid to the supplier selection and evaluation (Sharma and Balan 2012). Giving more importance in supplier selection process allows the purchasers to have long term relationship with their suppliers and hence have a competitive advantage in industrial market. The overall objective of the supplier evaluation process is to reduce risk and maximize overall value to the purchaser (Zeydan et al. 2011).

Supplier selection problem may involve both tangible and intangible criteria which are conflicting or affecting each other. Therefore supplier selection can be considered as a multi-criteria decision making (MCDM) problem that the selection process mainly involves evaluating a number of suppliers according to a set of common criteria for selecting suppliers to meet business needs (Liao and Kao 2010).

This paper is aimed to select the best supplier by means of multi-criteria decision making techniques. The proposed model tries to select the best supplier by integrating analytic network process with Taguchi loss function and PROMETHEE methods. In the last section of this study, for application, two integrated methods are developed for supplier selection in a tire manufacturing company based on "quality", "delivery", "price", "environmental health", "financial status", "managerial capabilities" and "working conditions" criteria. While modeling these criteria, weights have been calculated by using ANP. These weights are combined with scores of four suppliers by using Taguchi loss function and PROMETHEE methods for selecting the best supplier.

2. Literature review

In literature a large number of alternative methods have been used for evaluating and selecting the suppliers since the initial study of Dickson in 1966 (Dickson 1966). Most of these models make decision making on supplier selection based on a set of supplier performance criteria (Pi and Low 2006). Selected models differ from each other by having one or multi- objective or having different criteria.

The early models of supplier selection process, the problem has been considered as a single objective problem. Single objective weighted linear model was used by Timmerman (1986). Cost based approaches such as total cost of ownership method were some of the one objective methods in literature used by Ellram (1995), Degraeve et al. (2000) and Bhutta and Huq (2002).

In order to solve conflicting selection problems, mathematical models were developed in 1980's. Talluri and Narasimhan (2003), Ng (2008), Guneri et al. (2009) proposed a solution to this problem by means of linear programming. Integer linear programming (Chaundry et al. 1993), (Rosenthal et al. 1995); integer non-linear programming (Ghodsypour and O'Brien 2001); multi-objective programming (Weber and Ellram 1993), (Gao and Tang 2003), (Kannan 2013); goal programming (Karpak et al. 2011), (Chang et al. 2013); data envelopment analysis (Kuo and Lin 2012), (Partovi 2013) are some mathematical programming models which are used for supplier selection.

In recent years MCDM techniques are widely used for supplier selection. Since the evaluation always involves several and generally conflicting performance criteria, MCDM techniques help decision makers to manage the problem. Chai at al.(2013) classified the basic MCDM techniques into four categories: (1) multi-attribute utility methods such as Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP); (2) outranking methods such as Elimination and Choice Expressing Reality (ELECTRE) and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE); (3) compromise methods such as Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Multi- Criteria Optimization and Compromise Solution (VIKOR); and (4) other MCDM techniques such as Simple Multi-Attribute Rating Technique (SMART) and Decision-Making Trial and Evaluation Laboratory (DEMATEL).

AHP and ANP have been used in different supplier selection problems. Kokangul and Susuz (2009), Rouyendegh and Erkan (2012), Labib (2011) used AHP method in their studies. Bayazıt (2006), Jharkharia and Shankar (2007), Gencer and Gurpinar (2007), Lin (2012), Pang and Bai (2013), Govindan et al. (2013) used ANP method to solve supplier selection problem. Shyur and Shih (2005) used ANP and TOPSIS integrated method for sup-

plier selection. Lin (2012) combined FANP (Fuzzy Analytic Network Process) with multi-objective linear programming method.

The study of Dulmin and Mininno (2003) investigated the contribution of PROMETHEE and GAIA (Geometrical Analysis for Interactive Aid) method for supplier selection problems. Radfar and Salahi (2014), proposed a hybrid model combining fuzzy DEA and PROMETHEE methods together in order to solve supplier selection problem in a manufacturing company. ELECTRE method was first proposed as an outranking concept by Royin 1974 (De Boer et al. 1998). Sevkli (2010) applied fuzzy ELECTRE method to supplier selection.

Zeydan et al. (2011) used a combined methodology including fuzzy AHP, fuzzy TOPSIS and DEA (Data Envelopment Analysis) for supplier selection and performance evaluation. Kasirian and Yusuff (2012) applied hybrid modified TOPSIS with a PGP (Preemptive Goal Programming) for the supplier selection with interdependent criteria. Li et al. (2012) combined FAHP (Fuzzy Analytic Hierarchy Process) with TOPSIS in supply chain management.

Sanayei et al. (2010) proposed their model for supplier selection in a firm that manufacturing automobile parts by using fuzzy VIKOR under fuzzy environment. Shemshadi at al. (2011) used a fuzzy VIKOR method based on entropy measure for objective weighting. Chang et al. (2011) made use of fuzzy DEMATEL method for developing supplier selection criteria. Chou and Chang (2008) used a strategy-aligned fuzzy SMART approach for building a decision support system for supplier selection problem.

Pi and Low (2006), evaluated supplier's attributes by using Taguchi loss function and transferred these losses into a variable for decision making by AHP method. Liao and Kao (2010) integrated Taguchi loss function, AHP and Multi-Choice Goal Programming (MCGP) model for solving a supplier selection problem with five criteria and five suppliers. Liao (2010) used Delphi technique to obtain the criteria, then transferred them into Taguchi loss function and combined with AHP based weights for selecting the best supplier in a food manufacturing factory. Ordoobadi (2010) used Taguchi loss function to measure the performance of each of three suppliers of a manufacturing company. AHP method was used to determine the relative importance of the criteria and the supplier with the minimum loss is selected. Sharma and Balan (2012) integrated Taguchi loss function with TOPSIS and multi-criteria goal programming to indentify the best performing supplier in a manufacturing company in automotive industry.

3. The proposed model

In this study, the methodology for selecting the best supplier has two steps: (1) the criteria for supplier selection process are determined. Relative weight of each criteria are determined by using ANP method, (2) suppliers are evaluated according to their performance, Taguchi loss function and PROMETHEE methods are used comparatively for selecting the best supplier.

3.1. Analytic network process

ANP is a special form of AHP and it can be used to solve more complex decision problems. As an extension of AHP, ANP takes into consideration the interdependence of attributes of criteria and defines the selection problem as a network. This network can include both tangible and intangible variables. The weights of each criterion are derived by

means of pair wise comparisons in ANP method. The fundamental comparison scale for ANP which is proposed by Saaty (2009) is shown in table (1).

Table 1. The scale for ANP

Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

The ANP methodology can be explained step by step approach as following:

1. In the first step, the problem is formulated. In this step, the aim, main criteria, sub criteria and alternatives (suppliers) should be identified clearly.
2. Interdependencies of criteria are formulated and paired comparisons between clusters and elements are performed.
3. The consistency of pair wise comparison matrices is determined. If the consistency ratio (CR) is equal or smaller than 0.1 value, the comparisons are consistent.
4. The next and final step is to contract the super matrix. The super matrix is a partial matrix including pair wise comparisons. Weighted limit super matrix gives us the weights (relative importance) of each criterion.

3.2. Taguchi loss function

Dr. Genichi Taguchi has developed a method called Taguchi method to increase process and product quality after The Word War II. Compared to conventional methods, Taguchi method which helps saving time and money has been used for a long time for quality control since that time period. In recent years this method is also used for evaluating the performance of suppliers.

Taguchi loss function can be expressed as a function of deviation from ideal or target value of a given design parameter (Roy 1990). Taguchi's loss function is classified into three types of functions: "the smaller the better", "the larger the better" and "a specific target value is the best" (Dehnad 1985).

The proper function depends on the magnitude of variation, such variation being allowed in both directions from the target value (Pi and Low 2006). In the context of the specific target value is the better quality characteristics, the target value will be at the center and the two sides give the upper and lower specification limits (Sharma and Balan 2012).

Nominal-is-best Taguchi loss function can be formulated as follows (Roy 1990):

$$L(y) = k(y - m)^2 \quad (1)$$

where

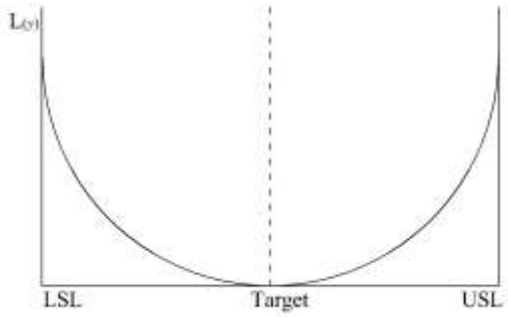
y: The quality characteristics, such as performance

m: The target value for the quality characteristic

k:A constant which is dependent upon the structure of a manufacturing process or organization

Here, the term (y –m) represents the deviation from the target value m. This target can be at the center within two sided (lower and upper) specification limits (Fig.1). LSL presents Lower Specification Limits and USL presents Upper Specification Limits.

Fig. 1. Nominal-is-better loss function



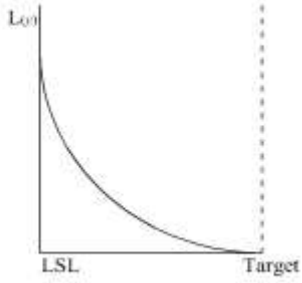
The other two loss functions include the one-sided minimum specification limit called smaller-is-better (Fig.2) and one-sided maximum specification limit called larger-is-better (Fig.3) which are formulated in equation (2) and equation (3) respectively.

$$L(y) = k.\,(y)^2 \quad (2)$$

$$L(y) = k / y^2 \quad (3)$$

Fig. 2. Smaller-is-better loss function

Fig. 3. Larger-is-better loss function



3.3. PROMETHEE Method

Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) is a multi-criteria decision making method developed by Brans et al. (1986). PROMETHEE is a simple outranking method to solve the decision problems with finite number of alternatives. The implementation of PROMETHEE method requires the weights of the criteria and the decision function to evaluate the alternatives in terms of each criterion. In this study the weights of the criteria are determined by using ANP method. And these weights are com-

bined with the preference function of PROMETHEE. The preference function (P_j) translates the difference between the evaluations obtained by two alternatives in terms of a particular criterion, into a preference degree (Macharis et al. 2004):

$$P_j(a,b) = G_j\left[f_j(a) - f_j(b)\right] \quad (4)$$

$$0 \leq P_j(a,b) \leq 1$$

where

P_j : Preference function

$f_j(.)$: Criterion

G_j: No decreasing function of observed deviation between $f_j(a)$and$f_j(b)$.

PROMETHEE introduces more functions to describe decision making preferences for each criterion with a clearer interpretation of the parameters (Dulmin and Mininno 2003). Brans and Vincke (1985) proposed six basic types of function: (1) usual criterion, (2) U-shape criterion, (3) V-shape criterion, (4) level criterion, (5) V-shape with indifference criterion and (6) Gaussian criterion. PROMETHEE I provides partial ranking where PROMETHEE II provides a full ranking of all actions.

4. A case application

This study establishes and demonstrates the application of the proposed methods for supplier selection in a tire manufacturing company that produces tire for cars, motorcycles, trucks and buses. The company is one of the leading tire companies in automotive industry in Turkey. The company outsources "Automation System" activities from four different suppliers. It has been aimed to evaluate suppliers and choose the one who better meets the needs and expectations of the company. Supplier selection process starts with the determination of the criteria by a team made up of experts from purchasing, finance, engineering, quality control and work safety departments."Quality", "On-time delivery", "Price" and "Service" are the most common criteria in a supplier selection problem. In this study, the expert team determined seven main criteria and thirty one sub criteria which are already used to evaluate the suppliers of the company (In table (2) main criteria and sub criteria are given).

Table 2. Main and sub criteria

Criteria	Explanation
Quality	Quality of service and/or product
Q1	Percentage of defective products (real value)
Q2	Continuous improvement
Q3	Quality control system
Q4	Quality certificate
Delivery	On time and appropriate delivery
D1	Compliance with the packaging requirements
D2	Accurate billing
D3	Flexibility to deadline changes
D4	Delay in delivery (real value)
D5	Delivery according to the order quantity
D6	On time order bid, confirmation and billing
Price	Price level
P1	Price level (real price)
P2	Effectiveness in reducing costs

P3	Payment term
Env. Health	Environmental health and work safety
E1	Having knowledge about environmental health and work safety
E2	Providing safety training to employees
E3	Taking account of the environmental impact of the production process
E4	Taking safety precautions
E5	Having clean and tidy working environment
Fin. Status	Financial status
F1	Financial transparency
F2	Having detailed financial statements
F3	Adequate financial structure
Man. Cap.	Managerial capabilities
M1	Providing services to other firms
M2	Having modern communication tools
M3	Having a good organizational structure
M4	Having now how about the company
M5	The availability of responsible staff
M6	Educated and experienced management team
Work. Con.	Working conditions
W1	Having a clear policy on discipline and discrimination
W2	Providing the employee the necessary training
W3	Compliance with legislation on social benefits and overtime
W4	Having handbook of management

Automation system activities involve mainly the software, montage and maintenance of machines which are used in computer aided manufacturing. The norm decision matrix shows us the performance scores of supplier's for each criterion (Table 7). The norm matrix is determined by purchasing experts and is based on "0-5" scale. The following analyses by ANP, Taguchi and PROMETHEE methods are based on the norm matrix.

4.1. Application of ANP Method

In order to apply ANP method, the purchasing department of the company developed a pair wise comparison matrix that shows the relative importance of each criterion by considering the company priorities (Table 3). The matrices indicating the contribution of sub criteria to the main criteria and interdependence of criteria are also prepared by purchasing department experts (Table 4 and 5).The pair wise comparisons in the model are based on "0-9" scale which is proposed by Saaty (2009).

Table 3. Main criteria pair wise comparison matrix

	Quality	Delivery	Price	Env. Health	Fin. Status	Man. Cap.	Work. Con.
Quality	1	2	2	3	5	7	7
Delivery		1	1	2	4	6	6
Price			1	2	4	6	6
Env. Health				1	3	5	5
Fin. Status					1	3	3
Man. Cap.						1	1
Work. Con.							1

Table 4. Contribution of sub criteria to the main criteria

Quality	Q_1	Q_2	Q_3	Q_4
Q_1	1	3	5	7
Q_2		1	3	5
Q_3			1	3
Q_4				1

Delivery	D_1	D_2	D_3	D_4	D_5	D_6
D_1	1	3	1/4	1/6	1/2	2
D_2		1	1/6	1/8	1/4	1/2
D_3			1	1/3	3	5
D_4				1	5	7
D_5					1	3
D_6						1
Price	P_1	P_2	P_3			
P_1	1	5	6			
P_2		1	2			
P_3			1			
Env. Health	E_1	E_2	E_3	E_4	E_5	
E_1	1	1	1/5	1/7	1/3	
E_2		1	1/5	1/7	1/3	
E_3			1	1/3	3	
E_4				1	5	
E_5					1	
Fin. Status	F_1	F_2	F_3			
F_1	1	1/2	1/6			
F_2		1	1/5			
F_3			1			
Man. Cap.	M_1	M_2	M_3	M_4	M_5	M_6
M_1	1	1/2	1/4	1/7	1/5	1/3
M_2		1	1/3	1/6	1/4	1/2
M_3			1	1/4	1/2	2
M_4				1	3	5
M_5					1	3
M_6						1
Work. Con.	W_1	W_2	W_3	W_4		
W_1	1	1/3	3	1/5		
W_2		1	5	1/3		
W_3			1	1/7		
W_4				1		

Table 5. Interdependencies

Quality	Price	Delivery	Fin. Status	Env. Health	Man. Cap.	Work. Con.
Price	1	1	3	1	2	4
Delivery		1	1	1	1	1
Fin. Status			1	1	1/2	2
Env. Health				1	1	1
Man. Cap.					1	3
Work. Con.						1
Delivery	Quality	Price	Fin. Status	Env. Health	Man. Cap.	Work. Con.
Quality	1	1	1	1	1	1
Price		1	3	1	2	4
Fin. Status			1	1	1/2	2
Env. Health				1	1	1
Man. Cap.					1	3
Work. Con.						1
Price	Quality	Delivery	Fin. Status	Env. Health	Man. Cap.	Work. Con.
Quality	1	2	1	3	4	5
Delivery		1	1	2	3	4
Fin. Status			1	1	1	1
Env. Health				1	2	3
Man. Cap.					1	1
Work. Con.						1

Pair wise comparison matrices and interdependency matrices are combined and analyzed for ANP solution with the help of "Super Decision 2.2.6" software. The solution

gives us the weight of each criterion. These weights indicate the importance degree of criteria with respect to each other and they are used for further analysis with Taguchi and PROMETHEE to select the best supplier.

Table 6. Weights of the main criteria

Criteria	Weights	Criteria	Weights
Quality	0,32373	E_3	0,18992
Q_1	0,33165	E_4	0,24208
Q_2	0,25316	E_5	0,20343
Q_3	0,21566	Fin. Status	0,06523
Q_4	0,19953	F_1	0,30776
Delivery	0,20690	F_2	0,31551
D_1	0,14901	F_3	0,37673
D_2	0,13993	Man. Cap.	0,03165
D_3	0,17991	M_1	0,15945
D_4	0,22958	M_2	0,15756
D_5	0,15841	M_3	0,16013
D_6	0,14317	M_4	0,18852
Price	0,20690	M_5	0,16735
P_1	0,40988	M_6	0,16699
P_2	0,20189	Work. Con.	0,03165
P_3	0,28823	W_1	0,24128
Env. Health	0,13395	W_2	0,25081
E_1	0,18229	W_3	0,23718
E_2	0,18229	W_4	0,27073

The judgments used in pair wise comparisons should be consistent. The ANP method measures the consistency of judgments by means of consistency ratio (CR). If the CR is larger than 0,1 the judgments must be revised (Saaty and Vargas 2000). The main criteria comparison matrix is consistent with CR= 0,02147 which is smaller than 0,1 value. All pair wise comparison matrices used in the model are checked that they have CR value smaller than 0,1.

Fig. (4) shows the comparison matrix and the weights of the main criteria. The suppliers are referred to as suppliers A, B, C and D. The network of ANP solution can be seen at fig.(5).

Fig. 4. Main criteria comparison matrix

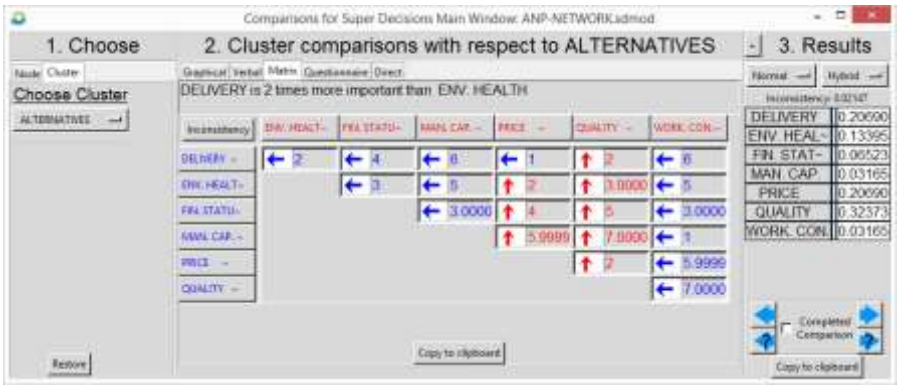
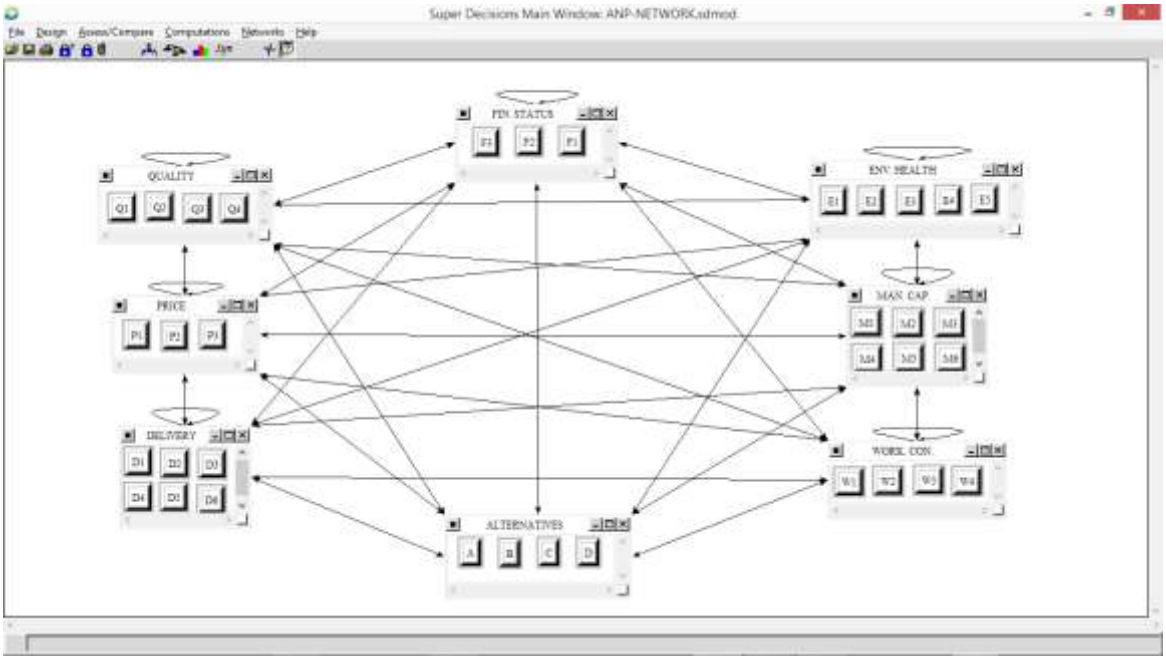


Fig. 5. The network of ANP model



The measurable criteria (delay in delivery, price level and defective product ratio) are "smaller-is-better", while the other criteria are "larger-is-better". In the standard norm matrix, the rates of these criteria are given according to meet the expectations of the buyer company. The highest rate "5" indicates zero delay, the best price and zero defects. The norm matrix having the rates of four suppliers for each criterion is shown in table (7). The suppliers are referred as A, B, C and D.

Table 7. The norm matrix

	Work. Con.					Quality			
	W_1	W_2	W_3	W_4		Q_1	Q_2	Q_3	Q_4
A	4	4,3	4	4		4	4	4	4
B	3	3,3	4	3		4	4	5	4
C	4	3,6	4	4		4	4	4	4
D	4	3,6	4	4		4	4	4	4
	Fin. Status				Env. Health				
	F_1	F_2	F_3		E_1	E_2	E_3	E_4	E_5
A	4	4	4		4	3	3	4	4
B	4	4	4		3	3	3	4	4
C	3	4	4		4	3	3	4	4
D	4	4	5		4	4	3	4	4
	Man. Cap.								
	M_1	M_2	M_3	M_4	M_5	M_6			
A	5	4	5	4	4	4,3			
B	5	4	3	4	4	3,3			
C	5	4	4	4	4	4			
D	5	4	3	5	4	4			
	Delivery							Price	
	D_1	D_2	D_3	D_4	D_5	D_6		P_1	P_2	P_3
A	4	4	3	5	4	3,6		4	4	3
B	5	5	5	5	5	5		4	3	4
C	5	5	5	4	4	4		4	4	3
D	5	5	5	5	5	5		3	4	4

4.2. Application of Taguchi loss function

Taguchi method enables us to analyze the tangible values with intangible ones. In this case, "percentage of defective products", "price level" and "delay on delivery" are tangible and measurable criteria while the others are intangible and immeasurable. The specification limits and target values determined by the buyer are listed in table (8). Up to this table, we can say that, 0% defect causes zero loss and 5% defect ratio cause 100% loss.

Table 8. Decision variables for selecting a supplier

	Target value	Specification limit	Range
Defective products	0%	5%	0% - 5%
Price	Minimum	Min + 30%	0% -30%
Delay in delivery	0 Day	15 Days	0 - 15 Days
Other criteria	100%	50%	0% - 50%

Table 9. Characteristic and relative values of suppliers

	Defective products		Price		Delay in delivery	
	Value	Relative value	Value	Relative value	Value	Relative value
A	2%	2%	100%	0%	0	0
B	2%	2%	100%	0%	0	0
C	2%	2%	100%	0%	5	5
D	2%	2%	110%	10%	0	0

Table 10. Conversion table for Taguchi loss function

Score	Percentage score
5	100%
4	80%
3	60%

The real values for measurable criteria and their relative values are listed in table (9). The weights received from ANP solution are combined with Taguchi losses for each criterion. The supplier having the smallest overall loss is named as the best supplier. Since the target value is minimum, "smaller-is-better" Taguchi loss function is used for calculations. The calculation of immeasurable criteria values are based on the unperformed ratio 50% (100% - 50%).

The coefficient "k" values for defect product ratio, price and delay in delivery are found as 40.000; 1,111 and 0,444 respectively by using equation (2). For price criteria $k = 100 / (0, 30)^2$. The k value for immeasurable criteria is 400. After defining k values, the loss for each criterion is calculated with the help of equation (1). For the supplier D, the loss in price criteria is : $L(y) = 1{,}111.(0{,}1- 0)^2 = 0{,}11$.The loss for other criteria is calculated after converting the norm matrix scores into percentage scores by using conversion table that is performed by purchasing team.

The overall Taguchi losses for each supplier are determined by adding the weighted losses of each criterion for that supplier (See table 11). Suppliers are then ranked from the one with the least overall loss. The supplier having minimum loss is the best supplier. Table (12) shows the rank of the suppliers. According to ANP and Taguchi Loss Function decision process, the best supplier is chosen as the supplier "D".

Table 11. Taguchi losses

	Work. Con.					Quality			
	W_1	W_2	W_3	W_4		Q_1	Q_2	Q_3	Q_4
A	16	8	16	16		16	16	16	16
B	64	46	16	64		16	16	0	16
C	16	31	16	16		16	16	16	16
D	16	31	16	16		16	16	16	16
Weigh t	0,00764	0,00794	0,00751	0,00857		0,10737	0,08196	0,06982	0,06459

	Fin. Status			Env. Health				
	F_1	F_2	F_3	E_1	E_2	E_3	E_4	E_5
A	16	16	16	16	64	64	16	16
B	16	16	16	64	64	64	16	16
C	64	16	16	16	64	64	16	16
D	16	16	0	16	16	64	16	16
Weigh t	0,02008	0,02058	0,02457	0,02442	0,02442	0,02544	0,03243	0,02725

	Man. Cap.					
	M_1	M_2	M_3	M_4	M_5	M_6
A	0	16	0	16	16	8
B	0	16	64	16	16	46
C	0	16	16	16	16	16
D	0	16	64	0	16	16
Weigh t	0,00505	0,00499	0,00507	0,00597	0,00530	0,00529

	Delivery						Price		
	D_1	D_2	D_3	D_4	D_5	D_6	P_1	P_2	P_3
A	16	16	64	0	16	31	0	16	64
B	0	0	0	0	0	0	0	64	16
C	0	0	0	22	16	16	0	16	64
D	0	0	0	0	0	0	11	16	16
Weigh t	0,03083	0,02895	0,03722	0,04750	0,03278	0,02962	0,08480	0,06246	0,05963

Table 12. Ranking for ANP and Taguchi solution

Rank	Supplier	Taguchi loss
1	D	13%
2	B	18%
3	C	20%
4	A	21%

4.3. Application of PROMETHEE method

In this section of the study, PROMETHEE method is used as an alternative way to Taguchi Loss Function for selecting the best supplier. The weights derived from the ANP solution from previous section and the norm matrix scores of suppliers in table (7) are directly used in PROMETHEE functions. The model is analyzed by "Visual PROMETHEE 1.4" software. Usual criterion function is used for analysis. In the flow table (Table 13), "Phi+" and "Phi-" columns are positive and negative flow values respectively. "Phi" column shows us the net flow values of that supplier and the ranking is based on these net flow values. According to PROMETHEE flow table, the best supplier is selected as supplier "D".

Table 13. PROMETHEE flow table

Rank	Supplier	Phi	Phi+	Phi-
1	D	0,1146	0,2304	0,1159
2	B	0,0976	0,2351	0,1375
3	C	-0,0849	0,1126	0,1975
4	A	-0,1272	0,1032	0,2304

5. Conclusion

In literature there are different methods and applications for supplier selection problem. When the problem contains a high number of criteria which are sometimes conflicting, the solution may be too complicated. This study aims to solve a complex supplier selection problem in an effective and easier manner.

AHP and ANP are most frequently used techniques in supplier selection with the usage rates of 24,39% and 12,20% respectively. The multi-attribute utility techniques including AHP and ANP dominate other techniques because of their effectiveness in rating and task choices (Chai et.al, 2013).

In this study ANP method is preferred for determining the weights, since it analyzed not only priorities of the criteria, but also the interrelations between them. The main decision criteria for the case application are "quality", "delivery", "price", "environmental health", "financial status", "managerial capabilities" and "working conditions". ANP analysis gives more accurate results for this complex problem with seven main criteria and thirty one subcriteria. After defining the weights, two different multi-criteria decision methods, Taguchi loss function and PROMETHEE approaches are used comparatively to find the best supplier and rank the suppliers.

The advantage of Taguchi method is that, it enables to include the measurable and tangible values into the model directly. This method can be important for outsourcing strategic products/services which need sensitive analysis. Because in this model, the specification limits for specific criteria can be used for defining the upper and lower limits. When the company doesn't accept a supplier's score lower than any limit, it can be directly adopted the beginning scale of analysis. Furthermore, in this method, the intervals in the scale are not to be necessarily linear. The method may be shaped for the needs and priorities of each company and product.

The complexity in calculations of Taguchi analysis, brings a need for an easier way to get the same specialized results. The easier and more recent technique is PROMETHEE method. In this study the alternative solution is done by PROMETHEE. The main advantage is that the preference functions make clear the criteria which serve the purpose. This provides to come forward the alternatives that meet the criteria best. PROMETHEE method gives the priorities and weaknesses of alternatives without promise. In the case, the results of PROMETHEE analysis confirm the Taguchi solution results.

As a result of this study, PROMETHEE method can be used in practice for complex and specific supplier selection problems, for the simplicity in its usage.

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FINDINGS REGARDING ROMANIAN ICT SMES' ORGANIZATIONAL PERFORMANCE IN KNOWLEDGE ECONOMY

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Abstract

The purpose of this paper is to examine the influence of knowledge management (KM) on the performance of small and medium ICT companies from Romania. To achieve this goal, I conducted a survey on a sample of 79 SMEs. By using relevant statistical techniques. I found out that hypothesis of the research are checked and results indicate that knowledge management has significant direct effects on the performance in SMEs. I must emphasize that this paper shows only in a compact manner results of research who suggests that the promotion of initiatives in the field of knowledge management definitely improve organizational performance.

Keywords: *Small to medium-sized enterprises, Knowledge management, SMEs performance*

Introduction

Firm performance was studied intensively in the last decades, but results were obtained particularly only in large companies. Moreover, performance it is also a complex and multidimensional business phenomenon. Performance can be characterized as "the firm's ability to create acceptable outcomes and actions" (Ceptureanu EG et al, 2014). For any organizations obtaining improved performance is not only dependent on the successful deployment of tangible or intangible assets but also on the effective management of knowledge (Ceptureanu SI, 2015a). SMEs have their own roles to play in the economy, as to large organizations. Therefore, not only do large organizations need to improve themselves through knowledge management (KM) in their pursuit for excellence, but so also should small and medium ones.

The concept of knowledge-based economy is widely used in a variety of contexts and with several meanings (Nonata et al, 1995; Ceptureanu SI, 2014). Initially, knowledge-based economy was addressed only to high-tech industries but now days, knowledge-based economy is viewed more broadly. Moreover, application of knowledge to generate new products or services, occupies a central place in the literature devoted to the knowledge economy. However, more recent work (Sissons, A, 2011) tends to address broader concept,

addressing not only innovation. Florida emphasizes the key role of "social class creative" in generating competitive advantage (Florida, R, 2002).

The concept of KM has witnessed considerable research during the last decades (Carrillo et al., 2003; Tsai and Shih, 2004; Lin and Tseg, 2005; Young, 2006). Nonaka and Takeuchi (1995), in their theory on knowledge-based organizations, further emphasized the importance of knowledge in the new economy. Their thesis is that knowledge represents one of the sources of sustainable competitive advantages and that knowledge is the basic foundation for economic performance. Knowledge is an important asset for small and medium-size firms in the time of global competition. Knowledge can be determined an important determinant of success of small and medium-size firms and undoubtedly one of the sources of sustainable competitive advantage. For these organizations, KM is an innovative management tool that enables them to benefit from the current interest in the subject in academia and business practice. Gloet and Terziovski (2004) describe KM as the formalization of and access to experience, knowledge, and expertise that create new capabilities, enable superior performance, encourage innovation, and enhance stakeholder's value.

Literature review

Knowledge is important to any modern organization in XXI century. Knowledge had witnessed considerable research in the past few years (Bruton et al., 2007). It is widely recognized that knowledge is an essential strategic resource for a firm to retain sustainable competitive advantage (Ceptureanu SI, 2015b). As knowledge is created and disseminated throughout the company, it has the potential to contribute to the company's value by enhancing its capability to respond to new and unusual situations. Knowledge is "an asset that needs to be effectively managed" (Davenport et al., 1998). Interest in knowledge management has grown dramatically in the recent years, as more researchers and practitioners have become aware of the "knowledge potential to drive innovation and improve performance" (Cavaleri, 2004). Knowledge management is an emerging concept in the field of management and widely adopted in organizations for enhancing performance. It is promoted as an essential cornerstone for companies to develop sustainable competitive advantage and to remain at the forefront of excellence in a level playing field market (Ceptureanu EG, 2015a). Liebowitz and Wilcox (1997) stated that KM can be defined as the explicit control and management of knowledge within an organization aimed at achieving the company's objectives.

Knowledge management is an approach of more actively leveraging "the knowledge and expertise to create value and enhance organizational effectiveness" (Gold et al., 2001; Scarbrough, 2003). It provides a new way for the organization to achieve explicit and tacit knowledge sharing (Ceptureanu SI et al, 2015b). Knowledge management impacts firm performance through its efficiency in developing the intellectual assets that are a source of competitive advantage (Ndlela and du Toit, 2001). For an organization to remain competitive, it must effectively "practice the activities of creating, acquiring, documenting, transferring, and applying knowledge in solving problems and exploiting opportunities" (Zack, 1999). Further, effective KM entails an "understanding of the interrelationships that may exist among KM processes such as knowledge acquisition, knowledge creation, knowledge documentation, knowledge transfer, and knowledge application" (Lee et al., 2005). Firms that exhibit a greater level of KM capacity experience a learning effect that can reduce redundancy, respond rapidly to change and develop creative ideas and innovation (Gold et al.,

2001; Scarbrough, 2003, Ceptureanu EG, 2015b). The quality of decision making depends on acquisition, sharing, and application of knowledge across individuals and organizational groupings. As described by Bergeron (2003), the KM approach or process consists of eight fundamental components, namely acquisition, modification, use, archiving, transfer, translation, access, and disposal. Scholars have addressed several KM processes or activities, including acquisition or creation, storage, sharing or transfer, and usage or application (Bouthillier and Shearer, 2002; Beckman, 1999; Wiig, 1999). In this research I study three KM processes: acquisition, sharing and application of knowledge.

Knowledge acquisition is one part of KM which, in turn, has been defined as "[...] the process of critically managing knowledge to meet existing needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities" (Quinstas et al., 1997). Knowledge acquisition is "the process by which knowledge is obtained" (Huber, 1991). Knowledge acquired can be tacit, explicit or a combination of both. Knowledge acquisition results from individual participation and interactions with tasks, technologies, resources, and people within a particular context (Tsoukas, 1996). Several scholars agree that part of managing knowledge within the organization is developing processes that acquire knowledge (Leonard, 1995; Nonaka and Takeuchi, 1995). Two primary means for collecting knowledge are as follows:

(1) to seek and acquire entirely new knowledge;

or

(2) to create new knowledge out of existing knowledge through collaboration between individuals and between business partners (Leonard, 1995; Nonaka and Takeuchi, 1995). Several researchers also emphasize that collaboration with other organizations is critical to knowledge acquisition (Grant, 1996; Matusik and Hill, 1998).

Firms who can acquire external and internal knowledge would reduce uncertainty and achieve a greater number of administrative and technological distinctiveness (Sarin and McDermott, 2003).

The goal of **knowledge sharing** can either be to create new knowledge by differently combining existing knowledge or to become better at exploiting existing knowledge. It comprises a set of shared understandings related to providing employees access to relevant information and building and using knowledge networks within organizations (Hogel et al., 2003, Ceptureanu SI et al., 2015a). Knowledge sharing refers to collective beliefs or behavioural routines related to the spread of learning among different individuals or units within an organization (Moorman and Miner, 1998). It is about how individuals, groups, and organizations communicate and learn from each other. Personal or organizational networks play an important role in accessing knowledge. The sharing of knowledge is facilitated by some kind of personal or virtual network. Without networks there is no opportunity for accessing knowledge. Networks can be maintained by formal or informal face-to-face meetings, or – the latest trend – by physical structures that do not allow individual cubicles, but emphasizes transparent community spaces. Knowledge sharing is critical to a firm's success (Davenport et al., 1998). Knowledge sharing creates opportunities to maximize organization ability to meet those needs and generates solutions and efficiencies that provide a business with a competitive advantage (Reid, 2003).

Another important aspect of the KM process in organizations is **knowledge application**. Wiig (1999) notes that the value of knowledge assets is realized when the assets are

used to create products or deliver services, or when they are sold or traded for value. Knowledge application is a focal element in KM process (Grant, 1996). Knowledge application is defined by some researchers as "the utilization and use of knowledge in an enterprise's value-adding process". It includes adapting, integrating, and applying knowledge to the organization's processes and products. By effectively applying knowledge, individuals might make fewer mistakes or improve their efficiency and reduce redundancy (Gold et al., 2001).

SMEs **performance** is an indicator which measures how well an enterprise achieves their objectives. Ho (2008) defined performance in terms of "how well an organization accomplishes its objectives". Schermerhorn et al. (2002) point out that "performance refers to the quality and quantity of individual or group work achievement". Delaney and Huselid (1996) suggest two ways to assess SME and market performance. Koh et al. (2007) rightly pointed out that although performance is measured by both financial and market criteria, the short-term objectives of supply chain management are to enhance productivity and reduce inventory and lead time. A number of prior studies have measured performance using both financial and market criteria, including return on investment (ROI), market share, profit margin on sales, growth of return of investment, growth of sales, growth of market share and overall competitive position (Vickery et al., 1999; Stock et al., 2000). Tippins and Sohi (2003) propose performance measures on four dimensions: relative profitability, return of investment, customer retention and total sales growth. Morales et al. (2011) identifies four dimensions of performance, including:

- Return on assets,
- Return on equity,
- Return on sales and market share
- Growth of sales.

Zack et al. (2009) propose performance measures on five dimensions: innovation, rate of new product development, customer satisfaction, customer retention, and operating costs. Based on the above literature, I focus on three dimensions of performance including turnover, TQM and stakeholders satisfaction.

Wolff and Pett (2006) argued that SMEs and entrepreneurial firms are a key segment and driver for most national economies. Successful SMEs have a similar competitive advantage factor that allows them to create a niche in the market by changing their product mix to satisfy customer needs (Gadenne, 1998). SMEs are defined in different ways in different parts of the world. Some define them in terms of assets, while others use employment, shareholder funds or sales as criteria. Some others use a combination of revenue and employment as a hybrid criterion. Current literature suggests that SMEs may be differentiated from larger companies by a number of key characteristics. These are generally described (Ghobadian et al., 1997; Berry, 1998) as: personalized management, with little devolution of authority; severe resource limitations in terms of management and manpower, as well as finance; reliance on a small number of customers, and operating in limited markets; flat, flexible structures; high innovatory potential; reactive, fire-fighting mentality; and informal, dynamic strategies.

Lane et al. (2001), suggest that large organizations may suffer from inertia and thus retard learning. This view is also highlighted by some studies, which propose that larger organizations may gain less knowledge internally than smaller organizations, because they are able to create knowledge by themselves (Minbaeva et al., 2003) or are likely to have

more opportunities to acquire knowledge from external sources (Almeida et al., 2003). According to Day et al. (2006), this is because SMEs have a propensity to seek out information more eagerly through interactions with knowledge possessors than large firms. One important dimension that has an effect on the practice of KM in SMEs is their special characteristics – management structure, markets, systems, culture, etc. – that differentiate them from large organizations. SME characteristics are likely to influence all activities in the life-cycle of knowledge – from the acquisition and capture of knowledge, its organization and storage, and its dissemination/transfer, to its ultimate application. The practice of KM in SMEs differs from that of a large organization because SMEs are not "a little big business" (Wong and Aspinwall, 2004). First, they are a source of innovation in products and services; they supplement a variety of products and services by operating in niche markets (Storey, 1994). Thus, SMEs are an important and indispensable part of a country's growth. Second, some of the widely cited potential benefits of KM apply aptly to SMEs. These are improvements in efficiency, decision making, competency, learning, innovation, and responsiveness, among others (Civi, 2000; Frey, 2001; Jarrar, 2002). The vast majority of studies in the literature of KM suggest that KM positively impacts firm performance (Hoopes et al., 1999; Lloyd, 1996; Lubit, 2001). In Jantunen's (2005) research, he states that knowledge is posited in an organization as a strategic asset which can help the firm maintain its competitive ability in a turbulent environment. Gorelick and Tantawy-Monsou (2005) view KM as a system or framework that integrates people, processes, and technology to achieve sustainable results by increasing performance through learning. The results indicate that KM practices are positively associated with OP as generally suggested by the KM literature, both qualitative (Nonaka, 1994) and quantitative (Choi et al., 2003; Darroch et al., 2002; Schulz et al., 2001; Simonin, 1997; Tanriverdi, 2005, Ceptureanu EG, 2015c). Given the importance of organizational knowledge, many companies have been trying to influence the acquisition, sharing and application of knowledge (Coombs et al., 1998; DeCarolis et al., 1999; Von Krogh et al., 2001). In fact, knowledge-based assets and KM processes are critical for a firm's performance. Based on the literature review and research objectives, the following hypotheses were derived: KM processes are positively related to SMEs' turnover, TQM and stakeholder's satisfaction.

Research methodology and results

Variables in the questionnaire include background information, knowledge acquisition, knowledge sharing, knowledge application, turnover, TQM and stakeholder's satisfaction. All independent and dependent variables require five-point Likert style responses ranging from "strongly disagree" to "strongly agree". This study examined a sample of 79 SMEs in Romania. Each company received five questionnaires to answer. The authors request the questionnaires to be completed by entrepreneurs or managers who are familiar with the topic of this study. Of the 112 SMEs 79 returned questionnaires and those was valid and complete for the quantitative analysis (valid return rate is 0.7053 percent). The reliability of the measurements in the survey was tested using Cronbach's coefficients. Hair et al. (1998) stated that a value of 0.70 and higher is often "considered the criterion for internally consistent established factors". The Cronbach's coefficients in parentheses indicating the internal consistency reliability of the measures in the six factors are all above the suggested value of 0.70 (Hair et al., 1998). Table I displays the research statistics and Table II presents the re-

sults of regression analysis regarding the effects of KM processes on SMEs' performance. Coefficients of knowledge acquisition, sharing and application are positive and significant for turnover ($p < 0.05$, $p<0.01$, and $p<0.01$, respectively). These findings indicate that SMEs would achieve a higher level of turnover if they have well-developed knowledge acquisition, sharing and application. In summary, all three factors of KM processes have the expected signs and also have significant effects on SMEs' performance.

Table I. Research statistics

The variables	Mean	SD	1	2	3	4	5	6
Knowledge acquisition	5.38	0.89	1	-	-	-	-	-
Knowledge sharing	5.24	0.81	0.28*	1	-	-	-	-
Knowledge application	5.18	1.01	0.57**	0.31*	1	-	-	-
Turnover	5.01	1.0	0.18*	0.27*	0.42**	1	-	-
TQM	5.44	0.66	0.19*	0.44**	0.41**	0.42**	1	-
Stakeholders satisfaction	5.11	1.02	0.17*	0.19*	0.49**	0.55**	0.54**	1

Notes: Significant at: *p<0.05 and * *p<0.01

Table II. Results of regression analysis

Variables	SME Performance		
	Turnover	TQM	Stakeholders satisfaction
K acquisition	0.09*	0.21**	0.1*
K sharing	0.21**	0.23**	0.17**
K application	0.27**	0.35**	0.32**
R2	0.26	0.34	0.22
F	18.2**	10.4**	15.2**

Note: Significant at: *p<0.05 and * *p<0.01

Discussion and conclusions

This study examines the role of KM processes on SMEs' performance. My results indicate that KM processes have positive and significant effects on SMEs' performance. The implication of the results is that entrepreneurs or senior managers need to actively manage their firm's human capital to stimulate managing knowledge acquisition, sharing and application. Furthermore, research suggests appropriate investments in KM initiatives can enhance performance. It is therefore important that firms recognize the variableness of knowledge processes and the need to deploy strategies that lead to the acquisition and deployment of those that are most relevant to the firm's objectives. This study has also some limitations. The first limitation is the number of responses obtained from the survey was rather small. A larger number of responses would probably yield a more accurate finding and so, future research could replicate this study, with the hope that more SMEs have implemented KM. In addition, since this study only investigates Romanian SMEs, hence, the findings and conclusions drawn from this research are representative of the Romanian SMEs, and the findings may not generalize to other geographic regions or cultures.

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COUNTERPARTY RISK EVALUATION IN POWER DERIVATIVES

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Abstract:

Power derivatives are financial risk management tools that have been used over time in the energy sector, based on an underlying energy asset. The remarkable increase of the over-the-counter transactions in this field forces the financial institutions to include the cost of counterparty in the pricing framework. The goal of our research is to present measurement formulas for quoting "completed" power derivatives, i.e. instruments embracing the risk to each party of a contract that the counterparty will not live up to its contractual obligations. Our proposal consists in evaluating derivatives completed of innovative collaterals, such as Credit value adjustment (CVA) and bilateral CVA (BCVA).
We stress the approach by empirical results.

Key words: Counterparty Risk, Power Derivatives, Forward Contract, Credit Value Adjustment (CVA), Bilateral CVA (BCVA), Debt Value Adjustment (DVA)

1. Introduction

Since many year the volatility of the oil price significantly impacts on the balance sheet of the oil companies.

Until the first half of 1960s the oil price was quite steady, indeed many oil companies arranged a long-term contracts with the oil producing countries.

The problems started with the establishment in 1960 of the OPEC (Organization of Petroleum Exporting Countries) that is a permanent intergovernmental organization of 12 oil-exporting developing nations that coordinates and unifies the petroleum policies of its Member Countries.

This organization has affected the price of oil for more than 50 years.

A first substantial increase in oil prices, there has been between 1973 and 1974 when the members of the Organization of Arab Petroleum Exporting Countries (OAPEC) namely the Arab members of the OPEC proclaimed an oil embargo. The oil price increased suddenly from $2.90 to $12.00 per barrel. It was called also first crisis.

Between the 1978 and 1979 there was the second crisis characterized by an increase of the oil price from $ 12 to $ 30 per barrel.

A further decline in oil price there was in 1997 and 1998 thanks the Asian financial crisis.

Generally, oil market more than other resources is affected by political, economic and environmental events, like financial crisis, terrorist attacks, hurricanes and so on. The figure 1. shows the trend in the Crude oil Brent price in the last 20 years.

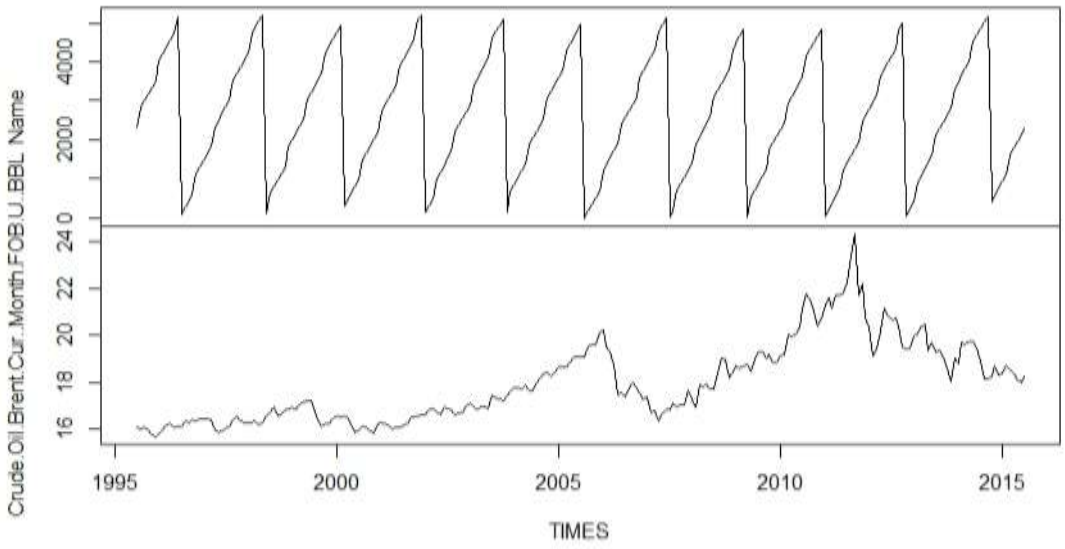

Figure 1. Crude Oil Brent Price from 1995 to 2015

The high volatility in the oil market from the 1960 to nowadays led to the formation of an oil derivatives market and a variety of hedging instruments such as forwards, futures and options written on these commodities.

The paper is organised as follows: in section 2 we investigate the long-term contracts, future and forwards. in section 3 we model counterparty risk in the forward market.

Section 4 provides an empirical application.

2. Long-term Contract, Future and Forward Market

Long-term contract

Long-term contracts are negotiated bilaterally between buyers and sellers. This kind of contract concerns an series of oil deliveries referred to a specified period. Generally the period varies among one and two years. First the parties of the long-term contract specify the method used for calculating the price of an oil cargo. Usually the oil price for each cargo scheduled into the contract is linked to a market (spot) price.

Other information specified into the contract by the parties are: the volumes of crude oil to be delivered, the delivery schedule and the actions to be taken in case of default.

Futures market

The futures markets have been developed after the second oil shock. The future is a derivative contract traded in the exchange, in which two parties agree to buy or sell oil at a certain maturity and certain price. This contract allows to the parties to hedge against the risk of price fluctuations (as for forward and option contracts). When a party agrees to buy an underlying asset on a certain futures maturity for a certain price, it assumes long position,

then it hedges against the risk that the price may increase over the time. While it assumes short position if he agrees to sell an underlying asset at certain maturity at certain price. In this case the party hedges the risk that the price of the underlying asset may decrease over the time.

Generally the parties that respectively enter in a long and short position develop divergent forecasts on oil prices.

As aforementioned, the futures contracts are traded into exchange market, therefore they are governed by precise operating rules. Indeed the counterparty risk relies on these contracts is very low because the broker requires that the investor has to deposit fund into a margin account in such way to reduce the potential loss in the case of counterparty default. This account is dearly adjusted.

Generally the intermediation is achieved by a clearinghouse.

Forward market

As well as the futures contract, the forward contracts allow to a party to cover the risk that the oil price may suffer fluctuations. Also the oil forward contracts are derivatives t in the Over-The-Country Market(OTC) traded.

As in the case of futures contract, the oil forward contract provides that a party agrees to buy an certain oil quantity at a future time at a determined price (long position), while the counterparty agrees to sell oil at the same maturity and same price.

Generally the payoff of the buyer (long position) in a forward contract is given by the following equation:

$$S_T - K$$

where S_T is the oil spot price at the maturity and K is the delivery price .

The buyer's payoff will be positive if the spot price is higher than the delivery price agreed by the contract. Vice versa it is negative.

The payoff from a short position in a forward contract is equal to:

$$K - S_T$$

In this case the payoff is positive if the forward price is higher than the oil spot price at the maturity date. Vice versa it is negative.

A problem is to define the oil forward price. According to Hull (2011) the delivery price of a oil forward contract on commodities (in this case the crude oil) is equal to the forward price at the inception, namely at time 0, that is given by the following formula:

$$K = F_0 = S_0 e^{(r+u-y)T}$$

F_0 is the forward price at the inception. The forward price is given by the product of S_0, the spot price of the crude oil at the inception and $e^{(r+u-y)T}$, i.e. the continuous compounding with the rate $r+u-y$, where r is the free-risk rate, u is the storage cost per annum, y is the convenience yield, T is the time until delivery in a forward contract. The storage cost, as well as the convenience yield, is a constant proportion of the spot price.

As it is possible to guess at the inception, the value of an oil forward contract should be equal to zero, since only at the inception K and F_0 are equal.

The oil forward price may change over the maturity of the trade, but the delivery price does not change. Then the value of the long oil forward contract over the maturity may change and it is given by the following equation:

$$f = (F_t - K)e^{-r(T-t)}$$

The crude oil forward contract can be assessed also over the duration of the contract. The forward contract value over the maturity may be positive or negative.

In the other side the value of the short oil forward contract over the maturity is given by:

$$f = (K - F_t)e^{-r(T-t)}$$

As we can note both the delivery price and the assessment over the maturity of the forward do not consider the significant counterparty risk typically located in OTC market characterized by higher flexibility of the contractual conditions, but lower price transparency than the exchanged market.

3. Counterparty Risk in the Forward Market

Counterparty risk is the risk that a counterparty in a contract will default prior to the expiration of a transaction and will not therefore fulfill the current and future payments required by the contract.

To evaluate the counterparty risk on a derivative contract we could consider innovative collateralization tools such a Credit Value Adjustment (CVA), Bilateral CVA (BCVA) and Debt Value Adjustment (DVA).

According to Gregory (2012), the CVA is defined as the market price of counterparty risk on a contract obtained by the risk neutral expectation of the loss that could occur for the counterparty default over the term of the contract weighted with the risk-neutral probability of the counterparty default.

The CVA as a stand-alone value is given by the following equation:

$$CVA(t,T) = -\left(1-\bar{\delta}\right)\left[\int_t^T B(t,u)EE(u,T)dS(t,u)\right] \approx$$

$$\left(1-\bar{\delta}\right)\sum_{i=1}^{t} B(t_i)EE(t_i)q(t_{i-1},t_i) \tag{1}$$

where $(1-\bar{\delta})$ is loss given default, i.e. one minus the recovery rate, δ; $B(t_i)$ denote the risk-free discounting factor at time t_i; $EE(u,T)$ calculated under the risk neutral-measure and $EE(t_i)$ is the expected exposure for the relevant dates in future time given by t_i for *i=0,t*, $S(t,u)$ the survival probability, while $q(t_{i-1},t_i)$ the marginal default probability in the interval between dates t_{i-1} and t_i.

This equation is obtained under the assumption of independence between credit exposure, default probability and recovery rate, of no wrong-way risk and that the party that values the trade cannot default.

The CVA is an innovative tool for easily pricing the counterparty risk, being determined by components that may be obtained from different sources of an institution, in addition you can use it as collateralization charging CVA to the counterparty.

The CVA may be expressed also as a running spread by:

$$CVA_{as\ a\ spread} = \frac{CVA(t,T)}{CVD_{premium}(t,T)} = \frac{CDS_{default}(t,T)}{CDS_{premium}(t,T)} \times EPE = X^{CDS} \times EPE$$

(2)

where X^{CDS} is the fixed periodic premium of a Credit Default Swap (CDS) with same maturity of the instrument in question and it may be defined as a credit spread, while $CDS_{premium}(t,T)$ is the present value of the premiums at time t, $CDS_{default}(t,T)$ being the value of the default component.

The counterparty risk has a bilateral nature. The cost of the counterparty risk considering the bilateral nature may be computed by mean the BCVA formula as following:

$$BCVA \approx \left(1-\bar{\delta}\right)\sum_{i=1}^{T} B(t_i)EE(t_i)[S_I(t_{i-1})q(t_i,t_{i-1})]$$
$$-\left(1-\bar{\delta}_I\right)\sum_{i=1}^{T} B(t_i)NEE(t_i)S(t_{i-1})q_I(t_i,t_{i-1}) \quad (3)$$

where $S_I(.)$ and $S(.)$ respectively represent the survival probabilities of the institution and its counterparty; $q_I(t_i,t_{i-1})$ denotes the default probability of the institution; $\bar{\delta}_I$ the recovery of the institution; while $NEE(t_i)$ is the negative expected exposure, i.e. the EE from the point of view of the counterparty.

The BCVA may be positive or negative according to which counterparty has an higher exposure and higher default probability.

Also the BCVA may be expressed as a running spread by the equation (4):

$$BCVA_{spread} = \frac{BCVA(t,T)}{CDS_{premium}(t,T)} = \frac{CVA(t,T)}{CDS_{premium}(t,T)} + X^{CDS}{}_I \times ENE =$$
$$X^{CDS} \times EE + X^{CDS}{}_I \times ENE \quad (4)$$

where X_I^{CDS} is the CDS fixed periodic premium of an institution and ENE is the expected negative exposure.

Symmetrically the DVA is the price of the counterparty risk obtained under the risk neutral expectation of the loss considering the assumption that the investor that evaluates the derivative may default and his counterparty is default-free. The DVA as a stand-alone value is given by the following formula:

$$DVA = (1-\bar{\bar{\delta}}_I)\sum_{i=1}^{T} B(t_i)NEE(t_i)q_F(t_i,t_{i-1}) \quad (5)$$

$\mathrm{q_I(t_i,t_{i-1})}$ denotes the default probability of the institution; $\bar{\delta}_\mathrm{I}$ the recovery of the institution; while $\mathrm{NEE(t_i)}$ the negative expected exposure, i.e. the EE from the point of view of the counterparty with the difference that the $\mathrm{NEE(t_i)}$ is a negative value.

The unilateral DVA as a credit spread is given by:

$$DVA_{as\ a\ spread} = X_F^{CDS} \times ENE \quad (6)$$

where $\mathrm{X_F^{CDS}}$ is the periodic premium paid by the investor that enter into the credit default swap to cover his counterparty risk exposure and ENE is the expected negative exposure.

The DVA as a stand-alone value and as a credit spread unlike the CVA are negative values.

For many reasons, the presence of counterparty risk impacts the oil forward contract value. Then for obtaining a fair value of the oil forward contract it is crucial to introduce another dimension in the traditional pricing framework such as the risk under consideration. Generally, the risky value of a derivative contract is given by:

$$risky\ value\ of\ a\ derivative = Free\ risk\ value - CVA$$

We propose pricing formulas of the oil forward derivatives that include the counterparty risk in such a way obtaining risky values of the derivatives (Blake 2014).

In this case we assume the perspective of the seller position in the oil forward contract, i.e the short position.

Under the assumption that the seller is default-free and his counterparty may default, we can use the CVA as a spread for assessing the derivative issued at time 0 at any time t between 0 and the maturity T as following:

$$f_{risky} = (K - F_t)e^{-(r+CVA_{spread})(T-t)} \quad (7)$$

where F_t is the forward price at time t and K is the delivery price.

In this way the oil forward contract value at time t is discounted with a free-risk rate plus the CVA as a spread. Then the risky oil forward contract today is less than its free-risk value. The presence of the counterparty risk for the investor reduces the oil forward values over the duration of the contract.

However, as well known, the value of an oil forward contract at the inception is equal to 0:

$$K = F_0$$

Furthrmore the delivery price namely the forward price at the inception is determined by the product of the spot price and $e^{(r+u-y)T}$. Then you could introduce also the charge of the counterparty risk the delivery price is given by the equation (8):

$$F_0 = S_0 e^{(r+u+CVA_{spread}-y)T} \quad (8)$$

where the CVA as a spread is added to the free-risk rate and the buyer have to pay on delivery a price higher than that of in the case of counterparty risk-free. In this way the cost of the counterparty risk is charged on the buyer.

Under the assumption that the seller, namely the investor that assesses the contract may default and his counterparty is default-free, we can use the DVA as a spread for pricing the derivative issued at a generic time t by mean the equation (9):

$$f_{risky} = (K - F_t)e^{-(r+DVA_{spread})(T-t)} \quad (9)$$

The DVA is a negative value, then it increases the value of the oil forward contract from the point of view of the seller.

Also in this case we include the cost of the counterparty risk into the delivery price of the contract by the expression (10):

$$F_0 = S_0 e^{(r+u+DVA_{spread}-y)T} \quad (10)$$

In formula (10), the DVA as spread reduces the delivery price paid to the seller, charging the cost of the counterparty risk to the seller.

Finally we introduce the evaluation of the oil forward contract at the generic time t from the point of view of the seller, considering the bilateral nature of the counterparty risk by means of the BCVA as a spread:

$$f_{risky} = (K - F_t)e^{-(r+BCVA_{spread})(T-t)} \quad (11)$$

The BCVA as a spread may be positive or negative according to the credit quality of the both parties. If it is positive the risky value of the derivative is lower than the free-risk value, in the other side it is higher.

If the parties of the oil forward contract decide to take in account the bilateral nature of the counterparty risk in the definition of the delivery price, we can write the equation:

$$F_0 = S_0 e^{(r+u+BCVA_{spread}-y)T} \quad (12)$$

In this case the delivery price may be higher or lower than the delivery price determined without the consideration of the counterparty risk according to the credit quality of both party and then the cost of the counterparty risk may be charged on the counterparty with lower credit quality. This cost does not include the *price* of the default.

4. Numerical Applications

Let us consider a 2-year forward contract on WTI (West Texas Intermediate) crude oil agreed between a refinery company, the buyer, and an oil producer, the seller. Generally the WTI is quoted on New York Mercantile Exchange (NYMEX).

In our empirical application, the two parties have agreed on January 1st , 2015 respectively to buy and sell 500'000 barrel of WTI crude oil on January 1st , 2017. Let us suppose that the delivery price was determined by the following equation:

$$K = F_0 = S_0 e^{+(r+u-y)T}$$

The Crude Oil-WTI Spot price at the inception was equal to $ 53.45. For determining the forward price it was needed also to know the storage cost per annum, the convenience yield and the free-risk rate.

The free risk used was the 2-year treasury rate that at the inception of the trade was 0.6727%.

The storage cost is fitted to a continuous annual rate of 15% on the delivery price and a convenience annual yield fitted to 7% of the delivery price, namely the oil forward price was equal to:

$$K = F_0 = \$53{,}45e^{+(0{,}6727+15-7)2} = \$\ 63.57375$$

On January 1st , 2017 the buyer is going to buy 500'000 barrel of WTI-oil at the price $\$\ 63.57375$, while the seller is going to receive the payment and to deliver the WTI-oil.

In this case the parties of the contract have not considered into the determination of the delivery price the counterparty risk.

We suppose that the seller would quarterly assess the forward contract, according to the following expression:

$$f = (K - F_t)e^{-r(T-t)}$$

where F_t is the oil forward price at the time t considering as maturity of T. Considering that the spot price of the WTI-oil in 31 March 2015 was equal to $ 47,72 and at the

same date the 2-yaer treasury rate was 0,5646% and supposing that the storage cost and convenience yield do not vary over the time the oil forward price for the first quarter was:

$$F_t = S_t e^{+(r+u-y)(T-t)} = 47{,}72e^{+(0.5646\%+15\%-7\%)} = 55.4122449$$

At this point you can determine the value of the forward contract on 30 March 2015 from the point of view of the seller as following:

$$f = (K - F_t)e^{-r(T-t)} = (63.57375 - 55.4122449)e^{-0.5646\%(2-0.25)} = 8{,}25933439$$

As you can see, from the point of view of the seller the contract had a positive value on March 31, 2015.

As regard the evaluation of the contract for the following quarterly we can achieve a projection of the 2-years treasury interest rate and the WTI-oil price.

For predicting the 2-years treasury interest rate for all the durations of the contract we project by the Cox–Ingersoll–Ross model (or CIR model, 1985) that is given by the following equation:

$$dr_t = \alpha(\beta - r_t)dt + \sigma\sqrt{r_t}dWt$$

where Wt is a Wiener process (modelling the random market risk factor) and α, β, and σ, are the parameters. The parameter α corresponds to the speed of adjustment, β to the mean and σ to volatility.

The table 1 shows the parameters of the CIR model on the aforementioned dataset, while the table 2 shows the simulated annual rate in percentage for the last day of each month until the maturity date.

Table 1. Parameters of the CIR Model

Parameters	values
α	0,205889
β	2,995961
σ	0,804416

Table 2. Evolution of interest rates obtained with the CIR Model

DATE	RATE
01/08/2015	0,680906
01/09/2015	0,390506
01/10/2015	0,380235
01/11/2015	0,45741
01/12/2015	0,55685
01/01/2016	0,372335
01/02/2016	0,252471
01/03/2016	0,22988
01/04/2016	0,330363
01/05/2016	0,468053
01/06/2016	0,571795
01/07/2016	0,466715
01/08/2016	0,374259
01/09/2016	0,268327
01/10/2016	0,370138
01/11/2016	0,205752
01/12/2016	0,154185
01/01/2017	0,208012

For the project of the WTI-oil prices we used the forecasts achieved by The Economist Intelligence Unit that reported in the table 3.

Table 3. Evolution of WTI oil price.

WTI	2015	2016	2017
1 Qtr	47,72[1]	59.40	71.15
2 Qtr	55.09[1]	63.30	74.60
3 Qtr	54.96	65.69	75.33
4 Qtr	56.93	65.89	-

Sources: Haver Analytics; The Economist Intelligence Unit.

Through these data you can observe how change over the time the value of the WTI-oil forward in any time from the point of view of the seller.

The table 4 report the prediction of oil quarterly forward contract values from the point of view of the seller.

Table 4. WTI oil forward contract values at the end of each quarterly from the point of view of the seller

		T-t	u-y	r	(r+u-y)(T-t)	exp+(r+u-y)(T-t)	S_t	F_t	$F_0(K)$	exp-r*(T-t)	f	f*500'000
2015	1 Qtr	1,75	0,08	0,0054	0,14945	1,161195	47,72	55,4122449	63,75	0,990595	8,259334	4129667
	2 Qtr	1,5	0,08	0,005848	0,128772	1,137431	59,48	67,6543816	63,75	0,991266	-3,87028	-1935141
	3 Qtr	1,25	0,08	0,00399	0,104988	1,110697	54,96	61,0438921	63,75	0,995025	2,692645	1346322
	4 Qtr	1	0,08	0,00395	0,08395	1,087575	56,93	61,9156171	63,75	0,996058	1,827151	913575,7
2016	1 Qtr	0,75	0,08	0,0032	0,0624	1,064388	59,4	63,2246481	63,75	0,997603	0,524093	262046,3
	2 Qtr	0,5	0,08	0,005156	0,042578	1,043497	63,3	66,0533883	63,75	0,997425	-2,29746	-1148729
	3 Qtr	0,25	0,08	0,003634	0,020909	1,021129	65,69	67,0779387	63,75	0,999092	-3,32492	-1662458
	4 Qtr	1	0,08	0,002484	0,082484	1,085981	65,89	71,5553077	63,75	0,997519	-7,78594	-3892972

As aforementioned, the forward price of the WTI oil changes over the time. According to how the forward price changes, also the value of the contract varies over the maturity.

The evaluation in this setting does not take in account the typical counterparty risk included in a OTC transaction. Indeed the values reported in the last column of the table 4 are the free-risk.

As seen previously, for taking into account the counterparty risk we can use the CVA, BCVA and DVA, namely the price or the cost of the counterparty risk under different assumptions.

Let us suppose that the seller would assess the forward contract over the time considering also the impact of the counterparty risk under the assumption that only his counterparty may default. To do this, the calculation can be obtained by the following formula:

$$f_{risky} = (K - F_t)e^{-(r+CVA_{spread})(T-t)}$$

where the CVA as a spread is given by the product of the Expected Positive Exposure (EPE) and periodic premium that would be paid if the seller enters into the CDS to cover his counterparty risk exposure (X^{CDS}).

Supposing that the EPE of the seller is 5% and the X^{CDS} is 2% the CVA as a spread is equal to 1%. Then we can compute the risky market value of the WTI-oil forward over the term of the contract, as shown in the table 5.

Table 5. Risky values of WTI oil forward contract at the end of each quarterly from the point of view of the seller under the assumption that only his counterparty may default

		T-t	u-y	r	(r+u-y)(T-t)	exp+(r+u-y)(T-t)	S_t	F_t	$F_0(K)$	CVA	exp-r*(T-t)	f	f*500'000
2015	1 Qtr	1,75	0,08	0,0054	0,14945	1,161195	47,72	55,4122449	63,75	1%	0,97341	8,116053	4058027
	2 Qtr	1,5	0,08	0,005848	0,128772	1,137431	59,48	67,6543816	63,75	1%	0,976508	-3,81266	-1906331
	3 Qtr	1,25	0,08	0,00399	0,104988	1,110697	54,96	61,0438921	63,75	1%	0,982665	2,659196	1329598
	4 Qtr	1	0,08	0,00395	0,08395	1,087575	56,93	61,9156171	63,75	1%	0,986147	1,808971	904485,5
2016	1 Qtr	0,75	0,08	0,0032	0,0624	1,064388	59,4	63,2246481	63,75	1%	0,990149	0,520177	260088,3
	2 Qtr	0,5	0,08	0,005156	0,042578	1,043497	63,3	66,0533883	63,75	1%	0,992451	-2,286	-1143000
	3 Qtr	0,25	0,08	0,003634	0,020909	1,021129	65,69	67,0779387	63,75	1%	0,996397	-3,31661	-1658307
	4 Qtr	1	0,08	0,002484	0,082484	1,085981	65,89	71,5553077	63,75	1%	0,987594	-7,70847	-3854236

The risky values of the WTI oil forward contract, computed under the assumption that only the counterparty may default, are lower than their free-risk values. Indeed as said above the consideration of the unilateral counterparty risk by mean the CVA as a spread reduces significantly the value of the derivative contract.

This kind of evaluation could be achieved also considering the bilateral nature of the counterparty risk through the BCVA or considering that the investor that assesses the contract may default and his is default- free by mean the DVA as a spread.

Fitting the DVA as a spread equal to 0.5% and the BCVA as spread equal to the difference between CVA and DVA, it is possible to calculate the risky value of the contract under the assumption that only seller may default or both parties may default. The risky values of the WTI oil forward over the term of the contract considering the BCVA are reported by the table 6, while the risky values of the forward under the assumption that only the seller may default are reported in the table 7.

Table 6. Risky values of WTI oil forward contract at the end of each quarterly from the point of view of the Seller under the assumption that both parties may default

		T-t	u-y	r	(r+u-y)(T-t)	exp+(r+u-y)(T-t)	S_t	F_t	$F_0(K)$	BCVA	exp-r*(T-t)	f	f*500'000
2015	1 Qtr	1,75	0,08	0,0054	0,14945	1,161195	47,72	55,4122449	63,75	0,5%	0,981965	8,18738	4093690
	2 Qtr	1,5	0,08	0,005848	0,128772	1,137431	59,48	67,6543816	63,75	0,5%	0,98386	-3,84136	-1920682
	3 Qtr	1,25	0,08	0,00399	0,104988	1,110697	54,96	61,0438921	63,75	0,5%	0,988825	2,675868	1337934
	4 Qtr	1	0,08	0,00395	0,08395	1,087575	56,93	61,9156171	63,75	0,5%	0,99109	1,818038	909019,2
2016	1 Qtr	0,75	0,08	0,0032	0,0624	1,064388	59,4	63,2246481	63,75	0,5%	0,993869	0,522131	261065,5
	2 Qtr	0,5	0,08	0,005156	0,042578	1,043497	63,3	66,0533883	63,75	0,5%	0,994935	-2,29172	-1145861
	3 Qtr	0,25	0,08	0,003634	0,020909	1,021129	65,69	67,0779387	63,75	0,5%	0,997844	-3,32076	-1660382
	4 Qtr	1	0,08	0,002484	0,082484	1,085981	65,89	71,5553077	63,75	0,5%	0,992544	-7,74711	-3873555

Table 7. Risky values of WTI oil forward contract at the end of each quarterly from the point of view of the Seller considering the own default

		T-t	u-y	r	(r+u-y)(T-t)	exp+(r+u-y)(T-t)	S_t	F_t	$F_0(K)$	BCVA	exp-r*(T-t)	f	f*500'000
2015	1 Qtr	1,75	0,08	0,0054	0,14945	1,161195	47,72	55,4122449	63,75	-0,5%	0,9993	8,331921	4165960
	2 Qtr	1,5	0,08	0,005848	0,128772	1,137431	59,48	67,6543816	63,75	-0,5%	0,998729	-3,89942	-1949709
	3 Qtr	1,25	0,08	0,00399	0,104988	1,110697	54,96	61,0438921	63,75	-0,5%	1,001263	2,709527	1354763
	4 Qtr	1	0,08	0,00395	0,08395	1,087575	56,93	61,9156171	63,75	-0,5%	1,001051	1,83631	918155
2016	1 Qtr	0,75	0,08	0,0032	0,0624	1,064388	59,4	63,2246481	63,75	-0,5%	1,001351	0,526062	263030,8
	2 Qtr	0,5	0,08	0,005156	0,042578	1,043497	63,3	66,0533883	63,75	-0,5%	0,999922	-2,30321	-1151604
	3 Qtr	0,25	0,08	0,003634	0,020909	1,021129	65,69	67,0779387	63,75	-0,5%	1,000342	-3,32908	-1664538
	4 Qtr	1	0,08	0,002484	0,082484	1,085981	65,89	71,5553077	63,75	-0,5%	1,002519	-7,82497	-3912485

The table 8 summarizes the values of the WTI oil forward contract referred the different hypothesis for a better comparison.

Table 8. Comparison between the free risk values and risky values of WTI oil forward contract

		free risk	CVA	BCVA	DVA
2015	1 Qtr	4129667	4058027	4093690	4165960
	2 Qtr	-1935141	-1906331	-1920682	-1949709
	3 Qtr	1346322	1329598	1337934	1354763
	4 Qtr	913575,7	904485,5	909019,2	918155
2016	1 Qtr	262046,3	260088,3	261065,5	263031
	2 Qtr	-1148729	-1143000	-1145861	-1151604
	3 Qtr	-1662458	-1658307	-1660382	-1664538
	4 Qtr	-3892972	-3854236	-3873555	-3912485

As just said, the risky values under the assumption that only the counterparty may default are lower than the free risk value, since the counterparty's default impacts on the balance sheet of the seller.

They are lower also than the values obtained with the BCVA, because in this last case the impact of the counterparty default to the net of cost of the own default is considered. In addition the risky forward values obtained by mean the DVA are higher than all other values, because it is represented the impact of the seller's default on the balance sheet of the counterparty.

In essence the counterparty risk under different assumptions affects substantially the WTI oil forward values. Then could be needed to contemplate the cost of counterparty risk in the delivery price. The choice of which kind of collateral could depend on which party has a o lower credit quality and bargaining power.

If the seller has a higher credit quality and higher bargaining power than his counterparty, he could require that the delivery price includes compounding of the CVA as a spread. In this way the seller obtains an higher delivery price and could account resources for covering the potential loss in the case of counterparty default.

If the spot price at the inception is equal to $53.45, the 2-years treasury interest rate to 0.6727%, the storage cost and the convenience yield are given respectively by 15% and 7% and a CVA as a spread is equal to 1%, the forward price at the inception, i.e. the delivery price is given by:

$$K_{CVA} = F_{0CVA} = S_0 e^{+(r+u+CVA-y)T} = \$53{,}45 e^{+(0{,}006727+0.15+0.01-0.07)2} = 64{,}85802417$$

In this case, the seller receives a higher price than that he would receive if it is not considered the impact of the unilateral counterparty risk.

If the counterparty of the seller in the WTI oil forward has higher credit quality and higher, he could require that the delivery price include the DVA as a spread. Considering the above data and a DVA as a spread equal to -0.5% the delivery price is:

$$K_{DVA} = F_{0DVA} = S_0 e^{+(r+u+DVA-y)T} = \$53{,}45 e^{+(0{,}006727+0.15-0.005-0.07)2} = 62{,}94118$$

In this case the impact of the counterparty risk of the buyer is charged on the seller that receives un lower delivery price than that he would receive if it is not considered the own default.

However from the point of view of a standardization of WTI oil forward, an Authority could require that the delivery price is determined considering the bilateral nature of the counterparty risk by mean the BCVA. In this case it is considered the impact of the counterparty referred to both parties of the WTI oil forward contract, then the cost of the counterparty risk is charged on the party that has a lower credit quality to the net of the cost of his ex-

posure to counterparty risk. If BCVA as a spread amounts to 0.5% (CVA-DVA), the delivery price of the WTI oil forward contract is given by the following formula:

$$K_{BCVA} = F_{0BCVA} = S_0 e^{+(r+u+BCVA-y)T} = \$53{,}45 e^{+(0{,}006727+0.15+0.005-0.07)2} = 64{,}21267605$$

In this case the seller collects an higher delivery price than that one of the counterparty risk-free, but lower than that he receives if it is considered his unilateral exposure to the counterparty risk.

To conclude, no contemplation of the counterparty risk could lead to issues of mispricing in an incomplete assessment of the integrated risks affected the derivative portfolio. On the contrary we propose a *complete* pricing approach for obtaining an adjustment of the evaluation market-oriented.

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[1] Final values

COMPETITIVE INTENSITY AND ITS IMPLICATION ON STRATEGIC POSITION OF COMPANIES

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Abstract:

The power of competition is an essential aspect of companies' external environment and their regional units, which influence the decision on strategy, the decision to enter new regions and markets, the choice of models and assessment of performance. Even if the reflection of the issue of competition in scientific publications is very broad, the aspect of measuring and assessing it is mentioned only a few works. And, more often the degree of competition is presented as something self-evident. While the phenomenon of competition is so difficult, multifaceted and variable, that requires specific criteria and methods for assessing the intensity of competition, adequate to the specificity of a certain market or region. The present paper is focused on the analysis of competition intensity and its influence on strategic position of companies on the market. All analyzed factors are important and significantly can intensify the competition fight among the firms. Thus, the main factors determining the intensity of competition examined in the paper are the distribution of market shares among the competitors, the growth rate and the profitability of the market. In this context, the quantitative coefficients of characterized factors are proposed to be examining as the measure of the competitive intensity. Furthermore, the competitive intensity has its implication on strategic position of companies, giving each of them its place on the market.

Key words: competitive intensity, competitive forces, strategic position, dairy market

Introduction

The concept of organizational strategy is connected within the evolution of strategic management as a scientific discipline (Punnet BJ et al 1994). During the crystallization of the concept of strategy, experts have various typologies," some distinctive and others based on prior developed frameworks" (Garrigos- Simon FJ et al, 2005). Of the various strategic typologies that have been proposed during the last decades, those of Porter (Porter, ME, 1980) and Miles and Snow (Miles et al, 1986) have received the most academic attention (Veet NMK et al, 2009). Porter underline that organizations must develop either cost or differentiation strategies, making no distinction regarding strategy focus. According to him, businesses that endeavour to combine differentiation and cost typically become "stuck in the middle" (Porter ME, 1980) (p. 41), an idea that received considerable advocacy (Dess, GG et al, 1984; Hawes JM et al, 1984). Recent studies questioned Porter's controversy and suggested that businesses adopting combination approaches might outperform business with single strategy orientation (Ghobadian A et al, 2006; Murray AI, 1988; Wright P, 1987, Nicolescu C. et al, 2009).

Competitive intensity

The analysis of the essence of a competition allows talking about its significant influence on the productive level of the competitiveness of the enterprises, that is, on a level of achievement by them of the pursued purposes of activity in conditions of the competitive market (Hussey D., 2002; Ceptureanu SI, 2015a). As the factor of competitiveness of the enterprise a competition, in most cases, acts, first of all, in the form of an external force of counteraction of its activity (Tracey P et al, 2011; Ceptureanu SI, 2015b). Thus, its basic characteristic, allowing characterizing a degree of the given influence is intensity.

Hence, the estimation of the productivity level of the competitiveness of the enterprise assumes carrying out an estimation of scale of competitive intensity as one of its defining factors (Thomson J, 1967).

The analysis of the literature on the above issue allows ascertaining the fact that the estimation of competitive intensity given by it is offered to be carried out only by indirect parameters of its manifestation (Zajac E et al, 1989).

The essence of all indirect methods of estimation consists in the fact that it is carried out not by an estimation of the scale of intensity of manifestation of the competitive forces, counteracting the activity of the considered subject of a competition, but by an estimation of the scale of the factors causing their manifestation with a certain level of intensity (Sun L, 2011). Thus assuming, the presence of estimated factors and the size of their manifestation allows to judge unequivocally that, firstly, competitive counteraction takes place, secondly, the size of the competitive intensity correlates with the size of manifestation of the estimated factor or the set of those (as a rule, assuming their linear dependence). Thus, the indirect approach to an estimation of the size of the competitive intensity is based on an estimation of really controllable causes and/or consequences of the given relations (Beal RM, 2000).

The estimation of the competitive intensity is of a global importance at the market analysis as it allows revealing the general appeal of intrusion on the market, making strategy of promotion of the goods, preliminary estimating activity results. The estimation of the competitive intensity includes:

- the analysis of distribution of market shares among competitors;
- the analysis of growing rates of the market;
- the analysis of profitability of the market.

For further estimation of interference of the competitive intensity and the distribution of market shares among the enterprises it is necessary to assess the competitive intensity in the set commodity market by means of measurement of the degree of similarity of market shares of competitors (Bowman D et al., 1995). With this purpose we shall take advantage of the factor of variation equal to the relation of the average square deviation of the shares to their arithmetic-mean value.

Obviously, higher the factor of variation, lower the competitive intensity and vice versa. The formula for calculation looks like:

$$U_D = 1 - \frac{\sqrt{\frac{1}{n}\sum (D_i - D_{av})^2}}{D_{av}}$$

$i = 1, \ldots, n,$

From the business practice it is known, that there is some critical proportion of shares of two independent competitors when the tendency to change the given proportion fades. Usually this proportion is defined as 2 to 1 and more. In other words, this is such a condition on the market when for two competitors *i* and *j* following inequality is carried out:

$$D_i \geq D_j,$$

and, to the contrary, the absence of a sharp difference of values of market shares essentially raises the activity of the enterprises competing for competitive advantages. Weaker ones try to attack the nearest competitors, slightly surpassing them by the degree of domination on the market. In turn, more powerful aspire to approve their position, which also demands certain efforts and is the reason of constant conflicts even on insignificant occasions (Bowman C et al. 2003).

The greatest competitive activity is observed at provisional equality of shares. In this case, at equivalence of competitors $D_i = D_j$, their strategies are often identical, which provides an attribute of a unstable, disputed condition on the market. Thus, in the absence of obvious leaders and outsiders, when the whole market of the considered goods (commodity group) is presented by the competitors owning equal market shares - the competitive intensity is maximal.

The economic factors defining the competitive intensity are:

1) the character of development of the market as a complete formation, namely dynamic characteristics of a supply and demand, which are expressed in rates of growth of sales volumes (U_{GS}). Proceeding from the world practice of business, it is considered, that the majority of situations of dynamics of commodities and services market is entered in a range of annual rates of growth from 70 % up to 140 %. In this range the values of factors of competitive intensity are distributed at developing rates of growth of sales on the given market which can be calculated under the formula:

$$U_{GS} = 1 - \frac{G_s - 70}{140 - 70} = \frac{140 - G_s}{70}$$

Where G_S - is the annual rate of growth of a sales volume in the considered commodity market without taking into account the inflationary component, %.

2) the ratio of profitability of the considered market (R_P), defined by the relation of the cumulative profit received by the enterprises in the given market (P), to the total amount of sales (TS):

$$R_P = \frac{P}{TS}$$

It is well-known, that the market with the high profitability is characterized by the excess of the demand over the offer (Capps CJ III et al, 2002). This fact allows enterprises attaining their objectives in a rather peaceful manner and by methods not infringing interests of other competitors.

With reduction of profitableness of business the situation changes to the opposite. Besides the indicator of profitableness of the market, R_P shows the level of activity of the competitive environment of the enterprise and reflects the degree of their "freedom" in profit taking (Bowman C, 2008). Higher the R_P, lesser the pressure of the competitive environment and, consequently, lower the competitive intensity and vice versa. The given conclusion can be generalized in the form of the formula:

$$U_P = 1 - \frac{P}{TS} = 1 - R_P$$

For the convenience of carrying out a comparative analysis of a competitive intensity on the various markets (segments of the market) and estimations of their appeal (from the point of view of competitive activity), turns useful to operate with the generalized characteristic of the competitive intensity.

Besides the comparison base it enables specifying results of the analysis of separate elements of the competitive environment of the enterprise and more consistently to approach to formation of the special analytical report.

The generalization of private parameters U_D, U_{GS}, U_P in view of their multiplicative character is possible to make on the basis of geometrical average:

$$U_K = \sqrt[3]{U_D * U_{GS} * U_P},$$

Where U_K - is the generalized parameter of the competitive intensity, $0 \le U_K \le 1.$

The estimation of the competitive intensity can be carried out also by means of estimation of the conditions of its occurrence and existence among the subjects of a competition. At the basis of this approach rests the concept of "five forces" of competition of M. Porter, according to which each branch (considered as the market of any goods) has a unique structure of fundamental economic and technical characteristics which are a source of competitive force for the subjects of the competition and define, at the end, their competitive intensity (Porter ME, 1980; Hoque Z, 2004; Ceptureanu SI, 2014).

According to Porter, five competitive forces exist in each industry and they together determine the intensity of industry competition and industry profitability. Competing sellers arc the first force and they affect environment of every industry (DeSarbo WS et al, 2005).

In the formation of industry competition, different influences are important. Different competitive forces have the key influence in each industry and different economic and technical characteristics of an industry are decisive for the intensity of each competitive pressure (Barth H, 2003). There are two reasons of rivalry among competing sellers: One or more competitors feel pressure, or they sec an opportunity of improvement of their position (Campbell-Hunt C, 2000). Seven factors influence the intensity of rivalry among competing

sellers - industry concentration rate, industry growth rate, exit barriers, level of fixed and storage costs, product differentiation and switching costs, size of capacity augmentation, and diversity of competitors (Clemens B et al, 2008).

If an industry is highly concentrated or controlled by one or a few businesses, they rarely make mistakes in the evaluation of their own power and leading businesses are able to establish discipline. The intensity of rivalry is going down with the high industry concentration rate (Ceptureanu EG et al, 2014).

Conclusions

If an industry growth rate is low, competition is concentrated into the market share rivalry for businesses, which make efforts for expansion (Ceptureanu EG et al, 2012). Exit barriers are economic, strategic, and emotional factors, which force competing businesses into competition in the industry even though the invested capital yield can be very low or even negative (Boulding W. et al, 2001). High fixed costs push on all businesses to maximize production capacity utilization (Ceptureanu SI et al, 2015c). It often leads to rapid reduction of prices if a capacity surplus exists in an industry. Product differentiation creates isolation from competitors. Customers prefer specific sellers and keep loyal. If economies of scale depend on building new capacities in jumps, it can have destructive influence on the equilibrium between supply and demand mainly in the situation, when the threat exists, that the expansion of capacity accumulates (Mitchell W, 1991). Competitors can come across each other, if they differ in strategies, origin, economic force, and relation to their mother companies (Nicolescu et al, 2009). Proper strategic choice for one business could be unacceptable for another.

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MAPPING THE INFORMAL EMPLOYMENT IN ROMANIA. A COMPARATIVE ANALYSIS BASED ON LABOUR AND DISCREPANCY APPROACHES

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Abstract:

Informal employment is a widespread phenomenon in Romania. Employees often lack access to social protection or employment benefits, and untaxed envelope payments are common.
As the OECD report stated "informality on this scale is a serious problem. It means less tax income for the state and therefore less room to provide infrastructure and public services. The insufficient reach of safety nets to the informal sector renders people vulnerable to economic shock and poverty".
Trying to abolish informal employment isn't the solution. A better understanding of the complexity of informal employment is needed.
The paper aims to estimate the level of informal employment in Romania at regional level using the labour approach and the discrepancy approach for the period 2000-2013 highlighting the regions with the highest level of informality using the both methods.
In order to do that, administrative data from Labour force balance, survey data from Labour Force Survey and data from Labour Cost Survey were used.
The empirical analysis based on the methods used revealed that using the labour approach survey data, the regions with the highest level of informality are South-West-Oltenia, South-East and South-Muntenia, while using administrative data the regions North-East, South-West-Oltenia, South-East and South-Muntenia represented poles of informality.
Using the second method, the discrepancy approach, the regions with the highest number of persons employed in the informal sector are South-Muntenia, North-East and North-West.
The main conclusion regarding the evaluation of informal employment at regional level using different methods of estimation highlighted two main regions as poles of informality-South-Muntenia and Nord-East for the year 2013.

Key words: informal employment, regional level, informality map, Romania

Introduction

The main purpose of this paper is to estimate the level of informal employment in Romania for the period 2000-2013 using the two methods-labour approach and discrepancy approach and to identify the main informality poles at regional level for the last year 2013 using all the estimations.

The fundamental hypothesis of the labour approach is that the changes in official population activity rates are caused by factors related to the underground economy. One

can suppose that the decreasing of this rate could indicate the existence of a flow of population from official to unofficial economy.

The starting point for this approach was represented by the studies of Crnkovic-Pozaic (1999) and Svec (2009) for Croatia, Nastav şi Bojnec (2007) for Slovenia.

In order to evaluate the informal employment using the labour approach, we use two types of data: administrative and survey data. The basic difference in the data is their application and comparability.

The second method of evaluation, the discrepancy method relies in the difference of actual (real) and official (registered) use of labour. The method analyses the discrepancy between the number of employees revealed by the Labour Force Survey and the number of employees revealed by the Labour Cost Survey.

There are two sources of evidence for these two aspects. On the one hand, the Labour Force Survey (LFS) reveals the actual side. On the other hand, the official records from the Romanian Employment Agency (REA) or the Romanian Institute of Statistics (RIS) provide the official labour use side in the labour market.

A previous estimation of the shadow economy in Romania using this method was made for both administrative and survey data for the period 2000-2009 and the empirical results indicate a substantial difference in the results obtained. While the figures from administrative data report only 800 thousand persons unofficially employed, the survey results reveal about 1900 thousand persons that work in unofficial sector (Davidescu, 2014).This difference is due to the different ways of data collecting for the official employment and unemployment.

Davidescu (2015) estimated the level of informal employment in Romania and to identify the main informality poles at county level using the labour approach based on administrative data from Labour force balance for the period 2000-2013 revealing that Maramures, Bihor, Salaj, Harghita, Covasna, Alba, Botosani, Neamt, Suceava, Galați, Braila, Giurgiu, Calarasi, Ilfov, Gorj și Caras-Severin are the main poles of informality at local level for the year 2013.

2. The methodology

According to Crnkovic-Pozaic (1999) and Svec (2009), the labour approach is one of indirect methods and is meaningful only if the changes in official population activity rates are caused by factors related to the underground economy. Its advantages are availability of data on rates and the simple calculation. The number of unemployed who work in unofficial economy can be revealed using this method, but the number of those employed in both unofficial and official economy remains unknown. The reduction of the rate can indicate the retreat of population from official and participation in unofficial economy.

According to Crnković-Pozaić (1997), the activity rate can be defined as a ratio of persons who either are or wish to be economically active to all persons of working-age:

activity rate = (the employed + the unemployed) / persons of working-age (1)

the employed + the unemployed = labour force (total labour supply, total working population, de facto economically active population) (2)

Alternative definition:

activity rate = (the employed + the unemployed) / total population (3)

The main steps are:

- Data on the employed and unemployed should be obtained from the National Institute of Statistics and de facto active population calculated according to the formula (2).
- Activity rate is to be calculated using the formula (1) or (3).
- Zero activity rate is defined according to the formula (1) or (3), in the process of which initial data of the given time series are used. Hypothetically active population for the time period t is equal to the product of multiplication of the zero activity rate and total population in year t.
- After the values from step 1), 2) and 3) have been calculated, it is possible to calculate the value of the employed in unofficial economy according to the formula (4). By this, the so called called *hypothetical* activity rates are calculated and then compared in each of the years to the official, *de-facto* activity rates. The latter would normally be (by assumption) lower and the difference between the hypothetical and de-facto active population is the measure of the number of people working in the shadow economy.
- The share of employed in the unofficial economy is computed as:

share of employed in the unofficial economy = (hypothetically active – de facto active) / de facto active (4)

In evaluating the informal employment using the discrepancy method, the Household Labour Force Survey provides information on labour supply and it was realized in individual households, with a quarterly basis on a yearly sample volume of sample 112 320 households.

According to the methodology of LFS, the employee is considered to be the person who exercise their activity based on a labor contract in an economic or social unit - regardless of its form of ownership – or to individuals in exchange to a salary remuneration, in cash or in kind, in the form of commission etc. By convention, this status was registered also for conscripts (until 2007).

On the other hand, the Labor Cost Survey provides information on labor demand and it was realized in units with legal personality, with annual periodicity, on a sample volume of about 26 000 economic and social agents. The investigation includes other units in the sector, now, units of the central government, local government units, and units of consumer and handicraft cooperatives.

According Labour Cost Survey, number of employees at the end of the reporting period is the number of salaried employees with labor contracts / service report on temporary or permanent, in full or in part (including the labor contract / service report suspended) records existing in the company at the end of the reporting period. There are not included the enrolled employees seconded to work abroad and those who accumulate multiple functions and have the basic function of the reporting unit. They exclude military personnel.

3. Data

The size of the informal employment was estimated using the labour approach, differentiating between the two methods of employment estimate in unofficial economy: the one based on historical activity rates (administrative data) and the other based on labour

force survey (LFS) using annual data covering the period 2000-2013. The main sources of data are Labour force survey (LFS) and Labour force balance.

In the case of discrepancy method, the number of persons employed in informal economy was estimated using two main data sources: The Labour force survey(LFS) and Labour Cost Survey.

The main source of these data is represented by National Institute of Statistics Tempo database.

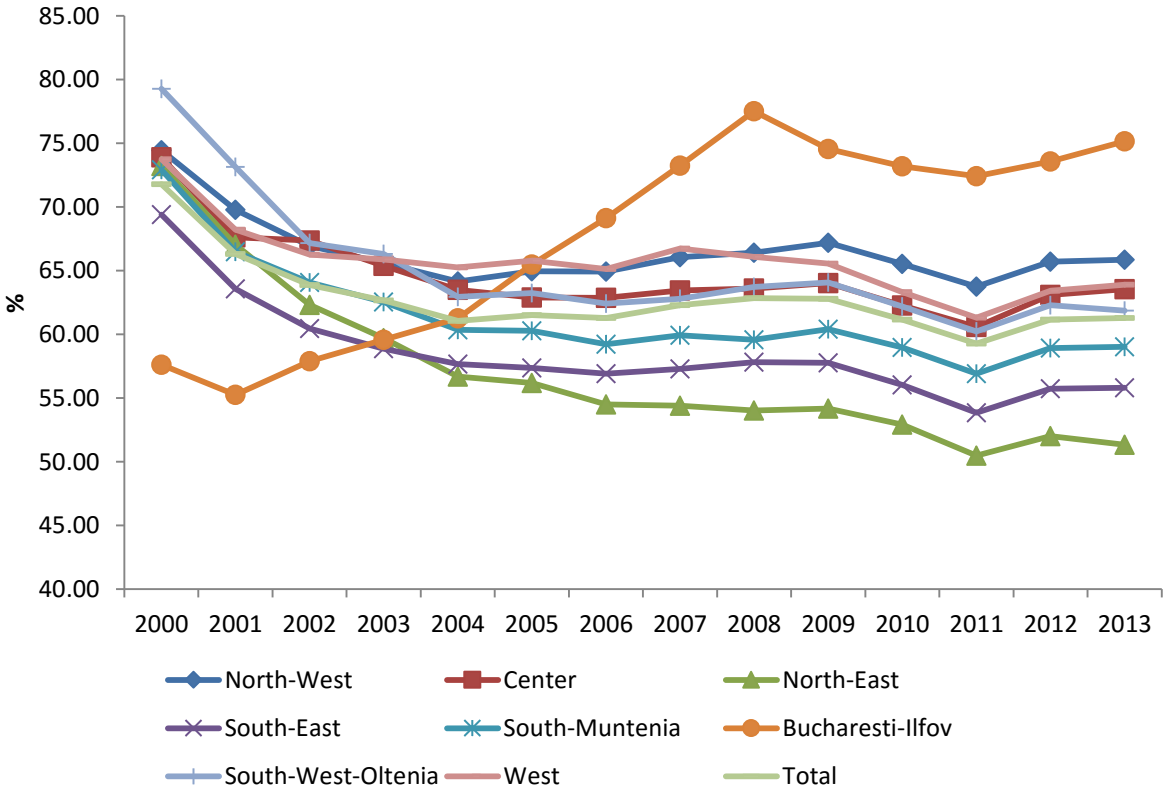
4. Empirical results

4.1. The labour approach using administrative data

In the process of estimation of informal employment has been used the alternative definition of activity rate (activity rate is equal to ratio of de facto active population to total population 15 years and over) because data on economically active population are not available.

If during the period 2000-2004 there is a sharp decline in the activity rate of population at the level of all regions, starting with 2005, it oscillated around a constant value until the beginning of 2009. In the period 2009-2011 there is a downward trend in the activity rate mainly due to the economic crisis, but for the last years 2012-2013 the activity rate registered a slowly increase. A discussion regarding the consequences of economic crisis in Romania is presented in Angelescu and Moldovan (2009) and Moldovan (2011).

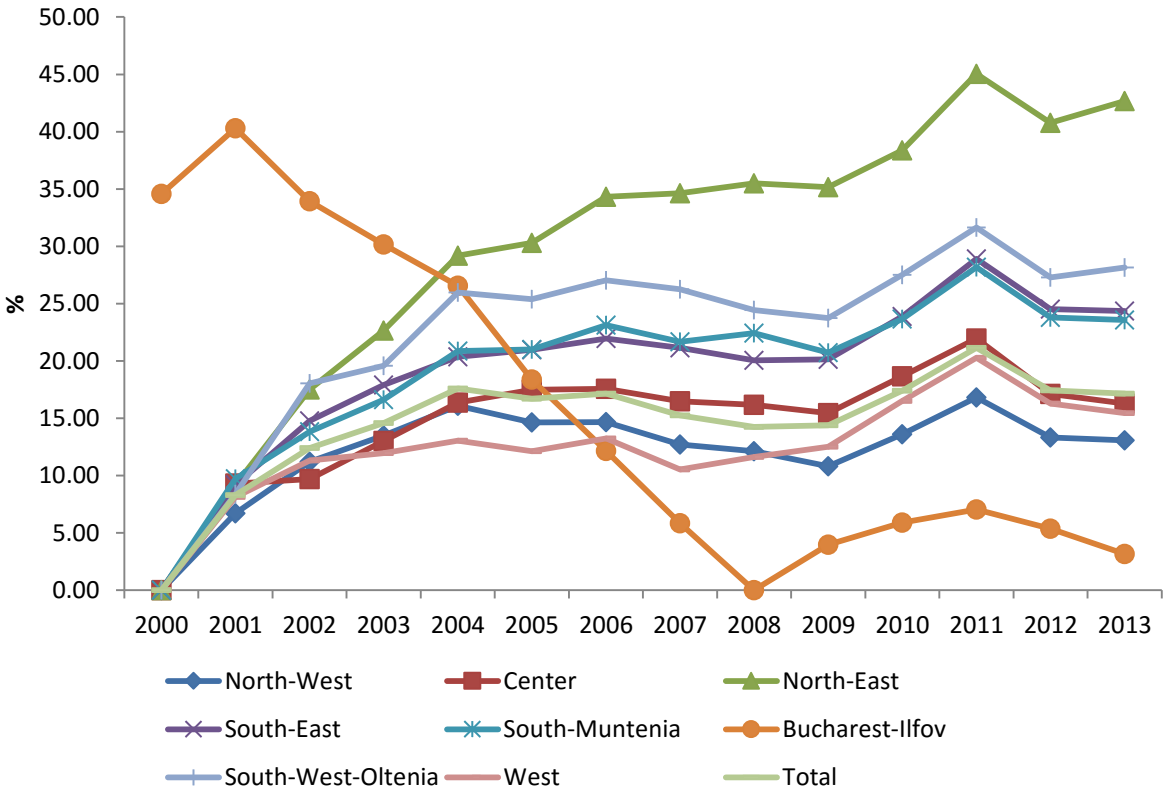
Fig.1. The evolution of activity rates at regional level in the period 2000-2013



By comparing both figures we find out that activity rate is inversely proportional to estimate of people employed in unofficial economy. As the activity rate falls, the unofficial employment grows. The obtained result is meaningful as the population switches from official to unofficial economy. One of the reasons for switching can be aspiration for higher earnings (black labour brings higher earnings). The assumption that everybody who leaves labour force enters unofficial economy is not entirely correct. Naturally, there is always a share of active population that becomes inactive, but this method cannot calculate its percentage.

However, the empirical results are approximatively, revealing the fact that the level of Romanian shadow economy is presumably underestimated due mainly to available statistics and method limitations.

Fig. 2. Estimate of employment in unofficial economy for 2000-2013
(% of civil active population)



The empirical results of regional analysis regarding the informal employment revealed the following:

- ✓ The regions with the highest ratio of informal employment over the analyzed period were North-East, South-West-Oltenia, South-Muntenia and South-East.
- ✓ Analyzing the evolution of informal employment, it can be highlighted the fact that all regions revealed an upward trend of informal employment until 2004, while after this period, to be maintained relatively constant until the beginning of 2009. For the period 2009-2011, it can be observed an increase of informal employment, while for the last two years its ratio to decrease slowly in intensity.

- ✓ An atypical case is registered by the Bucharest-Ilfov region who exhibits a strong downward trend from 40% in 2001 to 5.85% in 2007. This downward trend can be explained by the choice of the reference period in 2008 which considers the activities of the informal employment to have negligible size. Subsequently, there is an increase in informal employment activity which reaches its peak in 2011, while for the last two years it can observed a slightly downward trend.

Overall, the employment in the informal economy based on administrative data revealed an upward trend until 2006 reaching 17% while for the next three years, employment felled by three percentage points. Since 2009, the employment in the informal economy begins to grow reaching 21% in 2011.For the last two years, can be observed a decrease in informality to 17% level from active civil population.

At the level of the year 2013, the regions with the highest rates of employment in the informal economy as% of active population are North-East with a percentage of 42.6%, South-West Oltenia (28%), South-East (24) and South-Muntenia (23%).

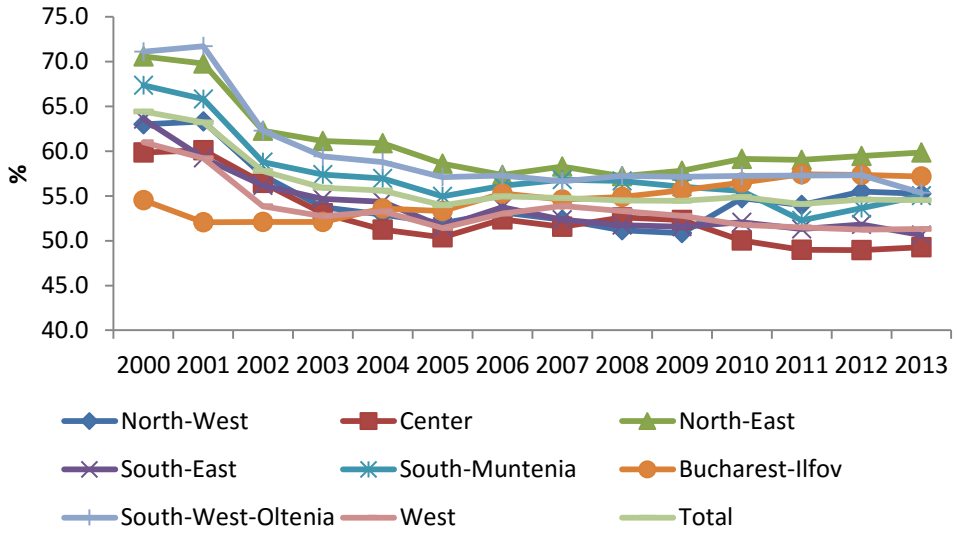
Fig.3. The map of informality in 2013 (administrative data)

4.2. The Labour approach using survey data

In order to determine the informal employment were used annual data regarding the activity rates from Labour Force Survey for the period 2000-2013 at regional level.

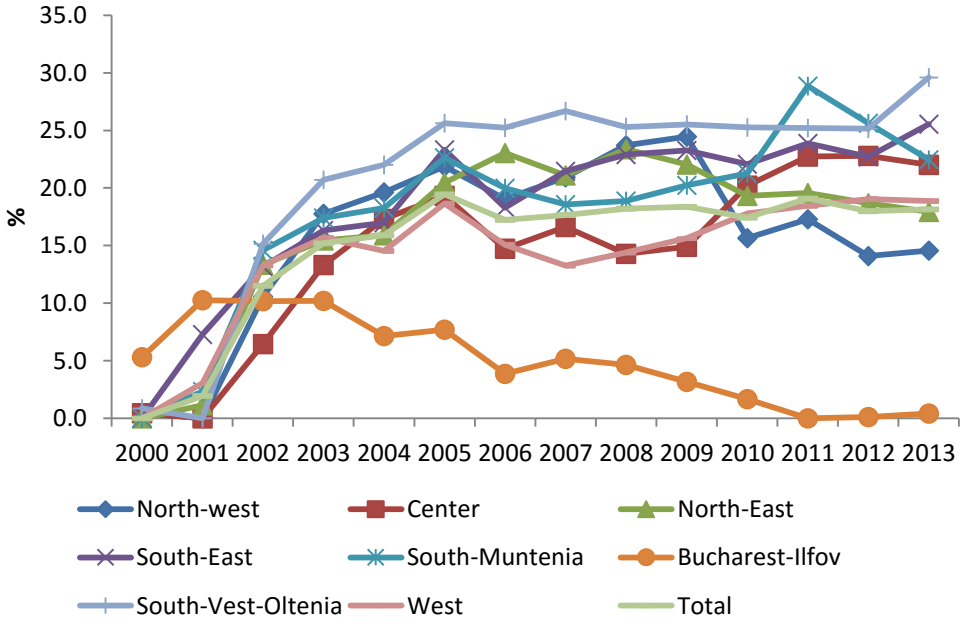
Analyzing the evolution of the activity rates using the LFS survey data, there is downward trend in the activity rates until 2007, while furthermore it highlighted a slowly increase who has maintained until the end of 2013. So, the activity rate lies between 49% and 71% during the whole period, with the exception of Bucharest-Ilfov region who manifest a ascendant trend registering the value of 52.1% at the end of 2001 and has reached the value of 57.2% at the end of 2013.

Fig.4. The evolution of activity rates at regional level in the period 2000-2013



By comparing both figures we find out that activity rate is inversely proportional to estimate of people employed in unofficial economy. As the activity rate falls, the unofficial employment grows. The obtained result is meaningful as the population switches from official to unofficial economy. One of the reasons for switching can be aspiration for higher earnings (black labour brings higher earnings). The assumption that everybody who leaves labour force enters unofficial economy is not entirely correct. Naturally, there is always a share of active population that becomes inactive, but this method cannot calculate its percentage.

Fig. 5. Estimate of employment in unofficial economy for 2000-2013
(% of civil active population)



Analyzing the ratio of people who work in the informal economy as % of active population on regions of development it was highlighted an ascendant tendency for the whole period in some regions while for others starting with 2008, the tendency was descendant. So, regions like North-West and North-East manifest a downward trend for the last years.

An atypical situation is registered by the Bucharest-Ilfov exhibiting unlike other regions a strongly decreasing trend until the reference year 2011 in which it is considered that informal businesses were negligible, as the average rate of activity reaches their peaks.

The analysis revealed the following regarding the informal employment on the regions of development:

- ✓ At the level of NW region, it showed an upward trend registering a value of 24.5% at the end of 2009, and then decline until reaching the value of 14.6% in 2013.
- ✓ The Central region, kept an ascending trend over the period analyzed, employment in the informal economy registering a value of 6.4% of active pop. in 2002 and reaches the the value of 22% at the level of 2013.
- ✓ The N-E Region showed an upward trend over the period 2000-2008, reaching 23.4% in 2008, and later decreased to 17.9% at the end of 2013.
- ✓ The S-E Region showed an upward tendency registering the value of 13.2% in 2002 and increased 25.5% in 2013.
- ✓ The S-W Region showed a decreasing trend until 2011, reaching the value of 28.9% in 2011 and 22.5% of the active population in 2013.
- ✓ An atypical case is Bucharest-Ilfov region exhibiting a strong downward trend from 10.2% in 2002 to 1.7% in 2010. This downward trend can be explained by the choice of the reference period (year 2011 it is considered to be the year in which the activities of the informal economy had negligible size).
- ✓ South-West Oltenia has the highest share of employment in the informal economy into the formal active population, highlighting a predominantly ascending trend, registering a value of 29.6% at the end of 2013.
- ✓ The West Region also show an upward trend for the period under review, reaching 13.3% in 2002 and reach 19% in 2013.

Overall, the employment in the informal economy based on data from the LFS survey revealed an upward trend until 2011 reaching 19% for the last two years. In the year 2013, the regions with the highest rates of employment in the informal economy as% of active population were: South-West Oltenia with a percentage of 29.6%, South-East (25.5%) and South-Muntenia (22.5%).

Fig.6. The map of informality in 2013(survey data)

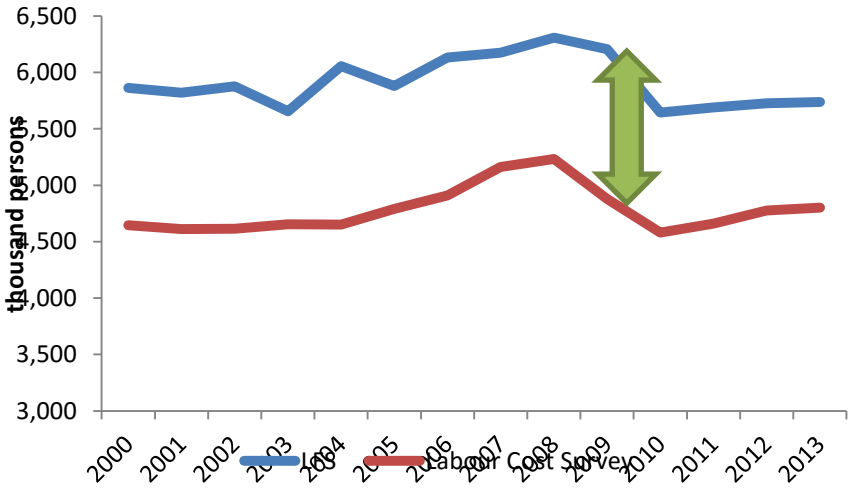
4.3. The Discrepancy method

In order to evaluate the level of informal employment we have analyzed the number of employees from two alternative sources-Labour Force Survey and Labour Cost Survey for the period 2000-2013.

Analyzing the evolution of the number of employees in Romania, having as a data source Labour Force Survey it can be highlighted an upward trend until 2008, when it has reached his maximum, 6308 thousand persons. In the period 2009-2010, the number employees begins to decrease reaching the value of 5644 thousand persons, with an absolute decrease of 664.5 thousand persons. For the period 2010-2013, the number of employees fallen on a slightly upward trend, reaching the value of 5.737.2 thousand people.

The data on employees using Labour Cost Survey revealed an increasing trend until 2008, reaching the value of 5232 thousand people, and sharpely decreased to 4580 thousand persons at the end of 2010. For the last years, we have a slowly increased trend reaching the value of 4900 thousand persons at the level fo 2013.

Fig.7. The evolution of the number of employees over the period 2000-2013



There are great differences between the data published by the National Statistics Institute (INS) on the number of people officially working and those that are paid for work performed.

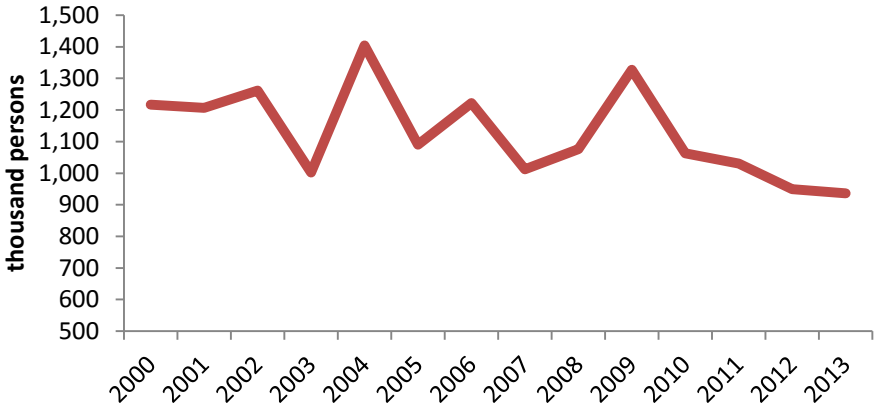
It still represents a practice in Romania, the situation in which employees receive money in envelope, without the employer to pay any tax to the state. The phenomenon has flourished particularly during the crisis. The main causes for this phenomenon are the excessive taxation on labor and lack of flexibility in the field, which does not allow hiring closely with periodic job creation but also the excessive bureaucracy.

Transforming the full-time contracts in part-time contracts, the usage of civil agreements or PFA contracts PFA represents the most usual methods through which employers avoid payment of taxes related to employees.

Analyzing any discrepancies between the number of employees on the basis of the two alternative data sources, it was highlighted the fact that the number of employees according to the Labour Force Survey for the period 2000-2013 stands at the level of 5.8 million people, while the number of employees estimated by the Labour Cost Survey is strongly underestimated to 4.8 million people, the difference can be attributed to people working illegally, adding up also the number of self-employed persons from agriculture.

Analyzing the people employed in the informal economy for the 2000-2013 period revealed that there are two points of maximum: the year 2004 (1400 thousand persons) and the year 2009 (1326 thousand persons). Since 2010, their number starts to decline registering a value of 936 thousand people at the end of 2013.

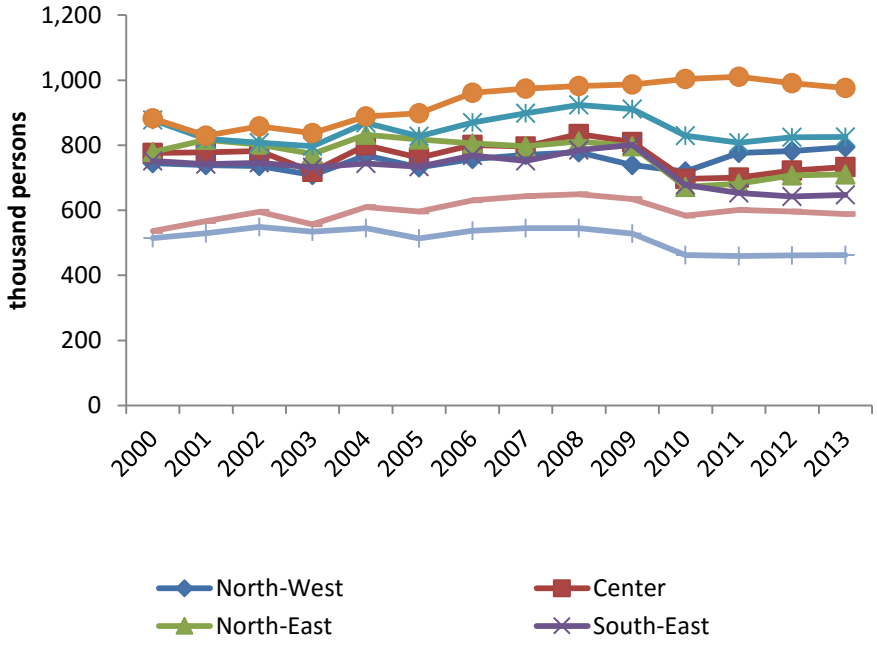
Fig.8. The number of persons employed in informal sector(thousand persons)



Analyzing now the distribution of employees on regions of development having the source of Labour Force Survey, it was highlighted an increase of its number in Bucharest-Ilfov region with 93.9 thousand persons from 882 thousand persons in 2000 to almost 976 thousand persons in 2013.

At the opposite side, it is South-West-Oltenia with the smallest number of employees for the whole period. The onset of the economic crisis in early 2009 is manifested in the number of employees in 2010, when it recorded steep declines in all regions except Bucharest-Ilfov region.

Fig.9. The evolution of employees on regions during the period 2000-2013



Data source: Employment and unemployment database, Eurostat

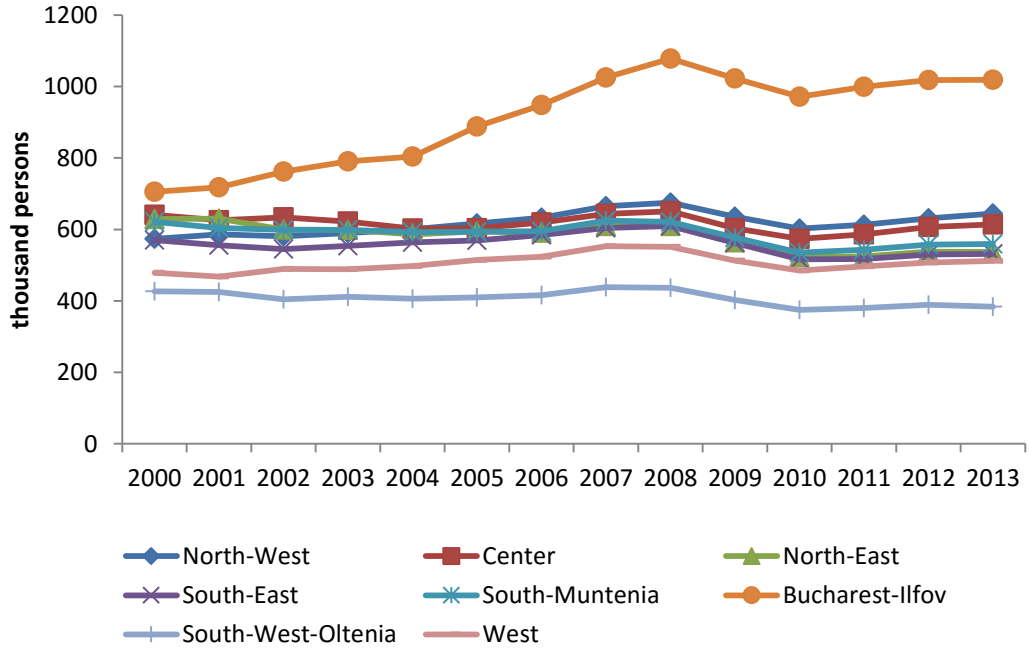
According to the Labor cost Survey in enterprises, it appears that the Bucharest-Ilfov region has the largest number of employees, unlike South-West Oltenia. The tendency in Bucharest-Ilfov region is steadily upward until 2008 because in 2008-2010, the trend to reverse and decrease their number. For the latest period there was a slight upward trend.

The decreasing of the demand for products and services has led to the reduction of employees in times of crisis. If the number of employees was decreased in 2010 compared to 2008 by about 651.7 thousand people, the number of employed persons decreased by only 575.5 thousand people. This means that part of the companies have fired part of the employees, but only on paper, because they continued to work, being paid without legal forms.

According to the Eurobarometer survey on undeclared work, Romania occupied the third place a year ago, alongside Greece and Slovenia among the countries where citizens have admitted receiving wages "in envelopes".

An important factor in the spread of undeclared work is held by taxes too high; a special category is represented by the day laborers in agriculture, the new form of "Day Laborers Law" adopted in 2014, provides clear rights and obligations for such workers.

Fig.10. The evolution of employees by regions of development during the period 2000-2013

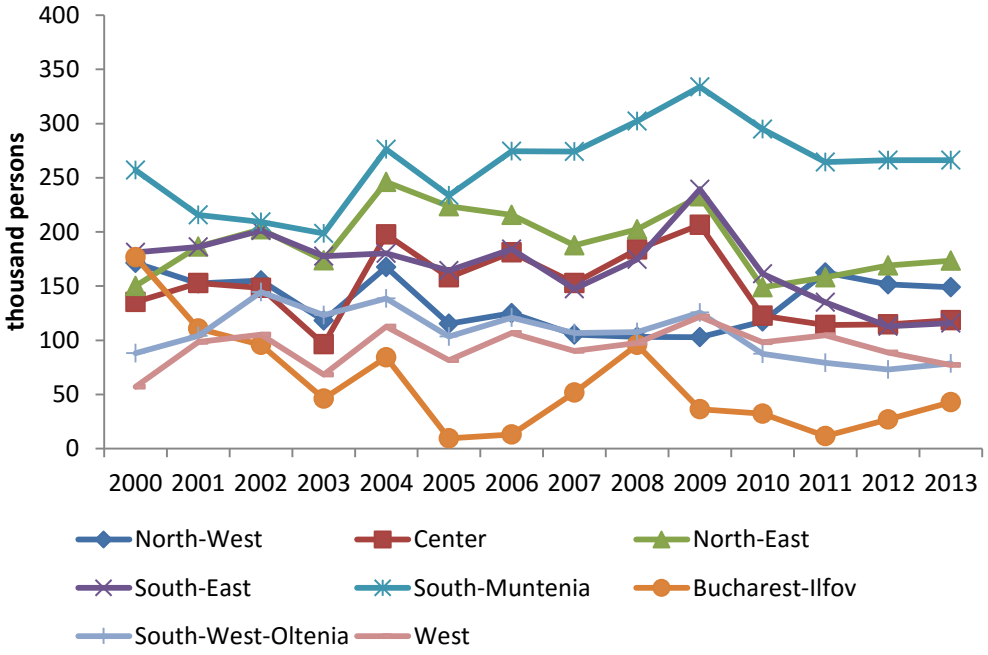


Data source: Tempo database, National Institute of Statistics

At regional level, the region with the highest number of persons employed in the informal economy is South-Muntenia region for the entire analyzed period ranging from 250 thousand people in 2000 to 334thousand people in 2009, reaching its peak at the onset of the economic crisis. For the past years, there is a downward trend, registering in 2013 the value of 266 thousand people.

At the opposite side, it was the Bucharest-Ilfov region with the lowest number of people involved in undeclared work in 2000 that recorded the amount of 177 thousand people and decreasing to only 42.8 thousand in 2013, falling by almost 75%.

Fig.11. Evolution of people employed in the informal economy by regions of development during 2000-2013



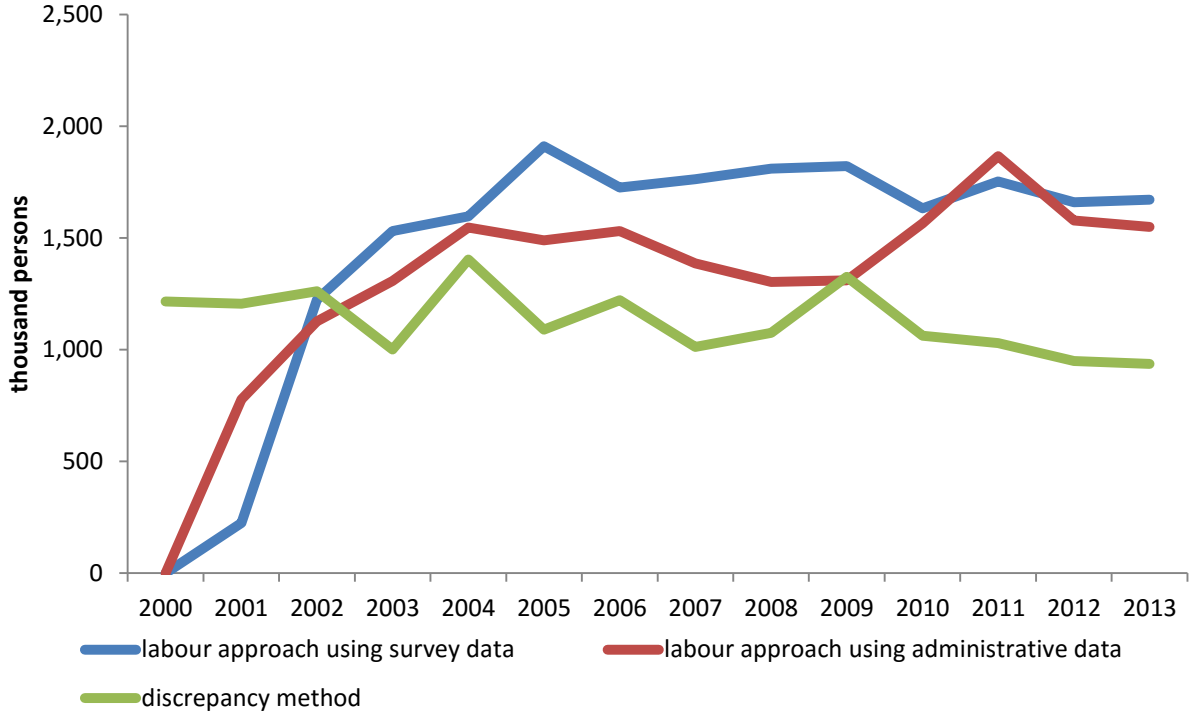
Analyzing the informality poles at the level of 2013, using the results of discrepancy method, we can highlighted the fact that South-Muntenia, North-East and North-West regions represented the informality poles for the year 2013, registering the highest number of people who work without legal forms. Contrarily, the Bucharest-Ilfov region represented the region with the smallest number of informal employed persons.

Fig.12. The map of informality in 2013(discrepancy method)

4.4. The comparisons of informal employment evaluations based on methods used

Comparing the results based on the labour approach using two alternative data sources (administrative data and survey data) as well as the results from discrepancy approach, it was pointed out the fact that unofficial employment based on labour approach using administrative data was deeply under evaluated, while the survey data reported significantly higher results, with the exception of the year 2011, when the number of informal employed persons from administrative data was 1866 thousand persons, in contrast with the results of 1753 thousand persons from LFS survey data.

Fig.13. The number of people employed in the informal economy during the period 2001-2013 using different methods

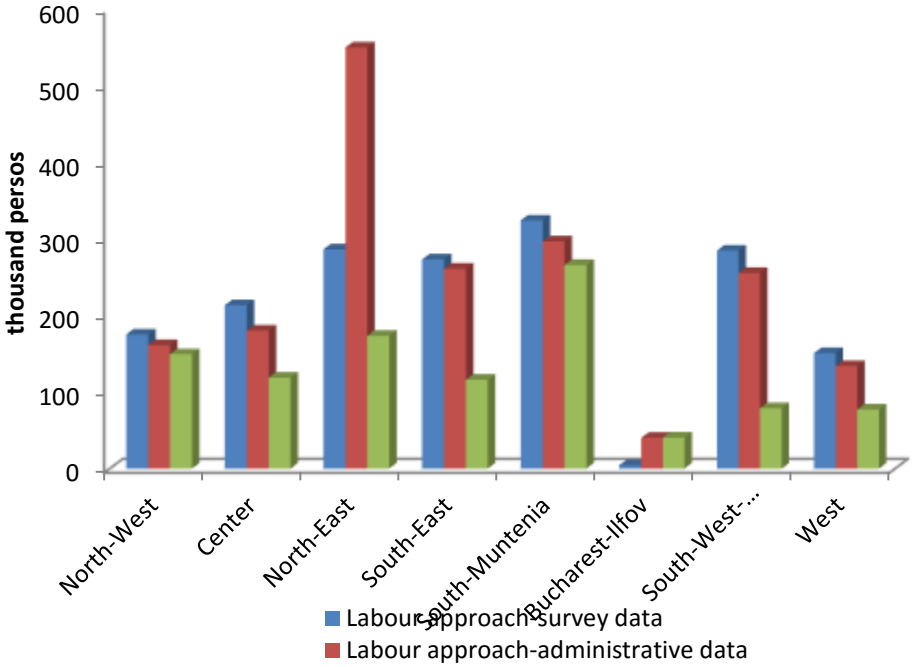


For 2013, the results from administrative data reported 1.55 million people that are employed informally, while the results from survey data suggested a larger number, 1.67 million people working in the informal sector. Since the total population aged 15 and over is similar for both data sources (the differences are negligible), variations in results may be due to differences in data on employment and unemployment.

The considerably lower results for informal employment based on administrative data can be explained by the lower figures of civilian employment and the unemployment compared with LFS survey data.

The empirical results based on the discrepancy method are considerably lower than those obtained from labour approach using both data sources. Thus, the number of people employed in the informal sector recorded two points of maximum: the year 2004 (1400 thousand) and 2009 (1.326 million people). Since 2010, their number started to decline registering the value of 936 thousand people.

Fig.14. The number of informal employed persons at regional level of 2013



The comparative analysis at regional level for 2013 based on the methods used revealed the following:

• Using labor approach based on survey data, the region with the highest number of people employed in the informal sector are South-West Oltenia, South-East and South-Muntenia;

• Using the labor approach based on administrative data, North-East, South-West Oltenia, South-East and South-Muntenia regions represented the poles of informality at the level of 2013.

Fig.15. Comparisons of informality based on the methods used at the level of 2013

Based on the results of discrepancy method, the regions with the highest number of persons employed in the informal sector are South-Muntenia, North-East and North-West.

The overall conclusion of the evaluation methods of informal employment on the regions of development based on the results of different methods of evaluation highlighted two main regions as poles of informality at the level of 2013-South-Muntenia and North-East regardless of the evaluation method.

Main conclusions

The paper aimed to estimate the level of informal employment in Romania at regional level using the labour approach and the discrepancy approach for the period 2000-2013 highlighting the regions with the highest level of informality using the both methods.

In order to do that, administrative data from Labour force balance, survey data from Labour Force Survey and data from Labour Cost Survey were used.

Comparing the results based on the labour approach using two alternative data sources (administrative data and survey data) as well as the results from discrepancy approach, it was pointed out the fact that unofficial employment based on labour approach using administrative data was deeply under evaluated, while the survey data reported significantly higher results, with the exception of the year 2011, when the number of informal employed persons from administrative data was higher comparative with the informal employed persons from survey data.

The considerably lower results for informal employment from the last years based on administrative data can be explained by the lower figures of civilian employment and the unemployment compared with LFS survey data.

The empirical results based on the discrepancy method are considerably lower than those obtained from labour approach using both data sources. Thus, the number of people employed in the informal sector recorded two points of maximum: the year 2004 (1400 thousand) and 2009 (1.326 million people). Since 2010, their number started to decline registering the value of 936 thousand people.

The empirical analysis based on the methods used revealed that using the labour approach based on survey data, the regions with the highest level of informality are South-West-Oltenia, South-East and South-Muntenia, while using the administrative data the regions North-East, South-West-Oltenia, South-East and South-Muntenia represented poles of informality for year 2013.

According to the second approach-discrepancy approach-, the regions with the highest number of persons employed in the informal sector are South-Muntenia, North-East and North-West.

The main conclusion regarding the evaluation of informal employment at regional level using different methods of estimation highlighted two main regions as poles of informality-South-Muntenia and Nord-East for the year 2013 regardless of the evaluation method.

It is important to note that because of its undetectable nature and character and taken into account the limitations of the methods, any theoretical or empirical inference derived from these results should always be regarded as an approximation.

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During the period June 2014-September 2015, she was a postdoctoral researcher in the project POSDRU/159/1.5/S/142115 „Performance and excellence in doctoral and postdoctoral research in Romanian economics science domain", analyzing the nature of the relationship between official economy and unofficial economy in Romania. She is the author of 4 books in the field of informal economy, of more than 37 articles in international journals of which 8 in ISI journals, more the 32 articles published in volumes of international scientific conferences recognized in the country and abroad. She has also participated to more than 5 courses and summer schools. She has a reach experience in the field of informal economy coordinating 5 projects in the field and more than 30 research projects as member team.

HIGHLIGHTING THE MAIN FACTORS OF JOB SATISFACTION AMONG JORDANIAN HOSPITAL EMPLOYEES

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Abstract:

The study of job satisfaction is justified on the basis of its potential value of understanding and in generating the positive outcomes from both the organisational and individual perspectives.
As Spector(1997) stated job satisfaction is more about "how people feel about different aspects of their jobs".
The present study was conducted on the hospital employees as they are one of the most important stakeholders in hospitals to probe the factors influencing their job satisfaction.
The paper aims to identify the main factors of job satisfaction using a sample of 325 hospital workers from Jordan using the Minnesota Satisfaction Questionnaire developed by Weiss (1967) a 5-point Likert-type scale with 20 items. This scale has been widely used in the literature being a well-known and stable over the time instrument with previous researches yielding excellent coefficient alpha.
Factor analysis was performed using Principal component analysis (PCA) method for extracting factors to establish characteristic components of the job satisfaction variables measured.
The empirical results revealed the existence of a 2-factor structure. This work aims at improving our understanding of the nature and assessment of Job Satisfaction in the Portuguese healthcare context, providing a more stable ground for future research in this area.

Key words: Job Satisfaction, exploratory factor analysis, hospital employees, healthcare context, Jordan

1. Introduction

This paper aims to investigate the empirical results of Minnesota Satisfaction Questionnaire – Short Version (Weiss et al., 1967) on a sample of 325 hospital workers from six hospitals of Jordan: King Abdullah Hospital public and private hospital, Amman Specialist Hospital private hospital in Amman, Irbid Specialist Hospital private hospital, Ibn Alnafis hospital private hospital, Al-shoneh hospital and Princess Basma hospital the biggest public hospital in Irbid city.

The present study was conducted on the hospital employees as they are one of the most important stakeholders in hospitals to probe the factors influencing their job satisfaction. Factor analysis will be performed using principal component analysis (PCA) method for extracting factors to establish characteristic components of the job satisfaction variables measured.

Taking into account the fact that several scales were used in the literature, I have decided to use MSQ short version having the advantages of being well-known and stable over the time instrument; also, the MSQ has been widely studied and validated (Fields, 2002).

There is a need for research regarding job satisfaction and related factors to explore the development of good human resources strategies in the context of hospital. The investigation of job satisfaction of the employees especially for healthcare institutions like hospitals can make a significant contribution to better understanding of the complex phenomena of employee behaviour.

2. Literature review

The term job satisfaction is referred to an individual's general attitude toward his or her job.

In research, job satisfaction, has been an assessed using global aspect as well as multiple facets like salary, career progression, supervisor (Fisher, 2003). This notion that satisfied employees will perform their work more effectively is the basis of many theories of performance, reward, job design and leadership (Shipton et al., 2006).

Job satisfaction is indirectly related to the quality of life, which depends on the degree of economic development. Improving the quality of people's lives represents the essence of sustainable development (Moldovan, 2016), while job satisfaction influences the economic performance of organizations. Tyson (2006, p.214) remarked that the achievement of the organizational aims and objectives depends on the quality of their employees' work performance. These employees have motivational needs for development, recognition, status, and achievement that can and should be met through job satisfaction and performance achievement.

Job satisfaction has been studied in the early studies by the two factor theory of Herzberg(1968) who describes two factor theories: the hygiene and motivator factors. Extrinsic factors such as administration, company strategies, work conditions, salary, and relationships among co-workers are considered "hygiene" factors which can cause job dissatisfaction.

Intrinsic factors such as recognition, achievement, personal development, advancement, and responsibility are referred to as "motivators" that can create job satisfaction. Using a sample of 100 hospital respondents, Yafe(2011) found the job satisfaction to be independent of the gender and the job experience of the employees of the hospital. Demographic variables such as age, gender, current job position, marital status, and experience have effect on job satisfaction or dissatisfaction.

Study by Chaulagain and Khadka (2012) found job satisfaction of healthcare professionals to be significantly influenced by factors such as opportunity to develop, responsibility, patient care, and staff relations. However no association was found between sociodemographic characteristics and job satisfaction.

Job satisfaction research in healthcare has been conducted mainly accordingly to different professions, studying nurses, doctors, therapists, etc. separately. Therefore there

seems to lack a global approach to healthcare, namely at hospitals, envisaging all employees as an important part of the healthcare service.

Romanian employees' job satisfaction through Herzberg's two-factor theory have been treated by Casuneanu (2011), Alexandru and Casuneanu (2010) and Alexandru and Casuneanu(2011).

Casuneanu (2010) analyze the main characteristics of employee motivation system in the Romanian companies revealing the job stability occupies the first place in employee preferences followed by job type and wage offer. The vocational development and the job enrichment are also important for the Romanian employees. The results of the study do confirm the assumption that money is not everything in terms of work motivation, suggesting that managers need to focus more on non-financial incentives to better motivate employees.

A previous study on the field was the paper of Casuneanu (2011) in which it were analyzed the most important motivating factors from the point of view of the Romanian employee, ranking up the factors using a mean score for each factor that illustrates its importance relative to other motivational factors. The empirical results pointed out that the most important motivating factors are job authority, responsibility and autonomy, job stability and professional development.

Alexandru and Casuneanu (2010) and Alexandru and Casuneanu (2011) applies Herzberg's two-factor theory to 402 Romanian employees, determining empirically the motivator-hygiene factors that have a significant impact on the overall level of Romanian employee job satisfaction, using the technique of principal components analysis, The results show that a motivation-hygiene theory with three principal components (achievement, company policy and administration and interpersonal relationships) best explains the process of motivating employees. The study also indicates that achievement and the company policy have a significant impact on the overall level of employee job satisfaction, suggesting that managers need to focus more on these factors to better motivate employees.

3. Minnesota Satisfaction Questionnaire

The Minnesota Satisfaction Questionnaire was one of the outputs from the "Work Adjustment Project" at the University of Minnesota; this is a self-reporting measure, suitable for individuals of all school levels that can be administrated separately or individually.

The 20 MSQ-short version items are rated on a 5-point Likert scale (1 "very dissatisfied with this aspect of my job", 2 "dissatisfied with this aspect of my job", 3 "can't decide if I'm satisfied or dissatisfied with this aspect of my job", 4 "satisfied with this aspect of my job" and 5 "very satisfied with this aspect of my job"). Item responses are summed or averaged to create a total score – the lower the score, the lower the level of job satisfaction. The MSQ "short form" includes only 20 of the 100 original items, namely, the ones that better represented each of the 20 original subscales (Ahmadi and Alireza, 2007).

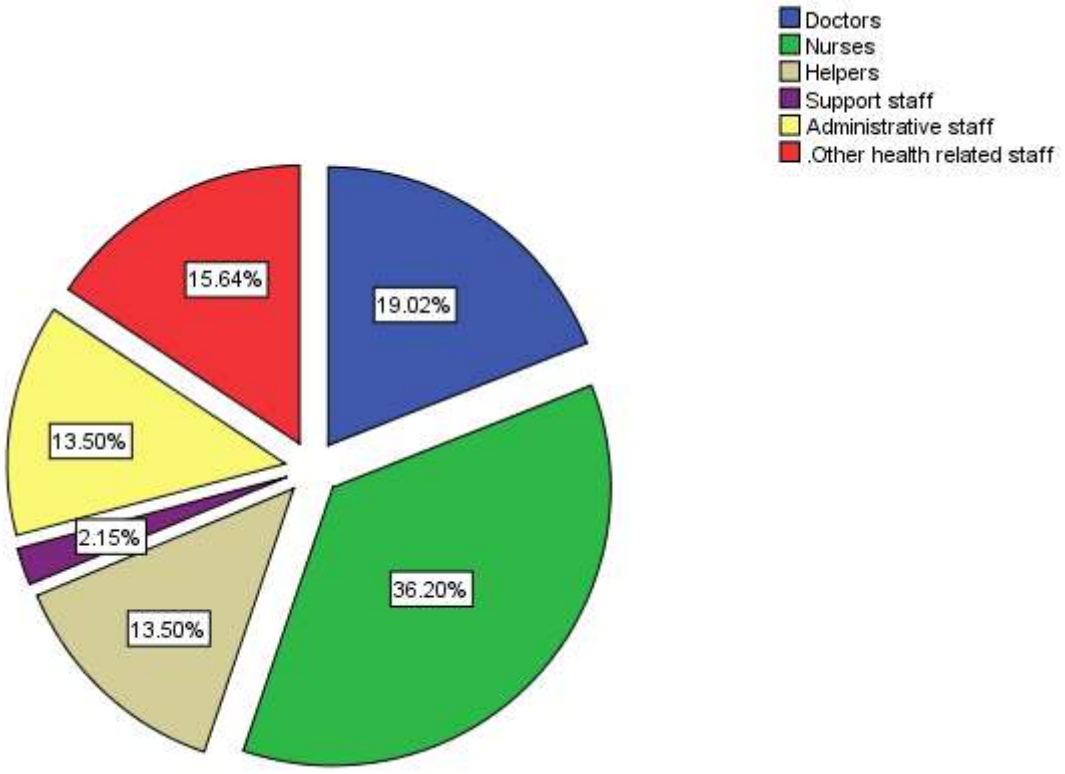
4. Sample and data analysis

The exploratory qualitative research was carried out among 400 health workers (doctors and nurses, from which we had 325 respondents and 75 does not filled properly) from six hospitals of Jordan both public and private hospitals.

The majority of the respondents have ages lying between 25 and 35 years(50.9%) and most respondents are male(53.1% male respondents), 43.3% of respondents have bachelor degree in science as level of graduation and 70.2% of the respondents are married.

In terms of the job, the distribution of staff per job group is shown in Figure 1, where nursing staff represents 36.2% of the total staff, medical doctor take up about 19%, helpers, that is to say the operational assistants for nurses and doctors, are about 13.5%, other health related staff (such as physical therapists, speech therapists, psychologists) represent 15.6%, administrative/support staff (employees with clerical functions, take up 13.5% and finally 2% are support jobs, related to maintenance and other logistics.

Fig.1. Percentages of staff in different job functions in our sample



In terms of seniority, the majority of the respondents have more than ten years' experience in working in the current hospital and also in the same positions.

Regarding the area of work, the majority of the respondents (52.1%) work in therapeutic area, while 70.9% of the respondents declared that they don't have management positions.

Regarding the unit's average daily census, 62.3% of the respondents declared that they have more than 20 patients per day.

In the present sample, descriptive statistics for each item revealed that the answers to almost all items ranged between the minimum and the maximum (Table I). The frequen-

cy's analysis in each response option revealed an acceptable distribution in all the items, with no percentages above 50% in a single response alternative. In most items, means and medians are similar; skewness and kurtosis values are acceptable, indicating that its distribution approximates the normal distribution.

Table 1. Content, means and standard deviations of the items

Descriptive statistics	Mean	Std. Deviation
Being able to keep busy all the time.	3.77	1.051
The chance to work alone on the job.	3.35	1.220
The chance to do different things from time to time.	3.20	1.185
The chance to be "somebody" in the community.	3.75	1.087
The way my boss handles his/her workers.	3.32	1.173
The competence of my supervisor in making decisions	3.36	1.185
Being able to do things that don't go against my conscience.	3.68	1.191
The way my job provides for steady employment.	3.78	1.058
The chance to do things for other people.	3.98	.908
The chance to tell people what to do.	3.73	1.018
The chance to do something that makes use of my abilities.	3.68	1.069
The way company policies are put into practice.	3.15	.996
My pay and the amount of work I do.	2.66	1.264
The chances for advancement on this job.	3.04	1.220
The freedom to use my own judgment	3.35	1.129
The chance to try my own methods of doing the job	3.51	1.086
The working conditions.	3.20	1.160
The way my co-workers get along with each other.	3.78	1.068
The praise I get for doing a good job.	2.94	1.236
The feeling of accomplishment I get from the job.	3.11	1.283

Exploratory factor analysis (EFA) has traditionally been employed by researchers as a tool to determine the number of underlying dimensions in a data set by grouping variables that are correlated (Tabachnick and Fidell, 2007).

5. Empirical results

A principal components analysis (PCA) was conducted on the 20 items with oblique rotation (promax) using SPSS software. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO=0.85 and all KMO for individual items (measures of sample adequacy) were >0.7 which is well above the acceptable limit of 0,5 (Field, 2009). Bartlett's test of sphericity $\chi 2(45)=685.67$, $p< 0.001$, indicated that correlations between items were sufficiently large for PCA.

Table 2. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.851
Bartlett's Test of Sphericity	Approx. Chi-Square	2360.889
	df	190
	Sig.	.000

An alternative way to investigate the degree of correlation among a set of variables is to use the Cronbach coefficient alpha (c-alpha), which is the most common estimate of internal consistency of items in a model or survey. Coefficient alpha (c-alpha) measures the

internal consistency in the set of individual indicators, how well they describe a unidimensional Construct (OECD, 2008).

C-alpha is not a statistical test, but a coefficient of reliability based on the correlation between individual indicators. That is, if the correlation is high, then there is evidence that the individual indicators are measuring the same underlying construct. Nunnally (19780 suggests 0.7 as an acceptable reliability threshold. Yet some authors use 0.75 or 0.80 as a cut-off value, while others are as lenient as 0.6. In our case, The C-alpha value of 0.877 revealed a good reliability of original data.

Table 3. Total Variance Explained

Component		Initial Eigenvalues			Extraction Sums of Squared Loadings	
		Total	% of Variance	Cumulative %	Total	% of Variance
dimension	1	6.132	30.658	30.658	6.132	30.658
	2	2.181	10.906	41.564	2.181	10.906
	3	1.634	8.172	49.736	1.634	8.172
	4	1.114	5.569	55.305	1.114	5.569
	5	.990	4.951	60.256	.990	4.951
	6	.924	4.619	64.875	.924	4.619
	7	.804	4.019	68.894		
	8	.747	3.737	72.631		
	9	.667	3.335	75.966		
	10	.658	3.289	79.256		
	11	.630	3.148	82.404		
	12	.537	2.685	85.089		
	13	.518	2.589	87.678		
	14	.457	2.286	89.964		
	15	.429	2.145	92.109		
	16	.380	1.901	94.010		
	17	.369	1.844	95.855		
	18	.297	1.487	97.342		
	19	.289	1.447	98.788		
	20	.242	1.212	100.000		
Extraction Method: Principal Component Analysis.						

Information on quality adjustment is expressed using the variance explained with the help of the eigenvalues (presented in Table 3). The table presents the variance explained by the initial solution (components), the extracted components and also the rotated components. Therefore, the analysis of the quality of the cloud of points 'adjustment is performed using the eigenvalues.

The first six principal components from the extracted solution explain 64.87% of the variability in the original twenty variables and they are the only ones with eigenvalues almost 1. One of the most commonly used techniques is Kaiser's criterion, or the eigenvalue rule. Regarding the entire process, step by step, we notice that adjusting the points' cloud by a single factorial axis (accepting only the first synthetic indicator), explains 30.65% of total variance; then, adjusting the points' cloud by the first two factorial axes (accepting two synthetic indicators), we recover an additional 10.90% of the total variance (a total of 41.56% of the initial variance). The last two principal components explain almost the same amount of the remaining variance, 4% of total variance.

Six components had eigenvalues over Kaiser's criterion of almost 1 and an analysis of the scree plot indicated the existence of four components as well. Table 4 shows the factor

loadings after the rotation. The items that cluster on the same components suggest that component 1 represents satisfaction with advancement, component 2 satisfaction with empowerment, component 3 satisfaction with task enrichment, component 4 satisfaction associated with the freedom to using own judgment, component 5 satisfaction with the ability of doing things that don't go against its own conscience and component 6 satisfaction with the way in which company policies are put into practice.

Davidescu(2013) and Davidescu(2014a, 2014b) stated that it is important to take into account also the main element of financial motivation-the salary-having in mind the fact that a low level of wages will deeply demotivated employees and thus will increase the propensity of going into the informal sector in order their earnings.

Table 4. The empirical results of Pattern Matrix of PCA analysis

	Component					
	1	2	3	4	5	6
Being able to keep busy all the time.	-.529	-.125	.350	.285	.266	.202
The chance to work alone on the job.	-.037	-.082	.751	-.177	.018	.302
The chance to do different things from time to time.	.063	.166	**.811**	-.071	-.164	.013
The chance to be "somebody" in the community.	-.159	.538	.427	-.007	.056	-.114
The way my boss handles his/her workers.	.229	.004	.727	-.037	.045	-.100
The competence of my supervisor in making decisions	.373	-.157	.622	.032	-.027	.053
Being able to do things that don't go against my conscience.	.191	.033	-.058	-.106	**.963**	-.213
The way my job provides for steady employment.	.093	.139	-.108	.055	.570	.315
The chance to do things for other people.	-.116	.718	.034	.098	.140	-.093
The chance to tell people what to do.	.138	**.768**	.023	-.177	-.013	.096
The chance to do something that makes use of my abilities.	.010	.683	-.003	.099	-.085	.243
The way company policies are put into practice.	.262	.083	.100	.035	-.131	**.763**
My pay and the amount of work I do.	.709	-.165	.056	.053	.017	.430
The chances for advancement on this job.	.525	-.101	.110	.495	.045	-.170
The freedom to use my own judgment	.113	-.007	-.139	**.897**	.064	-.055
The chance to try my own methods of doing the job	.020	.187	-.100	.767	-.223	.227
The working conditions.	.637	.045	-.048	-.048	.161	.352
The way my co-workers get along with each other.	.076	.606	-.133	.143	.046	-.019
The praise I get for doing a good job.	**.746**	.124	.069	-.051	.113	.106
The feeling of accomplishment I get from the job.	.575	.069	.286	.157	-.002	-.132
Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.						
a. Rotation converged in 10 iterations.						

After the original Weiss et al.'s (1967) factor solution, Schriesheim and colleagues (1993) conducted a content adequacy assessment of the MSQ short-form intrinsic and extrinsic subscales. Using its classification we can revealed the type of intrinsic or extrinsic motivation in our principal components.

Table 5. Summary of previous factor solutions found in the literature

	Original	Schriesheim et al., 1993	Martins, 2008	Sousa et al., 2011
The chance to do different things from time to time.	Intrinsic	Intrinsic	*	*
Being able to do things that don't go against my conscience.	Intrinsic	Intrinsic	*	*
The chance to tell people what to do.	Intrinsic	Intrinsic	Intrinsic	*
The way company policies are put into practice.	Extrinsic	Extrinsic	Extrinsic	Extrinsic
The freedom to use my own judgment	Intrinsic	Intrinsic	Extrinsic	*
The praise I get for doing a good job.	Extrinsic	General	*	*

6. Discussion and conclusions

The results of this study provide evidence that the MSQ-Short Version is a valid and reliable scale for the measurement of job satisfaction of hospital workers. Construct validity of the MSQ was explored by factor analysis, which determined the convergent assignment of constructs to items within each subscale of the MSQ. The items show good communalities and strong factor loadings.

For the majority of the workers it makes sense the mostly intrinsic satisfaction items, with major latent constructs: task enrichment, satisfaction with rightness, satisfaction with empowerment, satisfaction with the freedom of acting.

As extrinsic satisfaction items we have two latent constructs: satisfaction related with the way company policies are put into practice and the praise for doing a good job. The main conclusion of this paper is that the MSQ is a valid instrument for measuring job satisfaction of global hospital workers.

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