METODY ILOŚCIOWE
W BADANIACH EKONOMICZNYCH

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THE DIVERSITY OF EUROPEAN UNION COUNTRIES ACCORDING TO EQUIPMENT WITH AGRICULTURAL TRACTORS

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Abstract: The research of taxonomic structure of holdings owning agricultural tractors in EU countries was conducted on the basis of statistical information from EUROSTAT database, for 2013 year. The purpose of this article was to present level of equipment of holdings in European Union countries in agricultural tractors in the spatial aspect. The method of vector elimination was used in the analysis. Apart from the analysis concerning the fact of the possession of agricultural tractors according to areal groups of arable land in the European countries, the groups of countries with similar structure were distinguished. Percentage of holdings possessing tractors was related with the number of holdings in each groups of areal groups of arable land.

Keywords: agricultural tractors, European Union, additive structures

INTRODUCTION

Technical equipment of farms within the area of agricultural machines and devices is one of the fundamental factors influencing effective agricultural production. The level of this equipment in the countries of European Union (EU) depends mainly on the agrarian structure of the region, crop structure and

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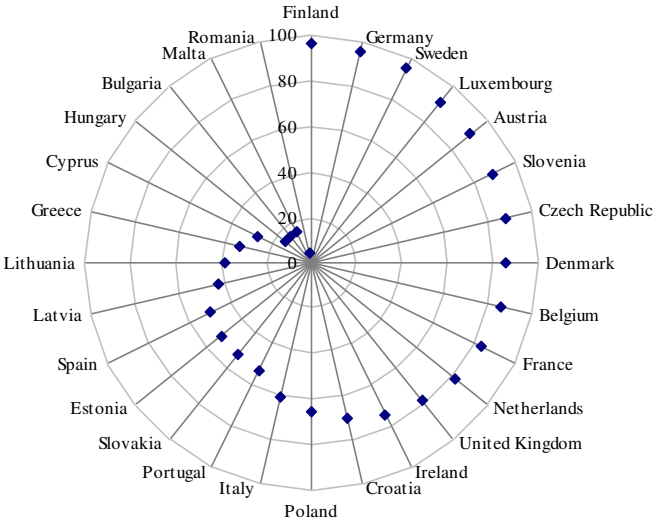
productivity of farms. Technical equipment of agriculture of Middle-East countries has been undergoing dynamic changes.

In spite of the fact that old machinery allows for performing basic agricultural activities concerning farm, new sophisticated devices are much better at stepping up farm productivity. Duczkowska-Małysz [1998] emphasizes that modernized farms are capable of absorbing biological and technical progress, cost reduction and meeting challenges of competence. In the EU policy there is a lot of attention focused on tasks connected with bridging disproportions of agricultural development in regional aspect.

In the countries of Western Europe (see Figure 1) in 2013 almost 100% of farms were in the possession of agricultural tractor. Best equipped farms were identified in Scandinavian countries and the countries of UE-12, in particular Germany, Austria and Benelux countries, where more than 90% of farms were equipped with agricultural tractor. One should also notice that the position of Poland in the ranking arrangement of the EU countries in this aspect is relatively high (66% of farms were in the possession of agricultural tractors). Moreover, Poland position was better than those of Italy, Portugal and Spain. Another observation is that agriculture in Romania and Bulgaria suffers from severe lack of finances. The reason for this phenomenon seems to be a significant fragmentation of farms.

Figure 1. Ranking arrangement of the EU countries with respect to the percentage of farms equipped with agricultural tractors in 2013



Source: own elaboration on the basis of Eurostat data

In 2013 (see Table 1) in case of one fourth of the EU countries with the lowest level of mechanization of agriculture the possession of agricultural tractors occurred in not more than 41.3% of farms. In turn, in case of half of the countries considered in the research the level of mechanization was satisfactory, the index of farms in with agricultural tractors achieved at least 68%. Moreover, in farms of the area more than 20 hectares in the countries of the European Union at least 86% of farms on average is equipped with agricultural tractors, while in the areal group of farms up to 5 hectares the percentage is significantly lower and differentiated.

Table 1. Basic characteristics of the percentage of farms equipped with agricultural tractors according to areal groups of arable land

Specification	Areal groups [hectares]						Total
	< =5	5-10	10-20	20-50	50-100	>=100	
quartile 1	21.13	57.59	69.61	79.08	81.20*	83.15*	41.30
median	46.88	74.49	83.93	89.81	92.27*	90.91*	67.60
quartile 3	64.13	87.59	92.07	95.73	96.24*	95.60*	86.15
arithmetic mean	45.59	69.08	79.42	85.89	88.19*	87.58*	61.50
coefficient of variation	55.89	30.08	19.82	13.66	11.79*	11.51*	45.77

Source: own elaboration; *estimated for 27 countries (apart from Malta)

The aim of the paper was to present the level of technical equipment of farms in the EU countries with respect to agricultural tractors in spatial aspect. The analysis of structure of farms being in the possession of agricultural tractors was carried out, according to areal groups of arable land in the EU countries and groups of countries with similar structure were distinguished.

MATERIAL AND METHOD

The analysis was conducted on the basis of data from the Polish Central Statistical Office, concerning international statistics and EUROSTAT database. The data considered in the research refer to the number of farms equipped with agricultural tractors according to areal groups determined as follows: up to 5 hectares, 5-10 hectares, 10-20 hectares, 20-50 hectares, 50-100 hectares, more than 100 hectares in the European Union.

The structure under investigation according to the determined areal groups in 2013 in the EU countries can be expressed in the form of the following matrix $\lfloor a_{ij} \rfloor$:

$$\left[a_{ij}\right]_{\substack{i=1,2,\ldots,n \\ j=1,2,\ldots,m}} = \begin{bmatrix} a_{11} & a_{12} & \ldots\ldots\ldots & a_{1m} \\ a_{21} & a_{22} & \ldots\ldots\ldots & a_{2m} \\ \ldots. & \ldots. & \ldots\ldots\ldots & \ldots. \\ \ldots. & \ldots. & \ldots\ldots\ldots & \ldots. \\ a_{n1} & a_{n2} & \ldots\ldots\ldots & a_{nm} \end{bmatrix} \quad (1)$$

where a_{ij} describes the partition of number of farms equipped with agricultural tractors from the areal group j in the total number of farms under investigation in the country i, under the assumption that the following conditions are fulfilled: $0 \le a_{ij} \le 1$ and $\sum_{j=1}^{m} a_{ij} = 1$, i =1, 2, …, n.

The measure of concentration degree of his phenomenon on the basis of the information contained in the matrix $\lfloor a_{ij} \rfloor$ can be obtained by the application of the following formula [Kukuła 1989]:

$$K_i = \frac{\left(m + \sqrt{m}\right) \cdot W_i - \sqrt{m} - 1}{m - 1} \tag{2}$$

where $W_i = \left(\sum_{j=1}^{m} a_{ij}^2 \right)^{1/2}$ is the specialization coefficient [Szyrmer 1975].

The measure K_i takes values from the interval [0, 1]. Low values of this measure can be interpreted in terms of uniform distribution of the phenomenon under investigation.

The basis for the division of countries into groups of objects that are similar with respect to the structure under consideration is the symmetric matrix $[d_{ik}]_{(i,k=1,\ldots,n)}$, elements of which represent measures of differentiation of structures being investigated that are estimated for each pair of countries according to the following formula [Kukuła 1989]:

$$d_{ik} = \frac{\sum_{j=1}^{m} \left| \alpha_{ij} - \alpha_{kj} \right|}{2} \tag{3}$$

Matrix $[d_{ik}]_{(i,k=1,\ldots,n)}$ was transformed into binary matrix of similarities $[p_{ik}]_{(i,k=1,\ldots,n)}$, with elements p_{ik} defined as follows:

$$p_{ik} = \begin{cases} 0, & when \quad d_{ik} < d^* \\ 1, & when \quad d_{ik} \ge d^* \end{cases}, \tag{4}$$

where the threshold value was assumed to be at the following level:

$$d^* = \frac{2 \sum_{i=1}^{n} \sum_{k>i} d_{ik}}{n(n-1)} \tag{5}$$

Matrix $[p_{ik}]_{(i,k=1,\ldots,n)}$ is the starting point for grouping of voivodeships according to the procedure of Victor elimination proposed by Chomątowski and Sokołowski [1978].

RESEARCH RESULTS

High differentiation level expressed in the value of the coefficient of variation (see Table 2) is observed in case of these elements of the structure that refer to the farms of smallest area (up to 5 hectares) or large area (more than 20 hectares). Only in case of seven EU countries not more than 11% of agricultural tractors were identified in farms of the area up to 5 hectares. Turn in half of these countries at least 46% of the total number of tractors were in the possession of these small farms.

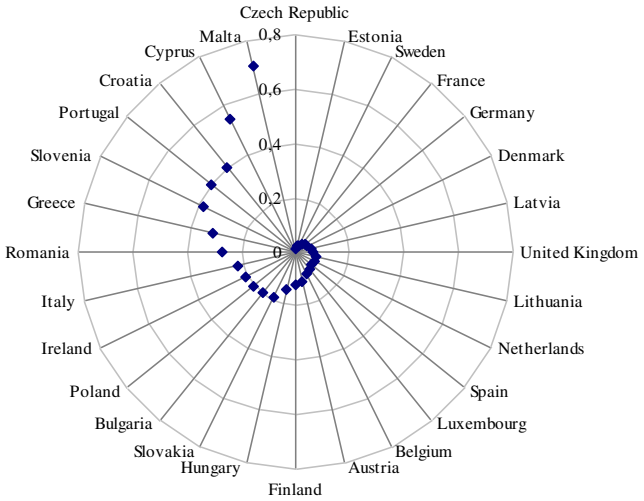
Table 2. Basic characteristics of elements of the structure of farms equipped with agricultural tractors according to areal groups of arable land

Specification	Areal groups [hectares]					
	< =5	5-10	10-20	20-50	50-100	>=100
quartile 1	0.11	0.12	0.11	0.09	0.03*	0.03*
median	0.27	0.16	0.16	0.17	0.07*	0.08*
quartile 3	0.46	0.21	0.20	0.23	0.17*	0.15*
arithmetic mean	0.29	0.17	0.16	0.18	0.10*	0.10*
coefficient of changeability	69.46	32.82	30.98	55.09	75.90*	83.64*

Source: own elaboration; *estimated for 27 countries (apart from Malta)

In the research of distribution uniformity of agricultural tractors in farms with respect to their area the concentration coefficient described by the formula (2) was applied. It is very useful due to its simple structure and easy interpretation. It is based merely on frequencies of occurring some levels instead of their values. Ranking arrangement of the EU countries with respect to the K_i value is presented by Figure 2. The highest level of the concentration coefficient was observed in Cyprus and Malta, in these countries there are most farms of the area up to 10 hectares and in fact there are no farms the area of which is more than 20 hectares, therefore the majority of machines occurred in small farms. In case of eight countries (Croatia, Portugal, Poland, Greece, Slovenia, Italy, Ireland and Romania) the average level of concentration of the phenomenon was established. In general in these countries most tractors were used in farms of the area up to 10 hectares. This fact can be explained by significant fragmentation of agriculture in case of countries classified in this group. The concentration coefficient in the other eighteen countries presented in the research and slow, on the level of less than 0.2, which show that the technical equipment of farms is uniform in all areal groups under investigation.

Figure 2. Ranking arrangement of the EU countries with respect to the K_i value estimated according to the formula (2)

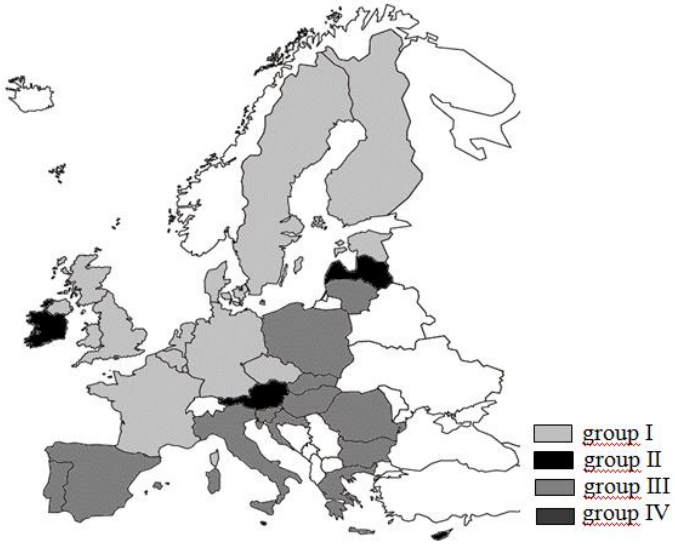


Source: own investigation

The interesting issue concerning such disciplines as regional policy for example, is the observation of objects with respect to the similarities that occur among them. The problem of identifying groups of similar objects out of the population under consideration can be solved with the help of vector elimination method. The result of the application of the research methods discussed earlier is the distinction of groups of objects of similar structure.

In 2013 assuming the thresh hold value for differentiation level to be $d^*=0.345$, basing on vector elimination method 4 groups of similar countries were distinguished. Membership of particular objects in distinguished typological groups is shown in Figure 3.

Figure 3. Groups of countries similar with respect to the structure of percentage of farms with agricultural tractors in 2013



Source: own elaboration on the basis of the EUROSTAT database

Group I consists of Scandinavian countries and the EU-12 (Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Luxemburg, The Netherlands, Sweden, Great Britain), where the percentage of farms in the possession of agricultural tractors in particular areal groups was the highest in case of large farms, of the area more than 20 hectares.

In the countries of group II (Austria, Ireland, Latvia) the domination of farms of the area 10-20 hectares and 20-50 hectares occurs. This is associated with the highest percentage of farms with agricultural tractors.

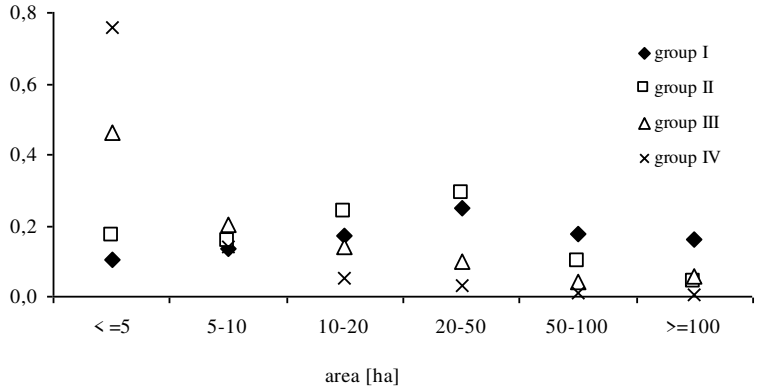
The most numerous group III contains countries (Bulgaria, Croatia, Greece, Hungary, Italy, Lithuania, Poland, Portugal, Romania, Slovakia, Slovenia, Spain) with the agriculture of the highest level of fragmentation, where the percentage of farms equipped with agricultural tractors according to areal groups of arable land is the highest in the group of farms of the area up to 5 hectares.

Group IV consists of island countries (Malta, Cyprus), where small farms of the area up to 5 hectares dominate and large farms of the area more than 20 hectares do not occur. Therefore the highest percentage of farms with agricultural tractors is noticed in the lowest areal group up to 5 hectares.

The average profile of the percentage of farms with the agricultural tractors in particular areal groups for the EU countries is moderated by the most numerous groups – first and third group. The highest level of differentiation of average values in groups of EU countries can be observed in case of farms of the area of less than

5 hectares. The average value for group IV (Malta and Cyprus) differs significantly from the others indicating high level of average percentage of farms with the tractors (76%) for the areal group of farms of he area less than 5 hectares. In turn, in case of other areal groups one can observe some similarity of groups of the countries considered.

Figure 4. Centres of gravity of distinguished groups of countries similar with respect to the structure of farms in the possession of agricultural tractors in areal groups



Source: own elaboration

CONCLUSIONS

The problem of selection of objects of similar structure out of the global population was solved with the help of the method of vector elimination. This procedure can be applied in case of the division of set into subsets containing units of similar structures. As a result of the application of this method four groups of countries of s method four types of countries were distinguished according to the similarity of the structure of farms being in the possession of agricultural tractors in particular areal groups of arable land. Tools of statistical analysis of structures turned out to be very helpful in the investigation that was carried out.

In case of farms of the area within 5-10 hectares, 10-20 hectares and 20-50 hectares one can observe a uniform distribution of the arithmetic mean and other position measures within each group.

The concentration coefficient related to the eighteen countries under investigation is rather low, less than 0.2, which proves uniform distribution of farm equipment with agricultural tractors in all of the areal groups under investigation.

The percentage of farms with agricultural tractors is connected with the character of areal structure of the particular country, therefore the highest percentage of farms being in the possession of such machinery in case

of Scandinavian countries and the countries of Western Europe occurs in the areal groups of 20-50 hectares, 50-100 hectares and more than 100 hectares. The countries of Western Europe with the agriculture of high level of fragmentation of farms (Italy, Portugal, Spain) and the EU members the accession of which took place after 2004 display the highest percentage of agricultural tractors for farms of the area up to 10 hectares. In countries such as Austria, Ireland or Latvia the percentage of farms with agricultural tractors is the highest in case of the areal groups of 10-20 hectares and 20-50 hectares. Island countries – Malta and Cyprus, form a separate group. In this case the highest percentage of farms in the possession of agricultural tractors occurs in small farms up to 5 hectares.

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VAR MODELS FOR ECONOMIC POLICY TARGETS OF OECD COUNTRIES IN 1990-2016. ASSUMPTIONS AND ESTIMATION RESULTS

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Abstract: Paper presents estimation results of three-equational VAR models separate for every of 34 OECD countries. The variables of every model are economic policy targets: GDP growth rate, unemployment rate and inflation rate. Quarterly data for period 1990 – 2016 were used. Special attention has been given to analysis of cause-effects relationships and random fluctuations.

Keywords: economic policy targets, VAR models

INTRODUCTION

The aim of the paper is to present the objectives, methods and results of the analysis using empirical vector autoregressive (VAR) models of the relationships between the three, most often applied in practice, macroeconomic policy targets: GDP growth rate and unemployment and inflation rates, separately for each OECD country on quarterly data in the period: first quarter 1990 to first quarter 2016.

Economic theoreticians devoted special attention to dependencies between every two of the above mentioned economic policy targets [Juselius 2006]. In these respects the Okun's curve (the relationship between the GDP growth rate and unemployment rate) [Okun 1962], the Phillips curve (the relationship between inflation and unemployment rates) [Phillips 1958], and aggregate supply curve [for

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instance, Błaszczuk 2015a] have been studied both theoretically as well as empirically.

These three concepts Błaszczuk [2015b, 2015c] combined into one model. Namely, the simultaneous relationships between every two targets were determined and analysed, firstly. On these bases, the three-equational general equilibrium (B) model has been constructed and solved yielding the long term equilibrium point.

The present analysis is a continuation of researches carried out by Błaszczuk [2015b, 2016] since 2013. However, a different idea in relationships between economic policy targets modelling is behind the VAR models. Essential *novum* in the present analysis is study of dynamic dependencies between all three analysed variables. Namely, formulating VAR model of an economic system one assumes that "everything depends on everything". In other words, every of n variables is explained as a function of $n \times p$ lagged variables (where p is the number of delays) and, possibly, of selected deterministic variables. Therefore, in the formulation of the VAR model one *a priori* does not take into account either economic theory assumptions or dependencies observed in practice. However, the latter relationships influence the structure of the subsequent VAR model versions at the stage of its (economic and/or statistical) verification if one does not stop on the estimation of a "full" version, in which in every equation all $n \times p$ variables are present. Eventually one obtains dynamic cause-and-effect relationships between every non-lagged variable and the all lagged ones. However, unlike in case of dynamic structural models, one does not interpret the estimates of VAR model parameters. Contrary, the response of every variable on the shock change of every of the other variables is examined. In the following paragraphs of the paper we: 1) show the basics of VAR modelling, 2) present and discuss results of our empirical analysis, 3) characterise directions of further researches.

VAR MODELLING

In the seventies of the last century large structural models had been constructed. They were criticised because [Sims 1980] that they forced to accept *a priori* a number of assumptions about the nature of the analysed relationships for which the compelling arguments were often lacking and because [Lucas 1976] they were hardly applicable in practice. Sims has suggested substitution of the structural models by vector autoregressive ones. Their concept is characterised by: (a) joint modelling of all the analysed variables, (b) lack of division on the endogenous variables and the exogenous ones, (c) no zero conditions, (d) rich dynamic specification of the model, (e) good forecasting and simulation properties. The principle of VAR modelling is to estimate the models on stationary data.

VAR model of the order p for n-dimensional vector of variables $\mathbf{Y}_t = [Y_{1t},...,Y_{nt}]^T$ is given by the formula:

$$\mathbf{Y}_t = \mathbf{A}_0\mathbf{D}_t + \sum_{i=1}^{p}\mathbf{A}_i\mathbf{Y}_{t-i} + \boldsymbol{\varepsilon}_t = \mathbf{A}_0\mathbf{D}_t + \mathbf{A}_1\mathbf{Y}_{t-1} + \mathbf{A}_2\mathbf{Y}_{t-2} + ... + \mathbf{A}_p\mathbf{Y}_{t-p} + \boldsymbol{\varepsilon}_t, \quad (1)$$

where n-dimensional random factor $\boldsymbol{\varepsilon}_t$ is subject to the following assumptions: $\boldsymbol{\varepsilon}_t \sim N(0,\Sigma)$ and $Cov(\boldsymbol{\varepsilon}_t, \boldsymbol{\varepsilon}_s) = 0$ for $t \neq s$, and $\mathbf{A}_0\mathbf{D}_t$ is the deterministic part of equation (for example, trend).

The VAR model equations may be estimated one by one using OLS or all together using MLE. In the absence of theoretical justification on row of lags (p) one can rely on the statistical properties of the model [Lütkepohl 2005, Juselius 2006]. Then the most common used are criteria: AIC, SIC, HQC. Another possibility in this respect is the analysis of residuals. Random variables of every equation should be characterised by lack of autocorrelation (to check this one can use Box - Pierce statistic or Ljung - Box one). Hypothesis about the lack of multidimensional autocorrelation of random variable can be tested with the help of the Breusch - Godfrey test. An indication for the choice of the maximum delay can also be the results of significance tests for the recent delays [Kusideł 2000, Wójcik 2014]. One should also remember that in practice, in order to estimate the model parameters properly, a large number of observations is required.

While verifying VAR model a special attention is paid to the analysis of causality. In accordance with the definition, the variable Y_2 is the cause of Y_1 in sense of Granger, if the current values of Y_1, can be predicted with greater precision, *ceteris paribus*, using past values of the Y_2 than without their use [Charemza & Deadman 1997]. The Granger test for causality is as follows. Let

$$Y_{1t} = \sum_{i=1}^{p}\alpha_i Y_{1,t-i} + \sum_{j=0}^{q}\beta_j Y_{2,t-j} + \varepsilon_t . \quad (2)$$

Null hypothesis: $H_0 : \beta_0 = \beta_1 = \ldots = \beta_q = 0$, so there are no one-way causal dependencies between Y_2 and Y_1, i.e. Y_2 is not the cause of Y_1. Test statistics for large samples converges to the $\chi^2(q)$ distribution.

Estimates of the VAR models parameters one does not interpret. Instead, one interprets all of the estimated parameters simultaneously by calculating the impulse response function (IRF). IRF reflects the dynamic (in k periods) response of the endogenous variable Y_i on the change of the j-th random variable (ε_j):

$$\mathrm{IRF}(i, j, k) = \frac{\partial Y_{i,t+k}}{\partial \varepsilon_{jt}} . \quad (3)$$

Analysis of the impulse response functions is a standard approach in the VAR modelling to study the reaction of the economic systems to shocks.

RESULTS OF INVESTIGATION

Sources of statistical data

In the analysis we used quarterly data on the GDP growth rates (*rGDP*), unemployment rates (*HUNR*) and the inflation rates (*CPI*) in all (34) OECD countries during the period 1990Q1 – 2016Q1 [http://stats.oecd.org/ (access 1.05.2016)].

Specification of the VAR models

In accordance with the purpose of the study, we decided to build comparable vector autoregressive models for individual OECD countries based on their historical data on *rGDP*, *CPI* and *HUNR*.

In our study we used nonstationary data because of the two circumstances. First, we obtained stationary data for various differences for different variables for different countries. Thus, comparing, computed on such data, relationships between the analysed variables for different countries would not be very meaningful, if reasonable at all. Secondly, we inputted deterministic variables taking into account time (t and t^2) and seasonality (Q_1, Q_2 and Q_3) thus eliminating to a large extent both non-stationarity and autocorrelation of random variables.

To determine the optimal order of lags we used, separately for every model, the AIC, SIC and HQC information criteria. In the vast majority of cases lags were rather small: 1 quarter: 10 countries; 2 quarters: 15 countries; 3 quarters: 4 countries; 4 quarters: 3 countries (see Table 1).

Table 1. VAR models types for OECD countries

VAR model type	Number of countries	Countries
VAR (1)	10	Belgium, Chile, France, Hungary, Israel, Italy, Japan, Korea, New Zealand, Slovenia
VAR(2)	15	Canada, Czech Republic, Denmark, Finland, Germany, Greece, Iceland, Ireland, Luxembourg, Netherlands, Norway, Slovakia, Sweden, United Kingdom, USA
VAR(3)	4	Australia, Mexico, Poland, Switzerland
VAR(4)	3	Estonia, Portugal, Spain
VAR(5)	1	Austria
VAR(8)	1	Turkey

Source: own calculations using the *gretl* package

The analysis of causality

In the majority of cases we identified one-way and/or two-way causalities. Bidirectional dependencies occurred particularly frequently between unemployment rate and the GDP growth rate. Just almost as often were one-way

dependencies: unemployment rate → inflation rate, the GDP growth rate → unemployment rate, and a little less often: inflation rate → the GDP growth rate and the GDP growth rate → inflation rate (see Table 2).

Table 2. One-way and/or two-way causalities in the 34 OECD countries VAR models (the significance level 10%)

Causality between			Number of countries	
CPI	↔	*rGDP*	2	21
	→		10	
	←		9	
HUNR	↔	*rGDP*	14	30
	→		3	
	←		13	
HUNR	↔	*CPI*	6	25
	→		15	
	←		4	

Source: own calculations

We discovered the lack of causal dependencies for all three pairs of variables only for Slovakia. There was causal dependence of for only one pair of variables: (a) *HUNR* ↔ *rGDP* in case of: Slovenia, the Czech Republic, Ireland, (b) *HUNR* → *CPI* in case of Norway, (c) *CPI* ← *rGDP* in case of Luxembourg.

Table 3. The causal dependencies for all the three pairs of variables

Country	Causal dependency type		
	CPI **?** *rGDP*	*HUNR* **?** *rGDP*	*HUNR* **?** *CPI*
Poland	↔	←	→
Japan	←	↔	↔
Austria	←	↔	→
Belgium	←	↔	→
France	←	↔	→
Mexico	←	←	↔
Turkey	←	←	→
Korea	→	↔	→
Finland	→	←	→
Israel	→	←	→
Greece	→	↔	←
Spain	→	↔	←
United	→	←	←
Iceland	→	→	↔
Australia	→	→	→

Source: own calculations

The causal relationships for two pairs of variables occurred for the larger groups of countries: (a) *HUNR* and *rGDP*, *HUNR* and *CPI* in case of: Canada, the Netherlands, Germany, Italy, Hungary, New Zealand, Sweden, (b) *CPI* and *rGDP*, *HUNR* and *rGDP* in case of: Denmark, Chile, Estonia, USA, (c) *CPI* and *rGDP*, *HUNR* and *CPI* in case of Portugal.

The causal dependencies for all three pairs of variables have been observed in up to 15 countries. In Table 3, there are five groups of countries with similar nature of causative dependencies between the analysed variables. In the first group we discovered influence of the GDP growth rates on inflation rates, two-ways relationships between *HUNR* and *rGDP*, and the impact of unemployment rates on the inflation rates. In the second group, there is the influence of the GDP growth rates on inflation rates and unemployment rates. Third group of countries is characterized by the impact of price level changes on the GDP growth rates, GDP growth rates on the unemployment rates and the unemployment rates on the inflation rates. Only the last relationships are reversed in the fourth group of countries when compared with the third one. The economies of the fifth group tend to be in their reactions unlike the other countries concerned.

All the discovered causal dependencies are shown in Table 4. The names of countries characterized by appropriate bi-directional causality are typed in bold.

Table 4. OECD countries by causal dependencies between analysed policy targets

→	*rGDP*	*CPI*	*HUNR*
rGDP	X	Austria, Belgium, Chile, Denmark, France, Japan, Luxembourg, Mexico, **Poland**, **Portugal**, Turkey	**Austria**, **Belgium**, **Canada,** Chile, **Czech Rep.**, **Denmark**, Estonia, Finland, **France**, **Germany**, **Greece**, Hungary, **Ireland**, Israel, Italy, **Japan**, **Korea**, Mexico, **Netherlands**, New Zeeland, Poland, **Slovenia**, Sweden, Turkey, United Kingdom, United States
CPI	Australia, Estonia, Finland, Greece, Iceland, Israel, Korea, **Poland**, **Portugal**, Spain, United Kingdom, United States	X	**Canada**, Germany, Greece, **Iceland**, **Italy, Japan**, **Mexico**, **Netherlands**, Spain, United Kingdom

→	*rGDP*	*CPI*	*HUNR*
HUNR	Australia, **Austria**, **Belgium**, **Canada**, **Czech Rep.**, **Denmark**, **France**, **Germany**, **Greece**, Iceland, **Ireland**, **Japan**, **Korea**, **Netherlands**, **Slovenia**, **Spain**, Switzerland	Australia, Austria, Belgium, **Canada**, Finland, France, Hungary, **Iceland**, Israel, **Italy, Japan**, Korea, **Mexico**, **Netherlands**, New Zeeland, Norway, Poland, Portugal, Sweden, Switzerland, Turkey	X

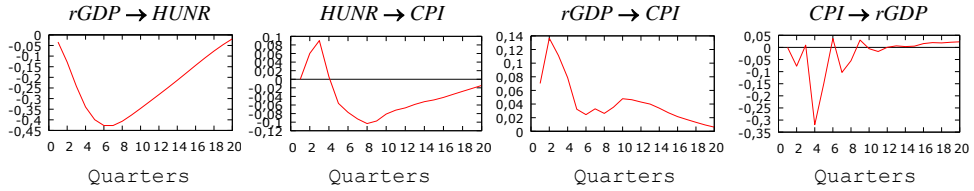
Source: own calculations

Summing up, we found causal dependencies for all the three pairs of variables for about half of the analysed countries, and for only a little less number of countries we stated causal dependencies for two pairs of variables. The most influencing and the most influenced variable was unemployment rate (17 + 21 cases and 26 + 10 cases, respectively) and the smallest influence had inflation rate (12 + 10 cases) while the least influenced – the GDP growth rate (12 + 17 cases).

The impulse response analysis

Then, based on the estimated equations we found the impulse response functions. We analysed obtained functions for all the countries and next classified them into "strategic groups". Then (because of shortage of space in the paper) we selected for further discussion one country only from every group with the relationships between all the three variables (see Table 3).

Figure 1. Impulse response functions for Poland

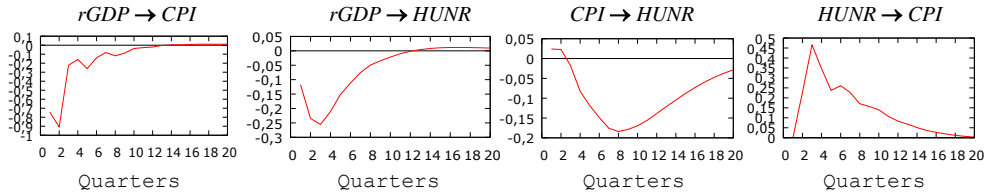


Source: own calculations

From the first group we have chosen Poland. In this country an increase of the GDP growth rate caused initially gradual decreases in unemployment rates down to more than 0.4% in the seventh quarter and then gradual return to reach the initial situation in the twentieth quarter (cf. Figure 1). On the other hand the increase in the unemployment rate invoked inflation rates rises during the first three quarters up to 0.09%, then their fall during the next five quarters down to -0.1%, and finally their return to the initial situation, perhaps in the end of the sixth year after the shock. The rising *rGDP* caused an increase of inflation in the second

quarter, but the rising *CPI* was associated with an decrease of *rGDP* in the fourth quarter.

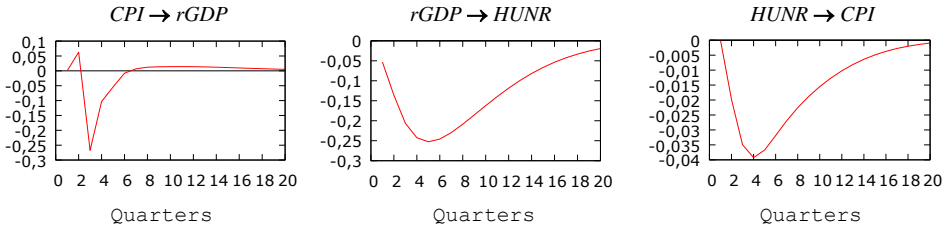
Figure 2. Impulse response functions for Mexico



Source: own calculations

In Mexico, the country from the second group, an increase of the GDP growth rate caused initially decreases in the inflation rate and in the unemployment rate in the second quarter (cf. Figure 2). The rising inflation rate was associated with a fall in unemployment.

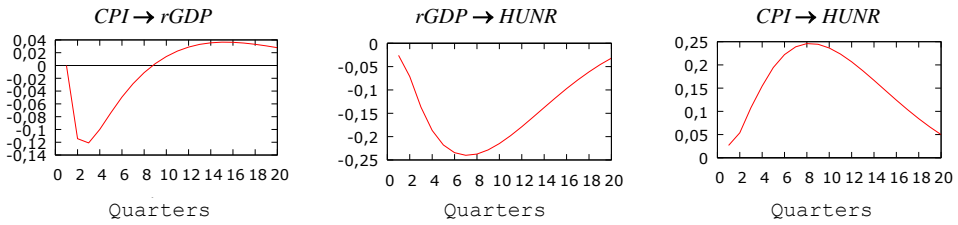
Figure 3. Impulse response functions for Finland



Source: own calculations

Other shapes have the respective functions for Finland which belongs to the third group (cf. Figure 3). For this country an increase of inflation caused decline in the GDP growth rates down to 0.25% in the third quarter, the decline in the GDP growth rates resulted in an increase in the unemployment rates up to 0.25% in the fifth quarter and rising unemployment rates were associated with a fall in inflation rates down to 0.04% in the fourth quarter. The recovery of the GDP growth rates took about a year while of the other two variables about 4 years.

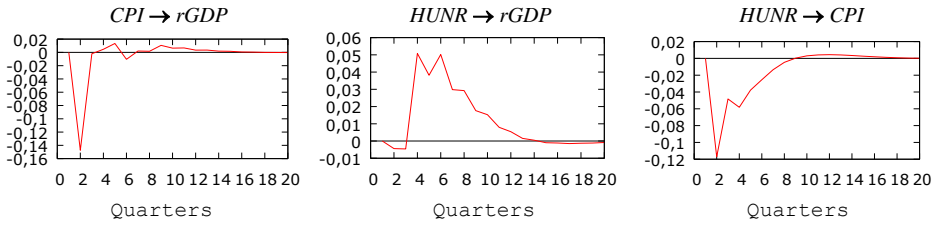
Figure 4. Impulse response functions for United Kingdom



Source: own calculations

From the fourth group we chose United Kingdom. The effect of inflation rate shock on the GDP growth rates and of the GDP growth rate on unemployment rates in this country are somewhat similar to that of Finland (cf. Figure 4). The recovery of the GDP lasted, however, 1½ years but thereafter there was the long lasting increase of the GDP growth rate by almost 0.04%/quarter during, probably, 3½ years. The decrease of the GDP growth rates caused similar increases of unemployment rates as in Finland but they lasted seven quarters. On the other hand, change in inflation rate caused increase in unemployment rates up to 0.25% after two years and then their decrease to the original level after next, say, 4 years.

Chart 5. Impulse response functions for Australia



Source: own calculations

Finally, we chose Australia for the analysis, where the rising *CPI* was associated with an decrease of *rGDP* in the second quarter. The rising *HUNR* caused only initially decreases in *rGDP* and in *CPI*.

FINAL REMARKS

In the paper we paid special attention to the analysis of the causal dependencies between the analysed variables and the respective impulse response functions. According to the received results we classified the analysed countries into a number of more or less similar "strategic" groups. It is very difficult, however, to identify factors being the reasons of similar behaviour of all the economies classified to the given group. To this end in future we plan to investigate the same relationships for the same group of countries using the stationary data after splitting the countries into groups with stationarity and trend-stationarity of data as well as with stationarity of their increases.

With this respect we are going to look for analysed relationships for these countries in different phases of the business cycles. Moreover, we plan to extend our analysis substituting CPI by the respective harmonised indices (HCPI).

Finally, on the basis of VAR models we plan to find an empirical long term equilibrium point for each country, just as in case of the three-equational B models. These points will be compared, on one hand, between the countries (using the concept of "strategic" groups maps), and on the other, with results of the analysis of the simultaneous relationships. The results of these comparisons

will, we hope, allow for formulation of recommendations for economic policymakers of the respective countries.

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INFORMATION VALUE OF THE CREDIT RATING ON THE CREDIT DEFAULT SWAPS MARKET

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Abstract: The paper examines the impact of the countries' credit ratings changes on the cost of credit defaults swaps premium. It is assumed statistical significance abnormal returns due to changes in credit ratings assigned by the agencies. It is has been put the hipothesis that ratings events convey new information and lead to significant abnormal reactions. The study used the ratings assigned by Standard & Poor's and Moody's for the period from January 2005 to November 2015 and spreads for five-year senior unsecured CDS. To verify the hypothesis the event study method (by daily data) is applied.

Keywords: credit rating, credit derivatives swap, abnormal rates of return

INTRODUCTION

The role of the credit rating agencies is to analyzing and monitoring the asymmetry of the information problem on the financial market. They assess countries' and institutions' creditworthiness and ability to repayment of liabilities. The previous researches analyse and verify the quality and risk connected with the borrower. A lot of scientist examine how fast credit ratings react on the changes of debtor condition.

Credit rating agencies have so far been often criticized as a violation of their basic function in this regard. For example, Carlson and Hale [2005] using the game theory came to the conclusion that the existence of credit rating agencies may jeopardize the functioning of financial market stability and erode the system of balance. Bannier and Tyrell [2005] report that unique balance can be restored only by creating a clear and precise evaluation system, which will enable market participants to make independent assessment of the reliability, quality and

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importance of credit ratings when making investment. The fact more accurate information and therefore more accurate ratings, the greater the consistency of decisions by investors, and therefore the market reacts as expected and accurately reflects the "quality" investment securities rated entities.

Credit rating agencies have to allocate the categories of risk to the issuer, depending on the assessment of the risk of insolvency, political and economic situation of the country. So far established three credit rating agencies having the largest scale of the operation, namely: Standard & Poor's Investor serive (S&P), Moody's Investors Service and Fitch Ratings. Although the industry led to different evaluation system the previous research results show a high correlation broadcast their evaluations. Researches conducted by Chodnicka [2013, 2014] show that credit ratings react in different periods of time for the publication of macroeconomic data. Furthermore, the survey methodology and analysis conducted using a panel data models suggest different sensitivities broadcast not on published information [Chodnicka 2014, 2015]. S&P focuses mainly on a prospective assessment of the likelihood of default. Moody's makes its decisions on the expected loss, which is a function of both probability of default and the expected recovery rate. Finally, Fitch takes into account both the probability of default and recovery rates [Elkhoury, 2009]. The problem from the point of view of the analyzes is the lack of detailed information on the methodology, conducted the risk assessment. Credit rating agencies does not expose methods give only general indicators taken into consideration in the evaluation.

The purpose of this article is to check and analyze the impact of changes in credit ratings of European countries broadcast on the cost of premiums for credit default swaps (CDS). In the first part of a review of the literature to date research and based on hypotheses created. Then describes the data and characterized the methodology applied. Chapter 4 is a description of the results, and the last is to present proposals and to try to discussions in the analyzed research problem.

LITERATURE REVIEW

It exists a lot of researches about the impact of credit ratings on the shares and bonds market[1]. There have been found some researches about the impact of credit ratings changes on the financial markets[2]. The most important are presented in the table below.

[1] Iankova et al. [2006]; Dichev, Piotroski [2001]; Steiner, Heinke [2001]; Gropp, Richards [2001]; Kliger, Sarig [2000]; Ederington, Goh [1998], Hite, Warga [1997], Kaserer [1995]; Goh, Ederington [1993], Wansely et al. [1992], Hand et al. [1992], Ederington et al. [1987], Wansley, Clauretie [1985]; Pinches, Singleton [1978]; Weinstein [1977]; Grier, Katz [1976]

[2] Hull et al. [2004]; Norden, Weber [2004]; Norden [2004].

Table 1. Literature review previous studies

Authors/ market	Results
Holthausen, Leftwich [1986] - stocks	1977 – 82, Moody's, S&P, 1014 rating changes, 256 Credit Watch S&P, daily abnormal stock returns, event window (-300; 60), significantly negative reaction after downgrades, no significant abnormal performance for upgrades
Glascock et al. [1987] - stocks	1977 – 81, Moody's, 162 rating changes, daily abnormal stock returns, event window (-90;90), significantly negative abnormal stock returns before and around downgrades, reversal after day zero (publication date)
Hand et al. [1992] – stocks, bonds	1977 – 82/1981- 83, Moody's, S&P, 1100 rating changes and 250 Credit Watch S&P, window spanning stock and bond returns, significantly negative abnormal stock and bond returns for downgrades and unexpected additions to S&P Credit Watch, no significant abnormal returns for upgrades
Goh, Ederington [1993] - stocks	1984 – 86, Moody's, daily abnormal stock returns, event window (-30;30), significantly negative returns for downgrades due to earnings deterioration, positive abnormal returns for downgrades due to increased leverage
Followill, Martell [1997]- stocks	1985 – 86, Moody's , 66 reviews and actual rating changes, daily abnormal stock returns, event window (-5;5), significantly negative returns at reviews for downgrades, negligible abnormal performance around actual downgrades
Dichev, Piotroski [2001] - stocks	1970 – 97, Moody's, 4727 rating changes, daily abnormal stock returns, significantly negative returns during the first month after downgrade, no significant reaction for upgrades
Vassalou, Xing [2003] - stocks	1971 – 99, Moody's, 5034 rating changes, monthly abnormal stock returns, event window (-36;36), stock returns in rating event studies should be adjusted by size, book – to market and default risk, increase of default loss indicator before and decrease after downgrades
Katz [1974] - bonds	1966 – 72, S&P, 115 bonds from 66 utilities, monthly yield changes, event window (-12;5), no anticipation, abnormal performance during 6-10 weeks after downgrades
Grier, Katz [1976] - bonds	1966 – 72, S&P, 96 bonds from utilities and industrials, monthly yield changes, event window (-4;3), anticipation only for industrials, price changes after downgrades stronger
Hettenhouse, Sartoris [1976] - bonds	1963 – 73, S&P, Moody's, 46 bonds from 66 utilities, monthly yield changes, event window (-6;6), small anticipation before downgrades, no reaction to upgrades
Weinstein [1977] - bonds	1962 – 74, Moody's, 412 bonds from utilities and industrials, monthly abnormal bond returns, event window (-6;7), early anticipation but no abnormal performance during 6 months before the event and no reaction afterwards
Wansley et al. [1992] - bonds	1982 – 84, S&P, 351 bonds, weekly abnormal bond returns, event window (-12;12), significantly negative returns in the week of downgrades, no significant response to upgrades
Hite, Warga [1997] - bonds	1985 – 95, S&P, Moody's, 1200 rating changes, monthly abnormal bond returns, event window (-12;12), significantly negative abnormal returns during 6 months before downgrades
Reisen, von Maltzan [1999] - bonds	1989 – 97, 29 countries, 152 credit rating changes, changes in country ratings on sovereign risk as measured by the yield spreads of domestic financial instruments relative to mature market benchmarks, significant only the possible downgrade, especially for ratings below investment - grade
Kraussl [2000] - bonds	1990, VAR model, impact of credit rating on the bond yield spreads, unexpected sovereign credit rating change does not necessarily have an immediate impact on emerging market bond yield spreads
Steiner, Heinke [2001] - bonds	1985 – 96, S&P, Moody's, 546 rating changes, 182 watch listings, daily abnormal bond returns, event window (-180; 180), significantly negative abnormal returns starting 90 days before downgrades and negative watch listings, evidence for overreaction directly after the event
Hull et al. [2003]- CDS	1998 – 02, Moody's, rating changes, reviews and outlooks, adjusted CDS spread changes, event window (-90;10); significantly positive adjusted CDS spread changes before negative rating events
Norden, Weber [2004] – CDS, stocks	2000 – 02, Moody's, S&P, Fitch, 25 institutions, 567090 quotes, event window (-90;90), both markets not only anticipate rating downgrades but also reviews for downgrade by all three agencies, reviews for downgrade by S&P and Moody's exhibit the largest impact on the both markets, the magnitude of abnormal performance in the both markets is influenced by the level of the old rating, previous rating events and, only in the CDS market by the pre-event average rating level by all agencies.

Source: own elaboration

The presented literature review suggests that it has been noticed the lack of analyses about the impact of credit ratings changes on the CDS spreads. The previous researches take into consideration the differentiated databases, but in pracitce it has not presented the analyses for the impact of European countries' credit ratings on the CDS spreads. The presented groups of observations are not homogenic, asa result the received findings are differentiated. The received results suggests that on the one hand, rating agencies argue that credit ratings contain new information. Rating agencies convey macroeconomic and political information to the markets through their ratings. On the other hand, rating agencies have been heavily criticised for not being able to correctly predict the current situations and bankruptcies [Kaserer, 1995]. This criticism has grown even more in the financial crisis after 2007. The agencies are accused of not anticipating, but merely mirroring what the markets have already priced in the securities of a given reference entity. Up to 70 - 90 per cent of credit ratings can be explained by models using only publicly available accounting information [Cantor, Packer, 1996; Chodnicka, 2013, 2014, 2015]. As a result it has been put the following hypothesis:

Hypothesis 1: Rating events convey new information and lead to statistically significant abnormal reactions.

According to the efficient market hypothesis, a market is said to be efficient if prices in that market reflect all available information. A market has semi-strong efficiency if prices fully reflect all readily-available public information—past prices, economic news, earnings reports, etc. Tests of semi-strong efficiency are those that study stock price movements following announcements, such as stock splits or earnings announcements. As a result market can react faster on the condition of countries' economies. The previous analysis can suggest that market are not the same sensitive on the negative and positive changes of credit ratings. More important for the potential investor can be the decision about decrease that increase of credit ratings. As a result it is put the hypothesis:

Hypothesis 2: CDS market react stronger on the decrease than increase of countries' credit ratings.

The presented literature review and practice knowledge of Author suggests that it exists the lack of researches about the impact of countires' credit ratings changes on CDS spreads. Most of researches are based on the analyses of the bond and stock market. The presented studies have been usially on the US-listed companies. This paper extend the previous researches on the analyses of the reaction of the CDS market on the credit ratings changes given for European countires. In previous researches has been only analysed the impact of long – term issuer credit ratings, there have not been verified the short-term notes.

DATA DESCRIPTION AND METHODOLOGY

The data on the rating events are collected from Thomson Reuters database. There have been included rating events from Standard & Poor's (S&P) and Moody's over the period from January 2005 to November 2015. For the preparation of the analysis, the long and short term issuer credit ratings are taken into consideration. For better understanding problem, according to the second hypothesis, credit ratings are divided on investment and speculative groups. For each reference entity resulting from the process above, daily CDS spread have been collected. CDS spreads for five-year senior unsecured contracts are chosen, as this is by far the most liquid contract. The analysis is made for European countries[3]. The sample is little different for particular credit rating agencies. As a result there exists some changes in CDS spreads taking into consideration.

It has been used classic event study methodology to analyse the influence of rating events on CDS spreads. The impact of country's credit rating changes announcements on changes in their CDS spread, and capture the cumulative impact of those announcements over a few days, has been verified. The methodology of event study requires aggregation of the abnormal differences in variable within each event window to construct cumulative abnormal differences (CAD), taking an assumption that none other factors occurred in that time. As the CDS there have been taken daily differences of the spread and the daily logarithmized differences representing the percentage adjust.

Following Greatrex [2009], the event window consist of the 20 trading days prior to the actual event, the event date (i.e. the announcement day), and the 20 days after the actual event. Thus, it includes a total of 41 trading days, which is referred to as the [-20, +20] time interval. The [-1, + l] time period is the announcement window of the study, while the [-20,-2] and [+2, +20] time periods is referred to as the pre- and post announcement window respectively. The day of the publication of the rating event is defined as day 0.

In the event study methodology statistical tests are based on abnormal differences, which means the difference between the actual daily spread difference value on each day of the event window and the expected spread difference value measured as the average daily spread change over the previous 250 working days of estimation window. This way we obtain abnormal differences, which we test whether they are statistically greater than zero using t-Student statistic in proper pooling samples. Parametric tests attribute an equal chance to achieve both positive and negative deviations from expectations. A small number of observations may

[3] Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Hercegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Georgia, Germany, Greece, Hungary, Island, Ireland, Italy, Latvia, Lichtenstein, Lithuania, Luxemburg, Macedonia, Malta, Moldavia, Monaco, Montenegro, Netherland, Norway, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, Great Britain.

weaken the power of statistical tests, suggesting the need to consider both the economic and statistical significance of results.

To create multiple sets of similar events, it has been classified announcements into two event types, downgrades and upgrades of the rating. Then it has been pooled within each sample of event type across countries.

RESULTS

The results received from event study prepared for the European countries give some interesting observations. At first changes on the credit ratings assessment give abnormal return for the CDS market according to the first hypothesis. The impact of the information about mentioned changes is stronger before the moment of the event, and its weaker over time, for the Moody's long term issue rating. According to the second more important for the CDS market are downgrades. During the preannouncement window, the downgrade of the Moody's long term issue rating influence on the increase of the CDS spread of the analysed European countries. The mentioned spreads rise on 355 basis points. During the event window, these spreads are changed on 152 basis point, and for the postannouncement window on 111 basis points. As a result the nominal value of the cumulated spreads reacts before the moment of publication of information about credit rating changes. The mentioned reaction is little different for the Standard &Poor's Investor Service information. At first it has been analysed the impact of long term issue rating on the CDS spreads. The mentioned variable increase the value of cumulated CDS spreads, before the moment of publication the information about downgrade, on 280 basis points. During the event window this change is on only 80 points, and in the post event moment the CDS spreads rise on 280 basis points. As a results the CDS market reacts stronger on the information about changes in the S&P's long term issue rating after the moment of publication, than in case of the Moody's credit rating changes. The downgrade of the S&P's short term issue rating influences stronger on the CDS market than the long term one. The impact of the mentioned credit rating changes increase the cumulated CDS spread during: the preannouncement window on 330 basis points; the event window on 133 basis points and the postannouncement window on 366 basis points. In the case of the Standard and Poor Investor Service, credit ratings influence with the similar strength before and after the moment of the event on the CDS spreads.

The second pooling is made for the upgrade. In the case of the influence of the Moody's long term issue rating on the CDS spreads is not observed. The nominal value of the mentioned spreads increase before the moment of event on the 8 points, during the event window decrease on 3 points and after the credit rating change also increase on the nearly 8 points. The CDS market react in the different way on the changes proposed by the Standard &Poor's Investor Service. Both for the long and short term issue credit rating changes is observed the negative impact on the cost of capital. The increase of the credit rating decrease the CDS spreads.

The mentioned relationship is weaker for the long term issue ratings, because in the period of the preannouncement window CDS spreads are decreased on 52 basis points, during the event window the mentioned variable is lower on the 7.5 basis points and in the postannouncement window the countries' CDS spreads are lower on 82 basis points. The changes of CDS spreads for the short term issue rating proposed by Standard & Poor's Investor Service decrease the cumulative value of the CDS spreads as follows: before the event moment on 220 basis points, during the event moment on 27 points and after the event moment on 220 basis points. The mentioned results are interpreted as differences from the mean of 250 working days.

Table 2. The impact of changes of Moody's long term issue rating, S&P' s long and short term issue ratings on the CDS spreads changes for European countries

CDS spread	Moody's long term			S&P's long term			S&P's short term		
	Coef.	t	P>t	Coef.	t	P>t	Coef.	t	P>t
Downgrade									
[-20;-2]	355.96	61.34	0.00	279.81	83.45	0.00	331.41	47.89	0.00
[-1;+1]	152.95	40.52	0.00	79.34	66.97	0.00	133.01	52.52	0.00
[+2;+20]	111.36	74.13	0.00	278.44	69.22	0.00	366.54	43.76	0.00
Upgrade									
[-20;-2]	8.20	68.03	0.00	-52.08	-19.81	0.00	-220.19	-61.25	0.00
[-1;+1]	-2.87	-91.28	0.00	-7.50	-18.17	0.00	-27.81	-47.48	0.00
[+2;+20]	7.67	59.02	0.00	-82.66	-34.93	0.00	-219.46	-61.12	0.00

Source: own calculations

The analysis of the percentage changes of the CDS spreads as an effect of the European countries' credit rating changes is presented in the Table 3. In the case of downgrade of the Moody's long term issue rating in the preannouncement window, it is observed the 3% increase of the CDS spread. During the event window, the mentioned spread rise on 2.5%, but for the postannouncement window the percentage changes of the CDS spreads are corrected (decrease of the CDS spreads on 3.5%). The CDS market is more sensitive on the publication of changes in credit ratings by the Standard & Poor's Investor Service. As a result of downgrade the S&P's long term issue credit rating, the mentioned spread increase before the moment of the event on 7.6%. For the moment of publication of the information the CDS spread rise on 3.5%, but changes during the period of time after the announcement are unimportant. For the pool of the changes of the short term issue ratings the situation is similar (7% increase before publication, 5% increase during the event window and 3% correction). The observation of the percentage changes of the European countries' CDS spreads suggest that the CDS market is more sensitive on the Standard& Poor's credit ratings changes. CDS spreads rise during the preannouncement window, smaller changes are observed for the moment of publication of the information and during the postannouncement window are noticed market corrections.

In the case of the upgrade of the Moody's long term issue credit ratings, before the moment of event CDS spreads rise on 3.4%. The decrease of the mentioned spreads is noticed during the moment of publication information about upgrade. After the publication CDS are market is unsensitised on the analysed determinant. The situation for the S&P's long term issue rating is little different. The CDS spread increases in the preannouncement window (2%), is insensitive during the publication and decreases (4%) in the postannouncement window. The positive change of the short term countries' credit ratings causes the reduction of the CDS spreads on nearly 5% before and after the publication of the information. During the event window the mentioned spreads are insensitive on the credit rating changes in the short term.

Table 3. The impact of changes of Moody's long term issue rating, S&P' s long and short term issue ratings on the percentage changes of CDS spreads for European countries

CDS spread	Moody's long term			S&P's long term			S&P's short term		
	Coef.	t	P>t	Coef.	t	P>t	Coef.	t	P>t
Downgrade									
[-20;-2]	0.0298	46.59	0.00	0.0762	107.18	0.00	0.0669	72.53	0.00
[-1;+1]	0.0256	52.57	0.00	0.0348	125.39	0.00	0.0534	117.84	0.00
[+2;+20]	-0.0352	-76.13	0.00	-0.0037	-7.08	0.00	-0.0286	-36.44	0.00
Upgrade									
[-20;-2]	0.0340	50.72	0.00	0.0236	35.99	0.00	-0.0427	-54.85	0.00
[-1;+1]	-0.0281	-125.38	0.00	0.0000	-0.20	0.84	0.0067	30.55	0.00
[+2;+20]	0.0096	10.22	0.00	-0.0384	-73.08	0.00	-0.0472	-51.5	0.00

Source: own calculations

CONCLUSIONS

The purpose of this article is to check and analyze the impact of changes in credit ratings of European countries broadcast on the cost of premiums for credit default swaps (CDS). In the first part of a review of the literature to date research and based on hypotheses created. There are put two hypothesis. The first one reads as follows: Rating events convey new information and lead to statistically significant abnormal reactions. The second one is: CDS market react stronger on the decrease than increase of countries' credit ratings. Both of them are verified by using the event study method. Credit rating changes convey new information. The change of credit rating implies the change of CDS spread above the mean for 250 trading days observations. For the changes of the Moody's long term issue rating the nominal value of the cumulated spreads reacts before the moment of publication of information about credit rating changes. The mentioned situation is little different for the Standard &Poor's Investor Service information. The CDS market verifies stronger the information about changes in the S&P's long term issue rating after the moment of publication, than in case of the Moody's credit rating changes. The downgrade of the S&P's short term issue rating influences stronger on the CDS

market than the long term one. In the case of the Standard and Poor Investor Service, credit ratings influence with the similar strength before and after the moment of the event on the CDS spreads. The second pooling is made for the upgrade. In the case of the influence of the Moody's long term issue rating on the CDS spreads is not observed. The CDS market react in the different way on the changes proposed by the Standard &Poor's Investor Service. Both for the long and short term issue credit rating changes is observed the negative impact on the cost of capital. The mentioned relationship is weaker for the long term issue ratings. The changes of CDS spreads for the short and long term issue rating proposed by Standard & Poor's Investor Service decrease the cumulative value of the CDS spreads stronger before after the moment of the event.

The observation of the percentage changes of the European countries' CDS spreads suggests that the CDS market is more sensitive on the Standard& Poor's credit ratings changes. CDS spreads rise during the preannouncement window, smaller changes are observed for the moment of publication of the information and during the postannouncement window are noticed market corrections. In the case of the upgrade of the Moody's long term issue credit ratings, before the moment of event CDS spreads rise. The decrease of the mentioned spreads is noticed during the moment of publication information about upgrade. After the publication CDS are market is unsensitised on the analysed determinant. For the pool of the S&P's long term issue credit rating changes, the CDS spread increases in the preannouncement window, is insensitive during the publication and decreases in the postannouncement window. The positive change of the short term countries' credit ratings causes the reduction of the CDS spreads before and after the publication of the information. During the event window the mentioned spreads are insensitive on the credit rating changes in the short term.

As a result the European CDS market is sensitive on the changes of the countries' credit ratings. The scale of impact of the mentioned changes is different for the particular credit rating agencies. More important is information publicised by Standard & Poor's Investor Service. The moment and strength of reaction is also strictly differentiated.

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COSTS AS A DETERMINANT OF CHOICE OF DISTRIBUTION CHANNEL IN A DIY ENTERPRISE

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Abstract: We attempt to validate the algorithms related to the costs of distribution and to create an analytical model enabling the identification of an effective distribution channel for suppliers of one of DIY chains. Within the framework of the paper, the substantive issues related to the topic of distribution channels and costs generated at this stage of the supply chain were described.Our main finding is that carrying out a comprehensive analysis of distribution costs contributes to minimizing these costs. Individual products or suppliers can generate a loss or profit for a business, depending on whether the distribution channel is assigned appropriately to them.

Keywords: distribution channel, supplier and retailer cooperation, cost optimization, reeingineering, do-it-yourself (DIY) enterprise

INTRODUCTION

In the last two decades of the twentieth century, the retail sector began to consolidate and the strength of the companies in this sector began to increase [Fernie et al. 2000]. This situation had two consequences. First, retailers have taken control over the supply chain and therefore they have been able to enforce demand-driven deliveries instead of deliveries based on production schedule [Sirohi 1998]. Together with the increase in the size of retail business, retailers began to focus on operations optimization. Second, since many retailers operating in the particular sectors had a significant market share, there was a slight possibility of gaining greater advantage over their competitors by purchasing power [Achrol et al. 2003].

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Forthis reason, even a greater attention was paid to the optimization of operational processes and to the increased awareness of stock-related costs [Seth et al. 2001].

As a part of the modern planning in an enterprise, emphasis is placed on the environment, analysis of organization and continuous monitoring of key processes. Regardless of the form in which an enterprise acquires resources from its suppliers, a well-thought-out strategy for the selection and management of suppliers is essential [Grant et al. 2006]. Strategies for suppliers vary depending on their importance to the company. The importance of suppliers relates to the impact of their products on the purchasing enterprise and the possibility of gaining market dominance [Romanowska 2009].

According to A. Rushton [Rushton 2010], channel objectives that differ from one company to another, are the first criterion in the distribution planning process for the development of the most appropriate distribution channel. But there is a number of general points that are likely to be relevant to most companies. The key points that should be addressed are as follows:

- Good product availability for the market. Ensuring product visibility in an appropriate type of store is the most important factor here.
- Increasing the probability of selling a product. This objective can be achieved in several ways. Good selling space, as well as active support from sales force are the main assumptions. Product should be easily seen, perhaps even presented in an attractive way for customers [Parasuraman et al. 1994].
- Achieving a certain service level. Both from the supplier and the retailer perspective, a certain quality level should be established, measured, maintained and monitored.
- Minimizing of operational and total costs. Costs are of highly significant as they are reflected in the final product price.
- Complex products often require direct selling because any intermediary may not be able to explain how the product works to potential customers.

Once the objectives of distribution channels are set, it may be helpful to consider the characteristics of the channel. This factor influences the decisions that have to be made by designing the distribution channel. The characteristics of distribution channel includes: specificity of the market, specificity of products, specificity of competition, enterprise resources [Lovell et al. 2005].

Distribution process covers several types of actions: production planning, sales forecasting, transportation processes, warehousing processes, packing, order processing and many others. Each of this actions is a source of cost. In some cases distribution costs amount to 30-40% of total product cost. According to Bendkowski [Bendkowski et al. 2011], total distribution cost includes transportation (37%),stock financing (22%), warehousing (21%), order processing (20%).

According to M. Christopher [Christopher 2005] distribution costs change together with the decision regarding the number of warehouses. Transportation

cost, storage cost and cost of order preparation increase if the number of warehouses increases. On the other hand, cost of local deliveries decreases significantly. Therefore, it is crucial to develop algorithms enabling calculation of these costs, what as a result significantly simplify making decisions regarding the choiceof the distribution channel.

The paper deals with issues related to one of the key logistic management processes - distribution. The aim of the paper is to optimize the decision making process regarding the selection of distribution channels for suppliers of one of the Polish DIY companies. An additional inspiration to address this issue is the fact that there is little research on complex cost analysis at the distribution stage between suppliers and retailers, especially regarding the DIY retailers. Mathematical relations used in the analysis based on algorithms commonly used in the literature, however they have been modified and adapted to the analyzed company, its products and suppliers.

METHODOLOGY AND DATA

The data used in the empirical analysis was provided by the analyzed DIY retailer operating on the Polish market. The company cooperates with over 600 national suppliers. A chain of supermarkets (28 stores) and a warehouse (in central Poland) belong to the companies' distribution network. The data concerns both logistic and cost parameters. Within the framework of the study over 46.000 products and over 460 suppliers have been analyzed. The products are distributed within two channels: direct delivery from supplier to store and delivery through the warehouse (supplier – warehouse – store).

Due to the fact that the direct delivery channel is the dominant one, the question was asked, what if a given supplier is moved from this channel to the delivery through warehouse. The preliminary assumptions stemming from the enterprise's specifics and arrangements with suppliers are as follows:

- Lead time to the stores will be significantly reduced, as an order is delivered from the warehouse (1-2 days), and not directly from the supplier (1-30 days).
- Minimum order value/quantity (established by each supplier) will not have a decisive influence on the decision if an order can be placed. It will be much easier for the retail chain to place one order (stock in the warehouse), than if each store orders individually.
- Safety stock in the retail chain will be significantly reduced as the stock is kept in the warehouse.
- Total cost of transportation and storage of products, and hence of all products from a given supplier, may be reduced or increased, depending on the specificity of the products and other variables.

The conducted analysis included the following stages:

1. Exclusion of suppliers which products are unsuitable for storage (eg. flowers or products sold only in three or lower number of stores) and establishment of constraints for minimum suppliers' order value/quantity, lead time and possibility of ordering multipacks instead of pallets.
2. Definition of groups of costs generated while delivering through the warehouse (transportation cost from supplier to the warehouse, costs of receiving goods into inventory of the warehouse, storage cost, cost of order picking, cost of preparing the products to the shipment from the warehouse, cost of transportation from the warehouse to the stores), creation of analytical models for each cost groups and use of formula for GMROI index (gross margin return on inventory index) on the product level.
3. Aggregation of the results to the supplier level.

The next part of this chapter includes the methodology for estimating the costs generated by delivery via warehouse.

The cost of transportation is calculated on the stage of delivery of products from supplier to the warehouse and from the warehouse to the stores. The following equation shows how the annual cost of transportation per product is calculated:

$$C_{yt} = \bar{C}_{wt} \cdot D_{wr} \cdot n_w \tag{1}$$

where: C_{yt} – annual transportation cost, $\bar{C}_{wt}$ – average weekly transportation cost of one pallet, D_{wr} – weekly demand for a product in the retail chain (in pallets), n_w– number of sales weeks for a product.

The following equation describes how weekly stock in the warehouse for the retail chain is calculated:

$$S_w = \frac{1}{2}U_p + \frac{1}{2}\bar{C}_{of}\bar{D}_{ws} + \max\left\{z \cdot \delta\bar{D}_{ws}\sqrt{L + \bar{C}_{ofr}} \cdot \sqrt{n_{sr}};\ \sqrt{n_{sr}} \cdot U_s\right\} \tag{2}$$

where: S_w – weekly stock in warehouse for the retail chain in pallets, U_p – number of pieces in the purchase unit,$\bar{C}_{of}$ – average order fullfillment cycle (number of weeks the warehouse needs to meet the minimum order quantity/value of the supplier),$\bar{D}_{ws}$ – average weekly demand for one store,z – level of service,$\delta\bar{D}_{ws}$ – standard deviation of average weekly demand for one store[1], L – supplier lead time, $\bar{C}_{ofr}$ – average order fullfillment cycle for stores where the product is the range product,n_{sr} – number of stores where the product is the range product,U_s – number of pieces in the shipping unit.

The calculation of weekly storage cost of a product in the warehouse is presented below:

$$C_{ys} = \max\left\{\frac{S_w}{q_p}; 0{,}125\right\} \cdot \bar{C}_{ws} \cdot n_{sw} \tag{3}$$

[1] We assumed that standard deviation is equal to 30% of the average weekly demand. Standard deviation is calculated from the equation $\delta\bar{D}_{ws} = 0{,}3 \cdot \bar{D}_{ws}$.

where: C_{ys} – annual storage cost, S_W – weekly stock in warehouse for the retail chain (in pallets),q_p – quantity of pieces on a pallet,$\bar{C}_{ws}$ – average weekly storagecost of one pallet,n_{sw} – number of weeks when product was sold.
The number 0,125 is a parametric value. It is introduced to the equation due to the fact that a lot of analyzed products are small in size and for example 1 piece occupies 0,0004 of a pallet. In order to take such products into consideration, we acknowledge that they cover 1/8 of a pallet.

The following equation shows the calculation of the annual handling time (per 1 product) :

$$T_o = T_{pp} + T_{ip} + T_{op} + T_{opi} + T_p + T_{ppi} \tag{4}$$

where: T_h – time of handling operations, T_{pp} – time of pallet picking, T_{ip} – time of inserting pallet to the location, T_{op} – time of pallet opening, T_{opi} – time of order picking, T_p – time of palletizing, T_{ppi} – time of pallet picking to the intermediate storage area.
Annual cost of labour is calculated as below:

$$C_{yo} = \bar{C}_{mw} \cdot T_o \cdot D_{yr} \tag{5}$$

where: C_{yo}– annual operational cost, $\bar{C}_{mw}$ – average cost of 1 minute work[2], T_o – time of handling operations, D_{yr} – annual demand of a product in the retail chain.
The total annual cost of keeping a product in the warehouse is calculated as follows:

$$TC_y = C_{yo} + C_{ys} + C_{yt} \tag{6}$$

where: TC_y – total annual cost, C_{yo} – annual operational cost, C_{ys} – annual storage cost, C_{yt} – annual transportation cost.

The last stage of the cost analysis is the use of stock effect index and GMROI index. The quantity stock effect index shows how the stock changes after a product is moved to the warehouse distribution channel. If the index is greater than zero, it means that after the change of the distribution channel the stock of a product increases in the retail chain. If it is lower than zero, it means that the stock in the retail chain decreases. If the index is equal to zero, there are no changes in the stock quantity. The equation for the quantity stock effect is presented below:

$$SE_q = S_w + (S_s - S_s') \cdot n_{sr} \tag{7}$$

where: SE_q – quantity stock effect, S_W – weekly stock in warehouse for the retail chain in pallets, S_s – stock in a single store if a product is ordered directly from supplier, S_s' – stock in a single store if a product is ordered directly from warehouse, n_{sr} – number of stores where the product is the range product.

[2] Handling operations last from 5 till 60 seconds on average (based on the company's data).

Stock in a single store if a product is ordered from the supplier is calculated as follows:

$$S_s = \frac{1}{2}U_p + \frac{1}{2}\bar{C}_{of} + z \cdot \delta\bar{D}_{ws}\sqrt{L + \bar{C}_{of}} \quad (8)$$

where: S_s – stock in a single store if a product is ordered directly from supplier, U_p – number of pieces in the purchase unit, $\bar{C}_{of}$ – average order fullfillment cycle (number of weeks the warehouse needs to meet the minimum orderquantity/value of the supplier),$\bar{D}_{ws}$ – average weekly demand for one store,z – level of service, $\delta\bar{D}_{ws}$ – standard deviation of average weekly demand for a single store, L – supplier lead time.

Stock in a single store if a product is ordered from warehouse is calculated as follows:

$$S_s' = \frac{1}{2}U_s + \frac{1}{2}\bar{D}_{ws} + z \cdot \delta\bar{D}_{ws} \quad (9)$$

where: S_s' – stock in a single store if a product is ordered directly from warehouse,U_s– number of pieces in the shipping unit, $\bar{D}_{ws}$– average weekly demand for a single store, $\delta\bar{D}_{ws}$– standard deviation of average weekly demand for a single store.

The stock effect can also be expressed in terms of value. The below equation shows the calculation:

$$SE_v = SE_q \cdot P_n \quad (10)$$

where: SE_v– value stock effect, SE_q– quantity stock effect, P_n– net purchase price.

The final indicator for making the decision if a product should be moved to the distribution channel via warehouse is the GMROI index (gross margin return on inventory index). The index is calculated with the following equation:

$$GMROI = \frac{C_y}{-SE_v} \quad (11)$$

where: GMROI – gross margin return on inventory index, SE_v– value stock effect, P_{net}– net purchase price.

If the value stock effect is greater than zero, it means that the costs of handling and transportation are much higher than the benefits of decreasing the stock in the retail chain. Therefore, such products are not taken into account in the analysis.

The treshold for the GMROI index is 1. If the index is lower that 1, a product should be moved to the warehouse distribution channel. The costs that are generated due to changing the distribution channel (value stock effect is lower than zero) are lower than the benefits of decreasing the stock in the retail chain.

Due to the fact that each supplier should only use one distribution channel, the decision whether the distribution channel should be changed or not has to be made on the supplier level and not on the product level. Therefore we aggregated the results from the previous part of the analysis to the supplier level. As a result, if the GMROI index is lower than 1, supplier should be moved to the warehouse distribution channel. The costs that are generated due to handling and

transportation operations (value stock effect is lower than zero) for all products of the supplier are lower than the benefits of decreasing the stock in the retail chain.

EMPIRICAL RESULTS

The purpose of the study was to create a comprehensive analytical model to identify products and suppliers which should change the distribution channel from direct delivery to the distribution channel via warehouse. The change of the distribution channel should result in better stock availability for the retail chain and a reduction in distribution costs. With use of the algorithms presented in the previous part of the paper we conducted an empirycal analysis that gives us the recommendation which suppliers should change the distribution channel.

In the first stage of the analysis we excluded products that should not be stored in the warehouse (eg. plants). Furthermore, products that are sold in three or lower number of stores (out of 28 stores) were also excluded. It was considered that if a product is not poplar in the whole retail chain there are no prerequisites for keeping stock of these products in the warehouse.

The next step was to impose constraints on the analysis. The constraints based on the specifics of the analyzed enterprise and suppliers. We assumed that a product should be distributed via the warehouse if:

- Minimum order value is greater than 500 PLN (with a logistic minimum of more than PLN 500 PLN, a store may have no place to store products from a given order and funds to pay for an order).
- Lead time is greater than 7 days (if the supplier determines the delivery time for more than 7 days, it is much safer to keep his products in the central warehouse to avoid products' unavailability).
- There is a possibility of reducing a purchase unit (multipacks instead of a pallet).

Based on the constraints mentioned above we chose 8 priority groups. These groups indicate which products were more or less likely to change the distribution channel even before conducting the cost analysis. This means that the following breakdown is based only on products' specifics. The groups are as follows:

- Group 1 – products that fullfill all three constraints. The change of the distribution channel is most likely.
- Group 2, 3 and 4 – products that fullfill two out of the three constraints.
- Group 5, 6 and 7 – products that fullfill only one out of the three constraints.
- Group 8 – products that do not fullfill any of the constraints. The change of the distribution channel is least likely.

Based on the available data concerning the three constraints, the classification of the products and suppliers to each priority group has been presented in Table 1. We analyzed 238 suppliers that offered 31,549 products.

Table 1. Classification of products and suppliers to each priority group

Group	Minimum order value > 500 PLN	Lead Time > 7 days	Possibility of decrasing the purchase unit	Number of supliers	Number of products
1	X	X	X	34	6,712
2	X		X	75	10,232
3	X	X		26	2,467
4		X	X	10	1,663
5	X			27	2,480
6		X		4	151
7			X	45	6,985
8				17	859
Sum:				238	31,549

Source: own work based on the data of the analyzed company

Group 1 (all constraints met) includes 34 suppliers with almost 7 thousand products. Constraints connected with minimum order value and the possibility of reducing the purchase unit (group 2) were fulfilled by 75 suppliers and over 10 thousands products. Only 17 suppliers and almost 900 products did not fullfill any constraint (group 8).These suppliers has not been taken in the consideration in the next step of the analysis.

The second stage of the analysis covered the cost analysis in the distribution channel via warehouse. We calculated average annual costs of transportation and cost of handling. Due to the fact that both suppliers and stores are located throughout Poland we estimated the average transportation cost of 1 pallet to be 60 PLN.

Table 2 includes average time and cost of handling operations in the warehouse. Based on the company's data we estimated that 1 minute of work of a warehouse employee is equal to 0.21 PLN.

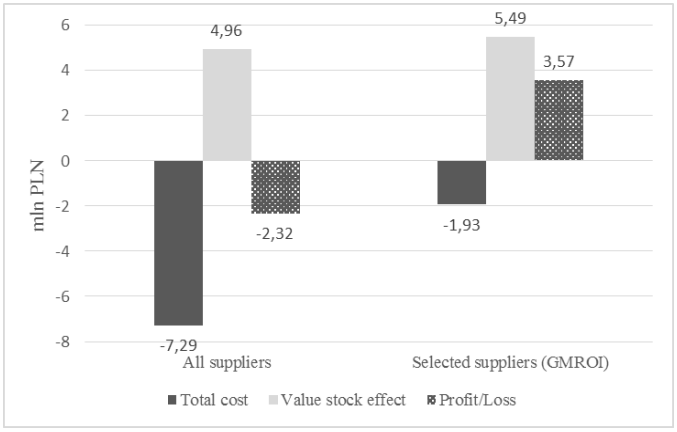
Table 2. Parameters of handling operations

Operation		Average time (sec.)	Average cost (PLN)
Pallet picking		60	0.21
Inserting the pallet to a location		20	0.07
Oppening the pallet		30	0.11
Order picking	Purchase unit = shipping unit	5	0.02
	Purchase unit > shipping unit (pallet to multipack)	10	0.04
Palletizing		60	0.21
Pallet picking to the intermediate storage area		30	0.11

Source: own work based on the data of the analyzed company

Figure 1 presents the results of the cost analysis for two scenarios. The first scenario concerns the situation when all the suppliers classified to the 8 priority groups and their products are moved from the direct delivery distribution channel to the warehouse distribution channel. As a result, the costs of transportation, handling and storing of the products far outwiegh the savings connected with moving the stock from the retail chain shops to the warehouse (value stock effect). We estimated that in this scenario the company could lose over 2.32 mln PLN annually.

Figure 1. Results of the cost analysis (in mln PLN)



Source: own work based on the data of the analyzed company

Obviously, the change of the delivery channel for all suppliers and their products is not beneficial to the company. Therefore, we calculated the GMROI index for each supplier in order to select the suppliers which do not generate additional costs for the company, ie. the benefits resulting from decreasing the stock in the retail chain outwiegh the costs of changing the distribution channel (the second scenario). After the GMROI index analysis we stated that 105 suppliers (44% of the suppliers) should be moved to the warehouse distribution channel. These suppliers deliver 11,528 products to the company (36% of all products).

If only the selected suppliers are moved to the warehouse distribution channel, the company can save around 3.57 mln PLN. The costs connected with transportation, handling and storing of the products are equal to almost 2 mln PLN and the value stock effect exceeds these costs almost three times.

CONCLUSIONS

This paper contributes to verification of the algorithms related to the costs of distribution and to creation of an analytical model enabling to identify an effective distribution channel for suppliers of a DIY enterprise. Based

on the empirical study the analyzed enterprise suppliers with recommendation for the change of the distribution channels have been selected. As a result, the enterprise could benefit from the lower costs of distribution and even generate profit. Taking into consideration the result of the analysis and the literature overview it may be stated that a comprehensive analysis of distribution costs contributes to the minimization of these costs. Individual products or suppliers can generate a loss or profit for a business, depending on whether the distribution channel is matched appropriately with the product, supplier, market and retailer specifics.

Although the analysis was conducted at a complex level, it was tailored to the needs of only one DIY company. Obviously, the obtained results may be generalized to the level of the whole non-food retail sector. However, there are still other sectors which were not included within the framework of the study. Therefore, this paper should be followed by an attempt of creation of analogous analytical models for other sectors, especially those dealing with products of a completely different nature, such as food sector. Furthermore, the study can be extended for non-Polish retail markets. In countries with different market environments, companies can organize their distribution processes in a completely different way.

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ECOLOGICAL AWARENESS OF STUDENTS IN THE LIGHT OF SURVEYS

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Abstract: The paper is an attempt to determine the condition of ecological awareness – pro-environmental attitudes of students from Poland and Slovakia, as well as correlation between the pro-environmental attitude declared by the youth and their place of residence. Apart from willingness to get to know beliefs, opinions and the condition of knowledge in many particular issues related to the subject, the paper has the following purposes: to learn dependence between personal features of people and the condition of their ecological awareness, to determine the degree of consistency of beliefs in different matters relating to the examined problems, to compare the force of interaction of particular sources of information on particular population categories.

Keywords: ecological awareness, survey research

INTRODUCTION

Intensifying ecological hazard stimulates growth in interest in the issues of environmental protection. In the professional literature and in the mass media discussions are held on the causes of ecological hazards as well as on the ways of overcoming them. More and more publications are issued about improvement in ecosystems, making them resistant to different forms of anthropogenic load. Technique and technology are improved from the point of view of their environmental impact. Research on biotechnologies develops dynamically. A man intensively watches nature and learns solutions more perfect than so far available.

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Environmental protection becomes a problem that affects every individual to a smaller or greater extent.

The condition of the society's ecological awareness, their knowledge, attitudes, opinions, habits and resulting behaviours are not neutral to the protection of natural environment. A man's daily life is in the direct proximity of nature and his actions often directly affect it.

Ecological awareness has many meanings and definitions, depending on field of science. The notion was used in the Polish literature for the first time by Z. Hull, according to whom it is "a unique, shaping form of social awareness, which is present both in thinking and experiences of people and valuation and functioning of biosphere"[1]. Another definition presents ecological awareness as "a set of information and convictions about the natural environment and perception of the relations between the condition and the character of the natural environment and the conditions and quality of human life" [2]. According to another definition, it is "the understanding of nature in our life and the understanding of the place and role of a man in nature. It results in learning his needs whose satisfying is necessary for life, effects of activities of a man who uses nature resources and reasons for disturbing the balance of ecosystems"[3].

In order to characterize the condition of ecological awareness, reference can be made to two categories introduced by T. Burger, namely: pro-environmental attitude and ecological indifference. The pro-ecological attitude is represented by individuals who opt for environmental protection in a determined way, while among people showing the attitude of ecological indifference he distinguished several groups:

- a group favourable for environmental protection, however, not demonstrating a clearly pro-environmental attitude,
- a group of neutral people who are not interested in this field and do not regard addressing environmental protection as necessary;
- group of people who notice problems of ecology but, at the same time, manifest a belief that time to solve them has not come yet;
- a group of conscious opponents of environmental protection[4].

[1] Kowalska M. [2011] Socjologiczne aspekty badania świadomości ekologicznej. Krakowskie Studia Małopolskie, 15, 383-396, Toruń.

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PURPOSE OF THE PAPER

Apart from willingness to get to know beliefs, opinions and the condition of knowledge in many particular issues related to the subject, the paper has the following purposes:

- To learn dependence between personal features of people and the condition of their ecological awareness,
- To determine the degree of consistency of beliefs in different matters relating to the examined problems,
- To compare the force of interaction of particular sources of information on particular population categories.

MATERIAL AND METHOD

The paper is an attempt to determine the condition of ecological awareness – pro-environmental attitudes of students from Poland and Slovakia, as well as correlation between the pro-environmental attitude declared by the youth and their place of residence.

The surveys were carried out in 2013. They covered a group of randomly selected 126 students of the University of Agriculture in Krakow (Lesser Poland) and the Slovak University of Agriculture in Nitra (Nitra land). The applied scheme of sampling and a sufficiently big test size of the sample provide its representative character, and consequently – conclusions drawn on its basis can be referred to the whole analysed population.

A research tool was a questionnaire prepared by the author in accordance with valid requirements for building forms for surveys[5].

The questionnaire consisted of 20 questions. These were mostly "closed-end" questions, often called categorized questions, questions with a choice or cafeteria, requiring the respondent to select answers from a ready set. Some questions were giving the respondent total freedom of statement, i.e. The possibility of adding own answer to the asked question.

The form consisted of two parts. The first included characteristics of the respondent (age, sex, education, evaluation of financial situation by the respondent). The second part contained questions that define views of the surveyed in environmental issues. These were questions addressed to the respondent with regard to:

- Development of civilization and hazards involved,
- Condition of the natural environment,

[5] See S. Mynarski [1986] Metody badań marketingowych, AE Krakow; Frankfort-Nachmias Ch., Nachmias D. [2001] Metody badawcze w naukach społecznych", Zysk i Ska, Poznań; Zając K. [1971] Zarys metod statystycznych, PWE, Warsaw.

- Interest in environmental problems,
- Environmental values and attitude to nature.

After collecting filled in questionnaires, the empirical material was subjected to computer processing, as a result the following was obtained:

- Percentage distributions of answers,
- Statistical dependences between some variables, using the χ^2 independence test[6].

The statistical analysis was conducted by means of spreadsheet Microsoft Excel 2007, among others, with the use of pivot table report.

When examining dependences that may occur between the studied features in the general population the χ^2 independence test was used.

RESULTS

The surveys were conducted among the students of the University of Agriculture in Krakow and the Slovak University of Agriculture in Nitra. The survey involved participation of 126 students including 96 women and 30 men who were 76.19 and 23.81% of the examined sample, respectively. The respondents were aged between 21 and 30. The respondents were students of the following majors: Economics and Management of the University of Agriculture in Krakow (62 individuals - 49.2%), as well as of the Slovak University of Agriculture in Nitra (64 individuals - 50.8%).

In the analysed group, 43 students (36.5%) assessed their financial situation as sufficient. This assessment was most common among the surveyed. 36 students (28.6%) assessed their financial situation as good and 39 as sufficient. Extreme assessments, i.e. Very good and bad appeared at 6.4% of the surveyed (3 and 5 individuals, respectively).

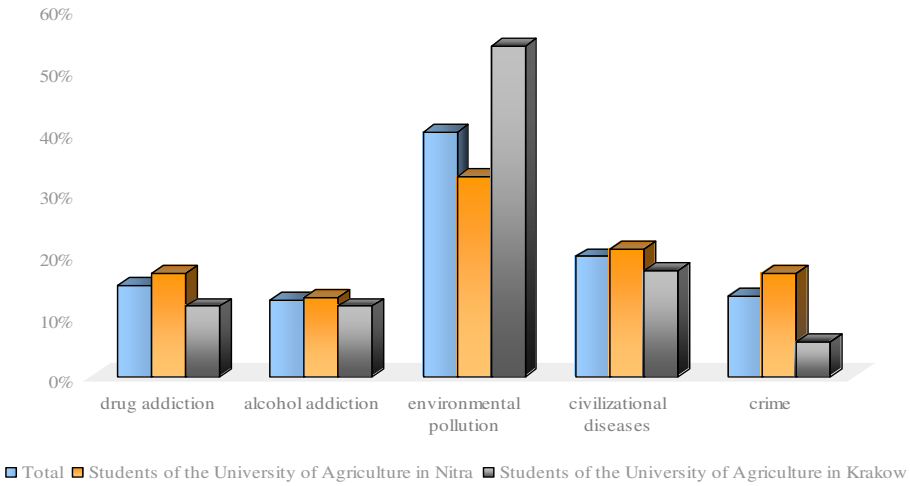
The natural environment of a man is "a value recognized" and declared, widely common in the Polish and Slovak society. This declared positive attitude to nature is not however fully reflected in specific choices of environmental values and behaviours proving relationships with nature. In the event of selection, when it is truly necessary to give up basic goods of civilization to protect nature or only contact with it the ecological values often lose. Some goods of civilization as e.g. A car are so attractive that they win over nature even at the level of verbal declarations.

Firstly, the opinions of respondents about the current condition of environment will presented; are we optimists or pessimists. In the opinion of the surveyed poisoning of the environment is one of the major civilization-related hazards (Figure 1). Almost 40% of the surveyed list this negative phenomenon as the first and only 9.1% puts it on the last place. The respondents believe that the development of civilization contributes to adverse changes in nature.

[6] see J. Greń, „Statystyka matematyczna. Modele i zadania”, PWN, Warsaw, 1976.

68% of students from Krakow and 89% students from Nitra are of this opinion. Positive impact is noticed only by 4.7% and 1.5 % of students of the surveyed universities. Other individuals do not have an opinion on this subject.

Figure 1. Most important civilization-related hazards according to the surveyed



Source: prepared by the authors on the basis of survey data

It turns out that the respondents' opinions on the condition of the environment do not dependent on sex ($\chi^2 \approx 5.155 < \chi^2_{\alpha=0.05} = 5.991$), nor on the place of studying ($\chi^2 \approx 4.063 < \chi^2_{\alpha=0.05} = 5.991$).

Table 1. Respondents by expressed opinions on the condition of the environment in the country in the past five years and place of studying (in %)

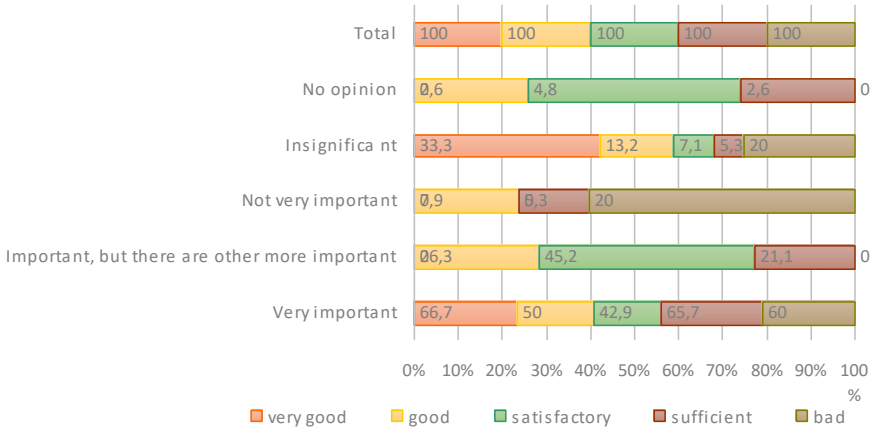
Condition of the environment	Place of studying		Total
	Slovak University of Agriculture in Nitra	University of Agriculture in Krakow	
improved definitely	0.0	9.7	4.8
improved a bit	1.6	32.3	16.7
is the same	37.5	16.1	27.0
is a bit worse	42.2	38.7	40.5
is definitely worse	18.7	3.2	11.0
Total	100.0	100.0	100.0

Source: prepared by the authors

Opinions expressed do not depend on the degree of wealth of the surveyed people ($\chi^2 \approx 2.352 < \chi^2_{\alpha=0.05} = 5.991$). Distribution of interest in the condition of the environment is presented in Table 2. The most numerous group – 106

respondents are individuals for whom the condition of the natural environment is important. Students who define their financial situation as fair and bad are not less interested in the condition of the environment than more wealth students.

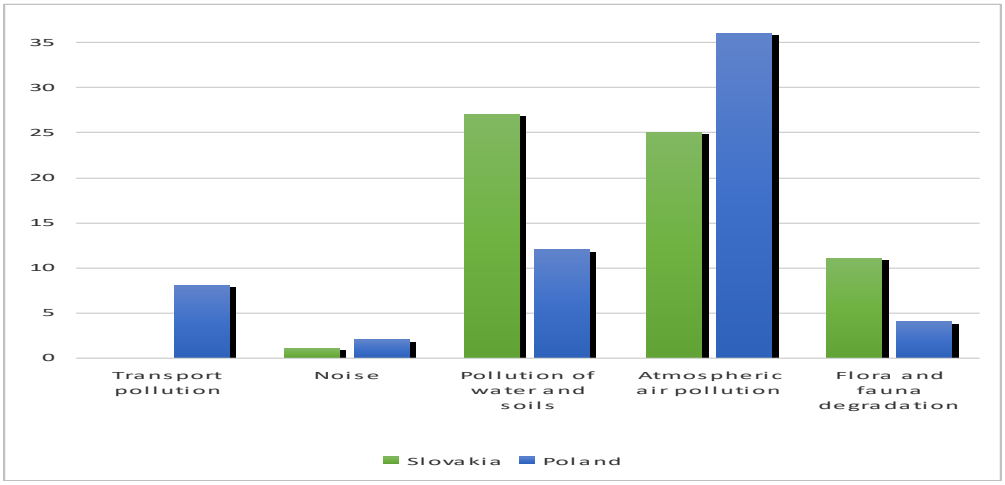
Figure 2. Respondents by interest in the condition of the environment and evaluation of financial situation (in %)



Source: prepared by the authors

As the most significant problems associated with the natural environment, the respondents listed in the first place atmospheric air pollution (58.1% of students of the University of Agriculture in Krakow and 39.1% of students of the Slovak University of Agriculture in Nitra) and pollution of water and soils (19.6% and 42.2%, respectively).other students pointed out to the degradation of the world of plants and animals, transport pollution and noise (Figure 2).

Figure 3. The most important problems associated with the environment according to the surveyed

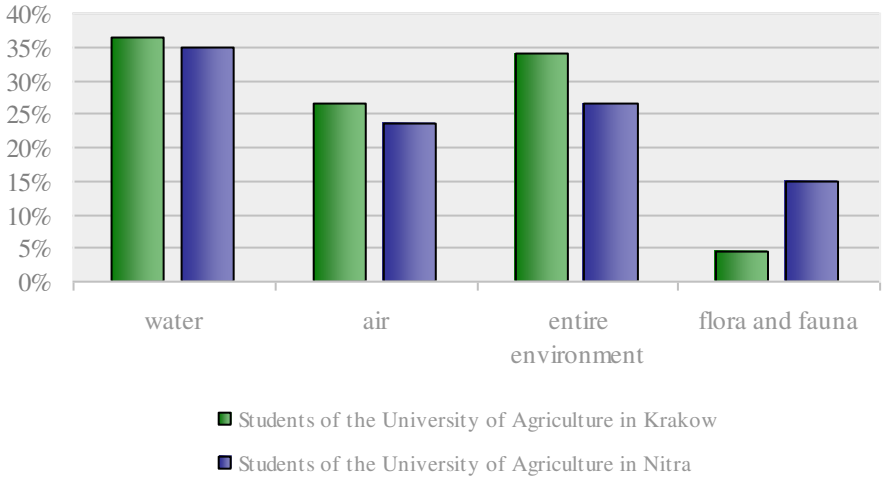


Source: prepared by the authors on the basis of survey data

Trends related to the anxiety about the condition of the natural environment are more visible when we compare the answers to the question: "would you grant voluntary funds for environmental protection?" the answer does not depend on sex ($\chi^2 \approx 0.013 < \chi^2_{\alpha=0.05} = 3.841$), place of origin ($\chi^2 \approx 1.370 < \chi^2_{\alpha=0.05} = 3.841$) and wealth of the surveyed ($\chi^2 \approx 5.926 < \chi^2_{\alpha=0.05} = 5.991$) people, regardless of the above listed features, are ready to grant voluntary funds for environmental protection.

On the other hand, in the answer to the question: "what would you grant money for environmental protection for?" all the respondents emphasized water quality (36.7% students of the University of Agriculture in Krakow, 35.2% of students of the Slovak University of Agriculture in Nitra), on the second place the entirety of environmental issues was mentioned (26.7% and 23%, respectively) (Figure 4).

Figure 4. Which elements of the environment would you grant money for?



Source: prepared by the authors on the basis of survey data

ATTEMPT TO ASSESS ECOLOGICAL AWARENESS OF THE SURVEYED

With the wish to get to know ecological awareness of the society, we can assume that we will encounter internally consistent set of beliefs and attitudes. We have to be aware of the difference between statements and actual behaviours [7]. We are dealing with two forms of awareness: declared and executed. Although, the first one predisposes an individual to certain behaviours, but is not determinant for them. Galiński explains these differences as follows: " dissonance between verbal and actual behaviours in the ecological sphere and preferences for instrumental environmental values are a sign of careless attitude of the Polish society to the surroundings at all – not only to the natural environment" [8]. And in fact it is difficult to call a person whose behaviour comes down only to verbal declarations as ecologically conscious. After all, ecological awareness comprises, according to sychut and chmielewski: an emotional-evaluating component (the adopted system of values), a behavioural component (needs, postulates in connection with the use of

[7] Mydlak M., Szafranek R. C., Trebnio D. (1994) Społeczno-kulturowe uwarunkowania świadomości ekologicznej rolników [in:] Doradztwo w ekorozwoju obszarów wiejskich, AR in Szczecin, ATR in Olsztyn, Szczecin.

[8] Dobrzańska B., Dobrzański G., Kiełczowski D. (2008) Ochrona środowiska przyrodniczego. Wydawnictwo Naukowe PWN. Warsaw.

environmental resources , as well as various forms of activity for natural protection), and a cognitive component (having a vision and deepening of knowledge)[9].

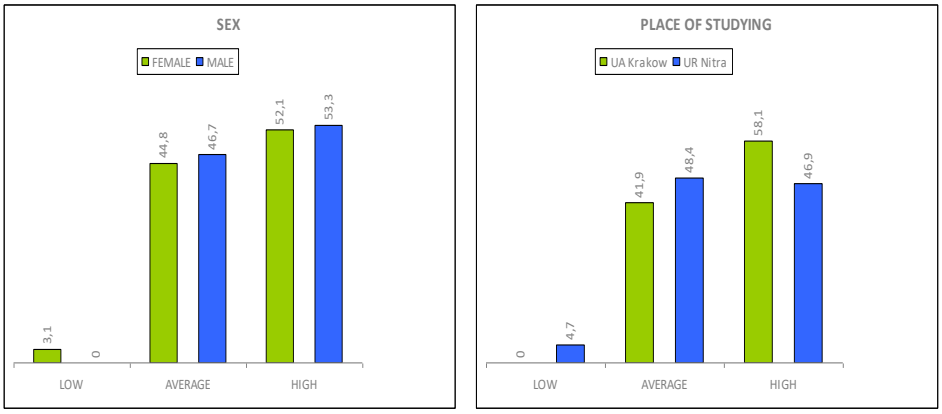
Compliance between the declared and performed contents depends largely on the importance attained to a given issue by the social environment of the individual[10]. It affects depth of interiorization of a respective norm and force of social pressure, forcing its observance.

Actual behaviors, due to their direct results, are of greater importance, however, research on them involves many difficulties. Since they are largely dependent on the attitude declared, the research is based on this attitude.

When characterizing the condition of ecological awareness of a given respondent their various statements were brought to one, general assessment, which allowed placing a given individual as compared to other respondents. For this purpose, from among 20 questions from the questionnaire questions were selected that determine in some way views of the respondent on environmental issues and which each (regardless of age or education) should be able to answer. The respondent giving "the right" answer to the selected question receives one point. Total points, after converted into a one-hundred-point scale are a "pro-environmental attitude index". The respondents were grouped by growing value of the index and divided into three groups with low, average and high index.

The applied index allows comparing with each other groups of respondents separated by various criteria. The average "pro-environmental attitude index" for the total surveyed was 68.3%, 73.3% for students of UA Krakow and 64.5% for students of UA Nitra.

Figure 5. "pro-environmental attitude index" in groups by sex and places of studying (%)



Source: prepared by the authors.

[9] Kowalska M. (2011) Socjologiczne aspekty badania świadomości ekologicznej. Krakowskie Studia Małopolskie, 15, 383 – 396, Toruń.

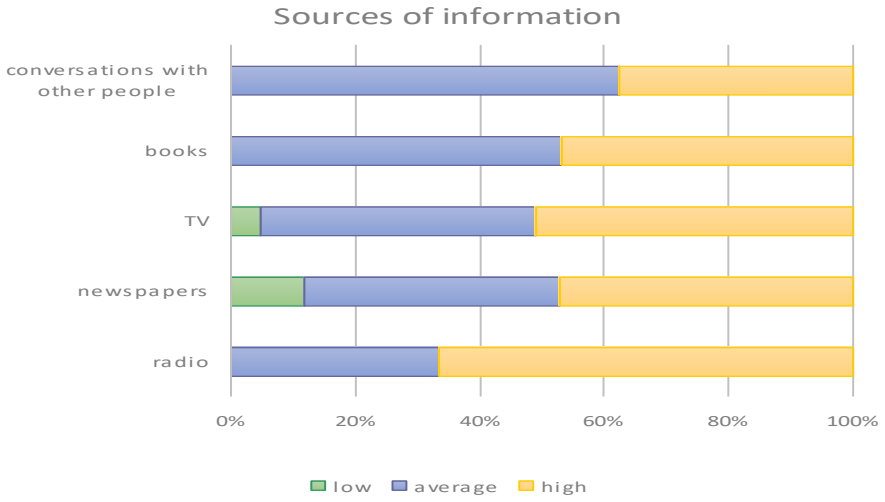
[10] Moskal S. (1995) Świadomość ekologiczna mieszkańców wsi, Wieś i Rolnictwo, 4.

Analysing the distribution of the level of "pro-environmental attitude index" by sex and places of studying of the respondents (Table 3), as well as verifying independence of these features by a test χ^2 , it can be concluded that the index level does not depend on the listed features $(\chi^2 \approx 0.014 < \chi^2_{\alpha=0.05} = 3.841)$, $(\chi^2 \approx 0.935 < \chi^2_{\alpha=0.05} = 3.841)$.

Awareness of hazards expressed in the surveys is very high: the respondents declare interest in environmental issues and feel responsible for the condition of the natural environment. This is, however, partially declared interest. The findings of our surveys indicate that only 7.9% of the respondents claim that they do not do anything detrimental to the environment, however 38.1% did not select waste.

The condition of ecological awareness includes both knowledge and beliefs. Sources of information which reaches the respondents with "pro-environmental attitude index" were compared. It turns out that that tv prevails over any other sources of information. Among the surveyed 48.4% pointed to television as the main source of information. In the group of low value of "pro-environmental attitude index" the share of particular information carriers is scant. Analysing this phenomenon, it is possible to indicate a medium which should be used for ecological education of the society.

Figure 6. Sources of information in groups of respondents by "pro-environmental attitude index" (%)



Source: prepared by the authors

CONCLUSIONS

From the analysis of surveys conducted among students of the Agricultural Universities in Kraków and Nitra it seems that:

1. most often the respondents believe that development of civilization contributes to adverse changes in nature,
2. 68% of students of the University of Agriculture in Krakow and 89% of students of the Slovak University of Agriculture in Nitra were of the opinion that development of civilization has a negative impact on the natural environment condition,
3. among the most endangered elements the respondents mentioned in the first place water, and only on the second place the entirety of environmental issues,
4. almost 21.5% of the surveyed were of the opinion that within five years the condition of the natural environment in the country improved,
5. high value of "pro-environmental attitudes index" enables indicating vast number of pro-environmental attitudes, at least declared.

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Mydlak M., Szafranek R. C., Trebnio D. (1994) Społeczno-kulturowe uwarunkowania świadomości ekologicznej rolników. [in:] Doradztwo w ekorozwoju obszarów wiejskich. AR in Szczecin, ATR in Olsztyn, Szczecin.

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CRIME AND THE STANDARD OF LIVING IN POLAND

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Abstract: The purpose of the paper is to conduct a statistical analysis that will examine the problem of crime against the standard of living. The paper attempts to determine the relationship between the level of crime in Poland, and the level of life. A ranking of provinces, determining the level of crime and quality of life, was created. In order to sort the objects the method of multidimensional comparative analysis was used. By using this method, the hierarchy of provinces was created. The research enabled indicating groups of objects that are similar in the examined phenomena.

Keywords: crime, standard of living, statistical analysis

INTRODUCTION

The period of transitions in the political system in Poland is associated with social transformations. The observed transformations have also their negative dimension. Problems such as inequality and social stratification, emergence of new business elites and wealth, on the one hand, and poverty, on the other hand, are reflected in increased disturbance and development of social pathologies. The intensification of criminal phenomena had its apogee in the years 2002-2003, followed by a gradual decrease in the number of registered crimes. This trend was accompanied by an increase in social trust in the Police, as well as increase in effectiveness of its work (manifesting itself for instance in increased crime detection).

Crime is, in its essence, a social phenomenon, and research on spatial aspects of crime has its "roots" in sociological papers (Jałowiecki 1980; Wódz 1989). Along with the emergence of more efficient tools of elaboration and analysis

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of statistical data, interest in research on the problems of crime in Poland clearly grew. Published papers relate both to the analysis of crime alone, in the light of police statistics (Mydel, Kozimor 1989; Maik 1995; Gronowski 2003; Mordwa 2006, 2011) and social perception of the phenomenon and its consequences (Marcińczak, Siejkowska 2003, 2004; Bogacka 2009).

Crimes are a very important factor influencing level of living of the inhabitants of Poland. The problem of crime is more and more serious and gathers attention not only of citizens but also scientists who analyse the relation between the size of committed crimes and quality of life indexes.

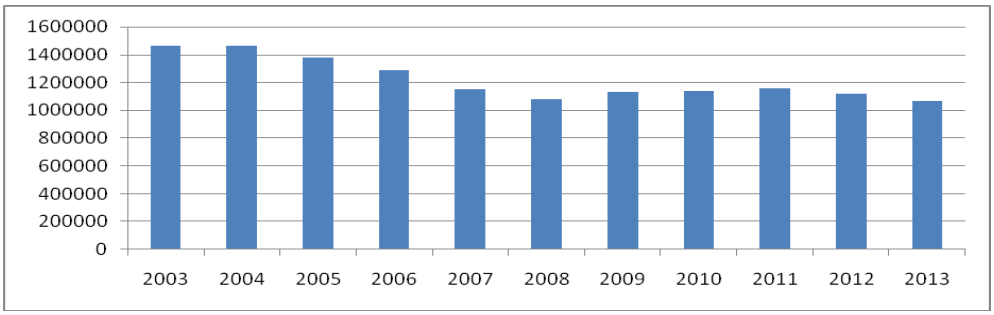
The purpose of this paper is to conduct a statistical analysis that will examine the problem of crime against standard of living. In order to achieve the established research purpose, the level of crime in Poland over the years 2008-2013 was presented and the quality of life in sixteen provinces was described.

STATE OF SECURITY IN POLAND IN THE YEARS 2008-2013

The most frequent crimes in Poland are: fights, beating up, health impairment, homicide, extortion, rapes, thefts of someone else's property, thefts with burglary, theft of a car and damage to objects. They account for more than 60% of the crimes registered in Poland and are the most burdensome from the social point of view.

The above crimes are termed as common crime due to the inconvenience for an ordinary citizen who predominantly has no contact with an organized criminal group. Therefore, the above listed crimes have a strong impact on standard of living.

Figure 1. The number of criminal offences in Poland (2003-2013)



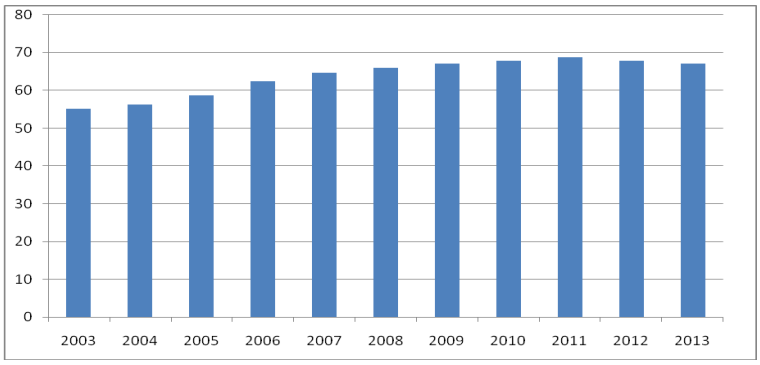
Source: study based on Report on the state of security in Poland (2013)

It can be easily noted that in Poland for a dozen of years the confirmed crimes have shown a downward trend (Figure 1). In 2013, the police confirmed 1 063 703 crimes in our country. In comparison with the previous year (1 119 803 crimes in 2008), it means a decrease by 5%. In the years 2009-2011, we can see a slight increase in crimes, after a prior big drop recorded in the years from 2004

to 2008. It is also worth noting that in 2013 the smallest number of crimes committed in Poland over the past decade was recorded. In comparison with 2003, when almost 1.5 million crimes were committed, it is a number smaller by about a third (27.5%). In the scale of the whole country, however, almost half of acts criminal are reported[1].

General downward trend noticeable in the number of crimes confirmed by the police has a close connection with their detection. In the recent decade, we have been dealing with clear growth in crime detection committed (Figure 2).

Figure 2. Crime detection in the years 2003-2013 (%)



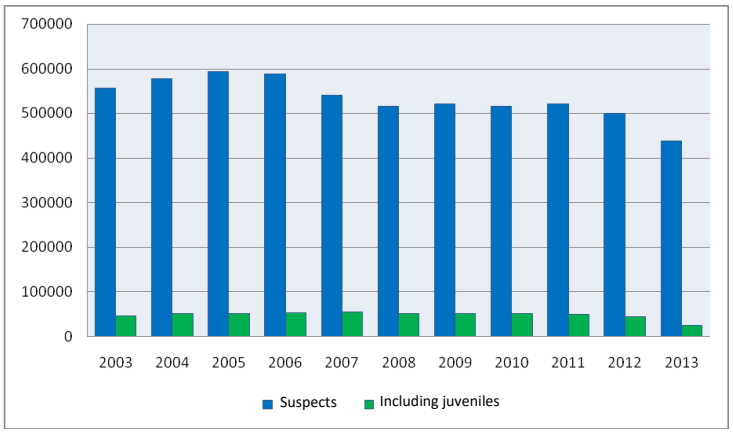
Source: study based on Report on the state of security in Poland [2013]

The index of crime detection in 2013 was 67.1% and was comparable with the year before when it recorded 67.8%. The best result in the last ten years was the result of 2011, when the index of detection was 68.7%. In 2003, detection was only 55.2%, therefore the index of detection increased over ten years by 11.9 percentage points.

In 2013, the police could not determine 438 662 suspects of crime. It means that the number of the determined suspects decreased by 12.3% as compared to the previous year, when this number was 500 539. In the years 2008-2012, the number of people suspected of crimes was stable and was running on a similar level (Figure 3).

[1] Siemaszko A. (2009) Polskie badanie przestępczości (2007-2009): Analiza wybranych rezultatów, Polska Akademia Nauk, Warszawa, p. 235.

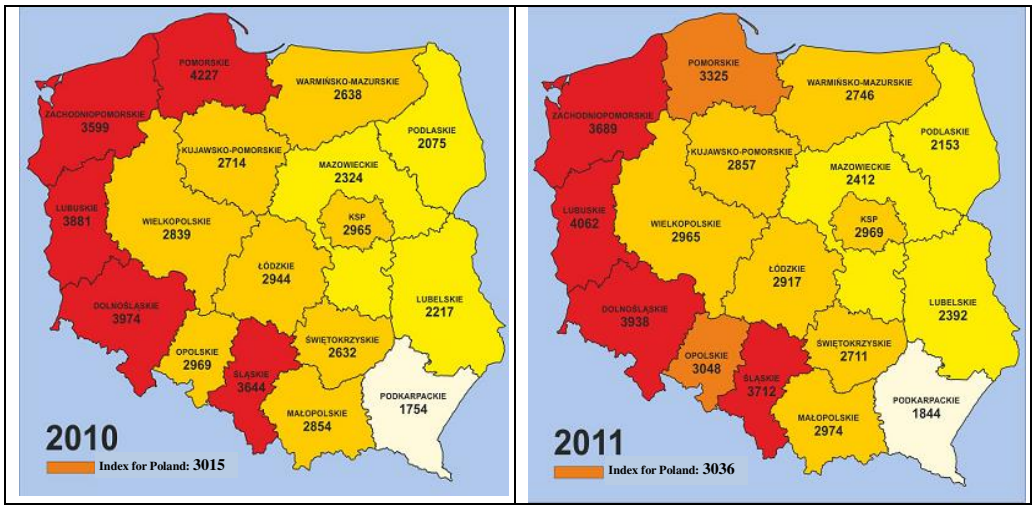
Figure 3. The number of suspects established by the police in the years 2003-2013

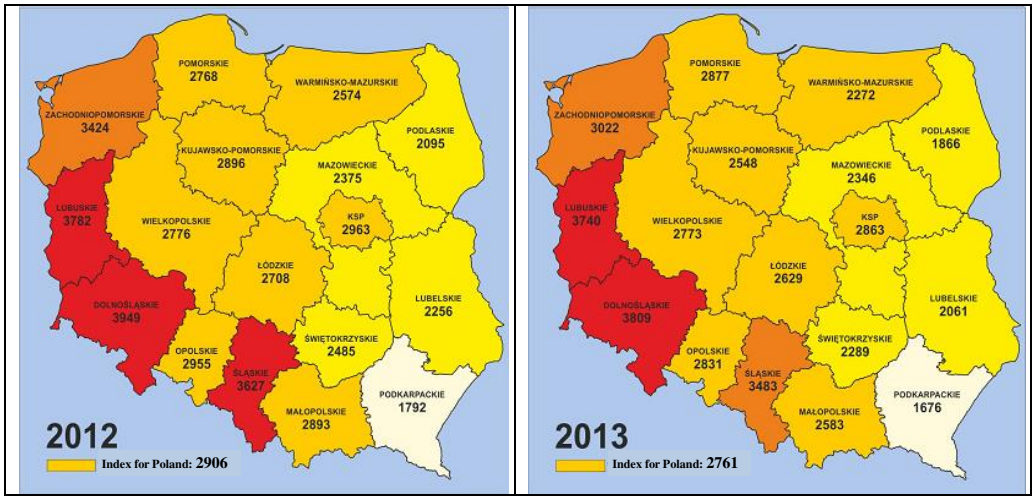


Source: study based on Report on the state of security in Poland [2013]

In 2013, from among 438 662 suspects only 25 248 were juveniles, which is a very good result. In comparison with 2012, decrease was recorded by 42.4%, when 43 847 were juveniles). In 2013, juveniles accounted for only 5.8% of suspects, and in 2012 this percentage was 8.8%.

Figure 4. Crime vulnerability index in the years 2010 – 2013 (Index for Poland)





Source: Report on the state of security in Poland [2013]

Average hazard of crimes per one hundred thousand inhabitants in 2013 was 2761 and was one of the lowest over recent years. The index changes along with total confirmed crimes and over the last years it was as follows:

- In 2010, the index for Poland was 3015. The highest values of crime vulnerability index in total per 100 thousand inhabitants were recorded in western provinces: Pomorskie, Zachodniopomorskie, Lubuskie, Dolnośląskie and Śląskie, and they exceeded the value of 3000. The highest index was recorded in Pomorskie Province (4227) and it was the only region where the value of the index exceeded 4000: on the other hand, it was the smallest in Podkarpackie Province, where it was 1754. In other provinces, the index was within the range of 2000-3000.
- In 2013, the index for the whole country was 2761. It is definitely the lowest crime vulnerability index in Poland in the analysed period. In comparison with the previous year (2011), it fell down by as much as 145. The lowest index was invariably recorded in Podkarpackie Province (1676). No province exceeded 4000, however, the highest index was recorded in Dolnośląskie Province and it was 3809.

STANDARD OF LIVING IN POLAND

In statistical, sociological and economic literature, the term of standard of living happens to be diverse and not entirely unified. The term of "conditions of living" is often used and it is defined most often as relations in which society, an individual or a household are living currently. The standard of family's living is determined, among others, by the possibility of satisfying its individual needs[2]. Research on standard of living make use of mathematics, statistics, economy,

[2] Jakość życia i spójność społeczna 2011 – Główny Urząd Statystyczny, Warszawa 2011, str. 5.

sociology, psychology and philosophy[3]. Living conditions are predominantly determined by several basic elements:

- Level of economic welfare.
- Degree of equipping - municipal and residential infrastructure.
- Degree of equipping with social infrastructure.
- Natural conditions of the environment where the human lives.

Within these groups, to describe living conditions it becomes necessary to conduct further disaggregation of components which are connected with specified human needs[4].

In recent years, gradual growth has been recorded in the importance of subjective indexes in research on quality of living, conducted by both public statistic and international organizations, and research centres[5].

The category of quality of life and problems related to its statistical measurement in the recent years have become the object of significant interest of not only science domains, but also general public and state authorities[6].

To determine standard of living, socio-economic indexes were used: they were grouped in the following categories describing the phenomenon:

1. Employment, working conditions, unemployment.

- Employment index (number of the employed per 1000 people at working age) - [S].
- Registered unemployment rate (share of the unemployed who are registered in the overall number of professionally active people) – [D].
- Long-term unemployment rate (share of the unemployed who are looking for job above twelve months in the overall number of professionally active people) – [D].
- Number of the unemployed against vacancies (number of unemployed people per one vacancy) – [D].
- Accident rate (people injured in accidents at work per 1000 working people) – [D].
- Employees in hazard conditions (number of people employed in hazard conditions per 1000 employees) – [D].

2. Income of population, housing conditions, material resources.

- Average available income, namely average monthly income per one person in a household, calculated in PLN – [S].
- Index of house maintenance costs. It consists of the cost of maintaining apartment and energy carriers per one person in households in % of total expenses – [D].

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[3] Owsiński J., Tarchalski T. (2008) Współczesne problemy zarządzania, Instytut Badań Systemowych, Warszawa, str. 1.

[4] Zróżnicowanie regionalne poziomu życia ludności w świetle wybranych wskaźników z badań Statystki Publicznej – Główny Urząd Statystyczny, Warszawa 2014, str. 2.

[5] Mieszkańcy Polski o swojej jakości życia – Główny Urząd Statystyczny, Warszawa 2014, str. 1.

[6] Jakość życia, kapitał społeczny, ubóstwo i wykluczenie społeczne w Polsce – Główny Urząd statystyczny, Warszawa 2013, str. 1.

- Density of apartments. This variable is divided into two categories:
  - Average floor area of an apartment per one person in square meters – [S].
  - Average number of people per one room – [D].
- Material resources, this variable shows percentage share of households with: passenger car [S]; personal computer with access to the Internet [S]; dishwasher [S].

3. Social exclusion and poverty.

- Use of social benefits: it shows the number of people who use such benefits (e.g. social aid) per 10 thousand inhabitants – [D].
- Index of hazard with relative poverty, namely percentage of the society living in a household with income lower than the poverty level – [D].
- Index of material deprivation: it shows percentage of people with at least three from among nine symptoms of poverty – [D].
- Index of the lack of material deprivation. This index shows percentage of people in society who are not affected by poverty – [S].

4. Economic development.

- Gross Domestic Product per capita in PLN – [S].
- Value of fixed assets in PLN, per capita, calculated gross – [S].
- Index of degree of region's attractiveness:
  - Inflows and outflows of local community (migration balance) per one thousand inhabitants – [S].
  - Newly registered entities in the REGON register per 10 thousand people – [S].
- Value of expenses on research-development activities per capita in PLN – [S].

5. Economic infrastructure.

- Railway transport: it presents operated railway lines in kilometres per 100 km2 – [S].
- Infrastructure of public roads: the index shows the number of kilometres of roads with hard pavement per 100 km2 – [S].
- Business entities, namely entities registered in REGON per 10 thousand people of local community – [S].

Constant weight, equal to 1, is assigned to all indexes. It enables giving them equal meanings. With the use of taxonomic methods, variables were brought to mutual comparability. Group indexes were calculated for each region, thanks to which a synthetic index was calculated: it is arithmetic average of group indexes[7]. Obtained thus values of the synthetic index enable ordering and assigning objects to four groups:

- M_I – with the highest standard of living.
- M_{II} – with the average standard of living.
- M_{III} – with the low standard of living.
- M_{IV} – with the lowest level of living.

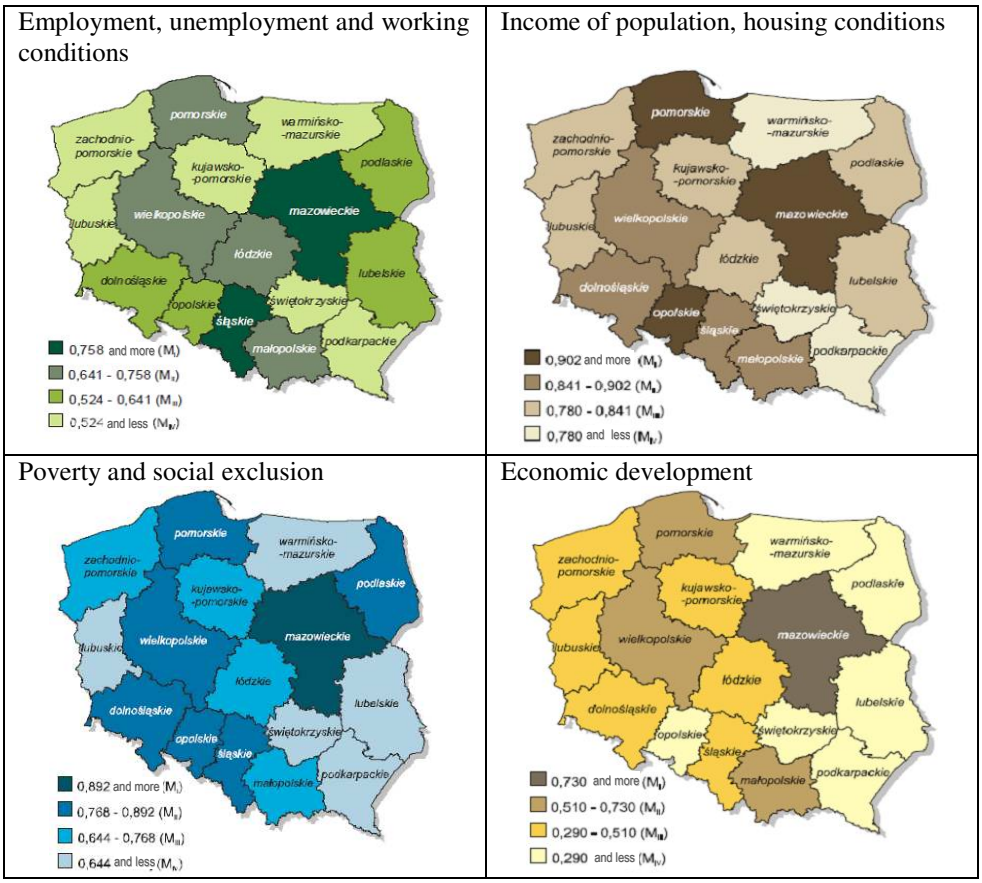
[7] http://stat.gov.pl/cps/rde/xbcr/lodz/ASSETS_referat_zroznicowanie_regionalne_poziomu_zycia.pdf (access 12.03.2015)

RESEARCH FINDINGS

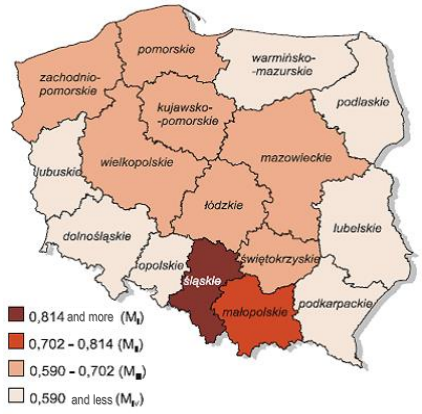
The crime vulnerability index per 100 thousand inhabitants was serving as a destimulant, whereas the index of standard of living were stimulants. It should also be mentioned that in the case of indexes concerning quality of life, we have been dealing with de-stimulants and stimulants, however, to calculate indexes all variables were converted to stimulants.

The assessment of diversity of the analysed phenomena by means of a multi-dimensional statistical analysis indicates that the Provinces: Mazowieckie, Śląskie, Wielkopolskie, Pomorskie and Małopolskie are characterized by the highest value of synthetic index of the standard of living in Poland, whereas it is the lowest in the Provinces: Zachodniopomorskie, Kujawsko-Pomorskie, Warmińsko-Mazurskie, Lubelskie, Lubuskie, Świetokrzyskie, Podkarpackie and Opolskie.

Figure 5. Gradation of provinces in terms of standard of living taking into account the category of socio-economic indexes



Economic infrastructure



Synthetic index of standard of living of population

Source: http://stat.gov.pl/ cps/rde/xbcr/lodz/ ASSETS_referat_zroznicowanie regionalne _poziomu_zycia.pdf (access: 05.02.2015)

Owing to the position held by particular provinces, ranks were assigned to each object, separately for the indexes regarding crimes, particular socio-economic indexes and the synthetic index describing the standard of living (Table 2).

Table 1. Ranks of provinces by particular indexes

Province	Crime vulnerability index per 100 000 inhabitants	Index of standard of living					
		I	II	III	IV	V	VI
Dolnośląskie	16	8	5	6	5	5	7
Kujawsko-Pomorskie	7	14	12	10	9	9	12
Lubelskie	3	10	13	14	15	15	14
Lubuskie	15	11	9	12	8	13	11
Łódzkie	9	5	1	11	7	4	8
Małopolskie	8	3	7	9	4	2	3
Mazowieckie	6	1	1	1	1	3	1
Opolskie	11	7	2	5	16	1	9
Podkarpackie	1	12	15	16	2	12	13
Podlaskie	2	9	8	3	11	14	6
Pomorskie	12	6	3	7	2	6	4
Śląskie	14	2	4	2	10	1	2
Świętokrzyskie	5	13	16	15	13	7	16
Warmińsko-Mazurskie	4	16	1	13	14	16	15
Wielkopolskie	10	4	6	4	5	8	5
Zachodniopomorskie	13	15	10	8	6	10	10

I – Employment, unemployment and working conditions,
II – Income of population, material resources,

III – Poverty and social exclusion,
IV – Economic development,
V – Economic infrastructure,
VI – Synthetic index of standard of living.

Source: Prepared by the author based on GUS data

When analyzing the relation between development and the analyzed phenomena, the Spearman's rank correlation coefficient was used.

Table 2. Spearman's rank correlation between the crime rate and living standard indexes

	$r_{crime\ index\ I}$	$r_{crime\ index\ II}$	$r_{crime\ index\ III}$	$r_{crime\ index\ IV}$	$r_{crime\ index\ V}$	$r_{crime\ index\ VI}$
Value of rank correlation coefficient	-0.262	-0.547	-0.385	-0.420	-0.442	-0.390

Source: own calculations

When examining dependencies between particular indexes of standard of living and the crime index, the strongest association occurred between the crime index and the index describing the material situation ($r_{crime\ index\ II} = -0.547$). Worse income situation, low condition of material resources result in increased crime index. The weakest, but also unfavorable relation can be noted between the crime index and the index related to employment ($r_{crime\ index\ I} = -0.262$).

The Spearman's coefficient for the synthetic standard of living as well as the crime index ($r_{crime\ index\ VI} = -0.390$) confirms negative relation between the index of crime and the level of living. Worsening standard of living affects increase in crime.

CONCLUSIONS

The conducted research proved downward trend of the number of crimes committed over the years 2003-2013. Crimes over this period fell by approximately a third (27.5%).

General downward trend noticeable in the number of crimes confirmed by the police has a close connection with their detection. In the recent decade, we have been dealing with clear growth in detection of committed crimes. In 2003 it accounted for 55.2% and this ratio increased over ten years by 11.9 percentage points.

In the examined period, the number of suspects drops as well. As a result of drop in crime, safety of Poles increases, which results in increased standard of living.

The analysis of the standard of living in Polish provinces showed large diversity between regions, mainly in two categories. In the case of the index regarding economic development, the range was as much as 0.903. High diversity was recorded also for the index of business infrastructure (0.455).

The Spearman's rank correlation coefficient showed a negative relation between all indexes of standard of living and the crime index. Decrease in employment, deterioration in material conditions, economic development and business infrastructure may result in growing crime level.

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APPLICATION OF L-MOMENTS IN HOMOGENEITY EXAMINATION FOR GROUPS OF PRODUCTION COMPANIES DISTINGUISHED BY DEA

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Abstract: In financial analysis rating systems can be applied to divide firms into homogeneous groups. One of these methods is provided by DEA. The method is based on the efficiency optimization for firms described by the set of financial indicators. An important issue is not only estimation of efficiency but also homogeneity of given groups. Within the Hosking-Wallis test one compares variability calculated with respect to L-moments with expected variability for homogeneous groups. The aim of our research was to apply the Hosking-Wallis test to investigate the homogeneity of DEA groups of companies. In the paper we present the results of our research for a set of Polish production companies listed on Warsaw Stock Exchange.

Keywords: DEA, clusters, homogeneity, Hosking-Wallis test

INTRODUCTION

An important task of multivariate data analysis is division of objects into groups of homogeneous elements. This can be obtained e.g., with help of cluster analysis which is understood as a range of methods and algorithms that utilize various distance measures. The number of obtained groups is not determined in advance and we expect the groups to be homogeneous with respect to their elements and heterogeneous among themselves. In order to determine the differences between groups one uses moments: average, variance and applies ANOVA provided normality assumption is valid. The quality of obtained division can also be determined with help of GLM models but they are also based on measuring the distance between means in the groups. An alternative way to examine homogeneity was proposed in hydrological research for assessing the homogeneity

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degree of a given group of sites with respect to flood frequency [see Hosking et al. 1997, Castellarin et al. 2008]. In the paper we apply the test of Hosking-Wallis (which is frequently used by hydrologists) to investigate the homogeneity of groups of production companies distinguished by DEA. The calculations were done in SAS 9.4.

DEA AS A METHOD OF CLUSTERING OBJECTS

A traditional approach for dividing objects into groups of similar elements is the cluster analysis. One can also divide objects into homogeneous groups using DEA (Data Envelopment Analysis) [Kaczmarska 2010, Grzybowska, Karwański 2014]. This approach is however not popular. In our research we investigate some properties of DEA derived division and show that it can successfully be applied as a grouping method.

Within DEA methods an efficiency ratio for each object is calculated [Cooper et al. 2006, Guzik 2009]. Efficient objects, i.e., objects with efficiency ratio 1, constitute the first group. For the remaining objects efficiency ratios are calculated again and the next group of objects can be distinguished. Proceeding in this way one can divide objects into separate groups.

On the other hand in the DEA super efficiency model, SE-CCR [Andersen, Petersen 1993], for each object a unique number, a super efficiency score can be assigned. Super efficiency scores allow for a ranking of objects and are a synthetic measure that describes them. Super efficiency scores will be used to derive L-moments and determine homogeneity of groups obtained by DEA division.

L-MOMENTS IN MEASURING DIVISION'S HOMOGENEITY

L-moments are an alternative way to describe the shape of a probability distribution. They are an extension of the so called weighted moments introduced by Greenwood [see Greenwood et al. 1979]. The weights are shifted Legendre polynomials $P_r^*(u) = \sum_{k=0}^{r} p_{r,k}^* \, u^k$, where

$$p_{r,k}^* = (-1)^{r-k} \binom{r}{k} \binom{r+k}{k}, \quad r = 0,1,2,\ldots \tag{1}$$

Polynomials $P_r^*(u)$, for $r = 0,1,2,\ldots$, are orthogonal on the interval $(0,1)$ and $P_r^*(1) = 1$.

Definition [Hosking 1990, p. 106]

L – moment of order r for a random variable X with a quartile function $x(u)$ is defined as

$$\lambda_r = \int_0^1 x(u)P_{r-1}^*(u)\,du. \tag{2}$$

The ratio of L- moments is expressed as:

$$\tau_r = \lambda_r/\lambda_2. \tag{3}$$

In particular, the coefficient of L-variability, denoted by L-CV, which is equal $\tau = \lambda_2/\lambda_1$, is a counterpart of variability coefficient.

The ratios of L-moments define the shape of the distribution independently of the scale of the measurement.

L-moments: λ_1, λ_2, L-CV τ, and their ratios τ_3 and τ_4 are the most important quantities that summarize the probability distribution. We have the following [Hosking 1990, p. 107]:

Theorem

If the probability distribution has a finite mean then all L-moments exist. Moreover, L-moments define uniquely the probability distribution, i. e., there are no two different distributions with the same L-moments.

In application of L-moments each object i is described by a sequence of n_i values of the same variable, where $i = 1, \dots, N$. Based on them sample L-moments for each object t^i, τ^i, t_3^i and t_4^i are calculated. Next, for each group of objects R, sample L-moments t^R, τ^R, t_3^R and t_4^R for groups are calculated [Hosking et al. 1997, p. 63] .

In particular L-mean for group R is calculated as:

$$t^R = \sum_{i=1}^N n_i t^{(i)} / \sum_{i=1}^N n_i. \tag{4}$$

Weighted deviation for a group R of N objects is given as:

$$V = \left\{\sum_{i=1}^N n_i\,(t^{(i)} - t^R)^2 / \sum_{i=1}^N n_i\right\}^{1/2}. \tag{5}$$

After four L-moments are calculated, parameters of the Kappa distribution are adjusted. The Kappa distribution is a general four parameter family of distributions [Hosking et al. 1997, p. 191], [Hosking 1994]. Once the parameters of a Kappa distribution are found, a simulation is conducted. For a given group of N objects a large set of data following the given by L-moments Kappa distribution is generated.

The heterogeneity measure H is calculated as:

$$H = \frac{(V-\mu_V)}{\sigma_V}, \tag{6}$$

where V is calculated based on considered data, while μ_V are σ_V are mean and deviation calculated for simulated data.

The group is regarded homogeneous for H<1.

The group is regarded heterogeneous for H≥ 2.

For $H \in <1,2)$ the group is regarded rather heterogeneous.
We use the measure H to investigate heterogeneity of DEA division.

DATA, METHODOLOGY APPLICATION AND RESULTS

In our research we have used quarterly financial data of 76 production companies listed on Stock Exchange in Warsaw between 2011 and 2012. Firms were divided into groups using DEA approach. A very important issue in DEA approach is variable selection. We have based our calculations on financial ratios that we have already used in our former research: Assets Turnover (AT) and Total Liabilities/Total Assets (DR) as input indicators and Return on Assets (ROA), Return on Equity (ROE), Current Ratio (CR), Operating profit margin (OPM) as output variables [Grzybowska, Karwański 2014]. We have applied the CCR DEA input oriented model with mean values of eight quarterly indicators as input and output. We have distinguished 9 groups of objects. Next, for each company a unique number, a super-efficiency score was calculated based on the mean values of all financial indicators. The elements of each group and the minimal and maximal values of super efficiency scores for each group can be found in Table 1. In the next step mean values of every following two quarterly financial ratios were calculated. In this way each company was described by 5 different numbers, namely 5 values of efficiency scores. These values were used as sample data for Hosking-Wallis test.

The first step was to examine the diversity of obtained division. We have used mean values of all financial ratios and the super efficiency score obtained with them. The summary statistics for each group can be found in Table 2. The groups differ with respect to mean values of financial indicators. The super efficiency scores in each group were used to examine the heterogeneity of obtained division. The method was to calculate L-moments for the whole set of companies and separately for each group of companies. Once the L-moments were calculated, data was generated based on them according to generalized Pareto, Kappa, log-normal, normal and logistic distribution.

The results of Hosking-Wallis heterogeneity test for the whole set of companies can be found in Table 3. Apart from the heterogeneity measure H, the coefficient of L-variability, $\mathrm{L}-\mathrm{CV}$, was calculated. Also using formulas (4) and (5) μ_V and weighted deviation V were calculated based on simulated data. While V value is the same for each model, as it was calculated using super-efficiency scores, the L-means μ_V and deviations σ_V differ slightly depending on the model. The results, high values of measure H, indicate that the whole set of companies divided into 9 groups (treated here as 9 objects) is heterogeneous with respect to considered probability distributions.

Table 1. DEA groups and their super-efficiency minimal and maximal values

Group	Companies	Number of elements	min SE	max SE
	AC, Berling, Eko_Exp, PGE, Windmob, Zywiec	6	1.04	2.79
	Cigames, Cityinte, Hydrotor, Izolacja_Jar, Megar, Panitere, Police, Pulawy, Wawel	9	0.75	0.92
	Alkal, Apator, Bscdruk, Intercar, Mennica, Relpol, Sonel, Zelmer	8	0.48	0.82
	Essystem, Forte, Izostal, Kety, Lotos, Polna, Stalprod, Stomil_s	8	0.37	0.58
	Debica, Hutmen, Integer, Invico, KPPD, Mój, Novita, Pepees, Projprzm, Tauron, ZUE, ZUK	12	0.20	0.49
	Amica, Biomaxim, Budvar, Duda, Ferro, Lentex, Muza, Patentus, Pozbud	11	0.23	0.41
	Boryszew, Energoin, ERG, Fasing, Rafako, Rafamet, Sniezka, Wielton,	8	0.21	0.30
	Graclin, Mieszko, Plastbox, Suwary, Zpc_Otm	5	0.11	0.22
	Armatura, Ferrum, Graal, Grajewo, Koelner, Pamapol, Rawlplug, Vistula, Wojas	9	0.09	0.2

Source: own calculations

Table 2. Summary statistics for DEA groups

Group		OPM	ROE	ROA	CR	AT	DR
1	Mean	0.16	0.36	0.17	3.99	445.75	0.30
	Min.	0.03	0.11	0.10	0.73	215.90	0.06
	Max.	0.26	0.98	0.25	7.56	1107.20	0.87
2	Mean	0.14	0.21	0.15	3.06	335.40	0.30
	Min.	0.03	0.08	0.03	1.60	174.86	0.13
	Max.	0.23	0.30	0.21	6.10	494.96	0.57
3	Mean	0.13	0.15	0.1	2.34	571.39	0.32
	Min.	0.04	0.05	0.04	0.61	181.55	0.14
	Max.	0.35	0.30	0.21	5.73	2019.7	0.58
4	Mean	0.07	0.10	0.06	2.47	366.95	0.32
	Min.	0.02	0.05	0.04	0.93	214.93	0.17
	Max.	0.13	0.15	0.10	4.63	575.84	0.60

Group		OPM	ROE	ROA	CR	AT	DR
5	Mean	0.05	0.09	0.05	1.94	473.61	0.37
	Min.	0.01	0.02	0.02	1.16	183.34	0.21
	Max.	0.10	0.22	0.08	3.55	1021.70	0.62
6	Mean	0.06	0.08	0.04	1.87	420.27	0.41
	Min.	0.01	0.02	0.01	1.18	181.46	0.23
	Max.	0.11	0.12	0.06	3.26	742.09	0.66
7	Mean	0.07	0.08	0.04	1.37	406.43	0.50
	Min.	0.02	0.05	0.03	1.14	273.54	0.39
	Max.	0.13	0.12	0.05	2.04	616.46	0.64
8	Mean	0.05	0.04	0.02	1.30	492.32	0.41
	Min.	0.04	0.01	0.01	1.03	359.49	0.26
	Max.	0.06	0.06	0.03	1.53	703.15	0.67
9	Mean	0.03	0.03	0.01	1.05	565.88	0.55
	Min.	0.02	0.01	0.01	0.58	359.58	0.45
	Max.	0.07	0.05	0.02	1.30	767.01	0.67

Source: own calculations

Table 3. Hosking-Wallis heterogeneity test for the whole set of objects (detailed results)

`	Hosking-Wallis heterogeneity measure H	V statistic	μ_V (model)	σ_V (model)
Gen.Pareto model	1.9962	0.2425	0.1493	0.0467
Kappa model	2.4880	0.2425	0.1510	0.0368
LogNormal model	2.6152	0.2425	0.1465	0.0367
Logistic model	2.1365	0.2425	0.1528	0.0420
Normal model	1.3325	0.2425	0.1374	0.0789

Source: own calculations

Next, in homogeneity investigation four remaining scores were used to examine the homogeneity of each group separately. (Values used in previous calculations would not provide a sufficiently large sample to describe separate, not numerous groups.) The results are shown in Table 4 for group 1 and in Table 5 for remaining groups. The values of Hosking-Wallis heterogeneity measure H indicate that groups 1, 2, 3, 4, 5, 6, 8 are homogeneous while the groups 7 and 9 cannot be explicitly regarded homogeneous. Still, the H measure for groups 7 and 9 is very close to 1, so we can venture a conclusion that they are rather homogeneous.

Table 4. Hosking-Wallis heterogeneity Test based on simulations for 1 group (detailed results)

Model	Hosking-Wallis heterogeneity measure	V statistic	μ_V (model)	σ_V (model)	Kolmogorov-Smirnov distance
Gen.Pareto model	0.2840	0.1277	0.1098	0.0630	0.1334
Kappa model	0.2143	0.1277	0.1152	0.0583	0.1479
LogNormal model	0.1911	0.1277	0.1164	0.0591	0.1251
Logistic model	0.2088	0.1277	0.1145	0.0632	0.1313
Normal model	0.1846	0.1277	0.1159	0.0639	0.3683

Source: own calculations

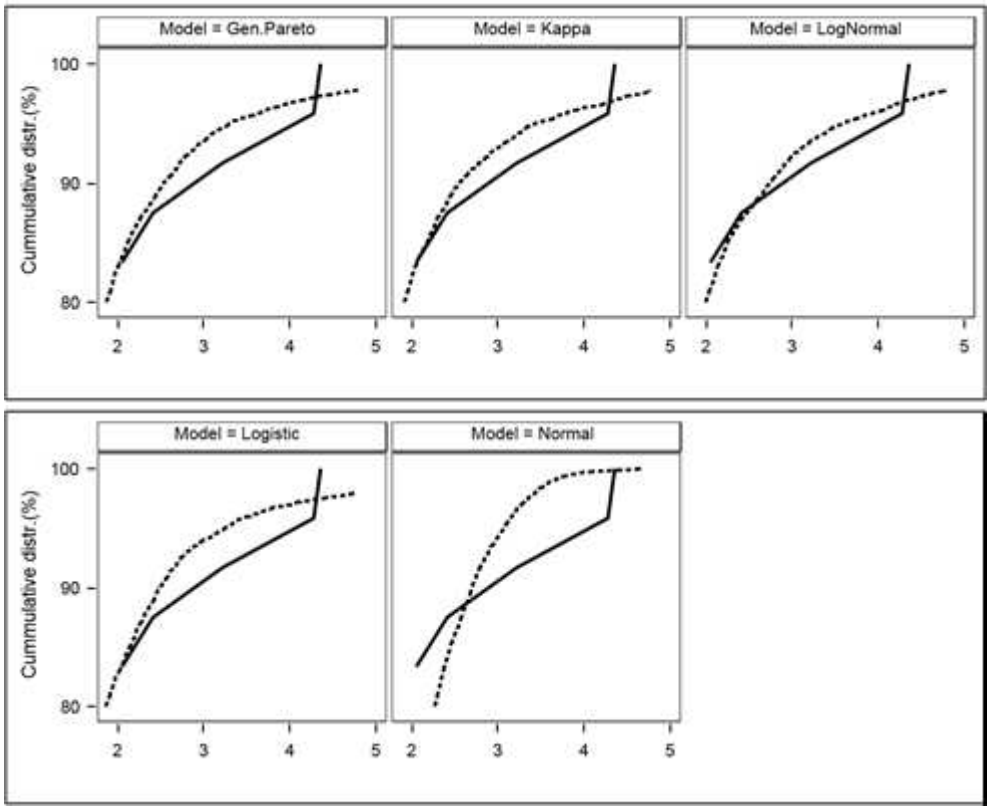
Table 5. The results of the Hosking-Wallis heterogeneity test for groups 2-9

Hosking-Wallis heterogeneity measure H					
Group	Gen. Pareto model	Kappa model	Log -Normal model	Logistic model	Normal model
2	0.592	0.8265	0.8792	0.6277	0.9405
3	0.365	0.3665	0.2399	0.4652	0.0086
4	0.2905	0.2142	0.2707	0.2641	0.5707
5	0.4879	0.7413	0.5326	0.5027	0.0406
6	0.5277	0.5722	0.7688	0.6062	0.6222
7	1.109	1.2417	1.156	1.2581	1.2881
8	0.2146	0.2628	0.2463	0.2305	0.235
9	1.0467	1.0139	1.0465	1.0299	0.9621

Source: own calculations

The homogeneity investigated by the Hosking-Wallis test is understood as being sampled from the same distribution. The obtained low values of Kolmogorov-Smirnov statistics confirm homogeneity and indicate the best fit distribution. For example, for the group 1 the best distribution is the log-normal distribution (see Table 4 and Figure 1).

Figure 1. Comparison of theoretical and simulated distributions for group 1. Solid line (—) corresponds to theoretical and dashed line (- - -) corresponds to simulated model



The values on the horizontal axis correspond to efficiency scores for group 1. The breaking point corresponds to Żywiec and PGE companies for which efficiency scores are far above the average in the group and exceed 4.

Source: own preparation

SUMMARY

In our research we have applied the Hosking-Wallis test to examine the quality of DEA derived division of production companies into separate groups. The results obtained confirm that the division fulfils our expectation. The groups are different among themselves and are homogenous with respect to their elements. It has got to be stressed again that DEA is not frequently applied as a method that enables division of objects into homogenous groups let alone investigated well.

The proposed method of homogeneity investigation to our knowledge has not been applied yet in financial setting. It seems to be a promising tool especially in cases were groups contain only a few objects. It can also be applied in cases when

one wants to compare the quality of division obtained with different methods, e. g., homogeneity of clusters obtained by Ward method with that obtained by DEA.

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DECOMPOSITION AND NORMALIZATION OF ABSOLUTE DIFFERENCES, WHEN POSITIVE AND NEGATIVE VALUES ARE CONSIDERED: APPLICATIONS TO THE GINI COEFFICIENT

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Abstract: We show how the absolute differences approach is particularly effective to interpret the Gini coefficient (G) when a distribution includes both positive and negative values. Either in erasing units having negative values, or in transforming negative values into zero, a significant variability fraction can be lost. When including negative values, instead of correcting G, to maintain it lower than 1, the standard G should be kept to compare the variability among different situations; a recent normalization, G_p, can be associated to G, to evaluate the variability percentage inside each situation.

Keywords: absolute difference components, negative values, normalization of Gini based coefficients

INTRODUCTION

The Gini coefficient is normally used in presence of non negative values, so that, when the distribution at stake includes negative values, it is common practice either excluding units with negative values, or transforming negative values into zero, with the latter suggested by OECD [2014]. Many transferable variables can take on negative values in their distributions. When dealing with monetary variables, e.g., there could be several reasons for an income unit to have negative net income, at least in terms of a particular source. For example, when assessing income units and financial assets such as capital gains, negative values can be

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observed. Negative values can also be seen dealing with self-employed workers' incomes, if losses are greater than gains; the same money transfers are positive revenues - taking into consideration persons who receive them – and negative revenues – while considering the other persons. Another example is tax systems that admit negative income taxes, which can originate, for instance, from child allowances.

The most frequently used single measure of income inequality is the Gini coefficient of concentration. However, when a distribution includes negative values, as Castellano [1937] observes, the Lorenz curve lays under the x-axis (here we suppose that the average of the variable is positive) and the Gini coefficient can assume values greater than one, as it is observed by Hagerbaumer [1977], Pyatt et al. [1980], Lambert and Yitzhaki [2013]. In eliminating the observations with negative values or in converting them into zero, this outcome is avoided.

However, this approach may neglect a significant proportion of variability and, as a consequence, can lead to unreliable comparisons among distributions.

In order to restrict the Gini coefficient to the range 0-1, Chen et al. [1982] modify the normalizing factor by adding a certain component. This component depends on the distribution of negative values and of such proportion of the smallest positive values, which are enough to compensate for the former. The authors' proposition is in fact not a normalization but rather an ad hoc correction, as it depends on the particular form of the compensating area at stake (Chen et al.'s method was subsequently completed by Berrebi and Silber [1985], who provided a correct expression for the general case - when the fractional number of smallest positive units compensates for the sum of the negative ones).

Chen et al.'s correction has the advantage of making the modified Gini coefficient decrease for any equalitarian redistribution. However, Chen et al.'s coefficient becomes less and less sensitive as the concentration increases. Raffinetti et al. [2015] provide several examples on this point and suggest a normalization that keeps into account the potential maximum Gini mean difference. The authors formulate certain conditions for the application of their normalization.

In this paper we attempt to better understand the behaviour and the meaning of the Gini coefficient, of its modifications presented in the literature and its practical adaptations when negative values are observed. Here, we consider, together with the standard Gini coefficient, the coefficient G_p, introduced by Raffinetti et al., and the correction introduced by Chen et al. including Berrebi and Silber's completion. The behaviours of these indexes are tested when compensative transfers occur between units with positive values and units with negative values of the variable, so that the negative values are transformed into zero, thanks to transfers from units with positive values. The paper is organized as follows. The next section examines the components of the standard Gini coefficient when it is calculated either by including units that have negative values or excluding these units or turning their values into zero. The section which follows, is an overview of several adjustments proposed in the literature on the calculation of the Gini

coefficient. In particular, the section provides a deepening on the Chen et al. correction and shows what Raffinetti et al.'s normalization means and how it should be used. The section entitled "Compensative redistributions" considers the behaviour of the indexes previously introduced under the compensative equalitarian redistribution. The section which comes next, provides a numerical example, which illustrates the theoretical behaviours described in the previous sections; this section shows also how the standard Gini coefficient should be interpreted, with the information provided by G_p. The last section offers a conclusion.

THE GINI COEFFICIENT IN THE PRESENCE OF NEGATIVE VALUES

Let's consider a variable that takes on negative values, units arranged in a non-decreasing order $\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_M\right]$.

We suppose that the first N units, $i = 1, 2, \ldots N$, have negative values, while the remaining units, $i = N + 1, N + 2, \ldots M$) are non-negative. We assume that the sum of the non-negative values, $\sum_{i=N+1}^{M} x_i = T_a$, is greater than the absolute sum of the negative values, $\sum_{i=1}^{N} |x_i| = T_n$, i.e., $\sum_{i=1}^{M} x_i = T_a - T_n > 0$.

If we split the whole distribution into two groups, the former containing the negative values and the latter the non-negative values, we can write the sum of the absolute differences as:

$$S = \sum_{i=1}^{M}\sum_{j=1}^{M}\left|x_i - x_j\right| = S_n + 2\left[NT_a + (M-N)T_n\right] + S_a . \quad (1)$$

In (1), $S_n = \sum_{i=1}^{N}\sum_{j=1}^{N}\left|x_i - x_j\right|$ is the within group component for the units with negative values, $S_a = \sum_{i=N+1}^{M}\sum_{j=N+1}^{M}\left|x_i - x_j\right|$ is the within group component for the units with non-negative values and $NT_a + (M-N)T_n = \sum_{i=1}^{N}\sum_{j=N+1}^{M}\left|x_i - x_j\right|$ is the between-group component, which in S appears twice (see appendix for further details).

If we apply the well-known results concerning the sum of absolute differences (see [Gini 1930; Castellano, 1937]), under the condition that the total amount both of absolute negative values, T_n, and of positive values, T_a, remain constant, we can see that $\max\{S_n\} = 2(N-1)T_n$; $\max\{S_a\} = 2(M-N-1)T_a$. Therefore, it follows that

$$\max\{S\} = \max\{S_n\} + 2\left[NT_a + (M-N)T_n\right] + \max\{S_a\}$$
$$= 2(N-1)T_n + 2\left[NT_a + (M-N)T_n\right] + 2(M-N-1)T_a$$

$$= 2(M-1)(T_a + T_n), \tag{2}$$

which illustrates what Raffinetti et al. [2015] report in their expression (5).

It follows that, when the distribution of the variable at stake includes negative values, the Gini coefficient

$$G = \frac{S}{2(M-1)(T_a - T_n)} \text{ lies in the interval } 0 \le G \le \frac{T_a + T_n}{T_a - T_n}. \tag{3}$$

The upper bound holds if the total positive amount is possessed by one unit, the total loss is suffered by another single unit, and x_i's are equal to 0 for the remaining (M - 2) units.

We stress that in (3) for the maximum to remain unchanged, it is enough that the ratio (T_n/T_a) remains constant.

When the number of units is large enough, G is approximated by $G = \Delta/2\mu$, with $\Delta = S/M^2$ and $\mu = (T_a - T_n)/M$. Analogous simplifications apply to other indexes considered in this paper, whenever deviations are substituted by ratios of averages.

As mentioned above, the majority of researchers either erase the units with negative values or convert the negative values into zero. These procedures should be adopted when both the sum of negative values and the number of units with negative values and are negligible.

The Gini coefficient erasing negative values

If the negative values are erased, the Gini coefficient becomes

$$G_a = \frac{S_a}{2(M-N-1)T_a}. \tag{4}$$

G_a excludes from its numerator both the variability within the units with negative values, S_n, and the variability between these units and those with non-negative values, $\left[NT_a + (M-N)T_n\right]$.

The Gini coefficient while turning negative values into zeros

When the negative values are turned into zero, the Gini coefficient becomes

$$G_{za} = \frac{2NT_a + S_a}{2(M-1)T_a}. \tag{5}$$

In expression (5), the component $2NT_a$ expresses the differences between the first N units (i = 1, 2,…, N), which are set as equal to zero and the units that maintain their original non-negative values ($i = N + 1, N + 2,\ldots, M$) (see appendix for further details).

G_{za} excludes S_n and part of the between-group variability, i.e., $(M-N)T_n$.

If we rewrite the denominator of (5) as $2(M-1)T_a = 2(M-N-1)T_a + 2NT_a$ and then compare G_{za} with G_a, we see that both the numerator and the denominator

of the former differ from the numerator and the denominator of the latter by the same quantity, $2NT_a$. Then, as $S_a \leq 2(M - N - 1)T_a$, we are able to conclude that $G_a \leq G_{za}$.

It should be noted that $G_{za} \leq G$, as the denominator of (3) is smaller than that of G_{za}, while the numerator of G is greater than that of G_{za}. Then, *a fortiori*, $G_a \leq G$.

NEGATIVE VALUES AND ADJUSTMENTS IN THE CALCULATION OF THE GINI COEFFICIENT

Chen et al. [1982] (henceforth CTR) suggest a correction that, on the one hand, allows preservation of the whole variability in S and, on the other hand, keeps the modified Gini coefficient within the range [0; 1]. Another treatment is proposed by Raffinetti et al. [2015]. Basing on (3), they suggest dividing S (as calculated with formula (1)) by $2(M-1)(T_a+T_n)$, i.e., dividing G by its upper bound $(T_a+T_n)/(T_a-T_n)$.

The CTR correction

The authors' correction is obtained by "freezing" the ratio between the average of the net available amount, and the average of absolute differences, calculated within a particular subset of the distribution: the subset which includes all the negative values and the smallest positive values. Even if CTR and BS start from absolute differences, the authors' methodology is eventually conducted and interpreted in terms of areas bounded by the Lorenz curve: consequently, according to the authors' approach, what is "frozen" is the area which lies below the x-axis. The CTR correction was completed by Berrebi and Silber [1985] (henceforth BS).

Here, we shall consider the CTR-BS correction entirely under the approach of absolute differences, as do Raffinetti et al. [2015].

In order to understand the rationale of the formula, we introduce some further pieces of notation. Having ordered the units in non-decreasing order with respect to the values of the variable, we suppose that $\sum_{i=1}^{K} x_i \leq 0$, and that $\sum_{i=1}^{K+1} x_i > 0$. Indeed, as BS observe, the sum of negative values is not necessarily compensated by an exact (integer) number of non-negative values; we can write that $\sum_{i=1}^{K} x_i + \eta x_{K+1} = 0$ and $(1-\eta)x_{K+1} + \sum_{i=K+2}^{M} x_i = T_a - T_n$, with $\eta = \left|\sum_{i=1}^{K} x_i\right| / x_{K+1}$ (or $\eta = -\sum_{i=1}^{K} x_i / x_{K+1}$).

We can now represent the distribution of the variable as

$$\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1, (x_{K+1})_2, x_{K+2}...., x_M\right] \quad (6)$$

In (6), x_i, $i = 1, 2,\ldots,N$, are the units with a negative value of the variable and, for the remaining units, $i = N + 1, 2,\ldots,M$, $x_i \geq 0$. In (6), x_{K+1} is split into two sub-units: $(x_{K+1})_1$ with weight η and $(x_{K+1})_2$ with weight $(1 - \eta)$, respectively, $\eta \leq 1$. It follows that

$$2\sum_{i=1}^{M}\left|x_{K+1}-x_i\right| = 2\sum_{i=1}^{K}\left(x_{K+1}-x_i\right)\eta + 2\sum_{i=1}^{K}\left(x_{K+1}-x_i\right)\left(1-\eta\right) + 2\sum_{i=K+2}^{M}\left(x_i-x_{K+1}\right)\eta + 2\sum_{i=K+2}^{M}\left(x_i-x_{K+1}\right)\left(1-\eta\right);$$

$(x_{K+1})_1$ will be regarded as belonging to the "lower" set in (6), and $(x_{K+1})_2$ as belonging to the "upper" set of (6).

Having defined

$$S_0 = \sum_{i=1}^{K}\sum_{j=1}^{K}\left|x_i-x_j\right| + 2\sum_{i=1}^{K}\left(x_{K+1}-x_i\right)\eta \quad (7)$$

which is the sum of absolute differences within the subset $\left[x_1, x_2, \ldots, x_N, x_{N+1}, x_{N+2}, \ldots, x_K, \left(x_{K+1}\right)_1\right]$, and referring to Raffinetti et al. [2015], formula 3 and the proof reported below the formula, the CTR-BS Gini coefficient can be written as:

$$G_{C-S} = \frac{S}{S_0 + 2\left(M-1\right)\left(T_a - T_n\right)}. \quad (8)$$

As the appendix shows (formulae A6 ÷ A11), an alternative decomposition for S is

$$S = S_0 + 2\left(K+\eta\right)\left(T_a - T_n\right) + S_u. \quad (9)$$

In (9)

$$S_u = \sum_{i=K+2}^{M}\sum_{j=K+2}^{M}\left|x_i-x_j\right| + 2\sum_{i=K+2}^{M}\left(x_i-x_{K+1}\right)\left(1-\eta\right) \quad (10)$$

is the sum of absolute differences among units in the subset $\left[\left(x_{K+1}\right)_2, x_{K+2}, \ldots, x_M\right]$; $\left(K+\eta\right)\left(T_a - T_n\right)$ is the sum of absolute differences between these units in subset $\left[x_1, x_2, \ldots, x_N, x_{N+1}, x_{N+2}, \ldots, x_K, \left(x_{K+1}\right)_1\right]$ and those in subset $\left[\left(x_{K+1}\right)_2, x_{K+2}, \ldots, x_M\right]$

If we focus just on S_u, by applying the usual results, S_u yields its maximum when $x_M = \left(T_a - T_n\right)$ and the remaining x_i (i=K+1, x_{K+2},…x_{M-1}) are zero; if this is the case,

$$\max\left\{S_u\right\} = 2\left(M-K-2\right)\left(T_a - T_n\right) + 2\left(T_a - T_n\right)\left(1-\eta\right) \quad (11)$$

and consequently

$$2\left(K+\eta\right)\left(T_a - T_n\right) + \max\left\{S_u\right\} = 2\left(M-1\right)\left(T_a - T_n\right). \quad (12)$$

Therefore, as $2\left(K+\eta\right)\left(T_a - T_n\right) + S_u \leq 2\left(M-1\right)\left(T_a - T_n\right)$, G_{C-S} cannot be greater than 1, as we have assumed that the net amount of the variable is positive, $0 \leq G_{C-S} \leq 1$. Obviously, G_{C-S} is zero if all x_i (i = 1, 2, …., M) are equal, in which case all the three components in (9) are zero.

We can observe that the CTR-BS correction does not refer to a theoretical extreme situation: it adds to the denominator a quantity, S_0, which is present in the numerator: consequently it is an ad hoc procedure. Moreover, even if G_{C-S} is a direct function of S_0, Raffinetti et al. [2015] observe that the more S_u approaches $\max\{S_u\}$, the less sensitive G_{C-S} is to what exists inside this set of units.

Reconsidering the CTR correction

We will now add several further considerations and introduce a revision of the CTR approach. Having accepted that the subset $\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1\right]$ is kept constant, for a given net amount $(T_a - T_n)$ the maximum S is generated by the set

$$\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1, (0)_2, 0...., (T_a - T_n)\right]. \tag{13}$$

In the appendix, formula (A20) shows that the overall sum of absolute differences for the elements in set (13) is

$$S^* = S_0 + 2(M-1)(T_a - T_n) + 4(M - K - 1 - \eta)T_n. \tag{14}$$

In (14), the component $4(M - K - 1 - \eta)T_n$ is the so-called transvariation term (see Dagum's terminology, 1997): it arises because the two subsets

$$\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1\right] \text{ and } \left[(0)_2, 0...., (T_a - T_n)\right] \tag{15}$$

now overlap, as, within the first subset, at least one x_i is greater than zero.

So, if we normalize by the maximum S (maximum - keeping the lower subset constant, as in (13)) we yield

$$G^*_{C-S} = \frac{S_0 + 2(K+\eta)(T_a - T_n) + S_u}{S_0 + 2(M-1)(T_a - T_n) + 4(M - K - 1 - \eta)T_n}. \tag{16}$$

We observe that if, instead of calculating the absolute differences $\sum_{i=1}^{M}\sum_{j=1}^{i}|x_i - x_j|$, among the elements of the set (13), we calculate the simple differences $\sum_{i=1}^{M}\sum_{j=1}^{i}(x_i - x_j)$, (see [Lambert 2001], Ch. 2), we yield $S_0 + 2(M-1)(T_a - T_n)$, which is the correction adopted by CTR. Note that S_0 would coincide with S^*; only if $x_i \geq x_j$, for all $i > j$ (i = 1, 2, …, M). This condition is not fulfilled in (13), then, being $S_0 < S^*$, we have that $G^*_{C-S} < G_{C-S}$.

The Raffinetti, Siletti and Vernizzi normalization

If we normalize G, taking into account its upper bound (as in (3)), we yield

$$G_p = G\frac{T_a - T_n}{T_a + T_n}, \tag{17}$$

G_p is the index suggested by Raffinetti et al. [2015]: the maximum for G_p is 1.

COMPENSATIVE REDISTRIBUTIONS

Any equitable transfer lowers the standard Gini coefficient, as defined by expression (3). If we consider a redistribution that compensates negative values into non-negative values, by subtracting the overall amount T_n from units having positive values, after the compensation, all the indexes, introduced above, coincide with the standard Gini coefficient. However, even if such a redistribution is performed by equitable transfers, after this redistribution, the Gini coefficient may be greater than G_a, G_{za}, G^*_{C-S}, and G_p, calculated for the distribution before these transfers . The only exception is G_{C-S}.

As an example, let's consider an equalitarian compensation, achieved at the expense of the units with the smallest positive values. This compensation acts inside the subset $\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1\right]$ and transforms all the x_i's within the subset into zeros. Notice that both before and after the compensation, $\sum_{i=1}^{K} x_i + \eta x_{K+1} = 0$. The subset $\left[(x_{K+1})_2, x_{K+2}...., x_M\right]$ remains unchanged. We label this redistribution "minimal compensation".

After such a redistribution, all the Gini indexes introduced in the previous sections (G_a, G_{za}, G_{C-S}, G^*_{C-S}, and G_p) can be reduced to the expression[1]

$$G = \frac{2(K+\eta)(T_a - T_n) + S_u}{2(M-1)(T_a - T_n)}. \tag{18}$$

Needless to say, for $M \to \infty$, when dividing the numerator and the denominator by M^2, the final result is practically the same if we leave (18) unchanged.

For what concerns the behaviour of G_{za}, having labelled S_c the sum of absolute differences within the subset $\left[x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1\right]$ and using the decomposition (see appendix, formula A14)

$$S_a = S_c + 2(K - N + \eta)(T_a - T_n) - 2(M - K - \eta)T_n + S_u, \tag{19}$$

[1] It should be noted that, if the compensation takes place involving the highest value, i.e., including the share η of x_M, than the denominator of (18) should be replaced by $2(M-1+\eta)(T_a - T_n)$.

G_{za} can be expressed as

$$G_{za} = \frac{2NT_a + S_a}{2(M-1)T_a} = \frac{S_c - 2(M-K-\eta-N)T_n + 2(K+\eta)(T_a - T_n) + S_u}{2(M-1)(T_a - T_n) + 2(M-1)T_n}. \quad (20)$$

It can be verified that after the compensation, the Gini coefficient, calculated by (18), is greater than the before-compensation G_{za}. In fact, after some manipulations we yield that inequality (20) is verified if

$$\frac{S_c - 2(M-K-\eta-N)T_n}{2T_n} < \frac{2(K+\eta)(T_a - T_n) + S_u}{2(T_a - T_n)}.$$

In the l.h.s. of the above expression, the maximum is reached when $S_c = 2(K+\eta-N-1)T_n$, whilst in the r.h.s. the minimum is reached when $S_u = 0$. When both circumstances are verified, after elementary simplifications, the inequality becomes $2(K+\eta)-1-M < K+\eta$, from which we yield $K+\eta-1 < M$, which is trivially verified.

As $G_{za} \geq G_a$, a fortiori, G_a is lower than the Gini coefficient in (18).

Let's now compare the after-compensation Gini coefficient (18) with G_p, which can be written as

$$G_p = \frac{S_0 + 2(K+\eta)(T_a - T_n) + S_u}{2(M-1)(T_a - T_n) + 4(M-1)T_n}. \quad (21)$$

Keeping in mind G_p, as in expression (21), and G, as in (18), let us investigate conditions under which it will happen, that: $G_p \geq G$. After some algebraic exercises we can see that it is equivalent to:

$$\frac{S_0}{4(M-1)T_n} \geq \frac{2(K+\eta)(T_a - T_n) + S_u}{2(M-1)(T_a - T_n)}. \quad (22)$$

However, inequality (22) does not hold, even when the left-hand side is maximum and the right-hand side is minimum. Indeed, in (22), the right-hand side is minimum when S_u is zero: in this case it reduces to $(K+\eta)/(M-1)$. The maximum for the left-hand side is obviously obtained when S_0 is maximum: as in the subset $\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1\right]$ both the sum of absolute negative values and that of positive values is T_n, we have that $\max\{S_0\} = 4(K+\eta-1)T_n$. Consequently, the maximum for the left-hand side of (22) is $(K+\eta-1)/(M-1)$. Thus, (22) never holds.

Conversely, before the compensation, G_{C-S} is greater than the after-compensation Gini coefficient (18). In fact, after the compensation, S_0 becomes zero; when this component disappears, the numerator of (8), expressed by (9), decreases proportionally more than its denominator.

The same does not happen for what concerns G^*_{C-S}. By comparing expression (16) with (18), we see that the former is greater than the latter if

$$\frac{S_0}{S_0 + 4(M-K-1-\eta)T_n} \geq \frac{2(K+\eta)(T_a - T_n) + S_u}{2(M-1)(T_a - T_n)}. \quad (23)$$

Ceteris paribus, the maximum for the left-hand side is reached when S_0 is maximum; that is, for $S_0 = 4(K+\eta-1)T_n$. In this case the inequality (23) is

$$\frac{(K+\eta-1)}{(M-2)} \geq \frac{(K+\eta)}{(M-1)} + \frac{S_u}{2(M-1)(T_a - T_n)}.$$

If both M and K are large enough, the left-hand side term and the first addend on the right-hand side are almost equal; thus, generally, inequality (23) does not hold. It follows that G^*_{C-S} cannot be greater than the Gini coefficient after the minimal compensation.

We conclude that only two of the indexes considered here always decrease when negative values are transformed into zero when compensated by an equalitarian redistribution from positive values: the usual Gini coefficient (as defined by expression (3)) and G_{C-S}. In adopting G we have to accept that it can be greater than 1. If we adopt G_{C-S}, we have to be aware that in the denominator it presents an ad hoc correction: due to this ad hoc correction, comparisons among G_{C-S} related to different situations, should be done only if the ratio between $(M-1)(T_a - T_n)$ and S_0 remains constant.

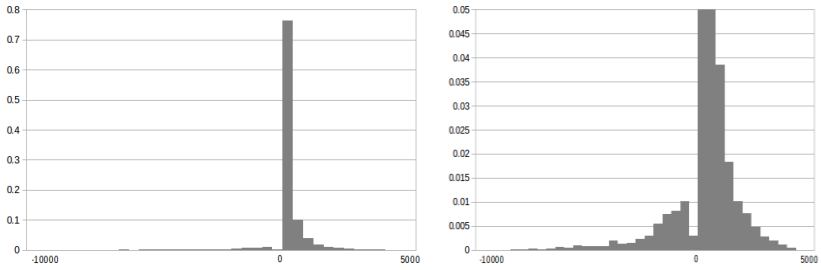
NUMERICAL EXAMPLE

In this section we will examine the measures discussed in the previous sections, as applied to the data generated from log-normal distribution. We will deal with two set of data, both consisting from 10,000 numbers. The first set includes 500 negative numbers generated from log-normal distribution with the parameters: (7.528; 0.812) (and with the sign inverted to negative), 1,500 zero's and 8,000 positive numbers generated from log-normal distribution with parameters (5.428; 1.262). The second set consists from 1000 negative numbers generated from log-normal distribution with the parameters: (7.528; 0.812) (and with the sign inverted to negative), 1,500 zero's and 7,500 positive numbers generated from log-normal distribution with parameters (5.278; 1.376). The relative sizes of negative, zero and positive samples were chosen as to mimic some known properties of empirical distributions of net incomes of Italian households. It is known, that the share of negative values varies over time, while the share of zero incomes remains relatively constant. Moreover, the parameters of the log-normal distributions were chosen to ensure realistic values of skewness and kurtosis for

both sets of data. The histograms of relative frequencies for set 1 and set 2 are presented in Figures 1 and 2, respectively.

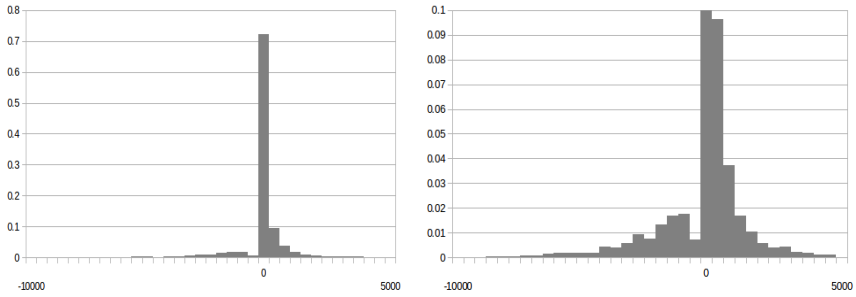
The main descriptive statistics of the data are summarized in the rows 2-14 of Table 1. The minimal compensation described in the above sections for non-decreasing series occurs at 8,568 and 9,767 positions for set 1 and set 2 respectively, see row 15 of Table 1.

Figure 1. Histogram of relative frequencies for random numbers constituting set 1. The right-hand-side picture is the same distribution but with truncated vertical axis, for better visualization of small relative frequencies for values far from 0



Source: own preparation

Figure 2. Histogram of relative frequencies for random numbers constituting set 2. The right-hand-side picture is the same distribution but with truncated vertical axis, for better visualization of small relative frequencies for values far from 0



Source: own preparation

Considering the simplest ways of dealing with negative values – erasing them – one can see, that in this way we omit 35% of variability for the set 1 (see: $S_a/S = 0.650$) and as much as 53.3% of overall variability for set 2 (as: $S_a/S = 0.467$). Moreover, as erasing negative values make the overall average greater than the real average, the value of the Gini index calculated over such treatment will capture even less of inequality than the fraction of variability captured suggest. Indeed, the ratio G_a/G equals to 0.461 for the set 1 (almost 54% missing)

and 0.164 for the set 2 (as much as almost 84% missing). Surely, it doesn't seem to be the proper way of dealing with data with this order of number of negative subset and with the overall average so influenced by the presence of negative values. Note, that it would suffice only one of these factors (strong underestimation of variability/strong overestimation of average value – of course, they are not independent) for the Gini value to be strongly influenced by such an artificial treatment of negative values.

Table 1. Descriptive statistics

	set number 1	set number 2
number of positive values	8,000	7,500
number of negative values	500	1,000
number of zeros	1,500	1,500
minumum value	-15,643.30	-28,121.30
maximum value	24,614.40	57,079.00
total amount of positive values	3,872,080.98	3,850,597.15
mean for positive values	484.01	513.41
total amount of absolute negative values	1,262,786.83	2,636,622.28
mean for negative values	-2,525.57	-2,636.62
overall mean	260.93	121.40
coefficient of variation	4.80	14.01
skewness	1.70	3.25
kurtosis	65	197
the lowest rank of the value for which the cumulative sum of ordered distribution is positive	8,568	9,767

Source: own calculations

The second simple way of dealing with negative values – turning them into zeros – gives a similar picture. The fractions of overall variability captured in this treatment increase – it is 69.8% for set 1 (= 0.698, which is an increase of 4.5 percentage points as compared to the previous treatment of erasing zeros) and 53.9% for set 2 (0.539, which is an increase of 7.2 percentage points as compared to the previous treatment of erasing zeros). Still, the fraction of the value of Gini index calculated for whole sets captured within this treatment is smaller than the fraction of overall variability captured, and is equal to 0.47 for set 1 and 0.17 for set 2, what is – for both set 1 and set 2 – higher fraction than within treatment of just erasing negative values.

If we consider the relevant share of variability not taken into account by G_a and G_{za}, we should conclude that these two indexes do not represent the actual variability, and consequently, they systematically underestimate the inequality. Moreover, there are problems in comparing distributions either with different percentages of units with negative values or with different ratios T_n/T_a.

As it was shown in the previous sections, values G_p, G_{za}, G_a, and G^*_{C-S} are always smaller than the value of Gini index after minimal compensation and it indeed holds for both set 1 and set 2 (see Table 2). Moreover, simple geometrical interpretation shows, that $G_{C\text{-}S}$ has always to be smaller than Gini index after minimal compensation. Indeed, minimal compensation just turns the negative part of the Lorenz curve into zero. As $G_{C\text{-}S}$ is equal to: $2(A + B)/(1 + 2A)$, while Gini after minimal compensation is equal to $2B$, (A – denoting the area between negative part of the Lorenz curve and horizontal axis, while B – the area between positive part of Lorenz curve, horizontal axis and the line of equal share) it turns out that if for $A > 0$ Gini after minimal compensation will be smaller than $G_{C\text{-}S}$ for $B < 1/2$, that is, always.

Table 2. Values of different measures of inequality discussed in the text

	set number 1	set number 2
G	1.558	4.453
upper bound for G	1.968	5.344
$G_p=G/G_{max}$	0.792	0.833
S_a/S	0.650	0.467
G_a	0.719	0.729
G_a/G	0.461	0.164
(S_a+2NT_a)/S	0.698	0.539
G_{za}	0.733	0.756
G_{za}/G	0.470	0.170
$G_{c\text{-}s}$	0.947	0.996
G^*_{C-S}	0.874	0.974
G after min. compensation	0.913	0.984

Source: own calculations

However if we look at the two $G_{C\text{-}S}$ indexes, the effect of the minimal compensation does not appear to be so relevant as it is detected by the standard Gini coefficients. Indeed, due to the compensation, the Gini coefficient lowers from 1.558 to 0.913 in data set 1, and from 4.453 to 0.984 in data set 2.. Conversely, the decrease of the two $G_{C\text{-}S}$ indexes appears much smaller in both data sets, as, before the compensation, the two indexes are 0.947 and 0.996, respectively (after the minimal compensation $G_{C\text{-}S}$ amd G coincide):

On the basis of Frosini's ([1984], p. 274) observation that the term concentration should be applied only when non-negative values are considered, we should keep in mind that, when negative values are considered, the Gini coefficient is no longer a concentration coefficient, it is just a relative variability index. By looking to the standard Gini coefficients, in Table 2, we can say that in the second data set the relative variability is 2.9 times greater than in the first one. After the minimal compensative equalitarian redistributions, the relative inequality decreases to 0.913 and to 0.984 in the two data sets, respectively. Moreover, as

after the compensations the negative values have been raised to zero, the two Gini coefficients can be considered concentration indexes. If we look at the G_p indexes, we can add that in the first data set, the relative variability is the 79.2 % of its potential maximum, whilst in the second it is the 83.3% of its potential maximum. After the compensative redistribution, even if the relative variability has decreased, the Gini coefficients are closer to their potential maximum, which is now 1, than they were before the compensation.

CONCLUSIONS

The purpose of this research was to indicate a valid operating procedure to calculate inequality when a distribution includes negative values. Generally, in overall income distributions only a few units have negative values. However, when we disaggregate overall income distributions into their sources, units having negative values can no longer be considered a negligible phenomenon. Another situation where many units with negative values can be observed is given by tax systems, which introduce family allowances through the form of negative income taxes.

In this article we have shown that when a distribution includes negative values, neither dropping units with negative values nor transforming these values to zero are suitable practices. This should not be done if we do not want both to exclude a part of the variability that can be considerable and to make invalid comparisons among distributions, related either to different populations or to the same population in different periods. Even if the Chen et al. [1982] coefficient appears a feasible procedure that preserves the whole variability, it presents some limits: first, it is an ad hoc procedure and second, it presents several abnormal behaviours in some circumstances, as stressed by Raffinetti et al. [2015]. Moreover, even accepting Chen et al.'s idea of compensating the negative values with the lowest positive values and not caring about abnormal behaviours, Chen et al. correction should be amended, as we highlighted in section "Negative values and adjustments…". By applying the amendment, however, we have shown that the modified coefficient can increase even after an equalitarian redistribution. Instead of adopting ad hoc corrections, we suggest a procedure based on two instruments. In comparing inequality among different distributions, the standard Gini coefficient can be still conveniently used, even when dealing with negative values; G is no longer a concentration measure but just a relative measure of variability. By dividing the Gini coefficient by its upper limit, one yields the normalized index G_p, suggested by Raffinetti et al.. This normalized index is a measure of the percentage of the potential maximum variability, for each specific situation, keeping constant the sum of negative values and the sum of positive ones. G_p can be used unconditionally, in the cases which present the same ratio between the sum of absolute negative values and the sum of positive values, T_n/T_a.

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APPENDIX A: THE DECOMPOSITION OF THE SUM OF ABSOLUTE DIFFERENCES

The distribution splits into the two subsets of negative and non-negative values

Consider the distribution

$$\begin{aligned}&\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_M\right]\\&x_i \le x_{i+h},\ \ h>1;\\&x_i<0,\ i=1,2,....,N,\ \ \sum_{i=1}^{N}\left|x_i\right|=T_n;\\&x_i \ge 0,\ i=N+1,N+2,....,M,\ \ \sum_{i=N+1}^{M} x_i=T_a;\ \ T_a-T_n>0.\end{aligned}, \tag{A1}$$

We can split

$$S=\sum_{i=1}^{M}\sum_{j=1}^{M}\left|x_i-x_j\right|$$

$$=\sum_{i=1}^{N}\sum_{j=1}^{N}\left|x_i-x_j\right|+2\sum_{i=1}^{N}\sum_{j=N+1}^{M}\left|x_i-x_j\right|+\sum_{i=N+1}^{M}\sum_{j=N+1}^{M}\left|x_i-x_j\right|.$$

In the terminology of Dagum [1997], the first and the third terms are within-group components and the second is the gross-between component, which corresponds to the between component because the two groups do not overlap, that is $x_j \ge x_i$, i=1, 2,…., K+1, j=K+1,.K+2,….,M. Indeed, in this case we can write $\sum_{i=1}^{N}\sum_{j=N+1}^{M}\left|x_i-x_j\right|$ as $\sum_{i=1}^{N}\sum_{j=N+1}^{M}\left(x_j-x_i\right)$. Keeping in mind that $x_i<0\ \left(i=1,2,....,N\right)$ and that $x_i \ge 0\left(i=N+1,N+2,....,M\right)$, it is easy to show that

$$S_{n,a}=\sum_{i=1}^{N}\sum_{j=N+1}^{M}\left|x_i-x_j\right|=\sum_{i=1}^{N}\sum_{j=N+1}^{M}\left(x_j-x_i\right)=NT_a+\left(M-N\right)T_n \tag{A2}$$

In this article we denote the two within-group components as:

$$S_n=\sum_{i=1}^{N}\sum_{j=1}^{N}\left|x_i-x_j\right|,\ \text{and}\ S_a=\sum_{i=N+1}^{M}\sum_{j=N+1}^{M}\left|x_i-x_j\right|. \tag{A3}$$

If the x_i, i= 1, 2, …N, are set as equal to zero, we have:

$S_{n,a}=\sum_{i=1}^{N}\sum_{j=N+1}^{M} x_j=NT_a$.

The distribution splits into the subset of minimal compensation and the complementary subset

Consider the distribution of the variable as

$$\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, \left(x_{K+1}\right)_1, \left(x_{K+1}\right)_2, x_{K+2}...., x_M\right] \tag{A4}$$

In (A4), all values are ranked in non-decreasing order. As in (A1), x_i, i = 1, 2,…,N are the units with a negative value of the variable and, for the remaining units, $i = N + 1, 2,\ldots,M$, $x_i \ge 0$. In (A4), x_{K+1} appears twice: the former

as $(x_{K+1})_1$, with weight $\eta = \left|\sum_{i=1}^{K} x_i\right| \Big/ x_{K+1} = -\sum_{i=1}^{K} x_i \Big/ x_{K+1}$ and the latter as $(x_{K+1})_2$, with weight $(1-\eta)$, so that $-\sum_{i=1}^{N} x_i = \sum_{i=N+1}^{K} x_i + x_{K+1}\eta = T_n$, $\sum_{i=1}^{K} x_i + \eta x_{K+1} = 0$ and $(1-\eta)x_{K+1} + \sum_{i=K+2}^{M} x_i = T_a - T_n$.

We can split (A4) into two subsets:

$$\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1\right] \text{ and } \left[(x_{K+1})_2, x_{K+2}...., x_M\right] \tag{A5}$$

and, coherently, we can split the sum of absolute differences as:

$$S = \sum_{i=1}^{M}\sum_{j=1}^{M}\left|x_i - x_j\right| = \left[\sum_{i=1}^{K}\sum_{j=1}^{K}\left|x_i - x_j\right| + 2\sum_{i=1}^{K}(x_{K+1} - x_i)\eta\right]$$
$$+2\left[\sum_{i=1}^{K}\sum_{j=K+2}^{M}(x_j - x_i) + \sum_{i=1}^{K}(x_{K+1} - x_i)(1-\eta) + \sum_{j=K+2}^{M}(x_j - x_{K+1})\eta\right]$$
$$+\sum_{i=K+2}^{M}\sum_{j=K+2}^{M}\left|x_i - x_j\right| + 2\sum_{i=K+2}^{M}(x_i - x_{K+1})(1-\eta). \tag{A6}$$

In (A6), the first addend is the sum of absolute differences within the first subset in (A5) and the third addend is the sum of absolute differences within the second subset. The second addend represents the sum of absolute differences between the elements of the two subsets: as the elements in the first subset are never greater than those in the second, all the differences are non-negative and the modulus symbol can be omitted.

We denote

$$S_0 = \sum_{i=1}^{K}\sum_{j=1}^{K}\left|x_i - x_j\right| + 2\sum_{i=1}^{K}(x_{K+1} - x_i)\eta \tag{A7}$$

and

$$S_u = \sum_{i=K+2}^{M}\sum_{j=K+2}^{M}\left|x_i - x_j\right| + 2\sum_{i=K+2}^{M}(x_i - x_{K+1})(1-\eta) \tag{A8}$$

For what concerns the between-subset component,

$$S_{0,u} = \sum_{i=1}^{K}\sum_{j=K+2}^{M}(x_j - x_i) + \sum_{i=1}^{K}(x_{K+1} - x_i)(1-\eta) + \sum_{j=K+2}^{M}(x_j - x_{K+1})\eta \tag{A9}$$

we can split and rearrange it as

$$S_{0,u} = K\sum_{j=K+2}^{M} x_j - (M-K-1)\sum_{i=1}^{K} x_i + Kx_{K+1}(1-\eta) - \sum_{i=1}^{K} x_i(1-\eta)$$
$$+\sum_{j=K+2}^{M} x_j\eta - (M-K-1)x_{K+1}\eta.$$

The six terms can now be conveniently combined as

- $K\sum_{j=K+2}^{M} x_j + Kx_{K+1}(1-\eta) = K(T_a - T_n)$;
- $-(M-K-1)\sum_{i=1}^{K} x_i - (M-K-1)x_{K+1}\eta = 0$;
- by adding and subtracting $x_{K+1}\eta$ to $\left[-\sum_{i=1}^{K} x_i(1-\eta) + \sum_{j=K+2}^{M} x_j\eta\right]$, we yield:

$$-\sum_{i=1}^{K} x_i - x_{K+1}\eta + \left(\sum_{i=1}^{K} x_i + x_{K+1} + \sum_{j=K+2}^{M} x_j\right)\eta = 0 + (T_a - T_n)\eta .$$

The results here allow us to rewrite the between component simply as:

$$S_{0,u} = (K+\eta)(T_a - T_n) . \tag{A10}$$

Therefore, we can represent (A6) in the form:

$$S = S_0 + 2(K+\eta)(T_a - T_n) + S_u . \tag{A11}$$

Define the sum of absolute values within the subset $\left[x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1\right]$:

$$S_c = \sum_{i=N+1}^{K}\sum_{N+1}^{K}\left|x_i - x_j\right| + 2\sum_{i=N+1}^{K}(x_{K+1} - x_i)\eta . \tag{A12}$$

Let's now consider the sum of absolute differences between this subset, which contains the lowest non-negative values, and $\left[(x_{K+1})_2, x_{K+2}...., x_M\right]$:

$$\begin{aligned} S_{c,u} &= \sum_{i=N+1}^{K}\sum_{j=K+2}^{M}\left|x_i - x_j\right| + \sum_{i=K+2}^{M}\left|x_i - x_{K+1}\right|\eta \\ &+ \sum_{i=N+1}^{K}\left|x_{K+1} - x_i\right|(1-\eta) + \left|x_{K+1} - x_{K+1}\right|\eta(1-\eta) \\ &= (K-N)\sum_{j=K+2}^{M} x_j - (M-K-1)\sum_{i=N+1}^{K} x_i + \sum_{j=K+2}^{M} x_j\eta - (M-K-1)x_{K+1}\eta \\ &+ (K-N)x_{K+1}(1-\eta) - \sum_{i=N+1}^{K} x_i(1-\eta); \end{aligned}$$

by adding the first addend to the third and the second addend to the sixth, we yield

$$\begin{aligned} &= (K-N+\eta)\sum_{j=K+2}^{M} x_j - (M-K-\eta)\sum_{i=N+1}^{K} x_i \\ &- (M-K-1)x_{K+1}\eta + (K-N)x_{K+1}(1-\eta) . \end{aligned}$$

If we now add $(K-N+\eta)(1-\eta)x_{K+1}$ to the first addend and subtract it from the fourth, and we subtract $(M-K-\eta)\eta x_{K+1}$ from the second addend and we add it to the third, we yield

$$(K-N+\eta)(T_a - T_n) - (M-K-\eta)T_n - \eta(1-\eta)x_{K+1} + \eta(1-\eta)x_{K+1}, \tag{A13}$$

having used $T_a - T_n = \sum_{j=K+2}^{M} x_j + x_{K+1}(1-\eta)$ and $T_n = \sum_{i=N+1}^{K} x_i + x_{K+1}\eta$.

Keeping in mind (A12), (A13) and (A8), S_a can be written as

$$S_a = S_c + 2(K+\eta-N)(T_a - T_n) - 2(M-K-\eta)T_n + S_u . \tag{A14}$$

Let's now consider the distribution

$$\left[x_1, x_2, ..., x_N, x_{N+1}, x_{N+2}, ..., x_K, (x_{K+1})_1, (0)_2, 0...., (T_a - T_n)\right]. \tag{A15}$$

In (A15), $(x_{K+1})_1$ has weight η and $(0)_2$ has weight $(1-\eta)$.

The within component S_0 remains unchanged as it was for (A7); conversely S_u becomes:

$$S_u = 2\sum_{i=K+2}^{M-1}\left|0 - (T_a - T_n)\right| + 2\left|0 - (T_a - T_n)\right|(1-\eta)$$

$$= 2\left(M-K-2\right)\left(T_a-T_n\right)+2\left(T_a-T_n\right)\left(1-\eta\right)$$

$$= 2\left(M-K-1-\eta\right)\left(T_a-T_n\right). \quad \text{(A16)}$$

In distribution (A15), the two groups overlap; then we have to consider the gross-between component:

$$S_{0,u} = \sum_{i=1}^{K}\sum_{j=K+2}^{M}\left|x_j-x_i\right|+\sum_{i=1}^{K}\left|x_{K+1}-x_i\right|\left(1-\eta\right)+\sum_{j=K+2}^{M}\left|x_j-x_{K+1}\right|\eta. \quad \text{(A17)}$$

Also, in this case we can avoid modulus but we have to express $S_{0,u}$ by adding to (A10) the transvariation component:

$$\begin{aligned} S_{0,u}^{T} &= 2\Big[\sum_{i=N+1}^{K}\sum_{j=K+2}^{M-1}\left(x_i-0\right)+\sum_{i=N+1}^{K}\left(x_i-0\right)\left(1-\eta\right) \\ &\quad +\sum_{j=K+2}^{M-1}\left(x_{K+1}-0\right)\eta+x_{K+1}\left(1-\eta\right)\eta\Big] \\ &= 2\left(M-K-2\right)\sum_{i=N+1}^{K}x_i+2\sum_{i=N+1}^{K}x_i\left(1-\eta\right)+ \\ &\quad +2\left(M-K-2\right)x_{K+1}\eta+x_{K+1}\left(1-\eta\right)\eta \\ &= 2\left(M-K-2\right)\sum_{i=N+1}^{K}\left(x_i+x_{K+1}\eta\right)+2\Big(\sum_{i=N+1}^{K}x_i+x_{K+1}\eta\Big)\left(1-\eta\right) \\ &= 2\left(M-K-1-\eta\right)\sum_{i=N+1}^{K}\left(x_i+x_{K+1}\eta\right)=2\left(M-K-1-\eta\right)T_n. \end{aligned} \quad \text{(A18)}$$

Therefore, (A17) becomes

$$S_{0,u} = 2\left(K+\eta\right)\left(T_a-T_n\right)+2S_{0,u}^{T} = 2\left(K+\eta\right)\left(T_a-T_n\right)+4\left(M-K-1-\eta\right)T_n. \quad \text{(A19)}$$

Using (A16) and (A19), the overall sum of absolute differences becomes

$$\begin{aligned} S^{*} &= S_0+2\left(K+\eta\right)\left(T_a-T_n\right)+4\left(M-K-1-\eta\right)T_n+S_u \\ &= S_0+2\left(M-1\right)\left(T_a-T_n\right)+4\left(M-K-1-\eta\right)T_n. \end{aligned} \quad \text{(A20)}$$

In (A20),

$$S_0+2\left(M-1\right)\left(T_a-T_n\right)=2\sum_{i=1}^{M}\sum_{j=1}^{i}\left(x_i-x_j\right),$$

which would be the sum of absolute differences if the rank in (A15) are the same as in (A1). For more details on the information provided by the different ordering, see [Lambert, 2001 Ch. 2].

APPENDIX B: OPERATING FORMULAE

In order to simplify and fasten calculations, one can apply the operating formulae enlisted in this appendix.

$$S_a = \sum_{i=1}^{P}\sum_{j=1}^{P}\left|x_i - x_j\right| = 4\sum_{i=1}^{P} x_i i - 2\left(P+1\right)\sum_{i=1}^{P} x_i \,, \tag{B1}$$

$$S_n = \sum_{i=1}^{N}\sum_{j=1}^{N}\left|x_i - x_j\right| = 4\sum_{i=1}^{N} x_i i - 2\left(N+1\right)\sum_{i=1}^{N} x_i \,. \tag{B2}$$

$$\begin{aligned} S_0 &= \sum_{i=1}^{K}\sum_{j=1}^{K}\left|x_i - x_j\right| + 2\sum_{i=1}^{K}\left(x_{K+1} - x_i\right)\eta \\ &= 4\sum_{i=1}^{K} x_i i - 2\left(2K+1\right)\sum_{i=1}^{K} x_i + x_{K+1}\eta^2 \,, \end{aligned} \tag{B3}$$

where $\eta = \left|\sum_{i=1}^{K} x_i\right| \Big/ x_{K+1} = -\sum_{i=1}^{K} x_i \Big/ x_{K+1}$.

If $\sum_{i=1}^{K} x_i = 0$, then $S_0 = 4\sum_{i=1}^{K} x_i i$.

$$\begin{aligned} S_u &= \sum_{i=K+2}^{M}\sum_{j=K+2}^{M}\left|x_i - x_j\right| + 2\sum_{i=K+2}^{M}\left(x_i - x_{K+1}\right)\left(1-\eta\right) \\ &= 4\sum_{i=K+2}^{M} x_i i - 2\left(M+K+2\right)\sum_{i=K+2}^{M} x_i - 2\left(M-K-1\right)\left(\sum_{i=1}^{K+1} x_i\right) \\ &\quad + 2\left[\left(\sum_{i=1}^{K+1} x_i\right)\left(\sum_{i=K+2}^{M} x_i\right)\right] \Big/ x_{K+1} \,. \end{aligned} \tag{B4}$$

If $\sum_{i=1}^{K} x_i = 0$, then $S_u = 4\sum_{i=K+1}^{M} x_i i - 2\left(M+K+1\right)\sum_{i=K+1}^{M} x_i$.

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CHARITY BANKING: UTOPIA OR AN ALTERNATIVE TO GREEDY FINANCE?

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Abstract: This paper will examine so-called charity banking in terms of the idea, the current impact on the banking market and the social aspects for communities and depositors. The current state-of-art is presented and an attempt to assess whether "charity" & "social" are appropriate words to describe banking. The terms: social/charity banking, social money and social return are defined. Then there are examples of banking institutions engaged in a social/charity approach. In the last part authors triy to evaluate how much truth there is in the social/charity statements of such institutions.

Keywords: charity, social banking, sustainable finance, social finance

INTRODUCTION

The financial crisis of 2007 led to a drop in the greed and naivety of the participants in the financial sector (banks, investors and insurance companies) as well as the conformism of ratings agencies. There was a lack of trust not only by bank clients but also on the banking market. The lack of transparency about the investment policy of funds meant that clients started to look for a safer place for their savings.

This brought about a mass questioning of banking values being a catalyst for economic growth and their moral responsibility for the reckless and short-termed credit policy on the American market [Keys et. al. 2010]. The crisis led to a wide

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range of scientific papers analysing the causes and effects, and even the film The Big Short [2015] by Adam McKay.

Interventions by central banks flooded the most needed institutions with extra liquidity. These institutions turned out not just to be investment banks, but also classical, deposit banks, which were also involved in the process of selling and buying credit portfolios. This could be the reason why, against the background of their main activities of deposit and investment banking, banks focused on the development of other forms of banking, such as social or charitable banking. During the difficult period for the financial sector of 2007-2011, this type of banking experienced fast growth. Based on the experience of the financial crisis, placing the two words "banking" and "charitable" together does not seem to not make any sense and seems to be a contradiction in terms. This article will present what social banking is on the market and whether it really is social.

This article is part of a range of studies by the authors into social banking, with a special focus on the financial instruments associated with social responsibility used by the actors on the financial market. Furthermore, the planned studies aim to examine the factors which have an effect on the financial decisions of bank depositors and donators to non-profit organisations (NGOs).

UNDERSTANDING THE CONCEPT OF SOCIAL/CHARITY BANKING

To date there is no extensive literature about social/charity banking. There is also no uniform and clearly accepted definition. In the literature about the subject and the publications of the institutions themselves the following terms appear: charity, social, ethical, value-based and sustainable banking. Currently it comprises a few items which are often associated with the principles of gift economy [Andreoni 1990, Akerlof 1884] or the social function of money [Zelizer 1994], an area with extensive literature concerning socially-responsible investment. One of the most popular books published on this topic was edited by Olaf Weber and Sven Remer [Weber and Remer 2011]. The principles of literature about this topic are considered in the economics of social responsibility [Becchetti, Borzaga (eds) 2010], the economy of happiness [Easterlin and Angelescu 2009] as well as the anthropological considerations about donations [Berg, Dickhaout and McCabe 1995]. A model study linking results from the financial sector with the productivity of the real economy was presented by Cecchetti and Kaharoubbi [2012, 2015] in their two articles in BIS Working Papers. In their own words "Two main conclusions emerge from the models. First, at the aggregate level, financial sector growth is negatively correlated with total factor productivity growth. Second, this negative correlation arises both because financial sector growth disproportionately benefits low productivity/high collateral sectors and because there is an externality that creates a possible misallocation of skilled labour" [Cecchetti and Kaharoubbi 2015].

As is confirmed by Weber and Remer [2011] as well as the banks which are members of the Global Alliance for Banking on Values (GABV), an agreed definition of social/charitybanking does not exist. Furthermore, the use of these terms interchangeably is imprecise albeit not incorrect. This type of banking activity has not been the focus of attention of a wider group both on the financial market and academically. This is why it is necessary to examine the issue of classification, the evaluation of the effectiveness and popularity of a way of banking based on different principles than the maximization of yield and profitability. In general terms "*social banking describes a way of value-driven banking that has a positive social and ecological impact as it heart, as well as its own economic sustainability*" [Weber and Remer 2011]. "*In some regions social banking is equated with government banking, in others it is equated with microfinance*" [Weber and Remer 2011].

The Institute for Social Banking has provided a very complex and multi-dimensional definition of social banking. At the same time, they also make the reservation that a single, short and conclusive definition of this activity does not exist "(…) We acknowledge that a generally accepted definition of "Social Banking" does not exist, and – given the variety of its historic origins and underlying values – arguably cannot exist. But we believe that there is a common denominator of many organisations that can be subsumed under this notion of social banking (…)" (http://www.social-banking.org/the-institute/what-is-social-banking/). Combining both definitions, GABV stated in its research report Real Economy-Real Return, that what makes sustainable banks stand out from other banks is that they are "(…) reassessing their role in supporting the delivery of social, economic and environmental impact (…)" [GABV 2015].

SCOPE OF ACTIVITY OF SOCIAL BANKS

It can be said that the activities of banking institutions which are the members of the GABV focus on lending. Analysing the missions of individual banks, it is difficult to formulate a uniform vision of the representatives of social banking. The common denominator of the missions of these institutes is actually the transparency of the use of deposits, the support of local social projects, or projects which are deemed to be ethical, necessary and of added value not just on a local but also on a global scale. It is necessary to highlight that the mission and type of borrowers receiving support from the bank are a key decision-making element for bank depositors. They are depositors who are aware of the needs, or are actively involved in the development, of the local community, or the fight against global social problems (work and the lack of child education, poverty, exclusion from health care, environmental pollution). By observing banks associated with the GABV it is possible to differentiate between two main regions of credit: north and south. Southern banks focus on increasing the standard of living of people in areas of poverty. They focus on local social projects. They mainly concern

the support of micro-businesses, the development of basic infrastructure (sewage-water networks and irrigation of agricultural terrain) and increased access to science for children. The fundamental instruments for supporting borrowers are microloans, guarantees and consultation. Northern banks focus on the ethical side of their activities, on account of the higher level of economic development. This division affects the mission, organization and structure of the institutions. As per March 2016, 28 banks are affiliated with GABV, which comprise a total of $100 billion.

Table 1. The members of the Global Alliance for Social Banking, split by geographic regions

Europe	**North America**
Alternative Bank Switzerland (Switzerland)	Affinity Credit Union (Canada)
Cultura Bank (Norway)	Assiniboine Credit Union (Canada)
Ekobanken (Sweden)	Vancity (Canada)
Ecology Building Society (United Kingdom)	Beneficial State Bank (USA)
Merkur Cooperative Bank (Denmark)	City First Bank of DC (USA)
Crédit Coopératif (France)	First Green Bank (USA)
Triodos Bank (Netherlands)	Sunrise Banks (USA)
GLS Bank (Germany)	New Resource Bank (USA)
Banca Etica (Italy)	Southern Bancorp (USA)
South America	**Asia**
Banco Fie (Bolivia)	BRAC Bank (Bangladesh)
BancoSol (Bolivia)	XacBank (Mongolia)
Vision Banco (Paraguay)	NMB Bank Limited (Nepal)
SAC Apoyo Integral, S.A. (El Salvador)	
Banco Ademi (Dominican Republic)	
Australia	**Africa**
Bank Australia	Centenary Bank (Uganda)

Source: GABV data available from www.gabv.org, [access 1st March 2016]

Examples of southern lending are the following credit decisions.

- Granting of loans for the building of greenhouses in areas with varying temperatures in Bolivia – this has had a considerable effect on economic productivity and the certainty of good harvests.
- Support with investment credit for the development of a catering company working in areas affected by unemployment in the Dominican Republic. The company is now financing meals for 300 children from poor families.
- The financing of a pilot project to provide electricity from solar plants in remote villages in Nepal, who did not have access to electricity. The availability of electricity did not just increase the standard of living of the villages, but also allowed them to develop their businesses (convenience stores, farming, laundry services and tourist services), and therefore brought the economic region to life.

- Financial support for a micro-company producing mats from coconut fibre. Through its activities, the company allowed the inhabitants of the village, where there was a high rate of unemployment, to develop professionally, and also increased the level of ecological awareness.
- Preferential lending for the purchasing of economical and efficient stoves in Ulaanbaator. The micro-loans of this program were characterised by reduced requirements regarding securities and a lower rate of interest. Thanks to the program, the least-affluent households were able to allocate the released funds to clothes and food. The costs of running the old stoves make up 80% of the income during the winter. The capital of Mongolia is not just one of the coldest capitals in the world but the atmosphere is also one of the most contaminated. Making efficient stoves more popular has a positive effect on the environment, because the vast majority of pollution in the air comes from stoves.

The focus of the support of banks and credit unions in the north (in developed economies) is on programs which are usually of a different nature than the programs in less-developed countries. This includes resocialization programs (for adults and young people), projects encouraging organic nutrition and renewable energy, as well as projects to provide professional opportunities to people with physical and mental disabilities, and people excluded from society. Examples of the support of these programs include:

- Lending for projects of French public benefit organisations dealing with the fight against drug addiction and HIV.
- On-going support and lending to public benefit foundations which are involved in the resocialisation and inclusion of people in Sicily. Thanks to support from the bank, the foundation has developed a program for the teaching of traditional crafts.
- The support and on-going lending to a Swiss foundation running a hotel, where they employ women with physical or mental handicaps, who were previously unemployed or working in difficult conditions.
- A loan for a micro-company providing organic food to Norwegian households. The capital obtained from the bank allowed the company to expand its client base from 10 to 1500. A restaurant was also opened which focuses on organic food, and already has three Michelin stars.
- Financing of the purchase and modernisation of an innovative pre-school, submerged in the ground at a listed UNESCO Heritage building in Germany.
- The granting of a mortgage to funds created by inhabitants of agricultural areas in Great Britain, in order to build affordable shared ownership houses. The co-ownership of the project means that it is unusual on the mortgage market, and therefore was rejected by traditional banks. The housing market in Great Britain is characterised by extremely high prices. Households are usually unable to save

enough money for the required down payments. The bank reduced the requirements concerning down payments and applied combined mortgage security. The bank's decision did not just help to meet the needs of the inhabitants of young households, but also protected the agricultural community from depopulation and ageing.

Reading the examples given above it is hard to specify a particular general rule of the credit policy of social/charitybanks. The range of topics and the support groups are incredibly diverse. However, an element that links all of them is the conviction of lenders and shareholders of banks to observe an ethical and balanced use of credit instruments. The feeling of social responsibility in an investment is even stronger once the technocracy and greed of banks as well as the other participants on the financial market have been stripped away. What's more, in the long-term a banking approach focussed on profit has failed even the most experienced players, such as global investment banks. Social banking is still not part of mainstream on the financial market, although it is no longer going unnoticed, mainly due to the good financial returns and the increased role of ethics in the financial sector.

THE FINANCIAL RETURNS OF SOCIAL BANKS BY SECTOR

This section was developed on the basis of the results of surveys performed by GABV [GABV 2015]. It split the respondents into two groups of institutions: sustainability-focused banks (SFBs) and global systematically-important financial institutions (GSIFIs). The assumption was made that the indicator (proxy) of how involved a bank is in financing the real economy, and not in funding activities on the financial market, is the level of lending. The indicators of loans to assets confirm that sustainable banks lend twice as much to the real economy as much as banks that focus on financing, in relation to their assets.

Table 2. Loans to assets ratio

Loans/Total assets	2014	2011	2008	2005
SFBs	75.2%	77%	75.7%	73%
GSIFIs	39.6%	39.4%	39.8%	41.8%

Source: [GABV 2015]

It has to be noted that social banks mainly focus on using deposits as a source for refinancing assets. The method of using deposits for refinancing creates a stronger relationship between the borrower and the lender, and also increases the expectations on the bank concerning the transparency of their credit policy. It is this ethical approach which attracts depositors to ethical banks. Banks thereby provide capital for the refinancing of projects of an ecological and social nature. The ratio of deposits to assets is greater for social banks, than for other banking institutions.

Table 3. Deposits to assets ratio

Deposits/ Assets	2014	2011	2008	2005
SFBs	78%	76%	71.6%	73.9%
GSIFIs	49%	46.1%	43.6%	45.1%

Source: [GABV 2015]

The interpretation of these indicators needs to be correlated to the size of the institution. Social banks are incomparably smaller than the global banking institutions examined in the study. This also means that less capital can be invested in more profitable assets (credit agreements) than can be done in larger institutions with greater capital resources. As a result, the profitability of equity capital and the profitability of assets (ROE and ROA) are at a similar level to the indicators of the GSIFI group of banks. However, during the worst period of the financial crisis [2008] the profitability indicators ROE and ROA did not register as big a drop in ethical banks as in other banking institutions, which have a wide range of activities on the financial market. In 2008 the ROA for SFBs was around 0.5%, while for GSIFIs it was 0.2% while the indicator ROE was 6.5% and minus 1% respectively [GABV 2015]. Furthermore, the standard deviation of ROE and ROA is lower for social banks compared to other institutions. This means that if the level of profitability for both groups of banks is similar, the credit risk is lower.

Table 4. ROA and ROE averages and standard deviation in 2005-2014

ROE	**Average**	**St. dev**
SFBs	0.63%	0.24%
GSIFIs	0.52%	0.38%
ROA	**Average**	**St. dev**
SFBs	8.4%	2.8%
GSIFIs	8.9%	8.7%

Source: [GABV 2015]

The strong criticism of global financial institutions and their separation from the real economy in securitization procedures overshadowed the innovative financial instruments and their salespeople (originators). The extensive scientific debate about the ethical values of instruments like collateral debt obligations (CDOs) and the mechanism of up-front banking without an in-depth credit analysis, led to a sentimental return by investors to the idea of classical bank financing. It does, however, need to be underlined that it is not the innovative financial instruments themselves, but their incorrect use that was the origin of the crisis on the financial market, which then affected the real economy. The natural path of development of sustainability-focused banks seems to be the path of capital refinancing. With an increasing conviction that the activities of social banks are right, their deposits will rise, as will the demands of borrowers. It is not the method of financing that

decides whether a bank is social or not. What attracts depositors and capital investors is the nature of the bank's activities, its mission and the transparency of the credit policy. The surveys run by GABV indicate that the financial results of the few small players on the banking market are similar and are actually better during a financial crisis. This means that the portfolio of social banks is interesting for responsible social investors on the capital market. In this potential case, innovations in the securitization process could bring a range of benefits to the real economy, and not just short-term profit for investors on the financial market.

SUMMARY

In response to the question of whether charity banking is at all possible, it is necessary to state that it is fully dependant on the ethical expectations of depositors at banks and investors on the capital market. The crisis in 2007 turned out to be not just a crisis on the financial market, but also a crisis of the values of its participants. The allegedly safe derivative instruments, which were far removed from reality, as well as the obligations which were synthetically affected by the problems of the real economy, were not able to provide security to investors or guarantee a return in investment. Ratings agencies working for investors but paid for by originators, acted against the interests of the buyers of securities [He, Qian and Strahan 2016]. It needs to be highlighted that this conflict of interests is still to be resolved. After the indulgement in financial innovations, which did not generate any added value, but just a positive rate of return, things turned to disappointment for the participants of the financial market in 2008. The need to return to classic brokering on the banking market grew. As the surveys show [Cecchetti and Kaharoubbi 2012, 2015] the dynamic growth of the financial sector came at a cost to the development of the other sectors of the economy. The financial sector competes with the other sectors for capital and human resources. With the best executives being hired by the financial sector, the other sectors are left without executives and therefore the sectors with large security potential receive preferential credit. "This evidence, together with recent experience during the financial crisis, lead us to conclude that there is a pressing need to reassess the relationship of finance and real growth in modern economic systems" [Cecchetti and Kaharoubbi 2012].

Charity banks are not philanthropic, which would be a much more difficult task. Currently, corporations that want to improve their image are becoming sporadic philanthropists on the side. The goal of social banks is not to give away capital, but to assign it responsibly to the areas when corporate philanthropy does not reach.

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APPLICATION OF GENERALIZED DISTANCE MEASURE TO THE CONSTRUCTION OF A SYNTHETIC INDEX OF SUBJECTIVE SENSE OF FINANCIAL SECURITY OF FARMERS' HOUSEHOLDS

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Abstract: The article aimed to construct a synthetic evaluation of the subjective sense of financial security among the Polish farmers' households in 2015. The research drew on microdata from Household Budget Survey conducted by the Central Statistical Office in 2015. Due to the ordinal character of simple features the construction employed Generalized Distance Measure (GDM) with TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method. Calculations were performed by clusterSim package of the R program.

Keywords: generalized distance measure GDM, TOPSIS method, financial security, farmers' households

INTRODUCTION

The procedure by which a synthetic feature is constructed follows a number of steps with decisions to be made at each of them on selection of simple features, a weighting system, normalization, but also on a measure of object similarity. The measure employed most commonly is the Euclidean distance [Wysocki 2010 p. 64], but its scope is limited to quantitative features. Measuring distance becomes complicated with other types of features (such as the ordinal ones) and even more so with a mixture of different types. Hence, a distance measures must then be employed that allows for such a case and the Generalized Distance Measure (GDM) stands out as the most universal among them.

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The GDM was used in construction of the synthetic index of subjective sense of financial security of farmers' households. The idea of financial security applied to a household has a complex and multidimensional nature but is commonly described as the ability to satisfy current and future needs of its members, to discharge its obligations, and to weather financial shocks without major stress to its standard of living [Jacobsen, Furst-Nichols 2011]. The subjective sense of a household's financial security is based on self-evaluation made by its head as expressed in form of several assessments of its current financial condition or money management, but also of future perspectives for a change in financial situation [Hacker 2011, Economic Security 2013, Espinosa et al. 2014, Raczkowski 2014, Diagnoza Społeczna 2015]. Those assessments were measured on an ordinal scale.

Household financial security, both objectively and subjectively, is highly diverse not just between socio-economic groups but also within them. Farmers' households are a very particular group with elevated levels of income risk factors and consequently lower financial security [Kozera et al. 2016b]. Most volatile of these factors are understandably related to the agricultural character of their main income source and include farm profitability sensitivity to weather conditions, incidence of pests and diseases, seasonality of revenues, or market price fluctuations [Kahan 2013, Wołoszyn 2013]. The farmers, deeply attached to their land, are also far less mobile professionally than workers or entrepreneurs. They are hard put to find alternative income sources necessary to cope with potential financial shocks. The diversity of farm sizes, types of economic activity or education of farm operators also add to the diversity of financial security within this group.

The article's main objective was a synthetic evaluation of the level of Polish farmers' households' subjective sense of financial security in 2015. Additionally, socio-economic characteristics that determine different levels of the financial security were identified.

SOURCES AND METHODS

The research drew on microdata from Household Budget Survey conducted by the Polish Central Statistical Office in 2015 and calculations were performed with clusterSim package of the R program. The study proceeded in two stages. First, the synthetic index of farmers' households' financial security was constructed with TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)[1] method [Hwang, Yoon 1981, Wysocki 2010]. Then, the second stage followed with identification of social and economic characteristics that determined different levels of that index. In the article only subjective sense of financial

[1] It is a modification of the linear ordering method of Hellwig [Hellwig 1968, Bąk 2016].

security was studied, hence the "subjective sense of" clause was dropped from the main body of the paper without fear of misunderstanding.

Stage I consisted of six steps. First, simple features were selected subject to data availability and following appraisal of their merits. As a result, the selected features reflected needs satisfaction score and estimation of the past, current, but also of the future financial condition, the last one being a possible indicator of household's preparedness for income shocks as well as future covering of the needs of its members [cf. Kozera et al. 2016a]. Consequently, the following questions and responses of the household's head from the HBS survey passed the selection procedure:

1. How do you assess the present financial situation of your household?
   - very good – 1,
   - rather good – 2 ,
   - neither good nor bad – 3,
   - rather bad – 4,
   - bad – 5.
2. How does the financial situation of your household now compare with what it was 12 months ago?
   - much better – 1,
   - a little better – 2,
   - no change – 3,
   - a little worse – 4,
   - much worse – 5.
3. Which of these statements best describes the present situation of your household?
   - we can afford some luxury – 1,
   - we have enough without special saving – 2,
   - we have enough for everyday living, but we have to save for greater purchases – 3,
   - we have to live economically everyday – 4,
   - we have not enough even for basic needs – 5.
4. How do you think the financial situation of your household will change over the next 12 months?
   - much better – 1,
   - a little better – 2,
   - no change – 3,
   - a little worse – 4,
   - much worse – 5.

In the second step all the simple features were deemed destimulants of the financial security level (the higher values of the features the lower the level) and transformed into stimulants. Usually, normalization follows in the third step, but all the simple features were being measured on the same ordinal scale, and no normalization procedures were necessary. Next, the coordinates of the positive (A+) and negative (A-) ideals were taken to be the maximum and minimum values of the features over the set of all N=1681 objects (households). These coordinates were needed for the fifth step: the calculation of the distance between objects and the ideals.

With a set of features measured on an ordinal scale the Euclidean distance cannot be used for object similarity measure. One solution is to choose instead the Generalized Distance Measure (GDM) as the most universal one when dealing with qualitative or mixed-type data. GDM is based on the notion of generalized correlation coefficient, which derives from Pearson linear and Kendall-tau rank correlation coefficient [Walesiak 2002, 2016]. GDM distance of the i-th object (i=1,…,N) to the positive ideal (N+1) and negative ideal (N+2) is given by the following formula (Walesiak 2016):

$$d_{ij}^{(*)} = \frac{1}{2} - \frac{\sum_{k=1}^{K} a_{ijk} b_{ijk} + \sum_{k=1}^{K} \sum_{l=1}^{N+2} a_{ilk} b_{jlk}}{2\left[\left(\sum_{k=1}^{K} a_{ijk}^2 + \sum_{k=1}^{K} \sum_{l=1,l\neq i,j}^{N+2} a_{ilk}^2\right) \cdot \left(\sum_{k=1}^{K} a_{ijk}^2 + \sum_{k=1}^{K} \sum_{l=1,l\neq i,j}^{N+2} a_{ilk}^2\right)\right]^{\frac{1}{2}}}, \tag{1}$$

where i=1, …, N, j=N+1, N+2, (*) denotes either positive or negative ideal.
For ordinal scale the distance indicator is calculated in the following way:

$$a_{iuk}\left(b_{jtk}\right) = \begin{cases} 1 & x_{ik} > x_{uk}\left(x_{jk} > x_{tk}\right) \\ 0 & x_{ik} = x_{uk}\left(x_{jk} = x_{tk}\right) \\ -1 & x_{ik} < x_{uk}\left(x_{jk} < x_{tk}\right) \end{cases} \tag{2}$$

where: x_{ik} (x_{jk} , x_{lk} , x_{uk}, x_{tk}) is the i-th (j-th, l-th, u-th, t-th) observation of k-th feature.
In step 6 the values of the synthetic index were calculated in the usual way of the TOPSIS method:

$$q_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad (i = 1, 2, \ldots, N), \tag{3}$$

where $0 \leq q_i \leq 1$
During the second stage some social and economic variables were identified that might determine the level of financial security among the farmers' households.

First, four distinct typological classes of the security level were isolated based on the mean and standard deviation of the synthetic index:

- class I (*high*): $q_i \geq \overline{q} + s_q$
- class II (*medium high*): $\overline{q} \leq q_i < \overline{q} + s_q$
- class III (*medium low*): $\overline{q} - s_q \leq q_i < \overline{q}$
- class IV (*low*): $q_i < \overline{q} - s_q$

Then, the isolated classes were described using simple features that formed the synthetic index as partial indices (so called *active features*) followed by selected social and economic determinants of the financial security (*passive variables*).

RESULTS

Classification results of farmers' households according to the level of their subjective sense of financial security are presented in Table 1. Below, Table 2 shows fractions of the households with particular levels of active features across four typological classes. Further down, passive social and economic passive variables, determining the level of financial security, appear in Table 3.

Conducted research found substantial diversity of financial security among farmers' households in 2015. High level marked 20.1% of all the households (class I), while low level – 17.9% (class IV). Most numerous class II formed the households with medium high level (46.9%) (Table 1).

Table 1. Classification results of Polish farmers' households according to their level of financial security in 2015

Values of synthetic index	Typological class	Level of financial security	Farmers' households	
			Number	Share (%)
<0.74, 1.00>	I	*high*	338	20.1
<0.52, 0.74)	II	*medium high*	789	46.9
<0.30, 0.52)	III	*medium low*	253	15.1
<0.00, 0.30)	IV	*low*	301	17.9
Total			1681	100

Source: own calculations based on data from HBS conducted by the Central Statistical Office in 2015

The households of class I, those of high level of financial security, usually judged their financial situation as rather good (74% of this class), did not notice any difference from the previous year (82%) or only some change for the better (17%). They also predicted no change in the future year (85%) or only minor improvement (12%). They considered their current budget to be sufficient for

everyday living, but most (64%) needed to save for a major purchase, while a minority of 32% did not (Table 1).

Table 2. Simple (active) features of the financial security across its typological classes in 2015 (median values)

Questions - Answers		Typological classes of financial security				Total
		I *high*	II *medium high*	III *medium low*	IV *low*	
How do you assess the present financial situation of your household	very good	22.5	1.4	0.0	0.0	5.2
	rather good	73.7	3.4	1.6	0.0	16.7
	neither good nor bad	3.8	95.2	91.3	44.2	67.1
	rather bad	0.0	0.0	5.5	44.5	8.8
	bad	0.0	0.0	1.6	11.3	2.2
	Total	100.0	100.0	100.0	100.0	100.0
How does the financial situation now compare with what it was 12 months ago?	much better	0.6	0.0	0.0	0.0	0.1
	a little better	17.2	3.8	0.8	0.0	5.4
	no change	82.0	92.5	71.1	31.2	76.2
	a little worse	0.3	3.7	24.5	55.8	15.5
	much worse	0.0	0.0	3.6	13.0	2.8
	Total	100.0	100.0	100.0	100.0	100.0
Which of these statements best describes the present situation of your household?	we can afford some luxury	4.1	0.6	0.0	0.0	1.1
	we have enough without special saving	31.7	3.2	2.8	0.0	8.3
	we have enough for everyday living. but we have to save for greater purchases	63.9	92.1	49.4	20.9	67.3
	we have to live economically everyday	0.3	4.1	47.0	74.1	22.3
	we have not enough even for basic needs	0.0	0.0	0.8	5.0	1.0
	Total	100.0	100.0	100.0	100.0	100.0
How do you think the financial situation of your household will change over the next 12 months?	much better	2.7	0.3	0.0	0.0	0.7
	a little better	12.4	6.0	2.0	3.0	6.1
	no change	84.9	92.3	77.5	44.5	80.0
	a little worse	0.0	1.5	18.6	47.2	12.0
	much worse	0.0	0.0	2.0	5.3	1.2
	Total	100.0	100.0	100.0	100.0	100.0

Source: own calculations based on data from HBS conducted by the Central Statistical Office in 2015

Almost all of class II (medium high level of financial security) households described their financial situation as neither good nor bad (95%), and assessed their

resources adequate for everyday living, but not without the need of saving for major purchases (92%). With few exceptions this entire (92%) class also believed their financial situation would not change in the next year, a highest percentage of all the four classes (Table 2).

Class III was formed by just 15% of all households, and its members viewed their level of financial security as medium low. Unlike in previous classes a substantial fraction of these households believed their financial condition worsened in the last 12 months (25%) and were pessimistic about future (10%). Nearly half of them had to live economically every day, while the other half needed to save for a major purchase (Table 2).

Class IV of low level of financial security was also half split between the households that viewed their financial condition as average and those that considered it rather bad (44% both). Most of the class had to be very economical (74%), and one in twenty declared they were lacking even the basics. Moreover, almost no household believed their future to improve with 45% thinking it would be even worse (Table 2).

Table 3. Selected social and economic (passive) variables across the classes of (subjective sense of) financial security

Specification		Typological classes of financial security				All
		I *high*	II *medium high*	III *medium low*	IV *low*	
Equivalent* disposable income (zł/month)		2724	1720	1365	1140	1798
Equivalent* expenditures (zł/month)		1626	1269	1231	1178	1328
Savings rate (%)		40.3	26.2	9.8	-3.3	26.1
Share of essential expenditures (food and housing) in total expenditures (%)		45.0	51.5	53.0	54.0	50.3
Farm average size (ha)		30.2	14.6	14.6	10.7	17.1
Education of the household head (%)	*junior high school or lower*	10.4	15.1	22.5	23.3	16.7
	vocational	39.9	53.6	48.2	52.2	49.8
	high school	38.8	26.0	27.3	21.6	28.0
	higher	10.9	5.3	2.0	3.0	5.5
	Total	100.0	100.0	100.0	100.0	100.0

*modified OECD scale was used

Source: own calculations based on data from HBS conducted by the Central Statistical Office in 2015

Objective or subjective, household financial security depends on many social and economic determinants, such as income, education, or socioeconomic

group affiliation, among many others. Selected determinants are presented in Table 3. The research found that farmers' households' financial security was highly correlated with their equivalent disposable income. Its average level in class I reached 2,724 zł and was the highest value of all classes while in class IV dropped to the lowest mark of 1,140 zł. Further correlation was discovered with aggregated savings rate: highest in class I (40%) and lowest in class IV (-3%). The last finding confirmed subjective opinion that the received income did not cover all basic needs in this class. Estimation of bad financial condition of this class was further reinforced by the fact that essential expenditures (food and housing) amounted to 54% of their household budget, compared to 50% for average farmers' household.

The study also found other determinants more loosely related to disposable income: educational level of the household's head and the farm size. The percentage of households with their head's low educational level (junior high or lower) was rising with the falling level of financial security (from 10% in class I to 23% in class IV). The opposite was true for the percentage of households with their head's high school or higher educational levels. For high school level it was falling from 39% in class I to 22% in class IV, and for higher educational level it was falling from 11% in class I to 3% in class IV.

As to the farm size, the average size of the farm in the first class was above 30 ha, while in the fourth class only 11 ha, the medium classes having average farm size of about 15 ha each (Table 3).

CONCLUSIONS

Due to the ordinal character of a majority of diagnostic variables, the Generalized Distance Measure was employed in the construction of a synthetic index of subjective sense of farmers' households' financial security, a construction that drew on opinions of the households' heads. The study showed that in 2015 on in every five farmers' households exhibited high level of the financial security, one in two – medium high, and one in three – at most medium low.

Moreover, the self-evaluation was largely determined by the households' objective financial security, especially by disposable income and savings rate, and to a smaller degree by share of essential expenditures. Furthermore, households of high level financial security farmed on average on 30ha, an area three times the size of farmsteads of low level households. Another determinant found in the study was educational level of households' head. Every second household of high level financial security was headed by a person with at least high school education, while three out of four low level households – with at most vocational education.

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TECHNICAL EQUIPMENT OF FARMS IN MAŁOPOLSKA AND LITHUANIA ON THE BASIS OF SURVEY RESEARCH

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Abstract: The aim of the research is to compare the level of farm equipment with agricultural machinery and devices improving production as well as to evaluate the quality of the equipment measured by its age, in Małopolska region and in south Lithuania. The empirical material constituted the results of the survey in 2017 in 144 farms in Małopolska and 70 farms in Lithuania. Questions taken into account in the research concerned power and age of tractors and combines, number of chosen machines and agricultural devices used according to the farm profile. The analysis of the material completed after the survey allows for the conclusion that the structure of technical equipment of farms both in Małopolska anf south Lithuania has undergone positive changes, especially in case of farms of average and large areas (15–20 hectares of arable land and >20 hectares of arable land). These farms, having the opportunity of easier access to credits and investment subventions, try to introduce general changes within machinery backup. At the same time the oldest equipment – often used more than 20 years, finds its place in farms of smallest areas of arable land.

Keywords: mechanization of agriculture, farm, structure

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INTRODUCTION

Bibliography covering the problem of technical equipment of farms in most cases depends on quantitative evaluation with no relation with the quality of the machinery and devices used in agriculture. There is a noticeable lack of the data concerning the age of the machinery, which is the basic determinant of the quality of technical equipment of farms. This fact make it difficult to estimate the level of farm equipment with mechanization means, which in turn may lead to misleading conclusions in the context of international comparisons. Specific information concerning farm equipment such as purchases of machinery regarding second hand market, age and technical condition can be obtained only by the way of survey carried out among farmers. The lack of information on machinery condition of Polish agriculture creates an awkward gap in the area of the research concerning agricultural equipment in Poland. The works referring to the analysis of the level of the equipment of farms with mechanization means were dedicated either to some chosen machinery [Muzalewski 2013] or concerned changes of technical equipment of farms within the area of the country [Piwowar 2012], as well as some international comparisons [Pawlak 2010]. The scope of these analyses was often restricted to quantitative evaluation. The survey research allows for multidimensional diagnosis regarding quantity, quality, finances corresponding machinery purchases, repairs and related costs.

The survey on the basis of which the analyses were carried out was conducted parallel within two areas: 144 farms located in Małopolskie voivodeship, in which the supposed successor is on the way to get qualifications at the University of Agriculture in Krakow, and 70 farms in South Lithuania, in which the supposed successor studies at Aleksandras Stulginskis University in Kaunas. The investigation was to answer the questions concerning the number and quality of farm equipment, in particular power and age of tractors and sophisticated combines, number of chosen machines and agricultural devices used accordingly to farm specialization.

Polish agriculture is known for its unfavorable areal structure of farms, with predominating number of small and very small units of the area less than 5 hectares, similar structure is observed in Romania, Portugal and Lithuania, therefore the area chosen for comparative investigation is Lithuania.

Lithuanian agriculture specializes mainly in milk and meat production. In 2014 there were about 171.5 thousand of farms of the average area of 6 hectares. The cultivations are mostly grains (wheat, rye, barley, corn), fodder beets, sugar beets, potatoes, while in farming he leading positions are taken by cattle, pigs and poultry [Greta, Lewandowski 2012].

In spite of many attempts to consolidate farm areas both in Poland and in Lithuania there is still a significant predomination of small farms [Burski, Sadkowski 2005]. The most numerous group – more than 50% - in both countries is constituted by farms of the area up to 5 hectares. Farms of the area not exceeding 20 hectares make up 30% while in other categories there are up to 7% of the total number of farms [Eurostat 2017].

Taking into account the information contained in Table 1, one can notice that Polish farmers are slightly better equipped with the machines for agricultural production. Both in

Poland and in Lithuania the most popular equipment used in farms is tractor. Regarding the character of the agriculture in these countries combines were also often used. Almost half of Polish farms were equipped with other sophisticated machinery while in Lithuania only 25% of the total number of farms were in the possession of such equipment.

Table 1. Utilization of agricultural machinery in farms in Poland and Lithuania in 2013 [%]

Specification		area [ha]					
		<2	[2, 5)	[5, 10)	[10, 20)	[20, 50)	>=50
tractors	Poland	31.73	58.73	82.24	91.39	94.47	90.89
	Lithuania	13.73	21.56	41.36	65.62	82.45	91.21
combines	Poland	10.87	27.47	53.28	74.61	85.34	80.68
	Lithuania	0.00	0.18	2.03	9.87	28.64	61.55
cultivators	Poland	2.79	5.51	7.74	8.98	9.99	13.52
	Lithuania	0.82	0.70	3.12	5.03	7.78	10.12
other machines	Poland	8.08	18.71	33.13	45.85	47.80	66.91
	Lithuania	6.06	3.20	8.53	16.64	24.67	26.79

Source: own calculations on the basis of Eurostat

MATERIAL AND METHODOLOGY OF THE RESEARCH

The analysis was based on the results of the survey carried out in January 2017, covering 144 farms situated in Małopolska and 70 farms located in South Lithuania. The subject of the investigation was the level of farm equipment as well as plans concerning modernization of the machinery being in the possession of the farm. The respondents were also asked about financial sources for investments planned in connection with equipment modernization. The basic grouping criteria were farm area and specialization. Six areal groups were distinguished. Due to significant fragmentation of farms in Małopolska farms of the area up to 2 hectares constituted a separate group. Within specialization farms of plant production, livestock production and multidirectional were distinguished.

Table 2. Characteristics of farms under investigation in Małopolska and Lithuania [%]

Characteristics		Małopolska	Lithuania
area [ha]	<2	5.56	0.00
	[2, 5)	25.69	2.86
	[5, 10)	30.56	14.29
	[10, 20)	20.14	5.71
	[20, 50)	11.81	17.14
	>=50	6.25	60.00
specialization	plant production	44.44	34.29
	livestock production	10.42	11.43
	multidirectional production	45.14	54.29

Source: own calculations on the basis of Eurostat data

The most numerous group out of farms in Małopolska was the group of farms of the area from the interval 5-10 ha (30.56%), and 2-5 ha (25.69%). In Lithuanian group the predominating majority constituted farms of the area more than 50 hectares while the smallest representation had farms of the area less than 5 hectares. In Małopolska the most numerous group constituted farms with multidirectional and plant production while in Lithuania the majority of farms was those with multidirectional production. Farms with specialization of livestock production constituted 10-11% of the total number of farms in both countries.

In most farms investigated in Małopolska with plant specialization there is a significant predomination of cereals in crop structure. Root plants were cultivated by 40% of respondents and vegetables – by 30% of respondents. In case of farms with predomination of livestock production most respondents declared milk cattle farming, 30% of respondents - pigs and similar percentage of respondents – poultry. In Lithuanian farms with plant production specialization similar to Małopolska there was a noticeable predomination of cereal cultivation and 40% of farms specialized in fodder plant production. Farming of cattle for slaughter and milk cattle predominated in the group of Lithuanian respondents.

RESEARCH RESULTS AND DISCUSSION

The most popular equipment both in Małopolska and in Lithuania were agricultural tractors (almost 90% of respondents in both samples declared having one) and agricultural trailers that constituted the equipment of 70% of farms in each group. Vast majority of farms in Małopolska (79.86%) declared having plough, while 59% of respondents among Rother agricultural machines listed field seeders, which is the basic equipment in case of farms with cereal cultivation specialization. In Poland most popular were distributors of fertilizer and sprayers – they appeared in more than a half of farms being surveyed, while in Lithuania distributors of fertilizer occurred only in 31.14% of farms and sprayers – in % of farms under investigation. Almost 70% of respondents in Lithuania have got in their farms tillage units. Many farms there (60%) are equipped with telescopic self-propelled loaders. Every third farm in both samples has got harvester combine. Almost a half of the Lithuanian respondents (45.71%) declared having potato harvester while automatic planters are used in the group of 37.14% of farms surveyed.

One of the objectives of the research was to determine the age of the machines and devices used in farms in Małopolska and Lithuania. It seems obvious that the equipment of farms needs modernization and adaptation to new production technologies that are friendly to environment. This in most cases concern agricultural tractors – it turns out that almost 60% of machines being in the posession of Polish farmers hale been used for more than 15 years and 38% - for more than 20 years. The average combine harvester-thresher age in the group under investigation is more than 15 years and 30% of this type of machinery is more than

20 years old. The survey confirms the results of the investigation carried out by Muzalewski [Muzalewski 2013], who in 2005 estimated the average combine harvester-thresher age to be 21 and in turn the average agricultural tractor age in farms investigated by Wójcicki [2013] was estimated to be about 14.5 years.

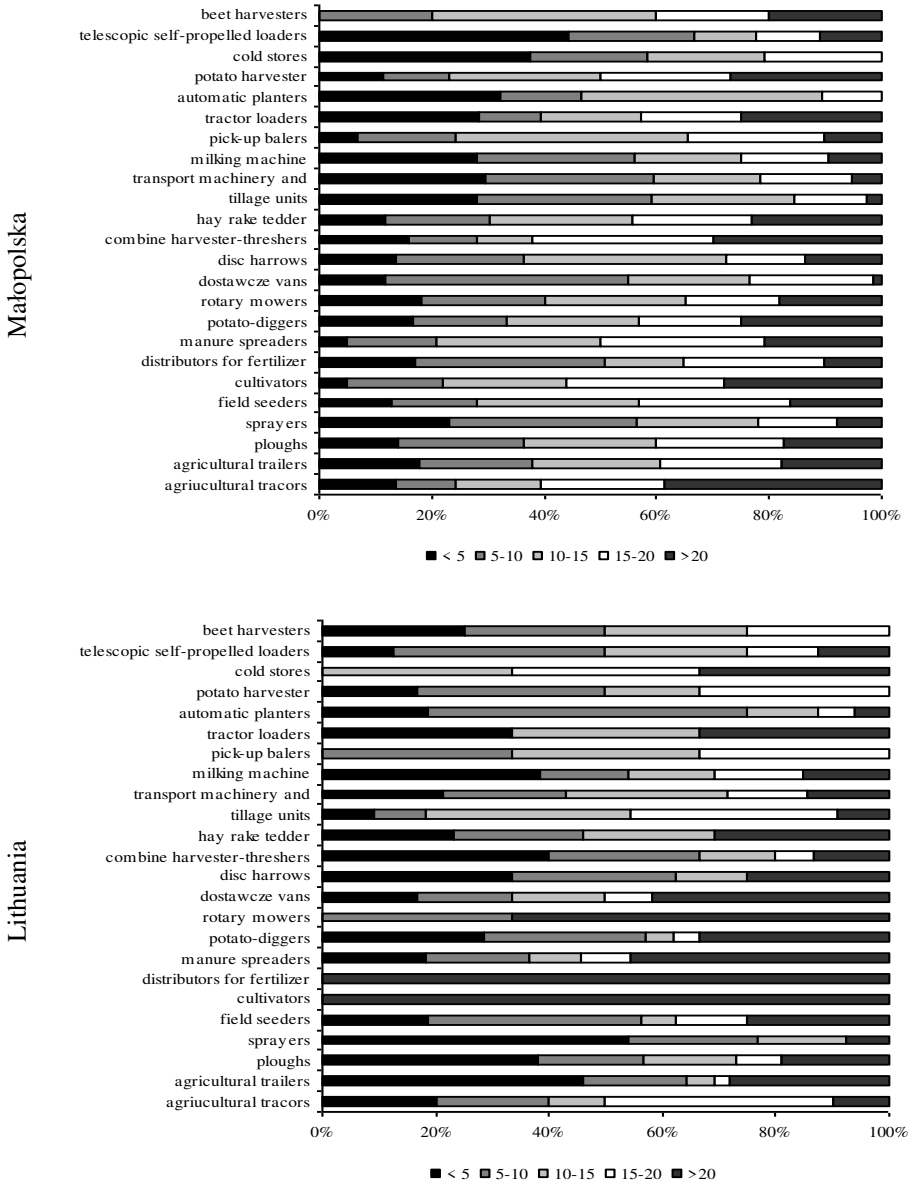
Table 3. Frequency* of occurrence of chosen agricultural equipment in the samples of farms investigated in Małopolska and Lithuania [%]

Equipment type	Małopolska	Lithuania
vans	41.67	28.57
agriucultural tracors	89.58	88.57
agricultural trailers	74.31	71.43
combine harvester-threshers	34.72	37.14
potato harvester	18.06	45.71
beet harvesters	3.47	5.71
disc harrows	40.28	2.86
cultivators	56.94	31.43
telescopic self-propelled loaders	6.25	60.00
tractor loaders	19.44	8.57
ploughs	79.86	34.29
tillage units	27.08	68.57
hay rake tedder	29.86	42.86
manure spreaders	43.06	37.14
distributors for fertilizer	53.47	31.43
field seeders	59.72	40.00
automatic planters	19.44	37.14
sprayers	60.42	8.57
pick-up balers	41.67	8.57
potato-diggers	20.14	45.71
milking machine	41.67	17.14
cold stores	22.22	8.57
transport and handling machinery	16.67	22.86

Source: own elaboration, *percentage of farms having at least one machine of the type

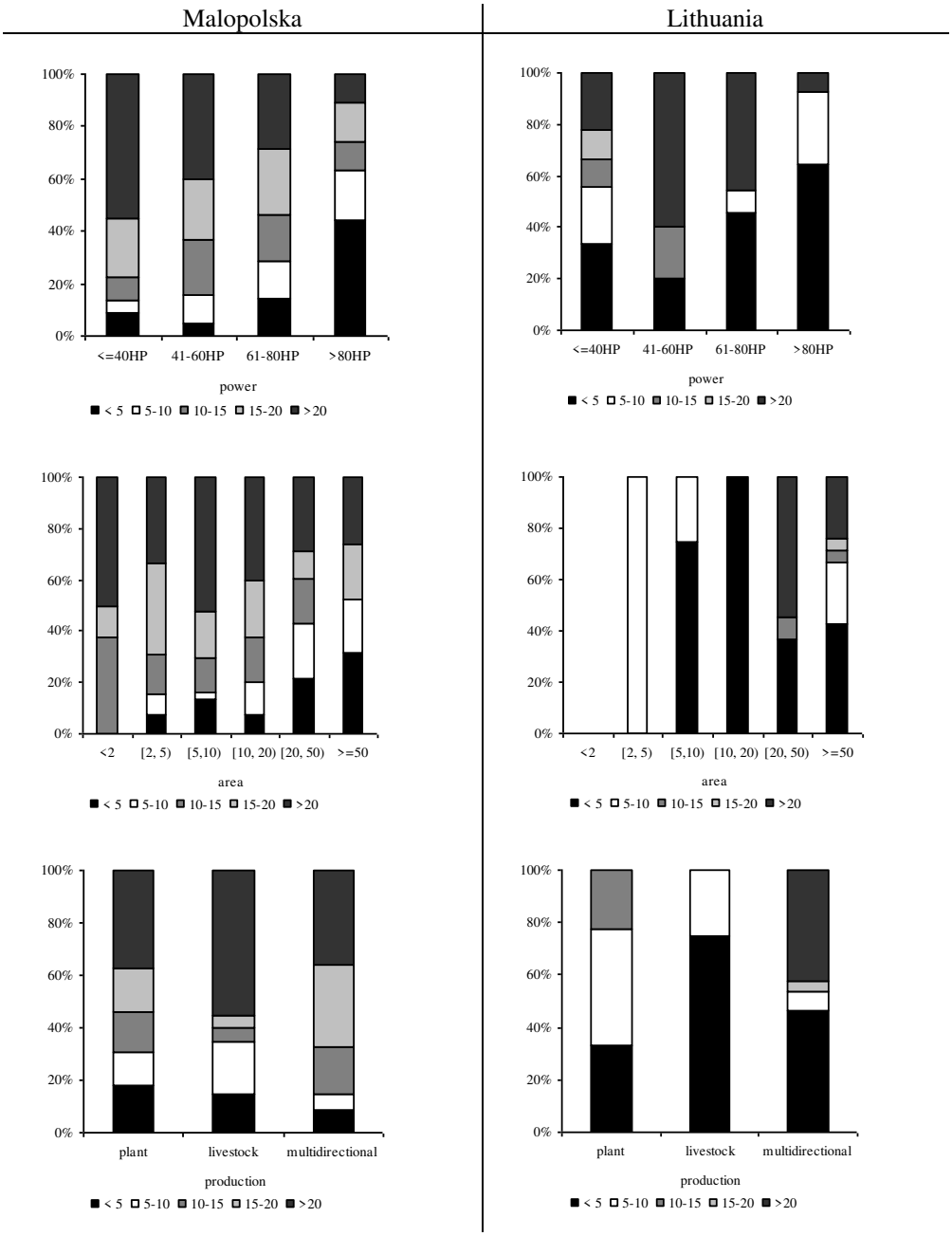
After the integration with the EU there was a noticeable progression within investment in Polish agriculture, many farmers bought tillage units, the age of which do not exceed 10 years at the present moment, they replaced long serving cultivators, disk harrows and rotary tillers. Almost 60% of transport and handling machinery, cold stores and vans in the farms surveyed in Małopolska are new, bought not later than 10 years before. Relatively new – not older than 10 years are sprayers and fertilizer distributors.

Figure 1. Structure of age [years] of agricultural machinery in farms under investigation in Małopolska and Lithuania



Source: own investigation

Figure 2. Structure of age [years] of agricultural tractors in farms under investigation in Małopolska (A) and Lithuania (B)



Source: own investigation

Large farms completing the basic machinery for years at present renew it by supplementing the equipment with transport and handling machinery and devices for work automation. In case of other machines listed in the survey questionnaire the age was very much differentiated in the group of farms surveyed in Małopolska and oscillated from 10 to 20 years, there were few new machines – up to 5 years old and few very old machines – more than 20 years.

Referring to the age estimation of agricultural equipment following from the Lithuanian survey one should emphasize that the age of beet harvesters and disc harrows in all of the farms under investigation is more than 20 years. Lithuanian farmers have been investing their financial means mainly in combine harvester threshers and tractors, 50% of the Lithuanian respondents declared that the age of the agricultural machines in their possession does not exceed 5 years. The age of more than 60% tillage units, pick-up balers, hay rake tedders working in Lithuanian farms is not more than 10 years.

The research carried out within Małopolska region showed that agricultural tractors of less than 40 horsepower were used mostly in farms of the area less than 2 ha and the age of most of the machines did not exceed 20 years. It turned out that the owners of farms of the area up to 2 ha did not make any investments as far as new equipment was concerned, since they had been using the machinery they had possessed for years. The age of almost 40% of tractors of the power of 60 was over 20 years. The owners of large and average farms of the area more than 20 ha got the financial means from the European funds and used it for purchasing tractors of the more than 80 horsepower. In the group of farms under investigation more than 45% of agricultural machines of this type was of the age less than 5 years. In case of the survey carried out in Małopolska the age of the machines was much more differentiated and the farm production specialization seemed to have no connection with it.

Figure 2 presenting the structure of the age of agricultural tractors indicates that the Lithuanian agricultural equipment is newer than those in Poland. The owners of farms of the area up to 10 ha directed their financial means into purchases of new equipment and the age of agricultural tractors used in this areal group did not exceed 10 years. Significant investment were made in the direction towards machines of big power, more than 80 horsepower, 64.29% of tractors was of the age under 5 years.

CONCLUSIONS AND REMARKS

Because of the changing situation in agricultural market and in the surroundings of agriculture there is a constant need for current research within changes in farm equipment with tractors and agricultural machines.

Large number of farms, especially in case of Małopolska region, taking advantage of beneficial possibilities for acquiring agricultural machinery after the liquidation of state-owned farms, purchased the property. Tractors, frequently

after 30 years of exploitation, of joint capacity far above the needs of farms of small area, in combination with old machinery, do not meet the demands of sophisticated technologies of livestock and plant production. In case of the analyses carried out this concerned mostly tractors of the power up to 40, in this case 55% of farms in Małopolska had tractors older than 20 years, while 40% of farms had tractors of the power from 40 to 60 older than 20 years.

Anyway, it follows from the survey that the structure of technical equipment of farms in Małopolska has been undergoing positive changes, especially in case of average and large farms (15–20 hectares of arable land and >20 hectares of arable land). These farms basing on easy access to credits and investment subventions try to modernize their technical equipment, although it often happens afterwards that they do not use or are not able to use its full potential.

The evaluation of farm equipment with tractors and agricultural machines is difficult and often has an approximate character. There is a lack of reliable data on production and sale of agricultural machines, especially it concerns of purchases on secondary market. Only in case of agricultural tractors the information is available thanks to the necessity of registration of these machines. The largest influence on the level of sale follows from the situation in agriculture and the level of income obtained by farmers.

The most popular machinery both in Małopolska and Lithuania were agricultural tractors and agricultural trailers (nearly 90% of farms declared having one). The owners of average and large farms above 20 hectares both in Małopolska and in Lithuania, got the financial means for the purchase of tractors of more than 80 horsepower from European Union, in Małopolska 45% of farms declared having such machines for the time period less than 5 years while in case of z Lithuania it was 64.29 farms.

On average every third farm in both samples was equipped with combine harvester-thresher, with relatively newer machines working in Lithuanian farms. Potato combines are much more frequently used in Lithuania, more than half of the farms surveyed declared having such machinery while in case of Lithuania every fifth farm was in the possession of it.

In farms of Małopolska the crop of potatoes is often proceeded traditionally with the use of potato diggers, due to which there were 42% respondents that declared having such devices while in Lithuanian farms there were only 17%.

Significant differences in frequency of occurring concern the machinery for fertilizing and plant protection.

The newest equipment working in farms of Małopolska are cold stores and telescopic self propelled loaders, while in case of Lithuanian farms relatively higher percentage is observed in case of combine harvester threshers.

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