THE SIZE OF THE SHADOW ECONOMY AS AN INDICATOR OF TAX COLLECTION EFFICIENCY

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Veľkosť tieňovej ekonomiky ako ukazovateľ efektívnosti výberu daní

Abstract: *The aim of the paper is to point out the relationship between the efficiency of tax collection (on the basis of the results obtained in the DEA analysis and other economic indicators) and the volume of the shadow economy, through regression analysis. The attention is paid to the effectiveness of tax collection from both sides – taxpayers and tax administrators. One of the requirements for an effective tax collection system is to minimise the associated costs, as well as to eliminate the tax evasion. Measuring the effectiveness of tax collection is relatively demanding. A wide range of opinions and attitudes to this issue published in recent years has shown that the issues of effective tax collection are more than just current.*

Keywords: *shadow economy, tax administration, collection of taxes, efficiency, DEA, panel regression analysis*

JEL Classification: H 20, H 26, O 17, C 21

1. Introduction and Literature Review

In the recent years there has been given a considerable attention to effective tax collection not only at the theoretical but at the practical level too. While theoreticians are looking for possible approaches of measuring effective tax collection, while justifying the substantiation of a specific approach, national and international financial institutions pay attention to estimating the loss of public revenue or even quantifying the level of tax evasion.

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Taxation affects not only the economic decisions of taxpayers regarding consumption or labour, but also their investment activities in the long run. Therefore, it is very important that the tax system is not "set up" in such a way that a taxpayer will prefer to spend fewer funds for avoidance than raising work or investment efforts. The result would be the creation of a space for tax evasion, which reflects on the ineffective tax collection.

Measuring the efficiency of tax collection as well as the efficiency of the whole public finance area is relatively difficult. Various approaches to this issue can be traced in the available literature. A wide range of opinions and attitudes show that the issue of effective tax collection is becoming more and more prevailing. This paper will focus on the effective tax collection, both from the point of view of taxpayers and tax administrator, as well as the linear relationship via panel regression between the effectiveness of tax collection, tax evasion, GDP per capita, and the size of the shadow economy.

The problem of measuring effectiveness was developed by *Farell* [9], who measured public finance efficiency as a relative distance from a certain efficiency limit. This method is known as empirical or relative efficiency.

The approach to measuring the efficiency of tax collection with an emphasis on direct administrative costs (tax administrator) is dealt by *Alm and Duncan* [3], *Crandall* [6] or *Galagher* [10].

The measuring of effective tax collection with an emphasis on indirect administrative costs for taxpayers we can find processed by *Alm, Bahl and Murray* [2] *Eichfelder and Schorn* [8] or *Pope and Rameste* [15].

The selected input and output parameters pointed to the fact that the efficiency of tax collection from both (the taxpayer’s and the taxpayer’s) point of view can be achieved through the optimal combination of the selected parameters, thus ensuring not only cost efficiency but also the administrative simplicity.

Several authors, as *Cremer and Gahvari* [7], *Martinez* [13], *Sandmo* [17] or *Schneider and Enste* [23] emphasize the *important relationship between the issue of tax collection efficiency, tax evasion, and the size of the shadow economy.*

Nonparametric DEA analysis to measure efficiency was introduced by *Charnes, Cooper, and Rhodes* [5], their approach was referred to as the CCR model. The primary aim of DEA is to compare the efficiency of homogeneous units, while their homogeneity does not represent the uniformity of outputs but the identity of the input parameters. Observed units, whose activity is rated by DEA, can be labelled as Decision Making Units (DMUs). Each unit uses certain inputs and the results of the activity are outputs.

The DEA (Data Envelopment Analysis) method is used in the current literature to measure the effectiveness of certain activities in the public sector. For example, *Savić, Dragojlović, Vujošević, Arsić, and Martić* [18], analyzed the performance of tax administration in 13 European countries for 2012.

The volume of the shadow economy is influenced by other factors, in addition to the efficiency of tax collection. This issue has been dealt with *Kanniainen, Pääkkönen, and Schneider* [12].

2. Hypothesis, Methodology and Data

Applying individual tax measurement efficiency approaches requires the use of econometric models or approximate methods.

Based on the research by *Savić, Dragojlović, Vujošević, Arsić*, and *Martić* [18], we used the DEA method for a comparative analysis of the tax collection efficiency in selected countries over a certain time period.

A representative sample of countries consists of selected OECD countries classified by the World Bank as the high-income countries where GNI is set at $12,056. Some OECD countries (Mexico and Turkey) do not meet this condition and are therefore classified by the World Bank as the middle-income countries. Considering this fact, the representative sample of countries does not include all OECD members. We assume the high economic development in a representative sample of countries, as well. This acts as a determinant of effective tax collection.

The aim of the paper is to look at the link between the efficiency of tax collection (on the basis of the results obtained in the DEA analysis and other economic indicators) and the volume of the shadow economy, through regression analysis.

The regression will be based on panel data and will be considered a basic regression model using panel data:

$$y_{it} = \beta_1 x_{it} + \beta_2 x_{it2} + \cdots + \beta_k x_{itk} + \alpha_2 z_{i1} + \alpha_2 z_{i2} + \cdots + \alpha_q z_{iq} + u_{it} \quad (1)$$

where *i* denotes a cross-sectional unit, *t* represents the time value, $x_1, \ldots, x_k$ represents individual independent variables. $z_1, \ldots, z_q$ are variables representing the individual effects through which the country can be differentiated from a group of countries.

The correlation of random error values, referred to as autocorrelation of random errors, will be eliminated by two methods using a variation–covariance matrix that is consistent even if heteroskedasticity occurs (this may occur if the random error variance is not constant) and autocorrelation to estimate the standard regression coefficient errors. Both of these methods can be used for estimation using a combined regression model as well as a regression model with fixed or random effects. In addition to removing autocorrelation, these estimators are also used to remove heteroskedasticity. [1]

We used the input-oriented CRS DEA model, which was chosen because it more appropriately distinguishes between efficient and inefficient units (monitored states).

The input variables in the DEA analysis were:

a) the share of the cost of tax administration on total tax revenue (*TaxAdCosts*);
b) the share of wage costs on total direct administrative costs (*SalToTotalExp*);
c) the number of tax payments per year (*TaxPaym*);
d) the time required to comply the tax liability (*TimeToComply*).

The output variable was the average income from the tax audit (RevPerAudit), which we expressed as the average amount of the post-paid tax and the fine for one tax audit.

The choice of input variables and output variable was made because the efficiency of tax collection is achieved not only by minimizing the direct administrative costs of the tax administrator represented by parameters a) and b) but also by ensuring the lowest indirect administrative costs of the taxpayers expressed in parameters c) and d).

A suitable combination of these parameters can make it possible to increase the efficiency of tax collection from the point of view of the tax administrator and the tax subject.

Based on the assumption that *an efficiently set tax collection system* (*DEA*) contributes to a reduction of the extent of the unrecognized income, it is possible to determine *the hypothesis that the variable DEA will have a negative effect on the explained variable size of the shadow economy.*

The verified hypothesis is based on the linear function of the shadow economy, while Peter [14] states that this function based on several empirical studies, is derived from a) the official tax burden, b) the rate of administrative controls (the efficiency of tax collection that reduces the possibility of tax evasion), c) macroeconomic volatility, and d) socio-economic development. The author adds that a non-linear dependency between taxes and government services can lead to a disruption of the linear function of the shadow economy. Therefore, we used – to eliminate this phenomenon – the explanatory variable GDP per capita, which is discussed in the following sections of this article.

The correlation relationship may also be reversed, the size of the shadow economy affects the volume of tax evasion and hence the efficiency of tax collection. Schneider and Buehn [21] argue that while the shadow economy and the tax evasion may not be congruent, activities in the shadow economy can help increase tax evasion and hence negatively impact the efficiency of tax collection [16]. Considering the above, we have also decided to verify the impact of the size of the shadow economy on effective tax collection (in our case the DEA variable) through regression analysis.

The explanatory variable *GDP per capita* (*GDPpercapita*) indicates the status of the economy of the observed state. The higher GDP per capita causes higher development of the economy in the monitored country. We assume that in a more developed economy there is a smaller size of the shadow economy, and therefore it is possible to expect *the negative effect of this explanatory variable on the explained variable.* The variable GDP per capita was also used by Schneider and Buehn [21] in their empirical study as an indicator of the size of the shadow economy. *The study assumes that increasing shadow economy lowers the officially reported GDP***.** As a reason they said that the larger shadow economy causes the lower tax revenue, which would cause the lower government's ability to provide public goods and services, which will result in the level of economic performance. As mentioned above, Peter [14] states that nonlinear dependence between taxes and government services can lead to a disruption of the linear function of the shadow economy.

Unemployment rate (*Unemp*) is one of the standard factors used in econometric models to estimate the extent of the shadow economy, for example by Schneider and Enste [23], or Schneider, Büehn and Montenegro [22]. Higher level of unemployment contributes to the growth of illegal undeclared work, which is part of the shadow economy. For this reason, we assume *the positive impact of the unemployment level – as an explanatory variable – on the size of the shadow economy.*

In the model the size of the shadow economy (*GreyEcon*) is used as a dependent variable, because it is affected by independent variables. Shadow economy (*GreyEcon*) represents the part of the economy of a given country that is not officially statistically reported and generates income that is not taxed. *The size of the shadow economy is expressed as % of GDP of the state,* based on research by Schneider [19, 11].

As variables affecting the shadow economy were considered for example the proportion of direct and indirect taxes, tax morality, GDP per capita and others.

For the purposes of compiling the econometric model, we have chosen as explanatory variables:

a) the effectiveness of tax collection (*DEA*),
b) GDP per capita (*GDPpercapita*),
c) unemployment (*Unemp*).

3. Results

Value of the achieved DEA score reflects the higher efficiency of tax collection based on the selected efficiency parameters. The DEA results were the basis for regression analysis using panel data.

Table 1

Overview of the achieved DEA score for 2010 – 2013

DMU	DEA score			
	2010	**2011**	**2012**	**2013**
Australia	0,30	0,34	1,17	0,96
Belgium	0,47	0,62	0,09	0,10
Canada	0,44	0,45	1,32	0,67
Estonia	0,07	0,25	1,15	2,52
Finland	0,27	0,25	0,63	0,49
France	0,37	0,35	0,68	0,51
Hungary	0,21	0,16	0,45	0,44
Japan	0,07	0,06	0,14	0,13
Netherlands	0,08	0,07	0,15	0,11
New Zealand	0,39	0,26	0,88	0,60
Poland	0,03	0,03	0,11	0,10

Portugal	0,02	0,02	0,07	0,06
Slovakia	0,20	0,21	0,12	0,19
Slovenia	0,12	0,07	0,48	0,26
Sweden	0,08	0,08	0,22	0,13
USA	0,13	0,10	0,29	0,19

Source: own processing based on EMS output.

Through the regression model, it was possible to point out the relationship between the efficiency of tax collection – as an input variable – and the scope of the shadow economy as an output variable. Tax evasion was considered to be one of the manifestations of the shadow economy.

One of the first regression analysis steps was to determine the occurrence of multi-collinearity between the explanatory variables, using the variance inflation factor, the results of which is the following table.

Table 2

The variance inflation factor between explanatory variables

VIF	
DEA	**1,042**
GDPpercapita	**1,638**
Unemp	**1,691**

Source: own processing based on Gretl output.

Since in none of the cases has the value of the variance inflation factor exceeded 10, the multi-collinearity between the explanatory variables was not present.

For panel regression based on panel data analysis, one of three models can be used:

a) pooled OLS model;
b) fixed effects model;
c) random effects model.

On the basis of the results of the three tests to select the appropriate model shown in Table 3, a regression model with fixed effects came out as most appropriate.

Table 3

Results of tests to select the appropriate model

F-test	F(15, 45) = 1538,17 with p-value 8,88069e^{-056}	We reject $H_0$and we accept the hypothesis H_1; fixed effects alternative is better than pooled OLS model.
Breusch-Pagan LM test	LM = 89,9885 with p-value = prob(chi-square(1) > 89,9885) = 2,39544e^{-021}	We reject H_0 and we accept the hypothesis H_1; random effects alternative is better than pooled OLS model.
Hausman test	H = 8,07584 with p-value = prob(chi-square(3) > 8,07584) = 0,0444701	We reject H_0 and we accept the hypothesis H_1; fixed effects alternative is better than random effects model.

Source: own processing based on Gretl output.

To eliminate the possible occurrence of autocorrelation and heteroskedasticity in the model, the Beck and Katz estimator was used. In Table 4 are the results of the estimation of individual parameters of the independent variables, where the results obtained by using all types of models are also presented for comparison.

Table 4

Estimation of regression coefficients

16 cross-sectional units Time-series length = 4 Dependent variable: Ygreyeconomy Beck-Katz standard errors			
	Pooled	**Fixed effects**	**Random effects**
constant	**29,12130** (2,00e^{-09}***)	**26,45420** (2,20e^{-012}***)	**26,66820** (7,61e^{-038} ***)
DEA	**1,739040** (-0,1743)	**−0,278539** (0,0014***)	**−0,258237** (0,0003***)
GDP per capita	**−0,000493012** (3,25e^{-09}***)	**−0,000287106** (1,49e^{-07}***)	**−0,000294158** (9,57e^{-022} ***)
Unemp	**0,3632240**	**−0,0874052**	**−0,0840002**

	(0,0991*)	(0,0252**)	(0,0184**)
Meandependent var	15,37	15,37	15,37
Sum sqared resid	948,11	1,85	1 460,21
LSDV R-Squared		1,00	
R - squared	0,64		
F (3 ,60)	35,73		
Log – likelihood	−177,07	22,66	−190,89
Schwarz criterion	370,78	33,69	398,42
Rho	0,96	0,02	
S. D. Dependent var	6,48	6,48	6,48
S. E. of regression	3,98	0,20	4,89
Within R-Squared		0,86	
Adjusted R – squared	0,62		
P – value (F)	0,00		
Akaikecriterion	362,14	−7,33	389,78
Hannan – Quinn	365,54	8,83	393,18
Durbin-Watson	0,04	1,28	

Source: own processing based on Gretl output.

The correctness of the use of the regression model with fixed effects was confirmed by the Akaike criterion, which measures the relevance of fit of an estimated modeland a Schwarz criterion that measures the efficiency of the model with parameters in terms of fitting the data.

Based on the results obtained, the resulting regression model with fixed effects can be expressed as:

$$GreyEcon_{i,t} = \alpha_i - 0{,}278539DEA_{i,t} - 0{,}000287106GDPpercapita_{i,t} + 0{,}0874052\ \text{Unemp}_{i,t} + u_{i,t} \quad (2)$$

All explanatory variables were statistically significant, although at different levels of significance.

Since fixed effects are present in the model, the level constant gets specific values for each country. The values of the level constant are shown in Table 5.

Table 5

Level constant for countries

Country	Constant
Australia	23,2037
Belgium	29,7670
Canada	24,5028
Estonia	36,8816
Finland	25,9012
France	22,5465
Hungary	30,2825
Japan	19,7475
Netherland	23,4878
New Zealand	19,1329
Poland	32,0965
Portugal	28,2249
Slovak Republic	24,5602
Slovenia	32,8456
Sweden	27,8392
USA	22,2467

Source: own processing based on Gretl output.

The results of the regression analysis indicated that all independent variables used in the model were statistically significant. The independent variables *GDP per capita* and *Unemp* can be considered statistically significant, although the statistical significance of the *Unemp*variable is at a lower level of statistical significance (0.05). *A statistically significant variable is DEA*, which expresses tax collection efficiency, and reduces the size of the shadow economy at 0.01 level of statistical significance. If the *DEA* variable is incremented by one unit, the explained *GrayEcon* variable drops by 0.28% of its original value. Also, the two remaining independent variables reduce the size of the shadow economy.

Within R-squared, the value was 0.86, which concluded that 86% of the total variability of the dependent variable is explained by independent variables, and the remainder is attributed to the influence of a random component or variables not in the model.

As was mentioned, the relationship between the size of the shadow economy and the effective tax collectiom is not just one-way, but the shadow economy can also have an impact on effective tax collection. In the following tables we estimate the regression model when the dependent variable is the efficiency of tax collection (DEA) and the independent variable is the size of the shadow economy.

Table 6

Results of tests to select the appropriate model

F-test	F(15, 47) =3,85463 with p-value 0,000193121	We reject H_0 and we accept the hypothesis H_1; fixed effects alternative is better than pooled OLS model.
Breusch-Pagan LM test	LM = 6,38543 with p-value = prob(chi-square(1) > 6,38543) = 0,0115061	We reject H_0 and we accept the hypothesis H_1; random effects alternative is better than pooled OLS model.
Hausman test	H = 11,8206 with p-value = prob(chi-square(3) > 11,8206) = 0,000585781	We reject H_0 and we accept the hypothesis H_1; fixed effects alternative is better than random effects model.

Source: own processing based on Gretl output.

Based on the previous tests, the regression model with fixed effects seems to be the most appropriate alternative. The estimate of the regression coefficientsis presented in the following table.

Table 7

Estimation of regression coefficients

Fixed -effects 16 cross-sectional units Time-series length = 4 Dependent variable: X1DEAScore Robust (HAC) standard errors				
	Coefficient	**Std. error**	**t-ratio**	**p-value**
Constant	**4,77103**	**2,39187**	**1,995**	**0,0646***
YGreyeconomy	**-0,288121**	**0,155632**	**-1,851**	**0,0839***

Mean dependent var	**0,342964**		**S.D. dependent var**	**0,404174**
Sum squared resid	4,604792		S.E. of regression	0,313008
LSDV R-squared	0,552561		Within R-squared	0,191281
Log-likelihood	−6,594927		Akaike criterion	47,18985
Schwarz criterion	83,89087		Hannan-Quinn	61,64824
rho	0,058040		Durbin-Watson	1,298309

Source: own processing based on Gretl output.

Based on the results of the panel regression with fixed effects, we can also confirm the reverse relationship, that the size of the shadow economy reduces the efficiency of tax collection, although at a lower conficence interval.

4. Conclusions

Based on the results achieved, it can be concluded that size of the shadow economy is influenced by the *efficiency of tax collection*in the surveyed representative sample of countries during the period under review and, by its impact, *negatively affects the size of the shadow economy.*

In addition to this factor. the size of the shadow economy is influenced by explanatory variable GDP per capita that reduces the shadow economy and the unemployment that causes an increase in the shadow economy. All the variables included in the model are statistically significant. In addition to the factors influencing the size of the shadow economy, *there are other* impacts such as the credibility of the tax administrator, the tax morale of tax subjects, the political situation in a country, and the use of tax revenue by the government to finance public goods (even though the tax is considered to be a non-equivalent payment).

The effectiveness of tax collection depends not only on the amount of tax payments but also on the costs associated with the performance of the tax administration. To quantify this parameter, we used the *DEA method*, which is currently very useful for evaluating efficiency not only in the area of public finances but also for evaluating the efficiency of production processes and various other activities in the private sphere.[4]

At the same time, we combined two basic approaches to measuring the effectiveness of tax collection – a measuring of effective tax collection with an emphasis on direct administrative costs (tax administrator) as well as an measuring of effective tax collection with an emphasis on indirect administrative costs for taxpayers. The crossover of both approaches is evident from the choice of input variables for the DEA method.

The selected input and output parameters pointed to the fact that the efficiency of tax collection from both (the taxpayer's and the taxpayer's) points of view can be achieved through the optimal combination of the selected parameters, thus ensuring not only cost efficiency but also the administrative simplicity.

The authors' suggestion was to point out the *important relationship between the issue of tax collection efficiency, tax evasion and the size of the shadow economy*. The regression relationship, when the size of the shadow economy is negatively affected by the efficiency of tax collection, can also be reversed. Consequently, the efficiency of tax collection is negatively influenced by the size of the shadow economy, which we also empirically validated by regression analysis with fixed effects based on panel data.

To bring about the implementation of measures in several areas, e.g. *improving the cooperation of control institutions, occupying the positions of inspectors by qualified staff, increasing tax discipline* (changing the set fines system) would have a demotivating effect on taxpayers' efforts to avoid paying tax. For example, *the introduction of a percentage fine, the amount of which would depend on the amount of the untaxed tax base,* could lead to an increase in tax discipline, in particular for high-taxed taxpayers, who are also expected to generate the highest amount of untaxed income. On a cross-community scale, the fight against corruption also plays a very important role in tax law.

We consider it necessary *to put more emphasis on the behavioural aspects of tax payments.* [11] Although the definition of tax as a non-equivalent payment is apparent from theory, our opinion is that an important factor in deciding on the payment of taxes is the tax entity's awareness of the purpose for which its "means" are used.

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[4]Savić, G., Dragojlović, A., Vujošević, M., Arsić, M. a Martić, M. [18] have used this method for assessing the effectiveness of tax collection in 2012 in Bulgaria, the Czech Republic, Hungary, Serbia, Slovak Republic, Slovenia, Lithuania, Latvia, Finland, Estonia, Ireland, Portugal, and Spain.

It is clear that new opportunities for tax evasion are opening up due to the development of the world economy and the ongoing globalization. By introducing more sophisticated tax administration methods, tax revenue efficiency has generally increased, not only because of increased tax discipline (for example due to high fines or high probability of tax control).

The employment of qualified tax and legal professionals as well as the emphasis on informatisation and targeted tax inspections, for example through the application of the neural network system as it is in the Slovak Republic, are also seen as means of increasing the efficiency of tax collection.

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