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Survey Paper

Estimation and Comparison of Underground Economy in Croatia and European Union Countries: Fuzzy Logic Approach

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Abstract

Underground economy (UE) is one of the undesired facts in every country. The size of the underground economy is an important parameter in determining the effectiveness of fiscal and monetary policy, the rate of economic growth, and income distribution. From a scientific point of view analysis of the UE is faced with severe data problems because underground activities are not recorded and anyone engaged in it has an incentive to hide them. Therefore, economists have developed a variety of methods to estimate the size of the underground economy. The aim of this paper is to estimate and compare the size of the Croatian underground economy with the underground economy of European Union (EU) countries in the period of 2004 till 2012.

The purpose of this paper is to address this issue in three ways. First, we review existing estimates of the size of the underground economy. Second, we apply a novel calculation method for estimation: fuzzy logic. Third, we calculated and compared underground economy index for 25 European Union countries and compared it, with special focus on Croatian underground economy index. Results indicated that Croatia has the thirteenth largest underground economy among measured members of the European Union. This study is the first of its kind with recent data to measure the size of underground economy in European Union countries by employing fuzzy logic approach.

Keywords: Shadow economy, unemployment, governments regulatives, fuzzy logic, financial crisis, economic crisis, underground economy index

1. Introduction

Strategic planning of countries´ economic development requires awareness of general operation of country economy. As s part of economic activities in every country, in some extent, there are performed hidden or non-registered activities. Producing goods

and services in this group of activities is called underground economy, or shadow economy, or hidden economy or black economy. In this paper we use term underground economy (UE).

During a long period of time the Republic of Croatia was faced with negative economic trends which resulted with high unemployment rate and increased rate of the poverty [1]. Such negative trends in the economy led to the increased size of the underground economy. This paper models the movements of underground economy index in Croatia for a period of nine years: from 2004 to 2012 through monitoring of two factors: the level of unemployment rate (UEMP), and thus the social exclusion of individuals, and changes in the number of registered crafts and companies (BS). The results will be compared with data on the number of operators in the performance of unregistered activities at competent state authority[1]. Due to the fact that Croatia has recently become a new member of the European Union (EU), we compare the size of Croatian underground economy with the other members of the EU. The union reached its current size of 28 member countries with the accession of Croatia on 1 July 2013 [2]. In this research we have calculated UE index for 24 members of EU, based on the available data.

Here, will try to give answers to the following questions: How did the underground economy index move in the last decade in the Croatia, newest EU member, and the rest of the countries? What is the position of Croatia considering the members of the European Union?

In the introduction we explain the term "underground economy" and forms of the underground economy, which will be the subject of this study. The term itself has a broad meaning and different authors define it according to their views. The underground economy is described in four forms, defined by Feige [3]:

- Illegal economy - including manufacturing and distribution goods and services forbidden by law, such as drugs, prostitution, smuggling, organized crime, usury, theft,
- Undeclared economy - activities which avoids some fiscal rules in the tax laws, we can talk about the evasion of taxes and contributions,
- Unregistered Economy - includes activities that are not reported to official statistics, we can say that is measured by the income that is not recorded in the national accounts,
- Informal economy-activities which reduce company costs and violate administrative rules which regulate property rights, employment contracts, loan contracts, social security.

At the national or international level we are talking about economic activities of individuals, informal groups or organizations that are not publicly declare (undeclared economy), it is often not recorded (unregistered economy) or not taxed (evasion) [4].

[1] The competent state authority-national authority for the implementation of inspection supervision-the State Inspectorate, ceased to operate 31.12.2013, their jobs took over Ministry of Finance [6]

These are the economic activities of organizations or individuals that do not comply with certain institutional procedures, or elude some components of social regulations including activities that are explicitly banned or their execution is related to crime. With respect to the defined forms of the UE this paper will follow the form of the UE "unregistered economy", which includes performing of activities by companies or persons which are not registered by the competent authority.

The Act on the Prohibition and Prevention of performing unregistered [5] was adopted in 2011 and it`s one of the legislative measures of state policy aimed to reduce this form of labor and thus combating the underground UE [5]. State Inspectorate, as the government institution, is in charge for law enforcement and identifying violations of activities without registering. Other measures which the government is trying to impact on reducing such negative trends are forms of business registration in the relevant institutions and various financial incentives. This paper seeks to identify the extent of UE in Croatia, find the factors affecting it and suggest measures to reduce it.

Scientific and methodological foundations focused on different models and techniques for underground economy estimations. We apply fuzzy approach for underground economy modeling since it is a new and innovative method. We think that fuzzy technique presented in this paper may be an acceptable alternative to traditional statistical analysis.

The paper is organized as follows. Next chapter gives an overview of previous research regarding underground economy. Third chapter describes fuzzy logic and data used in the research to estimate size of UE in European Union. The fourth chapter discusses empirical analysis and provides the results of estimated UE level in European Union with special attention on Croatia, for 9 years period. Fifth chapter summarizes measures to reduce the impact of the underground economy in Croatia and sixth chapter concludes the paper.

2. Review of related studies

The UE as negative economic phenomenon occurs in developed and developing countries [6]. But the difference is that in the countries with impoverished economy, as it is currently in Croatia, it has a big impact on the decline in the country's GDP. Reasons for the emergence of the UE can be classified into: economic factors, psychological factors and factors of opportunity.

The economic factors are financial problems of people including the current high rate of unemployment, high taxes, the likelihood of identifying (hope that tax evasion will not be revealed), severity of sanctions (hope that sanctions will not be severe), the expected profit (high profits due to high risk) etc [4].

The psychological factors may include distrust in the country and their economic measures, disagreement with the objectives and means of economic policy and attitude towards risk. As the most important factors of opportunity are work experience and education which is important in finding a job and successfully performing the job beyond the scope of legislation.

In fact, at the times when UE is spread most vulnerable are taxpayers. In other words, because of the increasing size of the UE is very difficult to perform normal registered activity, because the work in UE makes it impossible. The price of goods or services is under the influence of labor in the UE and decreases, meanwhile taxpayers` benefits to the state will remain the same. Here is an example of providing car repair business when a person who does not have a registered business and does not pay taxes, can do a favor for a third party at a lower price than the subject which is registered by the relevant authorities and who is a taxpayer. Furthermore, poverty in the country and the increasing rate of unemployment rate force the individuals to use such services at cheaper subjects who is an unregistered taxpayer. Such economic trends lead to the growing volume of UE. It is therefore important to constantly draw attention of people against this form of deterioration of the economy that is still insufficiently known area. In addition psychological factors may also play an important role in the development of the UE because in certain societies such as Croatian, people are still reluctant to report illegal performance to the relevant services.

Previous scientific research investigated various elements which can predict the level of UE, such as: unemployment rate [7], the number of registered business subjects [8], the corruption of government [9] and crime rates [6]. Radulescu Dragos connects the rate of underground economy to the globalization process [10]. Asiedu and Stengos measured the underground economy on the basis of data on tax evasion. By increasing the tax load and social security contributions increased rate of underground economy. Furthermore, some authors used the currency demand approach to measure underground activity and the profile of underground economy [11]. Unemployment rate (UEMP) and number of registered business subjects (BS) are considered to be the major ones and we use it in our research.

Many different methods have been used in the various empirical studies of the underground economy that have been undertaken so far. Trend of using "*Multiple Indicator, Multiple Causes*" (MIMIC) modelling to estimate the size of the underground economy was noticed. However, this approach has been criticized on econometric grounds by Breusch [6]. In order to avoid that and the need for rigid mathematical modeling and distribution assumptions, this study uses fuzzy set theory and fuzzy logic to estimate the size of Croatian`s UE over the period from 2004 to 2012. This gives one of the most valuable contribution of these paper application of a novel methodological approach in econometrics: fuzzy logic approach. To our knowledge there are only few such contributions: those of Draeseke and Giles from 2002 [12], Yu, Han-Min and Chen from 2006 [13], Ene and Hurdac from 2010 [14], and Wahab et al from 2013 [15]. Draeseke and Giles measured the level of UE in New Zealand [12], whereas Yu et al. measured UE in Taiwan [13]. Wahab et al measured UE index in Malaysia [15]. Ene and Hurdac [14] applied fuzzy logic to measure UE in European context, but only for one country, Romania, whereas Caleiro [16] applied it on 15 EU countries. Our paper represents first attempt to apply complex fuzzy logic methodology to measure underground economy on the whole European Union level.

3. Estimation methodology

Empirical analysis in this research uses fuzzy set theory and fuzzy logic models. Fuzzy logic has become an important tool for a number of different applications ranging from the control of engineering systems and artificial intelligence to social sciences. Contrary to traditional, Boolean logic, fuzzy logic allows partial or staggering membership of the element to the set. The universe is composed of several elements that can´t be strictly defined or delimited. Starting from such observation, Lotfi Zadeh (considered the father of fuzzy logic) has decided to extend the two logical values defined by the pair [0, 1] to a continuous range [0, 1] by using a gradual transition from false to true [17]. In contrast to the conventional parameter method, fuzzy logic avoids the need for rigid mathematical modelling and the distribution assumption. Fuzzy logic translates natural language descriptions of decision policies into an algorithm using a mathematical model.

Fuzzy logic is based on idea of fuzzy set. Fuzzy sets are actually an extension of the mathematical set concept. A mathematical set is a collection of same feature objects. Fuzzy sets use more than one condition to establish a belonging criterion. Fuzzy set consists of pair: value and membership degree. A degree of membership assume values between 0 and 1 and indicates the degree to which the value of belongs to a set. The concept of linguistic variables is used to model the state of the system which is imprecise and uncertain.

Fuzzy modelling consists of three phases: fuzzification, inference and defuzzification [29]. Fuzzification involves the transformation of fair input values. Fuzzy inference refers to definition of system behavior using rules. Defuzzification obtaines resulting values.

The purpose of fuzzification is to map the inputs (rate of unemployment and number of registered subjects) to values from 0 to 1 using a set of input membership functions. These input membership functions represent fuzzy concepts such as "high" or "low". Hereinafter, we use triangular function. Zhao evaluated different types of membership functions. The membership functions under consideration were triangular, trapezoidal, Gaussian, two-sided Gaussian, bell-shaped, polynomial-PI and sigmoidal. The results of the study indicate that triangular gives the best drive performance [18]. After the inputs are fuzzified, we know the degree to which each part of the antecedent is satisfied for each rule and we can perform fuzzy inference. If the antecedent of a given rule has more than one part, the fuzzy operator is applied to obtain one number that represents the result of the antecedent for that rule [17]. This number is then applied to the output function. The input to the fuzzy operator is two or more membership values from fuzzified input variables. To obtain the crisp number (UE index) as a result of a process we are performing defuzzification.

3.1. Data description

Data of unemployment rate and number of registered business subject in European Union for the period of 2004 to 2012 are collected from the Eurostat database [19]. Summary of the collected data is given in table 2. The choice of the length of the

period of the study depends solely on data availability. But first, we give full data consisting of unemployment rate and number of registered business subjects for Croatia in table 1.

	UEMP	BS
2004	18,0	178056
2005	17,9	178521
2006	16,6	189231
2007	14,8	196783
2008	13,2	204159
2009	14,9	198478
2010	17,4	201926
2011	17,8	195355
2012	18,9	200264

Table 1. Unemployment rate and number of registered business subjects in Croatia from 2004 to 2012 [19]

Table 2 summarises descriptive statistics for 24 EU countries, as far as the existing data allowed us. Only three countries are not included in our analysis. These are: Bulgaria, Latvia and Lithuania.

The results of descriptive statistics analysis for unemployment rate and number of registered business subjects in different EU countries show that highest value of unemployment rate in period from 2004 to 2012 was in Spain with amount of 24,80, whereas minimum value for the same period had Netherlands and it was value of 3,10. The dispersion statistics (standard deviation) indicator shows that the most homogenous country in terms of unemployment rate is Luxembourg, whereas most heterogenous is Spain. The minimum average value of UEMP in the nine year period has Netherlands, and the highest has Spain.

Since number of registered subjects is indicated in absolute value it is hard to compare. We can see that the miminal average number of registered business subjects has Luxembourg and maximum Spain.

In further analysis, we will calculate the values of underground economy index for 24 members´ state of the European Union (period 2004-2012) and based on these values we will compare results. Using indexes, we will comment the countries and see how Croatia stands in this context.

The data on underground economy index was constructed for annual time series for the period 2004 to 2012 using the fuzzy logic approach. Such a model consists of fuzzification, inference, and defuzzification [17]. In the present study, we follow closely the work of Draeseke and Giles because their approach was most cited in this field [12].

Country	UEMP min	UEMP max	UEMP average	UEMP StDev	BS min	BS max	BS average	BS StDev
BEL	7,00	8,50	7,86	0,55	394986	566006	466850	69456
CZE	4,40	8,30	6,74	1,22	856250	1007441	924266	61115
DNK	3,40	7,60	5,56	1,69	113993	216243	163137	45792
DEU	5,50	11,30	8,29	2,06	1667104	2189737	1922984	197678
EST	4,60	16,70	9,62	4,05	35806	58408	48006	7538
IRL	4,40	14,70	8,87	4,81	85638	168342	118587	35860
GRC	7,80	24,50	12,28	5,50	812745	833233	821986	11372
ESP	8,20	24,80	14,69	6,33	2457265	2814264	2527283	210570
FRA	7,40	9,80	8,82	0,72	2281820	2567431	2381699	150858
ITA	6,10	10,70	7,84	1,34	3740004	3948726	3854417	59290
CPY	3,70	11,90	5,96	2,57	45837	47854	46726	839
LUX	4,20	5,10	4,77	0,30	21202	29265	25793	2979
HUN	6,10	11,20	8,78	1,95	528519	573328	552893	12669
MLT	6,00	7,20	6,66	0,38	25998	28933	27386	1091
NLD	3,10	5,30	4,38	0,79	485200	862697	630711	145532
AUT	3,80	4,80	4,53	0,43	265090	308411	289904	14231
POL	7,10	19,10	11,69	4,29	1408402	1556438	1480482	46407
PRT	7,50	15,80	10,37	2,72	585065	943722	834048	102637
ROU	5,60	8,00	6,87	0,67	321750	506405	436943	55391
SVN	4,40	8,90	6,49	1,45	88736	119644	105190	11919
SVK	9,60	18,40	13,71	2,64	62497	414905	268916	188430
FIN	6,40	8,80	7,81	0,76	156293	226373	209643	24089
SWE	6,10	8,60	7,47	0,87	504565	661822	581430	53941
GBR	4,70	8,10	6,34	1,44	1531078	1730574	1651516	61925

Table 2. Descriptive statistics of the input variables

4. Empirical analysis

Estimates of the size of the underground economy in Croatia and settling it into European context have not been conducted so far. Since Croatia is in European Union from July 2013 we found it appropriate to compare Croatian underground economy index with European Union countries.

The first part of this section presents an analysis and results for underground economy index for Croatia and later, following the same principles and applying the same methodology, for European Union countries. To the best of our knowledge this study is first attempt to measure the underground economy in European Union using a fuzzy logic approach.

We choose factors with a major influence in terms of measuring the UE: unemployment rate and number of registered business subjects. First, we set up the membership functions for the two factors. Both factors are described using linguistic terms: Very Low (VL), Low (L), Normal (N), High (H), and Very High (VH). Each term is associated with membership functions. The boundaries of membership functions are calculated by using the moving average of the past consecutive years (for term Normal) and by adding or subtracting one or two standard deviations (SD) as seen for factor UEMP in table 3.

UEMP: uneployment rate				
Very Low (VL)	Low (L)	Normal(N)	High(H)	Very High(VH)
Mean-2SD	Mean-1SD	Mean	Mean+1SD	Mean+2SD

Table 3. Linguistic terms of UEMP

In this way two sets, each of five numbers corresponding to UEMP and BS are generated for each year. Consider the data from table 1 for year 2010. Value for UEMP is 17,4 which is somewhere between normal and high. How normal and how high it is depends on its location relative to the boundaries. In fuzzy logic the establishment of levels of associations is achieved by using *membership functions*. Membership functions are presented in table 4 and figure 1. UEMP in 2010 has following values of membership functions for the categories: HIGH= 0.0883 and NORMAL=0.91169.

$\mu_{VL}(x) = 1.0$	$if\ x \leq Mean \quad 2SD$
$\mu_{VL}(x) = \frac{Mean \quad SD \quad x}{SD}$	$if\ Mean \quad 2SD \leq x \leq Mean \quad SD$
$\mu_{L}(x) = \frac{x \quad Mean + 2SD}{SD}$	$if\ Mean \quad 2SD \leq x \leq Mean \quad SD$
$\mu_{L}(x) = \frac{Mean \quad x}{SD}$	$if\ Mean \quad SD \leq x \leq Mean$
$\mu_{N}(x) = \frac{x \quad Mean + SD}{SD}$	$if\ Mean \quad SD \leq x \leq Mean$
$\mu_{N}(x) = \frac{Mean + SD \quad x}{SD}$	$if\ Mean \leq x \leq Mean + SD$
$\mu_{H}(x) = \frac{x \quad Mean}{SD}$	$if\ Mean \leq x \leq Mean + SD$
$\mu_{H}(x) = \frac{Mean + 2SD \quad x}{SD}$	$if\ Mean + SD \leq x \leq Mean + 2SD$
$\mu_{VH}(x) = \frac{x \quad Mean \quad SD}{SD}$	$if\ Mean + SD \leq x \leq Mean + 2SD$
$\mu_{VH}(x) = 1.0$	$if\ x \geq Mean + 2SD$

Table 4. Membership functions

Next, we create decision rules that will determine how particular levels of association for each of UEMP and BS are combined to establish the levels of association for UE. Fuzzy rules are presented in table 5.

Rule	UEMP	BS	UE	Degree
1	VH	VL	VH	1.0
2	VH	L	VH	0.8
3	VH	N	L	1.0
4	VH	H	L	0.8
5	VH	VH	A	0.8
6	H	VL	VH	1.0
7	H	L	H	1.0
8	H	N	H	0.8
9	H	H	A	1.0
10	H	VH	L	1.0
11	N	VL	H	1.0
12	N	L	H	0.8
13	N	N	A	1.0
14	N	H	L	0.8
15	N	VH	L	1.0
16	L	VL	H	1.0
17	L	L	A	1.0
18	L	N	L	0.8
19	L	H	L	1.0
20	L	VH	VL	1.0
21	VL	VL	A	0.8
22	VL	L	L	0.8
23	VL	N	L	1.0
24	VL	H	VL	0.8
25	VL	VH	VL	1.0

Table 5. Fuzzy rules

This rules are easily human understandable. For example, the first rule

IF UEMP=VL AND BS=VL THE UE=VH

says:

If Unemployment is Very High and number of registered Business Subject is Very Low then the level of Underground Economy is Very High.

The column Degree in table 5 quantifies level of association for the UE. For instance, continuing with 2010 as an example, Rule 8 associates UE with HIGH at a degree of 0.8. This degree suggests that UE is not perfectly associated with HIGH.

The last phase of the analysis involves calculating numeric series for UE. This is achieved by assigning values of 0.0, 0.25, 0.5, 0.75 and 1.0 to the levels Very Low, Low, Normal, High and Very High for UE. Since there are two values for both factors, UEMP and BS, four rules are active for each UE value generated. For example of 2010 the associating values for the four different levels of magnitude are:

UEMP	HIGH	NORMAL
	0,0883	0,7117
BS	HIGH	NORMAL
	0,9117	0,2883

Now we can form four possible combinations, as follows:

UEMP/BS	**Rule**	**UE level [MIN (UEMP, BS)]**	**UE, MAX**
H/H	9	N: 1*0,0883=0,0883	drop
H/N	8	H:0,8*0,0883=0,0707	
N/H	14	L:0,8*0,7117=0,5694	
N/N	13	N:1*0,2883=0,2883	

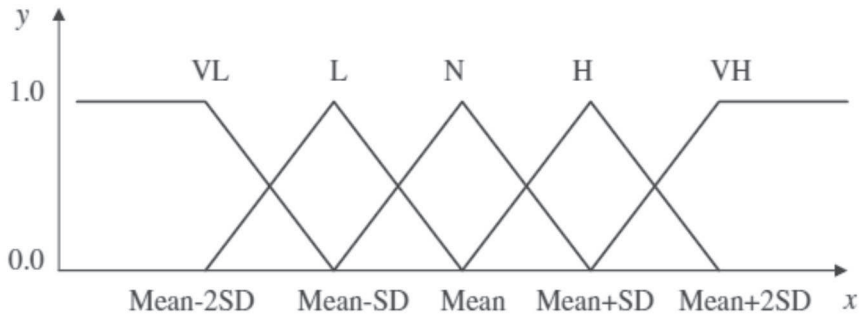

Figure 1. Membership function

The final step is to assign values for the UE levels. These levels have been set to: 0.0, 0.25, 0.5, 0.75 and 1.0, linked respectively to the levels: Very Low, Low, Normal, High and Very High.

For year 2010 we proceed as follows:

Level	**Value**	**Weight**
High	0,0707	0,75
Normal	0,5694	0,5
Low	0,2883	0,25

To obtain resulting numerical value we are conducting defuzzification by using COA (Center of Area) principle:

$$\frac{0{,}0707 \quad 0{,}75 + 0{,}5694 \quad 0{,}5 + 0{,}2883 \quad 0{,}25}{0{,}0707 + 0{,}5694 + 0{,}2883} = \mathbf{0,3657}$$

COA defuzzification method was used because it is the most commonly used defuzzification method. Furthermore, Naaz et. el. [20] compared five defuzzification methods: Largest of maximum, Smallest of maximum, Mean of maximum, Bisector of area and Center of Area. Their comparative analysis revealed Center of Area as the best method.

For the index value for UE to lie in the interval [0,1] the sum of the weights (i.e. the association values) must equal 1.0, which is accomplished by dividing by their sum. E.g. the UE index value of 0.3657 indicates that for 2010 in Croatia the willingness of agents to "go underground" was less than neutral. An average agent, on balance, would tend towards working openly and above-board.

Procedure shown here for 2010 was carried out for all other years. Results are presented in table 6.

Year	UE index
2004.	0,8079
2005.	0,7941
2006.	0,4997
2007.	0,2207
2008.	0,2259
2009.	0,2228
2010.	0,3657
2011.	0,5136
2012.	0,5367

Table 6. Estimated index for the underground economy in Croatia

Change of the underground economy index in the last decade is presented at figure 2.

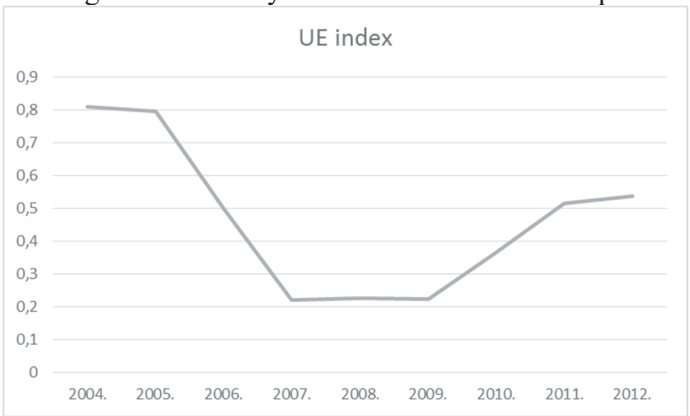

Figure 2. Croatian UE index flow through the years

Figure 2 clearly indicates highest level of UE index in the last decade was in 2004. Since 2004 till 2007 level of the underground economy is decreasing. In year 2007 UE index starts to increase till 2012. Two years ago the level of the underground economy was slightly lower than in 2012.

Reasons behind the largest index in 2004 in the last decade can be found in fact that in 2004 unemployment rate was very high and number of registered business subject was very low. Also, there were none State regulation in the field of unregistered activity. In recent years through state regulation in terms of legislation and the possibility of cheaper business subject`s registration, index of the underground economy was significantly reduced. If the state law has been brought before there might be lower index of underground economy today. Due to the fact that Croatia has recently become a new member of the EU, we prefer to compare the size of Croatian underground economy with the other members of the EU.

Table 7 presents the estimates for the 24 European Union countries calculated in this research study.

Country	'04	'05	'06	'07	'08	'09	'10	'11	'12
BEL	0,76	0,78	0,64	0,49	0,33	0,70	0,46	0,20	0,13
CZE	0,68	0,75	0,79	0,27	0,25	0,42	0,42	0,42	0,34
DNK	0,74	0,59	0,45	0,43	0,44	0,35	0,47	0,47	0,47
DEU	0,79	0,70	0,75	0,62	0,46	0,37	0,35	0,20	0,16
EST	0,79	0,64	0,29	0,19	0,24	0,65	0,34	0,55	0,23
IRL	0,49	0,29	0,46	0,46	0,52	0,41	0,50	0,45	0,45
GRC	0,60	0,43	0,34	0,32	0,25	0,57	0,78	0,89	0,83
ESP	0,46	0,29	0,26	0,24	0,15	0,50	0,53	1,00	0,71
FRA	0,75	0,65	0,57	0,19	0,25	0,83	0,46	0,40	0,34
ITA	0,78	0,59	0,36	0,18	0,10	0,37	0,44	0,59	0,57
CPY					0,16	0,34	0,56	0,77	0,74
LUX	0,89	0,60	0,54	0,25	0,57	0,61	0,30	0,25	0,46
HUN	0,17	0,32	0,52	0,43	0,12	0,57	0,59	0,72	0,98
MLT					0,43	0,60	0,40	0,34	0,40
NLD	0,75	0,80	0,69	0,42	0,34	0,33	0,30	0,25	0,35
AUT	0,94	0,88	0,64	0,47	0,08	0,62	0,31	0,05	0,16
POL	0,61	0,89	0,66	0,39	0,09	0,48	0,40	0,25	0,25
PRT	0,74	0,34	0,35	0,38	0,23	0,31	0,56	0,73	0,51
ROU	1,00	0,47	0,60	0,33	0,03	0,23	0,50	0,63	0,52
SVN	0,70	0,75	0,57	0,36	0,18	0,40	0,44	0,46	0,35
SVK					0,41	0,58	0,42	0,32	0,38

FIN	0,79	0,94	0,52	0,20	0,11	0,53	0,53	0,34	0,46
SWE	0,71	0,77	0,55	0,44	0,26	0,69	0,49	0,36	0,38
GBR	0,48	0,25	0,46	0,32	0,16	0,61	0,75	0,50	0,51

Table 7. Underground economy index for EU countries

During the analysing of the collection of European Union countries UE index for 2004-2012, the obvious question arose of how these compared with the level in other European countries. Does the level rise, as so often assumed, from north to south in Europe – and if so, how much? And are there differences in the level of black activities between the relatively similar welfare states of northern Europe, so that, for example, in countries (like Denmark for instance) with high direct taxation of earned income, relatively more people choose to work outside the tax system than in Croatia?

Results suggest that the underground economy labour force in Croatia is somwhere in the middle (11th lowest) in 2004-2012 when compared with the figures achieved by other European countries. Sweden, for example, had a quite large underground economy labour force in the observed period. The lowest average value had Slovakia. In addition, we associate our results with the global economic crisis because we have reasons to believe in the correlations between those two parameters. The world crisis began in 2007. Although it has been developed over a long time 2007 was year of the beginning of the financial crisis in the world. Crisis tentatively caused problems in the European banking system and caused the collapse of the European Monetary Union in 2009 consequently pinpointing basic economic problems: growth of unemployment and fall in GDP. The rate of the underground economy deepens its value and shapes in times of crisis. Based on our calculations, the rate of the underground economy was moving differently in the countries of the European Union in the period of 2004-2012.

During a period of economic crisis (2009-2012) the highest rate of the underground economy, in the beginning of the crisis, had the following countries: Belgium, Greece, Spain, France, Cyprus, Luxembourg, Hungary, Malta, Slovakia, Finland, Austria , Sweden, UK, while some countries this year have not yet entered into a crisis, such as Romania, whose index of the year 0,228. The Republic of Croatia in 2009 had relatively low UE index. In 2010 started to grow. With regard to our calculations and estimation the underground economy from the economic crisis came out in Austria and Germany and Poland.

Based on the results, we classified countries in three groups: countries seems to emerged from the crisis (Germany, Sweden, Belgium, Czech Republic, Netherlands, Austria and Poland), countries still in the crisis (Greece, Spain, Hungary and United Kingdom) and countries with oscillating UE index (Denmark, Estonia, Ireland, France, Italy, Luxembourg, Portugal, Romania, Slovenia and Finland).

Graphical representations of UE index movement for each group is presented in figures 3, 4 and 5.

Figure 3. UE index flow through the years for first group

UE index flow for first group of the countries is presented in figure 3. First group is consisted of countries with the trend of, mostly, decreasing level of underground economy for the period 2004-2012. We belive those are countries that experinced crisis the least.Germany is only country with almost linear decrease in the whole period from 2004 till 2012. There are only two slight exceptions in 2005 and 2010. The similar trend is noticed in the case of Netherlands. However, Netherlands UE index growth in the 2013 is worrying.

Belgium, Czech Republic, Austria, Poland and Sweden had two points of UE index growth which we associate with the peak of the highest crisis in these countries.

Figure 4. UE index flow through the years for second group

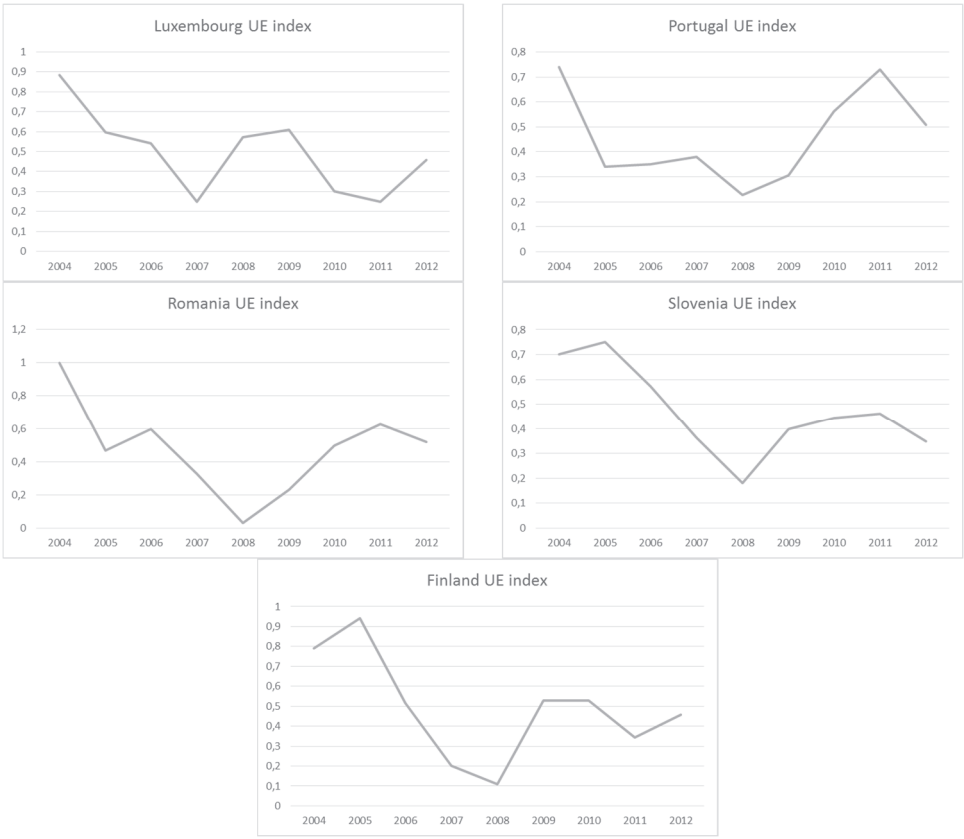

Figure 5. UE index flow through the years for third group

Second group (figure 4) consists of the countries that have not yet came out of the crisis. In the worst position seems to be Greece and Spain. The best trend has Denmark which, during the entire period, did not have big bouncing but the level of UE is relatively constant.

Justification of this kind of division and driven conclusions comes from latest evidence in literature from Leaven and Valencia [21] and Oreski and Pavkovic [22]. They indicated Greece, Spain, United Kingdom and Denmark as countries affected by the systematic banking crisis between 2007 and 2011, and Hungary as country that experienced borderline systematic crisis.

The third group (figure 5) consists of countries with the most changes in terms of changing the directions of UE index (decreasing and increasing) and it is difficult to identify the patterns. For instance, in Italy, Portugal, France, Romania, Slovenia and Finland it is visible beginning of the UE index growth in 2008, and the beginning of fall around 2011. UE index of Estonia, Ireland and Luxembourg is fluctuated in the observed period.

Hereinafter, we focus on the Croatia and analyze the types of unregistered activities and legislation taken for the reduction.

5. Unregistered activities

The Act on the Prohibition and Prevention of carrying out unregistered activities [5] defines what is considered to be unregistered activity, who has the authority for combating unregistered activities and supervise the implementation of this law: implementation of administrative measures and criminal legal sanctions

At the time of adoption of this Act supervision over implementation of the same was in the jurisdiction of the State Inspectorate, which is under the Ministry of Finance from 01.01.2014 [23].

Since the implementation of the Act started in the 2011th the question to be asked is: "Who did control unregistered activity in the period until the adoption of the Act and are there differences in the rate of the underground economy before and after the adoption of the Act?" The answer to this question is difficult to give, but we could conclude that until the adoption of the Act , this kind of employment in the economy was not defined and therefore there were no sanction for it, which can be seen on the basis of the calculated index of the UE in the initial years of the analysis. If the state regulation began earlier index rate of UE today would probably be much lower. Only one similar regulations which came to the application before than the *Act on the Prohibition and Prevention of carrying out unregistered activity* was *Act on Trade and Commerce* [5], [24] which defines *craft* as economic activity of buying and selling goods and/or services and *retailer* as company or person registered for this activity. But, given the fact that this regulation did not clearly define business services, and the method of proofing such activity was difficult.

The table 8 shows the achieved results in the area of identifying unregistered activities by the State Inspectorate in the period of the application of *Act on the Prohibition and Prevention of carrying out unregistered activity* [25],[26].

Achieved results	2011	2012
Number of inspections	1095	2163
Number of offenses	318	488
Decision prohibiting	561	369
Measures of seizure of goods	21	22

Table 8. Results of inspections unregistered business

Based on the data presented in the table we can conclude that the number of controls in unregistered business over a period of nearly two years increased one, and the number of identified violations increased too. Adoption of the Act significantly increased the actions aimed at combating the underground economy. Therefore, we

can conclude: if Act was adopted much earlier, UE index would probably be lower, which would have an impact to other negative trends in the economy (unemployment, number of the closed companies, social exclusion, individual decline in GDP).

The analysis of all indicators leads to the conclusion that the state legislation reduces the volume of the underground economy. Results would be better if the same action was conducted much earlier, and the psychological factor of the effects on population would be higher.

6. Measures to reduce the impact of the underground economy

This chapter gives comparative analysis of the methods of registration of a company or business which would improve economic recovery and reduce the UE index. Furthermore, the State should devote greater role to raising awareness of population and encourage them for registration of their activities by financial incentives available to them (the incentives for self-employment), providing cheap education, with the availability of timely and specific information and reducing costs or expenses (registration taxes and costs).

6.1. Registration craft

According to *Crafts Act* [27], the craft is considered to be independent and permanent pursuit of economic activities for the purpose of achieving profit through production, marketing or by providing services on the market. Craftsman is person who performs one or more of the activities in its own name and for its own account. Some activities persons can register as a cottage industry such as services of making jewelry, souvenirs, (services that people do by their own work, or as a secondary occupation activities which includes maintenance and repair).

Homecraft and secondary occupation people can register if they do not achieve revenue of more than ten average gross salaries, at the level of the average gross salary in Croatia.

There are three basic types of crafts [13]:

1. Free crafts which performance do not require professional qualification exam or master's exam. (for example to perform a hairdressing business people must have passed the master exam, which can be taken after a three years of working experience)
2. Related craft is the types of craft that can be registered by craftsman when he/she has a professional qualification.
3. Preferential craft is a type of craft which requires license or privilege issued by the competent Ministry.

When comparing these types of crafts, related crafts have the biggest obstacles in process of registration. The problem is in the necessary qualifications in terms of secondary education where often a craftsman who wants to open a business does not have sufficient qualifications. This obstacles lead to growing index of UE.

However, registration of craft gives some advantages in comparison to other forms of registration activities. The benefits of craft are: low cost of registering, there is a possibility of rasing money from giro, maintain business books is simple, craftsman can alone maintain business books, so it is cheaper. Furthermore, value-added tax is paid only when it is actually charged from customers, it is cheaper and easier to modify data such as address, name and crafts activities. When we talk about the disadvantages, it is important to note that a craftman for obligations corresponds alone with all its assets, income tax is paid in accordance with the tax rates on salaries, which are from 12% till 40% there is the impossibility of carrying out all activities because some require appropriate qualifications, as noted earlier.

6.2. Registering of the company

A company is a legal entity. There are the following types of companies: public company, limited partnership, joint stock company, limited liability company, and simply company [29].

To open a company registration at the Commercial Court is required. A company that wants to do business on the Croatian territory must have an address in the Republic of Croatia. The company's name is name on which the company operates.
The following are the advantages of registering a company: the owner or director is responsible for the company up to the amount that is invested (today for simply company it can be just 10,00 kunas). Company pasy the income tax of 20 % for the year, the company, as a legal entity, is independent of the owner, allows registration of any activity, there can be an unlimited number of activities regardless of the education level. However, the real performance of some activities there is a need to hire workers who have the appropriate qualifications.

The main disadvantage of registering the company is a large amount of money for a deposit, it is very expensive and time consuming process of closing the company. Furthermore, value-adde tax needs to be paid at the time when the company issues a bill, no matter if the amount for which the company has released a bill has not yet been paid. Bussiness books maintaing requiress additional costs because they have so called dual accounting. The owner can not raise money from the account without the paper justification. The biggest problem with the registration of any type of activities in Croatia are high costs at the beginning.

The Croatian Government's Guidelines for the implementation of active employment policy in 2014 [29] defines methods and measures for minimization of underground economy index. This should be achieved through a variety of support programs and support for self-employment in the form of irreversible financial resources and politics of connectivity between buyers and producers of services and products.

7. Conclusion

The paper empirically investigated the size of the Croatian and European Union underground economy by employing fuzzy logic approach over the period from 2004

to 2012. The paper has also attempted to compare the Croatia figures obtained from these approaches with 24 European Union countries. The estimated size of the UE index in Croatia varied from 0,8079 in 2004 to 0,2207 in 2007. Although the level of the underground economy declined in the period from 2004 to 2007, this has not been continued and later given a high level of unemployment. Underground economy index for the European Union countries fluctuate between 1 (for Romania in 2004 and Spain in 2011) and 0,0285 (for Romania in 2008).

Current economic gap in Croatia and the high rate of unemployment which is visible even in 2013 and 2014 shows a declining trend and affects a further increase in the volume of the underground economy in the form of performing illegal activities. Measures of state policy aimed to solve this problem are not sufficiently strong. Furthermore there is a huge gap in legislation, since there is a large amount of legislation which leads to misunderstandings and their unenforceability. Our study of UE index movement in different economies show that in all of them part of economic activities is ignored from the economic statistics and that even developed countries are not invulnerable from black activities. The application of the fuzzy logic approach to the wide European context and the econometric estimation of the European Union underground economy profile show that this approach have some appealing features regarding the analysis of underground economy activities. Fuzzy modeling shown to be a powerful tool for solving this problem where information is vague, ill-structured and uncertain. Furthermore, this is a first attempt to deal with underground economy in Croatia from scientific point of view, as well as the inclusion of a large number of countries in the calculations. Furthermore, the application of the fuzzy logic approach to the European economy has helped in measuring the size of the underground economy. Due to the complexity involved in capturing every facet of the underground economy, coupled with the lapses in the existing approaches used in measuring the underground economy, it is fair to say that the estimates may be subjective. The estimates for the size of the underground economy could be improved by including other variables. The results obtained in this study may have important implications for both monetary and fiscal policy design. Relationships between underground economy and variables presented here may be important for policy making.

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